City of Lawrence
Douglas County
PLANNING & DEVELOPMENT SERVICES

**Updated:**
**8/23/11 @ 11:30am**
**Added communications from applicant for Item 6 - Text Amendment; Synthetic Turf**

**8/22/11 @ 3:00pm**
**Added plans for Item 5B - Preliminary Development Plan; 1043 Indiana St**
**Added communications and staff response for Item 6 - Text Amendment; Synthetic Turf**
**Added communications for Item 4 - CPA to H2020; Inverness Park District Plan**

**8/16/11 @ 4:45pm**
**The following item was DEFERRED:**
**Item 3 - Rezoning of 4100 W 24th Place**

**LAWRENCE-DOUGLAS COUNTY METROPOLITAN PLANNING COMMISSION**
**CITY HALL, 6 EAST 6TH STREET, CITY COMMISSION MEETING ROOM**
**AGENDA FOR PUBLIC & NON-PUBLIC HEARING ITEMS**
**AUGUST 22 & 24, 2011 6:30 - 10:30 PM**

**GENERAL BUSINESS:**

**PLANNING COMMISSION MINUTES**

Receive and amend or approve the minutes from the Planning Commission meeting of July 25 & 27, 2011.

**COMMITTEE REPORTS**

Receive reports from any committees that met over the past month.

**COMMUNICATIONS**

a) Receive written communications from the public.
b) Receive written communications from staff, Planning Commissioners, or other commissioners.
   - August Mid-Month Meeting Summary
c) Receive written action of any waiver requests/determinations made to the City Engineer.
d) Disclosure of ex parte communications.
e) Declaration of abstentions from specific agenda items by commissioners.

*AGENDA ITEMS MAY BE TAKEN OUT OF ORDER AT THE COMMISSION'S DISCRETION*

**REGULAR AGENDA (AUGUST 22, 2011) MEETING**
**PUBLIC HEARING ITEMS:**

**ITEM NO. 1 RM12D TO RM12; 8 ACRES; SW CORNER OF E 25TH TERRACE & FRANKLIN ROAD (SLD)**

**Z-6-16-11**: Consider a request to rezone approximately 8 acres from RM12D (Multi-Dwelling Residential) to RM12 (Multi-Dwelling Residential), located at 25th Terrace and proposed Ellington Drive. The property is generally located at the SW corner of E 25th Terrace and Franklin Road. Submitted by Johnson Group LLC, for Fairfield Investors LLC, property owner of record.

**ITEM NO. 2 TEXT AMENDMENT TO CITY OF LAWRENCE DEVELOPMENT CODE; CHP 20; DETENTION (SLD)**

**TA-6-9-11**: Consider a Text Amendment to the City of Lawrence Land Development Code, Chapter 20, Article 4, Section 20-403 to allow detention facilities as a use in the GPI (General Public Institutional) District and delete "detention and correction institutions" from the definition of Major Utilities and Services in Article 17. *Initiated by Planning Commission on 3/28/11.*

****DEFERRED****

~~**ITEM NO. 3 RM15 TO RM24; 15 ACRES; 4100 W 24th PLACE (SLD)**~~

~~**Z-8-12-10**: Consider a request to rezone approximately 15 acres from RM15 (Multi-Dwelling Residential) to RM24 (Multi-Dwelling Residential), located at 4100 W. 24th Place. Submitted by BG Consultants, Inc., for Remington Square LC, property owner of record.~~

**NON-PUBLIC HEARING ITEM:**

**ITEM NO. 4 COMPREHENSIVE PLAN AMENDMENT TO H2020 - CHP14; INVERNESS PARK DISTRICT PLAN (DDW)**

**CPA-3-1-11**: Clarify approval of Comprehensive Plan Amendment to Horizon 2020 – Chapter 14 to include the Inverness Park District Plan. (PC Item 8; approved 7-1 on 7/27/11)

**MISCELLANEOUS NEW OR OLD BUSINESS**

Consideration of any other business to come before the Commission.

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**Recess until 6:30pm on August 24, 2011.**

## BEGIN PUBLIC HEARING (AUGUST 24, 2011):

### COMMUNICATIONS

a) Receive written communications from staff, Planning Commissioners, or other commissioners.
b) Disclosure of ex parte communications.
c) Declaration of abstentions from specific agenda items by commissioners.

*AGENDA ITEMS MAY BE TAKEN OUT OF ORDER AT THE COMMISSION'S DISCRETION*

## REGULAR AGENDA (AUGUST 24, 2011) MEETING
## PUBLIC HEARING ITEMS:

### ITEM NO. 5A U-KU TO RM32-PD; .80 ACRES; 1043 INDIANA ST (LBZ)

**Z-7-18-11**: Consider a request to rezone approximately 0.80 acres from U-KU (University-Kansas University) to RM32-PD (Multi-Dwelling Residential-Planned Development), located at 1043 Indiana Street. Submitted by Paul Werner Architects, for Triple T LLC, property owner of record.

### ITEM NO. 5B PRELIMINARY DEVELOPMENT PLAN; .80 ACRES; 1043 INDIANA ST (LBZ)

**PDP-7-1-11**: Consider a Preliminary Development Plan to relocate the Varsity House and development of a Multi-Dwelling Structure, located at 1043 Indiana Street. Submitted by Paul Werner Architects, for Triple T LLC, property owner of record.

### ITEM NO. 6 TEXT AMENDMENT TO CITY OF LAWRENCE DEVELOPMENT CODE; CHP 20; SYNTHETIC TURF AS LANDSCAPING MATERIAL (MKM)

**TA-4-6-11**: Consider Text Amendments to the City of Lawrence Land Development Code, Chapter 20, Articles 10 and 17, regarding synthetic turf as landscaping material. *Initiated by City Commission on 5/3/11. Deferred by Planning Commission on 6/22/11.*

### ITEM NO. 7 COMPREHENSIVE PLAN AMENDMENT TO CHP14; SOUTHEAST AREA PLAN (MJL)

**CPA-10-8-10**: Consider Comprehensive Plan Amendment to Chapter 14 – Southeast Area Plan, to reference and reflect the accepted Preliminary Alignment Study for 31st Street and to update the plan to reflect changes since adoption. Authorize the chair of the Planning Commission to sign Planning Commission Resolution PCR-8-3-11 regarding the amendment to *Horizon* 2020 – Chapter 14-Southeat Area Plan (CPA-10-8-10) updating the Southeast Area Plan, if appropriate.

### MISCELLANEOUS NEW OR OLD BUSINESS

### MISC NO. 1 INITIATE TEXT AMENDMENTS TO CLARIFY DENSITY & DIMENSIONAL STANDARDS (MJL)

Consider initiation of text amendments to the *Land Development Code,* Section 20-601 to clarify the density and dimensional standards and potentially to Section 20-1701 if definitions of terms are determined to be needed.

### PUBLIC COMMENT SECTION

**ADJOURN**

**CALENDAR**

| July | | | | | | 2011 |
|---|---|---|---|---|---|---|
| Sun | Mon | Tue | Wed | Thu | Fri | Sat |
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| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |

| August | | | | | | 2011 |
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| 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| 28 | 29 | 30 | 31 | | | |

| September | | | | | | 2011 |
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| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | |

**PCCM Meeting:** (Generally 2nd Wednesday of each month, 7:30am-9:00am)

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City of Lawrence
Douglas County
PLANNING & DEVELOPMENT SERVICES

**PLANNING COMMISSION MEETING**
**July 25 & 27, 2011**
**Meeting Minutes DRAFT**

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July 25, 2011 – 6:30 p.m.
Commissioners present: Belt, Blaser, Burger, Culver, Finkeldei, Hird, Liese, Singleton, von Achen
Staff present: McCullough, Stogsdill, Day, Larkin, Ewert

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## MINUTES

Receive and amend or approve the minutes from the Planning Commission meeting of June 20 & 22, 2011.

Motioned by Commissioner Singleton, seconded by Commissioner Blaser, to approve the June 20 & 22, 2011 Planning Commission minutes.

Approved 9-0.

## COMMITTEE REPORTS

Receive reports from any committees that met over the past month.

Commissioner Hird apologized that he was not able to attend the Agri-tourism Committee meeting.

## COMMUNICATIONS

Mr. Scott McCullough, Planning Director, reviewed new attachments and communications that were posted to the online Planning Commission agenda after the initial posting date.

Mr. McCullough noted the Oread Overlay District Update Memo that was included in the packet.

## EX PARTE / ABSTENTIONS / DEFERRAL REQUEST

- No ex parte.
- Abstentions:
  Commissioner Finkeldei said he would abstain from item 11 Wednesday evening.

Commissioner Hird presented former Planning Commissioner Stan Rasmussen with a plaque and thanked him for his service on the Planning Commission.

Mr. Stan Rasmussen thanked Planning Commission and staff.

PC Minutes 7/25/11 **DRAFT**

**ITEM NO. 1 CONDITIONAL USE PERMIT; 1271 N 222 RD (SLD)**

**CUP-5-4-11**: Consider a Conditional Use Permit for a commercial greenhouse and nursery to permit accessory retail sales, for an ecological restoration business, located at 1271 N 222 Rd, Baldwin City. Submitted by Landplan Engineering, P.A., for Ronald E. Shouse, property owner of record. *Joint meeting with Baldwin City Planning Commission.*

**STAFF PRESENTATION**

Ms. Sandra Day presented the item. She stated Baldwin City Planning Commission was not present but that they discussed the item at their regular meeting and did not have any comments.

**APPLICANT PRESENTATION**

Mr. Brian Sturm, Landplan Engineering, was present for questioning.

**PUBLIC HEARING**

No public comment.

**COMMISSION DISCUSSION**

Commissioner Finkeldei inquired about a timeline for the item.

Ms. Day said that seemed to be something the County Commission was moving away from a little bit. She stated the uses were allowed by right, it was just the commercial piece, which was a small element of the overall operation. She said staff did not feel a condition on a timeline was required for the proposed use.

Commissioner Finkeldei said he supported that.

**ACTION TAKEN**

Motioned by Commissioner Finkeldei, seconded by Commissioner Blaser, to approve the Conditional Use Permit for a Retail Nursery located at 1271 N 222 Road.

Unanimously approved 9-0.

PC Minutes 7/25/11 **DRAFT**

**ITEM NO. 2 A TO IG; ~~69~~ 67 ACRES; 933, 939, 943 N 1800 RD (SLD)**

**Z-3-8-11**: Consider a request to rezone approximately ~~69~~ 67 acres from A (Agricultural) to IG (General Industrial), located at 933, 939, & 943 N 1800 Rd. Submitted by Steven Rothwell, Timothy W. and Lani S. Rothwell, for Timothy Rothwell, Wilber C. Rothwell, and Donald Kenna Rothwell, property owners of record. (This is a reconsideration of this request due to an error in notice of the original consideration on May 25, 2011.)

**STAFF PRESENTATION**

Ms. Sandra Day presented the item.

Commissioner Finkeldei recused himself from the item.

**APPLICANT PRESENTATION**

Mr. Matt Todd, attorney representing the applicant, thanked staff for the presentation. He said the annexation determination had not been made yet by the County Commission and that the rezoning was contingent upon annexation into the city.

Mr. McCullough said this was an applicant driven request and that the annexation was pending before County Commission. He said in terms of time it appeared everyone was placed on notice for the hearing tonight. He stated Planning Commission would make a recommendation. He said staff's recommendation was to hear the item so as not to waste this time, unless the applicant wanted to defer it.

Commissioner Hird said it was his inclination to proceed with the item since there were people present this evening to speak about it.

Mr. Todd said the primary concern raised by one of the neighboring land owners was the notice requirement. He said there was another individual who was concerned about the IG zoning district. He said in May the Rothwell's sent an informal notice to the neighbors (he displayed it on the overhead). He said the Rothwell's did not hear any direct complaints or objections from the neighbors. He said the basis and justification for the industrial use of the property was to support the amenities the community wants with a strong tax base. He said industrial zoning was consistent with Horizon 2020 and the Sector Plan for the area.

**PUBLIC HEARING**

Ms. Gwen Klingenberg, Lawrence Association of Neighborhoods, discussed the incompatibility with residential. She said the IL zoning allowed 21 or more uses, which would invite more businesses. She stated IG zoning only had three more uses. She noted that zoning could be conditioned. She said Lawrence had more vacant industrial sites available than when discussing the 155 acres. She said that IL or IBP zoning would be a compromise for the neighbors.

Mr. Ronald Schneider, attorney representing Scenic Riverway Community Association, opposed the IG rezoning. He discussed the issue of jurisdiction and felt they should not accept a rezoning application until the property was annexed. He asked them to delay action on the rezoning until there was a formal annexation. He urged them to look at the Golden Issues and did not believe this met them. He stated the proposed IG use was unreasonable and would cause harm to the neighborhood would be excessive. He said there were alternatives, such as IBP or IL zoning. He said he did not disagree that the master plan calls for industrial use. He expressed concern about property values. He said regarding the letter that Mr. Todd mentioned the Rothwell's mailed to

neighbors, it said there would be no change in use and advises that the property owner was proceeding with annexation. He said the rezoning request was contrary to the letter. He said the probability for such uses that were only permitted in IG, such as heavy industrial and explosive use, was really not a foreseeable use or consequential activity on the land in question. He said it made no sense to proceed with IG zoning. He said it was unreasonable to believe that a high tech industry or science activity would want the type of activity that IG permits. He felt they should consider alternative zonings such as IBP and IL.

Ms. Beth Johnson, Lawrence Chamber of Commerce, said the Chamber receives requests every year for various needs in the industrial categories. She said when they first receive inquiries there is usually not enough information to say what the use will be classified as in the Development Code. She discussed competition and said IG zoning made the most sense because it was the most flexible. She said IL zoning allowed retail and commercial uses and Business Parks typically don't want retail or commercial due to the high volume of traffic it brings into the park. She said she was in favor of IG zoning.

Ms. Marguerite Ermeling said everybody would love to expand the tax base in Lawrence. She said when she hears the greatest flexibility happens in IG, she does not see that when she looks at the chart. She said the greatest flexibility comes with all the potential possibilities working in IL. She said she did not understand the discussion on that if indeed those kinds of industries weren't particularly within the framework of what people thought needed to be there. She said if any of the potential jobs they were looking for could fit into any other level of industrial then she did not understand the claim that the best possible use was IG for the land. She asked that they consider a different industrial zoning other than IG.

Mr. Don Rothwell said the community needed to create jobs and provide more tax base. He stated the I-70 corridor was the only spot left for IG. He said there was a lot of vacant retail space in town. He said a good industrial base would stay forever and that this would help the community more than it would hurt it.

**COMMISSION DISCUSSION**

Commissioner Liese inquired about jurisdiction.

Mr. Randy Larkin said the Planning Commission did not have the authority to make a final decision but they could make a recommendation to City Commission. He said City Commission could not make a final decision on the rezoning until the land was annexed.

Commissioner Liese asked if Mr. Schneider was the attorney for the neighbors or the Scenic Riverway Association.

Mr. Schneider said he was the attorney for the association and also individuals.

Commissioner Liese inquired about the uses allowed in the IL and IG districts.

Ms. Day said some of the tables were included in the packet. She said flexibility was a matter of perspective. She said staff felt it was very easy to subvert the IL for retail uses and lose the opportunity for industrial land. She stated IG was specific to industrial uses. It had fewer uses allowed but was more direct in its intent for industrial, manufacturing, or warehousing activity.

Commissioner Liese asked what a gateway treatment would be.

Mr. McCullough said it would include some sort of treatment, probably a private/public partnership, as development occurred where some amount of area would be reserved for signs or participation from the private sector in whatever land uses could accommodate tourism in that area.

Commissioner Belt asked if he was referring to a first impression of Lawrence.

Mr. McCullough said the Comprehensive Plan designates certain corridors as primary corridors into the city of Lawrence. He said Farmers Turnpike was an arterial road that was one of those corridors and the interchange off I-70 serves Lawrence and Lecompton. He said the idea was to get recognition that you're entering a place, whether that's historic Lecompton or Lawrence.

Commissioner von Achen inquired about the conditions on the recent rezoning of 155 acres.

Ms. Day said the three conditions were initiated and self restricted by the applicant. She said explosive storage and slaughtering were two of them but she could not remember the third.

Commissioner von Achen asked if there was any appropriateness for the same restrictions on this property.

Ms. Day said staff had not proposed that as a recommendation but that Planning Commission could carry that forward. She said staff would recommend looking at the uses by category instead of individual use.

Commissioner von Achen inquired about the 100+ year old barn on the property and if there was any architectural or historical significance to it.

Ms. Day said that was not known. She said she had a brief conversation with the applicant about taking photographs and documenting it. She said she also spoke with Lynne Braddock Zollner, Historic Resources Administrator, and that it was not a listed structure at this point in time so there were very little details about it. She said they found out how old it was through appraisal records.

Commissioner Liese asked Mr. Schneider why the neighbors were not present tonight.

Mr. Schneider said he did not learn about this until last week and that a number of people did not know about it. He said there was a certain sense of apathy in testifying and that their statements have fallen on deaf ears. He also said he confirmed with some that he would be present on their behalf.

Commissioner Liese asked if IL zoning would be preferred by the Scenic Riverway Association.

Mr. Schneider said the majority of neighbors indicated that IL was acceptable. He said IG was clearly designated as incompatible with residential but that IL and IBP were not incompatible with residential.

Commissioner Singleton said with the Sector Plan it was thoroughly explored where IG would be. She said with the approval of the Sector Plan it was determined to be an appropriate location of IG. She said she would support the rezoning.

**ACTION TAKEN**
Motioned by Commissioner Singleton, seconded by Commissioner Blaser, to approve the rezoning request for 67 acres from County A (Agricultural) District to City IG (General Industrial) District and

forwarding it to the City Commission with a recommendation for approval based on the findings of fact found in the body of the staff report.

Commissioner Belt felt there was still room for compromise. He said he would not feel comfortable asking the applicant to adhere to conditions but rather have the applicant reconsider IL or IBP.

Commissioner Blaser said he would vote in favor of the motion. He said they needed IG and it gave the city the best chance of landing a larger firm. He thought it was the best place in Lawrence for IG because of its location. He said heavy industry concerns, such as vibrations and toxic fumes, were regulated by federal standards. He also said that heavy industry would not want to be close to neighbors so they would probably choose the 155 acres.

Commissioner Burger said she would vote in favor of the rezoning. She thanked the Scenic Riverway Association for being represented tonight. She said this was within the K-10 & Farmers Turnpike plan. She felt they needed a certain amount of IG with the same kind of credentials to give competition to the marketplace and keep projects moving along.

Commissioner Hird said this was a difficult decision in May and it was still a difficult decision because nobody wants to offend neighbors. He said he did not hear anything different this evening than what was heard in May and he voted for it in May. He said the jurisdiction issue gave him pause but based on what Mr. Larkin indicated it did not trouble him as much. He said IG was called for in Farmers Turnpike Plan so he would support the motion.

Commissioner Liese said it was a more difficult decision now than in May because he was a more experienced Commissioner and it bothers him when neighbors stand up and say it would hurt them. He said the requested rezoning was consistent with Horizon 2020 and the K-10 & Farmers Turnpike Plan. He said the unknowns were difficult because they didn't know if a good business would move there. He said he believed Lecompton would benefit most from jobs that would come with general industrial. He said he would vote in favor of the rezoning.

Commissioner Burger said there were residential properties around Hallmark and Del Monte and they had greenspace, setbacks, and back-to-back treatments. She said transitions were possible with the planning process.

> Motion carried 7-1-1, with Commissioner Belt voting in opposition and Commissioner Finkeldei abstaining.

PC Minutes 7/25/11 **DRAFT**

**ITEM NO. 3 TEXT AMENDMENT TO CITY OF LAWRENCE DEVELOPMENT CODE & DOUGLAS COUNTY CODE; MINOR & MAJOR SUBDIVISIONS (SMS)**

**TA-3-3-10**: Consider Text Amendments to the joint city/county subdivision regulations in the City of Lawrence Land Development Code, Chapter 20, Article 8 and the Douglas County Code, Chapter 11, Article 1 to revise process requirements for division of property through Certificates of Survey, Minor Subdivisions and Major Subdivisions. Modifications include reformatting this article/chapter to eliminate duplicative text and to delete terminology not used. *Initiated by City Commission on 2/16/10. Re-initiated by Planning Commission on 5/23/11.*

**STAFF PRESENTATION**

Ms. Sheila Stogsdill presented the item and provided an overview of the proposed amendments to each of the articles. She indicated several sections were still "under construction" and were highlighted in grey.

Commissioner von Achen asked what they should look at and if there was a certain way to approach all of the information.

Ms. Stogsdill said the memo outlined what the changes were. She suggested looking at the margin notes for specific issues. She also said that any of the Planning Commissioners were welcome to call her and schedule one on one time to go over the document.

**PUBLIC HEARING**

Mr. Dean Grob, Grob Engineering, said he submitted some ideas for staff to consider specifically related to the Certificate of Survey process.

Commissioner Finkeldei asked how he felt the process was going.

Mr. Grob said it was going well.

**COMMISSION DISCUSSION**

Commissioner Finkeldei asked staff if there would be lots of changes and wondered if they should wait till the next draft to dig into the details.

Ms. Stogsdill said the majority of changes would be in the sections highlighted in grey. She said there were very good comments from the meeting in June with design consultants and that multiple people said they appreciated the change that permits dedications with the minor subdivisions. She stated they liked the idea of not doing the dedications at the preliminary plat stage. She said she had a positive response on eliminating the parks dedication and fee. She said generally there had been positive comments. She said she was not expecting a lot of changes and that section 20-804 through 20-807 would contain the most changes.

**NO ACTION TAKEN**

PC Minutes 7/25/11 **DRAFT**

**ITEM NO. 4 TEXT AMENDMENT TO CITY OF LAWRENCE DEVELOPMENT CODE; CHP 20; DETENTION (SLD)**

**TA-6-9-11**: Consider a Text Amendment to the City of Lawrence Land Development Code, Chapter 20, Article 4, Section 20-403 to change "Detention" from a use permitted by right in the GPI (General Public Institutional) District to one permitted with Special Use approval and to delete "detention and correction institutions" from the definition of Major Utilities and Services in Article 17. *Initiated by Planning Commission on 3/28/11.*

*Item 4 was deferred prior to the meeting.*

PC Minutes 7/25/11 **DRAFT**

**ITEM NO. 5 COMPREHENSIVE PLAN AMENDMENT TO CHP14; SOUTHEAST AREA PLAN (MJL)**

**CPA-10-8-10**: Consider Comprehensive Plan Amendment to Chapter 14 – Southeast Area Plan, to reference and reflect the accepted Preliminary Alignment Study for 31st Street.

*Item 5 was deferred prior to the meeting.*

PC Minutes 7/25/11 **DRAFT**

**MISCELLANEOUS NEW OR OLD BUSINESS**

**MISC NO. 1 AUTHORIZE CHAIR TO SIGN RESOLUTION PCR-6-1-11 (LBZ)**

Authorize the Chair to sign PCR-6-1-11, A Resolution adopting amendments to Horizon 2020, The Comprehensive Plan for the City of Lawrence and Unincorporated Douglas County, Kansas pertaining to Chapter 11 – Historic Resources.

Motioned by Commissioner Singleton, seconded by Commissioner Belt, to authorize the Chair to sign PCR-6-1-11, a Resolution adopting amendments to Horizon 2020, the Comprehensive Plan for the City of Lawrence and Unincorporated Douglas County, Kansas pertaining to Chapter 11 – Historic Resources.

Unanimously approved 9-0.

Consideration of any other business to come before the Commission.

Commissioner Liese reminded them about their Mid-Month meeting where they would discuss process further.

Mr. McCullough asked the Commission to think about possible Mid-Month meeting topics for the rest of the year.

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**Recess at 8:37pm until 6:30pm on July 27, 2011.**

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Reconvene July 27, 2011 – 6:30 p.m.

Commissioners present: Belt, Burger, Culver, Finkeldei, Hird, Liese, Singleton, von Achen
Staff present: McCullough, Stogsdill, Day, Larkin, M. Miller, Warner, Ewert

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**BEGIN PUBLIC HEARING (JULY 27, 2011):**

**COMMUNICATIONS**
Mr. McCullough said Ms. Jamie Hulse sent the Planning Commissioners an email after the communications deadline.

Commissioner Liese said the Commissioners also received emails from Mr. Brad Remington, Mr. Scott Meyers, Ms. LeAnn Cooper, and Mr. William Flores.

**EX PARTE / ABSTENTIONS / DEFERRAL REQUEST**

- No ex parte.
- No abstentions.

PC Minutes 7/27/11 **DRAFT**

**ITEM NO. 6 LAWRENCE MUNICIPAL AIRPORT MASTER PLAN**

Receive presentation on draft Lawrence Municipal Airport - Airport Master Plan and provide comment as appropriate.

**STAFF PRESENTATION**

Mr. Scott McCullough said Planning Commission was also the Airport Zoning Board.

Mr. Patrick Taylor, Coffman Associates, presented the Airport Master Plan on the overhead.

**NO ACTION TAKEN**

PC Minutes 7/27/11 **DRAFT**

**ITEM NO. 7 CONDITIONAL USE PERMIT FOR FRATERNAL ORDER OF POLICE SHOOTING RANGE; 768 E 661 DIAGONAL RD (MKM)**

**CUP-12-8-10**: Consider a Conditional Use Permit for the Fraternal Order of Police shooting range, located at 768 E. 661 Diagonal Road. Submitted by Dan Affalter, for Fraternal Order of Police, property owner of record. *Deferred by Planning Commission on 4/25/11.*

*Item 7 was deferred prior to the meeting.*

PC Minutes 7/27/11 **DRAFT**

**ITEM NO. 8 COMPREHENSIVE PLAN AMENDMENT TO H2020 - CHP14; INVERNESS PARK DISTRICT PLAN (DDW)**

**CPA-3-1-11**: Consider Comprehensive Plan Amendment to Horizon 2020 – Chapter 14 to include the Inverness Park District Plan.

**STAFF PRESENTATION**
Mr. Dan Warner presented the item.

**PUBLIC HEARING**
Mr. Matt Gough, attorney from Barber Emerson representing Remington Square and Hy-Vee, recommended adopting the plan as written. He said the existing apartments were 2-story.

**COMMISSION DISCUSSION**
Commissioner Finkeldei said he was intrigued by the League of Women Voters letter regarding the Planned Development (PD) overlay.

Mr. McCullough said the PD amendments that the Planning Commission recommended increasing density was now part of the Development Code. He said if PD was mandated it would give the Planning Commission the authority to look at landscaping, open space, quality, and character issues of the development. He said it was not staffs intent to allow PD that would increase density and he did not believe that was what the applicant was looking for. He said the PD would give the governing bodies a little more control over the design layout and aesthetics. He said if they include PD overlay they would want to put language in there about not giving any more density than what the land use designation was in the plan.

Commissioner Finkeldei thanked staff for their work and felt they were able to solve the most difficult issues. He felt the limitations in the plan would help address the density concerns by the neighbors. He said he liked the commercial on the two corners and was excited for what that might do for the area. He said he would support the plan.

Mr. McCullough said incorporating the PD overlay with the land use designation was a tool or method that had been employed in contentious areas of the city. He said the League of Women Voters proposal was something that staff would accept for this plan as well. He said there were two ways to look at it; RM15 with the current PD code language would allow an increase above the RM15 density; or go to RM24 and note in the plan that the density should not be increased with the PD overlay code standards.

Commissioner Finkeldei asked Mr. Gough to comment on that.

Mr. Gough said Remington Square had not had the opportunity to evaluate a PD overlay as an option to RM24 with limitation for 2-story single bedroom units. He said the PD overlay would not result in the same number of units, it would be a lesser number of units than what the RM24 would be building, exactly what was presently built. He said at this time it was not an option that Remington Square wanted to pursue. He said he did not have an objection to including the PD overlay as an option for those who wished to use it, but at this time Remington Square was more in favor of the originally drafted RM24 single bedroom idea. He said Hy-Vee was not requesting a PD overlay.

**ACTION TAKEN**

Motioned by Commissioner Burger, seconded by Commissioner Singleton, to approve the comprehensive plan amendment (CPA-3-1-11) to *Horizon 2020* by amending Chapter 14 – list of specific plans to add the Inverness Park District Plan description and also approving the plan for the City of Lawrence and unincorporated Douglas County and forwarding the comprehensive plan amendment to the Lawrence City Commission and the Douglas County Board of County Commissioners with a recommendation for approval, revising the staff proposed restriction for Remington Square property that structures be limited to one-story, and instead permit them to be two stories and with the additional requirement that any rezoning requests include a Planned Development (PD) overlay.

Commissioner Finkeldei said he was not sure parcels 4 and 5 should require a PD overlay.

Mr. McCullough said staff would probably agree with that.

Commissioner Burger amended the motion to only include parcels 1, 2, and 3.

Commissioner Singleton seconded the amended motion.

Commissioner Belt wanted to hear a compelling reason to move from RM15 to RM24.

Commissioner Hird asked if switching to RM24, with a limitation noted, would not increase the density, it would simply allow the additional five acres to the east to be built upon.

Mr. McCullough said it would bump up the density from what was there now. He said it maxed out its current density allowed by zoning. He said it had been a sticking point with the neighborhood that they did not want to see that 4-5 acres developed with any more apartments. He said the argument that staff tried to articulate was that the developer chose to develop this portion with a little bit of risk taking that they would gain some other density to get the other portion developed. He said they did not develop to the intensity they could have under RM15. He said staff's recommendation was to allow them to recapture some of that intensity that they did not use when it was originally site planned.

Commissioner Hird said he would probably support the motion. He said the appearance of what fronts onto Clinton Parkway was essential to the community and a PD overlay on those three parcels would be appropriate. He said with regard to Remington Square, since the builder did leave some of the density on the table, he did not have a problem with the land being built out as long as it was consistent with the existing structures.

Commissioner Culver said he would also support the RM24 with PD overlay on the three parcels. He said he supported infill development of that land to match what was currently there.

Commissioner Liese said he would also support the RM24 with PD overlay. He said he wished the neighbors who emailed the Commission had been present this evening because he wanted them to understand what decision was made and how much thought went into trying to address everyone's concerns.

Motion carried 7-1, with Commissioner Belt voting in opposition.

PC Minutes 7/27/11 **DRAFT**

**ITEM NO. 9 TEXT AMENDMENT TO CITY OF LAWRENCE DEVELOPMENT CODE; CHP 20; SYNTHETIC TURF AS LANDSCAPING MATERIAL (MKM)**

**TA-4-6-11**: Consider Text Amendments to the City of Lawrence Land Development Code, Chapter 20, Articles 10 and 17, regarding synthetic turf as landscaping material. *Initiated by City Commission on 5/3/11. Deferred by Planning Commission on 6/22/11.*

*Item 9 was deferred prior to the meeting.*

PC Minutes 7/27/11 **DRAFT**

**ITEM NO. 10 AGRI-TOURISM COMMITTEE RECOMMENDATIONS (MKM)**

Receive Agri-Tourism Committee report and recommendations. Initiate code amendments for future public hearing.

**STAFF PRESENTATION**

Ms. Mary Miller presented the item.

**PUBLIC HEARING**

No public comment.

**COMMISSION DISCUSSION**

Commissioner Burger asked if this would open the door for something like the Wakarusa Festival.

Ms. Miller said a Special Event Permit might allow something like the Wakarusa Festival but that it would be so large that it would go to County Commission for approval.

Commissioner von Achen inquired about road dust abatement for smaller venues and felt it was a burden on land owners to pay for that.

Ms. Miller said dust abatement was an ongoing issue. She said the committee asked the Townships if they had received complaints about dust during the yearly Farm Tour that attracts hundreds of people and they had not. She said in the past they approved a dust abatement measure for a reception facility where the farmer was going to spray water on the road.

Commissioner von Achen asked if dust abatement was to protect the tourists or the neighbors.

Ms. Miller said it was typically used to protect land owners who live on the route but a dusty road could also be an issue for vehicles.

Commissioner Hird said one of the recommendations by the committee was that the county governments be involved in funding dust abatement programs because agritourism was an economic stimulus to the economy and region. He said the influx of tourists and commercial activity justifies the county government spending some money on dust abatement.

**ACTION TAKEN**

Motioned by Commissioner Liese, seconded by Commissioner Culver, to:

1) Initiate a text amendment to the Zoning Regulations for the Unincorporated Territory of Douglas County to establish a Special Event Permit and develop application process and standards.
2) Initiate a text amendment to the Zoning Regulations for the Unincorporated Territory of Douglas County to establish Agritourism as a use. This would include defining the different levels of agritourism, establishing standards for each level, establishing signage regulations, and establishing a registration and approval processes for each level.

Unanimously approved 9-0.

**PUBLIC COMMENT SECTION**

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**ADJOURN 7:40pm**

# 2011
# LAWRENCE-DOUGLAS COUNTY METROPOLITAN PLANNING COMMISSION
# MID-MONTH & REGULAR MEETING DATES

| **Mid-Month Meetings, Wednesdays 7:30 – 9:00 AM** | **Mid-Month Topics** | | **Planning Commission Meetings 6:30 PM, Mon & Wed** | |
|---|---|---|---|---|
| Jan 12 | Housing Trends | Future Topics | Jan 24 | Jan 26 |
| Feb 9 | Complete Streets | | --- | Feb 23 |
| Mar 16 **- 8AM start** | Historic Preservation & H2020 – Chapter 11 Update | | Mar 28 | Mar 30 |
| ~~Apr 13~~ | *Canceled* | | Apr 25 | Apr 27 |
| May 11 **- 8AM start** | APA Conference follow-up | | May 23 | May 25 |
| ~~Jun 8~~ | *Canceled* | | Jun 20 | Jun 22 |
| Jul 15 ***Fri*** | *PC Training – all day Friday* | | Jul 25 | Jul 27 |
| Aug 10 | Continue 'How Meetings Are Run' Discussion from Orientation<br>Schedule remainder of 2011 Topics | | Aug 22 | Aug 24 |
| Sep 14 | Overlay Districts & Conditional Zoning | PC– General Process Questions | Sep 26 | Sep 28 |
| Oct 12 | Density Exercise | | Oct 24 | Oct 26 |
| Nov 2 | | | Nov 14 | Nov 16 |
| Nov 30 | | | Dec 12 | Dec 14 |

| | |
|---|---|
| | **Suggested topics for future meetings:**<br>*How City/County Depts interact on planning issues*<br>*Stormwater Stds Update – Stream Setbacks*<br>*Overview of different Advisory Groups – potential overlap on planning issues*<br>*Open Space Acquisition/Funding Mechanisms (examples from other states)*<br>*TDRs*<br>*Library Expansion Update*<br>*Joint meeting with other Cities' Planning Commissions*<br>*Joint meeting with other Cities and Townships – UGA potential revisions*<br>*Presentation from KC-metro Planning Directors*<br>*Tour City/County Facilities*<br>*2010 Census Data* |
| **Meeting Locations** | The Planning Commission meetings are held in the City Commission meeting room on the 1st floor of City Hall, 6th & Massachusetts Streets, unless otherwise noticed. |

**Planning & Development Services | Lawrence-Douglas County Planning Division | 785-832-3150 | www.lawrenceks.org/pds**

Revised 8/16/11

# Memorandum
# City of Lawrence
# Douglas County
# Planning & Development Services

**TO:** **Planning Commission**
**FROM:** **Sheila M. Stogsdill, Assistant Director**

**CC:** **Scott McCullough**

**Date:** **August 15, 2011**

**RE:** **08/10/11 Mid-Month Meeting Summary**

At the August 10th Planning Commission Mid-Month Meeting, the six commissioners in attendance discussed meeting procedures and various questions raised by commissioners regarding the planning process. Staff provided the attached excerpts from the PC By-Laws which outline the Conduct of Meetings as well as the PC Rules of Procedure. Staff also provided a copy of the Topeka PC Agenda which includes a 'welcome statement', a list of the hearing procedures, and rosters of both Planning Commission and Planning Staff members. Generally, the commission members agreed that the meeting procedures outlined were working but suggested staff review the by-laws for potential revisions. Commissioners also liked the handout from Topeka and suggested staff look for ways to include similar information at our meetings.

The remainder of the meeting involved discussion of multiple questions raised by commissioners including:

- What do we do with various types of feedback from Commissions when projects/amendments/etc bounce back?

- Deferrals – when are they appropriate?
  - Staff explained procedure outlined in by-laws. If request made prior to staff report packet being posted, agenda can be marked to provide notice of deferral. If request is after packet posting, PC must act on request – weigh the reasons provided and hardship to applicant. Factors could include number of other agenda items.

- Meeting time limits – when should meetings end?
  - Discussion of due process for those who have waited vs. ability to make quality decisions late in evening. Comments suggested that holding most commissioner questions until after public comments may result in more efficient meetings.

- Where do Sector Plans fit into Horizon 2020?
    - Sector Plans provide a more detailed look at a particular part of the community and identify more specific future land use recommendations. If the Sector Plan process results in a proposed conflict with Horizon 2020, one of the implementation steps is to initiate amendments to the comprehensive plan to address that issue.
    - This is a topic that was identified as one to be discussed in more detail at a future mid-month meeting.

- Should the market or economics be factors in Planning Commission's decision-making process? Should there be consideration of community-wide need?
    - Staff discussed comp plan and development code requirement for Retail Market Study when development may exceed 50,000 sf of retail commercial uses. This provides the commission with additional information to evaluate the potential impacts on downtown and the community as a whole. The comp plan and development code do not include policies requiring similar impact studies for other land uses.

- How should the Commission weigh a pending plan when reviewing a project?
    - A pending plan recommended for approval by the PC should be considered when reviewing current development applications. The recommendation on the project would be made based on the assumption that it is consistent with the recommended plan.

- Order of the agenda – how is it determined?
    - Staff discussed the various factors that are considered when determining when items are placed on the agenda – trying to have requests that involve similar parts of the community on the same night; balancing staff time; typically placing items with significant public involvement early on agendas; etc. Staff also consults with the Chair when necessary.

- One of the significant points that came out of the morning's discussion was the need to keep in mind that the Planning Commission has a limited role – making recommendations on whether a proposal is an appropriate land use in a specific location. The Governing Bodies may consider additional factors, such as economics, tax base, and community-wide impacts. The Governing Body often receives recommendations from several advisory boards, such as the Traffic Safety Commission, Public Incentives Review Board, etc – Planning Commission makes recommendations regarding appropriate land use and zoning.

Future Topics to consider for Mid-Month Meetings:

- Overlay Districts – what they do and how they relate to development issues
- KDOT presentation on the 5-County Study
- Conditional Zoning – how it works and when to use it
- Presentation on Utilities Master Plan (when complete)
- Meet with representatives of many of the other development related advisory boards

# Hearing Procedures

***Welcome!*** Your attendance and participation in tonight's hearing is important and ensures a comprehensive scope of review. Each item appearing on the agenda will be considered by the City of Topeka Planning Commission in the following manner:

1. The Topeka Planning Staff will introduce each agenda item and present the staff report and recommendation. Commission members will then have an opportunity to ask questions of staff.

2. Chairperson will call for a presentation by the applicant followed by questions from the Commission.

3. Chairperson will then call for public comments.

   Each speaker must come to the podium and state his/her name. At the conclusion of each speaker's comments, the Commission will have the opportunity to ask questions.

4. The applicant will be given an opportunity to respond to the public comments.

5. Chairperson will close the public hearing at which time no further public comments will be received, unless Planning Commission members have specific questions about evidence already presented. Commission members will then discuss the proposal.

6. Chairperson will then call for a motion on the item, which may be cast in the affirmative or negative. Upon a second to the motion, the Chairperson will call for a role call vote. Commission members will vote yes, no or abstain.

Each item appearing on the agenda represents a potential change in the manner in which land may be used or developed. Significant to this process is public comment. Your cooperation and attention to the above noted hearing procedure will ensure an orderly meeting and afford an opportunity for all to participate. Please Be Respectful! Each person's testimony is important regardless of his or her position. ***All questions and comments shall be directed to the Chairperson from the podium and not to the applicant, staff or audience.***

**Members of the Topeka Planning Commission**

Richard Beardmore
Kevin Beck
June Ewing
John Federico
Peter Hancock
Brett Klausman
Mike Lackey, Chairman
Lee Williams, Vice-Chairman
Dawn Wright

**Topeka Planning Staff**

David F. Thurbon, AICP, Planning Director
Bill Fiander, AICP, Deputy Planning Director
Carlton O. Scroggins, AICP, Planner III
Bill Hoover, AICP, Planner III
Tim Paris, Planner II
Dean W. Diediker, Planner II
Annie Driver, AICP, Planner II
Cylus Scarbrough, AICP, Planner I
Gaylene Epke, Zoning Inspector V
Loreena Munoz, Office Specialist

# TOPEKA PLANNING COMMISSION

# AGENDA

## Monday, July 18, 2011
## 6:00 P.M.

## 214 East 8th Street
## City Council Chambers, 2nd Floor
## Municipal Building
## Topeka, Kansas 66603

***Persons addressing the Planning Commission will be limited to four minutes of public address on a particular agenda item. Debate, questions/answer dialogue or discussion between Planning Commission members will not be counted towards the four minute time limitation. The Commission by affirmative vote of at least five members may extend the limitation an additional two minutes. The time limitation does not apply to the applicant's initial presentation.***

Items on this agenda will be forwarded to the City Council for final consideration. The progress of the cases can be tracked at: http://www.topeka.org/planning/staff_assignment/tracker.pdf

All information forwarded to the City Council can be accessed via the internet on Thursday prior to the City Council meeting at: http://public.agenda.topeka.org/meetings.aspx

**ADA Notice: For special accommodations for this event, please contact the Planning Department at 785-368-3728 at least three working days in advance.**

JULY 2011

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AUGUST 2011

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| 28 | 29 | 30 | 31 | | | |

City of Lawrence
Douglas County
PLANNING & DEVELOPMENT SERVICES

# Planning Commission Rules of Procedure

## Non-Public Hearing Items

The Planning Commission has adopted the following Rules of Procedure for all non-public hearing items. Procedure A applies to owner-initiated projects and Procedure B applied to City-initiated projects.

**PROCEDURE A**

RULES OF PROCEDURE FOR OWNER INITIATED NON-PUBLIC HEARING ITEMS

| ORDER OF PROCEEDINGS | SUGGESTED TIME ALLOTMENT |
|---|---|
| 1. Staff introduction of the request, including staff report and recommendation<br>2. Applicant presentation<br>3. Commission questions of staff and applicant<br>4. Commission discussion and deliberation (The Commission may direct questions to any participant at any time in the proceedings.)<br>5. Action | 10 minutes* |

*Related projects are frequently numbered on the agenda as 1A, 1B, etc. In this case, the applicant is allowed 10 minutes for the first project and 5 additional minutes for each additional project.

When public and non-public hearing items are combined, public comment shall be restricted to the public-hearing issue only. Examples include variance requests associated with plats, or rezonings and plats considered simultaneously.

**PROCEDURE B**

RULES OF PROCEDURE FOR NON-PUBLIC HEARING ITEMS INITIATED BY CITY

| ORDER OF PROCEEDINGS | SUGGESTED TIME ALLOTMENT |
|---|---|
| 1. Staff introduction of the request, including staff report and recommendation<br>2. Presentation by owner of subject property<br>3. Commission questions of staff and property owner<br>4. Commission discussion and deliberation *(The Commission may direct questions to any participant at any time in the proceedings.)*<br>5. Action | 10 minutes* |

*Related projects are frequently numbered on the agenda as 1A, 1B, etc. In this case, the applicant is allowed 10 minutes for the first project and 5 additional minutes for each additional project.

When public and non-public hearing items are combined, public comment shall be restricted to the public-hearing issue only. Examples include variance requests associated with plats, or rezonings and plats considered simultaneously.

## Public Hearing Items

The Planning Commission has adopted the following Rules of Procedure for all public hearing items. Procedure A applies to owner-initiated projects and Procedure B applies to City-initiated projects.

**PROCEDURE A**

RULES OF PROCEDURE FOR OWNER INITIATED PUBLIC HEARING ITEMS

| ORDER OF PROCEEDINGS | SUGGESTED TIME ALLOTMENT |
|---|---|
| 1. Staff introduction of the request, including staff report and recommendation | |
| 2. Applicant presentation | 10 minutes* |
| 3. Commission questions for staff or applicant | |
| 4. Public hearing *(All comments / questions should be directed to the Commission. No public comments will be received after the public hearing is closed.)* | 3 minutes per individual** |
| 5. Closing comments from applicant | 10 minutes |
| 6. Closing comments from Staff | 10 minutes |
| 7. Commission discussion and deliberation (The Commission may direct questions to any participant at any time in the proceedings.) | |
| 8. Action | |

*Related projects are frequently numbered on the agenda as 1A, 1B, etc. In this case, the applicant is allowed 10 minutes for the first project and 5 additional minutes for each additional project.

**Individuals representing a group (ex. a neighborhood association) are given 5 minutes. This representation must be stated at the beginning of the speaker's presentation.

When public and non-public hearing items are combined, public comment shall be restricted to the public-hearing issue only. Examples include variance requests associated with plats, or rezonings and plats considered simultaneously.

**PROCEDURE B**

RULES OF PROCEDURE FOR PUBLIC HEARING ITEMS INITIATED BY CITY

| ORDER OF PROCEEDINGS | SUGGESTED TIME ALLOTMENT |
|---|---|
| 1. Staff introduction of the request, including staff report and recommendation | |
| 2. Presentation by owner of subject property | 10 minutes* |
| 3. Commission questions for staff or property owner | |
| 4. Public hearing *(All comments / questions should be directed to the Commission. No public comments will be received after the public hearing is closed.)* | 3 minutes per individual** |
| 5. Closing comments from property owner | 10 minutes |
| 6. Closing comments from Staff | 10 minutes |
| 7. Commission discussion and deliberation *(The Commission may direct questions to any participant at any time in the proceedings.)* | |
| 8. Action | |

*Related projects are frequently numbered on the agenda as 1A, 1B, etc. In this case, the applicant is allowed 10 minutes for the first project and 5 additional minutes for each additional project.

**Individuals representing a group (ex. a neighborhood association) are given 5 minutes. This representation must be stated at the beginning of the speaker's presentation.

When public and non-public hearing items are combined, public comment shall be restricted to the public-hearing issue only. Examples include variance requests associated with plats, or rezonings and plats considered simultaneously.

Policy and regulatory issues follow Procedure B for public hearing items, without step 3. Examples include text amendments and adoption of policy documents.

## ARTICLE V
## Conduct of Meetings

SECTION 1. PARLIAMENTARY AUTHORITY. Meetings shall be conducted according to these by-laws and the Commission's adopted Rules of Procedure. Rules of Procedure can be suspended by a motion that is supported by a second, and a two-thirds majority vote in favor of the motion. Rules of Procedure are an addendum to the By-Laws.

SECTION 2. ORDER OF BUSINESS. The order of business shall be as follows:

The order of business for consideration at the first regularly scheduled monthly meeting shall be as follows:

a) Call to order
b) minutes
c) staff and committee reports
d) communications:
    1. public (written)
    2. planning commissioners or other boards and/or commissions (written or oral)
    3. staff (written or oral)
    4. declaration of intent to abstain on specific agenda items (oral)
    5. requests for deferral
e) election of chairman and vice-chairman [annually at the June meeting]
f) consent agenda items
g) items pulled from consent agenda
h) plats which require public hearing on variance requests
i) public hearing items that are:
    1. associated with non-public hearing items
    2. annexation referral requests
    3. minimum maintenance road requests
    4. City or County special use permits
    5. text amendments to zoning or subdivision regulations
    6. comprehensive plan amendments
j) ex parte communications disclosed for each separate quasi-judicial item (oral).
k) recess public hearing
l) old business [items returned for reconsideration by a governing body] and miscellaneous items

The order of business for consideration at the Wednesday night regular meeting shall be as follows:

a) Call to order
b) communications:
    1. staff (written or oral) response to questions raised by the public or commissioners
    2. declaration of intent to abstain on specific agenda items (oral)
c) reconvene public hearing
d) public hearing items that are:
    1. associated with non-public hearing items
    2. minimum maintenance road requests
    3. City or County special use permits
    4. comprehensive plan amendments

5. text amendments to zoning or subdivision regulations

e) ex parte communications disclosed for each separate quasi-judicial item (oral).
f) committee or commission generated plans or rezonings
g) old business or miscellaneous items
h) close public hearing
i) public comments
j) adjournment

* public and non-public hearing items that are related to a development project shall be placed on the same meeting's agenda in consecutive order under the regular agenda.

Any matter or subject not appearing on the agenda shall be considered under Miscellaneous Items if a majority of the Commission members vote consideration. Approval of consideration shall be based on a finding that a review or presentation would be in the best interest of the general public and not contrary to the provisions of public notice.

SECTION 2A. AGENDA MANAGEMENT BY STAFF. Items on the regular agenda shall be ordered according to Staff's estimation of various factors including: location within community [staff will attempt to schedule items within same area/neighborhood on the same night to accommodate public involvement]; staffing assignments [to minimize individual staff attendance at both meetings]; applicant's ability to attend; and balancing number of items between the two meetings. This shall apply to all Items, regardless of previous deferrals, except according to specific direction from the Planning Commission.

SECTION 2B. ITEMS PULLED FROM CONSENT AGENDA. An item may be removed from the consent agenda after the meeting has been called to order for one of three actions: approval by separate voice vote; clarification of a comment or recommendation in the staff report, when such clarification will take 5 minutes or less; or, for a lengthy discussion [one greater than 5 minutes] of a comment or recommendation in the staff report which involves presentation by the applicant, or numerous questions by the commission.

When an item is pulled only for a separate voice vote, it shall be considered immediately following action taken on the remainder of the consent agenda. An item pulled for clarification shall be considered after scheduled non-public hearing items are considered. An item pulled for lengthy discussion by the applicant shall, at the chairperson's discretion, be placed at the end of the commission agenda, prior to consideration of miscellaneous items OR on the following month's meeting agenda. An item requested to be pulled for lengthy discussion by a planning commissioner shall be placed at the end of the non-public hearing portion of the agenda.

SECTION 2C. DEFERRALS REQUESTED BY THE APPLICANT. Deferral requests that are made while a project is under review [prior to staff report posting on the website] will be noted on a revised agenda as 'Deferred' and staff will attempt to notify members of the public who have expressed interest in the project during the review period, as well as the media. Deferral requests made by the applicant after staff report posting and through the communications deadline shall be considered by the Commission under the Communications portion of the agenda. Such requests will be permitted only in cases in severe hardship or for the purpose of making a significant change to the original application and only with a majority vote of the Commission at the meeting. Such requests must be made in writing and must be submitted to Staff no later than 10:00AM on the day of the meeting.

The Commission has the authority to deny the deferral request on the grounds that such request was not made in a timely fashion, that notice of deferral has not been given to the adjacent property owners, or that the applicant is not seeking deferral in order to make significant changes to the original application.

SECTION 2D. DEFERRALS/TABLING INITIATED BY THE COMMISSION. The Commission may table or defer any item, including after the public hearing has been closed, when it is determined by the Commission that such action would be advantageous to the Commission for responding to issues raised and for gathering adequate information to make a well-informed recommendation.

SECTION 3. STAFF REPORTS. Staff reports on all agenda items shall be prepared and posted to the website five (5) calendar days prior to the day of the first meeting. Members of the public can sign up to receive automatic e-mail notification regarding staff report postings and updates.

SECTION 4A. APPEARANCE BEFORE THE COMMISSION. Petitioners or their representatives, members of the community at large, or individuals or their representatives who feel that they will be affected by any action may appear before the Commission to present views and statements either for or against agenda items. The public may address their comments or concerns to the Commission in person or in writing. Except as otherwise determined by the chair, the following time limits will apply: Applicant - 10 minutes per item up to a maximum of 30 minutes; Members of public representing themselves - 3 minutes (although any member of the public can give 2 minutes of his/her time to another member of the public, such additional time can not cause the total amount of time to exceed 10 minutes); Members of public representing a recognized organization or group of individuals - 5 minutes. The Chairperson may at his/her discretion change the length of presentation or discussion to ensure the orderly conduct of Commission business provided that the decision of the Chairperson may be overridden by a majority vote of those commissioners present.

After a motion to close the public record has been approved on a public hearing item, additional public testimony will not be taken with the exception that a Commissioner, after recognition by the Chairperson, may ask a speaker for clarification on a point raised. Such action shall be noted in the minutes and the returning speaker shall be instructed to reply only to the question raised.

SECTION 4B. INTRODUCTION OF UNREVIEWED INFORMATION. An applicant's written response to the recommendations in the Staff Report will be accepted by planning staff until 2:00PM on the business day prior to the day of the meeting on which the agenda item will appear. The applicant may present new information at a regular meeting under three circumstances:

(a) The information has been reviewed by Staff and Staff is prepared to respond;
(b) The information is in direct response to recommendations in the Staff Report; or
(c) The information is requested by a Commissioner is the course of the regular meeting.

In all other cases in which the applicant wishes to introduce new information, the applicant should make a timely request for deferral of the Item in accordance with Article V, Section 2C. If the Item stays on the agenda, Staff should notify the Commission if any attempt is made to introduce new information not complying with (a), (b) or (c) as described above. In such a

case, the Chair shall bar introduction of the new information and the Commission shall consider the Item without consideration of the new information.

SECTION 4C. WRITTEN COMMENTS FROM THE PUBLIC. Public comments on agenda items for the regularly scheduled monthly meetings will be accepted by planning staff until 10:00 a.m. on the day of the first regularly scheduled monthly meeting. This deadline provides time for correspondence to be posted to the website by the 2:00PM deadline established in Article IV, Section 2.

SECTION 5. COMMISSION ACTION. The Commission shall take action on each item presented at the conclusion of discussion of that item.

SECTION 6. MOTIONS. Motions before the Commission shall be restated by the Chairperson before a vote is taken.

SECTION 7. VOTING. Voting on non-public hearing items and for public hearing items shall be by a show of hands. Each member's vote shall be recorded by the Secretary or his/her designee on the official voting sheet. After a vote is taken the Chairperson or the Secretary shall announce the votes cast in favor of the motion, in opposition to the motion and whether the motion passed or failed.

For non-unanimous votes, the minutes shall note the members voting in favor of a motion, in opposition to a motion, and those abstaining from voting on the motion as well as the vote tally. For example, an 8-1-1 vote would be recorded as Commissioners a ,b ,c ,d ,e ,f ,g ,& h voted in the affirmative, Commissioner x voted in opposition to the motion and Commissioner y abstained from voting.

SECTION 8. ABSTENTION. It is the duty of each member to vote on each issue, but that member may abstain. No member shall vote on an issue in which he or she has a conflict of interest. During an item for which a member has declared an abstention because of a conflict of interest that member shall physically leave the meeting room.

SECTION 9. RECORD OF PROCEEDINGS. The secretary shall record the minutes of each meeting as a matter of public record and shall present such minutes to the Commission for approval.

A written voting log shall be kept for each motion. Included in this log shall be: the commissioner who made the motion; the commissioner seconding the motion; any commissioners abstaining from voting on the motion; the commissioners voting in favor of the motion; and the commissioners voting in opposition to the motion.

Draft minutes will be stamped as DRAFT and will be forwarded to the Commission when the staff report is posted to the website. Revisions may be made to the minutes at any time prior to approval of said minutes at the next regular meeting. Due to timing of the meetings, draft minutes are distributed to the Governing Bodies prior to approval by the Planning Commission.

**PLANNING COMMISSION REPORT**
**Regular Agenda - Public Hearing Item**

PC Staff Report
08/22/2011

**ITEM NO. 1 RM12D to RM12; 8.0 ACRES; 25TH TERRACE AND ELLINGTON DRIVE (SLD)**

**Z-6-16-11**: Consider a request to rezone approximately 8.0 acres from RM12D (Multi-Dwelling Residential) to RM12 (Multi-Dwelling Residential), located at 25th Terrace and proposed Ellington Drive. Submitted by Johnson Group LLC, for Fairfield Investors LLC, property owner of record.

**STAFF RECOMMENDATION:** Staff recommends approval of the request to rezone approximately 8.0 acres, from RM12D (Multi-Dwelling Residential) District to RM12 (Multi-Dwelling Residential) District based on the findings presented in the staff report and forwarding it to the City Commission with a recommendation for approval.

**Reason for Request:** *The current filed plat shows this area as RM12D zoning classification. The subject area would be rezoned to a RM12, allowing for the construction of town homes. A Minor Subdivision may be necessary to adjust lot lines.*

**KEY POINTS**
- There is an approved neighborhood plan for the area.
- This rezoning is an attempt to provide a different land use transition between the industrial and public uses to the east and the low density residential uses to the west.

**ASSOCIATED CASES/OTHER ACTION REQUIRED**
- Possible subdivision changes and site plan dependent upon the housing type to be constructed.

**PLANS AND STUDIES REQURIED**
- *Traffic Study* – Not required for rezoning.
- *Downstream Sanitary Sewer Analysis* – Not required for rezoning – letter provided to staff outlining development intent.
- *Drainage Study* – Not required for rezoning – letter provided to staff outlining development intent.
- *Retail Market Study* – Not applicable to residential request.

**ATTACHMENTS**
1. Area map
2. *Southeast Area Plan* Future Land Use Map 3-1
3. Residential Use Table
4. Dwelling Unit table type
5. Development concept plans provided by applicant.

**PUBLIC COMMENT RECEIVED PRIOR TO PRINTING**
- None to date

**Project Summary:**
This requested rezoning will establish a district boundary that follows the platted lot lines within the eastern portion of the Fairfield Farms East Subdivision. The intent is to provide a more defined land use transition between the Douglas County Jail and developing industrial property east of Franklin Road (extended) and planned low density residential lots to the west by using housing type and building form.

The proposed request is for RM12 zoning. Both the existing RM12D and the proposed RM 12 districts permit medium density development. Both districts have the same density and dimensional standards for setback, lot width, and building height. The maximum development density for both districts is 12 dwelling units per acre. The difference between the two districts is that the RM12 district allows multi-dwelling construction (three or more units) on a single lot while the RM12D district allows duplex (two units) on a single lot but restricts multi-dwelling development. This report will discuss the similarities and differences between attached dwellings, multi-dwellings, duplex and detached housing. This understanding is critical to the consideration of the base zoning district.

*Household Living* is a category of uses within the Residential Use Group found in the Development Code. Duplexes are defined as a single building with two dwelling units on a single platted lot. Multi-dwelling structures are buildings with three or more dwelling units on a single lot. The Development Code does not define a "townhouse" as a Household Living type (20-1734). This use is also not listed in Section 20-403 of the Development Code in the Residential Use Group. The terms townhouse or rowhouse are often used to describe individual ownership of a dwelling unit that is part of a larger building such as a duplex or multi-dwelling structure. The attached table is provided as a reference for the types of housing allowed in the various zoning districts.

## 1. CONFORMANCE WITH THE COMPREHENSIVE PLAN

Applicant's Response: *Proposed and existing zoning is residential neighborhood. This complies with the comprehensive plans for urban growth projects in the subject area.*

This property is located within the boundary of the *Southeast Area Plan*. The plan was amended into *Horizon 2020*, the City's comprehensive land use plan on December 1, 2008. The County Commission initiated a revision to the plan on September 29, 2010 (CPA-10-8-10) to reflect the 31st Street alignment. Additional items were identified for updates. The plan will be considered by the Planning Commission as a separate item. No changes to the medium density residential land use recommendations are proposed in the update.

Intensive land use is planned to be located adjacent to the abutting collector streets using back to back lot arrangements to transition to the lower density residential area. The plan states:

> *"Map 3-1 provides a general concept for the location of recommended land uses in the Southeast Area. It is not intended to provide a scalable map for determining specific land use/zoning boundaries within this area".*

Medium density residential land use is described as 7-15 dwelling units per acre. The plan identified the following areas for medium density residential land use:

- *Area east of O'Connell Road, generally along the following streets: 25th Way, Ralston Street, Windham Street, Ellington Drive, and Dalton Drive.*

- *Area east of O'Connell Road, north of E 28th Street extended, and west of Franklin Road.*

- *Area west of E 1700 Road, north of the Kitsmiller Tributary, and just south of E 28th Street extended.*

- *Area west of E 1750 Road (Noria Road), north of the future alignment of the SLT/K-10 Highway, and east of the tributary green space.*

The proposed RM12 zoning is identified in the plan as a zoning district that could be considered in medium density residential areas. Primary uses in the district include: Attached Dwellings, Cluster Dwellings, Duplex, Multi-Dwelling structures, various group living residential uses, and Community Facilities. A list of allowed uses is included with this report as an attachment – Residential Use Table.

Approval of the request does not modify the base density allowed within the proposed boundary. The housing type however is altered. Approval of the RM12 request will allow development of multi-dwelling (apartments) units.

The area plan recommends in Policy 3.2:

> *"…residential uses maintain a "back to back" relationship to more intense uses". "Medium-density residential development shall take the form of small lot, detached, attached or cluster type housing."*
>
> *"Medium-density residential use is not intended to provide for large scale apartment development."*

The proposed configuration of the zoning boundary does not accommodate a typical apartment complex development. The boundary includes a single row of lots between two platted streets (to be constructed). The overall lot depth within the proposed boundary along with setbacks and screening requirements will result in narrower buildings.

Building facades that face the remaining RM12D should retain a compatible appearance. There are no specific design guidelines or regulations to require a review of this type of detail.

**Staff Finding –** The proposed zoning is consistent with the land use recommendations, with regard to density and location, of the *Southeast Area Plan* and with the comprehensive plan, *Horizon 2020*. The plan addresses building form in that "large scale apartment development" is specifically not recommended. Compliance of this recommendation will require review of the subdivision and zoning regulations at the time a specific development proposal is submitted.

## 2. ZONING AND USE OF NEARBY PROPERTY, INCLUDING OVERLAY ZONING

Current Zoning and Land Use: RM12D (Multi-Dwelling Residential District); undeveloped property.

Surrounding Zoning and Land Use: RM12D (Multi-Dwelling Residential District) to the west and south; undeveloped lots to the west; detention pond to the south.

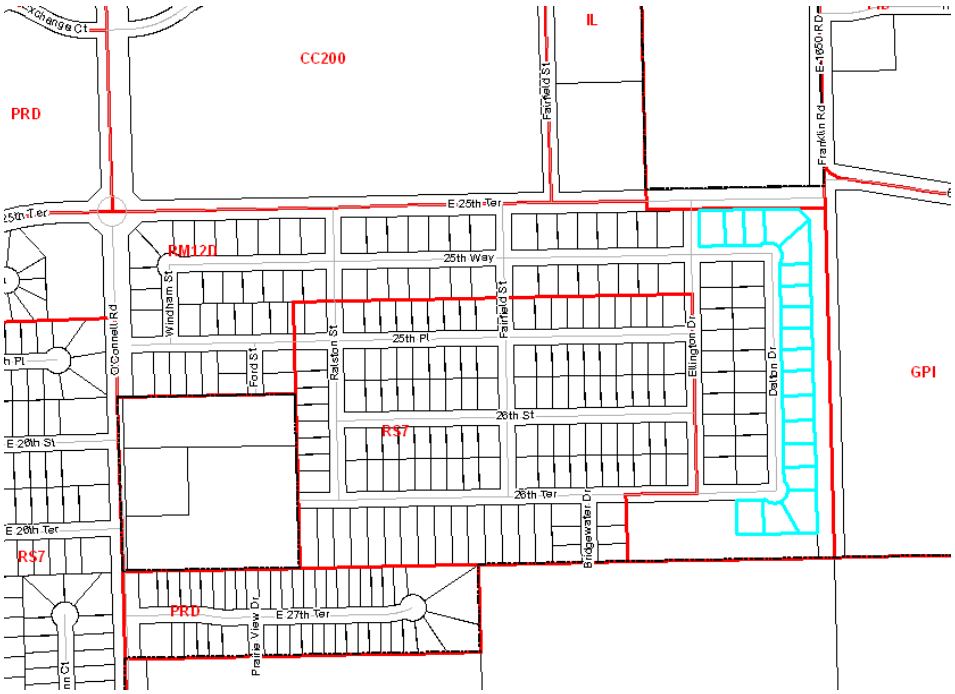
County A (Agricultural) District to the south; O'Connell Youth Ranch.

GPI (General Public and Institutional Use) District east of Franklin Road. Douglas County Jail.

PID [Mt. Blue PID] to the northeast; developing industrial park.

County A (Agricultural) and I-1 (Limited Industrial) Districts north side of E 25th Street; existing rural residence.

IL (Limited Industrial) to the northwest, north side of E 25th Street; developing non-residential area.




**Staff Finding –** This property is surrounded by both residential and non-residential zoning. The area is developing west of Franklin Road with industrial type uses. The area north of E 25th Terrace is planned for retail oriented development. The area to the west and south is planned for residential development.

## 3. CHARACTER OF THE NEIGHBORHOOD

Applicant's Response: *The neighborhood area is all residential bordered by agricultural, industrial and County Jail to the east, Further north there is some commercial property.*

The property is located within the southeast area of Lawrence. This request is located within a developing neighborhood that will include a mix of uses. Residential uses will dominate the area south of E 25th Terrace.

The subdivision provides the framework for the neighborhood pattern providing connectivity and access throughout the area. Lot orientation and zoning district boundaries are key features in establishing land use transition from the intensive activity planned north of E 25th Terrace and the low density residential uses to the south. The area located along E 25th Terrace and O'Connell Road was recently rezoned and preliminarily platted to accommodate a future church location on a single large lot. This proposed request is consistent with anticipated neighborhood development.

**Staff Finding –** The area between O'Connell Road and Franklin Road is a developing neighborhood. E 25th Terrace is established as the boundary between the residential and commercial land uses planned for the area. The proposed request is consistent with developing character of the area.

## 4. PLANS FOR THE AREA OR NEIGHBORHOOD, AS REFLECTED IN ADOPTED AREA AND/OR SECTOR PLANS INCLUDING THE PROPERTY OR ADJOINING PROPERTY

As noted above, this property is within the *Southeast Area Plan* planning boundary. Land uses include low and medium density residential uses south of E 25th Terrace between O'Connell Road and Franklin Road. Land use recommendations found in Section 3.11 of the *Southeast Area Plan* include:

> *"Detached dwellings, attached dwellings, duplex, group homes, public and civic uses"*.

The proposed request is intended to accommodate a type of attached housing referred to as townhouses. By code, attached housing is defined as individual dwelling units (house) on individual lots that share common walls. This request is intended to modify the zoning district boundary to accommodate a different type of housing form. The overall density proposed is consistent with the approved planning documents for the area.

**Staff Finding –** The proposed request is consistent with the density and location land use recommendations included in the *Southeast Area Plan*.

## 5. SUITABILITY OF SUBJECT PROPERTY FOR THE USES TO WHICH IT HAS BEEN RESTRICTED UNDER THE EXISTING ZONING REGULATIONS

Applicant's Response: *The existing zoning classification would only allow for duplex construction, and would not have the flexibility for town homes. This would allow for alternatives, while maintaining residential and allow densities of the existing zoning.*

The purpose of the RM12D "duplex" zoning is to provide a buffer and land use transition between the industrial development east of Franklin Road and the detached residential lots to the west. The current RM12D zoning anticipated only duplexes or one building with two units on each platted lot.

Attached housing is allowed in the RM12D district. Attached housing, each unit on a platted lot would result in massive buildings covering the lots from side yard to side yard across multiple lots. The existing lot configuration would result in substantially larger units inconsistent with the average housing types in the area.

The applicant proposes to construct a housing type referred to as "rowhouse" or "townhouse". These units are typically narrow and may or may not be located on an individual lot. The Development Code response to this type of residential unit is either multi-dwelling (as side by side units, rather than stacked apartments) or attached housing where each unit is located on an individual lot.

The platted lot sizes do not conform to the planned "rowhouse" or "townhouse" development. Existing lots are substantially wide given the proposed building form. Narrower lots, 50' or less, are generally anticipated for attached housing developments. If approved, the current platted lot configuration would allow a mix of two, three, and four units attached on a single lot.

**Development potential (number of units) for RM12D and RM12 as platted**

| LOT | Area (SF) | Width (ft) | acres | Density RM12D | Maximum Density RM12 | Developed RM12 |
|---|---|---|---|---|---|---|
| 21 | 12825 | 95 | 0.2944 | 2 | 3.5 | 3 |
| 20 | 10125 | 75 | 0.2324 | 2 | 2.8 | 2 |
| 19 | 10066 | 75 | 0.2311 | 2 | 2.8 | 2 |
| 18 | 16634 | 56 | 0.3819 | 2 | 4.6 | 4 |
| 17 | 13431 | 67 | 0.3083 | 2 | 3.7 | 3 |
| 16 | 9232 | 80 | 0.2119 | 2 | 2.5 | 2 |
| 15 | 9232 | 80 | 0.2119 | 2 | 2.5 | 2 |
| 14 | 9323 | 80 | 0.2140 | 2 | 2.6 | 2 |
| 13 | 9369 | 80 | 0.2151 | 2 | 2.6 | 2 |
| 12 | 9414 | 80 | 0.2161 | 2 | 2.6 | 2 |
| 11 | 11120 | 94 | 0.2553 | 2 | 3.1 | 3 |
| 10 | 11183 | 94 | 0.2567 | 2 | 3.1 | 3 |
| 9 | 10526 | 88 | 0.2416 | 2 | 2.9 | 2 |
| 8 | 10581 | 88 | 0.2429 | 2 | 2.9 | 2 |
| 7 | 10260 | 91 | 0.2355 | 2 | 2.8 | 2 |
| 6 | 16998 | 50 | 0.3902 | 2 | 4.7 | 4 |
| 5 | 12316 | 63 | 0.2827 | 2 | 3.4 | 3 |
| 4 | 13067 | 101 | 0.3000 | 2 | 3.6 | 3 |
| TOTAL | 205702 | | 4.7223 | 36 | 56.7 | 46 |
| Minimum Density | 6000 | 60 | | 7.6 du/ acre | 12 du/ acre | 9.7 du/ acre |

The approved area plan does not support large scale apartment type housing, though the proposed RM12 district would allows this use. The platted lot configuration limits the development intensity because of the limited block depth. Replatting the property to combine lots or to establish smaller (narrower lots) accommodating attached housing is possible.

As platted, the area could develop with a total of 36 units (in duplex form). This is equal to 7.6 dwelling units per acre. If approved the total number of units built on the 4.7 acres would increase to a maximum of 12 units per acre. The more probable development pattern will result in 9-10 dwelling units per acre. The proposed change would allow more efficient use of the same area with more units without adding land area to be served with municipal services.

The purpose of the RM zoning districts, including both the RM12D and the RM12 district "*is to accommodate multi-Dwelling housing. The districts are intended to create, maintain and promote higher density housing opportunities in areas with good transportation access*." (Section 20-204 of the Development Code) Both the RM12D and the RM12 zoning districts represent a medium density residential development pattern (7 to 15 dwelling units per acre).

Medium density residential zoning districts are frequently used as transition between land uses. The existing RM12D zoning provides only a nominal transition between the industrial and detached residential development separated by a future arterial street. As zoned the housing type is very homogenous with no real mix of housing type, scale or density proposed for the developing neighborhood.

**Staff Finding –**The existing zoning is suitable given the original development plans for the neighborhood and platted configuration with wide lots for duplex development. Both the existing and proposed zoning districts are suitable as transitional land uses. Both the existing and proposed zoning district accommodates medium density residential development. The proposed change accommodates a more efficient use of land with more units in the same area and consistent with the density recommendation for the area.

## 6. LENGTH OF TIME SUBJECT PROPERTY HAS REMAINED VACANT AS ZONED

Applicant's Response: *Approximately 6 years.*

The property is undeveloped but platted for duplex (two units on a single platted lot) development. The property was originally rezoned to RMD (Duplex Residential) District in 2005. The district was converted to RM12D (Multi-Dwelling Residential) District in 2006 with the adoption of the Land Development Code. The designation "D" in the label denotes duplex development and the dominant land use in the district.

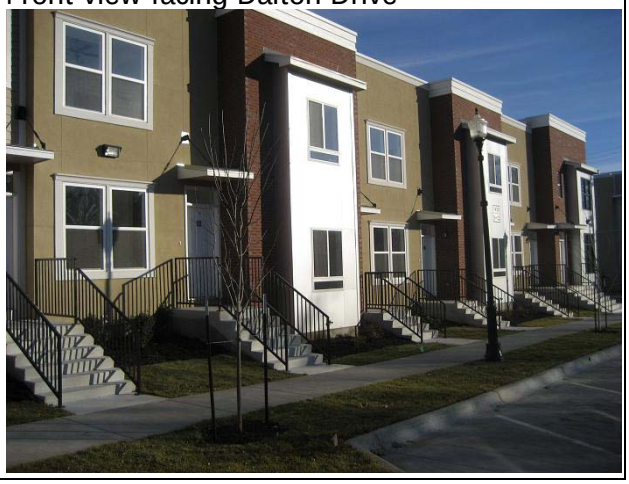
**Staff Finding –** The current zoning of RM12D has been in place since July 2006.

## 7. EXTENT TO WHICH APPROVING THE REZONING WILL DETRIMENTALLY AFFECT NEARBY PROPERTIES

Applicant's Response: *The change will be negligible and will harmonize with adjoining existing properties. The area directly east is the County Jail and this would give a nice transition and variety of town home to duplex to single family as you go east to west.*

Land use plans for the area designate RS5, RS3, RM12, RM12D and RM15, and Planned Development Overlay districts as suitable for medium density residential development. The residential portion of the area is undeveloped south of 25th Street. Industrial/Commercial development is planned north of 25th Street. Industrial and institutional uses exist to the east of the property. The intent of both the existing and the proposed zoning is to provide an adequate land use transition between the more intensive non-residential uses and the planned lower density residential uses to the west.

The conceptual development plan includes three story residential uses with rear entry garages (garages to jail) facing Franklin Road and row house facades facing Dalton Drive (townhouse to duplex)

| Rear view facing Franklin Road | Front view facing Dalton Drive |
|---|---|
| |  |

Approval of the zoning in advance of other lower intensity residential development results in clear expectations for future property owners as the area develops. Provision of appropriate infrastructure accommodates development with adequate public services for water, sewer, and streets.

**Staff Finding –** The existing and planned development pattern including location of streets, lot orientation and planned land uses provide effective transition between uses. The area between Franklin Road and O'Connell Road is undeveloped. No detrimental impacts are anticipated by this application.

**8. THE GAIN, IF ANY, TO THE PUBLIC HEALTH, SAFETY AND WELFARE DUE TO THE DENIAL OF THE APPLICATION, AS COMPARED TO THE HARDSHIP IMPOSED UPON THE LANDOWNER, IF ANY, AS A RESULT OF DENIAL OF THE APPLICATION**

Applicant's Response: *By rezoning the subject property would provide flexibility and alternatives for the construction while still keeping it residential. To leave property as is would result in duplex only, and a less variety of living options.*

Evaluation of this criterion includes weighing the benefits to the public versus the benefit of the owners of the subject property. Benefits are measured based on anticipated impacts of the rezoning request on the public health, safety, and welfare.

The purpose of this request is to facilitate future residential development and to protect or enhance the value of the detached single family lots with appropriate land use transition between residential and non-residential uses. Staff concurs that approval of the request increases housing options in the general area. Approval of the request would accommodate duplex, triplex as well as multi-unit development along the edge of the developing neighborhood. Intensity can be controlled through the subdivision plat process to limit or expand the number of attached units, based on lot size, as the property is replatted.

However, approval of the request does not guarantee development of the site with a particular housing type. Public benefits are not assured by the approval of this proposed request. Denial of the request would result in development of the subdivision with two types of housing options, detached and duplex housing.

**Staff Finding –** Gain to the public is not assured by the approval of this request. However, when considered in conjunction with the conceptual development, approval of the request will result in additional housing options for this area.

## 9. PROFESSIONAL STAFF RECOMMENDATION

The proposed request is consistent with neighborhood development plan recommendations for medium density development. The property abuts an arterial street and provides a land use transition between the industrial and institutional development to the east and the detached residential lots to the west. Approval of the request allows for a different building type and housing options within the neighborhood.

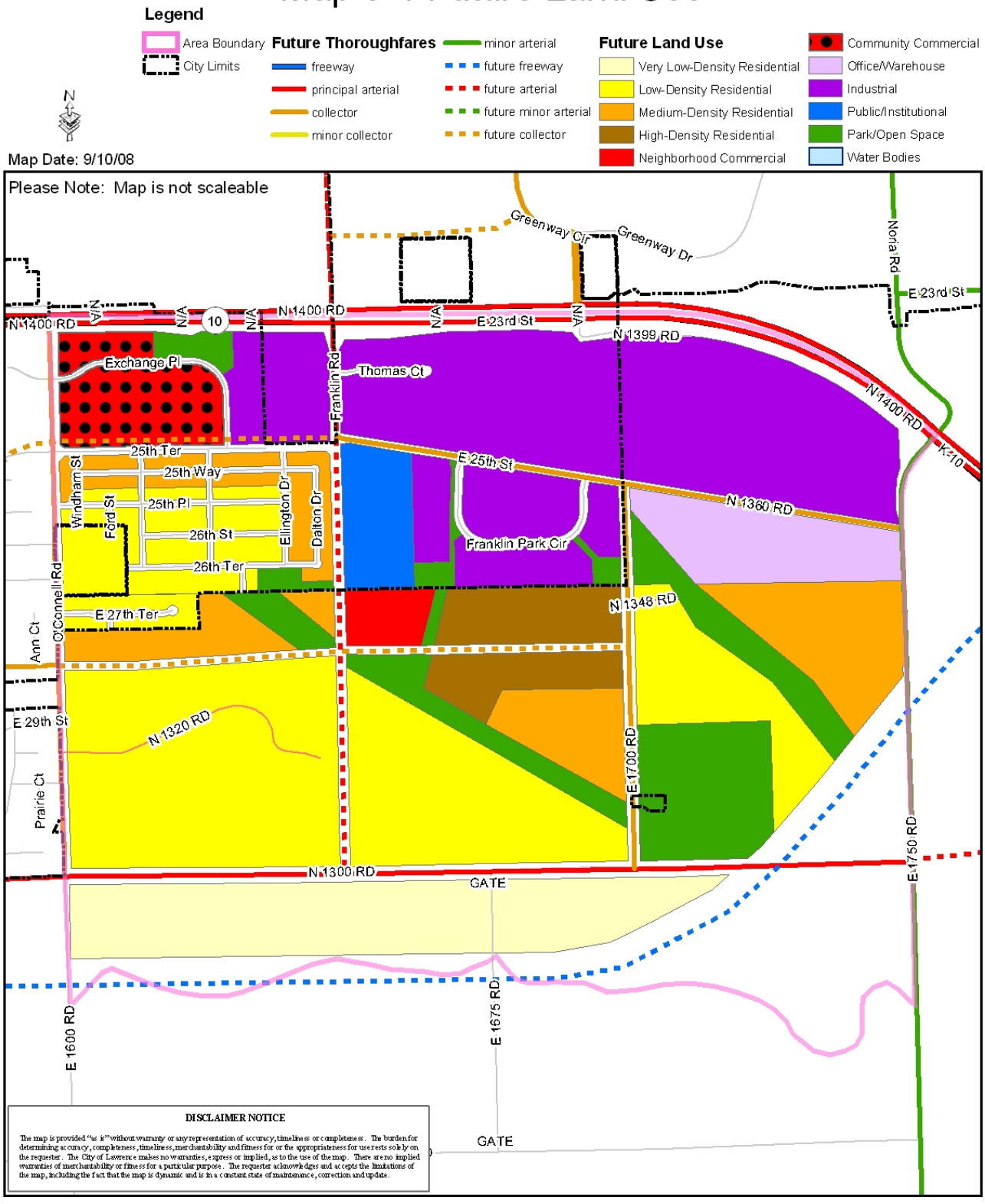
The property was originally subdivided in 2006. Since that time, surrounding development includes the new Tractor Supply Store along Fairfield Street to the north, storage facility along Thomas Court, part of the Mt. Blue PID, approval of the Lawrence Community Shelter to the east, and potential development of land for the Douglas County Public Works Department, consolidated operations south of E 25$^{th}$ Street. The Douglas County Jail site also includes a second phase that would include a building addition between the south side of the building and the south parking lot. In summary the area east of Franklin Road is developing with industrial type uses as anticipated. Development of a transitional land use such as the proposed row-house development in advance of the future detached housing will buffer uses and reduce impacts on the residential neighborhood as it develops out.

## CONCLUSION

This request is consistent with plans for the neighborhood and the developing land use pattern of the area. Staff recommends approval of the proposed rezoning.

# Southeast Area Plan

## Map 3-1 Future Land Use



**SECTION ONE:** Chapter 20, Article 4, Section 20-402 of the Code of the City of Lawrence, Kansas, 2011 Edition, and amendments thereto is hereby amended and shall read as follows:

**20-402 RESIDENTIAL DISTRICT USE TABLE**

| *Key:*<br>*A = Accessory*<br>*P = Permitted*<br>*S = Special Use*<br>** = Standard Applies*<br>*- = Use not allowed* | | *Base Zoning Districts* | | | | | | | | | | | | | | *Use-Specific Standards (Sec. 20-)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *RS40* | *RS20* | *RS10* | *RS7* | *RS5* | *RS3* | *RSO* | *RM12* | *RM12D* | *RM15* | *RM24* | *RM32* | *RMG* | *RMO* | |
| **RESIDENTIAL USE GROUP** | | | | | | | | | | | | | | | | |
| Household Living | Accessory Dwelling Unit | A* | A* | A* | A* | – | – | – | – | – | – | – | – | – | – | 534 |
| | Attached Dwelling | – | – | S* | S* | S* | S* | S* | P* | P* | P* | P* | P* | – | P* | 503 |
| | Cluster Dwelling | P* | P* | P* | P* | P* | P* | P* | P* | P* | P* | P* | P* | – | P* | 702 |
| | Detached Dwelling | P* | P* | P* | P* | P* | P* | P* | S* | S* | S* | S* | S* | – | S* | 508 |
| | Duplex | – | – | – | – | – | – | P* | P* | P* | P* | P* | P* | – | P* | 503 |
| | Manufactured Home | – | – | – | – | – | – | – | S | S | S | S | S | – | – | |
| | Manufactured Home, Residential-Design | P* | P* | P* | P* | P* | P* | P* | S* | S* | S* | S* | S* | – | S* | 513 |
| | Mobile Home | – | – | – | – | – | – | – | – | – | S | S | S | – | – | |
| | Mobile Home Park | – | – | – | – | – | – | – | – | – | S* | S* | S* | – | – | 514 |
| | Multi-Dwelling Structure | – | – | – | – | – | – | – | P* | – | P* | P* | P* | – | P* | 517 |
| | Non-Ground Floor Dwelling | -- | -- | -- | -- | -- | -- | P* | -- | -- | -- | -- | -- | -- | P* | 517/542 |
| | Work/Live Unit | -- | -- | -- | -- | -- | -- | P* | -- | -- | -- | -- | -- | -- | P* | 517/542 |
| | Zero Lot Line Dwelling | P* | P* | P* | P* | P* | P* | P* | P* | P* | P* | P* | P* | – | P* | 531 |
| | Home Occupation, Type A or B | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | – | A* | 537 |
| Group Living | Assisted Living | S | S | S | S | S | S | P | P | P | P | P | P | P | P | |
| | ~~Boarding Houses and Cooperatives~~ *Congregate Living* | – | – | – | – | – | – | – | P* | – | P* | P* | P* | – | P* | *20-546* |
| | Dormitory | – | – | – | – | – | – | – | – | – | – | – | – | P | – | |
| | Fraternity or Sorority House | – | – | – | – | – | – | – | – | – | – | – | – | P | – | |
| | Group Home, General [11 or more] | S | S | S | S | S | S | S | S | S | S | S | S | P | S | |
| | Group Home, Limited [10 or fewer] | P | P | P | P | P | P | P | P | P | P | P | P | – | P | |
| **PUBLIC AND CIVIC USE GROUP** | | | | | | | | | | | | | | | | |
| Community Facilities | Adult Day Care Home | S | S | S | S | S | S | P | P | P | P | P | P | P | P | |
| | Cemeteries | P* | P* | P* | P* | P* | P* | P* | P* | P* | P* | P* | P* | – | P* | 505 |
| | College/University | S | S | S | S | S | S | S | S | S | S | S | S | P | S | |
| | School | S | S | S | S | S | S | S | S | S | S | S | S | P | S | |
| | Cultural Center/ Library | S | S | S | S | S | S | S | S | S | S | S | S | P | S | |
| | Day Care Center | S*/A* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | P*/A* | S* | 507 |
| | Day Care Home, Class A | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | – | A* | 507 |

| *Key:*<br>*A = Accessory*<br>*P = Permitted*<br>*S = Special Use*<br>** = Standard Applies*<br>*- = Use not allowed* | | *Base Zoning Districts* | | | | | | | | | | | | | | *Use-Specific Standards (Sec. 20-)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *RS40* | *RS20* | *RS10* | *RS7* | *RS5* | *RS3* | *RSO* | *RM12* | *RM12D* | *RM15* | *RM24* | *RM32* | *RMG* | *RMO* | |
| | Day Care Home, Class B | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | – | S* | 507 |
| | Detention | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Lodge, Fraternal & Civic Assembly | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | 512 |
| | Postal Service | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Public Safety | S | S | S | S | S | S | S | S | S | S | S | S | P | S | |
| | Funeral and Interment | – | – | – | – | – | – | P* | – | – | – | – | – | – | P* | 505 |
| | Temporary Shelter | A* | A* | A* | A* | A* | A* | S*/A* | A* | A* | A* | A* | A* | A* | S*/A* | 544/522 |
| | Social Service Agency | – | – | – | – | – | – | P | – | – | – | – | – | – | P | |
| | Community Meal Program | A* | A* | A* | A* | A* | A* | S/A* | A* | A* | A* | A* | A* | A* | S/A* | 522 |
| | Utility, Minor | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | 530 |
| | Utility and Service, Major | S | S | S | S | S | S | S | S | S | S | S | S | – | S | |
| Medical Facilities | Extended Care Facility, General | – | – | – | – | – | – | S | P | P | P | P | P | P | P | |
| | Extended Care Facility, Limited | P | P | P | P | P | P | P | P | P | P | P | P | P | P | |
| | Health Care Office, Health Care Clinic, Health Care Center | – | – | – | – | – | – | P | – | – | – | – | – | – | P | |
| | Hospital | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Outpatient Care Facility | – | – | – | – | – | – | P* | – | – | – | – | – | P* | P* | 519 |
| Recreational Facilities | Active Recreation | S | S | S | S | S | S | S | S | S | S | S | S | – | S | |
| | Entertainment & Spectator Sports, Gen. | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Entertainment & Spectator Sports, Ltd. | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Passive Recreation | P | P | P | P | P | P | P | P | P | P | P | P | P | P | |
| | Nature Preserve/Undeveloped | P | P | P | P | P | P | P | P | P | P | P | P | – | P | |
| | Private Recreation | P | P | P | P | P | P | P | P | P | P | P | P | – | P | |
| | Participant Sports & Recreation, Indoor | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Participant Sports & Recreation, Outdoor | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| Religious Assembly | Campus or Community Institution | – | – | – | – | – | – | – | P* | P* | P* | P* | P* | P* | P* | 522 |
| | Neighborhood Institution | P* | P* | P* | P* | P* | P* | P* | P* | P* | P* | P* | P* | P* | P* | 522 |
| COMMERCIAL USE GROUP | | | | | | | | | | | | | | | | |
| al Se | Kennel | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |

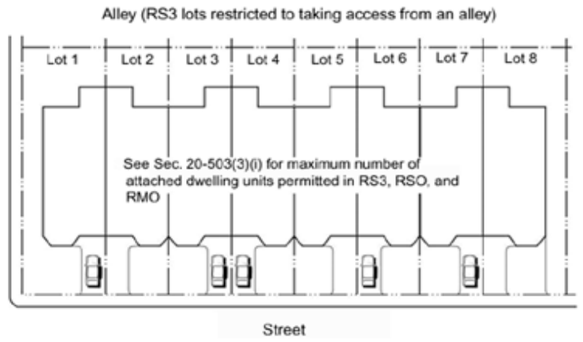
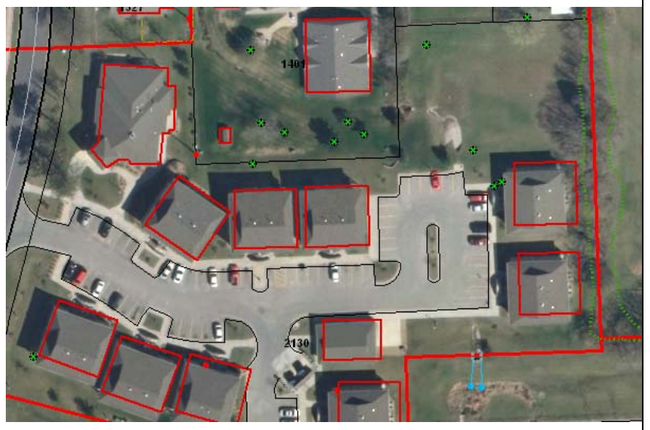
| Key:<br>A = Accessory<br>P = Permitted<br>S = Special Use<br>* = Standard Applies<br>- = Use not allowed | | Base Zoning Districts | | | | | | | | | | | | | | Use-Specific Standards (Sec. 20-) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RS40 | RS20 | RS10 | RS7 | RS5 | RS3 | RSO | RM12 | RM12D | RM15 | RM24 | RM32 | RMG | RMO | |
| | Livestock Sale | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Sales and Grooming | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Veterinary | – | – | – | – | – | – | P | – | – | – | – | – | – | P | |
| Eating & Drinking Establishments | Accessory Bar | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Bar or Lounge | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Brewpub | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Fast Order Food | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Fast Order Food, Drive-in | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Nightclub | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Private Dining Establishments | S* | S* | S* | S* | S* | – | S* | – | – | – | – | – | – | S* | 539 |
| | Restaurant, High-turnover | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Restaurant, Quality | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| Office | Administrative and Professional | – | – | – | – | – | – | P* | – | – | – | – | – | P* | P* | 518 |
| | Financial, Insurance & Real Estate | – | – | – | – | – | – | P* | – | – | – | – | – | P* | P* | 510 |
| | Other | – | – | – | – | – | – | P* | – | – | – | – | – | P* | P* | 510 |
| Parking Facilities | Accessory | – | – | – | – | – | A* | A* | A* | A* | A* | A* | A* | A* | A* | 535 |
| | Commercial | – | – | – | – | – | – | S | – | – | – | – | – | | – | |
| Retail Sales & Service | Building Maintenance | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Business Equipment | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Business Support | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Construction Sales and Service | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Food and Beverage | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Mixed Media Store | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Personal Convenience | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Personal Improvement | – | – | – | – | – | – | P* | – | – | – | – | – | P* | P* | 521 |
| | Repair Service, Consumer | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Retail Sales, General | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Retail Establishment, Large | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |

| Key:<br>A = Accessory<br>P = Permitted<br>S = Special Use<br>* = Standard Applies<br>- = Use not allowed | | Base Zoning Districts | | | | | | | | | | | | | | Use-Specific Standards (Sec. 20-) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RS40 | RS20 | RS10 | RS7 | RS5 | RS3 | RSO | RM12 | RM12D | RM15 | RM24 | RM32 | RMG | RMO | |
| | Retail Establishment, Medium | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Retail Establishment, Specialty | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| Sexually Oriented Businesses | Sexually Oriented Media Store | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Physical Sexually Oriented Business | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Sex Shop | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Sexually Oriented Theater | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| Transient Accommodation | Bed and Breakfast | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | P* | P* | – | P* | 504 |
| | Campground | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Elderhostel | – | – | – | – | – | – | – | – | – | – | – | – | S | – | |
| | Hotel, Motel, Extended Stay | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| Vehicle Sales & Service | Cleaning (e.g., car wash) | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Fleet Storage | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Gas and Fuel Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Heavy Equipment Repair | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Heavy Equipment Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Inoperable Vehicles Storage | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Light Equipment Repair | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Light Equipment Sales/Rental | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | RV and Boats Storage | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| INDUSTRIAL USE GROUP | | | | | | | | | | | | | | | | |
| Industrial Facilities | Explosive Storage | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Industrial, General | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Industrial, Intensive | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Laundry Service | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Manufacturing & Prod., Limited | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Manufacturing & Prod., Technological | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |

| Key:<br>A = Accessory<br>P = Permitted<br>S = Special Use<br>* = Standard Applies<br>- = Use not allowed | | Base Zoning Districts | | | | | | | | | | | | | | Use-Specific Standards (Sec. 20-) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | RS40 | RS20 | RS10 | RS7 | RS5 | RS3 | RSO | RM12 | RM12D | RM15 | RM24 | RM32 | RMG | RMO | |
| | Research Service | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Salvage Operation | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| Wholesale, Storage & Distribution | Heavy | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Light | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Mini-Warehouse | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| OTHER USES GROUP | | | | | | | | | | | | | | | | |
| Adaptive Reuse | Designated Historic Property | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | 501 |
| | Greek Housing Unit | – | – | – | – | – | – | – | – | – | – | – | – | S* | – | 501 |
| Agriculture | Agricultural Sales | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Agriculture, Animal | P* | – | – | – | – | – | – | – | – | – | – | – | – | – | 502 |
| | Agriculture, Crop | P | P | P | P | P | P | P | P | P | P | P | P | – | P | |
| Communications Facilities | Amateur and Receive-Only Antennas | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | – | A* | 536 |
| | Broadcasting Tower | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Communications Service Establishment | – | – | – | – | – | – | P | – | – | – | – | – | – | P | |
| | Telecommunications Antenna | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | 529 |
| | Telecommunications Tower | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | S* | 529 |
| | Satellite Dish | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | A* | 536 |
| Mining | Mining | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| Recycling Facilities | Large Collection | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Small Collection | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |
| | Processing Center | – | – | – | – | – | – | – | – | – | – | – | – | – | – | |

# Dwelling Unit Type Summary

**20-1734 Household Living:** Residential occupancy of a Dwelling Unit by a household with tenancy arranged on a month-to-month or longer basis.

| **Detached Dwelling:** | **Duplex:** | **Attached Dwelling:** | **Multi-Dwelling (Structure):** |
|---|---|---|---|
| A Dwelling Unit (single structure) located on its own Lot that is not attached to any other Dwelling Unit. | A single structure that contains two primary Dwelling Units on one Lot. The units may share common walls or common floor/ceilings. | A Dwelling Unit, located on its own Lot, that shares one or more common or abutting walls with one or more Dwelling Units.<br><br>An Attached Dwelling does not share common floor/ ceilings with other Dwelling Units. Also called a townhouse or a rowhouse. | A Structure that contains three or more Dwelling Units that share common walls or floor/ceilings with one or more units. The land underneath the structure is not divided into separate Lots. A Multi-Dwelling includes Structures commonly called garden apartments, apartments and condominiums. |
| Each building contains only one dwelling unit on a single lot.<br><br> | Each building contains two dwelling units on a single lot.<br><br> <br><br>This building contains two dwelling units on a single lot. The ownership of the lot has been split (not through any subdivision process) such that each dwelling units how has a separate legal description. | Each dwelling unit is located on a single platted lot.<br><br>  | This single lot includes multiple buildings with at least three dwelling units in each building.<br><br>  |
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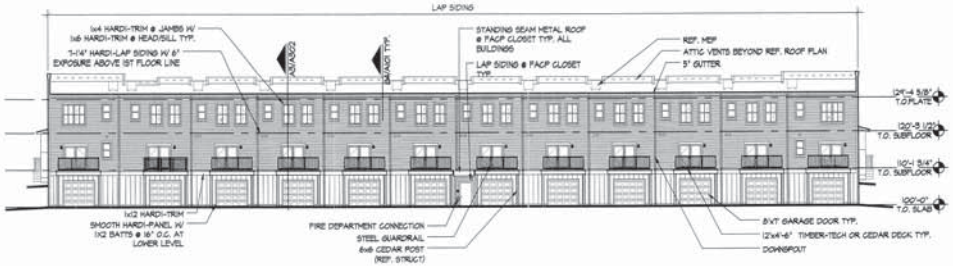


Building F East Elevation **D1**
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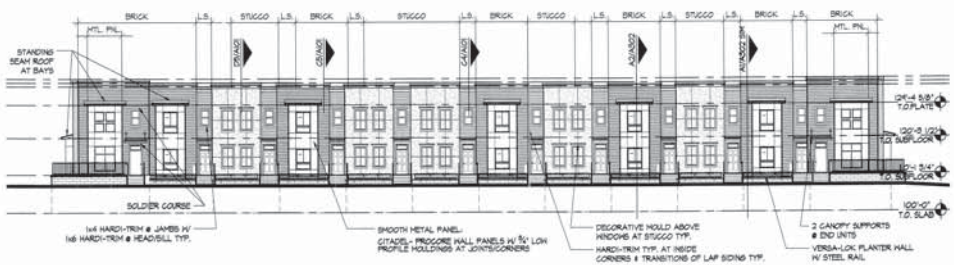


Building F West Elevation **C1**
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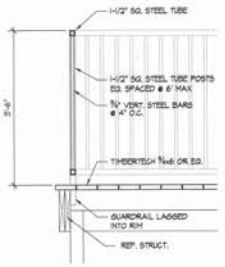


Guardrail Details **B4**
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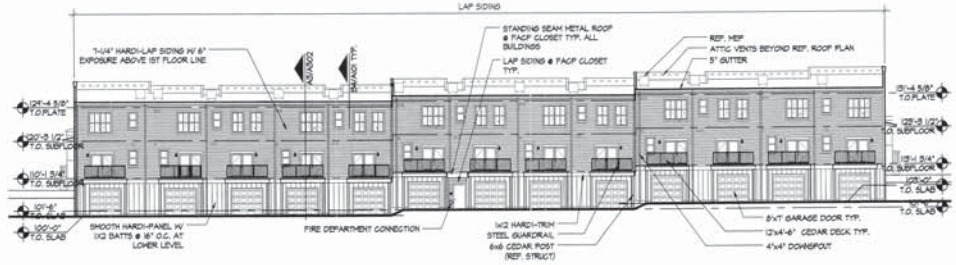


Building E East Elevation **B1**
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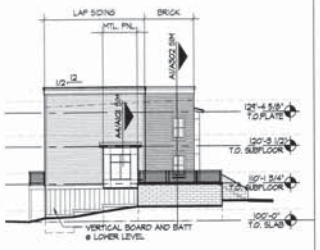


Building E North Elevation **A5**
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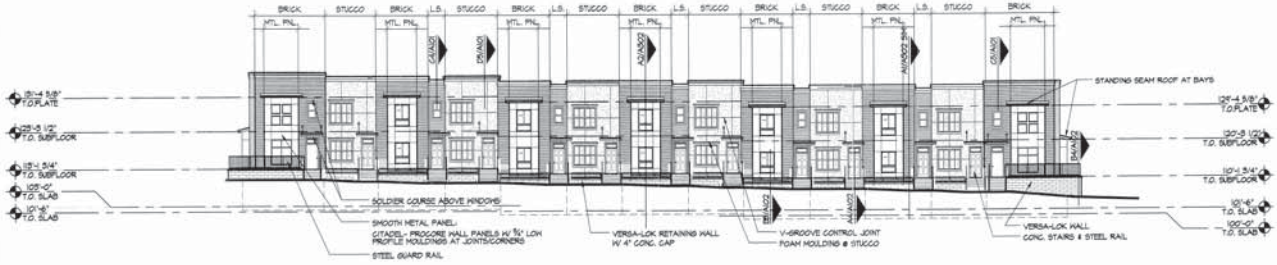


Building E West Elevation **A1**
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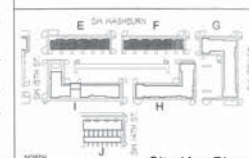


Site Key Plan

50163

# College Hill

Mixed-Use Development

***Townhomes Building Package***

Topeka, KS

**Southwind Capital, LLC**
801 Iowa Street
Lawrence, Kansas 66044
Office: 785.331.4644
Fax: 785.331.4611

APPROVED BY:

Name: - - - Date: - - -

Name: - - - Date: - - -

Name: - - - Date: - - -

TREANOR ARCHITECTS P.A.
110 McDonald Drive, Suite 177
Lawrence, Kansas 66044-7563
Office: 785.842.4838
Fax: 785.842.7356
www.treanorarchitects.com

8-30-2006

REVISIONS

| | |
|---|---|
| 1 | Comment: - - - |
| | Date: - - - |
| | Comment: |
| | Date: |
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| | Date: |
| | Comment: |
| | Date: |

Rel. Date: 08-30-2006

# A201

BUILDING ELEVATIONS

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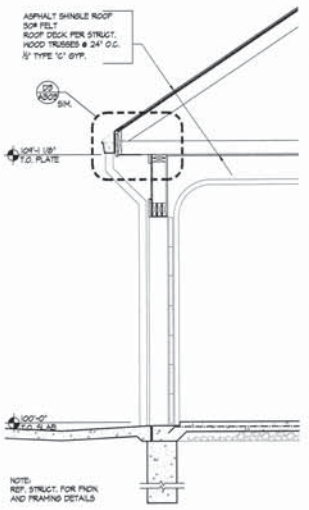


Garage Eave Wall Section @ J **C1**

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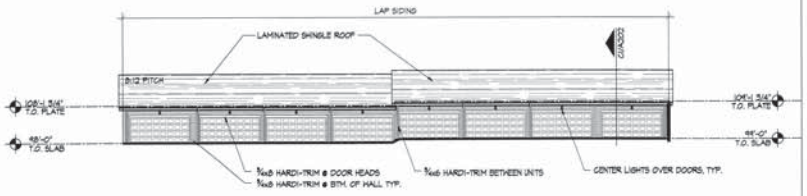


Building J East Elevation **B3**

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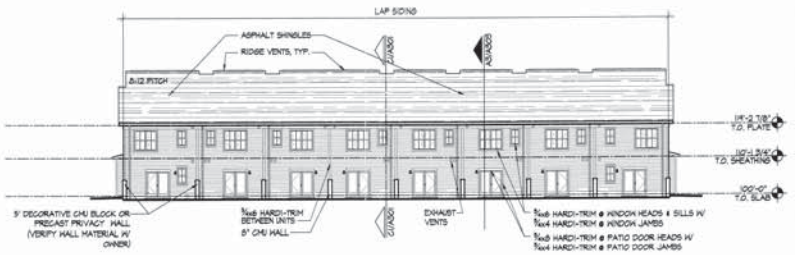


Building J East Elevation **B1**

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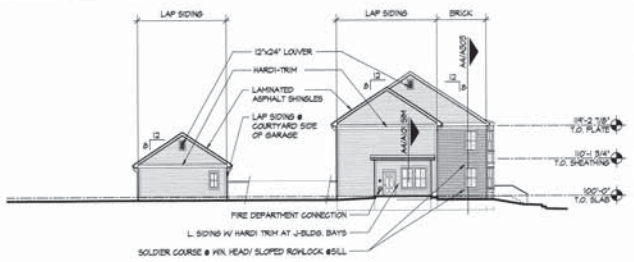


Building J North Elevation **A4**

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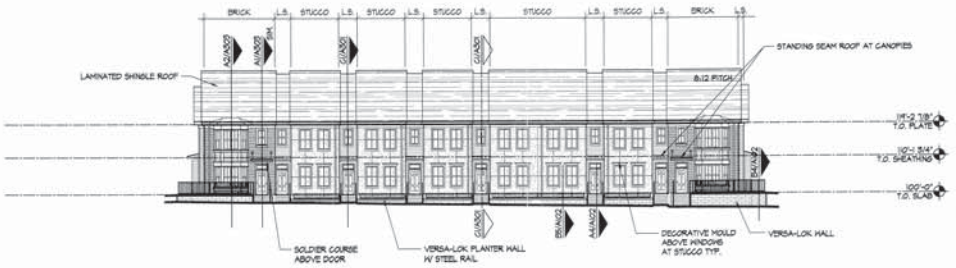


Building J West Elevation **A1**

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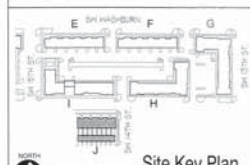


Site Key Plan

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# College Hill

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8-30-2006

REVISIONS

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| 1 | Comment: - - - | |
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**A202**

BUILDING ELEVATIONS

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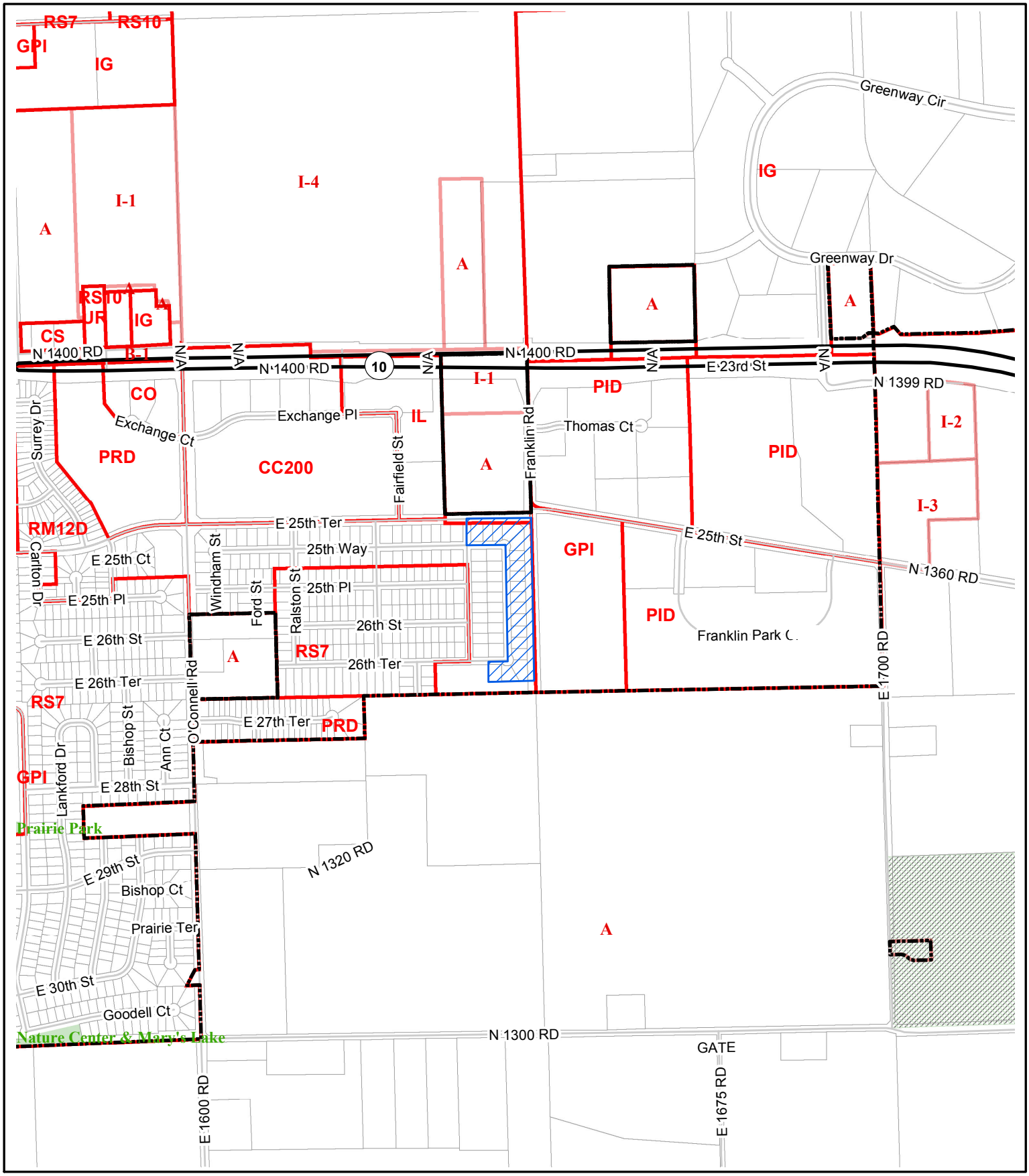
STOP




# Z-06-16-11: Rezone 8 acres from RM12D to RM12
# SW corner 25th Terrace & Franklin Rd

Lawrence-Douglas County Planning Office
August 2011

N
W E
S

Area Requested

Scale: 1 Inch = 1000 Feet

**PLANNING COMMISSION REPORT**
**Regular Agenda -- Public Hearing Item**

PC Staff Report
8/22/11

**ITEM NO. 2 TEXT AMENDMENT TO CITY OF LAWRENCE DEVELOPMENT CODE; TO ALLOW DETENTION FACILITIES AS A PERMTTED USE IN THE GPI DISTRICT AND TO AMEND THE DEFINITION OF MAJOR UTILITES AND SERVICES IN ARTICLE 17 (SLD)**

**TA-6-9-11**: Consider a Text Amendment to the City of Lawrence Land Development Code, Chapter 20, Article 4, Section 20-403 to allow detention facilities as a use in the GPI (General Public Institutional) District and delete "detention and correction institutions" from the definition of Major Utilities and Services in Article 17. *Initiated by Planning Commission on 3/28/11.*

**RECOMMENDATION: Staff Recommendation**
Staff recommends approval of ta-6-9-11 to amendment to Section 20-403 of the Land Development Code to add "Detention Facilities" as a Special Use in the GPI (General Public and Institutional Use) District and to Section 20-1764 to revise the definition of Major Utilities and Services by deleting "detention and correction institutions".

A second recommendation is made to instruct staff to change:

- the title of Section 20-1721 from "Detention" to Detention Facilities;
- to correct the use tables in Section 20-402 and 20-403 to list the use as "Detention Facilities";
- to list "Utility, Minor" as "Utilities, Minor"; and
- "Utilities Services, Major" as "Utilities and Services, Major"

to align with the terms in Article 17.

**Reason for Request:** A potential land use compatibility conflict has been identified that could be better addressed through the Special Use Permit process. Also, the definition of *Utilities and Service, Major* includes a use already listed as a specific use.

**RELEVANT FACTOR:**
- Conformance with the Comprehensive Plan.

**PUBLIC COMMENT RECEIVED PRIOR TO PRINTING**
- None to date.

**ATTACHEMENTS**
- Location of GPI zoning map.

**OVERVIEW OF PROPOSED AMENDMENT**
The primary purpose of the Development Code is to implement the Comprehensive Plan, *Horizon 2020*. This plan gives deference to neighborhoods and residential uses. A key feature of

the plan, recommends that; *"the City and County consider utilizing development/performance standards for all major land development projects. Standards would give the community reasonable control over design and development, and provide developers incentives for creative and quality new development."* The Special Use Permit review process is a tool that allows for review of applicable standards for development where potential land use compatibility concerns may exist.

"Detention" is a use listed as a Community Facility in the *Public and Civic Use Group* in the Nonresidential District use table in Section 20-403. A *Detention Facility* is defined in Section 20-1721 as: *"a facility for the housing of persons in the custody of a government agency awaiting trial or serving a sentence after being found guilty of a criminal offense."*

The community currently operates an adult jail and a juvenile detention facility.

| Douglas County Jail:<br>3601 E. 25th Street in southeast Lawrence. | Youth Detention Facility:<br>330 Industrial Lane in North Lawrence. |
|---|---|
| • GPI Zoning<br>• Existing beds 196<br>• Planned bed expansion 100<br>• Total planned occupancy 300<br>• Currently operating a reentry/work release program - 10 to 15 beds average. | • GPI Zoning<br>• Existing beds 14-16<br>• Multi-county facility<br>• 90 – 95% Housing of Douglas County youth.<br>• Includes a day school program. |

Both facilities were developed as *Community Facilities* under the 1966 development code. With the adoption of the 2006 Development Code publicly owned properties were rezoned to the GPI (General Public and Institutional Use) District. Use tables were not revised to include *Detention Facilities* as an allowed use in the GPI district. This text amendment would modify the use table in Section 20-403 to allow "Detention Facilities" as a Special Use in the GPI District.

Two issues are discussed in this report.

1. Detention uses exist but are not currently permitted uses in the GPI District and thus are non-conforming uses. This error occurs in the use table, Section 20-403 of the Development Code.

The definition of Utilities and Services, Major states:

2. *Services and utilities that have substantial impacts. Such uses may be permitted when the public interest supersedes the usual limitations placed on land use and transcends the usual restraints of the district for reasons of necessary location and community-wide interest. Typical uses include: water and wastewater treatment facilities, major water storage facilities, airports, power generation plants and detention and correction institutions*. This occurs in Article 17 – Terminology, 20-1764.

**CRITERIA FOR REVIEW AND DECISION-MAKING**

Section 20-1302(f) provides review and decision-making criteria on proposed text amendments. It states that review bodies shall consider at least the following factors:

**1) Whether the proposed text amendment corrects an error or inconsistency in the Development Code or meets the challenge of a changing condition; and**

**Applicant Response** *The City is the applicant for this request. A review of TA-3-5-11 found that the community rezoned existing detention facilities, along with all properties owned by the City, County or School District, to the GPI district but did not update the development code use table to include detention facilities as a permitted use in the GPI district. This action created non-conforming uses.*

**STAFF DISCUSSION**
The GPI District was created as a:

> *"Special Purpose Base District primarily intended to accommodate Institutional Uses occupying significant land areas but not appropriate for development in the H District or on property designated on the official zoning map as U. The District regulations are designed to offer the institution maximum flexibility for patterns of uses within the district while ensuring that uses and development patterns along the edges of the District are compatible with adjoining land uses."* Section 20-218 Land Development Code.

Several land uses that require large land areas include special zoning districts such as Hospitals and Universities. Other land uses are provided with specific overlay districts to meet minimum public health, safety and welfare such as Airspace, Floodplain, Historic and Urban Conservation District designations. Other public land uses that require large amounts of land can be addressed with tools such as site plan review or design standards and in some cases Special Use Permits.

- The incorporation of detention and correction institutions in the *Major Utilities and Services* definition is an error in the Development Code.

This use is typically a governmental function more appropriately located in the GPI district though private facilities can exist. A Detention Facility, especially one serving a catchment area larger than the City or County, can impact a community's social service providers, police, fire, and medical services. A Detention use operates 24/7 and can result in operational incompatibilities.

- The use, "Detention" is not a permitted use in the GPI District. This is an error in the Development Code. The purpose of this text amendment is to correct that error.

Revising the Development Code to permit the use as a Special Use in the GPI District allows for additional review to address the community service demands as well as site compatibility with surrounding uses. Approval of this request will introduce consistency to the Development Code for "Detention" uses that does not currently exist.

**2) Whether the proposed text amendment is consistent with the Comprehensive Plan and the stated purpose of this Development Code (Sec. 20-104).**

**Applicant Response** *The City is the applicant for this request. Staff identified a development code error in the review of a recent text amendment (TA-3-5-11).*

## STAFF DISCUSSION

### a) Comprehensive Plan Consistency

Community Facilities are addressed in Chapter 10 of *Horizon 2020*. The plan acknowledges that the need for pubic and semi-public uses is difficult to project. This chapter focuses on education facilities, municipal buildings and facilities, and utilities. The Plan seems to make a distinction between buildings & facilities and Utilities. Utilities are most commonly associated with the provision and delivery of services such as water, sewer, electric and gas. Some community services such as police and fire protection, libraries, hospitals, and public works are a combination of services provided and physical buildings or facilities.

Municipal buildings and facilities specifically considered in *Horizon 2020* are fire protection, emergency services, police and sheriff facilities, municipal offices, public works facilities, libraries and museums. The plan notes the completion of the Juvenile Detention Center that serves a multi-county region and plans for expansion of the County Jail facility. This expansion plan reference resulted in the development of the Douglas County Jail Facility located in southeast Lawrence in the late 1990's.

Municipal Buildings and Facility Strategies noted in *Horizon 2020* include:

- *Close intergovernmental cooperation is recommended to ensure, to the greatest degree possible, facilities and services are maximized while minimizing duplication.*

- *The potential for privatization of municipal services should continue to be explored. The city and county objective is to maximize desired services for residents while providing service delivery at the lowest possible cost. The strategy also includes the consolidation of service providers and entities wherever possible.*

*Horizon 2020* supports a mix of uses as well as appropriate land use transitions between residential and intensive non-residential uses. Approval of this text amendment brings the existing development into conformance with the Development Code and provides a public process for the consideration of the benefits of allowing a specific use for future expansions of those facilities if needed. Additionally, this amendment would require a public review process for any new facility that would be proposed in the community.

The Community Facility Chapter of *Horizon 2020* places importance on appropriate site design and land use transition between land uses. The purpose of the Development Code is to implement *Horizon 2020: "in a manner that protects, enhances, and promotes, the health, safety, and welfare of the citizens of Lawrence*." Making the use subject to a Special Use Permit allows the specific use to be considered based on the unique characteristics of the property location and proximity to other land uses. It is in this way that the proposed text amendment is consistent with *Horizon 2020* and the purpose statements of the Development Code.

A Detention Facility is defined in Section 20-1721 of the Development Code. No change to the definition of a *Detention Facility* is proposed. The revision to *Utilities and Services, Major*

removes a potential conflict and the need for use interpretations in the future. A *Detention Facility* includes common institutional uses such as jails but can also include transitional facilities that are part of a court-ordered service known as a "residential reentry center."

### b) Consistency with Development Code Purposes

Individual uses may be permitted by right or as Special Uses within a given zoning district. The Development Code currently prohibits "Detention" uses in all residential and commercial zoning districts. Recent changes to Section 20-403 allow the use in both the IG and IL Districts subject to a Special Use Permit.

The *Detention Facilities* use is currently allowed in the IL (Limited Industrial) and IG (General Industrial) District with a Special Use Permit; the use is not allowed in the IBP (Industrial/Business Park) District. There are no use standards or regulations associated with a *Detention Facility*. Two existing Detention facilities located in the City of Lawrence are currently zoned GPI (General Public and Institution Use) District.

If approved, this text amendment would revise the use table in Section 20-403 of the Development Code to allow "Detention Facilities" in the GPI District subject to a Special Use Permit review. Special Use Permit Review provides a *"discretionary approval process for uses with unique or widely varying operating characteristics or unusual site development features"* (Section 20-1306).

The Development Code provides an automatic Special Use Permit Status (Section 20-1306 (b)) for any existing use that was allowed by right at the time it was established, but is now regulated as a Special Use. Both existing Detention Facilities were allowed uses when originally approved. Approval of the text amendment will result in an automatic Special Use Permit status for both sites. The existing facilities will become conforming to the Development Code.

## STAFF CONCLUSION

- Approval of the text amendment brings the two existing facilities into compliance with the purpose and intent of the Development Code.
- Allowing this use in the GPI District subject to a Special Use Permit provides the community greater assurances that appropriate site concerns are addressed.
- Correcting the definition of *Utilities and Services, Major* brings the land uses into alignment with the purpose and intent of the Development Code.

- **Changes noted in Strikeout, red and highlight**

## DRAFT CODE TEXT
## (Partial Table Only)

### 20-403 NONRESIDENTIAL DISTRICT USE TABLE

| *Key:*<br>*A = Accessory*<br>*P = Permitted*<br>*S = Special Use*<br>** = Standard Applies*<br>*- = Use not allowed* | | *Base Zoning Districts* | | | | | | | | | | | | | | *Use-Specific Standards (Sec. 20-)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *CN1* | *CN2* | *MU* | *CO* | *CD* | *CC* | *CR* | *CS* | *IBP* | *IL* | *IG* | *OS* | *GPI* | *H* | |
| **PUBLIC AND CIVIC USE GROUP** | | | | | | | | | | | | | | | | |
| **Community Facilities** | Cemetery | P* | P* | – | P* | – | P* | P* | P* | P* | P* | – | P* | P* | – | 505 |
| | College/University | S | P | P | P | P | P | P | P | P | P | P | – | P | P | |
| | Cultural Center/ Library | S | P | P | S | P | P | – | – | P | – | – | S | P | A | |
| | Day Care Center | S* | P* | S* | S* | S* | P* | P* | P* | P* | P* | P* | – | – | – | 507 |
| | Day Care Home, Class A | P | P | P* | – | P | P | – | P | – | – | – | – | – | – | |
| | Day Care Home, Class B | S*/A* | P* | S* | – | P | P | – | P | – | – | – | – | – | – | 507 |
| | Detention Facilities | – | – | – | – | – | – | – | – | – | S | S | – | -<br>S | – | |
| | Lodge, Fraternal and Civic Assembly | S* | S* | S* | S* | P* | P* | P* | P* | – | P* | – | – | P* | – | 512 |
| | Postal & Parcel Service | – | P | P | P | P | P | P | P | P | P | P | – | P | – | |
| | Public Safety | S | P | P | P | P | P | P | P | P | P | P | – | P | – | |
| | School | P | P | P | P | P | P | P | P | – | – | – | – | P | – | |
| | Funeral and Interment | – | P* | – | P* | P* | P* | P* | P* | P* | P* | – | A* | – | – | 505 |
| | Temporary Shelter | S*/A* | S*/A* | S*/A* | S*/A* | S*/A* | S*/A* | S*/A* | S*/A* | S* | S*/A* | S* | – | S* | S*/A* | 544/522 |
| | Social Service Agency | P | P | P | P | P | P | P | P | P | P | P | – | P | P | |
| | Community Meal Program | S/A* | S/A* | S/A* | S/A* | S/A* | S/A* | S/A* | S/A* | S | S/A* | S | – | S | S/A* | 522 |
| | Utilities~~y~~, Minor | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | P*/ S* | – | 530 |
| | Utilities~~y~~ and Service, Major | S | S | S | S | S | S | S | S | S | S | P | S | P | – | |

### 20-1764 UTILITIES AND SERVICES, MAJOR

Services and utilities that have substantial impacts. Such uses may be permitted when the public interest supersedes the usual limitations placed on land use and transcends the usual restraints of the district for reasons of necessary location and community-wide interest. Typical uses include: water and wastewater treatment facilities, major water storage facilities, airports, and power generation plants. ~~and detention and correction institutions~~.

# PROPERTIES ZONED GPI

# Memorandum
# City of Lawrence
# Douglas County
# Planning & Development Services

**TO:** **Lawrence-Douglas County Planning Commission**

**FROM:** **Planning Staff**

**CC:** **Scott McCullough, Director of Planning and Development Services**

**Date:** **For August 22, 2011 Planning Commission Meeting**

**RE:** **Inverness Park District Plan – Approval Clarification**

The Planning Commission approved the Inverness Park District Plan at the July 27, 2011 meeting.

The Commission sought to ensure that more public process would be involved with the future development of the three properties along Clinton Parkway. Therefore, the Commission included in the approval of the plan that the three properties along Clinton Parkway must develop as Planned Development Overlay Districts (PD), which requires that a preliminary development plan be reviewed by the Planning Commission and City Commission. The PD district contains requirements to ensure compliance with *Horizon 2020* such as preserving 20% open space, flexibility in parking, and the ability to require other appropriate site elements.

However, potential issues arise from applying the PD district as the only option to the three properties on Clinton Parkway. Those issues include the requirement that a PD have at least 20% of the site as Common Open Space. There are certain elements that are required for the open space preservation. Those required elements include the establishment of a mandatory-membership homeowner's association to own and maintain the open space, or transfer of the land to a conservation trust or some other conservation-oriented entity, or dedication of the land to the City. These methods of preserving open space may not be appropriate for the anticipated development along Clinton Parkway. They are most appropriate for single-dwelling cluster developments.

There is another option for a public process in the development of these properties. That option is to rezone the properties with the condition that the site plan, which is normally administratively approved, be approved by the City Commission. Staff does not normally encourage the practice of conditional zoning, but it may be appropriate in this circumstance given the intent of the Planning Commission. Conditional zoning can also set a framework for development, such as limiting Remington Square to 1-bedroom, 2-story structure types.

Staff wants to ensure the intent of the Planning Commission is reflected in the plan. Is the intent to require properties to develop only with Planned Development Overlay Districts and all of their required elements, or is the intent that a public process be followed when the properties are developed and that options to reach that goal, including conditional zoning, be included in the plan?

**Staff Recommendation**

Clarify which of the two options below the PC intended to apply the three properties along Clinton Parkway.

**Option #1:** A Planned Development District Overlay is required to develop the properties along Clinton Parkway.

**Option #2:** A public process for site planning the properties, such as rezoning with a Planned Development Overlay or rezoning with conditions that require site plan approval from the City Commission, is required.

# Inverness Park District Plan

**Lawrence-Douglas County Planning and Development Services**

**Lawrence-Douglas County Planning Commission – 07/27/11**
**Lawrence City Commission –**
**Douglas County Board of County Commissioners –**

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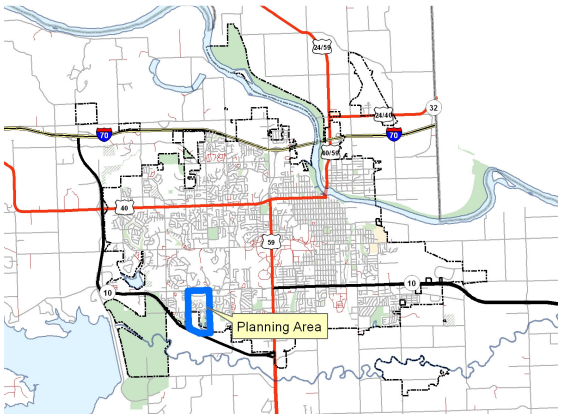
## I. Introduction and Purpose

**Location**

The Inverness Park planning area is located south of Clinton Parkway between Inverness and Crossgate Drives south to K-10 Highway.



Inverness Park District Plan Vicinity Map

**Setting**

The area is primarily urban in nature with most of the planning area within the city of Lawrence, but there is a rural residence and undeveloped county farm land in the southern portion of the planning area. Clinton Parkway, a principle arterial roadway, is the northern boundary of the planning area. There are public and private schools west and north of the planning area and park land in the southeastern portion of the planning area.

**Background**

The Inverness Park area began developing when an annexation request for 163.46 acres was approved in 1999. The development application for the area included multiple rezoning requests. Large tracts were platted along Clinton Parkway and zoned RO-1B to accommodate a mix of multi-family and office uses for the most intensive part of the development of the 163 acres. The area south of W. 24th Place, but north of the open space/drainage area was designated as the transition area to the lower density, detached residential home lots to the south. The area south of W. 24th Place was zoned PRD-2 with a maximum density of 12 dwelling units per acre. W. 24th Place was designed to provide access to all lots in the area with restrictions prohibiting access to Clinton Parkway as well as access limitations placed on Inverness Drive and Crossgate Drive.

The preliminary plat for the entire 163 acres was approved in October 1999 and later revised in February 2001. The revisions reduced the lot size of the single-family area and created more lots than the original approval. The large lot configuration along Clinton Parkway and W. 24th Place did not change. The preliminary plat served as the master plan for the development of the site. It provided the basic boundary of the various zoning districts planned for the 163 acres.

Much of the original land use discussion focused on the need to provide adequate public facilities such as improved streets and other infrastructure as well as the land use pattern and transition of land

uses throughout the entire acreage included in the Inverness Park Addition.

Multiple land use decisions made since 1999 have resulted in a land use pattern that has deviated from the original 163-acre plan with more apartments being developed than originally planned.

**Purpose**

The purpose of the Inverness Park District Plan is to plan for the urban development of the remaining undeveloped property within the planning area. Concerns have been raised by residents in the area about the proliferation of multi-family uses and the impact they are having on the area. This Plan will primarily act as the City's official land use guide for development of the remaining undeveloped land in the Inverness Park District Plan planning area. Development on the property in the unincorporated area is not anticipated until annexed into the city.

**Relation to Other Plans**

This Plan constitutes an amendment to *Horizon 2020*. The Plan deviates from some elements *of Horizon 2020*. Additional policy guidance has foundation in the following plans:

- *Transportation 2030*, Lawrence/Douglas County Long Range Transportation Plan. Lawrence/ Douglas County Metropolitan Planning Office and Parsons Brinkerhoff. March 26, 2008.
- Lawrence-Douglas County Bicycle Plan, Lawrence/Douglas County Metropolitan Planning Office. May 2004.
- City of Lawrence, Kansas Water Master Plan. Black & Veatch. December 2003.
- City of Lawrence, Kansas Wastewater Master Plan. Black & Veatch. December 2003.

**Process**

The Lawrence City Commission initiated the Inverness Park District Plan on November 9, 2010. A kick-off meeting for the Inverness Park District Plan was held on February 3, 2011. Stakeholders were asked to provide their thoughts on the Strengths, Weaknesses, Opportunities, and Threats (SWOT exercise) for the planning area and participate in a small group future land use exercise. The 2nd public meeting for the plan was held on March 3, 2011. Those that attended the meeting reviewed the SWOT exercise results and the draft goals and policies and were also asked to provide comments on future land use options. The group also heard a presentation from developers interested in the Inverness and Clinton Parkway corner. Planning Staff developed the 1st draft of the Plan with input from property owners within the planning area and other stakeholders.

The 1st draft of the Plan was reviewed by the Lawrence-Douglas County Planning Commission at their meeting on May 25, 2011. The Commission took public comment and provided direction to staff. The 2nd draft of the Plan was released on July 5, 2011. The Planning

Commission approved the plan at their meeting on July 27, 2011. The PC approved the 2nd draft with the change that the three properties along Clinton Parkway will be required to develop with Planned Development Overlay Districts because of their location along Clinton Parkway, the fact they are in an established neighborhood and because there is public interest in the development of those properties. (NOTE: THIS LANGUAGE MAY CHANGE AFTER RECEIVING CLARIFICATION FROM THE PLANNING COMMISSION).

## II. Existing Conditions

### A. Current Land Use

The planning area consists of approximately 303 acres of land. The primary land use in the planning area is residential, with single family, duplex and multi-family uses having been developed in the past decade. The majority of the planning area is urbanized and within Lawrence, but there are approximately 70 acres which is located within unincorporated Douglas County south of 27th Street that contains a rural residential and agriculture use. Existing and future parks are also uses within the planning area. See Map 2-1.

**Undeveloped Property**

The Inverness Park District Plan is focusing on providing future land use guidance for the remaining undeveloped property within the planning area. Those properties are described below (each is numbered and labeled on Map 2-1 and Map 2-1a):

No. 1: The southeast corner of Clinton Parkway and Inverness Drive is an approximately 11 acre parcel currently zoned RSO (previously zoned RO-1B). The property lies at the signalized intersection of Clinton Parkway and Inverness Drive. The access management policy in place along Clinton Parkway (described in Section V) prohibits direct access to Clinton Parkway for this property. Access to Inverness Drive is also restricted by plat, meaning this property would take access from W. 24th Place. There is an existing round-a-bout at W. 24th Place and Inverness Drive.

Issues:

- This is a larger parcel capable of accommodating neighborhood scale commercial and multi-family residential.
- Landscape buffer to buffer the higher intensity uses from the residential neighborhood to the west.
- Neighbor interest in park vs. feasibility of development potential due to location.

No. 2: The Remington Square property contains approximately 5 acres (out of a total of 15 acres) that is undeveloped and east of the existing apartments. The existing use of the property is multi-family residential. The property is zoned RM15 (originally zoned RO-1B – RSO and rezoned to RM15), and contains 40 1-bedroom units, which represents the maximum density permitted on the entire 15 acres parcel. The property owner has expressed an interest in rezoning the property to allow a higher density so that he can develop the remaining 5 acres with multi-family structures. The property contains regulatory flood hazard area along the eastern edge that will limit development.

Issues:

- The property is at maximum density, yet it is 1 bedroom development. More intensity is possible through renovation to add more bedrooms.
- Owner plans to maintain 1 bedroom development.

No 3: The property on the southwest corner of Clinton Parkway and Crossgate Drive is approximately 3 acres and is zoned RSO (previously zoned RO-1B). This property has regulatory flood hazard area along the west property line. Access management along Clinton Parkway and plat restrictions along Crossgate Drive meaning this property would take access from W. 24th Place. There is an existing round-a-bout at W. 24th Place and Crossgate Drive.

Issues:

- The Lawrence-Douglas County Planning Commission supported commercial zoning for a Walgreens at this location in 2008.

No. 4: The property on the southwest corner of Crossgate Drive and W. 24th Place is approximately 1 acre and is also zoned RSO. Access is restricted along Crossgate Drive by plat meaning this property would take access from W. 24th Place. This property also has regulatory flood hazard area along the west property line.

Issues:

- 1 acre size of property is challenging for development.

No. 5: There are two properties south of W. 27th Street that are within unincorporated Douglas County. The two parcels total approximately 70 acres. One parcel is a rural residential use and the other is an agriculture use. A large portion of the property contains regulatory flood hazard area, which will impact the developable area of the properties. This property has low density urban development to the north, west and east. The property is close to schools and parks, which makes it desirable for future urban low density development.

No. 6: Finally, there is another property within unincorporated Douglas County that is immediately south of the Pat Dawson Billings Nature Area that contains approximately 22 acres. This property is entirely encumbered by regulatory flood hazard area.

## B. Current Zoning

The City of Lawrence *Land Development Code* and the Douglas County *Zoning Regulations* are intended to implement the goals and policies in *Horizon 2020* in a manner that protects the health, safety, and general welfare of the citizens. The *Land Development Code* and the Douglas County *Zoning Regulations* establish zoning regulations for each land use category which development must follow.

The planning area is primarily located in the city and partially within the county. Map 2-2 shows the current zoning designations and Tables 2-1 and 2-2 below describe the map designations.

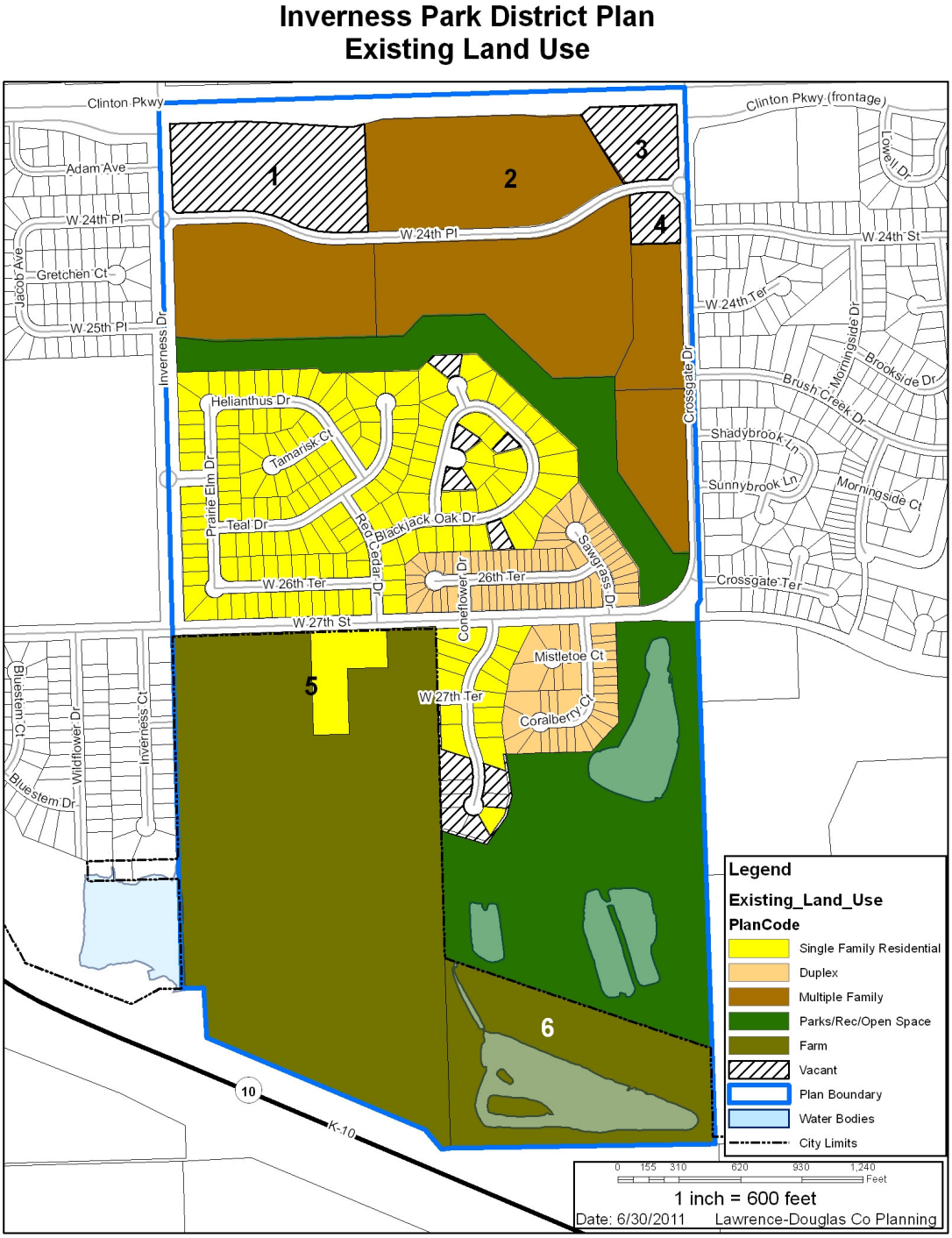
Table 2-1

| City Zoning | District Name | Comprehensive Plan Designation |
|---|---|---|
| RS7 | Single-Dwelling Residential (7,000 sq. feet per dwelling unit) | **Low-Density Residential** |
| RSO | Single-Dwelling Residential-Office (2,500 sq. feet per dwelling unit) | **Low or Medium-Density Residential** |
| RM12D | Multi-Dwelling Residential (12 dwelling units per acre) | **Medium-Density Residential** |
| RM15 | Multi-Dwelling Residential 15 dwelling units per acre | **Medium-Density Residential** |
| PRD | Planned Residential Development | **N/A** |
| OS | Open Space | **N/A** |

Table 2-2

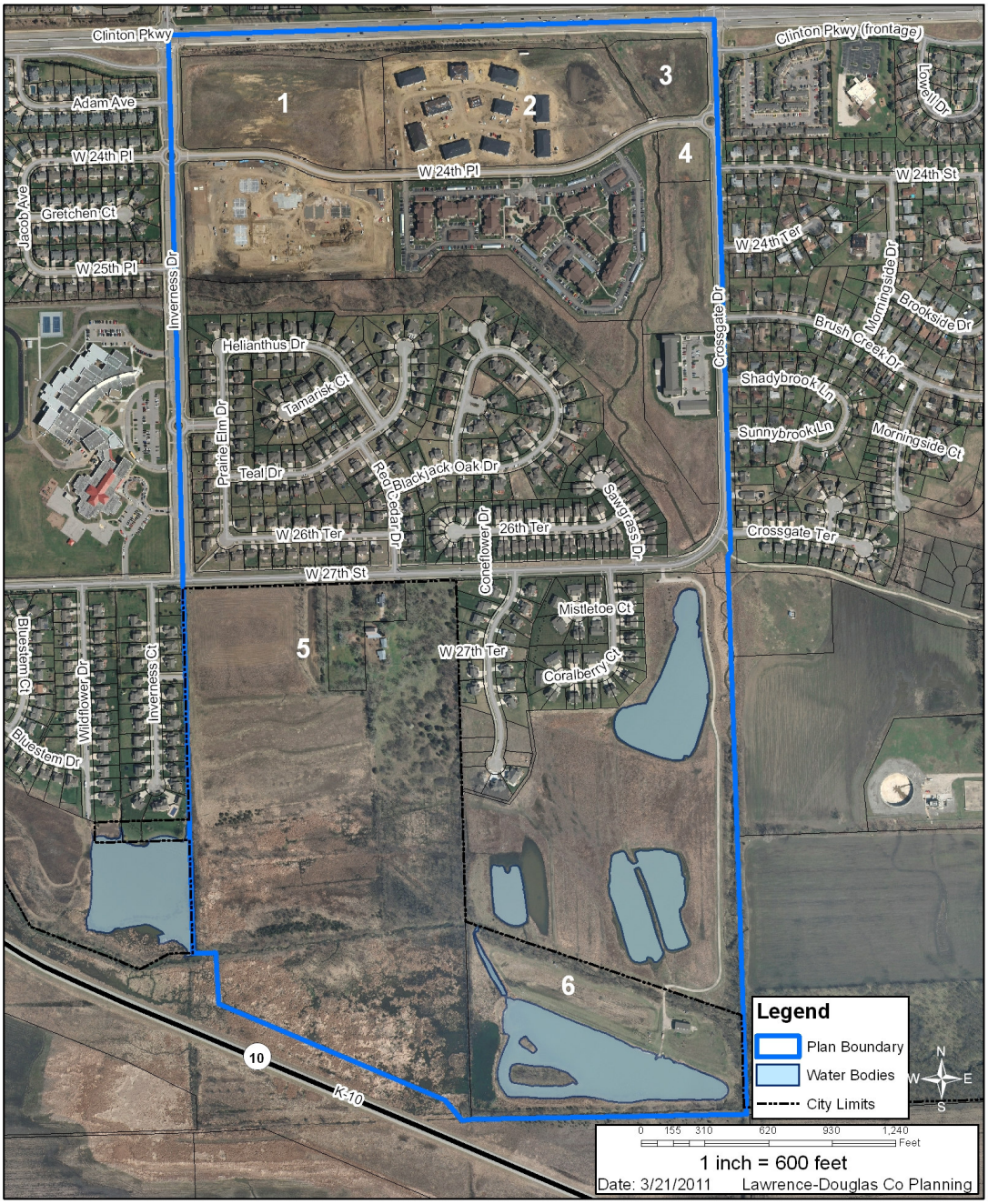
| County Zoning | District Name | Comprehensive Plan Designation |
|---|---|---|
| A | Agricultural | **Agriculture** |
| VC | Valley Channel | **N/A** |

## Map 2-1 Existing Land Use

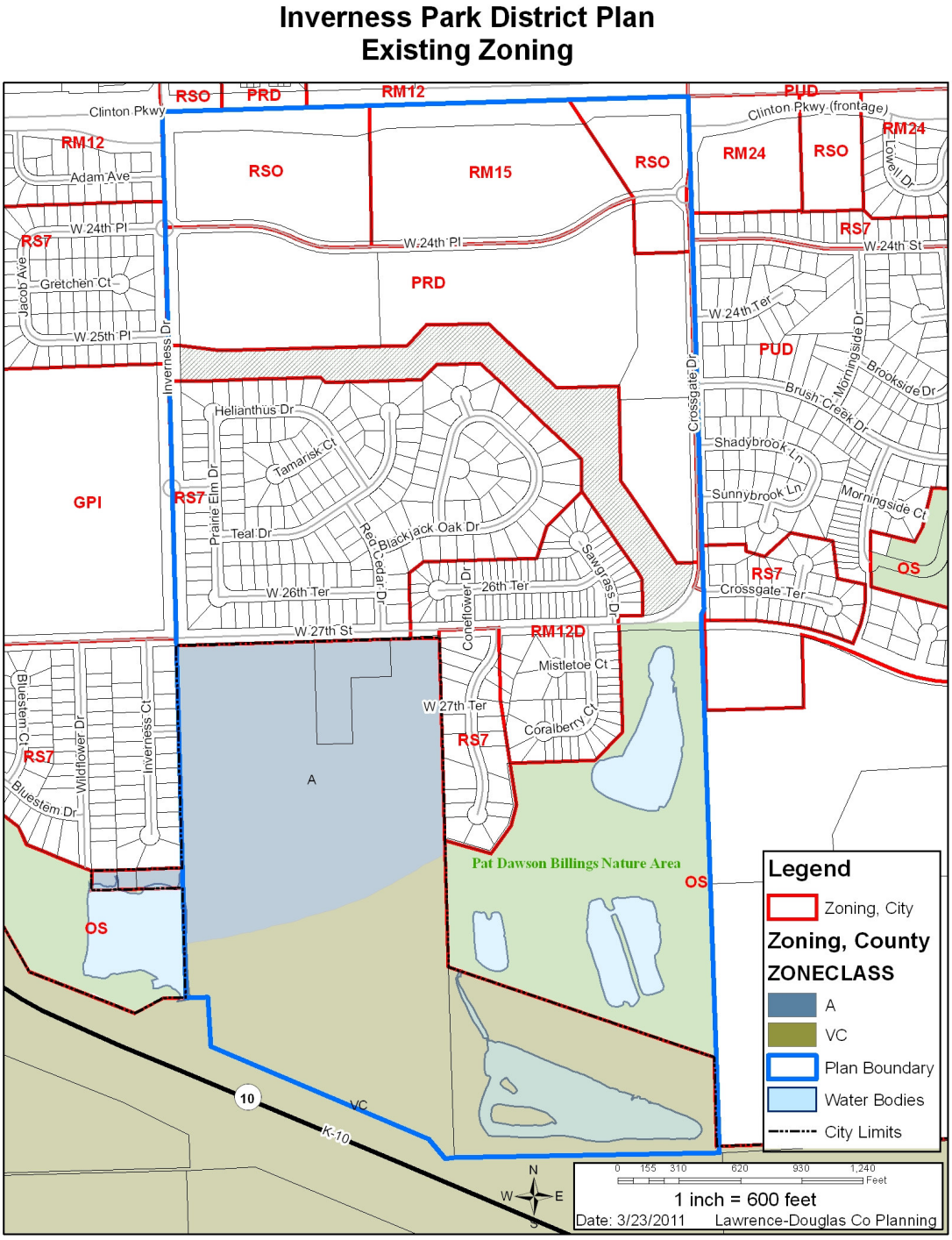


## Map 2-1a Aerial

**Inverness Park District Plan**
**Aerial**



## Map 2-2 Existing Zoning



## C. Flood Hazard Area

There is Federal Emergency Management Agency (FEMA) designated floodplain and floodway located within the planning area. See Map 2-3. The floodplain is any land area susceptible to being inundated by flood waters from any source. The floodway is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height. Developing in the floodplain is allowed both in the city and in the county based on corresponding regulations. No development is allowed in the floodway except for flood control structures, road improvements, easements and rights-of-way, or structures for bridging the floodway.

## D. Parks and Recreational Facilities

There are currently existing parks or park properties located in the planning area. The Pat Dawson Billings Nature Area is located south of 27th Street in the southeastern portion of the planning area. A future linear park is located south of the Legends at KU and The Grove properties, which are south of W. 24th Place. See Map 2-4.

## E. Transportation

*Transportation 2030* (T2030) is the comprehensive, long-range transportation plan for the metropolitan area. T2030 designates streets according to their functional classification or their primary purpose. These functional classifications are shown on Map 2-5. The classification system can be described as a hierarchy from the lowest order, (local streets) that serve to provide direct access to adjacent property, to (collector streets) that carry traffic from local streets, to major thoroughfares (arterial streets) that carry traffic across the entire city. Freeways and expressways are the highest order of streets and are designed with limited access to provide the highest degree of mobility to serve large traffic volumes with long trip lengths. Clinton Parkway is designated as a principle arterial. Inverness Drive, Crossgate Drive and W 27th Street are designated as collectors. The remaining streets within the planning area are local streets.

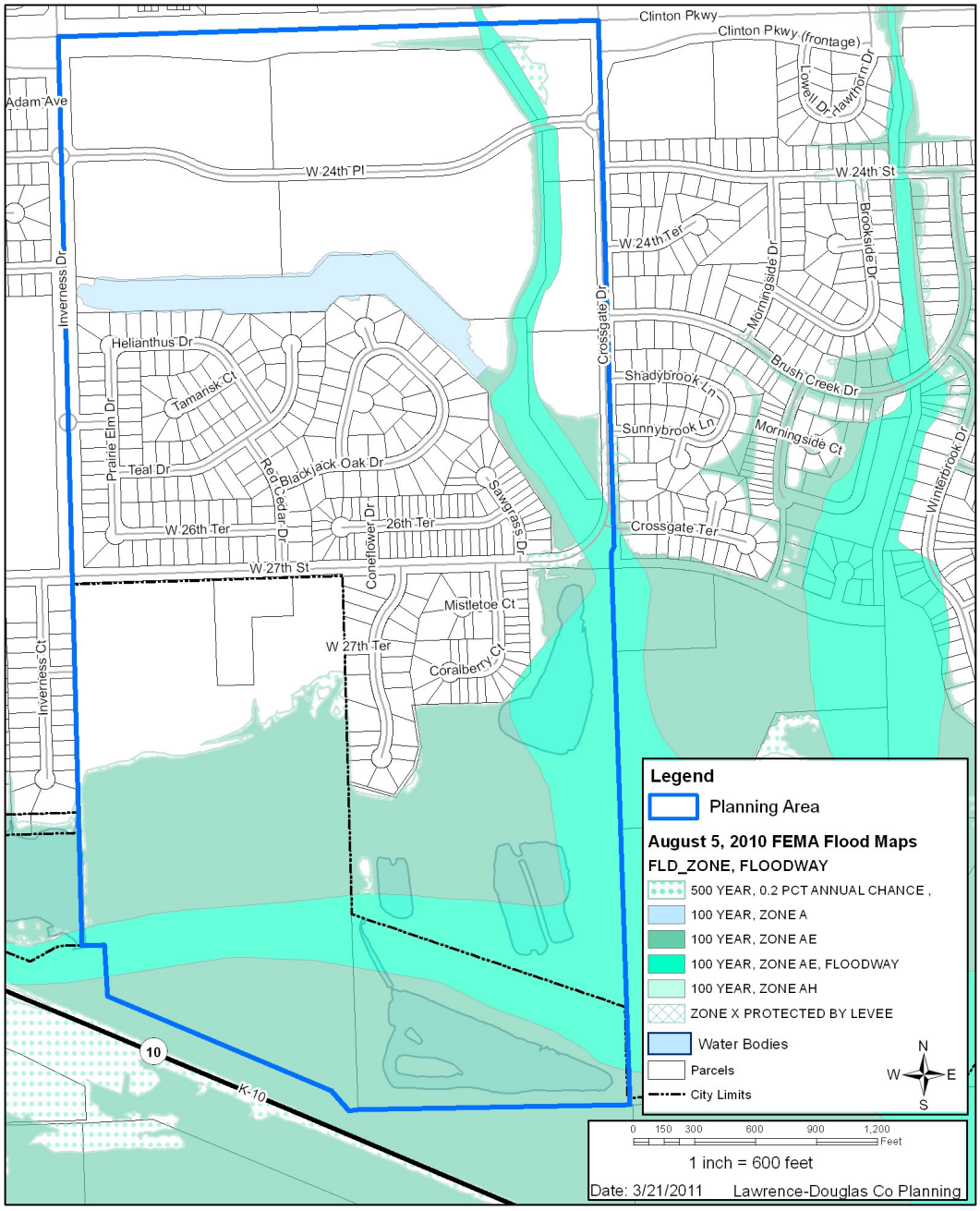
There currently are transit routes that travel to or through the planning area.

The planning area includes existing and future bike routes, lanes, and recreational paths identified by T2030 and these are shown on Map 2-6. Bike lanes are a separate space designated with striping, signage or pavement markings for exclusive use by bicycles with a street or road. Bike routes are a network of streets to enable direct, convenient, and safe access for bicyclists. A recreational path is a separate path adjacent to and independent of the street and is intended solely for non-motorized travel.

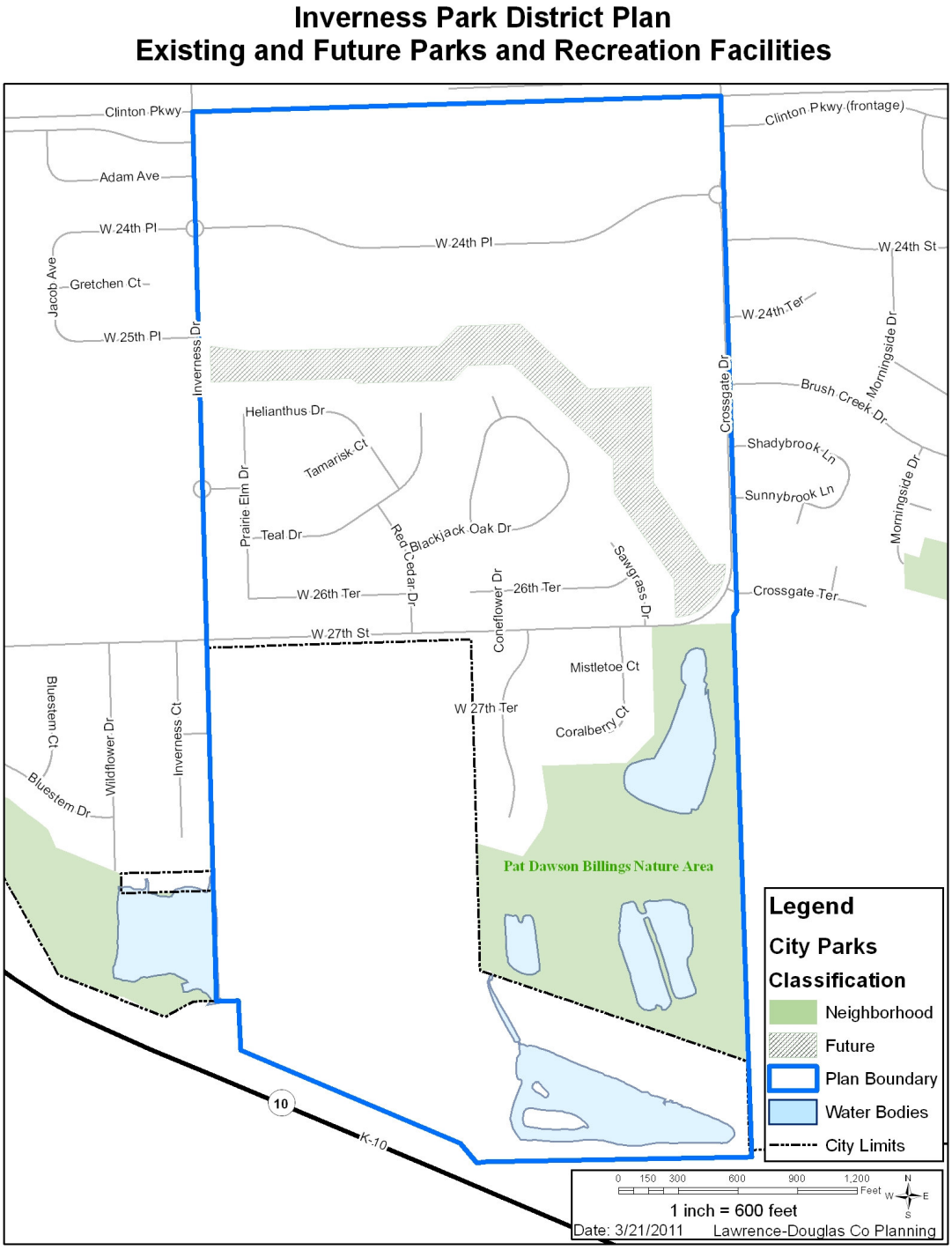
Different types of bicycle facilities are linked to a certain street classification. Recreational Paths are part of Arterials, Bike Lanes are part of Collectors, and Bike Routes are also part of Collectors. Clinton Parkway, Inverness Drive, and W. 27th Street are designated as shared use paths. Crossgate Drive is designated as a bike route.

## Map 2-3 Flood Hazard Area

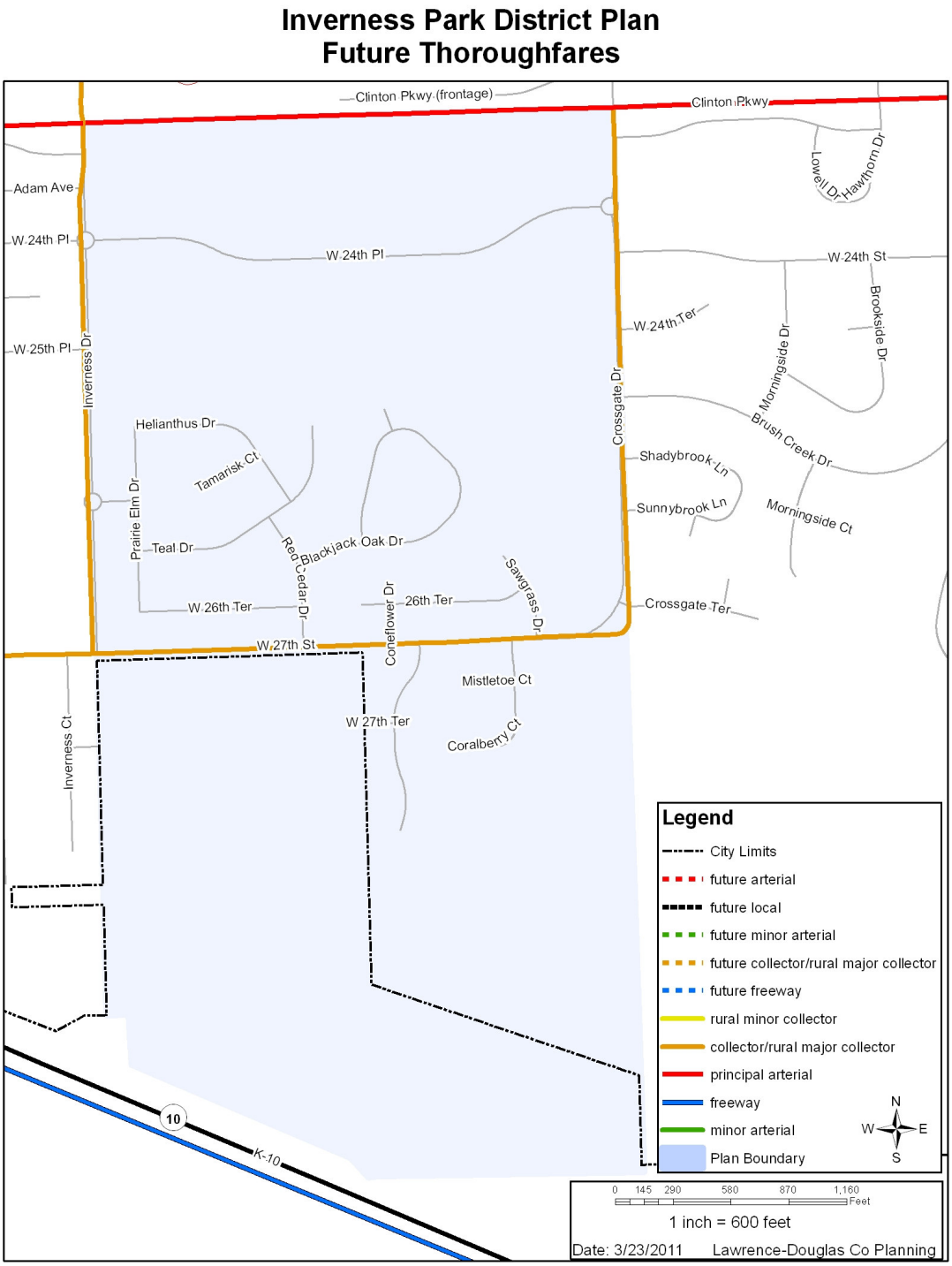
**Inverness Park District Plan**
**Flood Hazard Area**



## Map 2-4 Parks and Recreation Facilities



## Map 2-5 Future Thoroughfares



## Map 2-6 Bicycle Facilities

## F. Schools

School Districts

The planning area is located entirely within the Lawrence USD 497 school district.

School Locations

Public schools Sunflower Elementary and Southwest Jr. High are located just west of the planning area across Inverness Drive. Private schools are also located near the planning area. Bishop Seabury is located north of the planning area across Clinton Parkway and Raintree Montessori School is located west of the planning area along Clinton Parkway.

## III. Goals and Guiding Principles

The following policy statements in Sections III - V are for the development of the remaining undeveloped property in the Inverness Park District Plan planning area.

Revisions to the goals and policies that were released at the 2nd public meeting on March 3, 2011 are shown with strikethroughs for deleted language and underlines for new language.

### Goals

Encourage nonresidential land uses at the Inverness and Crossgate corners of Clinton Parkway that are compatible with the residential uses in the planning area.

Develop a strong park/trail system.

Develop single-family residential uses south of 27th Street at densities compatible with adjacent densities.

Protect the regulatory flood hazard areas from development.

### Policies

Allow for neighborhood-level commercial, office, civic, institutional and recreation activities on the Inverness and Crossgate corners of Clinton Parkway.

Encourage mixed use development (i.e. residential and non-residential uses) along Clinton Parkway.

Limit additional multi-family uses in the Planning Area.

Develop single-family residential uses south of 27th Street.

Encourage a creative mixture of development in the area south of 27th Street that includes small lots, but also large lots that can use the regulatory flood hazard areas as an amenity that is protected from development.

Ensure that adequate public facilities are available prior to developing the remaining undeveloped property within the planning area.

Develop a pedestrian trail on the future park land south of the Legends at KU and The Grove developments.

Maintain the integrity of Clinton Parkway as an access restricted thoroughfare.

Redevelopment of any existing properties should maintain their land use designations as reflected on Map 2-1.

## IV. Future Land Use

The Inverness Park District Plan Future Land Use Section illustrates conceptual guides for future development of the remaining undeveloped properties within the planning area that embody the vision and goals presented in Section III. The future land use map in this Section is conceptual and should not be used to determine precise zoning boundaries. The following land uses, zoning districts, and densities are the "maximum recommended" and assume that less intensive land uses, zoning districts, or densities are appropriate.

### Future Land Use Categories

**Residential – Low Density**

The intent of the low-density residential use is to allow for single-dwelling, duplex, and attached dwellings but emphasis is placed on residential type uses. Development in this area should be compatible with single-family character, which could include such uses as churches, small-scale daycares and institutional uses.

***Primary Uses:*** Detached dwellings, attached dwellings, group home, public and civic uses

***Zoning Districts:*** RS10 (Single-Dwelling Residential), RS7 (Single-Dwelling Residential), RS5 (Single-Dwelling Residential), PD (Planned Development Overlay)

***Density:*** 6 or fewer dwelling units/acre

**Residential – High Density**

The intent of the high-density residential category is to allow for compact residential development. These developments are primarily located at the intersection of two major roads or adjacent to commercial or employment uses. In this District Plan, only the area located adjacent to the east of what is currently named Remington Square Apartments is designated for this land use. Residential development in the High Density Residential category is limited to 1-bedroom 2-story apartments. That is a similar use to the existing Remington Square property.

Option 1: A Planned Development District Overlay is required to develop the remainder of this property. This requirement is in place due to the property's unique situation of its location on a major thoroughfare, its location in a developed area, and the public interest in the potential infill development of the remaining portion of the property. A PD Overlay will permit the governing body the ability to require the development to exceed certain Development Code minimums such as open space, landscaping, building design, etc.

Option 2: A public process for site planning this property, such as rezoning with a Planned Development Overlay or rezoning with conditions that require site plan approval from the City Commission, is required. This requirement is in place due to the property's unique situation of its location on a major thoroughfare, its

location in a developed area, and the public interest in the potential infill development of the remaining portion of the property. A public process for site planning will permit the governing body the ability to require the development to exceed certain Development Code minimums such as open space, landscaping, building design, etc.

***Primary Uses:*** 1-bedroom, 2 story multi-dwelling structures
***Zoning Districts:*** RM24 (Multi-Dwelling Residential) and PD (Planned Development Overlay) District
***Density:*** 16+ dwelling units/acre, not to exceed 24 dwelling units per acre

**Residential Office**
The intent of the residential/office use is to accommodate mixed use development of administrative and professional offices with medium density residential. This category can serve as a buffer between higher intensity uses and major roads to lower intensity/density land uses.
***Primary Uses:*** office, detached dwellings, duplex dwellings
***Zoning Districts:*** RSO (Single Dwelling Residential-Office)
***Density/Intensity:*** 7-15 dwelling units/acre/medium

**Commercial – Neighborhood Center**
The intent of the commercial use is to allow for retail and service uses. A Neighborhood Commercial Center provides for the sale of goods and services at the neighborhood level and may include mixed use structures to accommodate commercial and residential uses in one location.

Multi-family residential uses are not appropriate for this category. The planning area contains a number of existing multi-family residential uses. Additional multi-family uses in areas designated as Neighborhood Commercial are not suitable for the area.

The property on the Inverness corner is approximately 11 acres and could support a commercial strip center or one large anchor with a smaller center. This intensification would lead to more activity, traffic, noise, and light while providing the benefit of additional commercial services within walking distance for residents in the area. For comparison purposes, the neighborhood commercial centers around Lawrence with similar land areas include the Hy-Vee center at Kasold Drive and Clinton Parkway (13.6 acres), the Orchards center at Bob Billings Parkway and Kasold Drive (9 acres), the Hy-Vee center at Monterey Way and 6$^{th}$ Street (12 acres), and the center at Bob Billings Parkway and Wakarusa Drive (8 acres).

Particular attention should be paid to properly designing a large-scale development on the Inverness corner to fit into the context of a developed residential area. Preserving open space to help mitigate the size and scale of the development should be a priority. In addition, 4-sided architecture will be critical here because the property has road frontage on 3 sides (including Clinton Parkway) and is surrounded by a developed residential area. Providing easy

pedestrian connections into the development from the residential areas and from the multi-use pathway on Clinton Parkway is also important. New commercial development will have to comply with the Commercial Design Standards. Further, a review of the use table at the time of rezoning may be appropriate to analyze uses that limit impacts from traffic, noise, etc.

The property on the Crossgate corner is approximately 3 acres and could be developed with retail uses. This smaller property should have less impact with regards to traffic, noise, and light compared with the Inverness corner, while still providing commercial services within a walkable distance for neighborhood residents. New commercial development should provide pedestrian connects, will need to include 4-sided architecture and comply with the Commercial Design Standards.

Option 1: The properties in this category will be required to develop with a PD Planned Development Overlay District. This requirement applies to these properties because of their location on Clinton Parkway, the fact they are within a developed neighborhood, and because there is public interest in the potential infill development of these properties. A PD Overlay will permit the governing body the ability to require the development to exceed certain Development Code minimums such as open space, landscaping, building design, etc.

Option 2: A public process for site planning these properties, such as rezoning with a Planned Development Overlay or rezoning with conditions that require site plan approval from the City Commission, is required. This requirement applies to these properties because of their location on Clinton Parkway, the fact they are within a developed neighborhood, and because there is public interest in the potential infill development of these properties. A public process for site planning will permit the governing body the ability to require the development to exceed certain Development Code minimums such as open space, landscaping, building design, etc.

***Primary Uses:*** eating and drinking establishments, general office, retail sales and services, fuel sales, car wash, civic and public uses, medical facilities

***Zoning Districts:*** CN1 (Inner Neighborhood Commercial District), CN2 (Neighborhood Commercial Center District), CO (Office Commercial) District and PD (Planned Development Overlay) District

***Intensity:*** medium-high

**Open Space**

The intent of the open space use is to provide space for opportunities for public and private recreational facilities and natural area preservation. This category primarily includes the regulatory flood hazard areas within the planning area.

***Primary Uses:*** Park and open space

***Zoning Districts:*** GPI (General Public and Institutional District), OS (Open Space), UR (Urban Reserve)

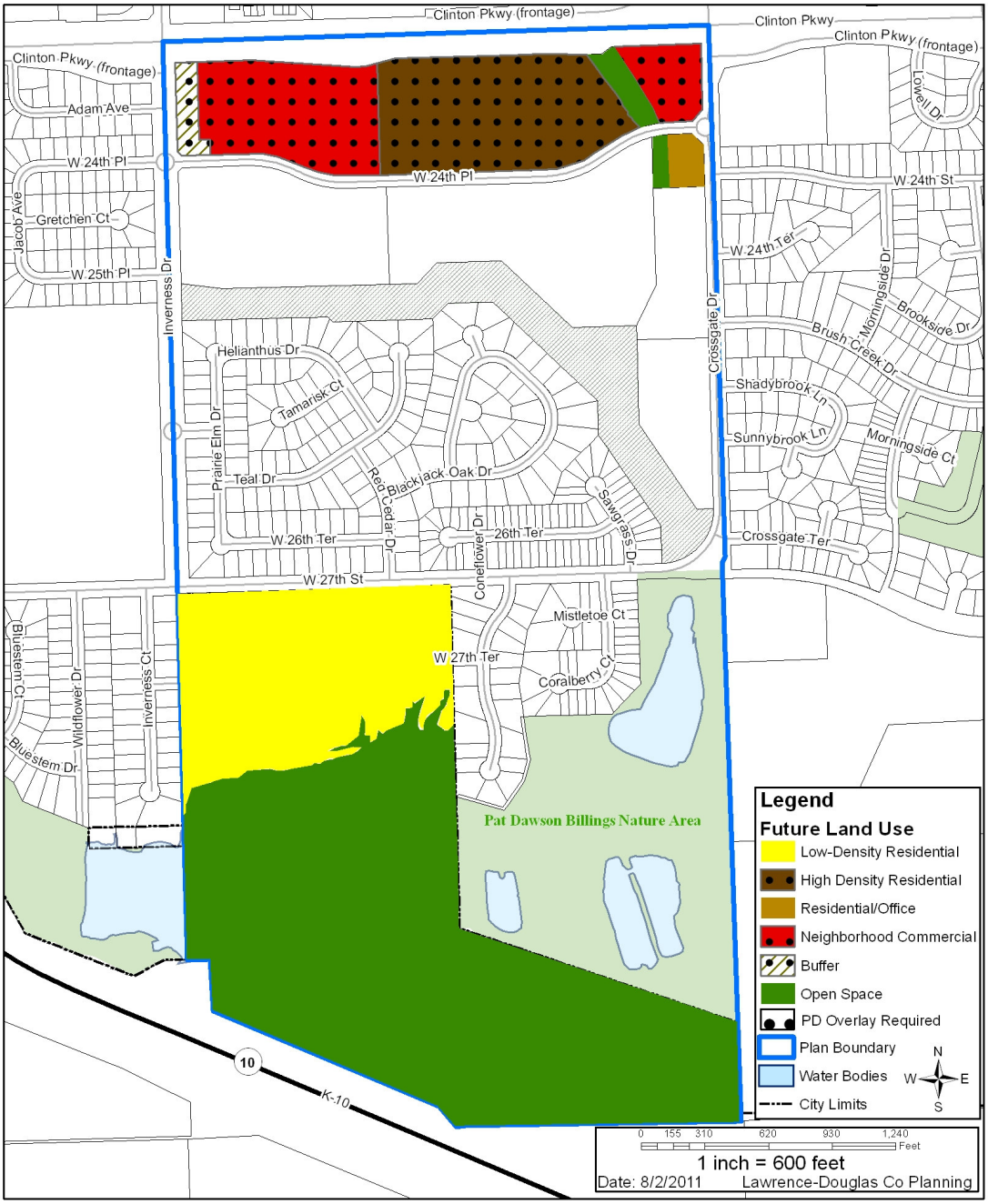
***Intensity:*** light

**Buffer**
This designation is provided on the property that is on the southeast corner of Inverness Drive and Clinton Parkway. It is to provide a landscape buffer for the low density residential uses that are west of the property across Inverness Drive. This area should be designed in a way to provide an effective buffer from the light and noise impacts associated with the commercial development on the Inverness corner. Compliance with the buffer will be required with site plan/ development plan approval.

***Primary Uses:*** Open Space/Landscaping
***Zoning Districts:*** Same as the entire property is zoned
***Intensity:*** light

## Map 4-1 – Future Land Use

**Inverness Park District Plan**
**Future Land Use**



## V. Clinton Parkway

### Access Management

The City of Lawrence and the Board of County Commissioners of Douglas County approved a Resolution in October of 1970 concerning access management along Clinton Parkway. The Resolution said this about Clinton Parkway:

RESOLUTION NO. 3727

WHEREAS, the Governing Body of the City of Lawrence, Kansas, and the Board of Commissioners of Douglas County, Kansas, recognize that the area within the boundaries of the City of Lawrence and within the growth pattern of the City is one urbanizing area, and

WHEREAS, it is the mutual desire and express intention of the abovenamed governing bodies that the aforementioned area should develop in an orderly manner that will provide a safe, efficient, convenient, and confortable living environment for residents of said area and

WHEREAS, both bodies realize the importance of the proposed Clinton Reservoir to the economy and general welfare of Lawrence and Douglas County, and

WHEREAS, it is expressly understood and agreed that Clinton Parkway (that portion of 23rd Street west of Iowa Street to the proposed Jayhawk Park) will be the main access to Clinton Reservoir for residents and visitors to the community, and

WHEREAS, preliminary engineering plans have been prepared, showing limited access for Clinton Parkway at approximately every quarter mile along said roadway;

NOW, THEREFORE, BE IT RESOLVED BY THE GOVERNING BODY OF THE CITY OF LAWRENCE, KANSAS, AND THE BOARD OF COMMISSIONERS OF DOUGLAS COUNTY, KANSAS:

That it is the mutual desire and intention of the Governing Body of the City of Lawrence, Kansas, and the Board of Commissioners of Douglas County, Kansas, that Clinton Parkway shall be a limited access road with no direct access except for intersecting collector roads and streets.

PASSED AND APPROVED this 6th day of October, 1970, by the Governing Body of the City of Lawrence.

THE CITY OF LAWRENCE, KANSAS

by Donald E. Metzler
Donald E. Metzler, Mayor

ATTEST:

Vera Mercer
Vera Mercer, City Clerk

PASSED AND APPROVED this 6th day of October, 1970, by the Governing Body of Douglas County, Kansas.

THE BOARD OF COMMISSIONERS OF DOUGLAS COUNTY, KANSAS

Travis E. Glass, Chairman

Arthur E. Heck

Raymond Ice

ATTEST:

Delbert Mathia
Delbert Mathia, County Clerk

Clinton Parkway ultimately was constructed with limited access in a manner agreed to by the governing bodies with no direct access except at collector street intersections. Any action to seek relief from this access management decision will require appropriate governing body approval.

The result of the access management put in place has created a highly functioning roadway. This Plan does not support additional access to Clinton Parkway that will degrade the functionality of Clinton Parkway.

However, if the property at the southeast corner of Inverness Drive and Clinton Parkway is designated for commercial uses, consideration may be given to providing some limited access to Clinton Parkway. This could help to limit the impact to Inverness Drive that could result from the traffic generated by the property that would have to use Inverness Drive (and the round-a-bout) to get to W. 24th Place in order to access the property. Any consideration for limited access should only be given after a careful and detailed study of a land use proposed. The impact to the traffic signal synchronization along Clinton Parkway should also be part of that study.

## VI. Implementation

The purpose of this section is to provide actions that should happen as this Plan is adopted and urban development starts to occur in the planning area. Each implementation action is assigned a group or groups ultimately responsible for completing or approving the action.

- Amend Horizon 2020 Chapter 14, Specific Plans, to include the Inverness Park District Plan by reference.
  **Who**: Planning Commission, City Commission, County Commission

- Amend Horizon 2020 Chapter 6, Commercial, to designate the southeast corner of Inverness Drive and Clinton Parkway and the southwest corner of Crossgate Drive and Clinton Parkway as Neighborhood Commercial Centers.
  **Who**: Planning Commission, City Commission, County Commission

# Memorandum
# City of Lawrence
# Legal Services Department

**TO:** **Scott McCullough, Director of Planning And Development Services**
**Toni Ramirez Wheeler, Director of Legal Services**

**From:** **John Jay Miller, Staff Attorney**

**Date:** **April 14, 2009**

**RE:** **Discussion on Conditioning Conventional Zoning**

At the February 24, 2009 meeting of the City Commission of Lawrence, Kansas, staff was directed to present information on conditioning conventional zoning to the Lawrence Douglas County Metropolitan Planning Commission. The League of Women Voters of Douglas-County raised the issue of conditional zoning at the City Commission meeting and their letter is attached for your review. For this discussion, conventional zoning means a rezoning request not a request for a special use permit, planned development or site plan. Provided is an overview of the authority to place conditions on conventional zoning and direction for the Planning Commission when considering conditional zoning.

**Development Code Provisions**

The Development Code of the City of Lawrence, Kansas is written to allow the conditioning of conventional zoning. Section 20-1301, General, of the Development Review Procedures, allows the approval of zoning map amendments with conditions or modifications. The code language in subsection (i), Action by Review Bodies, states:

> (i) Action by Review Bodies
>
> (1) Review bodies may take any action that is consistent with:
> (i) the regulations of this Article;
> (ii) the City's adopted Development Policy;
> (iii) any by-laws that may apply to the review body; and
> (iv) the notice that was given.
>
> (2) The review body's action may include recommending approval of the application, recommending approval with modifications or conditions, or recommending disapproval of the application.
>
> (3) The review body may recommend conditions, modifications or amendments if the effect of the condition, modification or amendment is to allow a less intensive use or Zoning District than indicated in the application, reduce the impact of the development, or reduce the amount of land area included in the application.
>
> (4) The review body may recommend that the application be approved conditionally upon the execution of a development agreement acceptable to the Director of Legal Services and/or compliance with the Access Management

Standards and Commercial Design Policies and Standards adopted by the City Commission from time to time.

(5) Review bodies may not recommend a greater Density of development; a more intensive use or a more intensive Zoning District than was indicated in the public notice.

(6) Review bodies are not required to recommend approval of the maximum Density or intensity of use allowed.

The code language in subsection (j), Action by Decision-Making Bodies, states:

(j) Action by Decision-Making Bodies

(1) Decision-making bodies may take any action that is consistent with:
(i) the regulations of this Article;
(ii) the City's adopted development policy;
(iii) any by-laws that may apply to the decision-making body; and
(iv) the notice that was given.

(2) The decision-making body's action may include approving the application, approving the application with modifications or conditions, or denying the application. A denial of application may be accompanied with a remand to the review body, if any, for further consideration.

(3) The decision-making body may impose conditions on the application or allow modifications or amendments if the effect of the condition, modification or amendment is to allow a less intensive use or Zoning District than indicated in the application or to reduce the impact of the development or to reduce the amount of land area included in the application.

(4) The decision-making body may approve the application upon the condition that the applicant executes a development agreement acceptable to the Director of Legal Services and/or compliance with the Access Management Standards and Commercial Design Policies and Standards adopted by the City Commission from time to time.

(5) Decision-making bodies may not approve a greater Density of development; a more intensive use or a more intensive Zoning District than was specified in the public notice.

(6) Decision-making bodies are not required to approve the maximum Density or intensity of use allowed.

The code language in subsection (m), Conditions of Approval, states:

(m) Conditions of Approval
When the procedures of this Article allow review bodies to recommend or decision making bodies to approve applications with conditions, the conditions shall relate to a situation created or aggravated by the proposed use or development. When conditions are imposed, an application will not be deemed approved until the applicant has complied with all of the conditions.

In addition, Section 20-1303 on Zoning Map Amendments states:

(e) Planning Commission's Review/Recommendation

The Planning Commission shall hold a public hearing on the proposed zoning map amendment, review the proposed amendment in accordance with the review and decision-making criteria of Subsection (g) of this Section and recommend that the City Commission approve, approve with modifications, or deny the proposed amendment. The Planning Commission is also authorized to forward the proposed amendment to the City Commission with no recommendation.

(f) City Commission Decision
After receiving the Planning Commission's recommendation, the City Commission shall take one of the following actions on the proposed zoning map amendment:
(1) approve, approve with conditions or modifications, or deny;

**Historical Background on the Enactment of the Development Code Pertaining to Conditional Zoning**

The City Commission discussed the issue of conditional zoning when considering approval of the Development Code. Stephen P. Chinn, a land use attorney with the firm of Stinson Morrison Hecker LLP, advised the City on the code and presented to the City Commission that he had not worked with a code in the past fifteen years that did not specifically authorize governing bodies to condition the approval of rezoning with reasonable conditions. With Mr. Chinn's assistance, the code was written to allow the conditioning of conventional zoning. An excerpt of the minutes from the March 28, 2006 City Commission agenda is attached for your review.

**Kansas Case Law on Conditional Zoning**

There does not appear to be any Kansas case law on the specific issue of conditioning conventional zoning. However, the Kansas Supreme Court took up the issue of conditional zoning in a special use permit situation in the 1994 case of *Water Dist. No. 1 of Johnson County v. City Council of City of Kansas City***,** 255 Kan. 183, 871 P.2d 1256 (Kan. Apr 15, 1994). In *Water District No.1,* the court upheld the conditions on the special use permit as reasonable.

Most recently, the Kansas Supreme Court in the case of *Manley v. City of Shawnee,* 287 Kan. 63, 75-76, 194 P.3d 1 (2008) reaffirmed their standard of review on the reasonableness of zoning body decisions and stated that "[w]hen reviewing a decision on zoning, special use permits, and conditional use permits, we are guided by principles set forth in *McPherson Landfill, Inc. v. Board of Shawnee County Comm'rs,* 274 Kan. 303, 304-05, 49 P.3d 522 (2002) (quoting *Combined Investment Co. v. Board of Butler County Comm'rs,* 227 Kan. 17, 28, 605 P.2d 533 [1980] ):

(1) The local zoning authority, and not the court, has the right to prescribe, change or refuse to change, zoning.

(2) The district court's power is limited to determining

(a) the lawfulness of the action taken, and

(b) the reasonableness of such action.

(3) There is a presumption that the zoning authority acted reasonably.

(4) The landowner has the burden of proving unreasonableness by a preponderance of the evidence.

(5) A court may not substitute its judgment for that of the administrative body, and should not declare the action unreasonable unless clearly compelled to do so by the evidence.

(6) Action is unreasonable when it is so arbitrary that it can be said it was taken without regard to the benefit or harm involved to the community at large, including all interested parties, and was so wide of the mark that its unreasonableness lies outside the realm of fair debate.

(7) Whether action is reasonable or not is a question of law, to be determined upon the basis of the facts which were presented to the zoning authority.

(8) An appellate court must make the same review of the zoning authority's action as did the district court."

**Treatise on Conditional Zoning**

In McQuillin: The Law of Municipal Corporations, 8 McQuillin Mun. Corp. § 25.93.10 (3rd ed.) the concept of conditional zoning is discussed. An excerpt of their explanation of conditional zoning states:

> "Conditional zoning is the granting of a zoning change which is subject to agreed upon specific conditions which limit permitted uses in the zoned district. Specifically, conditional zoning occurs when a governmental body, without committing its own authority, secures a given property owner's agreement to limit the use of his or her property to a particular use or to subject his or her tract to certain restrictions as a precondition to any rezoning. Because it permits a given local authority greater flexibility in balancing conflicting needs, the practice of conditional use zoning can be exceedingly valuable. Conditional zoning anticipates that when the rezoning of certain property within the general zoning framework would constitute an unacceptably drastic change, such a rezoning could still be accomplished through the addition of certain conditions or use limitations.
>
> Although sometimes condemned as illegal spot zoning, and as involving surrender of governmental authority to determine proper land use, the court will look to the reasonableness of the conditions and of the zoning change and will sustain the ordinance if found neither arbitrary nor capricious and where a reasonable relationship to the public welfare is found to exist. An increasing number of courts have either expressly held or strongly indicated support for conditional zoning. These courts, which comprise a growing trend, have concluded, among other things, that zoning legislation provides ample authority for the practice; the use under the practice of carefully tailored restraints advanced, rather than injured, the interests of adjacent landowners, and the practice is an appropriate means of harmonizing private interests in land thus benefiting the public interest."

**Planning Commission Considerations**

If the Planning Commission receives a request from staff, the applicant, the public, or initiates on its own placing conditions on a conventional rezoning request, then the Development Code gives the Planning Commission and then the City Commission the authority to establish reasonable land use conditions on conventional zoning requests. The Planning Commission when considering conditioning conventional zoning must apply the same review criteria they would for any rezoning application and make a recommendation to the City Commission on the rezoning request.

Ultimately, the governing body's decision on the rezoning request must be lawful and reasonable. The issue of lawfulness is whether the city followed statutory requirements and its own codes and procedures. As noted above the Development Code is written to allow conditional zoning and the Planning Commission can condition conventional zoning in conformity with the code.

For the issue of reasonableness in making the rezoning decision, the Planning Commission must at least consider the review and decision making criteria in Section 20-1303(g). The criteria are based on the eight suggested factors described in *Golden v. City of Overland Park*, 224 Kan. 591, 584 P.2d 130 (1978). The review criteria are not exclusive of other appropriate factors. These criteria go to the reasonableness of the rezoning recommendation of the Planning Commission. Any conditions placed on a conventional rezoning request would have to be reasonable and based on the review criteria of the Development Code and the evidence and testimony presented at the hearing.

**Conclusion**

The Development Code is written to give the Planning and City Commission the authority to place reasonable land use conditions on a conventional zoning request. If a rezoning were legally challenged, staff's opinion is that as long as the procedures are followed and the land use conditions are reasonable then we can make a strong argument to the court that the City had the legal authority to condition the zoning.

The discussion of conditioning conventional zoning only applies to City of Lawrence, Kansas rezoning requests and hearings and not rezoning requests for Douglas County.

**League of Women Voters of Lawrence-Douglas County**
P.O. Box 1072, Lawrence, Kansas 66044

RECEIVED
AUG 15 2011
City County Planning Office
Lawrence, Kansas

August 15, 2011

Mr. Richard Hird, Chairman
Members
Lawrence-Douglas County Metropolitan Planning Commission
City Hall
Lawrence, Kansas 66044

RE: **ITEM NO. 4 COMPREHENSIVE PLAN AMENDMENT TO H2020 - CHP14; INVERNESS PARK DISTRICT PLAN (DDW); CPA-3-1-11**: Clarify approval

Dear Chairman Hird and Planning Commissioners:

For the properties fronting on Clinton Parkway the planning staff is recommending a change different from what was approved by the Planning Commission on the Inverness Park District Plan at your July, 2011 meeting. We are writing this letter to register our objection to Option # 2, the second option recommended in the Staff Memo. This Option #2 provides that of " rezoning with conditions that require site plan approval from the City Commission..." This would mean that the second option would be to rezone the Remington Square 15-acre tract to RM24 with conditions.

The specific objection mentioned in the Staff Memo to the use of the Planned Development Overlay District, the option adopted by the Planning Commission last July, is to the "establishment of a mandatory-membership homeowner's association to own and maintain the open space..."

The PD Overlay District was intended to be used with any of our conventional zoning districts, not just single family or cluster development. The staff (or developer's) objection to using the PD Overlay District in Inverness Park is based on the development requiring a formal owner's maintenance agreement. Actually, such an agreement, regardless of how the land is used, depends on how the buildings and land surrounding each building is owned. If the total tract is a single lot and owned by a single entity—the developer or property owner—and will continue to be, there isn't a problem, since the owner of the land is responsible for its maintenance. In the case of the subdivision of apartments as condominiums, which would involve the buildings or parts of buildings and any other commonly-owned land by multiple owners, State law governs with 2010 HB 2472 - a bill enacting the Kansas Uniform Common Interest Owners Bill of Rights Act and previous legislation governing apartment ownership and condominiums.

Even in conventional zoning districts, Kansas State law requires maintenance agreements where there is property ownership by separate multiple owners, under provisions such as that listed above. If the land, or any portion of it, is subdivided and sold to separate owners, the land must be legally subdivided according to our Subdivision Regulations. Therefore, any problems with or objections to creating a maintenance agreement would apply to both circumstances: to a conventional apartment development or to a planned development. Therefore, we do not believe that this is a valid argument against utilizing a Planned Development Overlay District.

We object to regulating the development of the Remington Square Apartments by rezoning the property to RM24 that has been conditioned to essentially function in the same way that the PD Overlay District would. We object for the following reasons.

1. A conventional district, especially in the case of this property fronting on Clinton Parkway, in order to be conditioned, must be modified beyond the existing provisions of the Land Development Code and essentially treated like planned developments. One important

difference in the case of a conditioned conventional district is that the Site Plan will not be legally recorded unless it is made a provision of the zoning ordinance recorded for that specific development. Recordation of the Final Development Plan in a Planned Development is routine, and is a protection for the neighborhood and investors.

2. Conditioning of conventional zoning is not sanctioned by any existing ordinance; therefore it is essentially arbitrary, and establishes a precedence and unpredictability to those not familiar with Lawrence development practices. In order for these conditioned conventional districts to be distinguished from other conventional districts, they should (and we hope are) being given special notation on the Zoning District Map.

Regarding the need for increased density in Remington Square, the PD Overlay District has been changed by Ordinance 8641 which allows density values to be recalculated on the basis of number of bedrooms in an apartment. The PD Overlay District also allows a 25% increase in density if approved by the City Commission. Therefore, by utilizing the PD Overlay District with the existing RM15 zoning for the Remington Square Apartments, there should be no problem in developing the remaining vacant 4-acre tract as one-bedroom apartments.

We suggest that if this practice of conditioning conventional zoning is to be continued, that it be given official verification by modifying the Land Development Code to specifically allow it, including the requirement for a special notation on the Lawrence Zoning District Map.

We hope that you will seriously consider our concerns and suggestions and not change your recommendations for the Inverness Park District Plan that you adopted this past July. In other words, please do not include Option #2 in the Inverness Park District Plan.

Thank you.

Sincerely yours,

Alan Black

Milton Scott
Vice President

Alan Black, Chairman
Land Use Committee

**League of Women Voters of Lawrence-Douglas County**
P.O. Box 1072, Lawrence, Kansas 66044

RECEIVED
AUG 18 2011
City County Planning Office
Lawrence, Kansas

August 18, 2011

Mr. Richard Hird, Chairman
Members
Lawrence-Douglas County Metropolitan Planning Commission
City Hall
Lawrence, Kansas 66044

**RE: Staff Report for ITEM NO. 4 COMPREHENSIVE PLAN AMENDMENT TO H2020 - CHP14; INVERNESS PARK DISTRICT PLAN (DDW); CPA-3-1-11:** Clarify approval.

Dear Chairman Hird and Planning Commissioners:

Regarding the Staff Report in reply to our letter of August 15, which is included in the current packet on the Inverness Park District Plan, we believe that there is some misunderstanding of the important points that we were expressing, or trying to express, in this letter.

In order to clarify this letter of August 15, we are including an outline of the points that we were attempting to make. We hope this clarifies our suggestions.

We thank you for your patience and understanding.

Sincerely yours,

Alan Black

Alan Black, Chairman
Land Use Committee

Attachment

# SUMMARY OF LWV-L/DC THOUGHTS ON THE STAFF RECOMMENDATIONS TO CHANGE THE INVERNESS PARK DISTRICT PLAN FOR REMINGTON SQUARE.

August 18, 2011

Our Reasons for Objection to Staff recommended changes to the Inverness Pk Plan to include Option #2:

Option #2, apparently would allow the developer, having maxed the density of the RM15 District, to choose his development method—a PD or conditioned conventional zoning. The second option to develop under a conditioned conventional district of RM24 would limit the density and building type. We objected to Option #2 in our letter dated August 15, which is included in the Staff Report. Staff sent a rebuttal to our August 15 objections and in it gave arguments for the legal validity of conditioning conventional zoning.

Our letter did not question the legal validity of conditioning conventional zoning per se. Rather, we pointed out the unsolved problems with the process: its arbitrary nature, unpredictability, and the need for securing the future of the development outcomes. In other words, the need for incorporating the practice of conditioning conventional zoning in a formal way into the Land Development Code.

A. Staff (and presumably the developer) objected to the PD because it requires creating a mandatory membership in a homeowners association. Our letter pointed out that with both situations, property maintenance would be mandatory if there are multiple owners.

1. A mandatory-membership homeowner's association to own and maintain the open space applies for both options—Option#1 and Option#2. Why?
    a. If there are multiple owners with common property or ground, State law requires provision for maintenance of common ownership in both land and property through State apartment and condominium law in both PDs and conventional zoning.
    b. If there is no multiple ownership of common property or land, the owner has maintenance responsibility.
2. If there is land subdivision with individuals owning multiple tracts, the Subdivision Regulations govern. We assume that currently the Remington Square Apartments land is one 15-acre lot under one ownership. If not, it is in violation of the Subdivision Regulations, and this is a whole new situation.

B. Rezoning to RM24 requires conditioning of conventional zoning in order to control the development.
    1. Our objections to current methods for conditioning of conventional zoning:
        a. No formal regulations govern it. The two other methods of zoning for conditioning uses and sites are Special Use Permits and Planned Developments. Provisions and procedures for conditioning are written into these two articles.
        b. There is no consistent method for insuring that the conditions applied to a specific tract will be permanent or that changes will be subject to public review.
            1) Plans are presented as Site Plans and are not legally recorded in the same way as Final Development Plans.

2) The legal cases cited in the Staff Report; i.e., McQuillin: *The Law of Municipal Corporations*, 8 McQuillin Mun. Corp. § 25.93.10 (3rd ed.) mention the need for a development agreement with the developer. Development agreements may not be permanent unless they run with the land or at least are always legally recorded with the rezoning ordinance for the conditioned land.

c. There is a need for distinguishing the conditioned conventional districts from non-conditioned conventional districts on the Zoning District Map. Is it being done now?

2. Remedies for the problems listed above include two suggestions.

a. Provide an ordinance specifically permitting conditioning of conventional districts, outlining what can be conditioned, the process, public input, methods of insuring compliance and recordation to guarantee permanence.

b Require a distinguishing notation on the Zoning District Map for conditioned conventional districts so that prospective buyers are aware that the zoning on the site has conditions on it.

C. To repeat: the purpose of our letter to you of August 15, 2011, and this letter is to (1) request that you do not include Option #2 in the Inverness Park District Plan for Remington Square Apartments and (2) as described above, remedy the uncertainties of conditioning conventional zoning districts by incorporating the process formally into the Land Development Code.

LWV-L/DC Land Use Committee

**PLANNING COMMISSION REPORT**
**Regular Agenda - Public Hearing Item**

PC Staff Report
08/24/2011

**ITEM NO. 5A: Z-7-18-11 U-KU (University-Kansas University) District TO RM32PD (Multi-Dwelling Residential) District Planned Development; 0.08 Acres (LBZ)**

**Z-7-18-11**: Consider a request to rezone approximately 0.80 acres from U-KU (University-Kansas University) to RM32-PD (Multi-Dwelling Residential-Planned Development), located at 1043 Indiana Street. Submitted by Paul Werner Architects, for Triple T LLC, property owner of record.

**STAFF RECOMMENDATION:** Staff recommends approval of the request to rezone approximately 0.08 acres, from **U-KU (University-Kansas University) District TO RM32PD (Multi-Dwelling Residential) District Planned Development** based on the findings presented in the staff report and forwarding it to the City Commission with a recommendation for approval.

**Reason for Request:** *Currently the property is zoned U-KU and development is being planned by a private developer which requires the property to be rezoned to a City zoning designation. We are requesting the site be rezoned from U-KU to RM32 to a level of high density as designated in the Oread Neighborhood Plan. In addition, this zoning will allow a majority of 2-bedroom units.*

**KEY POINTS**
- The property is located in the environs of the Oread Historic District and the Michael D. Greenlee House, National Register of Historic Places.
- The property is located in the Oread Neighborhood Plan area.

**ASSOCIATED CASES/OTHER ACTION REQUIRED**
- **PDP-7-1-11 Preliminary Development Plan for 1043 Indiana Street**
- **DR-4-49-11 Design Review for 1043 Indiana Street**
- **Final Development Plan**
- **City Commission Approval**
- **Publication of the Zoning Ordinance**

**PLANS AND STUDIES REQURIED**
- *Traffic Study* – Not required for rezoning.
- *Downstream Sanitary Sewer Analysis* – not required for rezoning
- *Drainage Study* – Not required for rezoning
- *Retail Market Study* – Not applicable to residential request

**ATTACHMENTS**
- Area Map

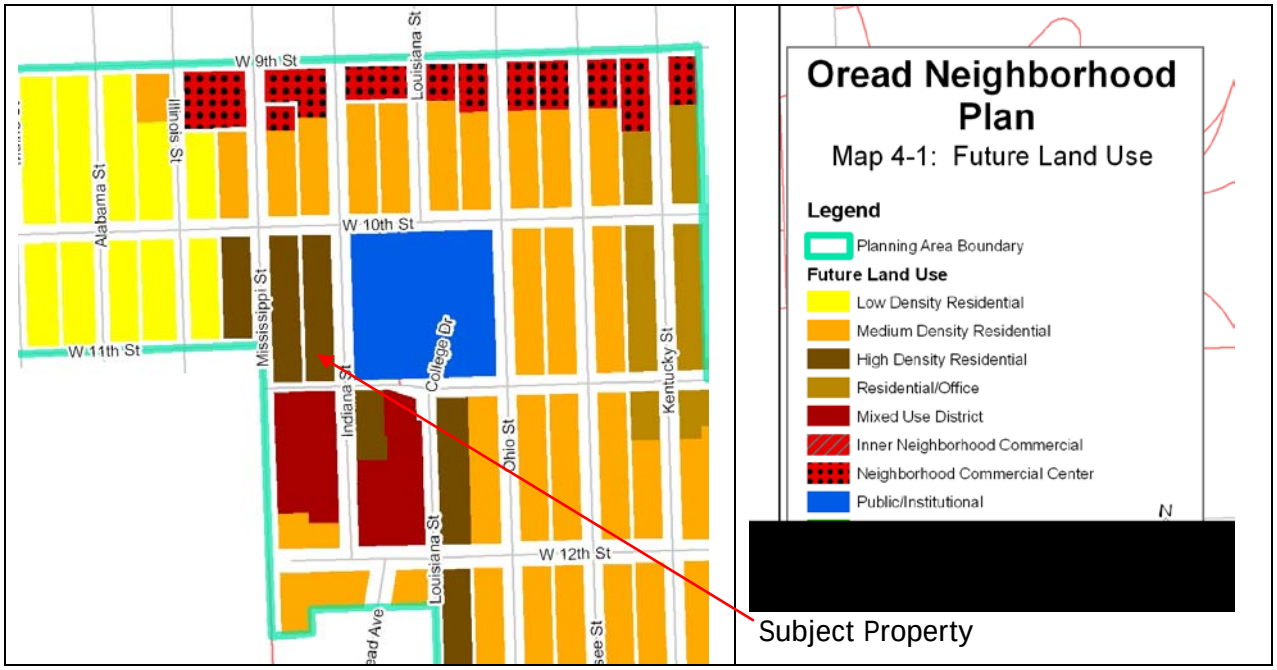
**PUBLIC COMMENT RECEIVED PRIOR TO PRINTING**
-

**Project Summary:**
The proposed request is for rezoning to allow for redevelopment of the property as a multi-dwelling apartment building. The proposed redevelopment will also require a preliminary development plan, a final development plan, a final plat, and Historic Resources Commission review. The current zoning allows only the University of Kansas to develop the property in accordance with the Cooperation Agreement Between the City of Lawrence, Kansas, and the University of Kansas, dated April 7, 2005. The University of Kansas no longer owns the property nor will the property be developed or used by the University. Therefore, it is necessary to rezone the property to a City zoning district. The new property owner desires to develop the property with a multi-family apartment building and the existing structure will be moved to the north end of the proposed development and will be used as a congregate residence. The proposed development will have a total of 51 dwelling units including the congregate residence.

## 1. CONFORMANCE WITH THE COMPREHENSIVE PLAN

Applicant's Response: *The Comprehensive Plan show this area developing as medium or high density residential. The Oread Neighborhood Plan, a more recent plan, designates this area as high density as well.*

**Staff Finding –** Staff finds that the proposal is in conformance with the comprehensive plan. Chapter Five – Residential Land Use identifies as the second strategy infill residential development. The fifth strategy for Residential Development identifies "The character and appearance of existing residential neighborhoods should be protected and enhanced. Infill development, rehabilitation or reconstruction should reflect architectural qualities and styles of existing neighborhoods." Chapter 14 – Specific Plans, Oread Neighborhood Plan identifies this area on the Future Land Use map as High Density Residential.



## 2. ZONING AND USE OF NEARBY PROPERTY, INCLUDING OVERLAY ZONING

| | |
|---|---|
| Current Zoning and Land Use: | U-KU (University-Kansas University) District, vacant structure and parking lot |
| Surrounding Zoning and Land Use: | North: RM32, multi-dwelling, apartments<br>South: RM32, multi-dwelling, apartments<br>East: U-KU, parking structure and University residence halls<br>West: RM32, multi-dwelling, apartments |

**Staff Finding –** The existing zoning U-KU does not allow for development because the University of Kansas no longer owns the property. The surrounding zoning other than the U-KU zoning to the east is all RM32. Currently the existing area is a mixture of multi-family residential in the forms of apartments, Greek housing, and residence halls. Directly to the east is the University parking structure that provides parking for the residence halls – GSP and Corbin – that are adjacent to the east. The area to the north includes large single family structures that have been converted into apartments or congregate residences. The proposed zoning is consistent with the zoning and uses in the area.

## 3. CHARACTER OF THE NEIGHBORHOOD

Applicant's Response: *Many older apartments, many 3 stories, converted single family homes, parking structures, large dormitories, and greek housing.*

**Staff Finding –** The Oread Neighborhood is a mixture of historic building stock, large apartment complexes, and University residence halls/buildings. The neighborhood wraps around the north and east of the University of Kansas and is between the University and the downtown area. Two National Register of Historic Places districts exist in this neighborhood as well as twelve individually listed properties. Historically, this area of the Oread neighborhood developed with a combination of large houses on multiple lots and standard size houses on single lots. The 1918 Sanborn Fire Insurance Map shows 1043 Indiana, constructed in 1908, as a Fraternity and the lot to the north as vacant. Old College, the original University building, was in the center of what is labeled University Park (now GSP and Corbin area) is directly to the east where the housing pattern was more developed with most lots supporting structures by 1918. In 1918 it also appears that the area to the north of the 1000 Block of Indiana and Old College had developed with a mix of smaller and moderate size dwellings. To the west of the 1000 Block of Indiana Street, Mississippi Street developed with moderate size houses on individual lots. The alley was used for accessory access with accompanying structures. The historic structures, narrow streets, alleys, location and diverse housing make the area ideal for individuals that desire to live close to downtown and the University. Because of the desirability of the area, many of the lots have been combined over time to redevelop as both small and large apartment complexes to serve the growing student population of the University. The Oread Neighborhood Plan identifies the area as "predominantly rental" and as a place "where a diverse array of people live, work, study, and celebrate."

Table 2-1 Existing Land Use Summary from the Oread Plan

| Land Use | Acres | Percent of Acreage |
|---|---|---|
| Single-Dwelling Residential | 51.19 | 32% |
| Duplex | 16.63 | 10% |
| Triplex | 10.09 | 6% |
| Fourplex | 12.44 | 8% |
| Congregate Living | 10.81 | 7% |
| Multiple-Dwelling Residential | 26.23 | 16% |
| Vacant Residential | 1.08 | 1% |
| Mixed Use | 1.90 | 1% |
| Commercial | 8.06 | 5% |
| Parking Lot | 2.96 | 2% |
| Parks/Rec/Open Space | 6.43 | 4% |
| Public/Institutional | 14.26 | 9% |
| Total Acres | 162.07 | 100% |

## 4. PLANS FOR THE AREA OR NEIGHBORHOOD, AS REFLECTED IN ADOPTED AREA AND/OR SECTOR PLANS INCLUDING THE PROPERTY OR ADJOINING PROPERTY

**Staff Finding –** The subject property is located in the Oread Neighborhood Plan area. The Oread Neighborhood Plan was adopted by the Lawrence City Commission on September 21, 2010. The plan identifies goals, policies and implementation strategies for the area with outlines for future land uses and a long-term guide for urban development and redevelopment. According to the plan,

### *3.1.1 Goal 1 – Land Use*

Maintain a variety of housing types to provide a balance in the diversity of people living in the neighborhood while maintaining strong neighborhood scale commercial areas.

3.1.1.1 Land Use Policies

E. New development should respect the historic integrity of the neighborhood.

### *3.1.2 Goal 2 - Preservation*

Preserve and improve the character of the neighborhood by encouraging the preservation of existing historic structures and features and by supporting infill development that is compatible with the surrounding neighborhood.

3.1.2.1 Preservation Policies

A. Continue the preservation and protection of historic resources in the neighborhood.

B. Infill structures should be compatible with the massing, scale, and bulk of the historic structures in the surrounding area.

The future land use map for the Oread Neighborhood Plan (shown above) identifies areas that are recommended for "High-Density Residential". The intent of the high-density residential use is to allow for compact residential development at a density of more than 16 units per acre. The Oread Neighborhood Plan also identifies overlay districts for the plan area. District 2

(which includes the subject property) is designated to be a High-Density Overlay District that should develop and redevelop as high-density and mixed use.

## 5. SUITABILITY OF SUBJECT PROPERTY FOR THE USES TO WHICH IT HAS BEEN RESTRICTED UNDER THE EXISTING ZONING REGULATIONS

Applicant's Response: *It is currently zoned KU and was previously designated RD which was the highest zoning category available at the time.*

**Staff Finding –**The 1996 city-wide rezoning designated properties owned by the University of Kansas as U-KU to reflect the land use agreement between the City of Lawrence and the University of Kansas. The subject property has recently been sold by the University of Kansas and is no longer subject to the agreement. Before development or redevelopment can occur, the property must be zoned to a zoning district that can allow for development by a non University entity. Prior to the 1996 rezoning, the subject property was zoned RD- Residential Dormitory District. The purpose of the RD district was to provide areas for high population density. The district was intended to permit the development of land for multiple-family dwellings and dormitory-type residence halls in properly planned and centrally located areas in a residential environment. In 2006, properties zoned RD were zoned RM32 as part of the adoption of the Land Development Code. Because the University no longer owns the subject property, the U-KU zoning is no longer appropriate.

## 6. LENGTH OF TIME SUBJECT PROPERTY HAS REMAINED VACANT AS ZONED

Applicant's Response: *It has been unoccupied for 4 years.*

**Staff Finding –** The parking area (Lots 7-10) is currently in use. The existing structure located at 1043 Indiana on Lots 11 and 12 is currently vacant and has been so for approximately four years. The property was sold to the current owner in August of 2009.

## 7. EXTENT TO WHICH APPROVING THE REZONING WILL DETRIMENTALLY AFFECT NEARBY PROPERTIES

Applicant's Response: *Surrounding properties are currently zoned RM32. There will be no detrimental affect to the neighbors.*

**Staff Finding –** The properties to the north, south, and west are all zoned RM32 and have multi-dwelling uses. The property to the east is a parking structure. Historically this area has been a high density area. The existing structure located at 1043 Indiana, while constructed for a single family use, was converted to a fraternity use by 1920. The RM32 zoning is compatible and consistent with the surrounding zoning and should not detrimentally affect the nearby properties.

## 8. THE GAIN, IF ANY, TO THE PUBLIC HEALTH, SAFETY AND WELFARE DUE TO THE DENIAL OF THE APPLICATION, AS COMPARED TO THE HARDSHIP IMPOSED UPON THE LANDOWNER, IF ANY, AS A RESULT OF DENIAL OF THE APPLICATION

Applicant's Response: *The gain to the community would be new higher and energy efficient apartments adjacent to KU, and near downtown. The hardship is the property cannot be developed under current zoning (U-KU).*

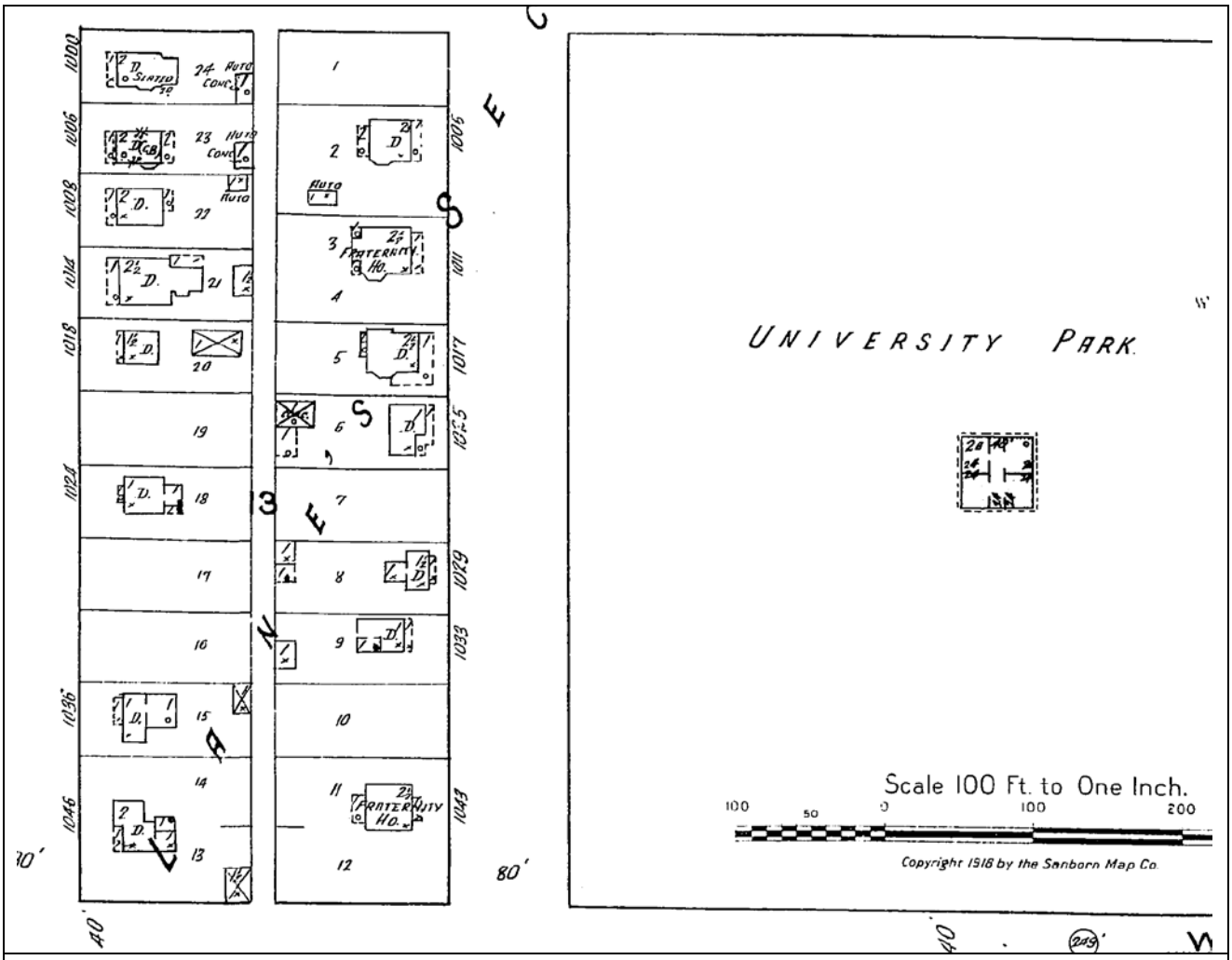
Evaluation of this criterion includes weighing the benefits to the public versus the benefit of the owners of the subject property. Benefits are measured based on anticipated impacts of the rezoning request on the public health, safety, and welfare.

**Staff Finding –** This rezoning request is part of a development proposal for the property that includes the moving of the existing structure to the north end of the property and the construction of a new 50 unit apartment building of approximately 69,728 sf and two levels of underground parking. The existing structure is historic although not listed on any register. The demolition of the structure would be a negative impact to the preservation principles outlined in the Oread Neighborhood Plan. The retention of the structure and the utilization of the property for infill development achieves goals addressed in the Oread Neighborhood Plan and the Comprehensive Plan. There is currently a hardship on the owner of the property as U-KU zoning is a specific zoning district for the University of Kansas. The denial of the application for rezoning would preclude any development on the land because the University no longer owns the property. For infill development to occur, the property must be zoned to a district other than U-KU.

## 9. PROFESSIONAL STAFF RECOMMENDATION

The structure located at 1043 Indiana Street was built in 1908 for Professor William Christian Hoad, a distinguished professor of Civil Engineering. Hoad was Assistant Professor, Associate Professor, and Professor of Civil Engineering and head of that department at the University of Kansas between 1900 and 1912. Hoad was also the Chief Engineer for the Kansas State Board of Public Health from 1907-1912. In this position, Hoad advised more than 200 Kansas cities and towns on public sanitation and initiated the 1907 law of sewage standards. Later, Hoad became the Professor of Municipal and Sanitary Engineering at the University of Michigan from 1912-1944.

1043 Indiana Street was converted to fraternity use by 1918. 1043 Indiana Street was purchased by KU in 1950. Commonly called the Varsity House, 1043 Indiana Street has housed various departments and groups from the University of Kansas. It was most notably known as the residence hall for football players during the 1950s, called Jock's Niche.



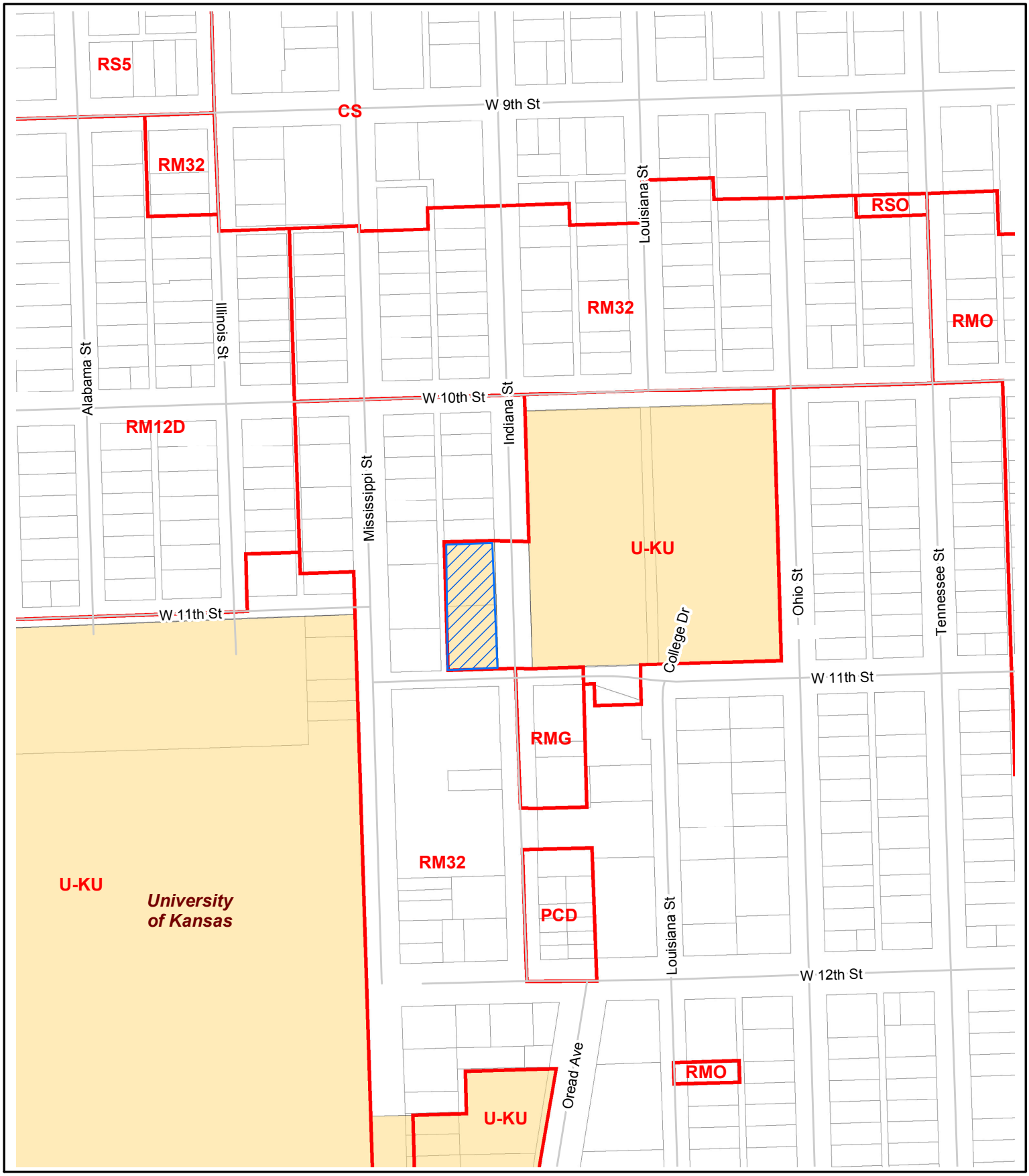

1918 Sanborn Fire Insurance Map for 1000 Block of Indiana

The existing zoning for the property is U-KU. This zoning was designed to reflect the City of Lawrence and the University of Kansas Land Use Agreement. The property is no longer owned by the University and is no longer subject to that agreement. The property must be rezoned to a zoning district that will allow for ownership other than the University.

The Oread Neighborhood Plan identifies this area on the future land use map as high density residential. The RM32 District is the appropriate district for high density residential. Rezoning with the Planned Development Overlay provides flexibility on the owner's part and additional review on the community's part for this significant infill development project.

**CONCLUSION**

Staff recommends approval of the request to rezone approximately 0.0807 acres, from **U-KU (University-Kansas University) District TO RM32PD (Multi-Dwelling Residential) District Planned Development** based on the findings presented in the staff report and forwarding it to the City Commission with a recommendation for approval.




# Z-07-18-11: Rezone 0.8 acres from U-KU to RM32-PD
# 1043 Indiana Street

Lawrence-Douglas County Planning Office
August 2011

N
W E
S

Area Requested

Scale: 1 Inch = 300 Feet

**PLANNING COMMISSION REPORT**
**Regular Agenda -Public Hearing Item**

PC Staff Report
08/24/11

**ITEM NO. 5B: PRELIMINARY DEVELOPMENT PLAN; .80 ACRES; 1043 INDIANA ST (LBZ)**

**PDP-7-1-11**: Consider a Preliminary Development Plan to relocate the Varsity House and development of a Multi-Dwelling Structure, located at 1043 Indiana Street. Submitted by Paul Werner Architects, for Triple T LLC, property owner of record.

**STAFF RECOMMENDATION:**

Staff recommends approval of the following waiver and reduction:
1. Reduction of the front yard setback to 7' on the north 50' of the property.

Staff recommends approval of the Preliminary Development Plan for 1043 Indiana Street based on the findings presented in the staff report and forwarding it to the City Commission with a recommendation for approval subject to the following conditions:

1. The applicant submit a drainage study to be reviewed and approved by the City prior to submission of a Final Development Plan.
2. The submission of public improvement plans prior to submission of a Final Development Plan.
3. Submission of a revised Preliminary Development Plan to include the following:
    a. A note identifying the 18' front yard setback is based on average setbacks on the block as permitted by Section 20-602(e)(i);
    b. A note identifying the 7' front yard setback along the north 50' of the property as an approved waiver with this Preliminary Development Plan;
    c. Correction of plans noted in staff review comments dated 08/08/11;
    d. Correction of total units on 4th floor in the Detailed Project Summary and identification of Varsity House as a Congregate Living unit;
    e. A note identifying the height of the retaining walls along all sides of the property;
    f. A note indicating this planned development is restricted to the uses allowed in the RM32 district; and
    g. Removal of the note that identifies the project will utilize removed brick from the alley to landscape on the site. If the alley is reconstructed, the historic brick must be gently removed and placed on pallets for delivery to the City.
4. The submission and approval of building elevations and floor plans that identify: height, common open space, and recreational space for Planning Staff to determine Development Code compliance.
5. The applicant verify the entire development site is under unified control.
6. Completion of Historic Resources Commission conditions of approval.

**ALTERNATE RECOMMENDATION**
If following the public hearing, the Planning Commission determines there are too many outstanding issues, the following alternate recommendation is provided:

The applicant will provide the necessary documents to complete the staff review. Staff will review the plans and make a final recommendation to the Planning Commission at the next Planning Commission meeting.

**Reason for Request:** Development of a multi-dwelling residential project.

**Attachments:**

1. Preliminary Development Plan drawing and renderings
2. Location Map
3. Historic Resources Staff Report for DR-4-49-11

**KEY POINTS**

- The property is located in the Oread Neighborhood Plan area.
- The property is located in the environs of the Oread Historic District and the Michael D. Greenlee House, National Register of Historic Places.

**FACTORS TO CONSIDER**

- Conformance with the purpose of Planned Developments (Section 20-701, Development Code).
- Compliance with Development Code.
- Conformance with *Horizon 2020*.
- Conformance with the Oread Neighborhood Plan
- Conformance with Subdivision Regulations.

**ASSOCIATED CASES/OTHER ACTION REQUIRED**

**Cases requiring action**

- City Commission approval of Preliminary Development Plan.
- Submittal of a Final Development Plan for approval and recordation at the Douglas County Register of Deeds Office.
- Submittal and approval of public improvement plans.
- Z-7-18-11 U-KU to RM32PD
- DR-4-49-11 Design Review for 1043 Indiana Street
- Submittal and approval of final plat.

**PLANS AND STUDIES REQUIRED**

- *Traffic Study* – Received and accepted by staff.
- *Downstream Sanitary Sewer Analysis* – Received and accepted by staff.
- *Drainage Study* – Not submitted
- *Commercial Design Guidelines* – Not applicable to this project.

**PUBLIC COMMENT RECEIVED PRIOR TO PRINTING**

None received to date

**GENERAL INFORMATION**

| | |
|---|---|
| Current Zoning and Land Use: | U-KU (University-Kansas University) District, vacant structure and parking lot |
| Surrounding Zoning and Land Use: | North: RM32, multi-family, apartments<br>South: RM32, multi-family, apartments<br>East: U-KU, parking structure and University residence halls<br>West: RM32, multi-family, apartments |

**Site Summary:**
The request is for a single phase, multi-dwelling apartment building located on the west side of the 1000 block of Indiana Street. The project includes 5 1-bedroom apartments, 41 2-bedroom apartments, 4 3-bedroom apartments, a congregate residence with 6 bedrooms, a club room, 11,169 sf of public open space, and two levels of underground parking.

- Waiver 1. Reduction in the required front yard setback from 25' to 7' along the east property line. The majority of the structure is located 18' from the east property line, but the relocated structure is only 7' from the east property line. (The structure is 19' from the property line but the substantial front porch is located 7' from the property line.) The applicant has provided an analysis of the setbacks in the block to determine if the proposed setback is eligible for the exception identified in 20-602(e)(1). The average setback for this side of the street is 16.5'. This section of the code would allow the project to comply with the average front setback of the existing buildings. However, the reduction to 7' is greater than the average allowed. Staff supports this waiver request as the majority of the building is behind the average setback and the reduced setback for the moved structure will help accentuate the structure as part of the development.

**STAFF ANALYSIS**
The property is located in the 1000 block of Indiana Street, lots 7-12 of Block 13 of Lane's Second Addition to the City of Lawrence. Access to the development will be taken from Indiana Street and from the alley located mid block between Indiana Street and Mississippi Street. The subject property will be bounded by residential development to the west, north and south and with a parking structure located to the east.

The development proposal is for a Planned Residential Development containing the relocated Varsity House, approximately 3,800 sf, and a new apartment building of approximately 69,728 sf. The Varsity House will be utilized as a six bedroom congregate residence and will be relocated to what is now Lot 7. The apartment structure will contain a mix of one, two, and three bedroom units for a total of 50 units. Total units for the development will be 51 units.

The proposed Preliminary Development Plan for Varsity House to be located at 1043 Indiana Street has been evaluated based upon findings of fact and conclusions per Section 20-1304(d)(9) of the Development Code for the City of Lawrence, requiring consideration of the following nine items:

1) *The Preliminary Development Plan's consistency with the Comprehensive Plan of the City.*

Staff finds that the proposal is in conformance with the comprehensive plan. Chapter Five – Residential Land Use identifies as the second strategy infill residential development. The fifth strategy for Residential Development identifies "The character and appearance of existing residential neighborhoods should be protected and enhanced. Infill development, rehabilitation or reconstruction should reflect architectural qualities and styles of existing neighborhoods." The proposed project does reflect the architectural qualities and style elements of the existing neighborhood. The overall size of the proposed structure is atypical for the area, but other large apartment complexes do exist in the area.

The Comprehensive Plan recommends that Development Proposals be reviewed for compatibility with existing land uses, including any neighborhood plan. (Policy 4.1, page 5-17) The subject property lies within the boundary of *The Oread Neighborhood Plan* that was adopted by the

Lawrence City Commission on September 21, 2010. The Oread Neighborhood Plan (Chapter 14 – Specific Plans, Oread Neighborhood Plan) identifies this area on the Future Land Use map as High Density Residential.

The Oread Neighborhood Plan identifies goals, policies and implementation strategies for the area with outlines for future land uses and a long-term guide for urban development and redevelopment. According to the plan,

### *3.1.1 Goal 1 – Land Use*

Maintain a variety of housing types to provide a balance in the diversity of people living in the neighborhood while maintaining strong neighborhood scale commercial areas.

3.1.1.1 Land Use Policies

E. New development should respect the historic integrity of the neighborhood.

The future land use map for the Oread Neighborhood Plan identifies areas that are recommended for "High-Density Residential". The intent of the high-density residential use is to allow for compact residential development at a density of more than 16 units per acre. The proposed project will utilize the density calculation identified in 20-701(f)(2)(ii). Using this calculated density, the proposed density of the project is 30.8 units per acre – high density.

The Oread Neighborhood Plan also identifies overlay districts for the plan area. District 2 (which includes the subject property) is designated to be a High-Density Overlay District that should develop and redevelop as high-density and mixed use. There are currently no overlay districts in place and no local design standards for new construction in this area.

The proposed project seeks to respect the historic integrity of the neighborhood by utilizing design techniques that attempt to reduce the overall scale and bulk of the new structure and using compatible materials and forms to help integrate the new structure into the neighborhood.

The Oread Neighborhood Plan also identifies goals, policies and implementation strategies for preservation.

### *3.1.2 Goal 2 - Preservation*

Preserve and improve the character of the neighborhood by encouraging the preservation of existing historic structures and features and by supporting infill development that is compatible with the surrounding neighborhood.

3.1.2.1 Preservation Policies

A. Continue the preservation and protection of historic resources in the neighborhood.

B. Infill structures should be compatible with the massing, scale, and bulk of the historic structures in the surrounding area.

The proposed project does not preserve the existing historic structure on site in its original location. The proposed project will, however, rehabilitate the existing structure and move it to the north end of the site as opposed to demolishing the structure.

The proposed project is not compatible with the massing, scale, and bulk of the historic structures in the surrounding area. However, directly across the street from this proposed development is the parking structure for the multi-story residence halls that are adjacent to the east.

**Staff Finding –** The proposed development generally complies with the land use provisions found in *Horizon 2020* and the *Oread Neighborhood Plan*. The proposed development may not comply with the preservation policies identified in the Oread Neighborhood Plan.

*2) Preliminary Development Plan's consistency with the Planned Development standards of Section 20-701 including the statement of purpose. (The statement of purpose of planned unit developments is found in Section 20-701(a) of the Development Code]*

The purpose statement includes the following:

a) *Ensure development that is consistent with the comprehensive plan*. As discussed previously, the proposed development's use, high density residential, is consistent with the comprehensive plan and the adopted plan for the area. The moving of the historic structure and the proposed one structure development may not meet the intent of the preservation and infill design characteristics defined in the Oread Neighborhood Plan.

b) *Ensure that development can be conveniently, efficiently and economically served by existing and planned utilities and services*.
The proposed infill development will utilize the existing public and private utilities that have been determined to be sufficient for the project. However, the City Stormwater Engineer indicated that the drainage study has not been submitted or approved for this project.

c) *Allow design flexibility which results in greater public benefits than could be achieved using conventional zoning district regulations.*
This area could develop as a conventional RM32 District. The benefit of requiring development through the planned development process is the ability to address the design of the site and the impact of the project on the existing features and neighborhood character at the preliminary plat stage (Preliminary Development Plan) and conserve as many of the character defining features as possible. An additional benefit for this project is the calculated density the PDP allows. This calculated density allows the applicant and the community the advantage of a higher residential density located adjacent to the University of Kansas.

d) *Preserve environmental and historic resources.*
The existing structure located at 1043 Indiana Street was built in 1908 for Professor William Christian Hoad, a distinguished professor of Civil Engineering. Hoad was Assistant Professor, Associate Professor, and Professor of Civil Engineering and head of that department at the University of Kansas between 1900 and 1912. Hoad was also the Chief Engineer for the Kansas State Board of Public Health from 1907-1912. In this position, Hoad advised more than 200 Kansas cities and towns on public sanitation and initiated the 1907 law of sewage standards. Later, Hoad became the Professor of Municipal and Sanitary Engineering at the University of Michigan from 1912-1944. The structure located at 1043 Indiana Street is also significant for its architecture. The architectural style of the structure is a vernacular interpretation of the Shingle Style and the Dutch Colonial Revival style with some Craftsman style detailing. This type of architecture is not common in Lawrence with only a few examples still extant. While the structure located at 1043 Indiana Street is not currently listed in any historic register, it has been identified as eligible for listing in the National Register of Historic Places by the State Historic Preservation Office. Moving historic structures is not recommended by the National Park Service of the State Historic Preservation Office as it removes the structure from its historic context and creates an artifact without environs. The proposed project will move the existing structure and destroy its existing context. The applicant proposes the moving of the structure as a compromise from an earlier proposal to

demolish the structure. The current proposal to move the structure will preserve some of the existing structure but will not preserve the structure and its context. (See attached historic resources report.)

Existing structure located at 1043 Indiana Street

e) *Promote attractive and functional residential, nonresidential, and mixed-use developments that are compatible with the character of the surrounding area*.
The proposed development will provide an attractive and functional residential development. The applicant has worked with staff and the Architectural Review Committee of the Historic Resources Commission to identify design techniques to help make the structure more compatible with the historic character of the area. While the overall massing, bulk and scale of the project is large, the design details make this an attractive addition to the area.

Section 20-701(d) states that all of the standards of the Development Code apply to development within a PD District except as expressly authorized by regulations of Section 20-701.

The Minimum District Size identified in Section 20-701(c) is ½ acre. The proposed development meets this standard at 0.80 acre.

Section 20-701(f) identifies the Standards Eligible for Modification for the planned development. The Planning Commission shall recommend and the City Commission shall approve, a list of uses allowed in a Planned Development at the time of the preliminary approval. The only uses proposed for this development are residential multi-dwelling uses. The mix of one, two, and three bedroom dwelling units and the proposed congregate residence are all allowed in the base district RM32.

The only other use will be the accessory use of a club house for the residences of the complex. Staff recommends the list of approved uses be the base district approved uses for the RM32 District.

The proposed development will be encompassing platted lots 7-12 of Lane's Second Addition to the City of Lawrence. Because the development will be one large structure that crosses over all of the platted lot lines, and because the applicant is using setbacks as though this is one lot, Staff has determined that the property should be replatted into one lot. The replat of these six lots into one lot will aid the development to meet certain criteria established for utilities. This preliminary development plan should be used as the preliminary plat for the replatting process.

One of the advantages of the Planned Development for residential development, particularly infill development that is supported by the Comprehensive Plan, is the ability to modify the residential density by using the Density Calculation identified in Section 20-701(f)(3)(ii).

***(ii) Density Calculation***

*For the purpose of calculating Net Density in Multi-Dwelling Structures, a studio or 1-bedroom unit shall count as .4 Dwelling Unit, a 2-bedroom shall count as .6 Dwelling Unit, a 3-bedroom unit shall count as .8 Dwelling Unit, and 4 or more bedroom units shall count as 1 Dwelling Unit. Minimum outdoor area, as required in Article 20-601(a), shall be met based on the total calculated Dwelling Unit count and not the actual number of Dwelling Units.*

For this project, the applicant has identified

| **Dwelling Unit Types** | **Actual # of Dwelling Units** | **Calculated # of Dwelling Units** | **# of Bedrooms** | **Req. Outdoor Area (square feet) (Calc du * 50 sf)** |
|---|---|---|---|---|
| 4<br>3-bedroom units (.8) | 4 | 4 * .8 = 3.2 | 4 * 3 = 12 | 3 * 50 = 150 sf |
| 41<br>2-bedroom units (.6) | 41 | 41 * .6 = 24.6 | 41 * 2 = 82 | 24.6 * 50 = 1,230 sf |
| 5<br>1-bedroom units (.4) | 5 | 5 * .4 = 2 | 5 * 1 = 5 | 2 * 50 = 100 sf |
| 1<br>Congregate Residence 6 bed rooms | 1 | 1 | 6 | 1 * 50 = 50 sf |

The calculated density of the project is 30.8 units per acre. The actual density for the project is 63 units per acre. The calculated density allows the actual number of bedrooms to be reflected in the open space and density requirements.

The minimum setback standards of the base district may be reduced by the City Commission provided that all exterior walls of detached buildings shall be separated by a minimum distance of 10 feet according to Section 20-701(f)(4). The applicant's proposal meets all of the setback requirements of the base district and the 10' separation of buildings except for the front yard setback. The applicant is requesting a reduction in front yard setback from 25' to 7' along the east property line. The majority of the structure is located 18' from the east property line, but the relocated structure is only 7' from the east property line. (The structure is 19' from the property line but the substantial front porch, 18' X 11', is located 7' from the property line.) The applicant has

provided an analysis of the setbacks in the block to determine if the proposed setback is eligible for the exception identified in 20-602(e)(1). The average setback for this side of the street is 16.5'. This section of the code would allow the project to comply with the average front setback of the existing buildings. However, the reduction to 7' is greater than the average allowed. Staff supports this waiver request as the majority of the building is behind the average setback and the reduced setback for the moved structure will help accentuate the structure as part of the development.

The proposed development contains a large four story structure with an undetermined height. Staff does not have current elevations that identify the height of the structure and cannot determine if a waiver is required for the overall height of the proposed development. The height limitation for the base RM32 district is 45'. In addition, the plan proposes retaining walls at the perimeter of the parking garage. Height has not been noted, therefore staff cannot determine if setback variances from the Board of Zoning Appeals may be necessary.

Balconies above the second story of a multi-dwelling unit building are prohibited along the exterior of a Planned Development unless the building setback is increased to at least double the required minimum setback and landscaping is enhanced with two or more of the following features: a minimum 4' berm, a solid screening fence (6' minimum Height) or a masonry wall (6' minimum Height). This provision shall apply only to those exterior sides of a Planned Development that are adjacent to RS zoning or to detached Dwelling Units. The proposed project is adjacent to RM32 and U-KU districts and is not adjacent to detached dwelling units.

The parking for this proposed development is all located on site and underground. As such, it is not required to meet the landscaping requirements of the code. The proposed project is required to have 106 parking spaces with 5 accessible spaces. The total provided in the two level underground parking areas is 115 with five accessible spaces for a total of 120 spaces. These spaces are distributed between the two levels and are accessible through interior elevators. Bicycle parking is also provided at 1 per four spaces for a total of 28 spaces.

Planned Developments shall include at least 20% of the total site area as Common Open Space. 50% of the Common Open Space shall be developed as Recreational Open Space unless environmentally sensitive lands are present. Common open space identified on the drawing for this development plan is located on the ground floor with 9,869 sf and on the fourth floor as 1,300 sf for a total of 11,169. This meets the requirement of 20% of the total site area. However, the application does not identify where this open space is and what areas are identified as recreational open space.

Additional Requirements and standards for the planned development include the following:

- Unified control – Two parcels are identified for the proposed project site. The owner of lots 7,8, and 9 is Thomas Fritzel and the owner of lots 10,11, and 12 is Triple T LLC. The applicant should verify that the proposed project site is under a single entity's control.
- Street access – The TIS for this project indicates that it will not generate 100 or more average daily trips. Therefore, access to a local street is compliant.
- Sidewalks – 5' sidewalks are required on Indiana Street and 11$^{th}$ Street. These sidewalks are shown on the plan.
- Landscaping - The Landscaping and Screening standards of Article 10 apply to Planned Developments. In addition, any part of the development area not used for Buildings, Structures, Parking, Streets, or Accessways shall be landscaped with a sufficient mixture of grass, vegetative Ground Cover, trees, and Shrubs, except those areas designated to be preserved with natural vegetation.

Preservation of natural features – there are no identified natural features on the development site.

The proposed development, *as conditioned*, meets the standards for a Planned Development in Article 701, with waivers or modifications being requested. However, the applicant must provide additional information before Staff can verify compliance with all standards in the Development Code. The proposed development meets the minimum area requirement for a PD district. The requested modification will not negatively impact any nearby development or property owners.

**Staff Finding –** The proposed Preliminary Development Plan is substantially consistent with the Statement of Purpose of Planned Development. The proposed Preliminary Development Plan, as conditioned, is consistent with the standards of Section 20-701 of the Development Code with the exception of the front yard setback, and the applicant has requested a modification from the City Commission and a waiver from the Planning Commission from this standard.

*3) The nature and extent of the common open space in the Planned Development.*

The Development Code requires that a minimum of 20% of the site must be designated as common open space and of that 50% must be utilized as open recreation space. The plan identifies 35,153 sf of total land space with 9, 869 sf of public open space. This exceeds the 20% required space. The plan does not identify the 50% recreation space.

**Staff Finding –** The proposed Preliminary Development Plan provides common open space which exceeds that required by Code. The plan must designate the area that is being set aside as Common Open Space. The plan must designate the area that is being set aside as recreation space.

*4) The reliability of the proposals for maintenance and conservation of the common open space.*
A note placed on the Preliminary Development Plan addresses this issue.

**Staff Finding –** A note on the plan insures protection of the common open space.

*5) The adequacy or inadequacy of the amount and function of the common open space in terms of the densities and dwelling types proposed in the plan.*

The density of the entire site is 63 units per acre but the calculated density is 30.8 units per acre. The planned development may use the calculated density to determine the required amount of open space. The dwelling types are a mixture of one, two, and three bedroom units with one congregate six bedroom unit. The Development Code requires 50 sq. ft. of outdoor area that can be used for recreational purposes for each dwelling unit in a conventional RM32 District. The Code states that the required outdoor areas serves as an alternative to a large rear setback and is an important aspect in addressing the livability of a residential structure on a small lot. The development plan proposes 51 dwelling units. The Development Code would require 2,550 sq. ft., (51 x 50 sq. ft) of outdoor area to mitigate the small lot size in a conventional RM32 Zoning District. This development is being designed as a planned development and is required to have 20% of the site as common open space. The calculated density would require 1,530 sf of open space. 9, 869 sf of public open space is shown on the plan. The majority of this space is located in the front yard. Section 20-602(g)(2)(iii) does not permit area within the required front setback to be used for the required outdoor area. The plan also identifies a public open space on the fourth floor. Initial plans indicated that this was a type of recreation area. Final plans have not been submitted at this time.

**Staff Finding –** The amount and function of the common open space is adequate based on the overall density and the calculated density for residential uses. The dwelling types are an apartment building which will contain 50 dwelling units and the Varsity House that will contain a congregate residence with six occupants. The amount of open space being provided exceeds that required by the Development Code for the conventional RM32 District.

*6) Whether the Preliminary Development Plan makes adequate provisions for public services, provides adequate control over vehicular traffic, and furthers the amenities of light and air, recreation and visual enjoyment.*

The development is designed to utilize the existing public services with the exception of the storm water system. The applicant is working with the Stormwater Engineer to identify the public improvements that will be required for this portion of the project. A drainage study has not been submitted, reviewed, or approved. The underground parking provides adequate control over vehicular traffic on site. The large amount of common open space will provide ample light and air. There will be several opportunities for recreational enjoyment on the site. A club house area will be located on the fourth floor which will also provide a recreation area.

**Staff Finding –**The Preliminary Development Plan has made adequate provisions for public services and provides adequate control over vehicular traffic through limited access points. The plan furthers the amenities of light and air, recreation and visual enjoyment through the provision of common open space and open recreation space. A drainage study is required and should be submitted, reviewed and approved prior to the submission of the Final Development Plan.

*7) Whether the plan will measurable and adversely impact development or conservation of the neighborhood area by:*
*a) doubling or more the traffic generated by the neighborhood;*

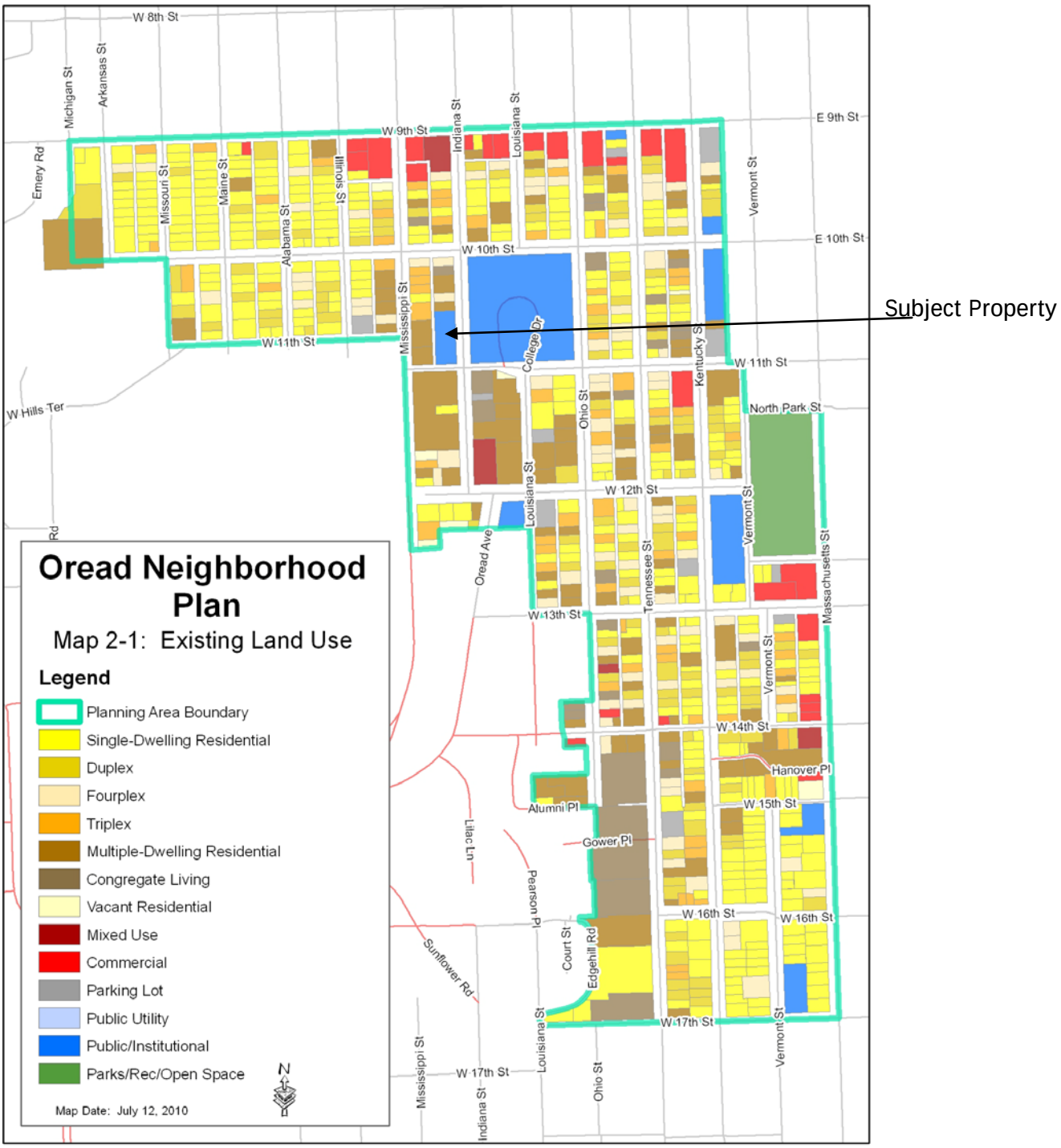
The project includes the reconstruction of the alley between 10th and 11$^{th}$ Streets and the removal of the historic brick that currently exists in the alley. The proposed parking garage will have two access points on the new alley and one access point on Indiana Street. The TIS indicated that the development will generate less than 100 trips during the peak hours and does not warrant further study at this time.

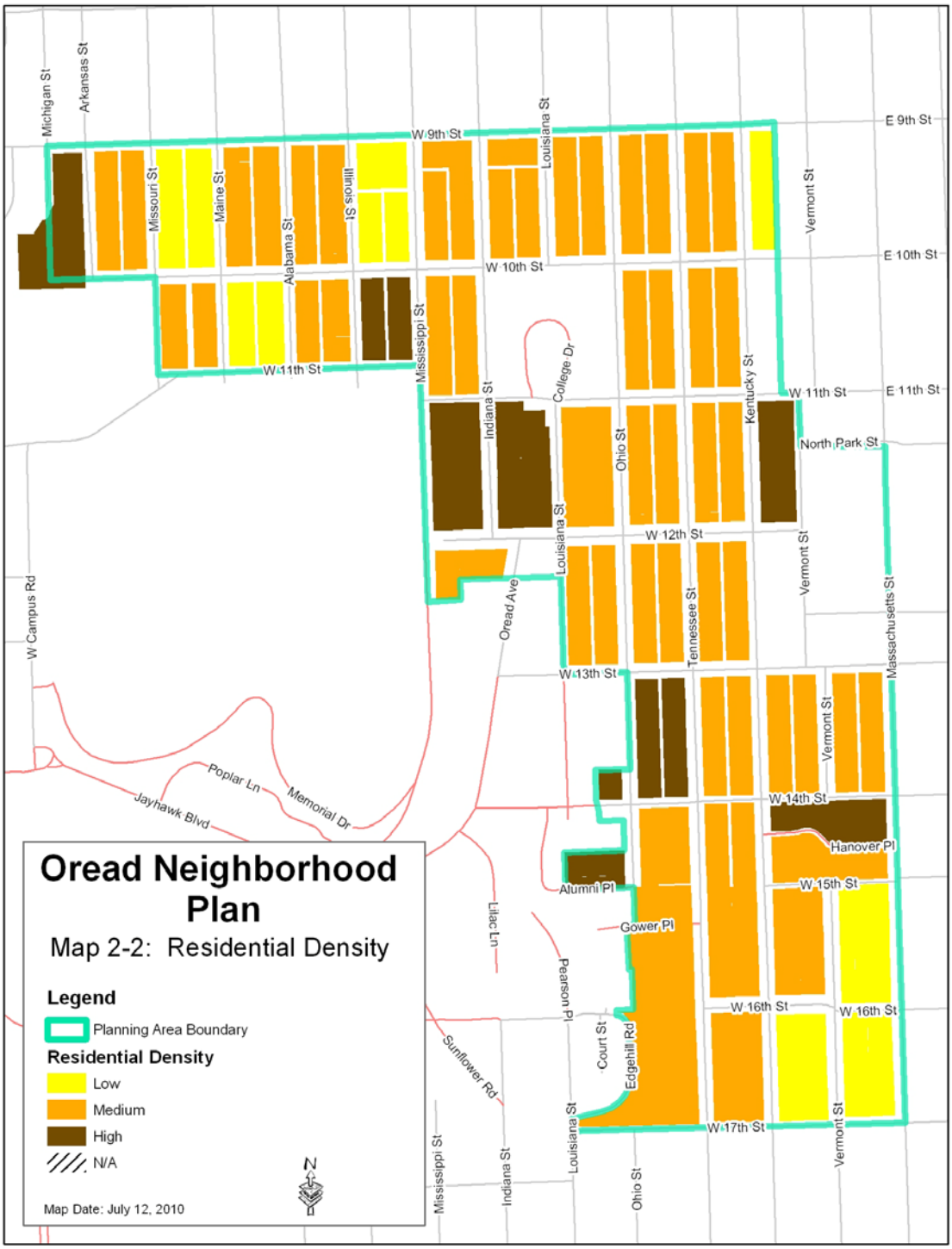
*b) proposing housing types, building heights or building massings that are incompatible with the established neighborhood pattern; or*

The housing type and massing are not compatible with the established historic neighborhood pattern. The proposed structure is, however, compatible with the large apartment complexes that have been developed in the area since the 1970's. Most of the residences in the area are two to two and a half stories. This structure is the equivalent to four stories. The only structures of this height in the area are the residence halls to the east and the Oread hotel to the south. The area is also mainly characterized with individual structures on individual lots. The proposed project is one large structure that sits on six platted lots. The existing structure that will be located to the north end of the project area is compatible with the size, scale, type and height of the overall character of the neighborhood.

*c) increasing the residential density 34% or more above the density of adjacent residential properties.*

The properties to the north, west, and south are zoned RM32 and the Oread Neighborhood Plan identifies this area as a mix of medium and high density with multi dwelling residential and congregate living being the dominate uses on the adjacent properties.






**Staff Finding –**Staff has determined that the Preliminary Development Plan will not have measurable and adverse impact on the development or conservation of the neighborhood area. The density is similar to surrounding residential properties.

*8) Whether potential adverse impacts have been mitigated to the maximum practical extent.*

Potential adverse impacts to the historic character of the neighborhood by the size, bulk, mass and scale of the proposed new structure are possible. To mitigate these potential impacts, the applicant will relocate the existing structure to the north end of the development and has designed the new structure to have compatible materials and roof forms. The new structure will have projections in the main façade to create a rhythm affect that is suggestive of the historic development pattern of 50' to 100' lots.

**Staff Finding –**
The adverse impacts of the development will be addressed by architectural detailing that will help to minimize the bulk, mass and scale of the proposed new structure.

*9) The sufficiency of the terms and conditions proposed to protect the interest of the public and the residents of the Planned Unit Development in the case of a plan that proposes development over a period of years.*

**Staff Finding-** A phased development has not been proposed.

**Staff Review and Conclusion**

The project site is located in the Oread Neighborhood Plan area and is located in the environs of the Oread Historic District and the Michael D. Greenlee House, National Register of Historic Places. The proposed Preliminary Development Plan conforms to the anticipated land use for this area as stated in the Comprehensive Plan and the Oread Neighborhood Plan. The development will provide infill development for four currently vacant lots and will redevelop the two lots now encumbered by the existing house. Infill development is encouraged in the Comprehensive Plan and the Oread Neighborhood Plan. The applicant chooses to develop the southernmost area of the project site with the new construction of the large apartment structure. This allows the applicant the most advantageous construction staging for the underground parking area, the new structure, and the new foundation for the existing structure. As an alternative to demolishing the existing structure, the applicant proposes to move the existing structure to the north end of the project area. This area is adjacent to structures that have a similar form and mass. The Historic Resources Commission (HRC) will review this project at their meeting on August 18, 2011 to determine if moving the structure and the proposed new development will encroach upon, damage or destroy the environs of the Oread Historic District and the Michael D. Greenlee House. This determination will be made using the Standards and Guidelines for Evaluating the Effect of Projects on Environs as prescribed by the State Preservation Law 75-2724, as amended and K.A.R. 118-3-1—118-3-16.

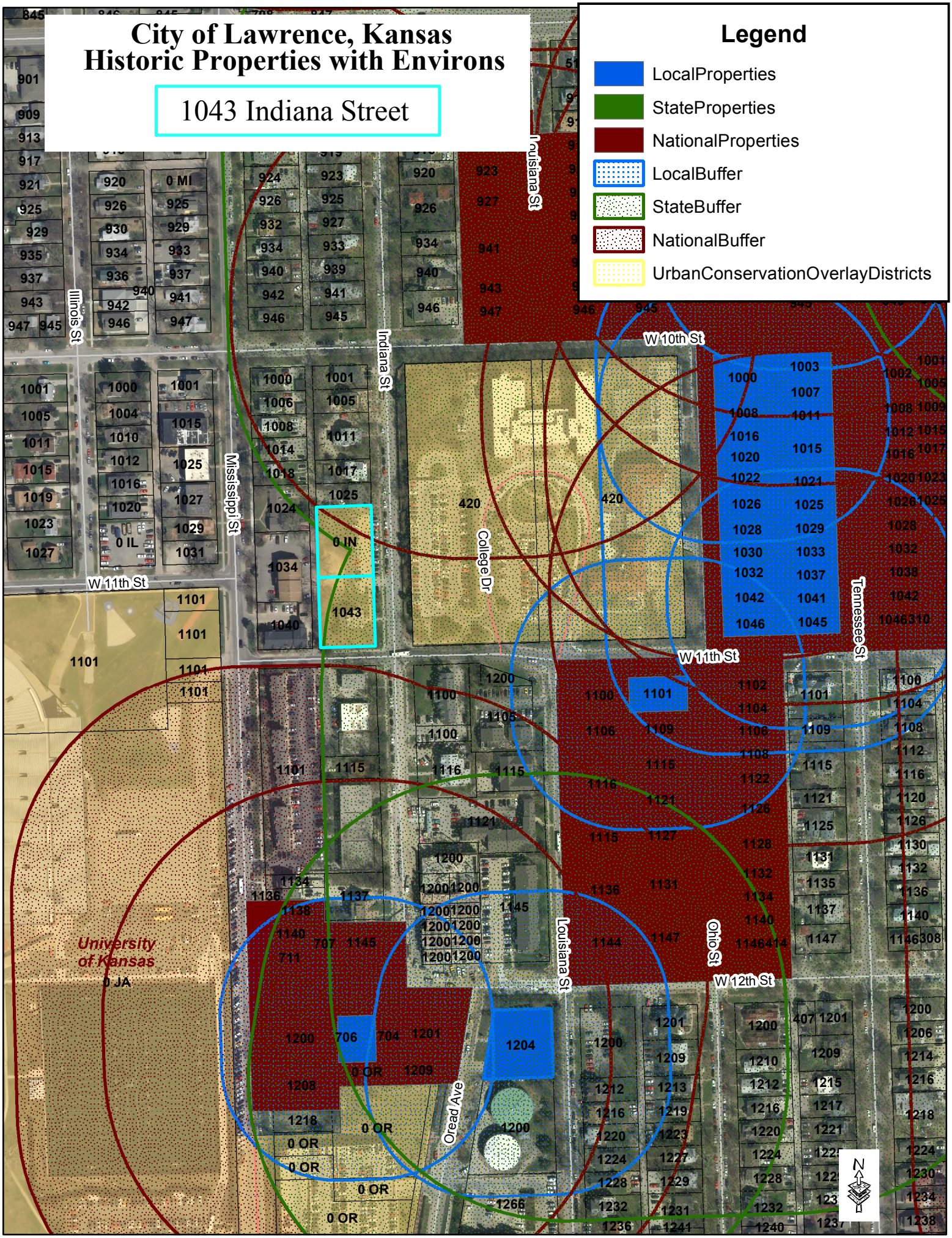
While the HRC will make a determination based on the State Preservation Law, the Planning Commission must make a recommendation for the project based on the Comprehensive Plan including the Oread Neighborhood Plan. Both of these documents address infill development, preservation, and the importance of neighborhood character.

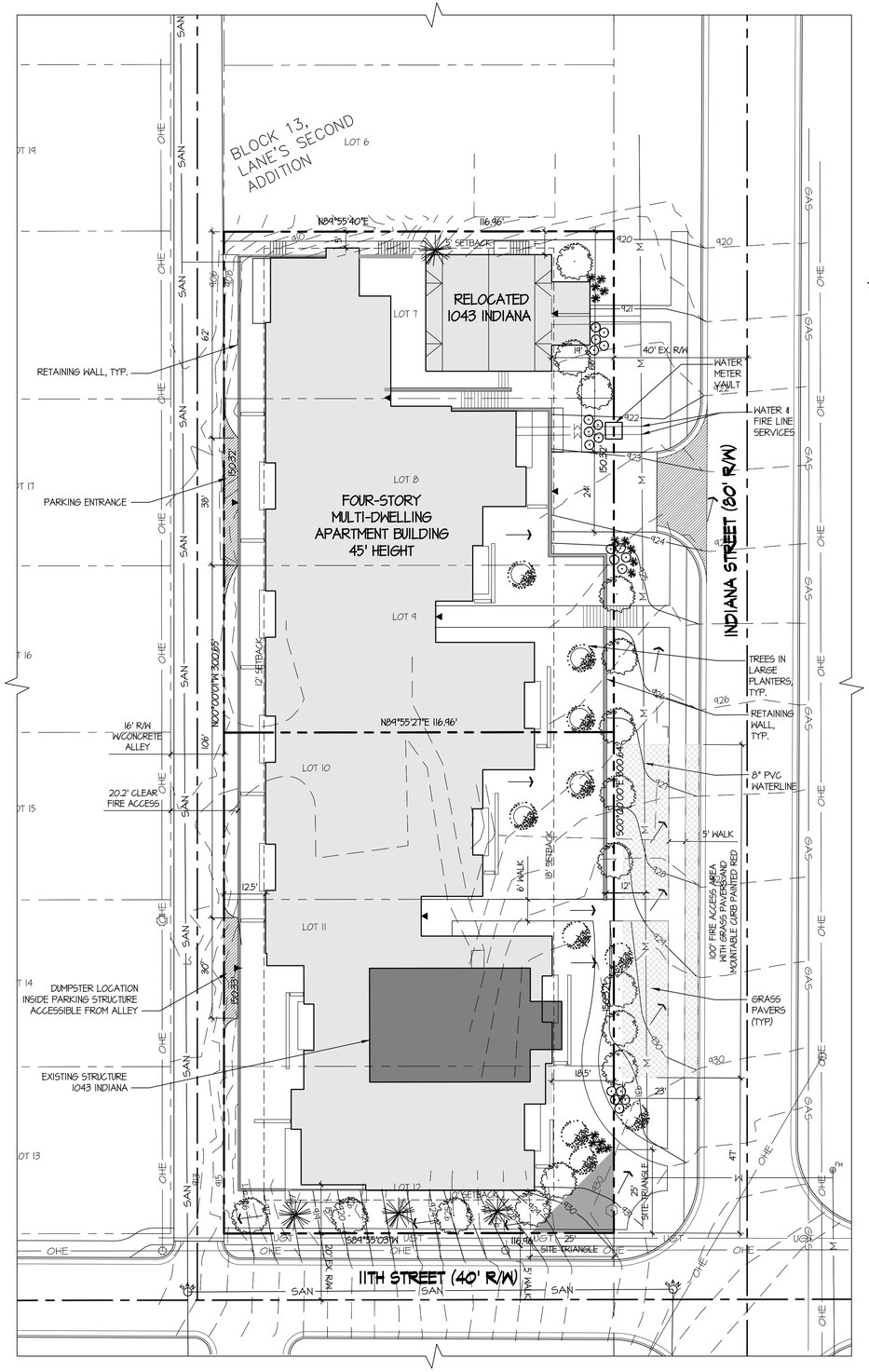
**CONCLUSION:**

Staff recommends approval of this proposed Preliminary Development Plan with the noted conditions.

# City of Lawrence, Kansas
# Historic Properties with Environs

1043 Indiana Street






## SITE PLAN

SCALE: 1" = 20'-0"

0 10 20 40 60

NORTH

## SURROUNDING PROPERTY

APPROXIMATE SCALE: 1" = 100'-0"

0 50 100 200 300

NORTH

## LEGAL DESCRIPTION:

LOTS 7 THROUGH 12, BLOCK 13, LANE'S SECOND ADDITION, LAWRENCE, DOUGLAS COUNTY, KANSAS

## PROPERTY OWNERS OF RECORD:

PROPERTY OWNER:
TRIPLE T, LLC
643 MASSACHUSETTS ST.
SUITE 300
LAWRENCE, KS 66044

## PROPERTY SURFACE SUMMARY:

PROJECT SITE: 0.80T ACRES (35,164 SQ. FT. +/-)

EXISTING SUMMARY:

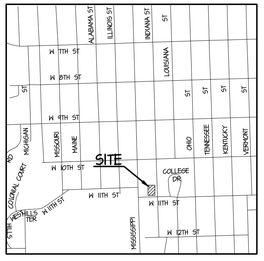
| | SQ. FT. | AC. |
|---|---|---|
| TOTAL BUILDINGS: | 1,650 | 0.038 |
| TOTAL PAVEMENT: | 453 | 0.010 |
| TOTAL IMPERVIOUS: | 2,103 | 0.048 |
| TOTAL PERVIOUS: | 33,061 | 0.754 |
| TOTAL PROPERTY AREA: | 35,164 | 0.80T |

SUMMARY AFTER PROJECT COMPLETION:

| | SQ. FT. | AC. |
|---|---|---|
| TOTAL BUILDINGS: | 19,102 | 0.439 |
| TOTAL PAVEMENT: | 2,233 | 0.051 |
| TOTAL IMPERVIOUS: | 21,335 | 0.489 |
| TOTAL PERVIOUS: | 13,829 | 0.318 |
| TOTAL PROPERTY AREA: | 35,164 | 0.80T |

## LOCATION MAP:

NOT TO SCALE




NORTH

## PROJECT SUMMARY:

1.1 CURRENT ZONING: KU

1.2 PROPOSED ZONING: RM32-PD

1.3 CURRENT USE: PARKING LOT/MULTI-DWELLING STRUCTURE

1.4 PROPOSED USE: MULTI-STORY DWELLING STRUCTURE

1.5 LAND AREA: 0.80T ACRES (35,164.02 SQ. FT. +/-)

1.6 PROJECT PROPOSED: RM32-PD ZONING ALLOWS 25% INCREASE; 32 UNITS/AC * 1.25 = 40 UNITS/AC * 0.80T ACRES = 32 UNITS ALLOWED;
RM32-PD ZONING TO ALLOW 1 BED APARTMENTS COUNTED AS 0.4 DWELLING UNITS,
2 BED APARTMENTS AS 0.6 DWELLING UNITS, 3 BED APARTMENTS AS 0.8 UNITS, AND 4 BED APARTMENTS AS 1.0 UNITS.
5 - 1 BEDROOM APARTMENTS = 2.0 DWELLING UNITS
41 - 2 BEDROOM APARTMENTS = 24.6 DWELLING UNITS
4 - 3 BEDROOM APARTMENTS = 3.2 DWELLING UNITS
1 - 6 BEDROOM APARTMENT (VARSITY HOUSE) = 1.0 DWELLING UNIT
(51 UNITS EQUIVALENT TO 30.8 DWELLING UNITS PROPOSED PER PD REQUIREMENTS)

## GENERAL SITE PLAN NOTES:

2.1 ALL REQUIRED ACCESSIBLE SIDEWALK RAMPS PER A.D.A. STANDARDS.

2.2 SITE PLAN HAS BEEN DESIGNED TO COMPLY WITH THE PROVISIONS OF THE AMERICANS WITH DISABILITIES ACT ACCESSIBILITY GUIDELINES (ADAAG) FOR BUILDINGS AND FACILITIES, APPENDIX A TO 28CFR PART 36.

2.3 SITE PLAN HAS BEEN DESIGNED TO COMPLY WITH THE MINIMUM PROVISIONS OF THE FINAL FAIR HOUSING ACCESSIBILITY GUIDELINES, 24 CFR, CHAPTER I, SUBCHAPTER A, APPENDIX II, OF THE FAIR HOUSING ACT OF 1968, AS AMENDED.

2.4 TRASH DUMPSTERS TO BE STORED IN GARAGE LEVEL P2 WITH ALLEY ACCESS TO REMAIN UNLOCKED AT ALL TIMES. RESIDENTS TO DEPOSIT TRASH INTO DUMPSTERS VIA TRASH CHUTES ABOVE THE DUMPSTER AREA INSIDE THE BUILDING.

2.5 THE CITY OF LAWRENCE WILL NOT BE HELD RESPONSIBLE FOR PAVEMENT DAMAGE CAUSED BY TRASH TRUCKS.

2.6 A DETAILED PHOTOMETRIC PLAN WILL BE PROVIDED FOR REVIEW AND APPROVAL PRIOR TO RELEASE OF SITE PLAN.

2.7 PLAN FOR CITY APPROVAL ONLY! CONSTRUCTION DOCUMENTS TO BE FURNISHED AT THE REQUEST OF OWNER.

2.8 INFORMATION TAKEN FROM AERIAL PHOTOS, CERTIFICATE OF SURVEY, AVAILABLE DOCUMENTS, AND ON SITE INVESTIGATIONS.

2.9 ALL TRAFFIC CONTROL SIGNS PLACED ON PRIVATE PROPERTY OPEN TO THE GENERAL PUBLIC SHALL COMPLY WITH THE "MANUAL ON UNIFORMS TRAFFIC CONTROL DEVICES" AND "STANDARD HIGHWAY SIGNS," PUBLISHED BY THE FEDERAL HIGHWAY ADMINISTRATION, WITH RESPECT TO SIZE, SHAPE, COLOR, RETROFLECTIVITY, AND POSITION.

2.10 OUTDOOR AREA REQUIRED: 50 S.F. PER UNIT x 30.8 UNITS = 1,540 S.F. SEE TABLE BELOW.

2.11 THE PROJECT WILL BE BUILT IN ONE PHASE.

2.12 ADEQUATE INFRASTRUCTURE EXISTS TO INSTALL THE PUBLIC IMPROVEMENTS FOR THIS PROJECT AS SHOWN.

2.13 PROPERTY OWNER SHALL MAINTAIN OWNERSHIP OF AND MAINTAIN COMMON OPEN SPACE, RECREATION FACILITIES, OR ANY OTHER AREA WITHIN THE DEVELOPMENT THAT IS RETAINED FOR THE EXCLUSIVE USE AND BENEFIT OF THE RESIDENTS, LESSEES, AND OWNER OF THE PLANNED DEVELOPMENT.

## PARKING INFORMATION:

3.1 PARKING REQUIRED: 1 SPACE PER BEDROOM (105 BEDROOMS), + 1 PER 10 UNITS (51 UNITS) = 111 SPACES

3.2 ACCESSIBLE PARKING REQUIRED = 5 SPACES (1 VAN, 4 AUTO)

3.3

| TYPE: | REQUIRED: | PROVIDED: |
|---|---|---|
| REGULAR | 106 | 115 |
| ACCESSIBLE | 5 | 5 |
| TOTAL: | 111 | 120 |

BICYCLE (1 PER 4 SPACES) 28 PROVIDED IN GARAGE - TO COMPLY WITH CITY CODE 20-913(g)

3.4 TYPICAL DIMENSIONS: 'R' SPACES - 9' X 18' (16.5' + 1.5' OVERHANG AT SIDEWALKS)
SIDEWALKS SHALL BE 4" CONCRETE - 5' OR 6.5' WIDE DEPENDING UPON THE LOCATION.
'H' SPACES - 8' X 20' (5' OR 8' AISLE)

3.5 PAVEMENT: APPROACHES: 7" - 4000 PSI CONCRETE W/ #5 BARS 12" O.C.B.W. - PER CITY STANDARDS
DRIVES: MIN. 6" ASPHALT ON 4" GRAVEL OR 5" CONCRETE - PER CITY STANDARDS
PARKING AREAS: MIN. 5" ASPHALT ON 4" GRAVEL OR 4" CONCRETE - PER CITY STANDARDS

## LANDSCAPING NOTES:

| SYM. | DESCRIPTION | QTY. | APPROVED TYPES | BOTANICAL NAMES | SIZE | COND. |
|---|---|---|---|---|---|---|
| | SHADE TREES | 16 | SAW TOOTH OAK<br>NORWAY MAPLE<br>THORNLESS HONEY LOCUST | QUERCUS ACUTISSIMA<br>ACER PLATANOIDES 'SUPERFORM'<br>GLEDITSIA TRIACANTHOS VAR. INERMIS | 2"-2 1/2" CAL | B & B |
| | EVERGREEN TREES | 4 | WHITE PINE<br>BLUE SPRUCE | PINUS STROBUS<br>PICEA PUNGENS | 6'-8' HT. | B & B |
| | ORNAMENTAL TREES | 10 | CLEVELAND SELECT PEAR<br>KOUSA DOGWOOD<br>CORAL BURST CRABAPPLE<br>EASTERN REDBUD | PYRUS CALLERYANA 'CHANTIELEER'<br>CORNUS KOUSA<br>MALUS 'CORALBURST'<br>CERCIS CANADENSIS | 1 3/4"-2" CAL | B & B |
| ⊙ | DECIDUOUS SHRUBS | 30 | DWARF JAPANESE BARBERRY<br>LEATHERLEAF VIBURNUM<br>BEAUTY BUSH<br>DWARF KOREAN LILAC | BERBERIS THUNBERGII 'CRIMSON PYGMY'<br>VIBURNUM RHYTIDOPHYLLUM<br>KOLKWITZIA AMABALIS<br>SYRINGA MEYERI 'PALIBIN' | 18"-24" HT. | CONT |
| * | EVERGREEN SHRUBS | 15 | CARMEL CREEPER<br>CREEPING ROSEMARY<br>BLUE PFITZER JUNIPER<br>BAR HARBOR JUNIPER CREEPER<br>ENGLISH YEW | CAENOTHUS GRISEUS HORIZONTALIS<br>ROSEMARY PROSTRATUS<br>JUNIPERUS CHINENSIS 'PFITZERIANA GLAUCA'<br>JUNIPERUS HORIZONTALIS 'BAR HARBOR'<br>TAXUS BACCATA | 24"- 36" HT. | CONT |

4.1 THERE MUST BE A MIN. OF (2) SPECIES USED IN EACH CATEGORY.

4.2 ALL TURF AREAS TO BE SEEDED WITH K-31 FESCUE, SOD.

## DETAILED PROJECT SUMMARY:

| FLOOR: | GSF(1) | NUMBER OF UNITS & TYPE 1 BEDS | 2 BEDS | 3 BEDS | TOTAL UNITS/ FLOOR | PARKING SPACES | PRIVATE DECKS | PUBLIC OPEN SPACE |
|---|---|---|---|---|---|---|---|---|
| P2 | 27,679 | - | - | - | - | 60 | - | - |
| P1 | 27,609 | - | - | 1 | 1 | 60 | - | - |
| 1st FLR | 17,782 | 1 | 11 | 1 | 13 | - | 2,830 | 9,869 |
| 2nd FLR | 17,782 | 1 | 11 | 1 | 13 | - | 923 | - |
| 3rd FLR | 17,982 | 1 | 11 | 1 | 13 | - | 923 | - |
| 4th FLR | 16,382 | 2 | 8 | - | 9 | - | 639 | 1,300 |
| TOTAL: | 126,459 | 5 | 41 | 4 | 50 | 120 | 5,315 | 11,169 |

| SEPARATE STRUCTURE: | GSF | NUMBER OF UNITS & TYPE | TOTAL UNITS |
|---|---|---|---|
| VARSITY HOUSE | 3,800 | 1 UNIT - 6 BEDS | 1 |

## RELEASE:

1.0 PRELIMINARY DEVELOPMENT PLAN SUBMITTAL 7.22.11
1.1 REVISED PDP RESUBMITTAL

## HRC SUBMITTAL DR-4-49-11

1.0 SUBMITTED 4-18-11

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SUITE B2
LAWRENCE, KS 66044
OFFICE: 785.832.0804
FAX: 785.832.0890
INFO@PAULWERNERARCHITECTS.COM

BUILDER:
DFC CO. OF LAWRENCE
643 MASSACHUSETTS
SUITE 300
LAWRENCE, KS 66044
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# PRELIMINARY DEVELOPMENT PLAN
# VARSITY HOUSE
1043 INDIANA STREET
LAWRENCE, KANSAS

PROJECT # 28600

| RELEASE: | DATE: |
|---|---|
| 1.0 | 7.22.11 |
| 1.1 | 8.5.11 |

SP-1

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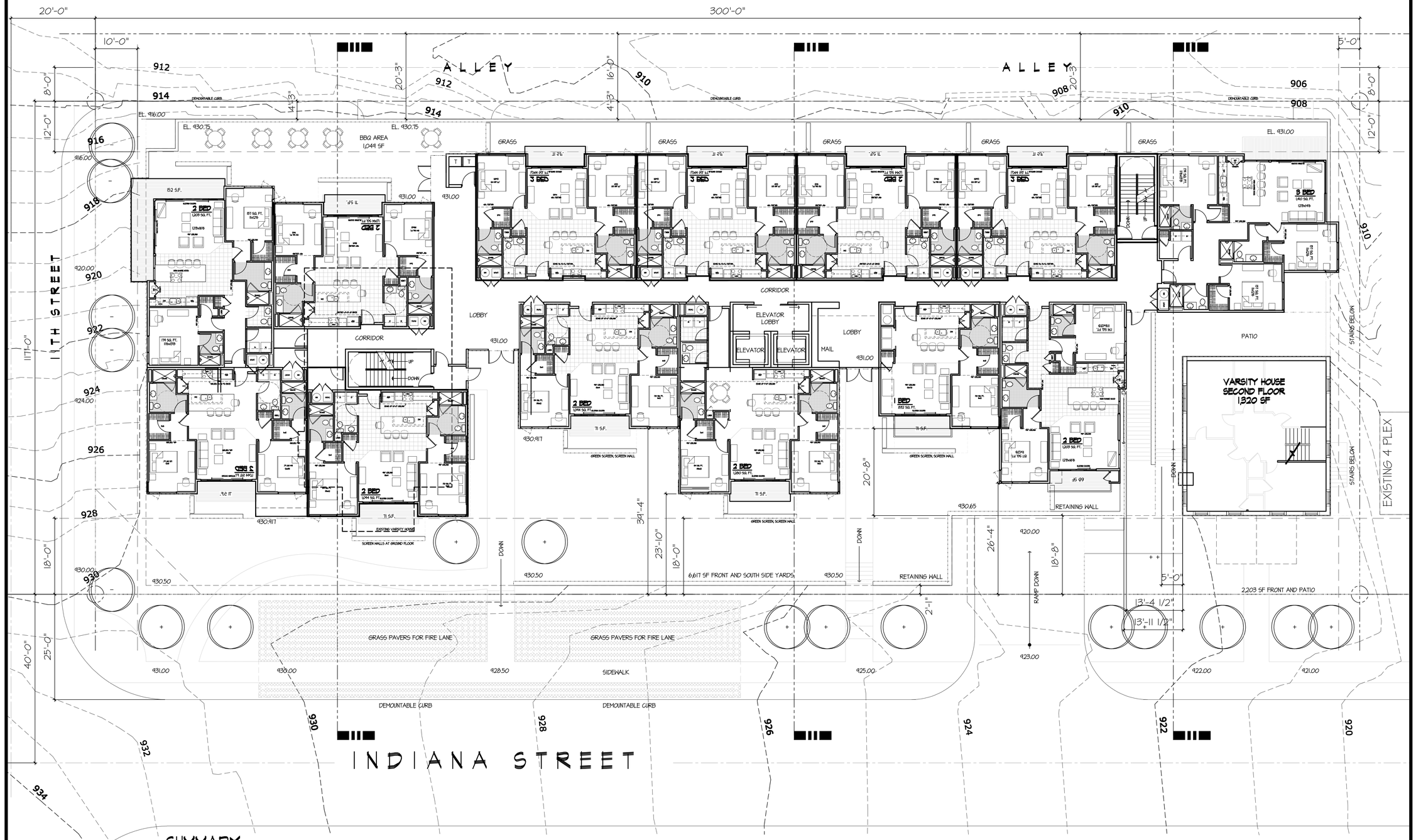


## SUMMARY

SITE 35,100 SF 0.80 AC

PROPOSED ZONING RM32-PD

PROPOSED 51 UNITS
(42) 2 BED, (4) 1 BED, (4) 3BED, (1) 6 BED

REQUIRED PARKING 106 SPACES + 6 GUEST SPACES = 112 TOTAL

PROVIDED PARKING 118 TOTAL SPACES

| | | |
|---|---|---|
| SITE COVERAGE | 18,985/35,100 | 54.08% |
| PUBLIC USABLE OPEN SPACE ON GROUND FLOOR | | 9,869 SF |

1 GROUND LEVEL 17,665 SF+1,320 SF=18,985 SF TOTAL
SCALE: 3/32" = 1'- 0"

14 UNITS (1)1B, (11)2B, (1)3B, (1)6B

NORTH


paulwerner ARCHITECTS

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SUITE B2
LAWRENCE, KS 66044

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# VARSITY HOUSE

1043 INDIANA STREET
LAWRENCE, KANSAS

PROJECT # 28600
8.19.2011

A200


J:\Projects\28000\28600\Building\CDs\sheets\2000-GroundFloorPlan.dwg, 8/19/2011 9:29:05 AM, DWG To PDF.pc3

LEVEL TWO 17,693 SF

1 2ND FLOOR PLAN (1) 1 BED, (11) 2 BED, (1) 3 BED
SCALE: 3/32" = 1'- 0"

NORTH

paulwerner ARCHITECTS
123 W. 8TH STREET
SUITE B2
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VARSITY HOUSE
1043 INDIANA STREET
LAWRENCE, KANSAS

PROJECT # 28600
8.19.2011

A201

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LEVEL THREE 17,791 SF

## 1 3RD FLOOR PLAN (12) 2 BED (1) 3 BED

SCALE: 3/32" = 1'- 0"

NORTH

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# VARSITY HOUSE

1043 INDIANA STREET
LAWRENCE, KANSAS

PROJECT # 28600
8.19.2011

A202

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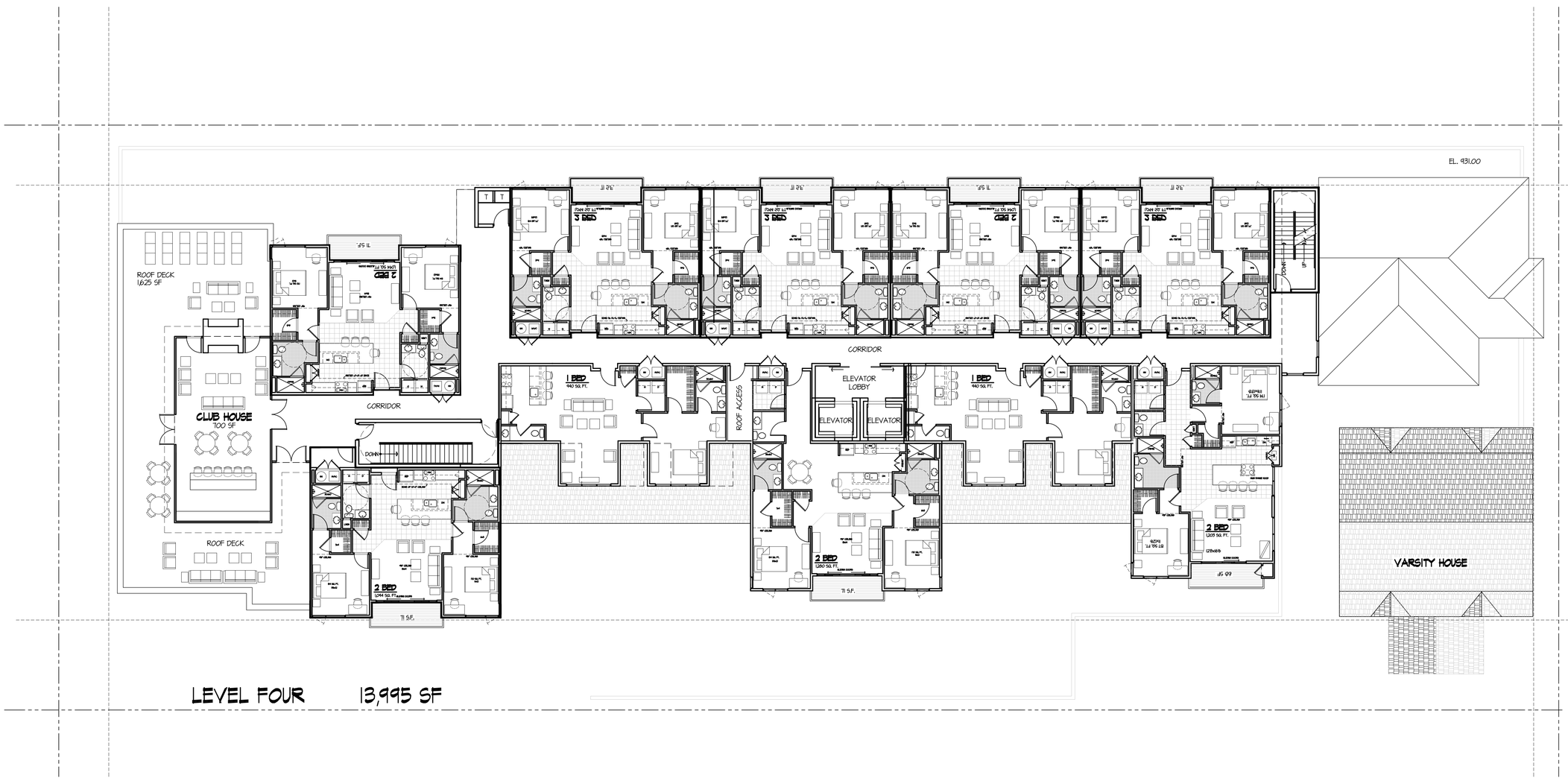


LEVEL FOUR 13,995 SF

1 4TH FLOOR PLAN (10) 2 BED
SCALE: 3/32" = 1'- 0"

NORTH

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# VARSITY HOUSE
1043 INDIANA STREET
LAWRENCE, KANSAS

PROJECT # 28600
8.19.2011

A203

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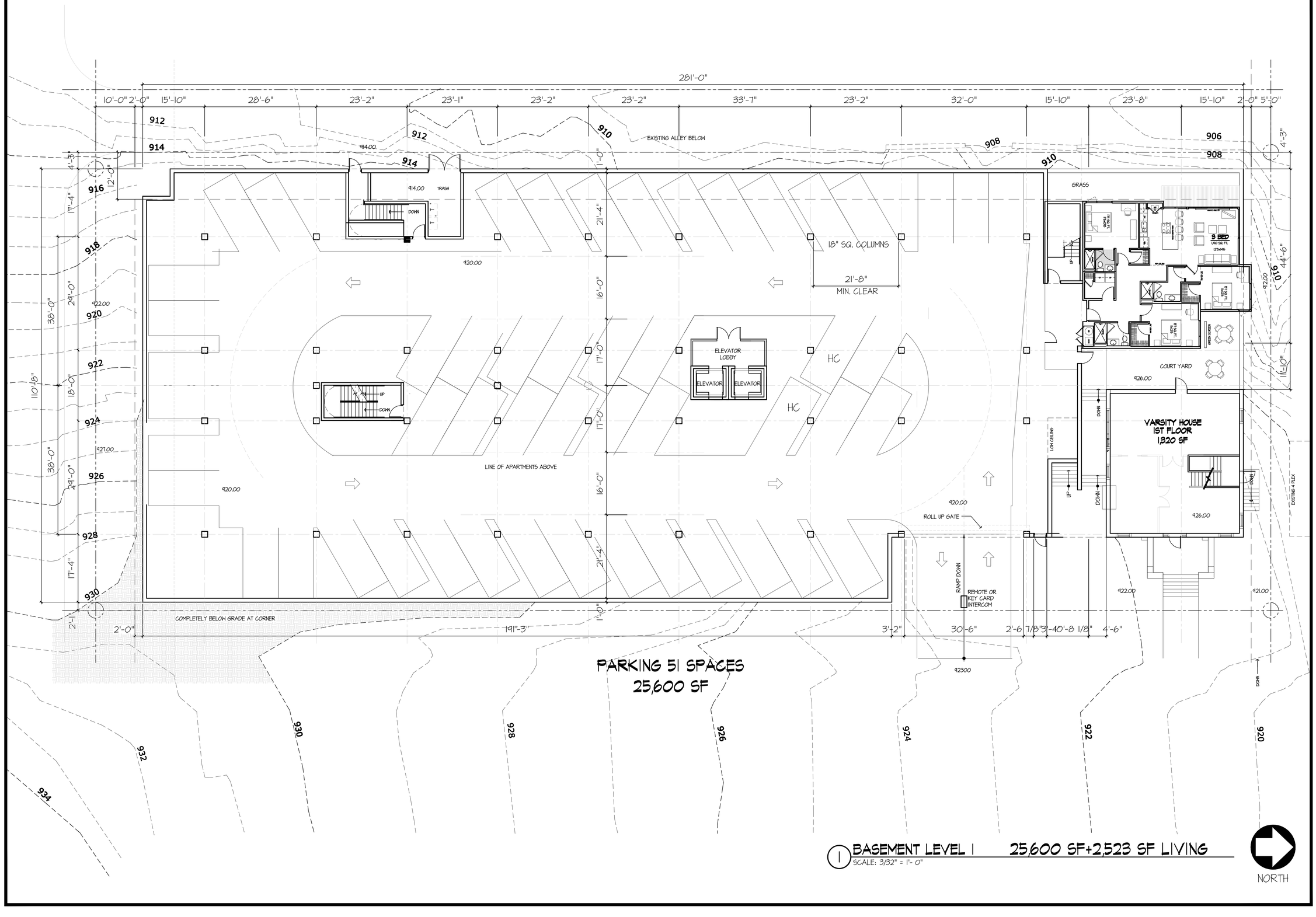


1 BASEMENT LEVEL 1 — 25,600 SF+2523 SF LIVING
SCALE: 3/32" = 1'- 0"

NORTH


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# VARSITY HOUSE
1043 INDIANA STREET
LAWRENCE, KANSAS

PROJECT # 28600
8.19.2011

A205


J:\Project\28000\28600\Building\CDsheets\a205-Parking81Plan.dwg, 8/19/2011 9:30:02 AM, DWG To PDF.pc3

281'-0"

15'-10" | 28'-6" | 23'-1" | 23'-2" | 23'-2" | 23'-2" | 33'-7" | 23'-2" | 32'-0" | 15'-10" | 23'-8" | 15'-10"

EXISTING ALLEY

912 914 916 918 920 922 924 926 928 930 932 934 910 908 906

914.00 909.00 910.00 922.00

17'-4" | 29'-0" | 18'-10" | 24'-0" | 17'-4"

T

UNEXCAVATED

RAMP DOWN

REMOTE OR KEY CARD INTERCOM

ROLL UP GATE

TYPICAL PARKING SPACE 9'-0" WIDE

HC

COMPACT

ELEVATOR LOBBY

ELEVATOR

ELEVATOR

UP

DOWN

30'-6"

(6) 8'-6" WIDE SPACES

EXISTING 4 PLEX

LOWER LEVEL OF PARKING COMPLETELY UNDERGROUND

1 BASEMENT LEVEL 2 — 67 SPACES 30,345 SF

SCALE: 3/32" = 1'- 0"

NORTH


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# VARSITY HOUSE

1043 INDIANA STREET
LAWRENCE, KANSAS

PROJECT # 28600
8.19.2011

A206


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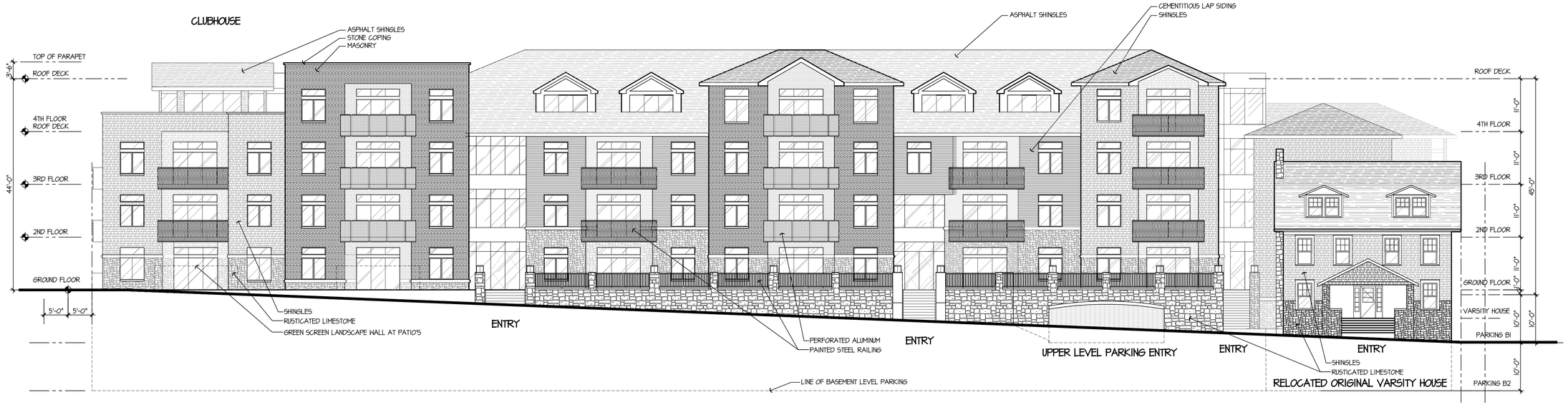
CLUBHOUSE

## 3 SOUTH ELEVATION, 11th STREET
SCALE: 3/32" = 1'- 0"




## 1 EAST ELEVATION, INDIANA STREET
SCALE: 3/32" = 1'- 0"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# VARSITY HOUSE
1043 INDIANA STREET
LAWRENCE, KANSAS

PROJECT # 28600
8.19.2011

A300


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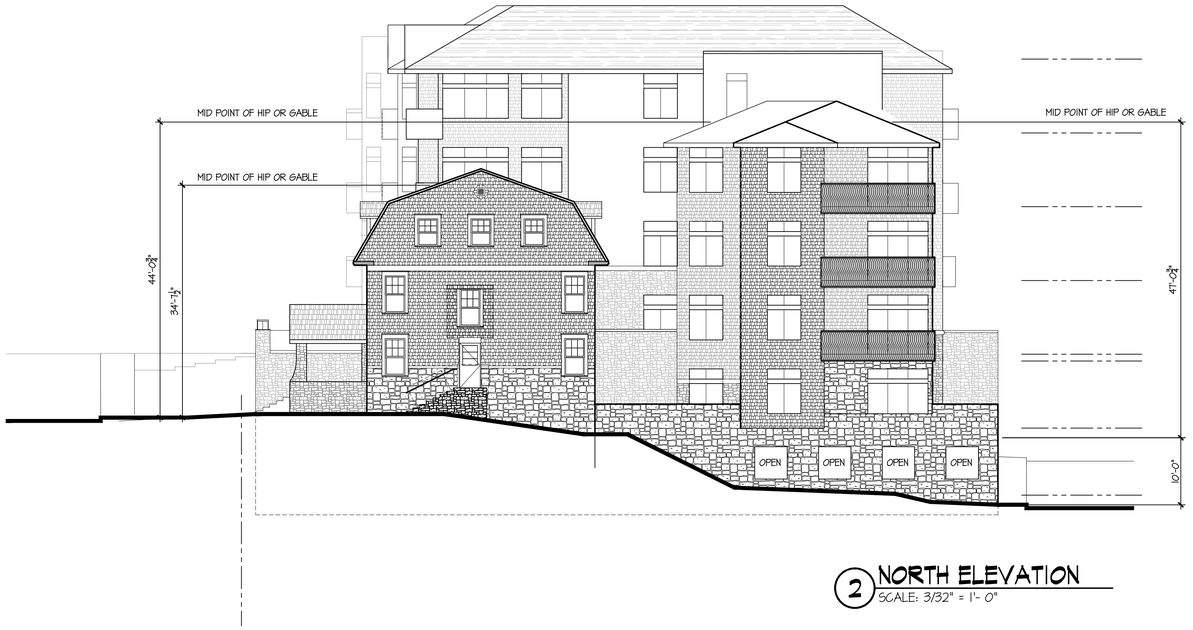
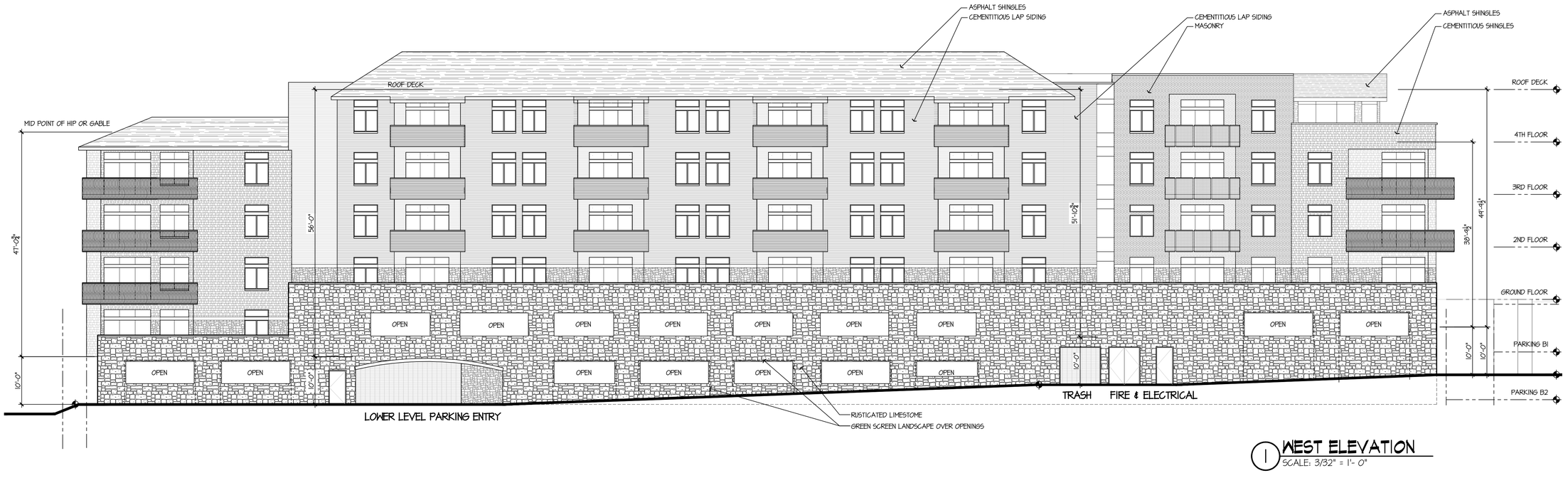



## 2 NORTH ELEVATION
SCALE: 3/32" = 1'- 0"




## 1 WEST ELEVATION
SCALE: 3/32" = 1'- 0"

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# VARSITY HOUSE
1043 INDIANA STREET
LAWRENCE, KANSAS

PROJECT # 28600
8.19.2011

A301

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paulwerner
ARCHITECTS

**LAWRENCE HISTORIC RESOURCES COMMISSION**
**ITEM NO. 3: DR-04-49-11, DR-7-103-11, PDP-7-1-11**
**STAFF REPORT**

## A. SUMMARY

**DR-04-49-11** DR-4-49-11, DR-7-103-11, PDP-7-1-11 1043 Indiana; Relocation and New Construction, Rezoning, and Development Plan; Certified Local Government Review. The property is in the environs of the Oread Historic District, National and Kansas Register of Historic Places. Submitted by Paul Werner Architects for Triple T LLC, property owner of record.

## B. PROJECT DESCRIPTION

The applicant is requesting to move the existing historic structure located at 1043 Indiana Street to the north end of the vacant lots and incorporate the structure into a design for a multi-unit apartment building. Currently the property is zoned U-KU and is vacant. The applicant is requesting to rezone the property to RM32PD. THE APPLICANT SUBMITTED REVISED RENDERINGS AUGUST 10, 2011. IT IS ANTICIPATED THAT REVISED ELEVATIONS WILL BE SUBMITTED PRIOR TO THE MEETING.

1043 Indiana Street on August 10, 2011

## C. STANDARD FOR REVIEW

For Certified Local Government Review of projects within the environs of listed properties, the Historic Resources Commission has typically used the Standards and Guidelines for Evaluating the Effect of Projects on Environs to evaluate the proposed project. Therefore, the following standards apply to the proposed project:

> *1. The character of a historic property's environs should be retained and preserved. The removal or alteration of distinctive buildings, structures, landscape features, spatial relationships, etc. that characterize the environs should be avoided.*
>
> *2. The environs of a property should be used as it has historically been used or allow the inclusion of new uses that require minimal change to the environs' distinctive materials, features, and spatial relationships.*
>
> *4. Demolition of character-defining buildings, structures, landscape features, etc. in a historic property's environs should be avoided. When the severity of deterioration requires removal within the environs, compatible reconstruction shall occur.*
>
> *6. New additions, exterior alterations, infill construction, or related new construction should not destroy character-defining features or spatial relationships that characterize the environs of a property. The new work shall be compatible with the historic materials, character-defining features, size, scale and proportion, and massing of the environs.*

**ADDITIONS**

**Recommended**

The scale of additions should not dominate the existing design patterns that characterize the environs of a listed property.

Additions should follow and/or be compatible with the patterns of setback, design, style, etc. that characterize the environs of the listed property.

Additions should be of the same material and/or compatible with the existing structure.

**Not Recommended**

Additions that dominate the existing structure and/or the environs of the listed property.

Additions that destroy relationships between character-defining features of the listed property's environs.

Additions that are not compatible and/or typical of the patters, design, style etc. already established in the environs of a listed property.

Additions that obstruct important views and vistas for or to the listed property.

**PARKING**

**Recommended**

When possible, maintain the parking patterns that characterize the environs of a listed property.

**Not Recommended**

Wholesale modification of traditional, character-defining parking patterns.

Creation of new parking areas that are

When new parking areas are required, design them to be consistent with the character of the environs and to intrude as little as possible.

incompatible and/or inconsistent with the parking patterns that characterize the environs.

**NEW / INFILL CONSTRUCTION**

**Recommended**

New construction should relate to the setback, size, form, patterns, textures, materials and color of the features that characterize the environs of the listed property.

Where there are inconsistent setbacks or varied patterns, the new construction should fall within the range of typical setbacks and patterns in the environs of the listed property.

**Not Recommended**

New construction that is inconsistent and/or incompatible with the character of the environs of the listed property.

New construction that destroys existing relationships within the environs of a listed property.

New construction that dominates the environs.

New construction that obstructs views or vistas from or to the listed property.

**ZONING**

Recommended

Maintain zoning that continues the histories land use in the environs of a listed property.

When rezoning is required within the environs of a listed property, the impact of the rezoning should be considered and steps taken to mitigate adverse effects.

When replatting is necessary, all subsequent new construction should be compatible with the environs in relationship to the setbacks, form, size, scale massing, etc.

Not Recommended

Rezoning to allow development that is incompatible and/or inconsistent with the character of the environs.

Speculative or spot zoning without a well-defined use for the property that is compatible with the environs.

Any rezoning without design documents indicating the compatibility of the proposed new use, addition, and/or infill construction.

Replatting to facilitate new construction that is incompatible and/or inconsistent with the character of the environs of a listed property.

## D. STAFF ANALYSIS

### HISTORY

For a full history of the structure located at 1043 Indiana, please visit http://www.lawrenceks.org/planning/documents/hrcagendaJuly11Full.pdf.

The structure located at 1043 Indiana Street was constructed in 1908.The architect for the structure has not been verified, but available information indicates the structure was designed by William Alexander Griffith or Harriet Tanner. The architectural style of the structure is a vernacular interpretation of an amalgamation of the Shingle Style and the Dutch Colonial Revival style with some Craftsman style detailing.

The structure located at 1043 Indiana Street was built for Professor William Christian Hoad, a distinguished professor of Civil Engineering. WC Hoad was born in Lecompton, KS on January 11, 1874 and died in 1962. Hoad was Assistant Professor, Associate Professor, and Professor of Civil Engineering and head of that department at the University of Kansas between 1900 and 1912. Hoad was also the Chief Engineer for the Kansas State Board of Public Health from 1907-1912. In this position, Hoad advised more than 200 Kansas cities and towns on public sanitation and initiated the 1907 law of sewage standards. Later, Hoad became the Professor of Municipal and Sanitary Engineering at the University of Michigan from 1912-1944.

1043 Indiana Street was converted to fraternity use by 1920. The demand for housing in Lawrence after WWII was perhaps even greater than in other areas because of the significant increase in enrollment at the University of Kansas. By 1950 KU had purchased the property and used it to house various departments. It was most notably known as the residence hall for varsity football players during the 1950s called Jock's Niche.

As part of the South of Memorial Stadium Survey, Hernly and Associates requested a preliminary determination of eligibility for the National Register of Historic Places from the State Historic Preservation Office for 1043 Indiana Street. The National Register Coordinator responded to the request (see attached) and agreed with Hernly's assessment that the structure is potentially eligible for inclusion in the National Register of Historic Places – either as part of a potential historic district or individually. The SHPO was of the opinion 1043 Indiana Street is individually eligible under Criterion C for its architecture and perhaps under Criterion A for its social history.

### ENVIRONS

"Environs," as defined by the Standards and Guidelines for Evaluating the Effect of Projects on Environs, means the historic property's *associated* surroundings and the elements or conditions which serve to *characterize* a specific place, neighborhood, district, or area. In an environs review the objective is to determine the impact of a proposed project on a listed property and its environs.

Like the treatments for historic properties, guidance for environs review begins with the identification of the character-defining features of the environs, its historic and current character, and what must be retained in order to preserve that character. The character of a listed property's environs may be defined by form; exterior materials such as masonry, wood or metal; exterior features and elements such as roofs, porches, windows or construction details; as well as size, scale

and proportion, massing, spatial relationships, etc.

The property located at 1043 Indiana Street is located in the environs of the Oread Historic District, National Register of Historic Places. (The property directly to the north, identified on the City GIS system as 1000 Blk #1 is located in the environs of the Michael D. Greenlee House at 947 Louisiana Street as well as the Oread Historic District, National Register of Historic Places.) Historically, this area of the environs of the Oread Historic District developed with a combination of large houses on multiple lots and standard size houses on single lots. The 1918 Sanborn Fire Insurance Map shows that 1043 Indiana was a Fraternity and the lot to the north was vacant. Old College in the center of what is labeled University Park is directly to the east where the housing pattern appears more developed with most lots supporting structure by 1918. In 1918 it also appears that the area to the north of the 1000 Block of Indiana and Old College had developed with a mix of smaller and moderate size dwellings. To the west of the 1000 Block of Indiana Street, Mississippi Street appears to be developing with moderate size houses on individual lots. The alley is used for accessory access with accompanying structures. Interestingly, several of the structures are identified as "auto" on the 1918 map.

The National Register Nomination for the Oread Historic District defines why the area was nominated and accepted for listing. The neighborhood is significant for its contribution to the community planning and development of Lawrence, for having architecture that is representative of the period of development and for its association with significant people in Lawrence and the world of architecture. The period of significant is 1863-1929. The materials commonly found in the district are limestone, concrete, brick, wood, stone and asbestos. Setback and lot size are also a common feature. According to the Kansas Historic Society, "environs means the historic property's associated surroundings". Environs do change over time; however, the purpose of environs review in accordance with the State Preservation Law is to insulate the historic property or district from encroachment of inappropriate development.

The size of the dwelling units as noted on the Sanborn maps varies from 1 to 2 ½ with Old College being the dominant structure in the area. Typical lot sizes are the platted 50' lot with some lot and ½ and a few 100' double lots. Setbacks vary in the area, but all clearly have a front yard, side yards and a rear yard. The structures facing Indiana Street in the 1000 block appear to be placed closer to the street, possibly because of the topography of the area. The historic materials identified for the area are predominately wood frame structures with wood sheathing but brick is also used as a building material in the environs. Historically, roofs had some pitch and were often simple gabled or hipped forms. 1043 Indiana is fairly unique with its gambrel roof form. Porches are clearly a dominate feature for the environs and are shown on almost all of the dwellings noted on the Sanborn maps. As noted above, automobiles are part of the historic environs of this area as identified by the "auto" accessory structures located on the alley.

The structure located at 1043 Indiana Street is not currently listed in the Kansas or National Register of Historic Places, but as noted above, the structure is eligible for listing and would be eligible for the financial incentives for rehabilitation associated with listing. The subject structure is located in the outermost area of the notification boundary for the Oread Historic District. There is a line of site, although limited by topography, from the listed property, the Oread Historic District.

Looking north on Indiana from 10th Street

**MOVING THE HISTORIC STRUCTURE**

As presented, the plan of moving the historic structure does not appear to meet the Standards and Guidelines for Evaluating the Effect of Projects on Environs, specifically standards

> *1. The character of a historic property's environs should be retained and preserved. The removal or alteration of distinctive buildings, structures, landscape features, spatial relationships, etc. that characterize the environs should be avoided.*

The applicant proposes the rehabilitation of the existing structure located at 1043 Indiana. As part of the rehabilitation, the structure will be moved to the north end of Lot 7. (The new apartment complex will be constructed on Lots 7-12.) As part of the move, the addition, basement, and chimney will be lost. The chimney can be rebuilt; and the applicant proposes to use the stone from the foundation to face the foundation at the new location. The existing rear (west) addition of the structure is in poor condition and is causing some damage to the original structure. Staff is in agreement with the applicant that this addition should be removed or replaced.

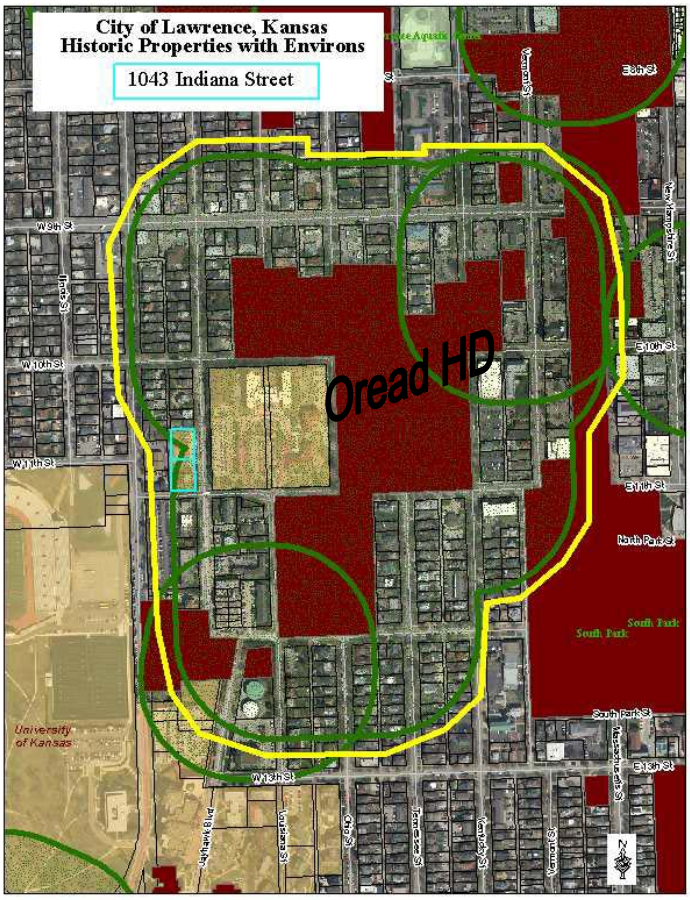
The National Park Service has very stringent guidelines on moving historic structures and their ability to maintain or achieve listing in the National Register. The applicant has requested a determination from the SHPO regarding whether the structure located at 1043 Indiana Street would remain eligible for listing if it is moved to the north of the development property. The SHPO (see attached) has responded that the structure would not be eligible for listing in the National Register and listing in the Register of Historic Kansas Places would require the applicant to work with the SHPO on the move and might not achieve register listing because of the loss of integrity associated with the move. According to the National Register publication *How to Apply the National Register Criteria for Evaluation,*

> The National Register criteria limit the consideration of moved properties because significance is embodied in locations and settings as well as in the properties themselves. Moving a property destroys the relationships between the property and its surroundings and destroys associations with historic events and persons. A move may also cause the loss of historic features such as landscaping, foundations, and chimneys, as well as loss of the potential for associated archeological deposits.
>
> One of the basic purposes of the National Register is to encourage the preservation of historic properties as living parts of their communities. In keeping with this purpose, it is not usual to list artificial groupings of buildings that have been created for purposes of interpretation, protection, or maintenance. Moving buildings to such a grouping destroys the integrity of location and setting, and can create a false sense of historic development.

The National Register criteria for evaluation highlight the importance of a structure's location and setting. While the history of the structure located at 1043 Indiana Street is significant, it does not enter into the evaluation of the move of the structure under State Preservation Law as part of this development project. The question for the HRC is: will the move of the structure and the

subsequent development encroach upon, damage, or destroy the environs of the Oread Historic District and the Michael D. Greenlee House. The National Register information on evaluation is relevant in that it shows the importance of location and setting for historic properties. While moving the structure to the north, both to save it and to group it with "like" buildings is preferable to demolition; staff is concerned about the possible creation of a false sense of streetscape and development of the block, as well as the loss of the association of the structure with the prominent corner lot.

In the application materials, the applicant identifies the reason for proceeding with a plan to move the structure is that it ultimately makes the most sense for the building. Keeping the structure where it is or moving it slightly to the south to maintain its presence on the corner would require moving the house two times, once to rebuild the foundation and again to put the house back on the new foundation. This plan also eliminates the ability for parking underneath. Moving the structure to the north will cause it to be moved only once. It will also provide the opportunity to reuse the foundation materials to face the new foundation and include underground parking under the new foundation.




It is the opinion of staff that moving the structure located at 1043 Indiana will encroach upon, damage and destroy the environs of the Oread Historic District. Staff does note that the western edge of the environs of the Oread District has already been damaged by modern infill redevelopment. What developed as a single family neighborhood has been altered. However, according to the Oread Neighborhood Plan, 31% of the acres are still used for single family dwelling.

The map to the left shows the district and its environs (outlined in yellow). As noted by the map, the environs encompasses a much larger area than just the 1000 block of Indiana. It is important to consider the environs as a whole. To further destroy the environs with the loss of this significant structure and its associated location and setting does not meet the applicable standards.

There are options available to the applicant to avoid this determination that the project does not meet the standards and will encroach upon, damage, or destroy the environs of the Oread Historic District. The structure at 1043 Indiana

could be rehabilitated on its current site and incorporated into a new apartment development. The western portion of Lots 11 and 12 could be used for the new development while maintaining the green space and existing structure as a focal point for the development. This project could be a great asset to the community by blending the historic character of the environs and the existing structure with the new development.

Staff is of the opinion the structure located at 1043 Indiana Street is a character defining feature of the environs of the Oread Historic District. Reasons the structure is character defining include the prominent location of the structure on two lots, architectural style, and continuance of the historic patterns of the neighborhood including but not limited to setbacks, green space, and building materials. As mentioned above, the move of the structure will alter not only the building location, but also the structure by removal of the basement, chimney, and addition. Using the Standards and Guidelines for Evaluating the Effect of Projects on Environs, it is staff's opinion that while preferable to demolition, the moving of the structure does not meet the intent of Standard 1.

1. *The character of a historic property's environs should be retained and preserved. The removal or alteration of distinctive buildings, structures, landscape features, spatial relationships, etc. that characterize the environs should be avoided.*

**It is the opinion of staff that the proposal of moving the historic and potentially eligible structure at 1043 Indiana Street does encroach, damage or destroy the environs of the Oread Historic District and the Michael Greenlee House at 947 Louisiana Street and does not meet the Standards and Guidelines for Evaluating the Effect of Projects on Environs.** In accordance with the Standards and Guidelines for Evaluating the Effect of Projects on Environs, the standard of evaluation, staff recommends the Commission deny the proposed project.

Staff additionally recommends that the applicant secure the building from further damage and intrusion and to prevent public harm. There are many broken windows and ways to enter the structure without permission.

---

If the members of the HRC rule that moving 1043 Indiana does NOT encroach, damage or destroy the environs, the following is the review of the proposed new infill construction:

**NEW CONSTRUCTION**

The applicant proposes to construct a new apartment complex on Lots 7-12 Block 13 Lane's Second Addition. As of August 15, 2011, complete architectural drawings and elevations that correspond with the submitted renderings have not been received by the Planning Department.

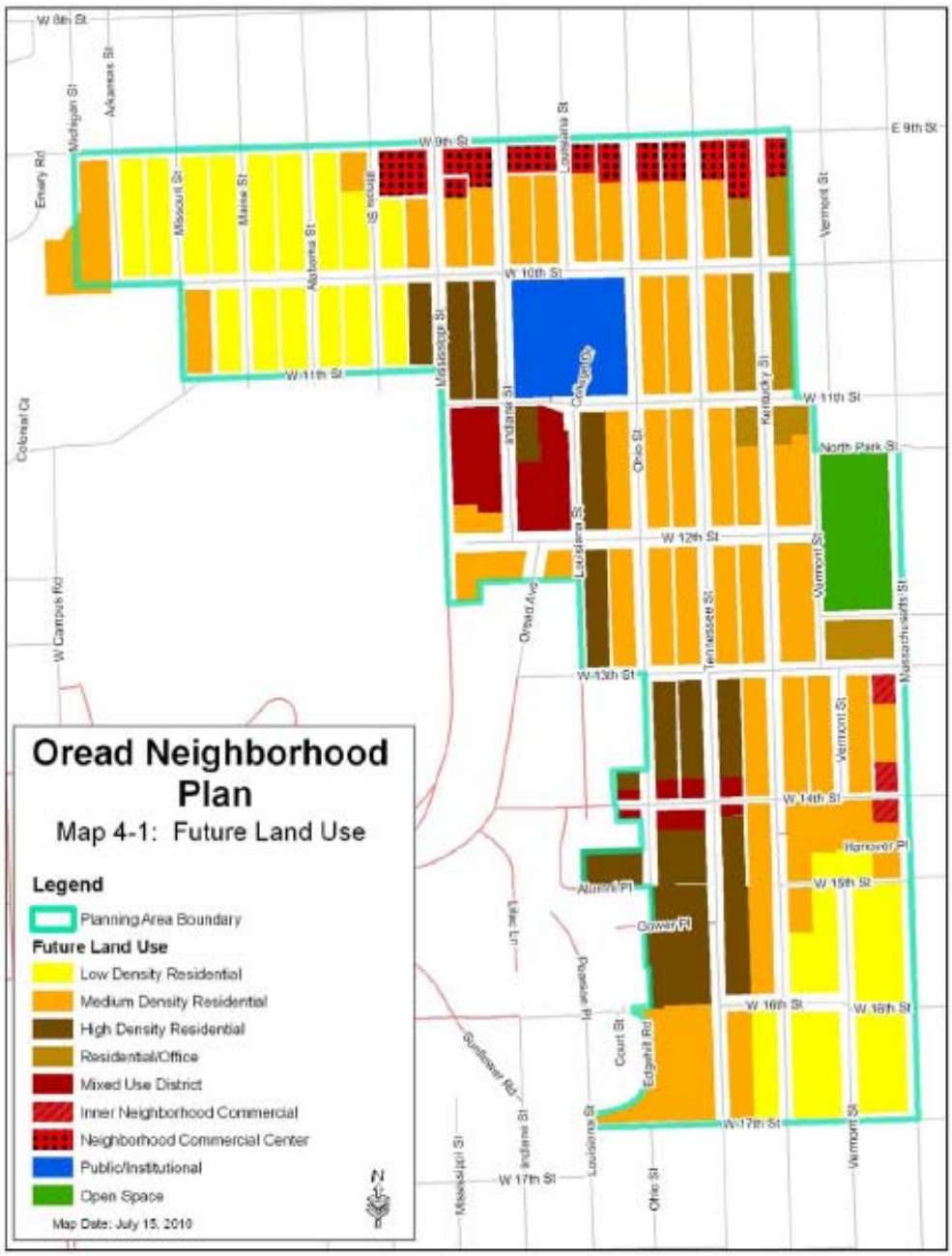
As presented, the plan does not appear to meet the Standards and Guidelines for Evaluating the Effect of Projects on Environs, specifically standards

2. *The environs of a property should be used as it has historically been used or allow the inclusion of new uses that require minimal change to the environs' distinctive materials, features, and spatial relationships.*

*6. New additions, exterior alterations, infill construction, or related new construction should not destroy character-defining features or spatial relationships that characterize the environs of a property. The new work shall be compatible with the historic materials, character-defining features, size, scale and proportion, and massing of the environs.*

Standard #2

Standard #2 states, "*The environs of a property should be used as it has historically been used or allow the inclusion of new uses that require minimal change to the environs' distinctive materials, features, and spatial relationships.*"



In the Oread Neighborhood Plan, the 1000 block of Indiana is planned as high density residential development. The rezoning of this property to RM32 and the accompanying building fit with the long-term plan set forth in the Oread Neighborhood Plan. The use and density is not the problem for this project.

In the Oread District, parking structures are not common and are not a historic use. For this project, the underground parking consists of two levels that are not connected to each other. Level 1 has access from Indiana Street. Level 2 has access from the alleyway off 11th Street. Both entries have a metal gate restricting access to residents. The west elevation has two levels of openings for the garage levels, which carry to the north and south elevations. The openings will have a green screen covering. While underground parking structures are not common, they are less intrusive to the environs of listed properties. Staff prefers underground parking to surface lots. The proposed materials and design for the parking structure portion of this project, particularly the entrance with the large retaining wall off of Indiana Street, appear to emphasize the existence of the underground parking as opposed to making the parking structure appear minimal.

Though the higher density use has been mentioned in long term planning, the change in lots 7-12 would be more than "minimal", as pertains to spatial relationships in the Standards. As further discussed below, the materials and features are less affected by the change.

Standard #6

This review is based on the HRC's approval to move the historic structure. Doing so eliminates #6a, "*New additions, exterior alterations, infill construction, or related new construction should not destroy character-defining features or spatial relationships that characterize the environs of a property."*

The following considers #6b, "*The new work shall be compatible with the historic materials, character-defining features, size, scale and proportion, and massing of the environs."*

Compliance with standards:

The applicant has worked diligently with the Architectural Review Committee to minimize the impact of the proposed structure to the environs through the use of building materials, roof forms, and a main façade that has variation in depth. The proposed structure incorporates features that are found in the historic neighborhood and the environs of the Oread Historic District and the Greenlee House. There are sections that are setback from the front façade presenting an undulating building. The roofline shares characteristics of those found in the environs with the choice of a pyramidal roof and dormers. The chosen materials are similar to those typically used in the environs. The ground floor is covered in rough stone and the upper stories alternate between wood shingles, cement lap siding and brick.

Staff has concerns about the overuse of the rusticated stone. Within the environs of the Oread Historic District stone is typically used only for basement materials and accent (there are small vernacular structures of stone in the area). Staff would suggest limiting the height of the rough stone so it does not dominate the pedestrian level, as it appears in the renderings. As seen in the photo, stone is only used on the porch and basement, just above ground level. Staff recommends keeping this pattern throughout the overall project design.

The north elevation best illustrates how the new construction will relate to the historic structure. It shows new construction that works to relate to the moved structure and its surroundings. The various rooflines on the proposed structure are similar to other dwellings in the environs. The infill structure tries to not tower over the historic structure and steps down to relate to its neighbors. This is a large apartment building in an area that has previously only seen small apartment buildings 2-3 stories tall.

North Elevation

Issues to address:
The typical rhythm and development pattern of the area is single structures on single or double lots. The proposed renderings address the feature of the environs by breaking up the façade with recessed glass entryways. In the north elevation above, it does read as separated buildings. Staff would still like to see the building further broken up with more green space in the 50 to 100 foot pattern of the environs.

On all sides of the façade are balconies with railings of perforated aluminum and painted steel. Balconies are not common in the environs. The free standing structures typically have front porches and back patios. Occasionally there will be a second floor balcony/porch where a sleeping porch would have been. Even then, those porches are made of stone and wood. The materials portrayed in the renderings do not match those in the neighborhood. Staff is of the opinion that, though not consistent with the environs, the inclusion of balconies in the proposed design increases the residential feel of the project.

The windows on the proposed building don't read as residential windows. The casement window with a horizontal crossbar on the top third of the windows does not fit the environs where most

windows would be double hung. Additionally, the windows in the new construction are larger than most in the residential environs.

**CONCLUSION**

Infill construction in historic neighborhoods is very difficult. One has to avoid creating a false history or creating something that does not relate to its surroundings. Preservation is not meant to stop the march of time, but to engage the best of the past and present to create responsible design. The proposed infill project, though not perfect has made great strides to relate to its surroundings. The choice of materials and the way the façade and roofline have been broken up helps the building fit in the environs. However, the architectural detailing, while aiding to minimize the impact of the large structure, cannot correct the overall size, mass and scale issues of the project.

## E. STAFF RECOMMENDATION

**Proposed Project of New Construction and Moving the Existing Structure – DR-04-49-11 PDP-7-1-11**

In accordance with the Standards and Guidelines for Evaluating the Effect of Projects on Environs, the standard of evaluation, staff recommends the Commission deny the proposed project and make the determination that the proposed project does encroach upon, damage, or destroy the environs of one or more listed historic properties. Specifically, the project does not meet the following standards:

*1. The character of a historic property's environs should be retained and preserved. The removal or alteration of distinctive buildings, structures, landscape features, spatial relationships, etc. that characterize the environs should be avoided.*

*2. The environs of a property should be used as it has historically been used or allow the inclusion of new uses that require minimal change to the environs' distinctive materials, features, and spatial relationships.*

*4. Demolition of character-defining buildings, structures, landscape features, etc. in a historic property's environs should be avoided. When the severity of deterioration requires removal within the environs, compatible reconstruction shall occur.*

*6. New additions, exterior alterations, infill construction, or related new construction should not destroy character-defining features or spatial relationships that characterize the environs of a property. The new work shall be compatible with the historic materials, character-defining features, size, scale and proportion, and massing of the environs.*

**ZONING DR-7-103-11**

In accordance with the Standards and Guidelines for Evaluating the Effect of Projects on Environs, the standard of evaluation, staff recommends the Commission approve the proposed project and make the determination that the proposed project does not encroach upon, damage, or destroy the environs of one or more listed historic properties with the following conditions:

1. Any changes to the approved plans should be resubmitted to the Historic Resources Commission prior to the commencement of any related work.

# Memorandum
# City of Lawrence
# Planning & Development Services

**TO:** **Planning Commission**

**FROM:** **Mary Miller, Planning Staff**

**CC:** **Scott McCullough, Planning and Development Services Director**
**Sheila Stogsdill, Assistant Planning Director**

**Date:** **For August 24, 2011 meeting**

**RE:** **Agenda Item No. 6: TA-4-6-11, a text amendment to the City of Lawrence Development Code; synthetic turf as landscaping material**

**Attachments:** A-G attached with original Staff Report
1— Photos of natural and artificial landscaping
2— Information from other communities
3— Association of Synthetic Grass Installers
4— Why Native Plants
5—Synthetic Surface Heat Studies

The Planning Commission considered the text amendment referenced above at their June 22 meeting and voted 7 to 1 to defer the item to the July meeting and directed Staff to provide additional information on the topics noted below.

1. Information on the Alternative Compliance provision in the Development Code
2. More information regarding other communities regulations pertaining to synthetic turf
3. Explanation of how the text amendment relates to the Environment Chapter
4. Discuss the table comparing synthetic turf, traditional lawn and low maintenance landscaping. (Cite sources. Also provide photos of other projects. )
5. Provision of 3 code options:
    a. Specifically prohibiting the use of synthetic turf as landscaping material even as Alternative Compliance
    b. Permitting use of synthetic turf as a landscape material in a limited fashion through Alternative Compliance, and
    c. Permitting use of synthetic turf as a landscape material and establishing standards for its use.

## 1. Alternative Compliance – Section 20-1007 of the Development Code

The Development Code contains interior parking lot, perimeter parking lot, and bufferyard landscaping requirements. The Code also recognizes that there may be situations where it is not possible to meet all the landscaping requirements. Alternative Compliance is a code provision intended to address these situations. The Code states that Alternative Compliance may be used when, *"Topography, soil, vegetation, space constraints or other site conditions are such that full compliance is impossible or impractical, or improved environmental quality would result from the alternative compliance,"* or when, *"Safety considerations make alternative compliance necessary."* [Section 20-1007(a)]

Per Section 20-1007(b), in order to be approved an Alternative Compliance landscape plan shall be equal to or exceed traditional compliance in terms of quality of materials and visual effect, effectiveness in meeting the purpose established in Section 20-1001, and material durability and hardiness.

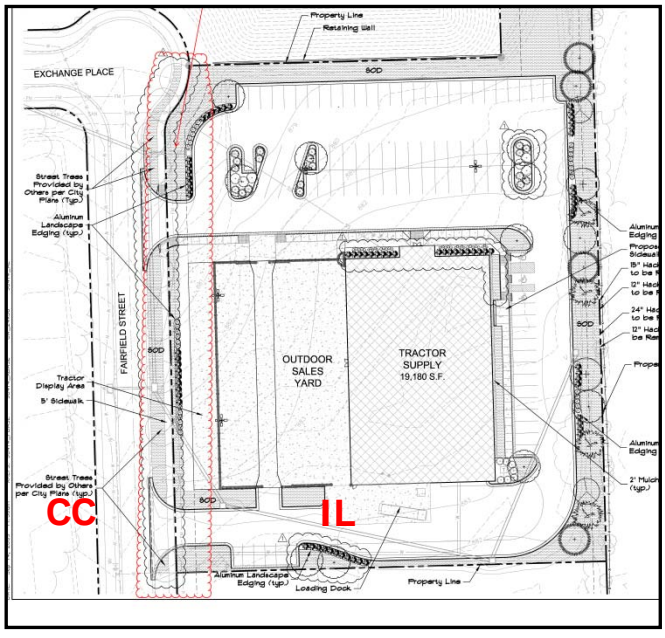
Alternative Compliance is granted on a case by case basis based on the specific characteristics of the site and the alternative landscape plan being proposed. Alternative Compliance does not establish precedent for acceptance of alternative compliance plans on other sites. [Section 20-1007(b)]

A request for receiving Alternative Compliance approval is processed at the time of site planning:

1) The applicant shall submit a request for Alternative Compliance to the Planning Director along with an alternate landscape plan and sufficient explanation and justification of the need for Alternative Compliance.
2) The Planning Director is authorized to approve the alternative compliance plan if the Director determines that one of the conditions in Section 20-1007(a) exist.
3) Appeals from the Planning Director's decision may be filed with the Board of Zoning Appeals.

Examples of Alternative Compliance that have been approved on some other sites may provide the clearest explanation. The following example is from the staff review of Alternative Compliance that was approved along the west side of the Tractor Supply Company development (outlined in red on figure to the right).

A landscaped buffer yard is required between the IL and CC zoning districts. The property contains a commercial use but is located in the industrial district. If the property was zoned commercially, no buffer yard would be required.



In this instance, screening is provided in the 15' parking lot setback and through the provision of street trees. The presence of utilities along Fairfield Street conflicts with the use of dense plantings. Alternative compliance is being used in lieu of a full scale buffer yard along the west property line.

The Code requirement for buffering between commercial and industrially zoned properties is intended to buffer commercial and industrial uses. However, in this case, the adjacent uses in the IL and CC zoning districts were both commercial. A site constraint was present in the form of utilities along Fairfield Street which conflicted with the bufferyard plantings. Alternative Compliance was granted for this property based on the site constraint of underground utilities in the bufferyard area and the fact that additional landscaping between two commercial uses would not serve the purpose of buffering, i.e. "to mitigate the impacts associated with incompatible land uses on adjacent properties. The standards require landscape bufferyards between such uses to minimize the harmful impacts of noise, dust/debris, glare and other objectionable activities." [Section 20-1005(a)].

The example below is Alternative Compliance which was approved from the interior parking lot landscaping area requirement in Section 20-1003(c) for the redevelopment of the Dillons at 1740 Massachusetts Street:

<table>
<tr><th colspan="3">Interior Parking Lot Landscaping</th></tr>
<tr><td>Code Requirement:</td><td colspan="2">Provided on plan:</td></tr>
<tr><td rowspan="2">Area:<br>40 sq ft / parking space<br>129 spaces x 40 = 5160 sq ft</td><td colspan="2">Area: 2241 sq ft</td></tr>
<tr><td colspan="2">Deficit: 2919 sq ft</td></tr>
<tr><td rowspan="2">Plantings:<br>1 tree and 3 shrubs per 10 spaces<br>129 spaces = 13 trees and 39 shrubs</td><td>Trees: 13</td><td>Shrubs: 0</td></tr>
<tr><td>No Deficit</td><td>Deficit: 39 shrubs</td></tr>
<tr><td colspan="3">Discussion:<br>The irregular configuration of the property and small area creates a space constraint for redevelopment. The applicant requested a variance from the Board of Zoning Appeals from the amount of parking required to permit 129 parking spaces which they've indicated should be adequate for their business. Requiring additional interior parking lot landscaping area would reduce the area available for parking or for the store itself. The amount of landscaping being provided is much greater than that which is currently provided on site: 1,895 sq ft of pervious surface is currently provided; 9,985 sq ft, is proposed. With the overall increase in landscaping with this redevelopment, alternative compliance from the interior parking lot landscaping area requirement is appropriate. The City Horticulture Manager indicated that space is available on the interior parking lot landscaping islands to provide 3 shrubs per tree.<br><br>Planning Director Determination on Alternative Compliance for Interior Parking Landscaping:<br>The Planning Director approves Alternative Compliance to permit 2,241 sq ft of interior parking lot landscaping area. The number of required trees and shrubs shall meet the code requirement of 13 trees and 39 shrubs.</td></tr>
</table>

These examples illustrate that it must first be shown that Alternative Compliance is necessary based on the applicability requirements in Section 20-1007. It then must be determined that the alternate landscaping being proposed 'meets or exceeds' that which is required by Code. In the case above, alternative compliance was approved from the area requirement, but as it was determined that adequate space was available for all the landscaping materials, Alternative Compliance was not approved for a reduction in the number of shrubs provided.

SYNTHETIC TURF AND ALTERNATIVE COMPLIANCE

The reduced maintenance and reduced amounts of fertilizer, pesticide and water necessary for landscapes utilizing synthetic turf are not factors to consider with an Alternative Compliance request. The request must meet one of the following applicability requirements in Section 20-1007:

- Topography, soil, vegetation, space constraints or other site conditions are such that full compliance is impossible or impractical, or improved environmental quality would result from the alternative compliance, or

- Safety considerations make alternative compliance necessary.

The staff report discussed the sustainability of synthetic turf in relation to low maintenance landscaping or traditional lawns. Sections 3 and 4 of this memo provide additional information on the sustainability discussion and an analysis of the compliance of synthetic turf with the Environment Chapter. The conclusion of this discussion and analysis is that the use of synthetic turf does not result in improved environmental quality.

Other site conditions include topography or space constraints. Synthetic turf requires a fairly level grade, so the only site condition that could apply would be space constraints: that is, if a landscaped area is so narrow that it is not possible to maintain regular turf or low maintenance landscaping effectively. The pictures in Attachment 1 show landscaping at various apartment developments throughout Lawrence. These examples show that it is possible to maintain attractive live landscaping in a limited space. Pictures of the synthetic turf which was installed at the Frontier Apartments show that the areas landscaped with synthetic turf are larger than those which are effectively landscaped with live plant materials at other developments. Given the fact that space constraints can be resolved with low maintenance or traditional landscaping (see attached photos), synthetic turf would not meet the requirements for Alternative Compliance as we have grown to understand the code through this text amendment process.

In addition, it is evident that permitting Synthetic Turf with Alternative Compliance creates confusion. Synthetic Turf was permitted with Alternative Compliance at the Oread Inn, also shown in Attachment 1, based on the unique circumstances of this development and with notice to the owner that such material is not typical. The same developer then applied synthetic turf at the Frontier Apartments without approval through Alternative Compliance, stating that he mistakenly assumed it was an approved landscape material. While Staff believes the code is clear in its allowance of only living plant materials, the Oread Hotel approval has clearly produced confusion on its use.

**SUMMARY**

As the use of synthetic turf would meet the applicability requirement for Alternative Compliance in only *very* limited situations, and the fact that permitting it with Alternative Compliance results in unclear regulations, staff recommends that the use of Artificial Plants, whether synthetic turf, flowers, shrubs, or trees not be permitted as a landscaping material with Alternative Compliance.

## 2. Other Communities Regulations Pertaining to Synthetic Turf

Several communities permit the use of synthetic turf as landscaping material. Some of these are listed in Attachment 2. The decision to permit synthetic turf was generally based on the need to conserve water. These communities are predominately located in areas with very low annual precipitation and they have adopted water conservation policies. The communities which permit synthetic turf have 15 inches of rainfall or less. (Lawrence's annual rainfall is 39.8 inches).

Some states which are experiencing severe water shortages, such as California and Arizona, have adopted strong water conservation measures which require their communities to reduce water usage per capita. From the State of California, Division 6 of the Water Code:

> "b) Growing population, climate change, and the need to protect and grow California's economy while protecting and restoring our fish and wildlife habitats make it essential that the state manage its water resources as efficiently as possible."
>
> "g) The Governor has called for a 20 percent per capita reduction in urban water use statewide by 2020."

California adopted a Model Water Efficient Landscape Ordinance, which many California communities have also adopted. The ordinance recommends the use of native plants.

The Arizona Division of Water Resources has also established a set of conservation regulations. Plant lists have been developed to encourage the use of low-water usage plants. In 2008, Tucson became the first municipality in the county to require developers of commercial properties to harvest rainwater for landscaping. The city requires that new developments must meet 50% of their landscaping requirements by capturing rainwater. While many communities permit the use of synthetic turf, others do not.

The Kansas Water Plan notes that most communities in Kansas have adequate water at this time, but water conservation is important to insure water supplies in the future. (page 1, Kansas Water Plan, Water Conservation Policy and Institutional Framework, January 2009) On page 5, the plan suggests that water needs could be reduced through the installation of low flow plumbing, low water need landscaping and reduction of runoff from watering and car washing and on page 9, the plan recommends water 'reuse' as a potentially significant conservation action.
http://www.kwo.org/Kansas_Water_Plan/KWP_Docs/VolumeII/Rpt_KWP_2009_Water_Conservation.pdf )

Many communities, primarily those in states with mandated water conservation measures and set attainment measures, permit the use of artificial turf as a landscaping material. The

Kansas Water Plan does not include a reduction of landscaped areas in the recommended conservation measures but does suggest the reuse of water.

Some of the communities reviewed permit synthetic turf but specifically omit it from the water conservation rebate. Glendale, Arizona removed synthetic turf from the rebate program following the Center for Disease Control and Prevention's warning. Santa Cruz, California specifically omitted synthetic turf with the following reasoning:

> *"The City of Santa Cruz' Lawn Removal Rebate Program was developed to help reduce peak water demand, improve water use efficiency, assist customers in controlling their utility costs, and encourage environmentally friendly landscape practices. The use of artificial turf is not consistent with a holistic landscaping approach and is therefore not rebated through the City's Lawn Removal Rebate program for the following reasons:*
>
> *1. Artificial turf does not foster soil health. Healthy living soil will:*
>
> - *Increase microbial activity which helps cycle nutrients and filter pollutants*
> - *Increase water holding capacity*
> - *Improve water quality*
>
> *2. Artificial turf is not easily recycled.*
>
> - *Cost and lack of infrastructure are an issue to end-of-life recycling for artificial turf*
> - *It ends up in the landfill*
>
> *3. The production, processing, and transportation of synthetic turf components are associated with significant greenhouse gas emissions."*
>
> *(http://www.cityofsantacruz.com/Modules/ShowDocument.aspx?documentid=20963)*

Cerritos, California, adopted a prohibition on the use of synthetic turf as a landscape material and provided the following explanation:

> *"The City of Cerritos takes great pride in the park-like appearance of the City. In order to maintain this lush environment, it has been a long-standing City policy to prohibit the use of artificial plant material and/or turf in landscape applications. Chapter 20.30.470 of the Cerritos Municipal Code specifically prohibits the use of artificial landscape materials including, but not limited to, silk plants, synthetic turf, and plastic shrubs and trees.*
>
> *City staff researched the use of synthetic turf material in residential applications and found that the use of artificial turf creates an area of diminished biological activity which inhibits the flow of oxygen and nutrients to the soil. Organic landscapes comprised of trees, shrubs and turf produce oxygen and store carbon, and provide benefits such as shade, lower temperatures and pollution mitigation. The use of artificial turf has the potential to diminish the health of trees and plants located in the surrounding landscape and environment.*
>
> *The City has determined that the use of artificial turf in residential applications is not an adequate substitute for organic plant material, and that it does not meet the City's development standards as established within the Cerritos Municipal Code for residential applications. California native and/or drought tolerant ground covers and shrubs are more beneficial substitutes for turf if property owners are looking for ways to lower water use and/or landscaping maintenance".*

The communities who permit synthetic turf range from permitting it only with Alternative Compliance or as a Special Exception, to permitting it in all zoning districts. The communities have all adopted standards related to synthetic turf. A summary of the standards is included in Attachment D. This summary illustrates the type of standards that would be necessary if synthetic turf is permitted as a landscaping material.

**SUMMARY**
The communities that permit synthetic turf seem to be attempting to meet an objective of conserving water in locations where water is sparse. The Midwest is fortunate to not have this issue to the degree that these other locations do. Even when permitted, synthetic turf appears to be the exception and not the rule.

## 3. Text Amendment's relation to Environment Chapter

Sustainability is one of the overall *Horizon 2020* Planning Goals and it is also a key goal in the Environment Chapter. "We will strive to ensure the sustainability of our physical environment, both natural and built, the health of our economy and the efficient and effective functioning of our community." (Page 16-1)

The "Summary of Issues for the Human and Built Environment" portion of the chapter states that creating a sustainable community can include minimizing negative impacts from development on the environment and promoting sustainable building and land use practices. (page 16-23)

The applicant indicated that synthetic turf is a sustainable alternative to turf grass for the following reasons:

1) Less watering needed: water conserving.
2) No fertilizer or pesticide required: reduced pollutants.
3) No need to mow: reduced emissions.

1) WATER CONSERVATION
Water conservation is addressed in Policy 6.6 with the following recommendations:

- Encourage the use of drought-tolerant native species,
- Encourage the use of alternative irrigation methods,
- Provide education on measures such as mulch and drip irrigation which would reduce water consumption for landscaping,
- Provide incentives for building and facility design which minimizes water usage such as water efficient plumbing fixtures, and reuse of gray water for irrigation. (page 16-25)

The chapter encourages water conservation. Reduced water usage is in compliance with the recommendation of the Environment Chapter; however, the chapter does not encourage or recommend the reduction of vegetation as a means to conserve water.

2) EMISSIONS
Policy 3.3: "Encourage education and outreach programs which explain the need for improvement and provide information on steps individuals, businesses, institutions, the City and the County can take to reduce their contribution to emissions in Douglas County."

The chapter encourages reduced emissions and focuses on reduced vehicle miles, mixed use development, and other changes to the built environment to reduce emissions. Reduced emissions is in compliance with the recommendation of the Environment Chapter; however, the chapter does not encourage or recommend the reduction of vegetation as a means to reduce emissions.

3) POLLUTANTS

Policy 1.2(d) "Encourage continued alignment with the Kansas Water Plan which lists the following measures:

- d.1 Use native plants in yards and gardens; they need fewer chemicals and water.
- d.2 Use fewer chemicals on lawn, gardens, fields and forests to protect water quality.
- d.3 Separate livestock operations from streams with a vegetated filter and adequate distance." (page 16-5)

Policy 1.5 "Develop programs and regulations, such as pesticide-free park programs and further stormwater regulations, to minimize pollutants leaching into underlying groundwater systems to help ensure the quality of our groundwater resources." (page 16-6)

Policy 1.7 "Encourage minimal and appropriate use of fertilizers, pesticides and other chemicals to reduce stormwater pollutants." (page 16-7)

The chapter encourages reduction of pollutants into the sub-surface water resources and recommends regulations to minimize pollutants into the groundwater. The reduced use of fertilizer and pesticide is in keeping with the recommendations of the Environment Chapter; however, the chapter does not encourage the reduction of vegetation as a means to reduce fertilizer and pesticide usage.

**GREEN INFRASTRUCTURE**

A principal concept of the Environment Chapter is the utilization of Green Infrastructure. The chapter encourages the use of natural systems to serve as green infrastructure. "Green infrastructure strategies actively seek to understand, leverage, and value the different ecological, social, and economic functions provided by natural systems in order to guide more efficient and sustainable land use and development patterns as well as protect ecosystems." (Page 16-2)

The chapter strongly recommends the use of 'green infrastructure': "A strategically planned and managed network of natural lands, working landscapes and other open spaces that conserve ecosystem values and functions and provide associated benefits to human populations." (Glossary, page16-27) Turf grass, ground cover, and other natural plants work as 'green infrastructure' to maintain air quality, reduce stormwater flow, filter pollutants, and reduce heat. The proposal to use artificial landscaping is not in compliance with the recommendation of the Environment Chapter to utilize natural systems as green infrastructure.

**SUMMARY**

The applicant's statement that synthetic turf is sustainable due to the fact that it requires little water, no mowing, and no fertilizer or pesticides ignores the fact that synthetic turf provides no benefits to the environment: it does not serve as a component of the green

infrastructure system, provides no habitat, neither takes in carbon dioxide or releases oxygen, and degrades the quality of the underlying soil. Reduced water usage, less frequent mowing, and reduced or eliminated use of pesticides and fertilizers are all in line with the Environment Chapter; however, reaching this objective through the use of native species and appropriate green infrastructure are preferred when compared with artificial materials. While synthetic turf does not require mowing, watering, fertilizer or pesticide, it contributes nothing to the environment and does not function as living components of green infrastructure. The use of synthetic turf as a landscaping material is not in compliance with the recommendations in the Environment Chapter.

## 4. Discussion of Comparison Chart

| | Synthetic Turf | Low Maintenance | Traditional Lawn |
|---|---|---|---|
| **Low water usage** | ✔ | ✔ | |

- Synthetic turf requires watering for cooling in hot temperatures and for cleaning. (Att F, Natural Landscaping and Artificial Turf, Page 4; Att 3, Association of Synthetic Grass Installers, Page 4)
- Low maintenance landscaping uses hardy native or adapted plants that are drought tolerant and well adapted to the climate and other characteristics of the area. Watering is not necessary. (Att G, K-State Report, Page 2) (Att B, LEED, page 30)
- Traditional lawn turf typically requires watering, although more drought tolerant varieties are available. (Att F, Page 1) (Att G, Page 1)

| | Synthetic Turf | Low Maintenance | Traditional Lawn |
|---|---|---|---|
| **No Pesticide usage** | ✔ | ✔ * | |

- Synthetic turf is a non-living material and does not require pesticide. (Att. F, Page 4)
- *Low maintenance landscaping may require pesticides prior to establishment to remove weeds from planting area but they should not be required once the plantings are established. (Att F, Page 2) Native plants have developed their own defenses against many pests and diseases. (Att 4, Why Native Plants, page 1) (Att B, LEED, page 30)
- Traditional lawns typically require yearly applications of pesticides to prevent weeds.

| | Synthetic Turf | Low Maintenance | Traditional Lawn |
|---|---|---|---|
| **No Fertilizer** | ✔ | ✔ * | |

- Synthetic turf is a non-living material which does not take nutrients from the soil; therefore, fertilizer is not needed. (Att. F, Page 4)
- *Low maintenance landscaping known as 'native landscaping' does not require fertilizer. (Att F, Page 2); native grasses should be fertilized sparingly or not at all. (Att G, Page 4) Att B, LEED, page 30)
- Fertilizers are routinely applied to traditional lawns. (Att F, Page 1)

| | Synthetic Turf | Low Maintenance | Traditional Lawn |
|---|---|---|---|
| **No mowing** | ✔ | ✔ * | |

- Synthetic turf is a non-living material; as it does not grow, mowing is not required.
- *Low maintenance landscaping utilizes ground covers and other hardy adapted plants. Mowing may be required if turf grasses are included in the low maintenance landscaping. The amount of mowing is less with a low-maintenance landscape than with a traditional lawn.(Att B, page 30)
- Traditional lawns require regular mowing; however, new turf grasses are being created which may reduce the need to mow traditional lawns.

| | Synthetic Turf | Low Maintenance | Traditional Lawn |
|---|---|---|---|
| **Pervious** | ✔ | ✔ | ✔ |

- The synthetic turf industry states that synthetic turf is pervious; however, each brand has a different degree. Proper base preparation and installation along with the correct product selection is important to insure permeability. (Att 3)
- Low maintenance and natural lawns are pervious.

| | Synthetic Turf | Low Maintenance | Traditional Lawn |
|---|---|---|---|
| **Filters pollutants** | | ✔ | ✔ |

- Live plants in low maintenance or traditional lawns acts as a natural filter, reducing pollution by purifying the water passing through its root zone. (Att 4)
- Synthetic turf does not have a root zone so pollutants are not filtered.

| | Synthetic Turf | Low Maintenance | Traditional Lawn |
|---|---|---|---|
| **Provides Habitat** | | ✔ | ✔ |

- Soil organisms are unable to live in the soil under synthetic grass. The soil under synthetic turf often becomes degraded due to lack of oxygen and soil organisms. (Att F, page 4)

| | Synthetic Turf | Low Maintenance | Traditional Lawn |
|---|---|---|---|
| **Provides Oxygen** | | ✔ | ✔ |
| **Absorbs Carbon Dioxide** | | ✔ | ✔ |

- Plants take up carbon dioxide and produce oxygen through photosynthesis. (Att F, Page 4)

| | Synthetic Turf | Low Maintenance | Traditional Lawn |
|---|---|---|---|
| **Reduces Heat Island** | | ✔ | ✔ |
| **Adds to Heat Island** | ✔ | | |

- Natural grass has the ability to cool the surrounding area through evapotranspiration. (Att F, Page 4)

- Artificial turf is often much hotter than grass, which adds to the heat island effect. (Synthetic Surface Heat Studies, Att 5,)

## 5. Provision of 3 Alternative Code Options

The Planning Commission requested three code options as described and discussed below to clarify whether synthetic turf is permitted in the Development Code. While the code is explicit in its prohibition on the use of artificial plants, staff's approval of its use at the Oread Hotel has created confusion and the need to add clarity in the code.

### A. COMPLETE PROHIBITION (new language in **bold** print)

Section 20-1007 ALTERNATIVE COMPLIANCE

(b) Approval Criteria

To be approved, an alternative compliance landscape plan shall be equal to or exceed traditional compliance in terms of quality of materials and visual effect, effectiveness in meeting the purpose established in Section 20-1001, and material durability and hardiness. **Only living plant materials may be approved for landscaping with Alternative Compliance. The use of artificial plants such as turf, flowers, shrubs or trees, shall not be permitted.**

Section 20-1009 LANDSCAPE MATERIAL STANDARDS

(b) Artificial Plants

No artificial plants shall be used to meet any standards of this section. **Artificial plants include, but are not limited to, artificial (synthetic) turf, flowers, shrubs and trees.**

### B. LIMITED USE OF SYNTHETIC TURF WITH ALTERNATIVE COMPLIANCE

Section 20-1007 ALTERNATIVE COMPLIANCE

(b) Approval Criteria

To be approved, an alternative compliance landscape plan shall be equal to or exceed traditional compliance in terms of quality of materials and visual effect, effectiveness in meeting the purpose established in Section 20-1001, and material durability and hardiness. **Only living plant materials may be approved for landscaping with Alternative Compliance except that artificial (synthetic) turf may be used in limited circumstances as noted below and with the following standards:**

1. **Synthetic turf may only be used as a border to define a landscaped area of living material and only when said border does not exceed 18 inches in width.**
2. **Synthetic turf may not be installed within the City Right-of-Way.**
3. **Specifications:**
   **Standards regarding the colors, weight, style, permeability, material and infill, backing, warranty, etc**
4. **Replacement:**
   **When synthetic turf is faded or damaged so that it no longer resembles a healthy thriving lawn, as determined by the Planning Director, the turf must be replaced within 60 days of the determination. Replacement turf materials and installation must be reviewed and approved by Planning Director.**

5. **Items required for submittal.**
   **Artificial turf must be shown on the landscape plan. Note the materials which must be submitted with the landscape plan.**

C. **SYNTHETIC TURF AS AN APPROVED LANDSCAPE MATERIAL**

20-1009 LANDSCAPE MATERIAL STANDARDS

(b) Artificial Plants

No artificial plants or vegetation may be used to meet any standards of this section, **with the exception of synthetic turf**. **The following standards apply to the use of synthetic turf as a landscape material:**

1. **Locational criteria:**
   **The zoning districts it would be permitted in.**
   **Any restrictions on the areas in which it would be permitted.**
2. **Specifications:**
   **Standards regarding the colors, weight, style, permeability, material and infill, backing, warranty, etc.**
3. **Installation:**
   **Required method of installation and authorized installers.**
4. **Maintenance:**
   **Standards to insure the turf is cleaned of debris and maintained in a clean and attractive condition. Damage to the turf must be repaired within a certain amount of time or the turf must be replaced. Replacement turf materials and installation must be reviewed and approved by Planning Director.**
5. **Replacement:**
   **When synthetic turf is faded or damaged so that it no longer resembles a healthy thriving lawn, as determined by the Planning Director, the turf must be replaced within 60 days of the determination. Replacement turf materials and installation must be reviewed and approved by Planning Director.**
6. **Approval process:**
   **Permit required for artificial turf in single family residential areas.**
   **Artificial turf must be shown on the landscape plan. Note the materials which must be submitted with the landscape plan.**

**SUMMARY**

Of the options, staff recommends Option A to clarify that the use of synthetic turf and other types of artificial plants are not allowed as landscape material.

Permitting the use of turf presents the following practical concerns:

1. Utility locates – appearance of the turf as companies mark their lines. Markings will remain for long periods of time.
2. Utility maintenance – Utility staff has little knowledge of, nor will necessarily take responsibility for, repairing turf if it is damaged when a line is repaired.
3. Produce expertise – how will staff determine at time of site plan approval that a product is of high enough quality and safe to meet the high standards of the community?

4. Concern for enforcing the future maintenance of the product when it fades, tears, burns, etc. Grass and other live materials are quick and inexpensive to establish.

In staff's opinion, this request to amend the code is not grounded in solving any identified public issue or concern. If environmental concerns are the applicant's justification for its use, then there are clearly more appropriate alternatives that address the environmental concerns and also maintain the health and permeability of the soil, aesthetics of the development, without creating practical issues for its maintenance for the city or owner.

**PLANNING COMMISSION REPORT**
**Regular Agenda -- Public Hearing Item**

PC Staff Report
6/22/11

**ITEM NO. 11 TEXT AMENDMENT TO CITY OF LAWRENCE DEVELOPMENT CODE; CHP 20; SYNTHETIC TURF AS LANDSCAPING MATERIAL (MKM)**

**TA-4-6-11**: Consider Text Amendments to the City of Lawrence Land Development Code, Chapter 20, Articles 10 and 17, regarding synthetic turf as landscaping material. *Initiated by City Commission on 5/3/11.*

**RECOMMENDATION:**
Staff recommends denial of the amendments to Articles 10 and 17 of the Land Development Code to add synthetic turf as landscaping material based on the analysis provided in the Staff Report.

**Reason for Request:** *"To allow synthetic turf landscaping recently applied to an apartment development to remain".*

**RELEVANT FACTOR:**
- Conformance with the Comprehensive Plan.

**PUBLIC COMMENT RECEIVED PRIOR TO PRINTING**
- None to date.

**ATTACHMENTS**
A. Initiation staff memo
B. LEED 2009 for New Construction and Major Renovations
C. State of New York Health Fact Sheet, including referenced studies
D. 2008 Center for Disease Control and Prevention Health Advisory
E. Connecticut Department of Environmental Protection Report
F. Natural Landscaping and Artificial Turf: Achieving Water Use and Pesticide Reduction
G. Low Maintenance Landscaping, K-State Experiment and Extension Office Report
H. Punta Gorda, FL Application

**OVERVIEW OF PROPOSED AMENDMENT**
The City Commission initiated consideration of a request to allow the use of synthetic turf as landscaping material at their May 3, 2011 meeting at the request of Paul Werner Architects. The request is being made in order to maintain recently installed synthetic turf at the apartment complex being constructed at the intersection of Trail and Frontier, formerly known as the Boardwalk Apartments. While the site plan was approved with code compliant landscape materials (sod, seed), a routine inspection of the site yielded the installation of the synthetic turf. The owner was informed of the non-compliant installation and was provided options to conform to the code, including installing the approved plant material, seeking a variance, or requesting a text amendment to revise the applicable sections of the code.

The applicant would like the city to consider revising the Development Code to permit the use of synthetic turf in any landscape application.

A similar situation occurred previously with the Oread Inn development. Synthetic turf was installed in a small area, although the approved development plan [FDP-02-03-09] required code compliant landscape materials. The artificial turf was discovered during a site inspection prior to the release of

occupancy permits. The Planning Director made the following statement when approving the use of this limited amount of artificial turf: "While artificial turf is not a normally accepted landscape material, it is appropriate in this specific situation in combination with the natural materials on site." It is possible that synthetic turf may be appropriate in some locations where traditional or low maintenance landscaping would be difficult to establish or maintain. In these cases, Alternative Compliance can be requested per the requirements in Section 20-1007. Section 20-1007(b) states that, "Alternative Compliance is limited to the specific site under consideration and does not establish precedent for acceptance of alternative compliance plans on other sites."

The amendment would include 'synthetic turf' in the definition of 'landscape materials'. Standards pertaining to the use of synthetic turf as landscaping material would likely need to be developed to support its use, if found to be appropriate, as discussed later in this report. The use of synthetic turf for athletic fields is not included in this amendment as the synthetic turf is being utilized in this situation as a 'surfacing' rather than 'landscaping' material.

**CONFORMANCE WITH THE COMPREHENSIVE PLAN**

A sustainable physical environment is a principal goal of *Horizon 2020.* Sustainable landscaping practices and materials comply with this goal. The comprehensive plan recommends the use of high quality materials in the construction of landscape areas and recognizes that natural vegetation adds greatly to the appearance of the community as a whole and should be maintained. *Horizon 2020* and the Land Development Code emphasize the use of natural and living plant materials. The proposed amendment to allow the use of synthetic landscaping materials is not in conformance with *Horizon 2020.*

**CRITERIA FOR REVIEW AND DECISION-MAKING**

Section 20-1302(f) provides review and decision-making criteria on proposed text amendments. It states that review bodies shall consider at least the following factors:

**1) Whether the proposed text amendment corrects an error or inconsistency in the Development Code or meets the challenge of a changing condition; and**

Applicant Response:
*"The amendment does not correct an error or inconsistency but instead provides an alternative option to turf grass. Synthetic turf is a viable option for turf management in the right location. This text amendment would give the Planning Department the ability to approve it."*

*"With the increased awareness of providing green building options synthetic turf has its benefits which include using no irrigation, fertilizer or pesticides to maintain it. Synthetic turf also reduces emissions since it does not need mowed."*

**Staff Review:**

The text amendment is intended to address a changing situation: the need for more sustainable development and greater environmental protection of our natural resources. The applicant indicated that, in the right location, synthetic turf is a viable option to natural turf because it does not require water, fertilizer, pesticide or mowing.

As a community, we are becoming more conscious of the environmental impacts of our actions and conservation of water is recognized as an important means to protect a non-renewable natural resource. Minimizing the use of fertilizers and pesticides are steps that could reduce negative impacts on our

ground and surface waters. Mowing may result in emissions so reduced mowing could be a factor in sustainable landscaping. In order to reduce the negative impacts and conserve water, landscaping which addresses these concerns is more sustainable and should be encouraged.

This staff report reviews the impact of synthetic turf to determine if the use of synthetic turf meets the challenge of increased sustainability. **This review concludes that artificial turf is not a sustainable means of landscaping and does not meet the challenge of changing conditions but that low maintenance natural landscaping does. Staff concludes that there is no error in the Comprehensive Plan or Development Code to correct and that the use of living and natural landscape materials is appropriate.**

**2) Whether the proposed text amendment is consistent with the Comprehensive Plan and the stated purpose of this Development Code (Sec. 20-104).**

**Applicant Response:**
*"Horizon 2020 states on pages 5-22, 5-28, and 6-28, "Encourage the use of high quality materials in the construction of screening and landscape areas to decrease long-term maintenance costs." Synthetic turf falls into this category because it is a high quality material made of partly recycled materials and has no yearly maintenance cost such as irrigation systems, fertilizers or pesticides.*

**Staff Review:**
As the applicant pointed out, *Horizon 2020* recommends the use of high quality materials in the construction of landscape areas to minimize maintenance costs. The comprehensive plan does not recommend the use or synthetic landscaping materials, but in several places emphasizes the importance of natural features and natural vegetation.

- "The Plan proposes the development of neighborhoods in a range of densities to provide a sense of community and to complement and preserve natural features in the area." (Page 3-1, Background Studies)
- "Natural environmental features within residential areas should be preserved and protected. Natural vegetation and large mature trees in residential areas add greatly to the appearance of the community as a whole and should be maintained. Changes to the natural topography should be minimal." (Policy 5.1, page 5-19 Residential)
- "Promote the integration of mature trees, natural vegetation, natural and environmentally sensitive areas whenever possible to buffer low-density developments from more intensive land uses. (Policy 6.1(c)(2)(a), page 5-21, Residential)
- "Site design and building features shall be reflective of the quality and character of the overall community and incorporate elements familiar to the local landscape." (Page 6-2, Commercial)
- "Encourage the use of existing vegetation, such as stands of mature trees, and other natural site features into the landscape design as natural buffers or focal points." (Policy 3.1(d)(4)(c). Page 7-16 Industrial and Employment)

Horizon 2020 does not specifically address synthetic landscaping materials, but does in several instances recommend the use of natural landscaping materials. The plan states in the residential chapter that natural vegetation 'adds greatly to the appearance of the community as a whole'. When discussing commercial development it recommends that site design should be reflective of the quality and character of the overall community and should incorporate elements familiar to the local landscape. The type of landscaping material used has an impact on the character of the area.

Introducing synthetic turf into the landscape creates an artificial characteristic that is inconsistent with the natural look of Lawrence today. **The proposed text amendment is not in conformance with the comprehensive plan.**

## GENERAL REVIEW

The purpose of landscaping, per Section 20-1001 of the Development Code, is to maintain the City's quality, heritage and character by enhancing its visual appearance, and to enhance environmental conditions by providing shade, air purification, oxygen regeneration, groundwater recharge filtering of stormwater runoff, abatement of noise, glare and heat. The review below analyzes synthetic turf in regards to these purposes:

- **to maintain the City's quality, heritage and character by enhancing its visual appearance**;

It may be a matter of opinion whether synthetic turf would enhance the visual appearance of the City; however, the addition of an artificial component into the landscape would not maintain the City's heritage and character. Figures 1-3 illustrate the installation process for the synthetic turf that was installed in Lawrence and the finished look.

- **to enhance environmental conditions by providing shade, air purification, oxygen regeneration, groundwater recharge filtering of stormwater runoff, abatement of noise, glare and heat;**

The applicant indicated that synthetic turf would be more environmentally friendly than natural turf because it would not need fertilizer, pesticide, mowing or watering as it is not a growing material. Synthetic turf does not require watering but does require washing, as organic matter does not decompose on synthetic turf and it may require water for cooling in hot temperatures, so the use of water may be reduced; however, it has not been eliminated.

The following information was taken from "Natural Landscaping and Artificial Turf: Achieving Water Use and Pesticide Reduction", an article written by Alex Wilson, Executive Editor of Environmental Building News:

> Kim Sorvig, research associate professor at the University of New Mexico, and co-author of *Sustainable Landscape Construction: A Guide to Green Building Outdoors*, is concerned about the soil conditions under artificial turf. "It blocks both water and sunlight either completely or in very large degree," he said, "and without that, you can't have a living system in the soil." Sorvig thinks it is ironic that artificial turf is heralded as a solution to water shortages, since it diminishes the health of the underlying soil, thereby decreasing its ability to hold water. "When you remove the vegetation from an area so completely," he said, "you're actually, in the long term, contributing to drought."

Synthetic landscaping materials would not contribute to air purification or oxygen regeneration. Landscaping materials are intended to provide abatement of heat; however, synthetic turf may contribute to the heat island effect.

### Health and Environmental

The State of New York Health Department prepared a fact sheet on crumb-rubber infilled synthetic turf athletic fields in 2008. The items reviewed were: heat stress, injury, infection, latex allergy, chemical exposure.

HEAT STRESS: The fact sheet states that the average surface temperature on a synthetic turf field at Brigham Young University in June 2002 was reported to be 117°F while the average surface

temperature on natural turf and asphalt were 78°F and 110°F respectively. The maximum temperature reported on the turf field was 200°F. Measurements taken at the University of Missouri field had a 138°F air temperature at 'head-level' height on a 98° F day. The surface temperature of the field was reported to be 178°F. A study at BYU found that watering synthetic turf reduced the surface temperature from 174°F to 85°F but the temperature rose to 120°F in five minutes and 164°F in twenty minutes.

INFECTION: The review concluded that synthetic turf surfaces are no more likely to harbor infectious agents than other surfaces.

LATEX ALLERGY: Tire rubber is used in many synthetic turf products as the infill material. Some people are allergic to 'latex allergens' which are substances within the latex in rubber tires. Tests did not find any relation between the crumb rubber used in synthetic turf and latex allergies.

CHEMICAL EXPOSURE: Studies have been conducted on the various chemicals used in synthetic turf and no negative results were obtained with the exception of 'lead'. Some types of synthetic turf fibers contain elevated levels of lead. Degradation of these fibers can form a dust that presents a potential source of lead exposure. The Centers for Disease Control and Prevention addressed the potential for lead exposure in a June 2008 Health Advisory, attached.

The Connecticut Department of Environmental Protection prepared an Artificial Turf Study in 2010 which looked specifically at health impacts and stormwater leaching. The study analyzed the runoff from turf fields and identified zinc as a potential risk to surface waters. Best Management Practices recommended for management of stormwater runoff from turf fields included wet ponds, infiltration structures, filters and bio-filtration structures.

Synthetic turf does not support soil organisms. The grass and these organisms play an ecological role by purifying water as it leaches into the earth.

Many developments in Lawrence are being constructed to LEED standards in order to obtain LEED certification. LEED, Leadership in Energy and Environmental Design, is an internationally recognized green building certification system. LEED offers credit for water efficient landscaping and recommends various options for reducing water requirements. (See pages 23-24 in attached LEED certification booklet.) LEED recommends installing landscaping that does not require permanent irrigation systems, but does not directly recommend synthetic turf or even infer its use. While synthetic turf may qualify for LEED points, it is not listed as a recommended landscaping option.

Some communities, particularly in areas with limited water sources such as California, have encouraged the use of artificial turf to conserve water. Glendale Arizona had once given rebates to residents for installing artificial turf but stopped giving rebates after the issuance of the Centers for Disease Control and Prevention 2008 health advisory.

To summarize, synthetic turf is not, in staff's opinion, an environmentally sustainable form of landscaping because it contributes to the heat island effect, diminishes the health of the underlying soil, has the potential to leach zinc into surface water through stormwater runoff and has potential health consequences related to the levels of lead in some types of synthetic turf fibers.

**LOW MAINTENANCE LANDSCAPING: XERISCAPE:**

Reducing the use of pesticides and fertilizer is a sound environmental concept and can be achieved with natural landscaping through the use of native species which are adapted to the climate and environment of the area. The following description of low maintenance landscaping was provided in the K-State Agricultural Experiment Station and Cooperative Extension Service Report: "It simply imitates nature's design: putting hardy, adapted plant materials in the places where they grow best. Once

established, this kind of landscape requires little maintenance because it is designed to work in harmony with nature, not against it." (page 2) Savings will be realized due to reduced water, pesticide and herbicide usage.

This report stated that turfgrass areas usually require the most water and maintenance in a landscape and recommended that irrigated turfgrass areas be limited to places with high use. Low-maintenance and native grasses are recommended for other areas.

The K-State report also recommends that a development collect runoff and 'harvest' water by collecting or redirecting water from the downspouts to areas of the landscape that need it. Different types of irrigation systems, such as drip or trickle, in addition to traditional sprinklers could also help conserve water. Watering slowly, deeply and infrequently will help reduce water usage.

**OTHER CONSIDERATIONS**

UTILITIES:

- When providing locates for underground utilities the location will more than likely be painted on the turf as flags are difficult to push through the fabric.
- Identifying the responsible party for restoration of the artificial turf should excavation be required to perform repairs/maintenance on existing infrastructure below the artificial turf or on surface structures within the artificial turf area such as meters, manhole, lids, etc, as well as areas that may be damaged adjacent to the work area due to access or storing materials, spoils etc. The Utilities Department does not currently have the expertise or equipment to repair and replace the synthetic turf.
- Establishing the appropriate way to make an excavation; cut the turf or roll the turf back before beginning an excavation.

TURF MAINTENANCE:

- Would need to establish regulations for maintenance of turf and require replacement when it has aged. The City of Punta Gorda, FL included the following requirement in their requirements for synthetic turf: "Artificial turf shall be maintained in a green fadeless condition and shall be maintained free of dirt, mud, stains, weeds, debris, tears, holes and impressions. All edges of the artificial turf shall not be loose, and must be maintained with appropriate edging or stakes."

PRODUCT SPECIFICATIONS:

- Many companies produce various types of synthetic turf and the quality varies between different brands or types of turf. Standards regulating the quality of synthetic turf would be necessary. The City of Punta Gorda, FL permits the use of synthetic turf with a Special Exception. A copy of the application is included with this report. Features considered are the minimum tufted weight, minimum permeability, color, and warranty. In addition, information on the anchoring system is required to ensure the turf will withstand the effects of wind.

While there may be solutions to some of these concerns, the effort necessary to accommodate synthetic turf does not appear to be justified when natural alternatives exist and have been in practice for decades without major issue.

**Staff Recommendation**

Staff recommends denial of the requested amendment to Articles 10 and 17 of the Land Development Code to permit synthetic turf as a landscape material. 'Low maintenance' landscaping can and should be utilized to meet the need for more sustainable landscaping practices.

**Figure 1.** Prepared Base

**Figure 2.** Installation

**Figure 3.** Finished product

| LANDSCAPING PRACTICES COMPARISON CHART: | | | |
|---|---|---|---|
| | Synthetic Turf | Low Maintenance Landscaping | Traditional Lawn |
| Low water usage | ✔ | ✔ | |
| No Pesticide usage | ✔ | ✔ | |
| No Fertilizer | ✔ | ✔ | |
| No mowing | ✔ | ✔ | |
| Pervious | ✔ | ✔ | ✔ |
| Filters pollutants | | ✔ | ✔ |
| Provides Habitat | | ✔ | ✔ |
| Provides Oxygen | | ✔ | ✔ |
| Absorbs Carbon Dioxide | | ✔ | ✔ |
| Reduces Heat Island | | ✔ | ✔ |
| Adds to Heat Island | ✔ | | |

Attachment A-
Initiation Memo

# Memorandum
# City of Lawrence
# Planning & Development Services

**TO:** **David L. Corliss, City Manager**

**FROM:** **Planning Staff**

**CC:** **Scott McCullough, Director of Planning and Development Services**
**Sheila Stogsdill, Assistant Planning Director**

**Date:** **For May 3, 2011 City Commission meeting**

**RE:** **Text Amendment Initiation to permit the use of synthetic turf to meet landscaping requirements in Article 10 of the Development Code**

A request was made by Paul Werner Architects to initiate a text amendment to the *Land Development Code* to include 'synthetic turf' in the list of landscape materials that may be used to meet the landscape requirements in Article 10 and to revise the definition of 'Landscaping' in Article 17 to include 'synthetic turf'. The request is being made in order to maintain recently installed synthetic turf at the apartment complex being constructed at the intersection of Trail and Frontier, formerly known as the Boardwalk Apartments. While the site plan was approved with code compliant landscape materials (sod, seed), a routine inspection of the site yielded the installation of the synthetic turf. The owner was informed of the non-compliant installation and was provided options to conform to the code, including installing the approved plant material, seeking a variance, or requesting a text amendment to revise the applicable sections of the code. The applicant would like the city to consider revising the Development Code to permit the use of synthetic turf for this and potentially future projects.

The code emphasizes the use of living landscape materials and states the following about landscaping (non-exclusive list):

Section 20-1009 Landscape Material Standards – (b) Artificial Plants – No artificial plants or vegetation may be used to meet any standards of this section.

Section 20-1009 Landscape Material Standards – (e) Grass Seed and Sod – Turf areas shall be planted with species suitable as permanent lawns in Lawrence. Turf areas may be sodded or seeded.

Section 20-1010(a)(2) – All Landscape Material, including trees, plant material and structural elements, shall be in place and healthy prior to issuance of a final Certificate of Occupancy. The Planning Director may authorize issuance of a temporary Certificate

of Occupancy prior to installation of required Landscaping, when seasonal conditions render installation impractical…

Section 20-1701 Definitions

Landscape Material – Such living material such as trees, Shrubs, Ground Cover/vines, turf grasses, and non-living material such as: ricks, pebbles, sand, bark, brick pavers, earthen mounds (excluding pavement), and/or other items of a decorative or embellishing nature such as: fountains, pools, walls, fencing, sculpture, etc.

Landscaping – Any combination of living plants such as trees, Shrubs, plants, vegetative Ground Cover or turf grasses…

Ground Cover – Living Landscape Materials or living low-growing plants other than turf grasses, installed in such a manner so as to provide a continuous cover of the ground surface and which, upon maturity, normally reach an average maximum Height of not greater than 24 inches.

The application noted that synthetic turf is low maintenance and may be appropriate in some locations. The application also identified synthetic turf as a 'green building option' as it does not require watering, mowing, or the use of fertilizers or pesticides. The application is attached for your reference.

If the text amendment is approved, it will be necessary to revise the Community Design Manual as well for landscaping requirements within the Commercial and Industrial Zoning Districts for consistency.

Staff recommends that the Commission initiate the amendment so that careful consideration can be given to the request and so that the pros and cons of using synthetic turf to meet the values of landscaping requirements can be discussed by the community stakeholders.

**Action requested:** Initiate a text amendment to Article 10 and Article 17 of the Land Development Code – Code of the City of Lawrence, Kansas regarding landscaping and landscape materials and associated revisions to the Community Design Manual, if appropriate.

City of Lawrence
Douglas County
PLANNING & DEVELOPMENT SERVICES

**Lawrence Douglas County**
**Metropolitan Planning Office**
6 East 6th Street, P.O. Box 708, Lawrence, KS 66044
(785) 832-3150 Fax (785) 832-3160
http://www.lawrenceplanning.org

# REQUEST FOR INITIATION of a TEXT AMENDMENT

APPLICATION FORM

**APPLICANT/AGENT INFORMATION**

Contact Joy Rhea

Company Paul Werner Architects

Address 1918 Edgelea Road

City Lawrence State KS ZIP 66044

Phone (785) 832-0804 Fax (785) 832-0890

E-mail joyr@paulwernerarchitects.com Mobile/Pager (___) _____

Pre-Application Meeting Date 4-1-11 Planner Scott McCullough

| **Are you submitting any other applications? If so, please state which one(s).** |
|---|
| |
| |

**Please identify the section of the Development Code or Subdivision Regulations proposed to be amended.** 20-1003(e) , 20-1009 (b), 20-1009(e)(4), 20-1701

**Please provide proposed amendment. (Attach additional sheets if needed)**

20-1003(e) In addition to required Shade Trees and Shrubs, landscape areas within the interior of off-street Parking Areas shall be planted with turf which can be synthetic or natural, Ground Cover, Ornamental Trees, or Shrubs.

20-1009(b) No artificial plants or vegetation other than synthetic turf may be used to meet any standards of this section.

ADD TO DEV CODE 20-1009(e)(4) Synthetic turf areas shall be installed per the manufactures specification as permanent lawns in Lawrence.

20-1701 - Landscaping: Such living material as trees, Shrubs, Ground Cover/vines, turf grasses, and non-living material suchas: rocks, pebbles, sand, bark, brick pavers, earthen mounds (excluding pavement), synthetic turf and/or other items of a decorative or embellishing nature such as: fountains, pools, walls, fencing, sculpture, etc.

City of Lawrence
Douglas County
PLANNING & DEVELOPMENT SERVICES

***Lawrence Douglas County***
***Metropolitan Planning Office***
6 East 6th Street, P.O. Box 708, Lawrence, KS 66044
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http://www.lawrenceplanning.org

**Please respond to the following questions to the best of your knowledge. In reviewing and making decisions on proposed text amendments review bodies shall consider the following factors. (Attach additional sheets if needed.)**

1. **Does the proposed text amendment correct an error or inconsistency in the Development Code or Subdivision Regulations?** If so, please provide the specific error found and/or reference the specific section of the Development Code that is inconsistent with the section identified to be amended above.
   The amendment does not correct an error or inconsistency but instead provides an alternative option to turf grass. Synthetic turf is a viable option for turf management in the right location. This text amendment would give the Planning Department the ability to approve it.

2. **Does the proposed amendment meet the challenge of a changing condition? If so, please explain.**
   With the increased awareness of providing green building options synthetic turf has its benefits which include using no irrigation, fertilizer or pesticides to maintain it. Synthetic turf also reduces emissions since it does not need mowed.

3. **Is the proposed amendment consistent with Horizon 2020? Please explain.**
   Horizon 2020 states on pages 5-22, 5-28 and 6-28, "Encourage the use of high quality materials in the construction of screening and landscape areas to decrease long-term maintenance costs." Synthetic turf falls into this category because it is a high quality material made of partly recycled materials and has no yearly maintenance cost such as irrigation systems, fertilizers or pesticides.

4. **Is the proposed amendment consistent with the stated purpose of the Development Code? See Sec. 20-104 of the Development Code for the stated purpose.**
   This amendment in no way endangers the health, safety and welfare of the public.

City of Lawrence
Douglas County
PLANNING & DEVELOPMENT SERVICES

**Lawrence Douglas County**
**Metropolitan Planning Office**
6 East 6th Street, P.O. Box 708, Lawrence, KS 66044
(785) 832-3150 Fax (785) 832-3160
http://www.lawrenceplanning.org

**SIGNATURE**

By execution of my/our signature, I/we do hereby officially apply to request initiation of the proposed text amendment as indicated above.

Signature(s): _____ Date 4-18-11

_____ Date _____

_____ Date _____

**STAFF USE ONLY**

Application No. _____

Date Received _____

Planning Commission Date _____

Fee $_____

Date Fee Paid _____

paulwerner
ARCHITECTS

# LETTER OF TRANSMITTAL

RECEIVED
APR 18 2011
City County Planning Office
Lawrence, Kansas

FROM : Joy Rhea
TO : Scott McCullough
DATE : **April 18, 2011**
RE : Text Amendment for synthetic turf

---

**We are Sending :**

__X__ Attached ____ Per your request ____ For your files

**Items Transmitted Via :**

____ US Mail ____ Overnight ____ Courier XOther

**Items Transmitted are For Your :**

___ Information ____ Use ___ Approval __X__ Review

**Items Transmitted are :**

__X__ Originals ___ Disk (s) ____ Shop Drawings ___ Blueprints
___ Specifications ____ Samples ___ Other _____.

| COPIES/ SETS: | DESCRIPTION: |
|---|---|
| 1 | Text Amendment Application |
| | |
| | |
| | |
| | |

REMARKS :

Office : 123 W. 8th Suite B2 : Lawrence, Kansas : 66044
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Attachment B-
LEED (pg 23-24)

# LEED 2009 FOR NEW CONSTRUCTION AND MAJOR RENOVATIONS

**For Public Use and Display**

**LEED 2009 for New Construction and Major Renovations Rating System**

**USGBC Member Approved November 2008 (Updated May 2011)**

# PREFACE FROM USGBC

The built environment has a profound impact on our natural environment, economy, health, and productivity. Breakthroughs in building science, technology, and operations are now available to designers, builders, operators, and owners who want to build green and maximize both economic and environmental performance.

Through the LEED® green building certification program, the U.S. Green Building Council (USGBC) is transforming the built environment. The green building movement offers an unprecedented opportunity to respond to the most important challenges of our time, including global climate change, dependence on non sustainable and expensive sources of energy, and threats to human health. The work of innovative building professionals is a fundamental driving force in the green building moment. Such leadership is a critical component to achieving USGBC's mission of a sustainable built environment for all within a generation.

## USGBC MEMBERSHIP

USGBC's greatest strength is the diversity of our membership. USGBC is a balanced, consensus based nonprofit with more than 18,000 member companies and organizations representing the entire building industry. Since its inception in 1993, USGBC has played a vital role in providing a leadership forum and a unique, integrating force for the building industry. USGBC's programs have three distinguishing characteristics:

### Committee-based

The heart of this effective coalition is our committee structure, in which volunteer members design strategies that are implemented by staff and expert consultants. Our committees provide a forum for members to resolve differences, build alliances, and forge cooperative solutions for influencing change in all sectors of the building industry.

### Member-driven

Membership is open and balanced and provides a comprehensive platform for carrying out important programs and activities. We target the issues identified by our members as the highest priority. We conduct an annual review of achievements that allows us to set policy, revise strategies, and devise work plans based on members' needs.

### Consensus-focused

We work together to promote green buildings, and in doing so, we help foster greater economic vitality and environmental health at lower costs. We work to bridge ideological gaps between industry segments and develop balanced policies that benefit the entire industry.

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# ACKNOWLEDGMENTS

The LEED 2009 Rating System has been made possible only through the efforts of many dedicated volunteers, staff members, and others in the USGBC community. The Rating System improvement work was managed and implemented by USGBC staff and included review and input by many Technical Advisory Group (TAG) members with oversight by the LEED Steering Committee. We extend our deepest gratitude to all of our LEED committee members who participated in the development of this rating system, for their tireless volunteer efforts and constant support of USGBC's mission:

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The LEED 2009 for New Construction Rating System builds on the work of those who helped create previous versions:

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# LEED 2009 FOR NEW CONSTRUCTION AND MAJOR RENOVATIONS PROJECT CHECKLIST

| Sustainable Sites | | 26 Possible Points |
|---|---|---|
| ☑ Prerequisite 1 | Construction Activity Pollution Prevention | Required |
| ☐ Credit 1 | Site Selection | 1 |
| ☐ Credit 2 | Development Density and Community Connectivity | 5 |
| ☐ Credit 3 | Brownfield Redevelopment | 1 |
| ☐ Credit 4.1 | Alternative Transportation—Public Transportation Access | 6 |
| ☐ Credit 4.2 | Alternative Transportation—Bicycle Storage and Changing Rooms | 1 |
| ☐ Credit 4.3 | Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles | 3 |
| ☐ Credit 4.4 | Alternative Transportation—Parking Capacity | 2 |
| ☐ Credit 5.1 | Site Development—Protect or Restore Habitat | 1 |
| ☐ Credit 5.2 | Site Development—Maximize Open Space | 1 |
| ☐ Credit 6.1 | Stormwater Design—Quantity Control | 1 |
| ☐ Credit 6.2 | Stormwater Design—Quality Control | 1 |
| ☐ Credit 7.1 | Heat Island Effect—Nonroof | 1 |
| ☐ Credit 7.2 | Heat Island Effect—Roof | 1 |
| ☐ Credit 8 | Light Pollution Reduction | 1 |

| Water Efficiency | | 10 Possible Points |
|---|---|---|
| ☑ Prerequisite 1 | Water Use Reduction | Required |
| ☐ Credit 1 | Water Efficient Landscaping | 2-4 |
| ☐ Credit 2 | Innovative Wastewater Technologies | 2 |
| ☐ Credit 3 | Water Use Reduction | 2-4 |

| Energy and Atmosphere | | 35 Possible Points |
|---|---|---|
| ☑ Prerequisite 1 | Fundamental Commissioning of Building Energy Systems | Required |
| ☑ Prerequisite 2 | Minimum Energy Performance | Required |
| ☑ Prerequisite 3 | Fundamental Refrigerant Management | Required |
| ☐ Credit 1 | Optimize Energy Performance | 1–19 |
| ☐ Credit 2 | On-site Renewable Energy | 1–7 |
| ☐ Credit 3 | Enhanced Commissioning | 2 |
| ☐ Credit 4 | Enhanced Refrigerant Management | 2 |
| ☐ Credit 5 | Measurement and Verification | 3 |
| ☐ Credit 6 | Green Power | 2 |

| Materials and Resources | | 14 Possible Points |
|---|---|---|
| ☑ Prerequisite 1 | Storage and Collection of Recyclables | Required |
| ☐ Credit 1.1 | Building Reuse—Maintain Existing Walls, Floors and Roof | 1-3 |
| ☐ Credit 1.2 | Building Reuse—Maintain Existing Interior Nonstructural Elements | 1 |
| ☐ Credit 2 | Construction Waste Management | 1-2 |
| ☐ Credit 3 | Materials Reuse | 1-2 |
| ☐ Credit 4 | Recycled Content | 1-2 |

| | | |
|---|---|---|
| ☐ Credit 5 | Regional Materials | 1-2 |
| ☐ Credit 6 | Rapidly Renewable Materials | 1 |
| ☐ Credit 7 | Certified Wood | 1 |

**Indoor Environmental Quality** **15 Possible Points**

| | | |
|---|---|---|
| ☑ Prerequisite 1 | Minimum Indoor Air Quality Performance | Required |
| ☑ Prerequisite 2 | Environmental Tobacco Smoke (ETS) Control | Required |
| ☐ Credit 1 | Outdoor Air Delivery Monitoring | 1 |
| ☐ Credit 2 | Increased Ventilation | 1 |
| ☐ Credit 3.1 | Construction Indoor Air Quality Management Plan—During Construction | 1 |
| ☐ Credit 3.2 | Construction Indoor Air Quality Management Plan—Before Occupancy | 1 |
| ☐ Credit 4.1 | Low-Emitting Materials—Adhesives and Sealants | 1 |
| ☐ Credit 4.2 | Low-Emitting Materials—Paints and Coatings | 1 |
| ☐ Credit 4.3 | Low-Emitting Materials—Flooring Systems | 1 |
| ☐ Credit 4.4 | Low-Emitting Materials—Composite Wood and Agrifiber Products | 1 |
| ☐ Credit 5 | Indoor Chemical and Pollutant Source Control | 1 |
| ☐ Credit 6.1 | Controllability of Systems—Lighting | 1 |
| ☐ Credit 6.2 | Controllability of Systems—Thermal Comfort | 1 |
| ☐ Credit 7.1 | Thermal Comfort—Design | 1 |
| ☐ Credit 7.2 | Thermal Comfort—Verification | 1 |
| ☐ Credit 8.1 | Daylight and Views—Daylight | 1 |
| ☐ Credit 8.2 | Daylight and Views—Views | 1 |

**Innovation in Design** **6 Possible Points**

| | | |
|---|---|---|
| ☐ Credit 1 | Innovation in Design | 1-5 |
| ☐ Credit 2 | LEED Accredited Professional | 1 |

**Regional Priority** **4 Possible Points**

| | | |
|---|---|---|
| ☐ Credit 1 | Regional Priority | 1-4 |

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### LEED 2009 for New Construction and Major Renovations

100 base points; 6 possible Innovation in Design and 4 Regional Priority points

| | |
|---|---|
| Certified | 40–49 points |
| Silver | 50–59 points |
| Gold | 60–79 points |
| Platinum | 80 points and above |

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# INTRODUCTION

## I. LEED® GREEN BUILDING RATING SYSTEM

### Background on LEED®

Following the formation of the U.S. Green Building Council (USGBC) in 1993, the organization's members quickly realized that the sustainable building industry needed a system to define and measure "green buildings." USGBC began to research existing green building metrics and rating systems. Less than a year after formation, the members acted on the initial findings by establishing a committee to focus solely on this topic. The composition of the committee was diverse; it included architects, real estate agents, a building owner, a lawyer, an environmentalist, and industry representatives. This cross section of people and professions added a richness and depth both to the process and to the ultimate product.

The first LEED Pilot Project Program, also referred to as LEED Version 1.0, was launched at the USGBC Membership Summit in August 1998. After extensive modifications, LEED Green Building Rating System Version 2.0 was released in March 2000, with LEED Version 2.1 following in 2002 and LEED Version 2.2 following in 2005.

As LEED has evolved and matured, the program has undertaken new initiatives. In addition to a rating system specifically devoted to building operational and maintenance issues (LEED for Existing Buildings: Operations & Maintenance), LEED addresses the different project development and delivery processes that exist in the U.S. building design and construction market, through rating systems for specific building typologies, sectors, and project scopes: LEED for Core & Shell, LEED for New Construction, LEED for Schools, LEED for Neighborhood Development, LEED for Retail, LEED for Healthcare, LEED for Homes, and LEED for Commercial Interiors.

Project teams interact with the Green Building Certification Institute (GBCI) for project registration

and certification. GBCI was established in 2008 as a separately incorporated entity with the support of the U.S. Green Building Council. GBCI administers credentialing and certification programs related to green building practice. These programs support the application of proven strategies for increasing and measuring the performance of buildings and communities as defined by industry systems such as LEED.

The green building field is growing and changing daily. New technologies and products are being introduced into the marketplace, and innovative designs and practices are proving their effectiveness. The LEED rating systems and reference guides will evolve as well. Project teams must comply with the version of the rating system that is current at the time of their registration.

USGBC will highlight new developments on its website on a continual basis at www.usgbc.org.

### Features of LEED®

The LEED Green Building Rating Systems are voluntary, consensus-based, and market-driven. Based on existing and proven technology, they evaluate environmental performance from a whole building perspective over a building's life cycle, providing a definitive standard for what constitutes a green building in design, construction, and operation.

The LEED rating systems are designed for rating new and existing commercial, institutional, and residential buildings. They are based on accepted energy and environmental principles and strike a balance between known, established practices and emerging concepts. Each rating system is organized into 5 environmental categories:

Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, and Indoor Environmental Quality. An additional category, Innovation in Design, addresses sustainable building expertise as well as design measures not covered under the 5 environmental categories. Regional bonus points are another feature of LEED and acknowledge the importance of local conditions in determining best environmental design and construction practices.

## The LEED Credit Weightings

In LEED 2009, the allocation of points between credits is based on the potential environmental impacts and human benefits of each credit with respect to a set of impact categories. The impacts are defined as the environmental or human effect of the design, construction, operation, and maintenance of the building, such as greenhouse gas emissions, fossil fuel use, toxins and carcinogens, air and water pollutants, indoor environmental conditions. A combination of approaches, including energy modeling, life-cycle assessment, and transportation analysis, is used to quantify each type of impact. The resulting allocation of points among credits is called credit weighting.

LEED 2009 uses the U.S. Environmental Protection Agency's TRACI[1] environmental impact categories as the basis for weighting each credit. TRACI was developed to assist with impact evaluation for life-cycle assessment, industrial ecology, process design, and pollution prevention.

LEED 2009 also takes into consideration the weightings developed by the National Institute of Standards and Technology (NIST); these compare impact categories with one another and assign a relative weight to each. Together, the 2 approaches provide a solid foundation for determining the point value of each credit in LEED 2009.

The LEED 2009 credit weightings process is based on the following parameters, which maintain consistency and usability across rating systems:

- All LEED credits are worth a minimum of 1 point.
- All LEED credits are positive, whole numbers; there are no fractions or negative values.
- All LEED credits receive a single, static weight in each rating system; there are no individualized scorecards based on project location.
- All LEED rating systems have 100 base points; Innovation in Design (or Operations) and Regional Priority credits provide opportunities for up to 10 bonus points.

Given the above criteria, the LEED 2009 credit weightings process involves 3 steps:

1. A reference building is used to estimate the environmental impacts in 13 categories associated with a typical building pursuing LEED certification.
2. The relative importance of building impacts in each category are set to reflect values based on the NIST weightings.[2]
3. Data that quantify building impacts on environmental and human health are used to assign points to individual credits.

Each credit is allocated points based on the relative importance of the building-related impacts that it addresses. The result is a weighted average that combines building impacts and the relative value of the impact categories. Credits that most directly address the most important impacts are given the greatest weight, subject to the system design parameters described above. Credit weights also reflect a decision by LEED to recognize the market implications of point allocation. The result is a significant change in allocation of points compared with previous LEED rating systems. Overall, the changes increase the relative emphasis on the reduction of energy consumption and greenhouse gas emissions associated with building systems, transportation, the embodied energy of water, the embodied energy of materials, and where applicable, solid waste.

The details of the weightings process vary slightly among individual rating systems. For example, LEED for Existing Buildings: Operations & Maintenance includes credits related to solid waste management but LEED for New Construction does not. This results in a difference in the portion of the environmental footprint addressed by each rating system and the relative allocation of points. The weightings process for each rating system is fully documented in a weightings workbook.

The credit weightings process will be reevaluated over time to incorporate changes in values ascribed to different building impacts and building types, based on both market reality and evolving scientific knowledge related to buildings. A complete explanation of the LEED credit weightings system is available on the USGBC website, at www.usgbc.org.

### Regional Priority Credits

To provide incentive to address geographically specific environmental issues, USGBC regional councils and chapters have identified 6 credits per rating system that are of particular importance to specific areas. Each regional priority credit is worth an additional 1 point, and a total of 4 regional priority points may be earned. Upon project registration, LEED Online automatically determines a project's regional priority credits based on its zip code. If the project achieves more than 4 regional priority credits, the team can choose the credits for which these points will apply. The USGBC website also contains a searchable database of regional priority credits.

## II. OVERVIEW AND PROCESS

The LEED 2009 Green Building Rating System for New Construction and Major Renovations is a set of performance standards for certifying the design and construction of commercial or institutional buildings and high-rise residential buildings of all sizes, both public and private. The intent is to promote healthful, durable, affordable, and environmentally sound practices in building design and construction.

Prerequisites and credits in the LEED 2009 for New Construction and Major Renovations addresses 7 topics:

- Sustainable Sites (SS)
- Water Efficiency (WE)
- Energy and Atmosphere (EA)
- Materials and Resources (MR)
- Indoor Environmental Quality (IEQ)
- Innovation in Design (ID)
- Regional Priority (RP)

LEED 2009 for New Construction and Major Renovations certifications are awarded according to the following scale:

| | |
|---|---|
| Certified | 40–49 points |
| Silver | 50–59 points |
| Gold | 60–79 points |
| Platinum | 80 points and above |

GBCI will recognize buildings that achieve 1 of these rating levels with a formal letter of certification.

### When to Use LEED 2009 for New Construction

LEED for New Construction was designed primarily for new commercial office buildings, but it has been applied to many other building types by LEED practitioners. All commercial buildings, as defined by standard building codes, are eligible for certification as LEED for New Construction buildings. Examples of commercial occupancies include offices, institutional buildings (libraries, museums, churches, etc.), hotels, and residential buildings of 4 or more habitable stories.

LEED for New Construction addresses design and construction activities for both new buildings and major renovations of existing buildings. If the project scope does not involve significant design and construction activities and focuses more on operations and maintenance activities, LEED for Existing Buildings: Operations & Maintenance is more appropriate because it addresses operational and maintenance issues of working buildings.

Please see the Rating System Selection Policy, located in the LEED resources section of www.usgbc.org, for more information about choosing a rating system.

### Registration

Project teams interested in earning LEED certification for their buildings must first register the project with GBCI. Projects can be registered on the GBCI website (www.gbci.org). The website also has information on registration costs for USGBC national members as well as nonmembers. Registration is an important step that establishes contact with GBCI and provides access to software tools, errata, critical communications, and other essential information.

### Certification

To earn LEED certification, the applicant project must satisfy all the prerequisites and qualify for a minimum number of points to attain the established project ratings as listed below. Having satisfied the basic prerequisites of the program, applicant projects are then rated according to their degree of compliance within the rating system.

LEED 2009 for New Construction provides the option of splitting a certification application into two phases: design and construction. Documentation for design phase credits, identified in LEED-Online, can be submitted for review at the end of the design phase; the submittals for these credits can be fully evaluated based on documentation available during this phase of the project. For example, if a project site meets the requirements of LEED for New Construction SS Credit 3, Brownfield Redevelopment, the likelihood of credit achievement can be assessed before construction is complete. The LEED credit itself, however, is not awarded at the design review stage.

For more information on the LEED certification process including LEED-Online, Credit Interpretation Requests and Rulings, Appeals, and Fees please see the LEED Reference Guide for Green Building Design and Construction, 2009 Edition and visit www.usgbc.org or www.gbci.org.

## III. MINIMUM PROGRAM REQUIREMENTS

The LEED 2009 Minimum Program Requirements (MPRs) define the minimum characteristics that a project must possess in order to be eligible for certification under LEED 2009. These requirements define the categories of buildings that the LEED rating systems were designed to evaluate, and taken together serve three goals: to give clear guidance to customers, to protect the integrity of the LEED program, and to reduce challenges that occur during the LEED certification process. It is expected that MPRs will evolve over time along with LEED rating system improvements. The requirements will apply only to those projects registering under LEED 2009.

To view the MPRs and the MPR Supplemental Guidance, visit the LEED Resources and Tools section of www.usgbc.org/projecttools.

## IV. EXEMPLARY PERFORMANCE STRATEGIES

Exemplary performance strategies result in performance that greatly exceeds the performance level or expands the scope required by an existing LEED 2009 for New Construction credit. To earn exemplary performance credits, teams must meet the performance level defined by the next step in the threshold progression. For credits with more than 1 compliance path, an Innovation in Design point can be earned by satisfying more than 1 compliance path if their benefits are additive.

The credits for which exemplary performance points are available through expanded performance or scope are noted in the LEED Reference Guide for Green Design & Construction, 2009 Edition and in LEED Online.

### Endnotes

1. Tools for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI). U.S. Environmental Protection Agency, Office of Research and Development. http://www.epa.gov/nrmrl/std/sab/traci/.
2. Relative impact category weights based on an exercise undertaken by NIST (National Institute of Standards and Technology) for the BEES program. http://www.bfrl.nist.gov/oae/software/bees/.

# SUSTAINABLE SITES

## SS Prerequisite 1: Construction Activity Pollution Prevention

## Required

### Intent

To reduce pollution from construction activities by controlling soil erosion, waterway sedimentation and airborne dust generation.

### Requirements

Create and implement an erosion and sedimentation control plan for all construction activities associated with the project. The plan must conform to the erosion and sedimentation requirements of the 2003 EPA Construction General Permit OR local standards and codes, whichever is more stringent. The plan must describe the measures implemented to accomplish the following objectives:

- To prevent loss of soil during construction by stormwater runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse.
- To prevent sedimentation of storm sewers or receiving streams.
- To prevent pollution of the air with dust and particulate matter.

The EPA's construction general permit outlines the provisions necessary to comply with Phase I and Phase II of the National Pollutant Discharge Elimination System (NPDES) program. While the permit only applies to construction sites greater than 1 acre, the requirements are applied to all projects for the purposes of this prerequisite. Information on the EPA construction general permit is available at http://cfpub.epa.gov/npdes/stormwater/cgp.cfm.

### Potential Technologies & Strategies

Create an erosion and sedimentation control plan during the design phase of the project. Consider employing strategies such as temporary and permanent seeding, mulching, earthen dikes, silt fencing, sediment traps and sediment basins.

## SS Credit 1: Site Selection

## 1 Point

### Intent

To avoid the development of inappropriate sites and reduce the environmental impact from the location of a building on a site.

### Requirements

Do not develop buildings, hardscape, roads or parking areas on portions of sites that meet any of the following criteria:

- Prime farmland as defined by the U.S. Department of Agriculture in the United States Code of Federal Regulations, Title 7, Volume 6, Parts 400 to 699, Section 657.5 (citation 7CFR657.5)
- Previously undeveloped land whose elevation is lower than 5 feet above the elevation of the 100-year flood as defined by the Federal Emergency Management Agency (FEMA)
- Land specifically identified as habitat for any species on federal or state threatened or endangered lists
- Land within 100 feet of any wetlands as defined by the U.S. Code of Federal Regulations 40 CFR, Parts 230-233 and Part 22, and isolated wetlands or areas of special concern identified by state or local rule, OR within setback distances from wetlands prescribed in state or local regulations, as defined by local or state rule or law, whichever is more stringent
- Previously undeveloped land that is within 50 feet of a water body, defined as seas, lakes, rivers, streams and tributaries that support or could support fish, recreation or industrial use, consistent with the terminology of the Clean Water Act
- Land that prior to acquisition for the project was public parkland, unless land of equal or greater value as parkland is accepted in trade by the public landowner (park authority projects are exempt).

### Potential Technologies & Strategies

During the site selection process, give preference to sites that do not include sensitive elements or restrictive land types. Select a suitable building location and design the building with a minimal footprint to minimize disruption of the environmentally sensitive areas identified above.

## SS Credit 2: Development Density and Community Connectivity

## 5 Points

### Intent

To channel development to urban areas with existing infrastructure, protect greenfields, and preserve habitat and natural resources.

### Requirements

OPTION 1. Development Density

Construct or renovate a building on a previously developed site AND in a community with a minimum density of 60,000 square feet per acre net. The density calculation is based on a typical two-story downtown development and must include the area of the project being built.

OR

OPTION 2. Community Connectivity

Construct or renovate a building on a site that meets the following criteria:

- Is located on a previously developed site
- Is within 1/2 mile of a residential area or neighborhood with an average density of 10 units per acre net
- Is within 1/2 mile of at least 10 basic services
- Has pedestrian access between the building and the services

For mixed-use projects, no more than 1 service within the project boundary may be counted as 1 of the 10 basic services, provided it is open to the public. No more than 2 of the 10 services required may be anticipated (i.e., at least 8 must be existing and operational). In addition, the anticipated services must demonstrate that they will be operational in the locations indicated within 1 year of occupation of the applicant project.

Examples of basic services include the following:

- Bank
- Place of Worship
- Convenience Grocery
- Day Care Center
- Cleaners
- Fire Station
- Beauty Salon
- Hardware
- Laundry
- Library
- Medical or Dental Office
- Senior Care Facility
- Park
- Pharmacy
- Post Office
- Restaurant
- School
- Supermarket
- Theater
- Community Center
- Fitness Center
- Museum

Proximity is determined by drawing a 1/2-mile radius around a main building entrance on a site map and counting the services within that radius.

### Potential Technologies & Strategies

During the site selection process, give preference to urban sites with pedestrian access to a variety of services.

## SS Credit 3: Brownfield Redevelopment

## 1 Point

### Intent

To rehabilitate damaged sites where development is complicated by environmental contamination and to reduce pressure on undeveloped land.

### Requirements

OPTION 1

Develop on a site documented as contaminated (by means of an ASTM E1903-97 Phase II Environmental Site Assessment or a local voluntary cleanup program).

OR

OPTION 2

Develop on a site defined as a brownfield by a local, state, or federal government agency.

For projects where asbestos is found and remediated also earn this credit. Testing should be done in accordance with EPA Reg 40CFR part 763, when applicable.

### Potential Technologies & Strategies

During the site selection process, give preference to brownfield sites. Identify tax incentives and property cost savings. Coordinate site development plans with remediation activity, as appropriate.

## SS Credit 4.1: Alternative Transportation—Public Transportation Access

## 6 Points

### Intent

To reduce pollution and land development impacts from automobile use.

### Requirements

OPTION 1. Rail Station Proximity

Locate the project within 1/2-mile walking distance (measured from a main building entrance) of an existing or planned and funded commuter rail, light rail or subway station.

OR

OPTION 2. Bus Stop Proximity

Locate the project within 1/4-mile walking distance (measured from a main building entrance) of 1 or more stops for 2 or more public, campus, or private bus lines usable by building occupants.

### Potential Technologies & Strategies

Perform a transportation survey of future building occupants to identify transportation needs. Locate the building near mass transit.

## SS Credit 4.2: Alternative Transportation—Bicycle Storage and Changing Rooms

## 1 Point

### Intent

To reduce pollution and land development impacts from automobile use.

### Requirements

CASE 1. Commercial or Institutional Projects

Provide secure bicycle racks and/or storage within 200 yards of a building entrance for 5% or more of all building users (measured at peak periods)

Provide shower and changing facilities in the building, or within 200 yards of a building entrance, for 0.5% of full-time equivalent (FTE) occupants.

CASE 2. Residential Projects

Provide covered storage facilities for securing bicycles for 15% or more of building occupants.

### Potential Technologies & Strategies

Design the building with transportation amenities such as bicycle racks and shower/changing facilities.

## SS Credit 4.3: Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles

## 3 Points

### Intent

To reduce pollution and land development impacts from automobile use.

### Requirements

OPTION 1

Provide preferred parking[1] for low-emitting and fuel-efficient vehicles[2] for 5% of the total vehicle parking capacity of the site. Providing a discounted parking rate is an acceptable substitute for preferred parking for low-emitting/fuel-efficient vehicles. To establish a meaningful incentive in all potential markets, the parking rate must be discounted at least 20%. The discounted rate must be available to all customers (i.e., not limited to the number of customers equal to 5% of the vehicle parking capacity), publicly posted at the entrance of the parking area and available for a minimum of 2 years.

OR

OPTION 2

Install alternative-fuel fueling stations for 3% of the total vehicle parking capacity of the site. Liquid or gaseous fueling facilities must be separately ventilated or located outdoors.

OR

OPTION 3

Provide low-emitting and fuel-efficient vehicles[2] for 3% of full-time equivalent (FTE) occupants.

Provide preferred parking[1] for these vehicles.

OR

OPTION 4

Provide building occupants access to a low-emitting or fuel-efficient vehicle-sharing program. The following requirements must be met:

- One low-emitting or fuel-efficient vehicle must be provided per 3% of FTE occupants, assuming that 1 shared vehicle can carry 8 persons (i.e., 1 vehicle per 267 FTE occupants). For buildings with fewer than 267 FTE occupants, at least 1 low emitting or fuel-efficient vehicle must be provided.
- A vehicle-sharing contract must be provided that has an agreement of at least 2 years.

1 For the purposes of this credit "preferred parking" refers to the parking spots that are closest to the main entrance of the project (exclusive of spaces designated for handicapped persons) or parking passes provided at a discounted price.

2 For the purposes of this credit, low-emitting and fuel-efficient vehicles are defined as vehicles that are either classified as Zero Emission Vehicles (ZEV) by the California Air Resources Board or have achieved a minimum green score of 40 on the American Council for an Energy Efficient Economy (ACEEE) annual vehicle rating guide.

- The estimated number of customers served per vehicle must be supported by documentation.
- A narrative explaining the vehicle-sharing program and its administration must be submitted.
- Parking for low-emitting and fuel-efficient vehicles must be located in the nearest available spaces in the nearest available parking area. Provide a site plan or area map clearly highlighting the walking path from the parking area to the project site and noting the distance.

### Potential Technologies & Strategies

Provide transportation amenities such as alternative-fuel refueling stations. Consider sharing the costs and benefits of refueling stations with neighbors.

## SS Credit 4.4: Alternative Transportation—Parking Capacity

## 2 Points

### Intent

To reduce pollution and land development impacts from automobile use.

### Requirements

CASE 1. Non-Residential Projects

OPTION 1

Size parking capacity to meet but not exceed minimum local zoning requirements.

Provide preferred parking for carpools or vanpools for 5% of the total parking spaces.

OR

OPTION 2

For projects that provide parking for less than 5% of full-time equivalent (FTE) building occupants:

Provide preferred parking[1] for carpools or vanpools, marked as such, for 5% of total parking spaces. Providing a discounted parking rate is an acceptable substitute for preferred parking for carpool or vanpool vehicles. To establish a meaningful incentive in all potential markets, the parking rate must be discounted at least 20%. The discounted rate must be available to all customers (i.e., not limited to the number of customers equal to 5% of the vehicle parking capacity), publicly posted at the entrance of the parking area, and available for a minimum of 2 years.

OR

OPTION 3

Provide no new parking.

OR

OPTION 4

For projects that have no minimum local zoning requirements, provide 25% fewer parking spaces than the applicable standard listed in the 2003 Institute of Transportation Engineers (ITE) "Parking Generation" study at http://www.ite.org.

CASE 2. Residential Projects

OPTION 1

Size parking capacity to meet but not exceed minimum local zoning requirements

Provide infrastructure and support programs to facilitate shared vehicle use such as carpool drop-off areas, designated parking for vanpools, car-share services, ride boards and shuttle services to mass transit.

1 For the purposes of this credit "preferred parking" refers to the parking spots that are closest to the main entrance of the project (exclusive of spaces designated for handicapped persons) or parking passes provided at a discounted price.

OR

OPTION 2

Provide no new parking.

CASE 3. Mixed Use (Residential with Commercial/Retail) Projects

OPTION 1

Mixed-use buildings with less than 10% commercial area must be considered residential and adhere to the residential requirements in Case 2. For mixed-use buildings with more than 10% commercial area, the commercial space must adhere to non-residential requirements in Case 1 and the residential component must adhere to residential requirements in Case 2.

OR

OPTION 2

Provide no new parking.

### Potential Technologies & Strategies

Minimize parking lot/garage size. Consider sharing parking facilities with adjacent buildings. Consider alternatives that will limit the use of single occupancy vehicles.

## SS Credit 5.1: Site Development—Protect or Restore Habitat

## 1 Point

### Intent

To conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.

### Requirements

CASE 1. Greenfield Sites[1]

Limit all site disturbance to the following parameters:

- 40 feet beyond the building perimeter;
- 10 feet beyond surface walkways, patios, surface parking and utilities less than 12 inches in diameter;
- 15 feet beyond primary roadway curbs and main utility branch trenches;
- 25 feet beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities and playing fields) that require additional staging areas to limit compaction in the constructed area.

CASE 2. Previously Developed[2] Areas or Graded Sites

Restore or protect a minimum of 50% of the site (excluding the building footprint) or 20% of the total site area (including building footprint), whichever is greater, with native or adapted vegetation[3]. Projects earning SS Credit 2: Development Density and Community Connectivity may include vegetated roof surface in this calculation if the plants are native or adapted, provide habitat, and promote biodiversity.

Projects with limited landscape opportunities may also donate offsite land in perpetuity, equal to 60% of the previously developed area (including the building footprint), to a land trust within the same EPA Level III Ecoregion identified for the project site. The land trust must adhere to the Land Trust Alliance 'Land Trust Standards and Practices' 2004 Revision.

### Potential Technologies & Strategies

Survey greenfield sites to identify site elements and adopt a master plan for developing the project site. Carefully site the building to minimize disruption to existing ecosystems and design the building to minimize its footprint. Strategies include stacking the building program, tuck-under parking and sharing parking facilities with neighbors. Establish clearly-marked construction boundaries to minimize disturbance of the existing site and restore previously degraded areas to their natural state. For previously developed sites, use local and regional governmental agencies, consultants, educational facilities and native plant societies as resources for the selection of appropriate native or adapted plants. Prohibit plants listed as invasive or noxious weed species. Once established, native/adapted plants require minimal or no irrigation; do not require active maintenance such as mowing or chemical inputs such as fertilizers, pesticides or herbicides; and provide habitat value and promote biodiversity through avoidance of monoculture plantings.

1 Greenfield sites are those that are not previously developed or graded and remain in a natural state.
2 Previously developed areas are those that previously contained buildings, roadways, parking lots or were graded or altered by direct human activities.
3 Native or adapted plants are plants indigenous to a locality or cultivars of native plants that are adapted to the local climate and are not considered invasive species or noxious weeds.

## SS Credit 5.2: Site Development—Maximize Open Space

## 1 Point

### Intent

To promote biodiversity by providing a high ratio of open space to development footprint.

### Requirements

CASE 1. Sites with Local Zoning Open Space Requirements

Reduce the development footprint[1] and/or provide vegetated open space within the project boundary such that the amount of open space exceeds local zoning requirements by 25%.

CASE 2. Sites with No Local Zoning Requirements (e.g. some university campuses, military bases)

Provide a vegetated open space area adjacent to the building that is equal in area to the building footprint.

CASE 3. Sites with Zoning Ordinances but No Open Space Requirements

Provide vegetated open space equal to 20% of the project site area.

ALL CASES

For projects in urban areas that earn SS Credit 2: Development Density and Community Connectivity, vegetated roof areas can contribute to credit compliance.

For projects in urban areas that earn SS Credit 2: Development Density and Community Connectivity, pedestrian-oriented hardscape areas can contribute to credit compliance. For such projects, a minimum of 25% of the open space counted must be vegetated.

Wetlands or naturally designed ponds may count as open space and the side slope gradients average 1:4 (vertical: horizontal) or less and are vegetated.

### Potential Technologies & Strategies

Perform a site survey to identify site elements and adopt a master plan for developing the project site. Select a suitable building location and design the building footprint to minimize site disruption. Strategies include stacking the building program, tuck-under parking and sharing parking facilities with neighbors to maximize the amount of open space on the site.

1 Development footprint is defined as the total area of the building footprint, hardscape, access roads and parking.

## SS Credit 6.1: Stormwater Design—Quantity Control

## 1 Point

### Intent

To limit disruption of natural hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from stormwater runoff and eliminating contaminants.

### Requirements

CASE 1. Sites with Existing Imperviousness 50% or Less

OPTION 1

Implement a stormwater management plan that prevents the postdevelopment peak discharge rate and quantity from exceeding the predevelopment peak discharge rate and quantity for the 1- and 2-year 24-hour design storms.

OR

OPTION 2

Implement a stormwater management plan that protects receiving stream channels from excessive erosion. The stormwater management plan must include stream channel protection and quantity control strategies.

CASE 2. Sites with Existing Imperviousness Greater Than 50%

Implement a stormwater management plan that results in a 25% decrease in the volume of stormwater runoff from the 2-year 24-hour design storm.

### Potential Technologies & Strategies

Design the project site to maintain natural stormwater flows by promoting infiltration. Specify vegetated roofs, pervious paving and other measures to minimize impervious surfaces. Reuse stormwater for non-potable uses such as landscape irrigation, toilet and urinal flushing, and custodial uses.

## SS Credit 6.2: Stormwater Design—Quality Control

## 1 Point

### Intent

To limit disruption and pollution of natural water flows by managing stormwater runoff.

### Requirements

Implement a stormwater management plan that reduces impervious cover, promotes infiltration and captures and treats the stormwater runoff from 90% of the average annual rainfall[1] using acceptable best management practices (BMPs).

BMPs used to treat runoff must be capable of removing 80% of the average annual postdevelopment total suspended solids (TSS) load based on existing monitoring reports. BMPs are considered to meet these criteria if:

- They are designed in accordance with standards and specifications from a state or local program that has adopted these performance standards,

OR

- There exists infield performance monitoring data demonstrating compliance with the criteria. Data must conform to accepted protocol (e.g., Technology Acceptance Reciprocity Partnership [TARP], Washington State Department of Ecology) for BMP monitoring.

### Potential Technologies & Strategies

Use alternative surfaces (e.g., vegetated roofs, pervious pavement, grid pavers) and nonstructural techniques (e.g., rain gardens, vegetated swales, disconnection of imperviousness, rainwater recycling) to reduce imperviousness and promote infiltration and thereby reduce pollutant loadings.

Use sustainable design strategies (e.g., low-impact development, environmentally sensitive design) to create integrated natural and mechanical treatment systems such as constructed wetlands, vegetated filters and open channels to treat stormwater runoff.

1 There are 3 distinct climates in the United States that influence the nature and amount of annual rainfall. Humid watersheds are defined as those that receive at least 40 inches of rainfall each year. Semiarid watersheds receive between 20 and 40 inches of rainfall per year, and arid watersheds receive less than 20 inches of rainfall per year. For this credit, 90% of the average annual rainfall is equivalent to treating the runoff from the following (based on climate):
- Humid Watersheds — 1 inch of rainfall
- Semiarid Watersheds — 0.75 inches of rainfall
- Arid Watersheds — 0.5 inches of rainfall

## SS Credit 7.1: Heat Island Effect—Nonroof

## 1 Point

### Intent

To reduce heat islands[1] to minimize impacts on microclimates and human and wildlife habitats.

### Requirements

OPTION 1

Use any combination of the following strategies for 50% of the site hardscape (including roads, sidewalks, courtyards and parking lots):

- Provide shade from the existing tree canopy or within 5 years of landscape installation. Landscaping (trees) must be in place at the time of occupancy.
- Provide shade from structures covered by solar panels that produce energy used to offset some nonrenewable resource use.
- Provide shade from architectural devices or structures that have a solar reflectance index[2] (SRI) of at least 29.
- Use hardscape materials with an SRI of at least 29.
- Use an open-grid pavement system (at least 50% pervious).

OR

OPTION 2

Place a minimum of 50% of parking spaces under cover[3]. Any roof used to shade or cover parking must have an SRI of at least 29, be a vegetated green roof or be covered by solar panels that produce energy used to offset some nonrenewable resource use.

### Potential Technologies & Strategies

Employ strategies, materials and landscaping techniques that reduce the heat absorption of exterior materials. Use shade (calculated on June 21, noon solar time) from native or adapted trees and large shrubs, vegetated trellises or other exterior structures supporting vegetation. Consider using new coatings and integral colorants for asphalt to achieve light-colored surfaces instead of blacktop. Position photovoltaic cells to shade impervious surfaces.

Consider replacing constructed surfaces (e.g., roof, roads, sidewalks, etc.) with vegetated surfaces such as vegetated roofs and open grid paving or specify high-albedo materials, such as concrete, to reduce heat absorption.

1 Heat islands are defined as thermal gradient differences between developed and undeveloped areas.

2 The solar reflectance index (SRI) is a measure of the constructed surface's ability to reflect solar heat, as shown by a small temperature rise. It is defined so that a standard black surface (reflectance 0.05, emittance 0.90) is 0 and a standard white surface (reflectance 0.80, emittance 0.90) is 100. To calculate the SRI for a given material, obtain the reflectance value and emittance value for the material. SRI is calculated according to ASTM E 1980. Reflectance is measured according to ASTM E 903, ASTM E 1918, or ASTM C 1549. Emittance is measured according to ASTM E 408 or ASTM C 1371.

3 For the purposes of this credit, under cover parking is defined as parking underground, under deck, under roof, or under a building.

## SS Credit 7.2: Heat Island Effect—Roof

## 1 Point

### Intent

To reduce heat islands[1] to minimize impacts on microclimates and human and wildlife habitats.

### Requirements

OPTION 1

Use roofing materials with a solar reflectance index[2] (SRI) equal to or greater than the values in the table below for a minimum of 75% of the roof surface.

Roofing materials having a lower SRI value than those listed below may be used if the weighted rooftop SRI average meets the following criteria:

$$\frac{\text{Area Roof Meeting Minimum SRI}}{\text{Total Roof Area}} \times \frac{\text{SRI of Installed Roof}}{\text{Required SRI}} \geq 75\%$$

| Roof Type | Slope | SRI |
|---|---|---|
| Low-sloped roof | ≤ 2:12 | 78 |
| Steep-sloped roof | > 2:12 | 29 |

OR

OPTION 2

Install a vegetated roof that covers at least 50% of the roof area.

OR

OPTION 3

Install high-albedo and vegetated roof surfaces that, in combination, meet the following criteria:

$$\frac{\text{Area Roof Meeting Minimum SRI}}{0.75} + \frac{\text{Area of Vegetated Roof}}{0.5} \geq \text{Total Roof Area}$$

| Roof Type | Slope | SRI |
|---|---|---|
| Low-sloped roof | ≤ 2:12 | 78 |
| Steep-sloped roof | > 2:12 | 29 |

1 Heat islands are defined as thermal gradient differences between developed and undeveloped areas.

2 The solar reflectance index (SRI) is a measure of the constructed surface's ability to reflect solar heat, as shown by a small temperature rise. It is defined so that a standard black surface (reflectance 0.05, emittance 0.90) is 0 and a standard white surface (reflectance 0.80, emittance 0.90) is 100. To calculate the SRI for a given material, obtain the reflectance value and emittance value for the material. SRI is calculated according to ASTM E 1980. Reflectance is measured according to ASTM E 903, ASTM E 1918 or ASTM C 1549. Emittance is measured according to ASTM E 408 or ASTM C 1371.

### Potential Technologies & Strategies

Consider installing high-albedo and vegetated roofs to reduce heat absorption. Default values will be available in the LEED Reference Guide for Green Building Design and Construction, 2009 Edition. Product information is available from the Cool Roof Rating Council Web site at http://www.coolroofs.org/ and the ENERGY STAR® Web site at http://www.energystar.gov/.

## SS Credit 8: Light Pollution Reduction

## 1 Point

### Intent

To minimize light trespass from the building and site, reduce sky-glow to increase night sky access, improve nighttime visibility through glare reduction and reduce development impact from lighting on nocturnal environments.

### Requirements

Project teams must comply with 1 of the 2 options for interior lighting AND the requirement for exterior lighting.

For Interior Lighting

OPTION 1

Reduce the input power (by automatic device) of all nonemergency interior luminaires with a direct line of sight to any openings in the envelope (translucent or transparent) by at least 50% between 11 p.m. and 5 a.m. After-hours override may be provided by a manual or occupant-sensing device provided the override lasts no more than 30 minutes.

OR

OPTION 2

All openings in the envelope (translucent or transparent) with a direct line of sight to any nonemergency luminaires must have shielding (controlled/closed by automatic device for a resultant transmittance of less than 10% between 11 p.m. and 5 a.m.).

For Exterior Lighting

Light areas only as required for safety and comfort. Exterior lighting power densities shall not exceed those specified in ANSI/ASHRAE/IESNA Standard 90.1-2007 with Addenda 1 for the documented lighting zone. Justification shall be provided for the selected lighting zone. Lighting controls for all exterior lighting shall comply with section 9.4.1.3 of ANSI/ASHRAE/IESNA Standard 90.1- 2007, without amendments[1].

Classify the project under 1 of the following zones, as defined in IESNA RP-33, and follow all the requirements for that zone:

**LZ1: Dark** (**developed areas within national parks, state parks, forest land and rural areas**)
Design exterior lighting so that all site and building-mounted luminaires produce a maximum initial illuminance value no greater than 0.01 horizontal and vertical footcandles at the site boundary and beyond. Document that 0% of the total initial designed fixture lumens (sum total of all fixtures on site) are emitted at an angle of 90 degrees or higher from nadir (straight down).

1 The requirement to use ASHRAE Addenda I is unique to this credit and does not obligate Project teams to use ASHRAE approved addenda for other credits.

**LZ2: Low** (**primarily residential zones, neighborhood business districts, light industrial areas with limited nighttime use and residential mixed-use areas**)
Design exterior lighting so that all site and building-mounted luminaires produce a maximum initial illuminance value no greater than 0.10 horizontal and vertical footcandles at the site boundary and no greater than 0.01 horizontal footcandles 10 feet beyond the site boundary. Document that no more than 2% of the total initial designed fixture lumens (sum total of all fixtures on site) are emitted at an angle of 90 degrees or higher from nadir (straight down).

**LZ3: Medium** (**all other areas not included in LZ1, LZ2 or LZ4, such as commercial/ industrial, and high-density residential**)
Design exterior lighting so that all site and building-mounted luminaires produce a maximum initial illuminance value no greater than 0.20 horizontal and vertical footcandles at the site boundary and no greater than 0.01 horizontal footcandles 15 feet beyond the site. Document that no more than 5% of the total initial designed fixture lumens (sum total of all fixtures on site) are emitted at an angle of 90 degrees or higher from nadir (straight down).

**LZ4: High**[2] (**high-activity commercial districts in major metropolitan areas**)
Design exterior lighting so that all site and building-mounted luminaires produce a maximum initial illuminance value no greater than 0.60 horizontal and vertical footcandles at the site boundary and no greater than 0.01 horizontal footcandles 15 feet beyond the site. Document that no more than 10% of the total initial designed fixture lumens (sum total of all fixtures on site) are emitted at an angle of 90 degrees or higher from nadir (straight down).

**LZ2, LZ3 and LZ4** - For site boundaries that abut public rights-of-way, light trespass requirements may be met relative to the curb line instead of the site boundary.

**For All Zones**
Illuminance generated from a single luminaire placed at the intersection of a private vehicular driveway and public roadway accessing the site is allowed to use the centerline of the public roadway as the site boundary for a length of 2 times the driveway width centered at the centerline of the driveway.

## Potential Technologies & Strategies

Adopt site lighting criteria to maintain safe light levels while avoiding off-site lighting and night sky pollution. Minimize site lighting where possible, and use computer software to model the site lighting. Technologies to reduce light pollution include full cutoff luminaires, low-reflectance surfaces and low-angle spotlights.

2 To be LZ4, the area must be so designated by an organization with local jurisdiction, such as the local zoning authority.

# WATER EFFICIENCY

## WE Prerequisite 1: Water Use Reduction

## Required

### Intent

To increase water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

### Requirements

Employ strategies that in aggregate use 20% less water than the water use baseline calculated for the building (not including irrigation).

Calculate the baseline according to the commercial and/or residential baselines outlined below.[1] Calculations are based on estimated occupant usage and must include only the following fixtures and fixture fittings (as applicable to the project scope): water closets, urinals, lavatory faucets, showers, kitchen sink faucets and prerinse spray valves.

| Commercial Fixtures, Fittings, and Appliances | Current Baseline |
|---|---|
| Commercial toilets | 1.6 gallons per flush (gpf)*<br>Except blow-out fixtures: 3.5 (gpf) |
| Commercial urinals | 1.0 (gpf) |
| Commercial lavatory (restroom) faucets | 2.2 gallons per minute (gpm) at 60 pounds per square inch (psi), private applications only (hotel or motel guest rooms, hospital patient rooms)<br>0.5 (gpm) at 60 (psi)** all others except private applications<br>0.25 gallons per cycle for metering faucets |
| Commercial prerinse spray valves<br>(for food service applications) | Flow rate ≤ 1.6 (gpm)<br>(no pressure specified; no performance requirement) |

| Residential Fixtures, Fittings, and Appliances | Current Baseline |
|---|---|
| Residential toilets | 1.6 (gpf)*** |
| Residential lavatory (bathroom) faucets | 2.2 (gpm) at 60 psi |
| Residential kitchen faucet | |
| Residential showerheads | 2.5 (gpm) at 80 (psi) per shower stall**** |

* EPAct 1992 standard for toilets applies to both commercial and residential models.
** In addition to EPAct requirements, the American Society of Mechanical Engineers standard for public lavatory faucets is 0.5 gpm at 60 psi (ASME A112.18.1-2005). This maximum has been incorporated into the national Uniform Plumbing Code and the International Plumbing Code.
*** EPAct 1992 standard for toilets applies to both commercial and residential models.
**** Residential shower compartment (stall) in dwelling units: The total allowable flow rate from all flowing showerheads at any given time, including rain systems, waterfalls, bodysprays, bodyspas and jets, must be limited to the allowable showerhead flow rate as specified above (2.5 gpm) per shower compartment, where the floor area of the shower compartment is less than 2,500 square inches. For each increment of 2,500 square inches of floor area thereafter or part thereof, an additional showerhead with total allowable flow rate from all flowing devices equal to or less than the allowable flow rate as specified above must be allowed. Exception: Showers that emit recirculated nonpotable water originating from within the shower compartment while operating are allowed to exceed the maximum as long as the total potable water flow does not exceed the flow rate as specified above.

1 Tables adapted from information developed and summarized by the U.S. Environmental Protection Agency (EPA) Office of Water based on requirements of the Energy Policy Act (EPAct) of 1992 and subsequent rulings by the Department of Energy, requirements of the EPAct of 2005, and the plumbing code requirements as stated in the 2006 editions of the Uniform Plumbing Code or International Plumbing Code pertaining to fixture performance.

The following fixtures, fittings and appliances are outside the scope of the water use reduction calculation:

- Commercial Steam Cookers
- Commercial Dishwashers
- Automatic Commercial Ice Makers
- Commercial (family sized) Clothes Washers
- Residential Clothes Washers
- Standard and Compact Residential Dishwashers

### Potential Technologies & Strategies

WaterSense-certified fixtures and fixture fittings should be used where available. Use high-efficiency fixtures (e.g., water closets and urinals) and dry fixtures, such as toilets attached to composting systems, to reduce potable water demand. Consider using alternative on-site sources of water (e.g., rainwater, stormwater, and air conditioner condensate) and graywater for nonpotable applications such as custodial uses and toilet and urinal flushing. The quality of any alternative source of water used must be taken into consideration based on its application or use.

## WE Credit 1: Water Efficient Landscaping

## 2–4 Points

### Intent

To limit or eliminate the use of potable water or other natural surface or subsurface water resources available on or near the project site for landscape irrigation.

### Requirements

OPTION 1. Reduce by 50% (2 points)

Reduce potable water consumption for irrigation by 50% from a calculated midsummer baseline case.

Reductions must be attributed to any combination of the following items:

- Plant species, density and microclimate factor
- Irrigation efficiency
- Use of captured rainwater
- Use of recycled wastewater
- Use of water treated and conveyed by a public agency specifically for nonpotable uses

Groundwater seepage that is pumped away from the immediate vicinity of building slabs and foundations may be used for landscape irrigation to meet the intent of this credit. However, the project team must demonstrate that doing so does not affect site stormwater management systems.

OR

OPTION 2. No Potable Water Use or Irrigation[1] (4 points)

Meet the requirements for Option 1.

AND

PATH 1

Use only captured rainwater, recycled wastewater, recycled graywater or water treated and conveyed by a public agency specifically for nonpotable uses for irrigation.

OR

PATH 2

Install landscaping that does not require permanent irrigation systems. Temporary irrigation systems used for plant establishment are allowed only if removed within a period not to exceed 18 months of installation.

1 If the percent reduction of potable water is 100% AND the percent reduction of total water is equal to or greater than 50%, then Option 2 is earned, for a total of 4 points.

### Potential Technologies & Strategies

Perform a soil/climate analysis to determine appropriate plant material and design the landscape with native or adapted plants to reduce or eliminate irrigation requirements. Where irrigation is required, use high-efficiency equipment and/or climate-based controllers.

## WE Credit 2: Innovative Wastewater Technologies

## 2 Points

### Intent

To reduce wastewater generation and potable water demand while increasing the local aquifer recharge.

### Requirements

OPTION 1

Reduce potable water use for building sewage conveyance by 50% through the use of water-conserving fixtures (e.g., water closets, urinals) or nonpotable water (e.g., captured rainwater, recycled graywater, on-site or municipally treated wastewater).

OR

OPTION 2

Treat 50% of wastewater on-site to tertiary standards. Treated water must be infiltrated or used on-site.

### Potential Technologies & Strategies

Specify high-efficiency fixtures and dry fixtures (e.g., composting toilet systems, nonwater-using urinals) to reduce wastewater volumes. Consider reusing stormwater or graywater for sewage conveyance or on-site mechanical and/or natural wastewater treatment systems. Options for on-site wastewater treatment include packaged biological nutrient removal systems, constructed wetlands and high-efficiency filtration systems.

# WE Credit 3: Water Use Reduction

## 2–4 Points

### Intent

To further increase water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

### Requirements

Employ strategies that in aggregate use less water than the water use baseline calculated for the building (not including irrigation). The minimum water savings percentage for each point threshold is as follows:

| Percentage Reduction | Points |
|---|---|
| 30% | 2 |
| 35% | 3 |
| 40% | 4 |

Calculate the baseline according to the commercial and/or residential baselines outlined below.[1] Calculations are based on estimated occupant usage and must include only the following fixtures and fixture fittings (as applicable to the project scope): water closets, urinals, lavatory faucets, showers, kitchen sink faucets and pre-rinse spray valves.

| Commercial Fixtures, Fittings, and Appliances | Current Baseline |
|---|---|
| Commercial toilets | 1.6 gallons per flush (gpf)*<br>Except blow-out fixtures: 3.5 (gpf) |
| Commercial urinals | 1.0 (gpf) |
| Commercial lavatory (restroom) faucets | 2.2 gallons per minute (gpm) at 60 pounds per square inch (psi), private applications only (hotel or motel guest rooms, hospital patient rooms)<br>0.5 (gpm) at 60 (psi)** all others except private applications<br>0.25 gallons per cycle for metering faucets |
| Commercial prerinse spray valves<br>(for food service applications) | Flow rate ≤ 1.6 (gpm)<br>(no pressure specified; no performance requirement) |

| Residential Fixtures, Fittings, and Appliances | Current Baseline |
|---|---|
| Residential toilets | 1.6 (gpf)*** |
| Residential lavatory (bathroom) faucets | 2.2 (gpm) at 60 psi |
| Residential kitchen faucet | |
| Residential showerheads | 2.5 (gpm) at 80 (psi) per shower stall**** |

* EPAct 1992 standard for toilets applies to both commercial and residential models.
** In addition to EPAct requirements, the American Society of Mechanical Engineers standard for public lavatory faucets is 0.5 gpm at 60 psi (ASME A112.18.1-2005). This maximum has been incorporated into the national Uniform Plumbing Code and the International Plumbing Code.
*** EPAct 1992 standard for toilets applies to both commercial and residential models.
**** Residential shower compartment (stall) in dwelling units: The total allowable flow rate from all flowing showerheads at any given time, including rain systems, waterfalls, bodysprays, bodyspas and jets, must be limited to the allowable showerhead flow rate as specified above (2.5 gpm) per shower compartment, where the floor area of the shower compartment is less than 2,500 square inches. For each increment of 2,500 square inches of floor area thereafter or part thereof, an additional showerhead with total allowable flow rate from all flowing devices equal to or less than the allowable flow rate as specified above must be allowed. Exception: Showers that emit recirculated nonpotable water originating from within the shower compartment while operating are allowed to exceed the maximum as long as the total potable water flow does not exceed the flow rate as specified above.

1 Tables adapted from information developed and summarized by the U.S. Environmental Protection Agency (EPA) Office of Water based on requirements of the Energy Policy Act (EPAct) of 1992 and subsequent rulings by the Department of Energy, requirements of the EPAct of 2005, and the plumbing code requirements as stated in the 2006 editions of the Uniform Plumbing Code or International Plumbing Code pertaining to fixture performance.

The following fixtures, fittings and appliances are outside the scope of the water use reduction calculation:

- Commercial Steam Cookers
- Commercial Dishwashers
- Automatic Commercial Ice Makers
- Commercial (family-sized) Clothes Washers
- Residential Clothes Washers
- Standard and Compact Residential Dishwashers

### Potential Technologies & Strategies

Use WaterSense-certified fixtures and fixture fittings where available. Use high-efficiency fixtures (e.g., water closets and urinals) and dry fixtures, such as toilets attached to composting systems, to reduce the potable water demand. Consider using alternative on-site sources of water (e.g., rainwater, stormwater, and air conditioner condensate, graywater) for nonpotable applications (e.g., toilet and urinal flushing, custodial uses). The quality of any alternative source of water being used must be taken into consideration based on its application or use.

# ENERGY & ATMOSPHERE

## EA Prerequisite 1: Fundamental Commissioning of Building Energy Systems

## Required

### Intent

To verify that the project's energy-related systems are installed, and calibrated to perform according to the owner's project requirements, basis of design and construction documents.

Benefits of commissioning include reduced energy use, lower operating costs, fewer contractor callbacks, better building documentation, improved occupant productivity and verification that the systems perform in accordance with the owner's project requirements.

### Requirements

The following commissioning process activities must be completed by the project team:

- Designate an individual as the commissioning authority (CxA) to lead, review and oversee the completion of the commissioning process activities.
  - The CxA must have documented commissioning authority experience in at least 2 building projects.
  - The individual serving as the CxA must be independent of the project design and construction management, though the CxA may be an employee of any firm providing those services. The CxA may be a qualified employee or consultant of the owner.
  - The CxA must report results, findings and recommendations directly to the owner.
  - For projects smaller than 50,000 gross square feet, the CxA may be a qualified person on the design or construction team who has the required experience.
- The owner must document the owner's project requirements. The design team must develop the basis of design. The CxA must review these documents for clarity and completeness. The owner and design team must be responsible for updates to their respective documents.
- Develop and incorporate commissioning requirements into the construction documents.
- Develop and implement a commissioning plan.
- Verify the installation and performance of the systems to be commissioned.
- Complete a summary commissioning report.

#### Commissioned Systems

Commissioning process activities must be completed for the following energy-related systems, at a minimum:

- Heating, ventilating, air conditioning and refrigeration (HVAC&R) systems (mechanical and passive) and associated controls
- Lighting and daylighting controls
- Domestic hot water systems
- Renewable energy systems (e.g., wind, solar)

## Potential Technologies & Strategies

Engage a CxA as early as possible in the design process. Determine the owner's project requirements, develop and maintain a commissioning plan for use during design and construction and incorporate commissioning requirements in bid documents. Assemble the commissioning team, and prior to occupancy verify the performance of energy consuming systems. Complete the commissioning reports with recommendations prior to accepting the commissioned systems.

Owners are encouraged to seek out qualified individuals to lead the commissioning process. Qualified individuals are identified as those who possess a high level of experience in the following areas:

- Energy systems design, installation and operation
- Commissioning planning and process management
- Hands-on field experience with energy systems performance, interaction, start-up, balancing, testing, troubleshooting, operation and maintenance procedures
- Energy systems automation control knowledge

Owners are encouraged to consider including water-using systems, building envelope systems, and other systems in the scope of the commissioning plan as appropriate. The building envelope is an important component of a facility that impacts energy consumption, occupant comfort and indoor air quality. While this prerequisite does not require building envelope commissioning, an owner can achieve significant financial savings and reduce risk of poor indoor air quality by including it in the commissioning process.

The LEED Reference Guide for Green Building Design and Construction, 2009 Edition provides guidance on the rigor expected for this prerequisite for the following:

- Owner's project requirements
- Basis of design
- Commissioning plan
- Commissioning specification
- Performance verification documentation
- Commissioning report

## EA Prerequisite 2: Minimum Energy Performance

## Required

### Intent

To establish the minimum level of energy efficiency for the proposed building and systems to reduce environmental and economic impacts associated with excessive energy use.

### Requirements

OPTION 1. Whole Building Energy Simulation

Demonstrate a 10% improvement in the proposed building performance rating for new buildings, or a 5% improvement in the proposed building performance rating for major renovations to existing buildings, compared with the baseline building performance rating.

Calculate the baseline building performance rating according to the building performance rating method in Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007 (with errata but without addenda[1]) using a computer simulation model for the whole building project.

Appendix G of Standard 90.1-2007 requires that the energy analysis done for the building performance rating method include all energy costs associated with the building project. To achieve points using this credit, the proposed design must meet the following criteria:

- Comply with the mandatory provisions (Sections 5.4, 6.4, 7.4, 8.4, 9.4 and 10.4) in Standard 90.1-2007 (with errata but without addenda[1]).
- Include all energy costs associated with the building project.
- Compare against a baseline building that complies with Appendix G of Standard 90.1-2007 (with errata but without addenda[1]). The default process energy cost is 25% of the total energy cost for the baseline building. If the building's process energy cost is less than 25% of the baseline building energy cost, the LEED submittal must include documentation substantiating that process energy inputs are appropriate.

For the purpose of this analysis, process energy is considered to include, but is not limited to, office and general miscellaneous equipment, computers, elevators and escalators, kitchen cooking and refrigeration, laundry washing and drying, lighting exempt from the lighting power allowance (e.g., lighting integral to medical equipment) and other (e.g., waterfall pumps).

Regulated (non-process) energy includes lighting (for the interior, parking garage, surface parking, façade, or building grounds, etc. except as noted above), heating, ventilation and air conditioning (HVAC) (for space heating, space cooling, fans, pumps, toilet exhaust, parking garage ventilation, kitchen hood exhaust, etc.), and service water heating for domestic or space heating purposes.

Process loads must be identical for both the baseline building performance rating and the proposed building performance rating. However, project teams may follow the exceptional calculation method (ANSI/ASHRAE/IESNA Standard 90.1-2007 G2.5) to document measures that reduce process loads. Documentation of process

1 Project teams wishing to use ASHRAE approved addenda for the purposes of this credit may do so at their discretion. Addenda must be applied consistently across all LEED credits.

load energy savings must include a list of the assumptions made for both the base and the proposed design, and theoretical or empirical information supporting these assumptions.

Projects in California may use Title 24-2005, Part 6 in place of ANSI/ASHRAE/IESNA Standard 90.1-2007 for Option 1.

OR

OPTION 2. Prescriptive Compliance Path: ASHRAE Advanced Energy Design Guide

Comply with the prescriptive measures of the ASHRAE Advanced Energy Design Guide appropriate to the project scope, outlined below. Project teams must comply with all applicable criteria as established in the Advanced Energy Design Guide for the climate zone in which the building is located.

PATH 1. ASHRAE Advanced Energy Design Guide for Small Office Buildings 2004

The building must meet the following requirements:

- Less than 20,000 square feet.
- Office occupancy.

PATH 2. ASHRAE Advanced Energy Design Guide for Small Retail Buildings 2006

The building must meet the following requirements:

- Less than 20,000 square feet.
- Retail occupancy.

PATH 3. ASHRAE Advanced Energy Design Guide for Small Warehouses and Self Storage Buildings 2008

The building must meet the following requirements:

- Less than 50,000 square feet.
- Warehouse or self-storage occupancy.

OR

OPTION 3. Prescriptive Compliance Path: Advanced Buildings™ Core Performance™ Guide

Comply with the prescriptive measures identified in the Advanced Buildings™ Core Performance™ Guide developed by the New Buildings Institute. The building must meet the following requirements:

- Less than 100,000 square feet.
- Comply with Section 1: Design Process Strategies, and Section 2: Core Performance Requirements.
- Health care, warehouse and laboratory projects are ineligible for this path.

### Potential Technologies & Strategies

Design the building envelope and systems to meet baseline requirements. Use a computer simulation model to assess the energy performance and identify the most cost-effective energy efficiency measures. Quantify energy performance compared with a baseline building.

If local code has demonstrated quantitative and textual equivalence following, at a minimum, the U.S. Department of Energy (DOE) standard process for commercial energy code determination, then the results of that analysis may be used to correlate local code performance with ANSI/ASHRAE/IESNA Standard 90.1-2007. Details on the DOE process for commercial energy code determination can be found at http://www.energycodes.gov/implement/determinations_com.stm.

## EA Prerequisite 3: Fundamental Refrigerant Management

### Required

#### Intent
To reduce stratospheric ozone depletion.

#### Requirements
Zero use of chlorofluorocarbon (CFC)-based refrigerants in new base building heating, ventilating, air conditioning and refrigeration (HVAC&R) systems. When reusing existing base building HVAC equipment, complete a comprehensive CFC phase-out conversion prior to project completion. Phase-out plans extending beyond the project completion date will be considered on their merits.

Existing small HVAC units (defined as containing less than 0.5 pounds of refrigerant) and other equipment, such as standard refrigerators, small water coolers and any other equipment that contains less than 0.5 pounds of refrigerant, are not considered part of the base building system and are not subject to the requirements of this prerequisite.

#### Potential Technologies & Strategies
When reusing existing HVAC systems, conduct an inventory to identify equipment that uses CFC-based refrigerants and provide a replacement schedule for these refrigerants. For new buildings, specify new HVAC equipment in the base building that uses no CFC-based refrigerants.

# EA Credit 1: Optimize Energy Performance

## 1–19 Points

### Intent

To achieve increasing levels of energy performance beyond the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use.

### Requirements

Select 1 of the 3 compliance path options described below. Project teams documenting achievement using any of the 3 options are assumed to be in compliance with EA Prerequisite 2: Minimum Energy Performance.

OPTION 1. Whole Building Energy Simulation (1–19 points)

Demonstrate a percentage improvement in the proposed building performance rating compared with the baseline building performance rating. Calculate the baseline building performance according to Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007 (with errata but without addenda[1]) using a computer simulation model for the whole building project. The minimum energy cost savings percentage for each point threshold is as follows:

| New Buildings | Existing Building Renovations | Points |
|---|---|---|
| 12% | 8% | 1 |
| 14% | 10% | 2 |
| 16% | 12% | 3 |
| 18% | 14% | 4 |
| 20% | 16% | 5 |
| 22% | 18% | 6 |
| 24% | 20% | 7 |
| 26% | 22% | 8 |
| 28% | 24% | 9 |
| 30% | 26% | 10 |
| 32% | 28% | 11 |
| 34% | 30% | 12 |
| 36% | 32% | 13 |
| 38% | 34% | 14 |
| 40% | 36% | 15 |
| 42% | 38% | 16 |
| 44% | 40% | 17 |
| 46% | 42% | 18 |
| 48% | 44% | 19 |

1 Project teams wishing to use ASHRAE approved addenda for the purposes of this credit may do so at their discretion. Addenda must be applied consistently across all LEED credits.

Appendix G of Standard 90.1-2007 requires that the energy analysis done for the building performance rating method include all the energy costs associated with the building project. To achieve points under this credit, the proposed design must meet the following criteria:

- Compliance with the mandatory provisions (Sections 5.4, 6.4, 7.4, 8.4, 9.4 and 10.4) in Standard 90.1-2007 (with errata but without addenda).
- Inclusion of all the energy costs within and associated with the building project.
- Comparison against a baseline building that complies with Appendix G of Standard 90.1-2007 (with errata but without addenda). The default process energy cost is 25% of the total energy cost for the baseline building. If the building's process energy cost is less than 25% of the baseline building energy cost, the LEED submittal must include documentation substantiating that process energy inputs are appropriate.

For the purpose of this analysis, process energy is considered to include, but is not limited to, office and general miscellaneous equipment, computers, elevators and escalators, kitchen cooking and refrigeration, laundry washing and drying, lighting exempt from the lighting power allowance (e.g., lighting integral to medical equipment) and other (e.g., waterfall pumps).

Regulated (non-process) energy includes lighting (e.g., for the interior, parking garage, surface parking, façade, or building grounds, etc. except as noted above), heating, ventilating, and air conditioning (HVAC) (e.g., for space heating, space cooling, fans, pumps, toilet exhaust, parking garage ventilation, kitchen hood exhaust, etc.), and service water heating for domestic or space heating purposes.

For this credit, process loads must be identical for both the baseline building performance rating and the proposed building performance rating. However, project teams may follow the exceptional calculation method (ANSI/ASHRAE/IESNA Standard 90.1-2007 G2.5) to document measures that reduce process loads. Documentation of process load energy savings must include a list of the assumptions made for both the base and proposed design, and theoretical or empirical information supporting these assumptions.

Projects in California may use Title 24-2005, Part 6 in place of ANSI/ASHRAE/IESNA Standard 90.1-2007 for Option 1.

OR

### OPTION 2. Prescriptive Compliance Path: ASHRAE Advanced Energy Design Guide (1 point)

Comply with the prescriptive measures of the ASHRAE Advanced Energy Design Guide appropriate to the project scope, outlined below. Project teams must comply with all applicable criteria as established in the Advanced Energy Design Guide for the climate zone in which the building is located.

#### PATH 1. ASHRAE Advanced Energy Design Guide for Small Office Buildings 2004

The building must meet the following requirements:

- Less than 20,000 square feet.
- Office occupancy.

#### PATH 2. ASHRAE Advanced Energy Design Guide for Small Retail Buildings 2006

The building must meet the following requirements:

- Less than 20,000 square feet.
- Retail occupancy.

PATH 3. ASHRAE Advanced Energy Design Guide for Small Warehouses and Self Storage Buildings 2008

The building must meet the following requirements:

- Less than 50,000 square feet.
- Warehouse or self-storage occupancy.

OR

OPTION 3. Prescriptive Compliance Path: Advanced Buildings™ Core Performance™ Guide (1–3 points)

Comply with the prescriptive measures identified in the Advanced Buildings™ Core Performance™ Guide developed by the New Buildings Institute. The building must meet the following requirements:

- Less than 100,000 square feet.
- Comply with Section 1: Design Process Strategies, and Section 2: Core Performance Requirements.
- Health care, warehouse or laboratory projects are ineligible for this path.

Points achieved under Option 3 (1 point):

- 1 point is available for all projects (office, school, public assembly, and retail projects) less than 100,000 square feet that comply with Sections 1 and 2 of the Core Performance Guide.
- Up to 2 additional points are available to projects that implement performance strategies listed in Section 3, Enhanced Performance. For every 3 strategies implemented from this section, 1 point is available.
- The following strategies are addressed by other aspects of LEED and are not eligible for additional points under EA Credit 1:
  - 3.1 — Cool Roofs
  - 3.8 — Night Venting
  - 3.13 — Additional Commissioning

## Potential Technologies & Strategies

Design the building envelope and systems to maximize energy performance. Use a computer simulation model to assess the energy performance and identify the most cost-effective energy efficiency measures. Quantify energy performance compared with a baseline building.

If local code has demonstrated quantitative and textual equivalence following, at a minimum, the U.S. Department of Energy (DOE) standard process for commercial energy code determination, the results of that analysis may be used to correlate local code performance with ANSI/ASHRAE/IESNA Standard 90.1-2007. Details on the DOE process for commercial energy code determination can be found at http://www.energycodes.gov/implement/determinations_com.stm.

## EA Credit 2: On-site Renewable Energy

## 1–7 Points

### Intent

To encourage and recognize increasing levels of on-site renewable energy self-supply to reduce environmental and economic impacts associated with fossil fuel energy use.

### Requirements

Use on-site renewable energy systems to offset building energy costs. Calculate project performance by expressing the energy produced by the renewable systems as a percentage of the building's annual energy cost and use the table below to determine the number of points achieved.

Use the building annual energy cost calculated in EA Credit 1: Optimize Energy Performance or the U.S. Department of Energy's Commercial Buildings Energy Consumption Survey database to determine the estimated electricity use.

The minimum renewable energy percentage for each point threshold is as follows:

| Percentage Renewable Energy | Points |
|---|---|
| 1% | 1 |
| 3% | 2 |
| 5% | 3 |
| 7% | 4 |
| 9% | 5 |
| 11% | 6 |
| 13% | 7 |

### Potential Technologies & Strategies

Assess the project for nonpolluting and renewable energy potential including solar, wind, geothermal, low-impact hydro, biomass and bio-gas strategies. When applying these strategies, take advantage of net metering with the local utility.

## EA Credit 3: Enhanced Commissioning

## 2 Points

### Intent

To begin the commissioning process early in the design process and execute additional activities after systems performance verification is completed.

### Requirements

Implement, or have a contract in place to implement, the following additional commissioning process activities in addition to the requirements of EA Prerequisite 1: Fundamental Commissioning of Building Energy Systems and in accordance with the LEED Reference Guide for Green Building Design and Construction, 2009 Edition:

- Prior to the start of the construction documents phase, designate an independent commissioning authority (CxA) to lead, review and oversee the completion of all commissioning process activities.
  - The CxA must have documented commissioning authority experience in at least 2 building projects.
  - The individual serving as the CxA:
    - Must be independent of the work of design and construction.
    - Must not be an employee of the design firm, though he or she may be contracted through them.
    - Must not be an employee of, or contracted through, a contractor or construction manager holding construction contracts.
    - May be a qualified employee or consultant of the owner.
  - The CxA must report results, findings and recommendations directly to the owner.
- The CxA must conduct, at a minimum, 1 commissioning design review of the owner's project requirements basis of design, and design documents prior to the mid-construction documents phase and back-check the review comments in the subsequent design submission.
- The CxA must review contractor submittals applicable to systems being commissioned for compliance with the owner's project requirements and basis of design. This review must be concurrent with the review of the architect or engineer of record and submitted to the design team and the owner.
- The CxA or other project team members must develop a systems manual that gives future operating staff the information needed to understand and optimally operate the commissioned systems.
- The CxA or other project team members must verify that the requirements for training operating personnel and building occupants have been completed.
- The CxA must be involved in reviewing the operation of the building with operations and maintenance (O&M) staff and occupants within 10 months after substantial completion. A plan for resolving outstanding commissioning-related issues must be included.

## Potential Technologies & Strategies

Although it is preferable that the CxA be contracted by the owner, for the enhanced commissioning credit the CxA may also be contracted through the design firms or construction management firms not holding construction contracts.

The LEED Reference Guide for Green Building Design and Construction, 2009 Edition provides detailed guidance on the rigor expected for the following process activities:

- Commissioning design review
- Commissioning submittal review
- Systems manual.

# EA Credit 4: Enhanced Refrigerant Management

## 2 Points

### Intent

To reduce ozone depletion and support early compliance with the Montreal Protocol while minimizing direct contributions to climate change.

### Requirements

OPTION 1

Do not use refrigerants.

OR

OPTION 2

Select refrigerants and heating, ventilation, air conditioning and refrigeration (HVAC&R) equipment that minimize or eliminate the emission of compounds that contribute to ozone depletion and climate change. The base building HVAC&R equipment must comply with the following formula, which sets a maximum threshold for the combined contributions to ozone depletion and global warming potential:

$$LCGWP + LCODP \times 10^5 \leq 100$$

| Calculation definitions for $LCGWP + LCODP \times 10^5 \leq 100$ |
|---|
| LCODP = [ODPr x (Lr x Life +Mr) x Rc]/Life |
| LCGWP = [GWPr x (Lr x Life +Mr) x Rc]/Life |
| LCODP: Lifecycle Ozone Depletion Potential (lb CFC 11/Ton-Year) |
| LCGWP: Lifecycle Direct Global Warming Potential (lb $CO_2$/Ton-Year) |
| GWPr: Global Warming Potential of Refrigerant (0 to 12,000 lb $CO_2$/lbr) |
| ODPr: Ozone Depletion Potential of Refrigerant (0 to 0.2 lb CFC 11/lbr) |
| Lr: Refrigerant Leakage Rate (0.5% to 2.0%; default of 2% unless otherwise demonstrated) |
| Mr: End-of-life Refrigerant Loss (2% to 10%; default of 10% unless otherwise demonstrated) |
| Rc: Refrigerant Charge (0.5 to 5.0 lbs of refrigerant per ton of gross ARI rated cooling capacity) |
| Life: Equipment Life (10 years; default based on equipment type, unless otherwise demonstrated) |

For multiple types of equipment, a weighted average of all base building HVAC&R equipment must be calculated using the following formula:

$$\frac{\Sigma \left( LCGWP + LCODP \times 10^5 \right) \times Qunit}{Qtotal} \leq 100$$

| Calculation definitions for $[ \sum (LCGWP + LCODP \times 10^5) \times Qunit ] / Qtotal \leq 100$ |
|---|
| Qunit = Gross ARI rated cooling capacity of an individual HVAC or refrigeration unit (Tons) |
| Qtotal = Total gross ARI rated cooling capacity of all HVAC or refrigeration |

Small HVAC units (defined as containing less than 0.5 pounds of refrigerant) and other equipment, such as standard refrigerators, small water coolers and any other cooling equipment that contains less than 0.5 pounds of refrigerant, are not considered part of the base building system and are not subject to the requirements of this credit.

Do not operate or install fire suppression systems that contain ozone-depleting substances such as CFCs, hydrochlorofluorocarbons (HCFCs) or halons.

## Potential Technologies & Strategies

Design and operate the facility without mechanical cooling and refrigeration equipment. Where mechanical cooling is used, utilize base building HVAC&R systems for the refrigeration cycle that minimize direct impact on ozone depletion and global climate change. Select HVAC&R equipment with reduced refrigerant charge and increased equipment life. Maintain equipment to prevent leakage of refrigerant to the atmosphere. Use fire suppression systems that do not contain HCFCs or halons.

## EA Credit 5: Measurement and Verification

## 3 Points

### Intent

To provide for the ongoing accountability of building energy consumption over time.

### Requirements

OPTION 1

Develop and implement a measurement and verification (M&V) plan consistent with Option D: Calibrated Simulation (Savings Estimation Method 2) as specified in the International Performance Measurement & Verification Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction, April 2003.

The M&V period must cover at least 1 year of post-construction occupancy.

Provide a process for corrective action if the results of the M&V plan indicate that energy savings are not being achieved.

OR

OPTION 2

Develop and implement a measurement and verification (M&V) plan consistent with Option B: Energy Conservation Measure Isolation, as specified in the International Performance Measurement & Verification Protocol (IPMVP) Volume III: Concepts and Options for Determining Energy Savings in New Construction, April 2003.

The M&V period must cover at least 1 year of post-construction occupancy.

Provide a process for corrective action if the results of the M&V plan indicate that energy savings are not being achieved.

OR

OPTION 3 (1 point)

Meet MPR 6 through compliance Opttion1: Energy and Water Data Release Form. Projects must register an account in ENERGY STAR's Portfolio Manager tool and share the project file with the USGBC master account.

### Potential Technologies & Strategies

Develop an M&V plan to evaluate building and/or energy system performance. Characterize the building and/or energy systems through energy simulation or engineering analysis. Install the necessary metering equipment to measure energy use. Track performance by comparing predicted performance to actual performance, broken down by component or system as appropriate. Evaluate energy efficiency by comparing actual performance to baseline performance.

While the IPMVP describes specific actions for verifying savings associated with energy conservation measures (ECMs) and strategies, this LEED credit expands upon typical IPMVP M&V objectives. Measurement & verification activities should not necessarily be confined to energy systems where ECMs or energy conservation strategies have been implemented. The IPMVP provides guidance on M&V strategies and their appropriate applications for various situations. These strategies should be used in conjunction with monitoring and trend logging of significant energy systems to provide for the ongoing accountability of building energy performance.

For the corrective action process, consider installing diagnostics within the control system to alert the staff when equipment is not being optimally operated. Conditions that might warrant alarms to alert staff could include:

- Leaking valves in the cooling and heating coils within air handling units;
- Missed economizer opportunities (e.g., faulty economizer damper controls) ;
- Software and manual overrides allowing equipment to operate 24 hours a day/7 days a week;
- Equipment operation during unusual circumstances (e.g., boiler on when outside air temperature is above 65 °F).

Besides control diagnostics, consider employing retro-commissioning services or dedicating staff to investigate increases in energy usage (such a staff member is usually a resource conservation manager — see http://www.energy.state.or.us/rcm/rcmhm.htm for additional information).

## EA Credit 6: Green Power

## 2 Points

### Intent

To encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis.

### Requirements

Engage in at least a 2-year renewable energy contract to provide at least 35% of the building's electricity from renewable sources, as defined by the Center for Resource Solutions' Green-e Energy product certification requirements.

All purchases of green power shall be based on the quantity of energy consumed, not the cost.

OPTION 1. Determine Baseline Electricity Use

Use the annual electricity consumption from the results of EA Credit 1: Optimize Energy Performance.

OR

OPTION 2. Estimate Baseline Electricity Use

Use the U.S. Department of Energy's Commercial Buildings Energy Consumption Survey database to determine the estimated electricity use.

### Potential Technologies & Strategies

Determine the energy needs of the building and investigate opportunities to engage in a green power contract. Green power is derived from solar, wind, geothermal, biomass or low-impact hydro sources. Visit http://www.green-e.org/energy for details about the Green-e Energy program. The green power product purchased to comply with credit requirements need not be Green-e Energy certified. Other sources of green power are eligible if they satisfy the Green-e Energy program's technical requirements. Renewable energy certificates (RECs), tradable renewable certificates (TRCs), green tags and other forms of green power that comply with the technical requirements of the Green-e Energy program may be used to document compliance with this credit.

## MR Prerequisite 1: Storage and Collection of Recyclables

## Required

### Intent

To facilitate the reduction of waste generated by building occupants that is hauled to and disposed of in landfills.

### Requirements

Provide an easily-accessible dedicated area or areas for the collection and storage of materials for recycling for the entire building. Materials must include, at a minimum: paper, corrugated cardboard, glass, plastics and metals.

### Potential Technologies & Strategies

Designate an area for recyclable collection and storage that is appropriately sized and located in a convenient area. Identify local waste handlers and buyers for glass, plastic, metals, office paper, newspaper, cardboard and organic wastes. Instruct occupants on recycling procedures. Consider employing cardboard balers, aluminum can crushers, recycling chutes and other waste management strategies to further enhance the recycling program.

## MR Credit 1.1: Building Reuse—Maintain Existing Walls, Floors and Roof

## 1–3 Points

### Intent

To extend the lifecycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

### Requirements

Maintain the existing building structure (including structural floor and roof decking) and envelope (the exterior skin and framing, excluding window assemblies and non-structural roofing material). The minimum percentage building reuse for each point threshold is as follows:

| Building Reuse | Points |
|---|---|
| 55% | 1 |
| 75% | 2 |
| 95% | 3 |

Hazardous materials that are remediated as a part of the project must be excluded from the calculation of the percentage maintained. If the project includes an addition that is more than 2 times the square footage of the existing building, this credit is not applicable.

### Potential Technologies & Strategies

Consider reusing existing, previously-occupied building structures, envelopes and elements. Remove elements that pose a contamination risk to building occupants and upgrade components that would improve energy and water efficiency such as windows, mechanical systems and plumbing fixtures.

## MR Credit 1.2: Building Reuse—Maintain Interior Nonstructural Elements

## 1 Point

### Intent

To extend the lifecycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

### Requirements

Use existing interior nonstructural elements (e.g., interior walls, doors, floor coverings and ceiling systems) in at least 50% (by area) of the completed building, including additions. If the project includes an addition with square footage more than 2 times the square footage of the existing building, this credit is not applicable.

### Potential Technologies & Strategies

Consider reusing existing building structures, envelopes and interior nonstructural elements. Remove elements that pose a contamination risk to building occupants, and upgrade components that would improve energy and water efficiency such as mechanical systems and plumbing fixtures. Quantify the extent of building reuse.

## MR Credit 2: Construction Waste Management

## 1–2 Points

### Intent

To divert construction and demolition debris from disposal in landfills and incineration facilities. Redirect recyclable recovered resources back to the manufacturing process and reusable materials to appropriate sites.

### Requirements

Recycle and/or salvage nonhazardous construction and demolition debris. Develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or comingled. Excavated soil and land-clearing debris do not contribute to this credit. Calculations can be done by weight or volume, but must be consistent throughout. The minimum percentage debris to be recycled or salvaged for each point threshold is as follows:

| Recycled or Salvaged | Points |
|---|---|
| 50% | 1 |
| 75% | 2 |

### Potential Technologies & Strategies

Establish goals for diversion from disposal in landfills and incineration facilities and adopt a construction waste management plan to achieve these goals. Consider recycling cardboard, metal, brick, mineral fiber panel, concrete, plastic, clean wood, glass, gypsum wallboard, carpet and insulation. Construction debris processed into a recycled content commodity that has an open market value (e.g., wood derived fuel [WDF], alternative daily cover material, etc.) may be applied to the construction waste calculation. Designate a specific area(s) on the construction site for segregated or comingled collection of recyclable materials, and track recycling efforts throughout the construction process. Identify construction haulers and recyclers to handle the designated materials. Note that diversion may include donation of materials to charitable organizations and salvage of materials on-site.

## MR Credit 3: Materials Reuse

## 1–2 Points

### Intent

To reuse building materials and products to reduce demand for virgin materials and reduce waste, thereby lessening impacts associated with the extraction and processing of virgin resources.

### Requirements

Use salvaged, refurbished or reused materials, the sum of which constitutes at least 5% or 10%, based on cost, of the total value of materials on the project. The minimum percentage materials reused for each point threshold is as follows:

| Reused Materials | Points |
|---|---|
| 5% | 1 |
| 10% | 2 |

Mechanical, electrical and plumbing components and specialty items such as elevators and equipment cannot be included in this calculation. Include only materials permanently installed in the project. Furniture may be included if it is included consistently in MR Credit 3: Materials Reuse through MR Credit 7: Certified Wood.

### Potential Technologies & Strategies

Identify opportunities to incorporate salvaged materials into the building design, and research potential material suppliers. Consider salvaged materials such as beams and posts, flooring, paneling, doors and frames, cabinetry and furniture, brick, and decorative items.

# MR Credit 4: Recycled Content

## 1–2 Points

### Intent

To increase demand for building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials.

### Requirements

Use materials with recycled content[1] such that the sum of postconsumer[2] recycled content plus 1/2 of the preconsumer[3] content constitutes at least 10% or 20%, based on cost, of the total value of the materials in the project. The minimum percentage materials recycled for each point threshold is as follows:

| Recycled Content | Points |
|---|---|
| 10% | 1 |
| 20% | 2 |

The recycled content value of a material assembly is determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.

Mechanical, electrical and plumbing components and specialty items such as elevators cannot be included in this calculation. Include only materials permanently installed in the project. Furniture may be included if it is included consistently in MR Credit 3: Materials Reuse through MR Credit 7: Certified Wood.

### Potential Technologies & Strategies

Establish a project goal for recycled content materials, and identify material suppliers that can achieve this goal. During construction, ensure that the specified recycled content materials are installed. Consider a range of environmental, economic and performance attributes when selecting products and materials.

1 Recycled content is defined in accordance with the International Organization of Standards document, ISO 14021 — Environmental labels and declarations — Self-declared environmental claims (Type II environmental labeling).

2 Postconsumer material is defined as waste material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose.

3 Preconsumer material is defined as material diverted from the waste stream during the manufacturing process. Reutilization of materials (i.e., rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it) is excluded.

## MR Credit 5: Regional Materials

## 1–2 Points

### Intent

To increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the use of indigenous resources and reducing the environmental impacts resulting from transportation.

### Requirements

Use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site for a minimum of 10% or 20%, based on cost, of the total materials value. If only a fraction of a product or material is extracted, harvested, or recovered and manufactured locally, then only that percentage (by weight) can contribute to the regional value. The minimum percentage regional materials for each point threshold is as follows:

| Regional Materials | Points |
|---|---|
| 10% | 1 |
| 20% | 2 |

Mechanical, electrical and plumbing components and specialty items such as elevators and equipment must not be included in this calculation. Include only materials permanently installed in the project. Furniture may be included if it is included consistently in MR Credit 3: Materials Reuse through MR Credit 7: Certified Wood.

### Potential Technologies & Strategies

Establish a project goal for locally sourced materials, and identify materials and material suppliers that can achieve this goal. During construction, ensure that the specified local materials are installed, and quantify the total percentage of local materials installed. Consider a range of environmental, economic and performance attributes when selecting products and materials.

## MR Credit 6: Rapidly Renewable Materials

## 1 Point

### Intent

To reduce the use and depletion of finite raw materials and long-cycle renewable materials by replacing them with rapidly renewable materials.

### Requirements

Use rapidly renewable building materials and products for 2.5% of the total value of all building materials and products used in the project, based on cost. Rapidly renewable building materials and products are made from plants that are typically harvested within a 10-year or shorter cycle.

### Potential Technologies & Strategies

Establish a project goal for rapidly renewable materials, and identify products and suppliers that can support achievement of this goal. Consider materials such as bamboo, wool, cotton insulation, agrifiber, linoleum, wheatboard, strawboard and cork. During construction, ensure that the specified renewable materials are installed.

## MR Credit 7: Certified Wood

## 1 Point

### Intent

To encourage environmentally responsible forest management.

### Requirements

Use a minimum of 50% (based on cost) of wood-based materials and products that are certified in accordance with the Forest Stewardship Council's principles and criteria, for wood building components. These components include at a minimum, structural framing and general dimensional framing, flooring, sub-flooring, wood doors and finishes.

Include only materials permanently installed in the project. Wood products purchased for temporary use on the project (e.g., formwork, bracing, scaffolding, sidewalk protection, and guard rails) may be included in the calculation at the project team's discretion. If any such materials are included, all such materials must be included in the calculation. If such materials are purchased for use on multiple projects, the applicant may include these materials for only one project, at its discretion. Furniture may be included if it is included consistently in MR Credits 3, Materials Reuse, through MR Credit 7, Certified Wood.

### Potential Technologies & Strategies

Establish a project goal for FSC-certified wood products and identify suppliers that can achieve this goal. During construction, ensure that the FSC-certified wood products are installed and quantify the total percentage of FSC-certified wood products installed.

## IEQ Prerequisite 1: Minimum Indoor Air Quality Performance

## Required

### Intent

To establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in buildings, thus contributing to the comfort and well-being of the occupants.

### Requirements

Meet the minimum requirements of Sections 4 through 7 of ASHRAE Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality (with errata but without addenda[1]).

AND

CASE 1. Mechanically Ventilated Spaces

Mechanical ventilation systems must be designed using the ventilation rate procedure or the applicable local code, whichever is more stringent.

CASE 2. Naturally Ventilated Spaces

Naturally ventilated buildings must comply with ASHRAE Standard 62.1-2007, Paragraph 5.1 (with errata but without addenda[1]).

### Potential Technologies & Strategies

Design ventilation systems to meet or exceed the minimum outdoor air ventilation rates as described in the ASHRAE standard. Balance the impacts of ventilation rates on energy use and indoor air quality to optimize for energy efficiency and occupant comfort. Use the ASHRAE Standard 62.1-2007 Users Manual (with errata but without addenda[1]) for detailed guidance on meeting the referenced requirements.

1 Project teams wishing to use ASHRAE approved addenda for the purposes of this prerequisite may do so at their discretion. Addenda must be applied consistently across all LEED credits.

## IEQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control

## Required

### Intent

To prevent or minimize exposure of building occupants, indoor surfaces and ventilation air distribution systems to environmental tobacco smoke (ETS).

### Requirements

OPTION 1

Prohibit smoking in the building.

Prohibit on-property smoking within 25 feet of entries, outdoor air intakes and operable windows. Provide signage to allow smoking in designated areas, prohibit smoking in designated areas or prohibit smoking on the entire property.

OR

OPTION 2

CASE 1. Non-Residential Projects

Prohibit smoking in the building except in designated smoking areas.

Prohibit on-property smoking within 25 feet of entries, outdoor air intakes and operable windows. Provide signage to allow smoking in designated areas, prohibit smoking in designated areas or prohibit smoking on the entire property.

Provide designated smoking rooms designed to contain, capture and remove ETS from the building. At a minimum, the smoking room must be directly exhausted to the outdoors, away from air intakes and building entry paths, with no recirculation of ETS-containing air to nonsmoking areas and enclosed with impermeable deck-to-deck partitions. Operate exhaust sufficient to create a negative pressure differential with the surrounding spaces of at least an average of 5 Pascals (Pa) (0.02 inches of water gauge) and a minimum of 1 Pa (0.004 inches of water gauge) when the doors to the smoking rooms are closed.

Verify performance of the smoking rooms' differential air pressures by conducting 15 minutes of measurement, with a minimum of 1 measurement every 10 seconds, of the differential pressure in the smoking room with respect to each adjacent area and in each adjacent vertical chase with the doors to the smoking room closed. Conduct the testing with each space configured for worst-case conditions of transport of air from the smoking rooms (with closed doors) to adjacent spaces.

CASE 2. Residential and Hospitality Projects

Prohibit smoking in all common areas of the building.

Locate any exterior designated smoking areas, including balconies where smoking is permitted, at least 25 feet from entries, outdoor air intakes and operable windows opening to common areas.

Prohibit on-property smoking within 25 feet of entries, outdoor air intakes and operable windows. Provide signage to allow smoking in designated areas, prohibit smoking in designated areas or prohibit smoking on the entire property.

Weather-strip all exterior doors and operable windows in the residential units to minimize leakage from outdoors.

Minimize uncontrolled pathways for ETS transfer between individual residential units by sealing penetrations in walls, ceilings and floors in the residential units and by sealing vertical chases adjacent to the units.

Weather-strip all doors in the residential units leading to common hallways to minimize air leakage into the hallway[1].

Demonstrate acceptable sealing of residential units by a blower door test conducted in accordance with ANSI/ASTM-E779-03, Standard Test Method for Determining Air Leakage Rate By Fan Pressurization.

Use the progressive sampling methodology defined in Chapter 4 (Compliance Through Quality Construction) of the Residential Manual for Compliance with California's 2001 Energy Efficiency Standards. Residential units must demonstrate less than 1.25 square inches leakage area per 100 square feet of enclosure area (i.e., sum of all wall, ceiling and floor areas).

## Potential Technologies & Strategies

Prohibit smoking in commercial buildings or effectively control the ventilation air in smoking rooms. For residential buildings, prohibit smoking in common areas and design building envelope and systems to minimize ETS transfer among dwelling units.

1 If the common hallways are pressurized with respect to the residential units then doors in the residential units leading to the common hallways need not be weather-stripped provided that the positive differential pressure is demonstrated as in Option 2, Case 1 above, considering the residential unit as the smoking room.

## IEQ Credit 1: Outdoor Air Delivery Monitoring

## 1 Point

### Intent

To provide capacity for ventilation system monitoring to help promote occupant comfort and well-being.

### Requirements

Install permanent monitoring systems to ensure that ventilation systems maintain design minimum requirements. Configure all monitoring equipment to generate an alarm when airflow values or carbon dioxide ($CO_2$) levels vary by 10% or more from the design values via either a building automation system alarm to the building operator or a visual or audible alert to the building occupants

AND

CASE 1. Mechanically Ventilated Spaces

Monitor $CO_2$ concentrations within all densely occupied spaces (those with a design occupant density of 25 people or more per 1,000 square feet). $CO_2$ monitors must be between 3 and 6 feet above the floor.

Provide a direct outdoor airflow measurement device capable of measuring the minimum outdoor air intake flow with an accuracy of plus or minus 15% of the design minimum outdoor air rate, as defined by ASHRAE 62.1-2007 (with errata but without addenda[1]) for mechanical ventilation systems where 20% or more of the design supply airflow serves nondensely occupied spaces.

CASE 2. Naturally Ventilated Spaces

Monitor $CO_2$ concentrations within all naturally ventilated spaces. $CO_2$ monitors must be between 3 and 6 feet above the floor. One $CO_2$ sensor may be used to monitor multiple nondensely occupied spaces if the natural ventilation design uses passive stack(s) or other means to induce airflow through those spaces equally and simultaneously without intervention by building occupants.

### Potential Technologies & Strategies

Install $CO_2$ and airflow measurement equipment and feed the information to the heating, ventilating and air conditioning (HVAC) system and/or building automation system (BAS) to trigger corrective action, if applicable. If such automatic controls are not feasible with the building systems, use the measurement equipment to trigger alarms that inform building operators or occupants of a possible deficiency in outdoor air delivery.

1 Project teams wishing to use addenda approved by ASHRAE for the purposes of this credit may do so at their discretion. Addenda must be applied consistently across all LEED credits.

# IEQ Credit 2: Increased Ventilation

## 1 Point

### Intent

To provide additional outdoor air ventilation to improve indoor air quality (IAQ) and promote occupant comfort, well-being and productivity.

### Requirements

CASE 1. Mechanically Ventilated Spaces

Increase breathing zone outdoor air ventilation rates to all occupied spaces by at least 30% above the minimum rates required by ASHRAE Standard 62.1-2007 (with errata but without addenda[1]) as determined by IEQ Prerequisite 1: Minimum Indoor Air Quality Performance.

CASE 2. Naturally Ventilated Spaces

Determine that natural ventilation is an effective strategy for the project by following the flow diagram process shown in Figure 2.8 of the CIBSE Applications Manual 10: 2005, Natural Ventilation in Non-domestic Buildings.

AND

OPTION 1

Show that the natural ventilation systems design meets the recommendations set forth in the CIBSE manuals appropriate to the project space.

PATH 1. CIBSE Applications Manual 10: 2005, Natural Ventilation in Non-domestic Buildings

PATH 2. CIBSE AM 13:2000, Mixed Mode Ventilation

OR

OPTION 2

Use a macroscopic, multizone, analytic model to predict that room-by-room airflows will effectively naturally ventilate, defined as providing the minimum ventilation rates required by ASHRAE 62.1-2007 Chapter 6 (with errata but without addenda[1]), for at least 90% of occupied spaces.

### Potential Technologies & Strategies

For mechanically ventilated spaces: Use heat recovery, where appropriate, to minimize the additional energy consumption associated with higher ventilation rates.

For naturally ventilated spaces, follow the 8 design steps described in the Carbon Trust Good Practice Guide 237:

- Develop design requirements.
- Plan airflow paths.

1 Project teams wishing to use ASHRAE approved addenda for the purposes of this credit may do so at their discretion. Addenda must be applied consistently across all LEED credits.

- Identify building uses and features that might require special attention.
- Determine ventilation requirements.
- Estimate external driving pressures.
- Select types of ventilation devices.
- Size ventilation devices.
- Analyze the design.

Use public domain software such as NIST's CONTAM, Multizone Modeling Software, along with LoopDA, Natural Ventilation Sizing Tool, to analytically predict room-by-room airflows.

## IEQ Credit 3.1: Construction Indoor Air Quality Management Plan—During Construction

## 1 Point

### Intent

To reduce indoor air quality (IAQ) problems resulting from construction or renovation and promote the comfort and well-being of construction workers and building occupants.

### Requirements

Develop and implement an IAQ management plan for the construction and preoccupancy phases of the building as follows:

- During construction, meet or exceed the recommended control measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines For Occupied Buildings Under Construction, 2nd Edition 2007, ANSI/SMACNA 008-2008 (Chapter 3).
- Protect stored on-site and installed absorptive materials from moisture damage.
- If permanently installed air handlers are used during construction, filtration media with a minimum efficiency reporting value (MERV) of 8 must be used at each return air grille, as determined by ASHRAE Standard 52.2-1999 (with errata but without addenda[1]). Replace all filtration media immediately prior to occupancy.

### Potential Technologies & Strategies

Adopt an IAQ management plan to protect the heating, ventilating and air conditioning (HVAC) system during construction, control pollutant sources and interrupt contamination pathways. Sequence the installation of materials to avoid contamination of absorptive materials, such as insulation, carpeting, ceiling tile and gypsum wallboard. Coordinate with IEQ Credit 3.2: Construction IAQ Management Plan — Before Occupancy and IEQ Credit 5: Indoor Chemical & Pollutant Source Control to determine the appropriate specifications and schedules for filtration media.

If possible, avoid using permanently installed air handlers for temporary heating/cooling during construction. Consult the LEED Reference Guide for Green Building Design and Construction, 2009 Edition for more detailed information on how to ensure the well-being of construction workers and building occupants if permanently installed air handlers must be used during construction.

1 Project teams wishing to use ASHRAE approved addenda for the purposes of this credit may do so at their discretion. Addenda must be applied consistently across all LEED credits.

## IEQ Credit 3.2: Construction Indoor Air Quality Management Plan—Before Occupancy

## 1 Point

### Intent

To reduce indoor air quality (IAQ) problems resulting from construction or renovation to promote the comfort and well-being of construction workers and building occupants.

### Requirements

Develop an IAQ management plan and implement it after all finishes have been installed and the building has been completely cleaned before occupancy.

OPTION 1. Flush-Out[1]

PATH 1

After construction ends, prior to occupancy and with all interior finishes installed, install new filtration media and , perform a building flush-out by supplying a total air volume of 14,000 cubic feet of outdoor air per square foot of floor area while maintaining an internal temperature of at least 60° F and relative humidity no higher than 60%.

OR

PATH 2

If occupancy is desired prior to completion of the flush-out, the space may be occupied following delivery of a minimum of 3,500 cubic feet of outdoor air per square foot of floor area. Once the space is occupied, it must be ventilated at a minimum rate of 0.30 cubic feet per minute (cfm) per square foot of outside air or the design minimum outside air rate determined in IEQ Prerequisite 1: Minimum Indoor Air Quality Performance, whichever is greater. During each day of the flush-out period, ventilation must begin a minimum of 3 hours prior to occupancy and continue during occupancy. These conditions must be maintained until a total of 14,000 cubic feet per square foot of outside air has been delivered to the space.

OR

OPTION 2. Air Testing

Conduct baseline IAQ testing after construction ends and prior to occupancy using testing protocols consistent with the EPA Compendium of Methods for the Determination of Air Pollutants in Indoor Air or the ISO method listed in the table below. Testing must be done in accordance with one standard; project teams may not mix requirements from the EPA Compendium of Methods with ISO.

1 All finishes must be installed prior to flush-out.

Demonstrate that the contaminant maximum concentration levels listed below are not exceeded:

| Contaminant | Maximum Concentration | EPA Compendium method | ISO method |
|---|---|---|---|
| Formaldehyde | 27 parts per billion | IP-6 | ISO 16000-3 |
| Particulates (PM10) | 50 micrograms per cubic meter | IP-10 | ISO 7708 |
| Total volatile organic compounds (TVOCs) | 500 micrograms per cubic meter | IP-1 | ISO 16000-6 |
| 4-Phenylcyclohexene (4-PCH) * | 6.5 micrograms per cubic meter | IP-1 | ISO 16000-6 |
| Carbon monoxide (CO) | 9 parts per million and no greater than 2 parts per million above outdoor levels | IP-3 | ISO 4224 |
| *This test is required only if carpets and fabrics with styrene butadiene rubber (SBR) latex backing are installed as part of the base building systems. | | | |

For each sampling point where the maximum concentration limits are exceeded, conduct an additional flush-out with outside air and retest the noncompliant concentrations. Repeat until all requirements are met. When retesting noncompliant building areas, take samples from the same locations as in the first test, although it is not required.

Conduct the air sample testing as follows:

- All measurements must be conducted prior to occupancy, but during normal occupied hours with the building ventilation system started at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the test.
- All interior finishes must be installed, including but not limited to millwork, doors, paint, carpet and acoustic tiles. Movable furnishings such as workstations and partitions should be in place for the testing, although it is not required.
- The number of sampling locations will depend on the size of the building and number of ventilation systems. The number of sampling locations must include the entire building and all representative situations. Include areas with the least ventilation and greatest presumed source strength.
- Air samples must be collected between 3 and 6 feet from the floor to represent the breathing zone of occupants, and over a minimum 4-hour period.

## Potential Technologies & Strategies

Prior to occupancy, perform a building flush-out or test the air contaminant levels in the building. The flush-out is often used where occupancy is not required immediately upon substantial completion of construction. IAQ testing can minimize schedule impacts but may be more costly. Coordinate with IEQ Credit 3.1: Construction IAQ Management Plan — During Construction and IEQ Credit 5: Indoor Chemical & Pollutant Source Control to determine the appropriate specifications and schedules for filtration media.

The intent of this credit is to eliminate IAQ problems that occur as a result of construction. Architectural finishes used in tenant build-outs constitute a significant source of air pollutants and must be addressed to qualify for this credit.

# IEQ Credit 4.1: Low-Emitting Materials—Adhesives and Sealants

## 1 Point

### Intent

To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

### Requirements

All adhesives and sealants used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) must comply with the following requirements as applicable to the project scope[1]:

- Adhesives, Sealants and Sealant Primers must comply with South Coast Air Quality Management District (SCAQMD) Rule #1168. Volatile organic compound (VOC) limits listed in the table below correspond to an effective date of July 1, 2005 and rule amendment date of January 7, 2005.

| Architectural Applications | VOC Limit (g/L less water) | Specialty Applications | VOC Limit (g/L less water) |
|---|---|---|---|
| Indoor carpet adhesives | 50 | PVC welding | 510 |
| Carpet pad adhesives | 50 | CPVC welding | 490 |
| Wood flooring adhesives | 100 | ABS welding | 325 |
| Rubber floor adhesives | 60 | Plastic cement welding | 250 |
| Subfloor adhesives | 50 | Adhesive primer for plastic | 550 |
| Ceramic tile adhesives | 65 | Contact adhesive | 80 |
| VCT and asphalt adhesives | 50 | Special purpose contact adhesive | 250 |
| Drywall and panel adhesives | 50 | Structural wood member adhesive | 140 |
| Cove base adhesives | 50 | Sheet applied rubber lining operations | 850 |
| Multipurpose construction adhesives | 70 | Top and trim adhesive | 250 |
| Structural glazing adhesives | 100 | | |
| **Substrate Specific Applications** | **VOC Limit (g/L less water)** | **Sealants** | **VOC Limit (g/L less water)** |
| Metal to metal | 30 | Architectural | 250 |
| Plastic foams | 50 | Roadway | 250 |
| Porous material (except wood) | 50 | Other | 420 |
| Wood | 30 | | |
| Fiberglass | 80 | | |
| **Sealant Primers** | **VOC Limit (g/L less water)** | | |
| Architectural, nonporous | 250 | | |
| Architectural, porous | 775 | | |
| Other | 750 | | |
| This table excludes adhesives and sealants integral to the water-proofing system or that are not building related. | | | |

1 The use of a VOC budget is permissible for compliance with this credit.

- Aerosol Adhesives must comply with Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.

| Aerosol Adhesives | VOC Limit |
|---|---|
| General purpose mist spray | 65% VOCs by weight |
| General purpose web spray | 55% VOCs by weight |
| Special purpose aerosol adhesives (all types) | 70% VOCs by weight |

## Potential Technologies & Strategies

Specify low-VOC materials in construction documents. Ensure that VOC limits are clearly stated in each section of the specifications where adhesives and sealants are addressed. Common products to evaluate include general construction adhesives, flooring adhesives, fire-stopping sealants, caulking, duct sealants, plumbing adhesives and cove base adhesives. Review product cut sheets, material safety data (MSD) sheets, signed attestations or other official literature from the manufacturer clearly identifying the VOC contents or compliance with referenced standards.

## IEQ Credit 4.2: Low-Emitting Materials—Paints and Coatings

## 1 Point

### Intent

To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

### Requirements

Paints and coatings used on the interior of the building (i.e., inside of the weatherproofing system and applied on-site) must comply with the following criteria as applicable to the project scope[1]:

- Architectural paints and coatings applied to interior walls and ceilings must not exceed the volatile organic compound (VOC) content limits established in Green Seal Standard GS-11, Paints, 1st Edition, May 20, 1993.
- Anti-corrosive and anti-rust paints applied to interior ferrous metal substrates must not exceed the VOC content limit of 250 g/L established in Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.
- Clear wood finishes, floor coatings, stains, primers, sealers, and shellacs applied to interior elements must not exceed the VOC content limits established in South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.

### Potential Technologies & Strategies

Specify low-VOC paints and coatings in construction documents. Ensure that VOC limits are clearly stated in each section of the specifications where paints and coatings are addressed. Track the VOC content of all interior paints and coatings during construction.

1 The use of a VOC budget is permissible for compliance with this credit.

## IEQ Credit 4.3: Low-Emitting Materials—Flooring Systems

## 1 Point

### Intent

To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

### Requirements

OPTION 1

All flooring must comply with the following as applicable to the project scope:

- All carpet installed in the building interior must meet the testing and product requirements of the Carpet and Rug Institute Green Label Plus[1] program.
- All carpet cushion installed in the building interior must meet the requirements of the Carpet and Rug Institute Green Label program.
- All carpet adhesive must meet the requirements of IEQ Credit 4.1: Adhesives and Sealants, which includes a volatile organic compound (VOC) limit of 50 g/L.
- All hard surface flooring must meet the requirements of the FloorScore[2] standard (current as of the date of this rating system, or more stringent version) as shown with testing by an independent third-party. Mineral-based finish flooring products such as tile, masonry, terrazzo, and cut stone without integral organic-based coatings and sealants and unfinished/untreated solid wood flooring qualify for credit without any IAQ testing requirements. However, associated site-applied adhesives, grouts, finishes and sealers must be compliant for a mineral-based or unfinished/untreated solid wood flooring system to qualify for credit.
- Concrete, wood, bamboo and cork floor finishes such as sealer, stain and finish must meet the requirements of South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural Coatings, rules in effect on January 1, 2004.
- Tile setting adhesives and grout must meet South Coast Air Quality Management District (SCAQMD) Rule 1168. VOC limits correspond to an effective date of July 1, 2005 and rule amendment date of January 7, 2005.

OR

OPTION 2

All flooring elements installed in the building interior must meet the testing and product requirements of the California Department of Health Services Standard Practice for the Testing of Volatile Organic Emissions

1 The Green Label Plus program for carpets and its associated VOC emission criteria in micrograms per square meter per hour, along with information on testing method and sample collection developed by the Carpet & Rug Institute (CRI) in coordination with California's Sustainable Building Task Force and the California Department of Public Health, are described in Section 9, Acceptable Emissions Testing for Carpet, DHS Standard Practice CA/DHS/EHLB/R-174, dated 07/15/04. This document is available at http://www.dhs.ca.gov/ps/deodc/ehlb/iaq/VOCS/Section01350_7_15_2004_FINAL_PLUS_ADDENDUM-2004-01.pdf (also published as Section 01350 Section 9 [dated 2004] by the Collaborative for High Performance Schools [http://www.chps.net]).

2 FloorScore is a voluntary, independent certification program that tests and certifies hard surface flooring and associated products for compliance with criteria adopted in California for indoor air emissions of VOCs with potential health effects. The program uses a small-scale chamber test protocol and incorporates VOC emissions criteria, which are widely known as Section 1350, developed by the California Department of Health Services.

from Various Sources Using Small-Scale Environmental Chambers, including 2004 Addenda. Mineral-based finish flooring products such as tile, masonry, terrazzo, and cut stone without integral organic-based coatings and sealants and unfinished/untreated solid wood flooring qualify for credit without any IAQ testing requirements. However, associated site-applied adhesives, grouts, finishes and sealers must be compliant for a mineral-based or unfinished/untreated solid wood flooring system to qualify for credit.

### Potential Technologies & Strategies

Clearly specify requirements for product testing and/or certification in the construction documents. Select products that are either certified under the Green Label Plus program or for which testing has been done by qualified independent laboratories in accordance with the appropriate requirements.

## IEQ Credit 4.4: Low-Emitting Materials—Composite Wood and Agrifiber Products

## 1 Point

### Intent

To reduce the quantity of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well-being of installers and occupants.

### Requirements

Composite wood and agrifiber products used on the interior of the building (i.e., inside the weatherproofing system) must contain no added urea-formaldehyde resins. Laminating adhesives used to fabricate on-site and shop-applied composite wood and agrifiber assemblies must not contain added urea-formaldehyde resins.

Composite wood and agrifiber products are defined as particleboard, medium density fiberboard (MDF), plywood, wheatboard, strawboard, panel substrates and door cores. Materials considered fixtures, furniture and equipment (FF&E) are not considered base building elements and are not included.

### Potential Technologies & Strategies

Specify wood and agrifiber products that contain no added urea-formaldehyde resins. Specify laminating adhesives for field and shop-applied assemblies that contain no added urea-formaldehyde resins. Review product cut sheets, material safety data (MSD) sheets, signed attestations or other official literature from the manufacturer.

## IEQ Credit 5: Indoor Chemical and Pollutant Source Control

## 1 Point

### Intent

To minimize building occupant exposure to potentially hazardous particulates and chemical pollutants.

### Requirements

Design to minimize and control the entry of pollutants into buildings and later cross-contamination of regularly occupied areas through the following strategies:

- Employ permanent entryway systems at least 10 feet long in the primary direction of travel to capture dirt and particulates entering the building at regularly used exterior entrances. Acceptable entryway systems include permanently installed grates, grill s and slotted systems that allow for cleaning underneath. Roll-out mats are acceptable only when maintained on a weekly basis by a contracted service organization.
- Sufficiently exhaust each space where hazardous gases or chemicals may be present or used (e.g., garages, housekeeping and laundry areas, copying and printing rooms) to create negative pressure with respect to adjacent spaces when the doors to the room are closed. For each of these spaces, provide self-closing doors and deck-to-deck partitions or a hard-lid ceiling. The exhaust rate must be at least 0.50 cubic feet per minute (cfm) per square foot with no air recirculation. The pressure differential with the surrounding spaces must be at least 5 Pascals (Pa) (0.02 inches of water gauge) on average and 1 Pa (0.004 inches of water) at a minimum when the doors to the rooms are closed.
- In mechanically ventilated buildings, each ventilation system that supplies outdoor air shall comply with the following:
  - Particle filters or air cleaning devices shall be provided to clean the outdoor air at any location prior to its introduction to occupied spaces.
  - These filters or devices shall be rated a minimum efficiency reporting value (MERV) of 13 or higher in accordance with ASHRAE Standard 52.2.
  - Clean air Filtration media shall be installed in all air systems after completion of construction and prior to occupancy.

### Potential Technologies & Strategies

Design facility cleaning and maintenance areas with isolated exhaust systems for contaminants. Maintain physical isolation from the rest of the regularly occupied areas of the building. Install permanent architectural entryway systems such as grills or grates to prevent occupant-borne contaminants from entering the building. Install high-level filtration systems in air handling units processing outside supply air. Ensure that air handling units can accommodate required filter sizes and pressure drops.

## IEQ Credit 6.1: Controllability of Systems—Lighting

## 1 Point

### Intent

To provide a high level of lighting system control by individual occupants or groups in multi-occupant spaces (e.g., classrooms and conference areas) and promote their productivity, comfort and well-being.

### Requirements

Provide individual lighting controls for 90% (minimum) of the building occupants to enable adjustments to suit individual task needs and preferences

Provide lighting system controls for all shared multi-occupant spaces to enable adjustments that meet group needs and preferences.

### Potential Technologies & Strategies

Design the building with occupant controls for lighting. Strategies to consider include lighting controls and task lighting. Integrate lighting systems controllability into the overall lighting design, providing ambient and task lighting while managing the overall energy use of the building.

## IEQ Credit 6.2: Controllability of Systems—Thermal Comfort

## 1 Point

### Intent

To provide a high level of thermal comfort system control[1] by individual occupants or groups in multi-occupant spaces (e.g., classrooms or conference areas) and promote their productivity, comfort and well-being.

### Requirements

Provide individual comfort controls for 50% (minimum) of the building occupants to enable adjustments to meet individual needs and preferences. Operable windows may be used in lieu of controls for occupants located 20 feet inside and 10 feet to either side of the operable part of a window. The areas of operable window must meet the requirements of ASHRAE Standard 62.1-2007 paragraph 5.1 Natural Ventilation (with errata but without addenda[2]).

Provide comfort system controls for all shared multi-occupant spaces to enable adjustments that meet group needs and preferences.

Conditions for thermal comfort are described in ASHRAE Standard 55-2004 (with errata but without addenda[2]) and include the primary factors of air temperature, radiant temperature, air speed and humidity.

### Potential Technologies & Strategies

Design the building and systems with comfort controls to allow adjustments to suit individual needs or those of groups in shared spaces. ASHRAE Standard 55-2004 (with errata but without addenda[2]) identifies the factors of thermal comfort and a process for developing comfort criteria for building spaces that suit the needs of the occupants involved in their daily activities. Control strategies can be developed to expand on the comfort criteria and enable individuals to make adjustments to suit their needs and preferences. These strategies may involve system designs incorporating operable windows, hybrid systems integrating operable windows and mechanical systems, or mechanical systems alone. Individual adjustments may involve individual thermostat controls, local diffusers at floor, desk or overhead levels, control of individual radiant panels or other means integrated into the overall building, thermal comfort systems and energy systems design. Designers should evaluate the closely tied interactions between thermal comfort as required by ASHRAE Standard 55-2004 (with errata but without addenda[2]) and acceptable indoor air quality as required by ASHRAE Standard 62.1-2007 (with errata but without addenda[2]), whether natural or mechanical ventilation.

1 For the purposes of this credit, comfort system control is defined as control over at least 1 of the following primary factors in the occupant's vicinity: air temperature, radiant temperature, air speed and humidity.

2 Project teams wishing to use ASHRAE approved addenda for the purposes of this credit may do so at their discretion. Addenda must be applied consistently across all LEED credits.

## IEQ Credit 7.1: Thermal Comfort—Design

## 1 Point

### Intent

To provide a comfortable thermal environment that promotes occupant productivity and well-being.

### Requirements

Design heating, ventilating and air conditioning (HVAC) systems and the building envelope to meet the requirements of ASHRAE Standard 55-2004, Thermal Comfort Conditions for Human Occupancy (with errata but without addenda[1]). Demonstrate design compliance in accordance with the Section 6.1.1 documentation.

### Potential Technologies & Strategies

Establish comfort criteria according to ASHRAE 55-2004 (with errata but without addenda) that support the desired quality and occupant satisfaction with building performance. Design the building envelope and systems with the capability to meet the comfort criteria under expected environmental and use conditions. Evaluate air temperature, radiant temperature, air speed and relative humidity in an integrated fashion, and coordinate these criteria with IEQ Prerequisite 1: Minimum IAQ Performance, IEQ Credit 1: Outdoor Air Delivery Monitoring, and IEQ Credit 2: Increased Ventilation.

1 Project teams wishing to use ASHRAE approved addenda for the purposes of this credit may do so at their discretion. Addenda must be applied consistently across all LEED credits.

## IEQ Credit 7.2: Thermal Comfort—Verification

### 1 point in addition to IEQ credit 7.1

#### Intent

To provide for the assessment of building occupant thermal comfort over time.

#### Requirements

Achieve IEQ Credit 7.1: Thermal Comfort—Design

Provide a permanent monitoring system to ensure that building performance meets the desired comfort criteria as determined by IEQ Credit 7.1: Thermal Comfort—Design.

Agree to conduct a thermal comfort survey of building occupants within 6 to 18 months after occupancy. This survey should collect anonymous responses about thermal comfort in the building, including an assessment of overall satisfaction with thermal performance and identification of thermal comfort-related problems. Agree to develop a plan for corrective action if the survey results indicate that more than 20% of occupants are dissatisfied with thermal comfort in the building. This plan should include measurement of relevant environmental variables in problem areas in accordance with ASHRAE Standard 55-2004 (with errata but without addenda[1]).

Residential projects are not eligible for this credit.

#### Potential Technologies & Strategies

ASHRAE 55-2004 provides guidance for establishing thermal comfort criteria and documenting and validating building performance to the criteria. While the standard is not intended for purposes of continuous monitoring and maintenance of the thermal environment, the principles expressed in the standard provide a basis for the design of monitoring and corrective action systems.

1 Project teams wishing to use ASHRAE approved addenda for the purposes of this credit may do so at their discretion. Addenda must be applied consistently across all LEED credits.

# IEQ Credit 8.1: Daylight and Views—Daylight

## 1 Point

### Intent

To provide for the building occupants with a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

### Requirements

Through 1 of the 4 options, achieve daylighting in at least the following spaces[1]:

| Regularly Occupied Spaces | Points |
|---|---|
| 75% | 1 |

OPTION 1. Simulation

Demonstrate through computer simulations that the applicable spaces achieve daylight illuminance levels of a minimum of 10 footcandles (fc) and a maximum of 500 fc in a clear sky condition on September 21 at 9 a.m. and 3 p.m.

Provide glare control devices to avoid high-contrast situations that could impede visual tasks. However, designs that incorporate view-preserving automated shades for glare control may demonstrate compliance for only the minimum 10 fc illuminance level.

OR

OPTION 2. Prescriptive

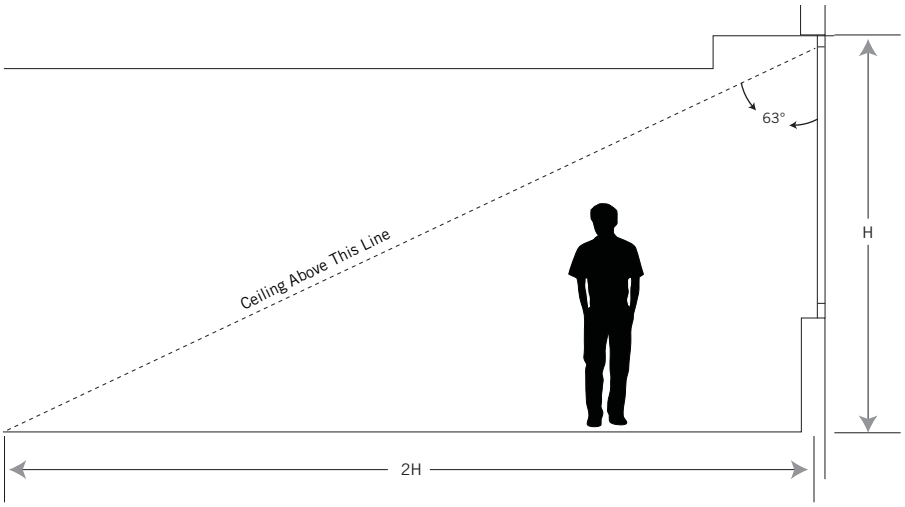
For side-lighting zones:

- Achieve a value, calculated as the product of the visible light transmittance (VLT) and window-to-floor area ratio (WFR) between 0.150 and 0.180.

$$0.150 < VLT \times WFR < 0.180$$

- The window area included in the calculation must be at least 30 inches above the floor.
- In section, the ceiling must not obstruct a line that extends from the window-head to a point on the floor that is located twice the height of the window-head from the exterior wall as measured perpendicular to the glass (see diagram on next page).

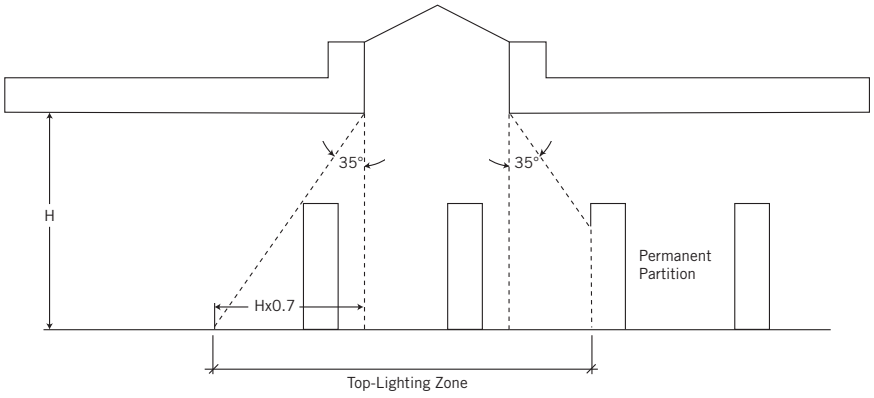
1 Exceptions for areas where tasks would be hindered by the use of daylight will be considered on their merits.




- Provide glare control devices to avoid high-contrast situations that could impede visual tasks. However, designs that incorporate view-preserving automated shades for glare control may demonstrate compliance for only the minimum 0.150 value.

For top-lighting zones:

- The top-lighting zone under a skylight is the outline of the opening beneath the skylight, plus in each direction the lesser of (see diagram below):
  - 70% of the ceiling height,
  - 1/2 the distance to the edge of the nearest skylight,
  - The distance to any permanent partition that is closer than 70% of the distance between the top of the partition and the ceiling.



- Achieve skylight coverage for the applicable space (containing the top-lighting zone) between 3% and 6% of the total floor area.
- The skylight must have a minimum 0.5 VLT.
- A skylight diffuser, if used, must have a measured haze value of greater than 90% when tested according to ASTM D1003.

OR

OPTION 3. Measurement

Demonstrate through records of indoor light measurements that a minimum daylight illumination level of 10 fc and a maximum of 500 fc has been achieved in the applicable spaces. Measurements must be taken on a 10-foot grid and shall be recorded on building floor plans.

Provide glare control devices to avoid high-contrast situations that could impede visual tasks. However, designs that incorporate view-preserving automated shades for glare control may demonstrate compliance for only the minimum 10 fc illuminance level.

OR

OPTION 4. Combination

Any of the above calculation methods may be combined to document the minimum daylight illumination in the applicable spaces.

### Potential Technologies & Strategies

Design the building to maximize interior daylighting. Strategies to consider include building orientation, shallow floor plates, increased building perimeter, exterior and interior permanent shading devices, high-performance glazing, and high-ceiling reflectance values; ly, additionally, automatic photocell-based controls can help to reduce energy use. Predict daylight factors via manual calculations or model daylighting strategies with a physical or computer model to assess footcandle levels and daylight factors achieved.

## IEQ Credit 8.2: Daylight and Views—Views

## 1 Point

### Intent

To provide building occupants a connection to the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

### Requirements

Achieve a direct line of sight to the outdoor environment via vision glazing between 30 inches and 90 inches above the finish floor for building occupants in 90% of all regularly occupied areas. Determine the area with a direct line of sight by totaling the regularly occupied square footage that meets the following criteria:

- In plan view, the area is within sight lines drawn from perimeter vision glazing.
- In section view, a direct sight line can be drawn from the area to perimeter vision glazing.

The line of sight may be drawn through interior glazing. For private offices, the entire square footage of the office may be counted if 75% or more of the area has a direct line of sight to perimeter vision glazing. For multi-occupant spaces, the actual square footage with a direct line of sight to perimeter vision glazing is counted.

### Potential Technologies & Strategies

Design the space to maximize daylighting and view opportunities. Strategies to consider include lower partitions, interior shading devices, interior glazing and automatic photocell-based controls.

## ID Credit 1: Innovation in Design

### 1–5 Points

#### Intent

To provide design teams and projects the opportunity to achieve exceptional performance above the requirements set by the LEED Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED Green Building Rating System.

#### Requirements

Credit can be achieved through any combination of the Innovation in Design and Exemplary Performance paths as described below:

PATH 1. Innovation in Design (1-5 points)

Achieve significant, measurable environmental performance using a strategy not addressed in the LEED 2009 for New Construction and Major Renovations Rating System.

One point is awarded for each innovation achieved. No more than 5 points under IDc1 may be earned through PATH 1—Innovation in Design.

Identify the following in writing:

- The intent of the proposed innovation credit.
- The proposed requirement for compliance.
- The proposed submittals to demonstrate compliance.
- The design approach (strategies) used to meet the requirements.

PATH 2. Exemplary Performance (1-3 points)

Achieve exemplary performance in an existing LEED 2009 for New Construction and Major Renovations prerequisite or credit that allows exemplary performance as specified in the LEED Reference Guide for Green Building Design & Construction, 2009 Edition. An exemplary performance point may be earned for achieving double the credit requirements and/or achieving the next incremental percentage threshold of an existing credit in LEED.

One point is awarded for each exemplary performance achieved. No more than 3 points under IDc1 may be earned through PATH 2— Exemplary Performance.

PATH 3. Pilot Credit (1-5 points)

Attempt a pilot credit available in the Pilot Credit Library at www.usgbc.org/pilotcreditlibrary. Register as a pilot credit participant and complete the required documentation. Projects may pursue up to 5 Pilot Credits total.

#### Potential Technologies & Strategies

Substantially exceed a LEED 2009 for New Construction and Major Renovations performance credit such as energy performance or water efficiency. Apply strategies or measures that demonstrate a comprehensive approach and quantifiable environment and/or health benefits.

## ID Credit 2: LEED Accredited Professional

## 1 Point

### Intent

To support and encourage the design integration required by LEED to streamline the application and certification process.

### Requirements

At least 1 principal participant of the project team shall be a LEED Accredited Professional (AP).

### Potential Technologies & Strategies

Educate the project team members about green building design and construction, the LEED requirements and application process early in the life of the project. Consider assigning integrated design and construction process facilitation to the LEED AP.

# REGIONAL PRIORITY

## RP Credit 1: Regional Priority

### 1–4 Points

#### Intent
To provide an incentive for the achievement of credits that address geographically-specific environmental priorities.

#### Requirements
Earn 1-4 of the 6 Regional Priority credits identified by the USGBC regional councils and chapters as having environmental importance for a project's region. A database of Regional Priority credits and their geographic applicability is available on the USGBC website, http://www.usgbc.org.

One point is awarded for each Regional Priority credit achieved; no more than 4 credits identified as Regional Priority credits may be earned. The USGBC has prioritized credits for projects located in the U.S., Puerto Rico, the U.S. Virgin Islands, and Guam. All other international projects should check the database for eligible Regional Priority credits.

#### Potential Technologies & Strategies
Determine and pursue the prioritized credits for the project location.

Attachment C-
NY Fact Sheet and Brigham Young and MU reports

STATE OF NEW YORK
DEPARTMENT OF HEALTH
Flanigan Square 547 River Street Troy, New York 12180-2216

Richard F. Daines, M.D.
*Commissioner*

Wendy E. Saunders
*Chief of Staff*

# FACT SHEET
# Crumb-Rubber Infilled Synthetic Turf Athletic Fields
***August 2008***

## PURPOSE
There are several kinds of synthetic turf surfaces (*e.g.*, surfaces that use a fill material ("infill") between the blades of artificial grass and those that do not), and synthetic turf may be installed for different uses (*e.g.*, single or multiple sport athletic fields, landscaping, golf applications). The focus of this fact sheet is athletic fields with crumb rubber infilled synthetic turf. This fact sheet was developed to assist people in making decisions about installing or using this kind of synthetic turf athletic field. Considerations related to other kinds of synthetic turf fields are not addressed in this fact sheet.

## BACKGROUND
The first well-publicized use of AstroTurf, a synthetic turf for athletic fields, was at the Houston Astrodome in 1966. This first generation of synthetic turf was essentially a short pile carpet with a foam backing. Since then, design changes have resulted in a greater variety of synthetic turf athletic fields. One type of synthetic turf is fabricated using synthetic fibers, manufactured to resemble natural grass, and a base material that stabilizes and cushions the playing surface. The fibers are typically made from nylon, polypropylene or polyethylene and are connected to a backing material. The base material, also called infill, consists of one or more granular materials that are worked in between the fibers during the installation process. Commonly used base materials are granulated crumb rubber (usually from used tires), flexible plastic pellets, sand, and rubber-coated sand. A combination of sand and crumb rubber is often used.

Crumb rubber is produced by grinding used tires. Steel and fiber tire components are removed during the process and the rubber pellets are sorted by size. Pellet sizes ranging from about one-sixteenth to one-quarter inch in diameter are used on synthetic turf. Crumb rubber is typically applied at a rate of two to three pounds per square foot of field surface.

## HEALTH AND SAFETY CONSIDERATIONS
Some potential health and safety considerations related to synthetic turf have generated public concern. These include:

- Heat stress
- Injury
- Infection
- Latex allergy
- Chemical exposure

**Heat Stress**

Synthetic turf fields absorb heat, resulting in surface temperatures that are much higher than the temperatures of the surrounding air. In June 2002 at Brigham Young University (BYU) in Utah, the average surface temperature on a synthetic turf field was reported to be 117°F while the average surface temperatures on natural turf and asphalt were 78°F and 110°F, respectively. A maximum surface temperature of 200°F on the BYU synthetic turf field was reported. A turfgrass specialist at the University of Missouri reported measuring an air temperature of 138°F at "head-level" height on the university's synthetic turf field on a sunny 98°F day. The surface temperature of the field was reported to be 178°F. A study conducted at Penn State University measured surface temperatures on experimental plots of nine different types of infilled turf. Temperature measurements were made on three occasions. The average air temperatures reported were 79°, 78°, and 85°F. The corresponding average surface temperatures reported for the synthetic turf plots are 120°, 130° and 146°F.

Water can be applied to synthetic turf to reduce the surface temperatures on warm days. A study at BYU found that watering synthetic turf lowered the surface temperature from 174°F to 85°F, but the temperature rose to 120°F in five minutes and to 164°F in twenty minutes. A study conducted by Penn State University on experimental synthetic turf plots examined the effect of watering synthetic turf on surface temperature. Measurements were made on three occasions. For one monitoring period, surface temperatures ranging from about 130° to 160°F were lowered initially to about 75°F, but increased within 30 minutes to temperatures ranging from about 90° to 120°F, where they remained fairly stable for the three-hour monitoring period.

The surface temperatures reported on synthetic turf fields can get high enough to reach levels of discomfort and may contribute to heat stress among users of the fields. While watering synthetic turf may reduce surface temperatures, other factors are likely to influence its effectiveness. At the present time, NYSDOH is unaware of any studies that have examined the role of synthetic turf in contributing to heat stress or that have compared the occurrence of heat stress among athletes playing on natural turf and synthetic turf.

Because of the potential for high temperatures on infilled synthetic turf fields, it is important that people who play or work on the fields be provided with adequate warnings regarding the potential for heat stress. People should also be advised to remain hydrated and to seek relief from the heat in shaded areas. The potential for and frequency of high surface temperatures warrant consideration when making decisions about installing and using a synthetic turf field.

**Injury**

There is a common perception that there are more sports injuries on synthetic than on natural turf athletic fields. Many factors influence the rate of sports injuries, including the type of playing surface. The many kinds of synthetic turf surfaces and changes in the turf products over the years complicate the assessment of how the playing surface affects injury rates. Other risk factors have been implicated in injury rates among athletes, in addition to the type of playing surface. These risk factors include level of competition, skill level, age, shoe type, previous injury and rehabilitation, and a number of individual physical characteristics. We identified five studies that compared injury (*e.g.*, sprains, lacerations, fractures) rates among athletes when playing on infilled synthetic turf and natural turf fields. Although the ability of the studies to detect differences in the injury rates was limited by the small number of injuries reported, the

studies concluded that there were no major differences in overall injury rates between natural and infilled synthetic turf. Although each study found some differences in specific injury types, there was no consistent pattern across the studies.

The potential for head injuries from contact with the surfaces has been assessed by determining the ability of the surfaces to absorb impacts. Tests have shown that the force of impact on asphalt surfaces is much higher than the level generally accepted to be associated with serious head injury. The force of impact on many types of natural turf and all types of synthetic turf tested are below this level. The force of impact on frozen natural turf is typically above the acceptable level. No data are available for the force of impact on frozen synthetic turf.

The abrasiveness of synthetic turf fibers may contribute to the injury risk among athletes, particularly for abrasions or "turf burns." The degree of abrasiveness appears to be dependent on the composition and shape of the turf fibers. A study conducted at Penn State University suggests that synthetic turf with nylon fibers is more abrasive than synthetic turf with other types of fibers.

**Infection Risk**

Some people have expressed concern that infections, including methicillin-resistant *Staphylococcus aureus* (MRSA), may be more common among users of synthetic turf fields than users of natural turf fields. This possibility has not been studied systematically, and no definitive statements can be made about differences in risk between the two surfaces.

At least two questions are important in evaluating the risk of infection. Does skin damage occur more frequently on synthetic turf than natural turf, thus providing a place where infections are more likely to occur? Are there more germs on synthetic turf than natural turf?

While injury studies have not consistently identified differences in abrasion and laceration risks between natural and infilled synthetic turf, some types of synthetic turf may result in more skin abrasions. Although very few tests have been performed, the available data do not suggest the widespread presence of infectious agents, such as MRSA, on synthetic turf fields. Also, the available information indicates that outdoor or indoor synthetic turf surfaces are no more likely to harbor infectious agents than other surfaces in those same environments. Disease outbreak investigations conducted in response to illnesses caused by a variety of germs (*e.g.*, MRSA, *Campylobacter*, meningococcus, echovirus, herpes simplex virus, hepatitis virus, coxsackie virus) have not identified playing fields, either natural or synthetic, as likely to increase the risk of transmitting infections.

Skin cuts and abrasions that may result from contact with athletic fields, including both natural and synthetic fields, are susceptible to infection. Athletes and others developing skin abrasions should clean the wounds and seek prompt medical attention. Athletes should avoid sharing towels (on and off the field), equipment, razors, soap and other objects with others, because sharing these items can spread germs.

**Latex Allergy**

Latex, a substance found in natural rubber, contains substances called "latex allergens," which can cause an allergic response in some people. About 6 percent of the general population is allergic to the substances in latex. Tire rubber contains the latex allergen, although at much lower levels than in latex

gloves and other consumer products. People playing on synthetic turf may be exposed to latex allergens through direct contact with the skin (dermal exposure) and inhalation of small rubber particles suspended in the air.

A study conducted for the California Environmental Protection Agency tested samples of tire rubber on the skin of guinea pigs. None of the animals developed any rashes or allergic reactions from contact with the rubber.

Whether crumb rubber can cause an allergic response in people is not known. NYSDOH is unaware of any occurrences of latex allergy associated with contact with crumb rubber or synthetic turf fields.

**Chemical Exposure**

Exposure to a chemical requires contact with it. Contact with a chemical occurs in three ways: swallowing it (ingestion exposure), breathing it (inhalation exposure), and having it come in contact with the skin (dermal exposure) or eyes (ocular exposure). The potential for harmful effects from exposure to a chemical depends on the amount of the chemical a person contacts, how the chemical enters the body (ingestion, inhalation, dermal, or ocular), how often contact occurs, and the toxic properties of the chemical. The ability of a chemical to be released from a substance (*e.g.*, crumb rubber) is an important factor in determining how much exposure actually occurs. Other factors that can influence a person's risk for adverse health effects from environmental chemicals include age, gender, general health, genetic differences, exposure to other chemicals and lifestyle choices.

Tires are manufactured from natural and synthetic rubbers along with numerous chemical additives, including zinc, sulfur, carbon black, and oils that contain polyaromatic hydrocarbons (PAHs) and volatile organic chemicals. Because crumb rubber is manufactured from used tires, it probably contains the same chemicals as tire rubber.

Studies have been conducted by the California Environmental Protection Agency Office of Environmental Health Hazard Assessment and the Norwegian Institute of Public Health to assess the potential for ingestion exposure to the chemicals in crumb rubber by children playing on synthetic turf. Both studies concluded that health risks to children resulting from the ingestion of crumb rubber are low.

The Norwegian Institute of Public Health also collected data to assess potential health risks resulting from dermal and inhalation exposures to chemicals contained in synthetic turf fields. Health assessments were conducted for adults and children. The researchers concluded that adverse health effects resulting dermal exposures to crumb rubber or from inhalation exposures to organic chemicals released from the fields are unlikely. No health assessment of the concentrations of rubber particles in the air was made.

A French study measured the concentrations of organic chemicals emitted as gases (known as volatile organic compounds or VOCs) from crumb rubber under laboratory conditions. The data were used by the French National Institute for Industrial Environment and Risks to evaluate possible health effects from inhaling VOCs released from synthetic turf. The study authors concluded that the concentrations of organic compounds emitted did not pose a health concern for athletes, officials or spectators.

Some types of synthetic turf fibers contain elevated levels of lead (*e.g.*, in the range of about 2,000 to 9,000 parts per million). Degradation of these fibers can form a dust that presents a potential source of

lead exposure to users of the fields. The Centers for Disease Control and Prevention and the Agency for Toxic Substances and Disease Registry addressed the potential for lead exposures from synthetic turf fibers in a June 2008 Health Advisory (http://www.cdc.gov/nceh/lead/artificialturf.htm). For new or replacement installations, select synthetic turf products that do not have elevated lead levels.

Our review of the available information on crumb rubber and crumb rubber infilled turf fields indicates that ingestion, dermal or inhalation exposures to chemicals in or released from crumb rubber do not pose a significant public health concern.

**OTHER CONSIDERATIONS**

A number of other factors may need to be considered when installing and using synthetic turf.

**Use:** Synthetic turf is more durable than natural turf and can be used without the rest periods that natural turf requires to keep the turf healthy. The New York City Department of Parks and Recreation (NYCDPR) estimates that on an annual basis, permitted use (hours per year) for synthetic turf athletic fields is 28 percent higher than for natural grass fields.

**Installation:** Installation costs of synthetic turf vary depending on the amount of site preparation required and the specific field design. The installation costs of synthetic turf are generally much higher than the installation costs of natural turf.

**Maintenance:** The maintenance costs of synthetic turf will vary depending on the field's use and design, but are typically estimated to be lower than the maintenance costs of natural turf. Natural turf requires regular mowing, fertilizer application, pest control and possibly watering. Synthetic turf requires replacing infill materials, repairing seams and removing weeds and moss. Specialized equipment, which may or may not be included in the field's purchase price, is required for these activities.

**Lifetime:** NYCDPR estimates that the lifetime of a natural turf field is on the order of five years. The synthetic turf industry estimates that the lifetime of an infilled synthetic turf athletic field is eight to ten years, depending on care during installation and use. NYCDPR and other New York entities have seen similar lifetimes.

**SUMMARY OF INFORMATION FOR CRUMB-RUBBER INFILLED SYNTHETIC TURF ATHLETIC FIELDS**

| | |
|---|---|
| Heat stress | Surface temperatures on crumb-rubber infilled synthetic turf fields can reach levels of discomfort and may contribute to heat stress. This warrants consideration when making decisions about installing and using a synthetic turf field. While watering synthetic turf may briefly reduce surface temperatures, a number of factors may influence its effectiveness. People using these fields should be advised to remain hydrated and to seek relief from the heat in shaded areas. |
| Injury | Overall, studies have found no consistent differences in injury rates between natural and crumb-rubber infilled synthetic turf. |
| Infection | Skin cuts and abrasions that may result from contact with athletic fields (natural and synthetic turf) are susceptible to infection. Athletes and others developing skin abrasions should clean the wounds and seek prompt medical attention. Athletes should avoid sharing equipment, razors, towels, soap and other objects with others, because these items can spread germs. |
| Latex allergy | At the present time, NYSDOH is unaware of any occurrences of latex allergy resulting from contact with crumb rubber or synthetic turf fields. |
| Chemical exposures | Based on the available information, chemical exposures from crumb rubber in synthetic turf do not pose a public health hazard. |

## WHERE CAN I GET MORE INFORMATION?

If you have any questions about the information in this fact sheet or would like to know more about in-filled synthetic turf athletic fields, please call the NYSDOH at 1-800-458-1158 or write to the following address:

New York State Department of Health
Bureau of Toxic Substance Assessment
Flanigan Square, 547 River St.
Troy, NY 12180-2216

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Brigham Young University Study

**"Synthetic Surface Heat Studies"**

***C. Frank Williams and Gilbert E. Pulley***
***Brigham Young University***

Synthetic turf surfaces have long been regarded as a lower maintenance alternative to natural turf. However, synthetic surfaces like natural turf have their shortcomings. In the spring of 2002 a Field Turf synthetic surface was installed on one half of Brigham Young University's Football Practice Field. The other half of the installation is a sand-based natural turf field. Shortly after the Field Turf was installed football camps were started. The coaches noticed the surface of the synthetic turf was very hot. One of the coaches got blisters on the bottom of his feet through his tennis shoes. An investigation was launched to determine the range of the temperatures, the effect water for cooling of the surfaces, and how the temperatures compared to other surfaces.

On June of 2002 preliminary temperatures were taken at five feet and six inches above the surface and at the surface with an infrared thermometer of the synthetic turf, natural turf, bare soil, asphalt and concrete. A soil thermometer was used to measure the temperature at two inches below the surface of the synthetic turf. Also, water was used to cool the surface of the natural and artificial turf. It was determined that the natural turf did not heat up very quickly after the irrigation so only the artificial turf was tracked at five and twenty minutes after wetting. The results of the preliminary study are shocking. The surface temperature of the synthetic turf was 37º F higher than asphalt and 86.5º F hotter than natural turf. Two inches below the synthetic turf surface was 28.5º F hotter than natural turf at the surface. Irrigation of the synthetic turf had a significant result cooling the surface from 174º F to 85º F but after five minutes the temperature rebounded to 120º F. The temperature rebuilt to 164º F after only twenty minutes. These preliminary findings led to a more comprehensive look at the factors involved in heating of the artificial turf.

Three aspects of light were measured along with relative humidity. The synthetic surface was treated as two areas, the soccer field and the football field and the natural turf was one area. Four randomly selected sampling spots were marked with a measuring tape from reference points on the fields so it could be accessed for subsequent data collection. Bare soil, concrete, and asphalt sampling areas were selected and marked in a similar manner. The results are shown in table form below:

Table 1.

| **Surface** | **Average Surface Temperature between 7:00 AM and 7:00 PM** | |
|---|---|---|
| Soccer | 117.38º F | high 157º F |
| Football | 117.04º F | high 156º F |
| Natural Turf | 78.19º F | high 88.5º F |
| Concrete | 94.08º F | |
| Asphalt | 109.62º F | |
| Bare Soil | 98.23º F | |

Table 2.

| **Two inch depth** | **Average Soil Temperature between 7:00 AM and 7:00 PM** | |
|---|---|---|
| Soccer | 95.33º F | high 116º F |
| Football | 96.48º F | high 116.75º F |
| Natural Turf | 80.42º F | high 90.75º F |
| Bare Soil | 90.08º F | |

Table 3.

| **Shade** | **Average Temperature between 9:00 AM and 2:00 PM** | |
|---|---|---|
| Surface Temperature of Natural Turf | 66.35º F | high 75º F |
| Surface Temperature of Artificial Turf | 75.89º F | high 99º F |
| Average Air Temperature | 81.42º F | |

Surface Temperature of A.T. (Artificial Turf) is significantly higher than air or soil temperature of A.T. The amount of light (electromagnetic radiation) has a greater impact on temperature of A.T. than air temperature. The hottest surface temperature recorded was 200º F on a 98º F day. Even in October the surface temperature reached 112.4º F. This is 32.4º F higher than the air temperature. White lines and shaded areas are less affected because of reflection and intensity of light. Natural grass areas have the lowest surface and subsurface temperatures than other surfaces measured. Cooling with water could be a good strategy but the volume of water needed to dissipate the heat is greatly lessened by poor engineering (infiltration and percolation).

Average air temperature over natural turf in the late afternoon is lower than other surfaces. Soil temperature of A.T. is greater than bare soil and natural turf. Humidity appears to be inversely related to surface and soil temperature. It is likely that energy is absorbed from the sunlight by the water vapor.

The heating characteristics of the A.T. make cooling during events a priority. The Safety Office at B.Y.U. set 120º F as the maximum temperature that the surface could reach. When temperature reaches 122º F it takes less than 10 minutes to cause injury to skin. At this temperature the surface had to be cooled before play was allowed to continue on the surface. The surface is monitored constantly and watered when temperatures reach the maximum. The heat control adds many maintenance dollars to the maintenance budget.

A budget comparison was made using actual dollars spent and for every dollar spent on the A.T. maintenance one dollar and thirty cents was spent on the natural turf (N.T.) practice field. While construction costs are very unbalanced, for every dollar spent on the N.T. eleven dollars and seventy-seven dollars were spent on the A.T.

The area under the carpet of BYU's installation is designed to move water from the surface and into an extensive drain mat system. This part of the installation is two thirds of the overall cost of the A.T. Thus, for a 2.5 million dollars installation approximately 1.7 million dollars go for the subsurface and drainage. The most interesting thing about this is that the drain mat probably sees little or nº water. The surface is hydrophobic and the undersurface is poorly engineered to favor water retention rather than drainage. That seems like a high price to pay for something that does not work!

Artificial turf surfaces have their place in the turf industry. They can work in environments where grass will not grow and are marginal. However, they are costly and not maintenance free. It is important to take all the factors in to consideration before making a large investment. Don't take the manufacture's word for the factors of concern i.e. don't let the fox guard the hen house. The propaganda on BYU's installation is charts with surface temperatures less than the air temperature and claims for drainage of 60 inches per hour. The question still remains is A.T. 11.47 times better than natural turf?

University of Missouri Report

Revised: July 21 2006
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Published by **CAFNR Communications**
Feature Research

# Synthetic Turf Playing Fields Present Unique Dangers

By Chuck Adamson

Brad Fresenburg made a disturbing discovery when he took surface temperatures of artificial playing turf on a summer afternoon.

The University of Missouri turfgrass expert found that on a 98-degree day at MU's Faurot Field the surface temperature on the synthetic grass was 173 degrees. Nearby natural grass showed a temperature of just 105 degrees.

When Fresenburg took the temperature at head-level height over the faux turf, the thermometer registered 138 degrees.

Fresenburg said there's a national trend toward high schools and municipal recreation departments replacing grass with artificial turf – once the almost exclusive purview of college and professional sports teams – and he wants coaches and parents to know how to keep players safe.

"If they are going to have artificial fields, we need coaches, parents and players to know that temperatures on these fields are going to be anywhere from 150 to 170 degrees on some days," Fresenburg said. "You might as well be sitting in an oven somewhere."

Brad Fresenburg takes the temperature at head-level height over the faux turf at Faurot Field; the thermometer registered 138 degrees. *Photo by Jim Curley*

**Turfgrass Debate** (WMV)

Brad Fresenburg on MU's football playing surface. *Photo by Adam Masloski*

**Natural Grass Systems** (Flash)

**Related Article: Synthetic Turfgrass Costs Far Exceed Natural Grass Playing Fields**

The new generation of synthetic turfs are as safe, even safer in some ways, as natural grass, concluded Michael Meyers, a professor at West Texas A&M University. He has tracked playing field injuries in Texas high schools for eight years now.

Athletes tend to suffer injuries at roughly the same frequency on natural and synthetic turfs, but different surfaces tend to result in different types of injuries, he said.

"There is more torque, more velocity and more traction" on artificial turf, Meyers said

"There is more torque, more velocity and more traction" on artificial turf, Meyers said.

That can lead to more muscle strains and spasms.

But natural grass has its own hazards, such as slippery mud or unseen potholes, and possibly in arid areas, harder surfaces. More concussions per games played occurred on natural grass fields.

The newer generation of synthetic turfs is "far superior," said Meyers, to previous types like the former industry standard Astroturf, which he described as basically a carpet and carpet pad laid over concrete. Now fields are built over surfaces in-filled with recycled rubber pellets and other materials that make for softer falls, mimicking natural grass and soil playing conditions.

The drawback, said Fresenburg, is that all those rubber and plastic materials amplify sunlight to cause near unbearable temperatures at certain times of the day.

Rex Sharp, MU's head athletic trainer, said he believes synthetic turf to be just as safe as grass. But he agrees that outdoor fields will get hotter under certain conditions. In his experience the artificial fields get at least 10 to 15 degrees hotter under the afternoon sun, he said.

University staff constantly monitors field temperatures during practices, Sharp said.

Fresenburg suggested that sports teams schedule morning and evening practices, times when playing surfaces are cool. In the hot afternoon hours of August and September he said teams should seek out natural grass alternatives.

Under any workout conditions, hydration of athletes should be closely monitored, he said.

MU has two artificial turf fields, the indoor field in the Devine Pavilion and the outdoor Faurot Field in Memorial Stadium.

The older-generation turf used at Devine Pavilion is more tacky and prone to cause twisting-related injuries, Sharp said. The football players wear special cleats when practicing there. Faurot Field has the newer-generation FieldTurf brand surface. He said players can wear regular grass cleats there, and he believes that the surface is just as safe as natural grass.

Fresenburg is not so sure.

Tests Fresenburg has done show increased potential pressure on joints and bones from the inability of a fully planted cleat-wearing foot to divot or twist out, an action that releases force.

The traction on synthetic turf is much greater, he said.

"Grounds managers prefer artificial turf over natural because when teams play on grass, they leave divots and rip out grass," Fresenburg said. "Most people see those areas as

damaged turf. I like to say those divots are a sign that the field is doing its job – yielding to the athletes' cleats."

Fresenburg tested four turf types, three natural grasses and MU's Faurot Field using a contraption of cleats, weights to simulate an athlete's weight and a torque wrench-like tool. When a cleat was completely planted in Faurot Field, it needed an average of 110 foot-pounds – a foot-pound is a measured unit of applied force – of torque to twist free. That was compared to 81 to 85 foot-pounds needed on the natural surfaces.

"In some areas of Faurot Field, we maxed out the instrument at 120 foot-pounds," Fresenburg said. "The cleated foot simply wouldn't shear. That's not good."

The good news is that the difference only occurred when a cleat was fully planted in the field. When only a portion of the cleat simulating the ball of a foot was planted, the force needed to twist free was the about the same on all surfaces.

The hidden danger on an artificial field is the threat of bacterial infections, Fresenburg said. He said disinfectant should be sprayed as needed if there's a known infection risk, but Fresenburg said he doesn't know what procedures are necessary to prevent bacterial contamination in the first place.

"Natural grass has a microbial system. It's self-cleaning. These synthetic fields don't have that," Fresenburg said. "There's warmth. There's moisture. Bacteria can thrive in there. There's sweat, spit and blood."

Sharp said players need to immediately report any "turf-burns," abrasions so named for their similarity to rug burns. Turf burns are common on certain types of synthetic turf. They must be immediately washed with soap and water to prevent infection, Sharp said.

Often young athletes are inclined to ignore seemingly minor injuries, Sharp said.

"We have done a good job of educating our students on turf burns," Sharp said. "We've had to educate our kids to let us clean and treat those."

Anyone interested in more tips on turfgrass safety can contact Fresenburg at 573-442-4893.

"Many schools or communities may only look at the maintenance chores of natural grass when deciding to switch to artificial turf," Fresenburg said. "They should look beyond that. They need to look at all the differences between the two surfaces."

Attachment D-CDC

Centers for Disease Control and Prevention
Your Online Source for Credible Health Information

# Artificial Turf

Recent tests by the New Jersey Department of Health and Senior Services (NJDHSS) of artificial turf playing fields in that state have found these fields contain potentially unhealthy levels of lead dust. The initial tests were conducted on a limited number of playing fields. NJDHSS sampling of additional athletic fields and other related commercial products indicates that artificial turf made of nylon or nylon/polyethylene blend fibers contains levels of lead that pose a potential public health concern. Tests of artificial turf fields made with only polyethylene fibers showed that these fields contained very low levels of lead.

Information provided by NJDHSS to CDC and ATSDR indicates that some of the fields with elevated lead in either dust and/or turf fiber samples were weathered and visibly dusty. Fields that are old, that are used frequently, and that are exposed to the weather break down into dust as the turf fibers are worn or demonstrate progressive signs of weathering, including fibers that are abraded, faded or broken. These factors should be considered when evaluating the potential for harmful lead exposures from a given field.

The risk for harmful lead exposure is low from new fields with elevated lead levels in their turf fibers because the turf fibers are still intact and the lead is unlikely to be available for harmful exposures to occur. As the turf ages and weathers, lead is released in dust that could then be ingested or inhaled, and the risk for harmful exposure increases. If exposures do occur, CDC currently does not know how much lead the body will absorb; however, if enough lead is absorbed, it can cause neurological development symptoms (e.g. deficits in IQ). Additional tests are being performed by NJDHSS to help us better understand the absorption of lead from these products.

## Learn About Lead Contamination in Artificial Turf

Potential Exposure to Lead in Artificial Turf
CDC Health Alert Network (HAN) Advisory from June 18, 2008, 16:10 EDT.

New Jersey Artificial Turf Investigation
Additional information about testing, dust suppression measures, and other topics related to New Jersey's artificial turf investigation.

## Learn About Lead

CDC's Lead Poisoning Prevention Program
Learn more about the CDC's efforts to eliminate childhood lead poisoning in the United States.

ToxFAQs™
Frequently asked questions from the Agency for Toxic Substances & Disease Registry (ATSDR).

Toxicological Profile

Toxicologic & adverse health effects information from the Agency for Toxic Substances & Disease Registry (ATSDR).

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Centers for Disease Control and Prevention 1600 Clifton Rd. Atlanta, GA 30333, USA
800-CDC-INFO (800-232-4636) TTY: (888) 232-6348, 24 Hours/Every Day - cdcinfo@cdc.gov

Attachment E
Connecticut Report

# Artificial Turf Field Investigation in Connecticut
# Final Report

Prepared By

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July 27, 2010

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## 1.0 Executive Summary

The primary purpose of this project was to characterize the concentrations of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), rubber-related chemicals (e.g. benzothiazole), and particulate matter less than 10 micron ($PM_{10}$ ) and its constituents in ambient air at selected crumb rubber fields in Connecticut under conditions of active field use.

This project employed a cross-sectional environmental sampling strategy of synthetic crumb rubber turf fields to capture a range of chemical exposures during the summer season when ambient air temperatures are above 75-80$^{o}$F. Three general types of fields were targeted: outdoor crumb rubber fields, indoor facilities with crumb rubber turf, and an outdoor grass field in a suburban area. Sampling goals were to collect air samples on old and new turf fields during active field use and to collect air samples at background sites upwind and off of each field. A special focus of the design study included personal air sampling of many of the chemicals reported in previous studies (e.g. VOCs and benzothiazole), and other chemicals of potential concern, such as a volatile nitrosamine reported to be part of rubber manufacture. The sampling strategy also included the collection of area air samples for chemicals at different heights on the turf to assess a vertical profile of release. These air samples were collected in areas on the turf field near active play and areas on the turf away from active play. Because crumb rubber includes some amount of dusts and small particles, particulate matter air monitoring was incorporated into the stationary sampling plan (using sampling at a single height only). Bulk samples of turf grass and crumb rubber were also collected, and meteorological data (e.g. air direction, wind speed and ambient air temperature) were recorded.

Industrial hygienists from the Section of Occupational and Environmental Medicine at the University of Connecticut Health Center (OEM UCHC) conducted the field sampling and managed the analytical components of this exposure investigation. This report summarizes the data collected by OEM UCHC. This report identifies and measures chemicals across several synthetic crumb rubber turf fields and background locations. The measurements collected from background locations are necessary to better understand the data because many of these chemicals are present in ambient air as a result of general air pollution.

CT DEP recruited six fields: 4 outdoor turf fields (Fields A-D), 1 indoor turf field (Field K) and 1 outdoor suburban grass area (Field L). Six additional fields were recruited to collect crumb rubber bulk samples only (Fields E-J). Air sampling occurred during July 2009 on crumb rubber fields with polyethylene fibers that were both new (<2 years) and old (>3years). Algorithms were developed to identify chemicals possibly related to turf. Of the 60 VOCs tested in air, 4 VOCs appear to be associated with turf. Of 22 PAHs, 6 were found in the air on the turf at 2 fold greater concentrations than in background locations on at least two fields. Of the five targeted SVOCs, benzothiazole and butylated hydroxytoluene were the only chemicals detected in the personal and area air samples from outdoor turf fields ranging from <80-1200 ng/m$^3$ and <80-130 ng/m$^3$, respectively. Nitrosamine air levels were below reporting levels. $PM_{10}$ air concentrations were greater in background locations than on the turf at all fields with the exception of Field B. However, the $PM_{10}$ air concentration on turf at Field B, 5.89 ug/m$^3$, was within the range of other $PM_{10}$ background concentrations. All of the composite samples of turf fibers and crumb rubber were below the level EPA considers as presenting a “soil-lead hazard” in play areas (400ppm).

The airborne concentrations of VOCs, targeted SVOCs (e.g. benzothiazole) and miscellaneous SVOCs were highest at the indoor field. These data were collected from only one indoor facility. Higher concentrations of these chemicals at the indoor field likely reflects the lack of air movement relative to outdoor fields. In addition, the air in the indoor field was not influenced by outdoor factors that may degrade and off-gas chemicals, such as sunlight, rain, and other weather conditions. Furthermore, potential point sources were identified in the facility, (electric carts, portable chargers, and maintenance supplies) and the indoor facility did not have its exhaust system operating on the day samples were collected. More research is needed to better understand chemical exposures in indoor facilities.

## 2.0 Introduction

### 2.1 Purpose

Crumb rubber fields have been installed or are being proposed in many towns throughout Connecticut, and elsewhere in the United States. Crumb rubber consists of recycled, chipped/pulverized, used automobile tires. The tire crumbs are roughly the size of grains of course sand and generally are spread two to three inches thick over the field surface and packed between ribbons of green plastic used to simulate grass. Crumb rubber granules may release a variety of chemicals typical in rubber, including polycyclic aromatic hydrocarbons (PAHs) and volatile organic chemicals (VOCs). In addition, crumb rubber includes some amount of dusts and small particles, which may be further increased by mechanical abrasion and wear that comes with use of the fields [1]. Health questions continue to arise because exposures and risks to playing on these fields have not been fully characterized [2, 3, 4].

The primary purpose of this project was to characterize the concentrations of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), rubber-related chemicals (e.g. benzothiazole), and particulate matter less than 10 micron concentrations ($PM_{10}$ ) and its constituents in ambient air at selected crumb rubber fields in Connecticut under conditions of active field use. Air monitoring data is needed to characterize exposure patterns of targeted compounds in the breathing zone of children using artificial turf fields. In addition, there is insufficient data on how relevant variables, such as weather conditions, age of field, nature of sporting activities and type of infill, affect exposure to chemical constituents and particulate matter.

In Connecticut, we know of at least 85 crumb rubber fields already in use, and another 30 that have been proposed or are being constructed. Air data collected at selected crumb rubber fields are needed to begin the characterization of potential exposures that could be used in a companion risk assessment of the data generated from this work.

Data from the Connecticut Agricultural Experiment Station (CAES) laboratory head space analyses on manufacturers' crumb rubber infill were used to guide aspects of the design of this field investigation [5]. We also established collaborative relationships with those doing similar research in New Jersey, New York State, New York City and U.S. EPA to learn of parallel activities and results as this project proceeded [6, 7]. For example, a recent study conducted in New York found that rubber dust was not found in the respirable range, and therefore, $PM_{10}$ was selected for this study [6].

### 2.2 Field Investigation Objectives

This exposure characterization had the following objectives.

1. Collect personal measurements in the breathing zone of the target population - young children who play on crumb rubber athletic fields.
2. Characterize the concentrations of VOCs, SVOCs, and particulate matter (PM) (and constituents on PM) in air at selected crumb rubber fields in Connecticut under conditions involving active field use in warm weather.
3. Assess airborne concentrations of the targeted chemicals and particulates in areas surrounding and away from the crumb rubber fields. The collection of background samples is a key component as exposure to airborne rubber particles and component gases is not unique to turf fields.

### 2.3 Sampling Plan

Industrial hygienists from the Section of Occupational and Environmental Medicine at the University of Connecticut Health Center (OEM UCHC) conducted the field sampling and managed the analytical components of this exposure investigation. OEM UCHC provides research, educational programs and training, industrial hygiene consulting, prevention guidance, risk communication and clinical care for occupational and environmental illnesses and problems. Specifically, OEM UCHC personnel performed the collection of air samples, contracted with laboratories for analyses, provided quality control /quality assurance, and reviewed and compiled the data. OEM UCHC sub-contracted laboratory analyses to three AIHA accredited laboratories: Wisconsin Occupational Health Laboratory (WOHL), the Wisconsin State Laboratory of Hygiene (WSLH) and the ESIS Environmental Health Laboratory (EHL) in Cromwell, Connecticut. WOHL is a full service industrial hygiene chemistry laboratory that is part of the Wisconsin State Laboratory of Hygiene (WSLH) at the University of Wisconsin-Madison. WSLH analyzed air samples for VOCs, SVOCs and $PM_{10}$. WOHL analyzed bulk crumb rubber head space for VOCs and targeted SVOCs (e.g. benzothiazole), and air samples for nitrosamines and targeted SVOCs. Additional bulk

samples were analyzed for lead by the ESIS Environmental Health Laboratory (EHL). The EHL has been accredited by the American Industrial Hygiene Association (AIHA) for both industrial hygiene and environmental lead. This report summarizes the data collected by OEM UCHC.

This project employed a cross-sectional environmental sampling strategy of synthetic crumb rubber turf fields to capture a range of chemical exposures during the summer season when ambient air temperatures are above 75-80$^{o}$F. Three general types of sites were targeted: outdoor crumb rubber fields, indoor facilities with crumb rubber turf, and an outdoor grass field in a suburban area. Sampling goals were to collect air samples on old and new turf fields during active field use and to collect air samples at an upwind site of each field. A special focus of the design included personal air sampling of many of the chemicals reported in previous studies (e.g. VOCs and benzothiazole), and other chemicals of potential concern, such as a nitrosamine. The sampling strategy also included the collection of area air samples for chemicals at different heights on the turf to assess a vertical profile of release. These air samples were collected in areas on the turf field near active play and areas on the turf away from active play. Because crumb rubber includes some amount of dusts and small particles, particulate matter air monitoring was incorporated into the stationary sampling plan (using sampling at a single height only). Bulk samples of turf grass and crumb rubber were also collected, and meteorological data (e.g. air direction, wind speed and ambient air temperature) were recorded.

*Bulk Samples*: Composite bulk samples of green artificial turf fibers and composite bulk samples of crumb rubber were collected from 5 locations on each study field. These samples were analyzed for lead by EHL in Connecticut. Additional bulk samples of crumb rubber were collected at eleven fields. These samples were analyzed for targeted SVOCs, VOCs and other chemicals in a 340 milliliter large volume sample headspace unit (LVSH) by WOHL. CAES collected and analyzed samples of crumb rubber material supplied by several manufacturers [5]. Their crumb rubber samples included material from only two of our outdoor fields (A and D). These two crumb rubber fields were manufactured by two different companies. The results are difficult to compare between the two laboratories (WOHL and CAES) because they used different analytical methods.

*Personal Sampling:* Study team members from the Connecticut Department of Public Health (CT DPH), Connecticut Department of Environmental Protection (CT DEP), and OEM-UCHC simulated a soccer game for the collection of the personal airborne chemicals. Active play among 3-4 players consisted of running and kicking the ball on the turf field, one on one soccer drills and “keep away” soccer games. Duration of play was two hours with one break. Personal air samples were collected at waist height, approximately 3-feet, with sampling equipment worn by 3 players during active play on the field. Personal measurements for nitrosamine, benzothiazole, and VOC were collected from players at each field. Two personal samples were collected for each of the types of measurements. Evacuated 1.4 liter SUMMA canisters were worn by players at hip height to collect VOC samples. Personal sampling pumps fit with absorptive media were worn by players at hip height to collect samples for benzothiazole, nitrosamine, 4-Tert (octyl) phenol, 2-mercaptobenzothiazole, Butylated hydroxyanisole (BHA) and Butylated hydroxytoluene (BHT).

*Area Sampling:*
Area samples were collected for 2 hours to measure VOCs, SVOCs, benzothiazole, and ambient $PM_{10}$ concentrations during active play. Samplers were located at various heights on the field in the immediate vicinity of the simulated soccer game and in an off-turf upwind area to represent background locations. Additional background samples were collected in one suburban community location (non-turf grass field) to help put the field-related results into a larger exposure context. VOCs were measured with 6-liter SUMMA canisters according to EPA Method TO-15 [8]. SVOCs in ambient air were measured with PS-1 Samplers according to EPA Method TO-13A [9]. An additional day of sampling for 6 hours was conducted with the PS-1 Samplers on one field without active play. Specific chemicals (e.g. benzothiazole and nitrosamines) were separately measured using sampling pumps and sorptive media to trap those chemicals according to NIOSH methods [10, 11]. $PM_{10}$ concentrations were measured using Harvard Impactors (Air Diagnostics and Engineering, Inc., Harrison, ME) [12, 13]. OEM-UCHC collected all samples and shipped sampling media to WOHL for analysis. Table 1 provides a general description of the targeted analytes, air sampling and analytical methods for each set of analytes. Appendix A provides a sampling map.

## 3.0 Methods and Results

### 3.1 Field Recruitment

CT DEP recruited six fields: 4 outdoor turf fields (Fields A-D), 1 indoor turf field (Field K) and 1 outdoor suburban grass area (Field L). Six additional fields were recruited to collect crumb rubber bulk samples only (Fields E-J). As shown in Table 2, air sampling occurred during July 2009 on crumb rubber fields with polyethylene fibers that were both new (<2 years) and old (>3years). Fields B, C, and J contained silica sand in the crumb rubber. Sampling dates were chosen to coordinate several factors: sunny and no wind days, rental sampling equipment costs/availability, field accessibility due to school summer programs, and staff availability. Table 2 provides the total number of air samples collected at each field.

Fields A-B and K were in located in rural areas and fields C, D and L were in suburban communities with nearby roads with high traffic volume. Field D was also near an interstate highway. Field K, the indoor turf facility, had four exhaust fans at each end of the building. These fans were not operating during sampling. There was an equipment room located inside the facility containing small electric motorized carts (these carts were driven out of the facility minutes before the sampling began). In addition, the room had a portable charger, an ice machine, maintenance supplies (e.g. cans of paints) and other gym equipment.

### 3.2 Meteorological Sampling

Meteorological conditions for each sampling day were collected by a subcontactor (Air Quality Research and Logistics, LLC) with a Davis Vantage Pro 2 weather station by Air Quality Research and Logistics, Inc. Meteorological parameters included: wind speed, wind direction and air temperature at different heights (near ground level and 3 feet above the ground). Thermometers were enclosed in naturally aspirated radiation shields (Davis Part. No. 7714). Measurement of continuous (15 minute average) ambient air temperature, wind direction and speed were collected. Table 3 provides a summary of the meteorological conditions at each field. Appendix B provides a report by Air Quality Research and Logistics, Inc. On July 28, 2009, meteorological data was not collected during the 6 hour sampling at Field D. Temperature and wind direction data were obtained from Weather Underground (www.wunderground.com).

**Table 1. Target Analytes, Air Sampling Equipment and Analytical Methods**

| Compounds | Type | N | Sampling Equipment and Media | Analytical Method |
|---|---|---|---|---|
| Volatile Organic Compounds (VOCs) | Personal<br>Area | 10<br>16 | 1.4 L SUMMA<br>6.0 L SUMMA | EPA TO-15 (GC/MS) |
| General Semi-Volatile Organic Compounds (SVOCs) scan | Area | 12 | PS-1 Sampler<br>PUF and XAD-2 | EPA TO-13A (modified)<br>GC/MS |
| Targeted SVOCs<br>Benzothiazole<br>2-mercaptobenzothiazole<br>4-Tert (octyl)phenol<br>Butylated hydroxyanisole<br>Butylated hydroxytoluene | Personal<br>Area | 10<br>35 | Personal Pump<br>Gilair®, SKC Airlite®<br>XAD-2<br>37mm, 2 µm PTFE pre-filter | WOHL Method LC-100 (based upon NIOSH 2550) |
| Nitrosamines | Personal<br>Area | 10<br>23 | Personal Pump<br>Gilair®, SKC Airlite®<br>Thermosorb/N™ | WOHL Method LC-96 (based upon NIOSH 2522) |
| Particulate Matter ($PM_{10}$) | Area | 12 | MS&T Area Sampler<br>20 L sampling pump<br>37 mm Teflon Filter<br>2 µm pore size | CFR Title 40 Part 50 (Appendix L)<br>WP001-03<br>Gravimetric Analysis |

**Table 2. Total number of air samples collected at each field**

| Compounds/ Methods | Location | N | Fields | | | | | | Sampling Comments |
|---|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | D | K | L | |
| VOCs<br>EPA TO-15 | Personal<br>On Turf Area<br>Background Area | 10<br>10<br>6 | 2<br>2<br>1 | 2<br>2<br>1 | 2<br>2<br>1 | 2<br>2<br>1 | 2<br>2<br>1 | 0<br>0<br>1 | At Field A, no data at 6" on turf AFAP<br><br>At Field C, pesticide application occurred adjacent to turf field |
| SVOCs scan<br>EPA TO-13A | On Turf Area<br>Background Area | 6<br>6 | 1<br>1 | 1<br>0 | 1<br>0 | 2<br>2 | 1<br>1 | 0<br>2 | At Fields B, C and L, no data at background locations |
| Targeted SVOCs<br>NIOSH 2550<br>(modified) | Personal<br>On Turf Area<br>Background Area<br>Field Blanks<br>Field Spikes | 10<br>23<br>12<br>7<br>6 | 2<br>4<br>2<br>1<br>1 | 2<br>4<br>2<br>1<br>2 | 2<br>4<br>2<br>1<br>0 | 2<br>6<br>2<br>2<br>1 | 2<br>4<br>2<br>1<br>2 | 0<br>1<br>2<br>1<br>0 | At Field D during 6 hour sampling, no data at 6" or 3' on turf |
| Nitrosamines<br>NIOSH 2522 | Personal<br>On Turf Area<br>Background Area<br>Field Blanks | 10<br>12<br>11<br>7 | 2<br>2<br>2<br>1 | 2<br>2<br>2<br>1 | 2<br>2<br>2<br>1 | 2<br>4<br>2<br>2 | 2<br>2<br>2<br>1 | 0<br>0<br>1<br>1 | None |
| $PM_{10}$<br>CFR Title 40 Part 50 | On Turf Area<br>Background Area<br>Field Blanks | 5<br>7<br>6 | 1<br>1<br>1 | 1<br>1<br>1 | 1<br>1<br>1 | 1<br>1<br>1 | 1<br>1<br>1 | 0<br>2<br>1 | At Field A, no data at 3' on turf or at background location |

**Table 3. Description of sampling fields and weather conditions during sampling day.**

| Field ID | Surface Age (location) | Sampling Date | Sampling Time of Day | Ambient Temperature On Surface ($^{o}$Fahrenheit) | | Wind Speed (mph) |
|---|---|---|---|---|---|---|
| | | | | 3 inches | 36 inches | |
| **A** | 2 years (outdoor) | 7/27/09 | 12:15-2:15pm | 79-89 | 76-83 | 0-6 |
| **B** | 2 years (outdoor) | 7/15/09 | 11:30-1:30pm | 83-89 | 77-80 | 4-8 |
| **C** | 5 years (outdoor) | 7/20/09 | 11:30-1:45pm | 85-88 | 81-82 | 1-2 |
| **D** | 2 years (outdoor) | 7/14/09 | 12:35-2:40pm | 80-88 | 76-86 | 1-3 |
| | | 7/28/09 | 9:30-3:30pm | | 68-87* | 2-8 |
| **K** | 3 years (indoor) | 7/22/09 | 3:50-5:50pm | 77-79 | 78-80 | 1-2 |
| **L** | Grass (outdoor) | 7/12/09 | 11:48-1:48pm | NA [a] | 78-80[b] | 1-3 |

* Temperature not measured directly. Information collected from Weather Underground.
[a]NA=Not available. Temperature information was not collected 3 inches above the surface.

### 3.3 Bulk Samples

*Crumb Rubber Bulk Sampling Methods for Head Space Analysis*: Crumb rubber bulk samples were collected from 11 different fields in June 2009. Table 3 provides the turf surface age for fields A-D, K. The turf surface age of the other six fields were: E (3 yrs), F (9 yrs), G (4 yrs), H (6 yrs), I (1 yr), and J (1 yr). Bulk samples were collected from 5 locations on each field (see Figure 1). At each location, crumb rubber was placed in a pre-cleaned glass jar, covered with foil and placed in a brown paper bag. Five samples per field were collected and shipped to WOHL (n=55).

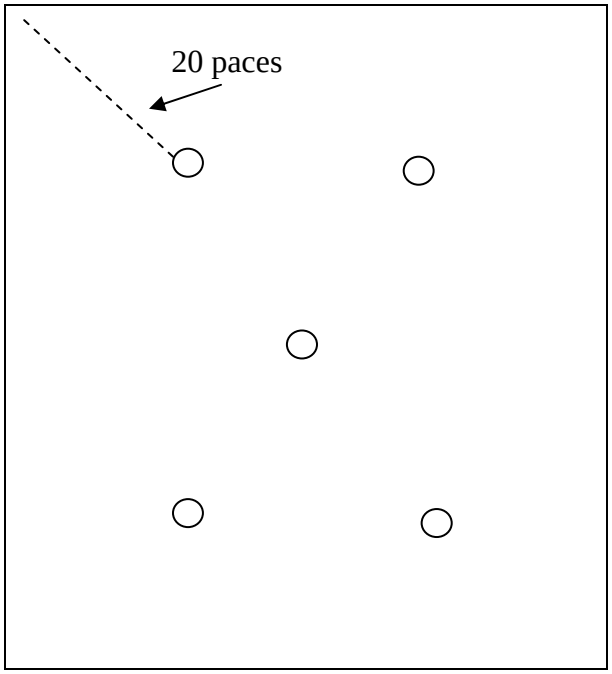


Figure 1. Sampling locations for bulk samples.

**3.3.1 VOC Crumb Rubber Head Space Analysis:** WOHL stored the samples in a refrigerator at 4°C. Bulk samples were analyzed for VOCs by WOHL method WG086.2, a method based on OSHA PV2120 for the analysis of volatile organic compounds (VOCs) in air. The samples were analyzed in a 340 milliliter large volume sample headspace unit (LVSH) as follows: The cleaned LVSH was heated to 70°C overnight and then brought to room temperature in a clean room. A 0.5 gram sample was placed in the LVSH and heated in an oven at 70°C for at least 1 hour. Immediately after the LVSH was removed from the oven, a 100 ml sample volume from the LVHS was cryofocused and injected in a gas chromatograph equipped with a mass selective detector and a RTX-624 capillary column. The following precautions were taken for the bulk crumb rubber VOC analysis: 1)bulk crumb rubber samples were stored in teflon lined screw capped jars and were opened only when removing sample for analysis;2) the 340mL LVSH were baked at 70°C overnight; and 3) one of the LVSH units was analyzed empty with each analytical run as a method blank, and any VOCs detected above reporting limit noted in the analytical report.

VOC identification was conducted by the National Institute of Standards and Technology Library (NIST) search. Laboratory blanks during analyses were below reporting limits for most compounds. Carbon disulfide, silyls, and siloxane-containing VOCs are common contaminants of the analytical system. Therefore, trace amounts of these VOCs reported may not be components of the samples. Trace levels of carbon disulfide were detected in laboratory blanks. All siloxane-containing VOCs were below reporting limits (<20ppb) in laboratory blanks. Because some of the VOC compounds detected in bulk crumb rubber off gassing experiments are commonly used laboratory solvents, a laboratory background VOC sample was also collected in the walk-in cooler/sample storage area and analyzed. The following VOC compounds were reported in the laboratory background sample: 2-methyl-butane (31ppb), acetone (830ppb), benzene (18ppb), methylene chloride (1030ppb), methyl alcohol (790ppb), and pentane (52ppb).

The head space methodology used by WOHL differed from CAES in several areas. WOHL used smaller amount of crumb rubber (0.5 vs.1 gram), a larger volume head space unit, and different analytical parameters (e.g. cryogenically concentrates head space injection vs. direct injection technique). Appendix C provides a description of the analytical method used by WOHL.

*Results:* Table 4 provides a list of VOCs identified in crumb rubber samples from the 11 different turf fields. The most commonly found VOCs (range of concentrations in parts per billion-ppbV) include: acetonitrile (60-300ppbV), methylene chloride (20-430ppbV), methyl alcohol (33-270ppbV), and methyl isobutyl ketone (21-150ppbV). Bulk crumb rubber from the newer fields (A, B and D) contained more than ten VOCs. Crumb rubber from other fields contained less than 5 VOCs. Carbon disulfide concentrations were found in the majority of field samples with estimates ranging from 41-141 ppb, and are considered a contaminant of the analytical system and not a turf related VOC. VOCs also found in the laboratory background sample are noted below with the asterisks "c". Appendix C provides the WOHL analytical laboratory reports of the data.

**Table 4. VOCs identified in bulk crumb rubber head space at 11 fields.**

| Volatile Organic Compounds (VOCs) | Fields A-D, K | Fields E-J |
|---|---|---|
| 1,1,2-Trichloro-1,2,2-trifluoroethane | A | |
| 2-methyl-Butane[c] | A, B, C | |
| 3-methyl-Pentane | A[a], B, D[b] | |
| Acetone[c] | A[a], B[a] | I[a] |
| Acetonitrile | A, B, C, D | E |
| Benzene[c] | A, D | |
| Carbon Tetrachloride | A | |
| Cyclopentane, methyl- | A, B, D | |
| Ethanol | A | |
| Ethyl Benzene | D | |
| Hexane | B, C, D | |
| Isopropyl Alcohol | A, B | |
| Methyl Alcohol[c] | A, B, C, D, K | E |
| Methylene Chloride[c] | A, B, C, D | E, F, G, H, I |
| Methyl Isobutyl Ketone | A, B, D | E, G, H, I |
| Pentane[c] | A | |
| Styrene | A, B, D | |
| Toluene | A, B, D | |

Reporting limit is <10 or 20 ppbV depending on the chemical.
[a]Indicates that the area summed includes an unresolved compound.
[b]Indicates that there is some question as to identity.
[c]Compound was also detected in the laboratory background sample.

**3.3.2 Targeted SVOCs Bulk Crumb Rubber Head Space Analysis:** In the crumb rubber bulk samples, five targeted SVOCs were analyzed: benzoathiazole, 2-mercaptobenzothiazole, butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), and 4-tert-(octyl)-phenol). Four chemicals, 2-mercaptobenzothiazole, BHA, BHT, and 4-tert-(octyl)-phenol) were added to the list of targeted SVOCs as a result of the findings reported by CAES in 2009. For targeted SVOCs, a Supelco Adsorbent Tube Injector System (ATIS) was utilized to thermally extract the bulk rubber infill samples. The off-gassed SVOCs were loaded onto sampling media and analyzed according to the various analytical methods used in the study. For benzothiazole/4-tert-(octyl)-phenol, the method is based upon National Institute for Occupational Safety and health (NIOSH) Method Number 2550 (Modified). In summary, SVOCs off gassed from bulk infill material collected on XAD filter air sampling devices were desorbed separately with 10 minutes of sonication performed 3 times with 3mL of methanol each. The combined methanol fractions were evaporated to approximately 0.5mL with nitrogen, and brought to a final volume of 1.0mL with methanol. Extracts were analyzed by reversed phase high-performance liquid chromatography employing a 0.1% formic acid:methanol linear gradient program. Detection was achieved by triple quadrupole mass spectrometry using multiple reaction monitoring (MRM).

*SVOCs Bulk Crumb Rubber Results:* Table 5 provides a list of SVOCs identified in crumb rubber samples from the 11 different turf field fields. Appendix D provides WOHL laboratory analytical reports.

**Table 5. Identification of targeted SVOCs in bulk crumb rubber head space samples collected at 11 fields.**

| Semi-Volatile Organic Compounds (SVOCs) | Study Turf Fields A-K | Additional Turf Fields E -J |
|---|---|---|
| Benzothiazole | A, B, C, D and K | E, G, J |
| 2-mercaptobenzothiazole | None | None |
| 4-tert-(octyl)-phenol | A, B, C, D and K | E, F, G, H, I, J |
| Butylated hydroxyanisole (BHA) | None | None |
| Butylated hydroxytoluene (BHT) | A, K | G |
| Nitrosamine | None | None |

### 3.3.3 Lead

*Bulk Sampling Method*: Composite bulk samples of green artificial turf fibers and composite bulk samples of crumb rubber were collected from 5 locations on each field (Figure 1) at study fields only. The bulk samples were placed in zip lock bags. Because lead was detected in the composite bulk sample from Field D, four additional crumb rubber composite bulk samples (two at 20 paces and two at 40 paces) and one additional composite fiber bulk sample were collected from Field D. The bulk samples were analyzed for environmental lead by the ESIS Environmental Health Laboratory (EHL) in Cromwell, Connecticut. The analytical method used by the laboratory was Modified EPA-SW-846-3050/ ICP, Modified OSHA ID 125. The sampling and analytical methods are similar to the methods used by New York City Department of Parks and Recreation during their study of 103 crumb rubber fields [14].

*Results:* Table 6 show that all of the composite samples were below the level EPA considers as presenting a "soil-lead hazard" in play areas (400ppm). This definition, however, applies to residential buildings and to soil rather than other surfaces [15]. Appendix E provides the EHL analytical laboratory reports.

**Table 6. Concentrations of microgram lead/gram material (µg/g) in fibers and crumb rubber at study field fields.**

| Field | Fiber Concentration (µg/g) | Crumb Rubber Concentration (µg/g) |
|---|---|---|
| A | < 60.1 | <71.4 |
| B | <59.0 | <68.9 |
| C | <60.2 | <70.4 |
| D | <59.0 | 271 (20 paces) |
| | <76.5 | <70.6 (20 paces) |
| | | <78.5 (20 paces) |
| | | <72.6 (40 paces) |
| | | <78.7 (40 paces) |
| K | <60.8 | <72.1 |

Limit of Detection: 7.5 µg/sample
Environmental Protection Agency (EPA) lead level for soil in children's play areas: 400 ppm (µg/g)

## 3.4 Air Samples

### 3.4.1 Volatile Organic Compounds (VOCs)

*Personal Sampling*: Personal air samples for VOCs were collected using evacuated 1.4 L silica-lined SUMMA Canisters with FSL QT MicroValve (Entech Instruments, California). Two study team members each wore a canister at waist-height during each sampling session. Each canister was placed inside a cotton "tool belt" and secured to a coated mesh waist belt with plastic ties. Study team members played soccer on the turf field with 2 other members for 120 minutes. One water/food break (5-10 minutes) was taken by the team members during the play period. At the beginning of each sampling event staff checked each canister's gauge and confirmed that the pressure was at the level noted in the laboratory's SOP. At the end of each sampling event, staff confirmed that the pressure gauge had reached "0". The majority of samples collected air for at least 60 minutes or greater. Two samples collected air for less than 25 minutes (collected at indoor field, Field K). Samples were sent to the WSLH laboratory (Madison, WI) by overnight mail on the day they were collected. All canisters were received by WSLH the next day. Ten samples were collected, two from each turf field field (Fields A, B, C, D, and K). All of the 1.4L cans were pressure checked upon return to the lab and prior to analysis. No data wereflagged to indicate problems.

Newly purchased items, such as apron belt, coated mesh belt, and plastic twist ties were used to hold the sampling equipment in place during personal sampling. Because several VOCs, such as acrolein, were present in personal samples and not in any area samples, a request was made to WOHL to analyze these extra items to determine if they released any VOC emissions. Therefore, seven months after sampling, a cloth apron, plastic twist tie, sampling pump, segment of the coated mesh waist belt and the belt buckle were analyzed for VOCs in the head space unit. This sampling was done because these items were in close contact to the sampling inlet of the 1.4L canisters that team members wore.

*Area Sampling:* Area air samples for VOCs were collected using evacuated 6 liter (L) silica-lined SUMMA Canisters with Nupro Valve (Entech Instruments, California). Canisters were placed at 6 inches and at 3 feet above the turf in an area away from active play of study team members (AFAP) during each sampling session. Another canister was placed upwind of the turf field on grass at 3 feet above the ground. At Field L (grass field), the canister was placed at 3 feet. At the beginning of each sampling event staff checked each canister's gauge and confirmed that the pressure was at the level noted in the laboratory's SOP. At the end of each sampling event, staff confirmed that the pressure gauge had reached "0". The majority of samples collected air for at least 60 minutes or greater. One sample collected air for less than 20 minutes (collected at outdoor background, Field K). Samples were sent to the WSLH (Madison, WI) by overnight mail on the day they were collected. All canisters were received by WSLH the next day. In total, sixteen samples were collected from the various fields. Samples were collected from the following fields: A (n=3), B (n=3), C (n=3), D (n=3), K (n=3) and L (n=1). The lab confirmed if the canister valve was closed and tight upon arrival. One 6 L canister valve was open upon arrival, and the sample was not analyzed (collected at Field A, 6 inches above the turf).

*Sample Preparation and Analysis:* All canisters (1.4L and 6L) were calibrated with a mass flow controller to collect air samples for up to 120 minutes by the ESS Organics WSHL. A modified version of Compendium EPA Method TO-15 by GC/MS was used to measure ambient-level concentrations for 60 VOC analytes. Briefly, this method incorporates a multi-stage concentration process using an Entech 7100A Preconcentrator. This removes carbon dioxide, nitrogen, and water with a series of traps. The sample (500ml) is injected on a glass bead trap at a temperature of -150°C. The trap is then heated to 10°C and purged gently with helium to transfer the VOCs and the carbon dioxide to a second trap. The second trap, which contains Tenax(tm), is then cooled to 10°C, allowing the carbon dioxide to pass through the trap while retaining the VOCs. The second trap is heated and back-flushed with helium, sending the sample to the focusing trap, which is cooled to -160°C. The focusing trap is then rapidly heated to 60°C and the sample is injected onto the Rxi-lm s (Restek U.S., 110 Benner Circle, Bellefonte, PA 16823), 60m capillary column and finally the mass spec detector. VOC concentrations were reported in ppbV and microgram per cubic meter ($\mu g/m^3$ ).

Each analytical run included one method blank per batch of samples. If an analyte in the method blank was greater than its limit of detection (LOD), the result for that analyte was flagged to indicate blank contamination. One set of samples contained acetone in the blank sample, and concentrations were corrected (samples collected at Field B). Duplicate analysis was performed on one sample per analytical batch. Duplicate analyses were always within 25% for each compound. Daily quality control checks were

performed using a second source standard. Analytes in the quality control/QC check standard were always within 30% of the corresponding calibration standards.

*Results:* The EPA Method TO-15 is designed to scan for 60 VOCs, and the results provide a list of VOCs that are detected at least once on field or background locations. WSHL analytical laboratory reports for all 60 VOCs (in ppbV) in air per field are summarized in Appendix F. Tables 7-10 summarize the VOC concentrations in $\mu g/m^3$ at Fields A-D, all outdoor turf fields. Table 11 shows the VOC concentrations from Field K (an indoor field), and Table 12 presents data for Field L (the non-turf grass background suburban site). Table 13 provides an additional list of VOCs in the personal, on-turf, and background samples that were tentatively identified through the use of the National Institute of Standards and Technology (NIST) library. VOC concentrations are shown in bold for each VOC analyte if concentrations were two times higher than the background concentration. Total Volatile Organic Compound (TVOC) value is the sum of the all the concentrations that were detectable, and is not an approximate concentration based on toluene response. The airborne VOC concentrations reported at Field C should be reviewed with caution (Table 9). During the first ten minutes of sampling at Field C, a pesticide mixture was applied to the grass field adjacent to the synthetic turf field. Study coordinator asked the applicator to stop the application. Unfortunately, air sampling had already begun in the background location near the grass field when the application occurred. Three different pesticides (Merit 75 WSP Insecticide, Drive 75 DF Herbicide, and Cross Check Insecticide) were applied to the perimeter of the field with a Perma Green Ride-on Spreader.

*Special Sampling Equipment Head Space Results:* WOHL's VOC head space analyses of the plastic ties, cloth apron bag, mesh waist belt and buckle are summarized in Appendix G. The cloth apron contained detectable levels of acetaldehyde, propanal, hexanal, nonanal, and octanal and trace levels of acrolein. The mesh belt contained acetaldehyde, 2-butenal, pentanal, hexanal, heptanal, and nonanal and trace levels of acrolein. A peak with NIST mass spectral library match for acrolein was detected in the cloth apron and mesh belt sample. These peaks were below the reporting limit of 20ppb and additional mass spectral peaks were present, including possible co-eluting compounds. Detectable levels of nonanal, decanal, and octanal were found in the plastic ties.

**Table 7. Volatile Organic Compound (VOC) Concentrations in µg/m$^3$ at Field A (personal and on-turf concentrations 2X higher than background are in bold)**

| | VOC Concentration (µg/m$^3$) | | | |
|---|---|---|---|---|
| **Compound Name** | **Personal** | **Personal** | **On Turf 3 AFAP 3 ft** | **Background 3 ft** |
| 1,1,2,2-Tetrachloroethane | <0.68 | <0.68 | <0.68 | 1.02 |
| 1,2,4-Trichlorobenzene | <0.74 | <0.74 | <0.74 | 0.89 |
| Acetone | **52.17** | **33.20** | 12.33 | 12.33 |
| Acrolein | **1.95** | **1.40** | <1.15 | <1.15 |
| Benzene | <0.32 | <0.32 | <0.32 | 0.41 |
| Bromoform | <1.02 | **2.35** | <1.022 | <1.02 |
| Carbon Tetrachloride | <0.62 | <0.62 | <0.62 | 0.93 |
| Chloromethane | 1.57 | 1.55 | 1.45 | 1.33 |
| Dichlorodifluoromethane | 2.42 | 2.47 | 2.28 | 2.23 |
| Ethyl Acetate | **1.37** | **1.76** | <0.36 | 0.61 |
| Halocarbon 11 | 1.85 | 1.79 | 1.74 | 1.96 |
| Hexane | **24.61** | **8.79** | <0.35 | 3.30 |
| Methyl Ethyl Ketone | 2.94 | 2.53 | 1.35 | 1.74 |
| Methylene Chloride | <0.34 | <0.34 | <0.34 | 0.69 |
| Propene | <0.17 | **0.38** | <0.17 | <0.17 |
| Toluene | **1.58** | **1.92** | <0.38 | 0.75 |
| Vinyl Acetate | 1.23 | 1.13 | <0.35 | 1.02 |
| Total VOCs* | 91.69 | 59.27 | 19.15 | 29.21 |

A tentative ID match for four compounds was made using the NIST Library in personal samples. No tentative ID matches were found in other areas. See Table 13.
AFAP= away from active play of study team members.
*Total VOCs is the sum of all the concentrations that were detectable (does not include values less than reporting limit).

**Table 8. Volatile Organic Compound (VOC) Concentrations in µg/m$^3$ at Field B. (personal and on-turf concentrations 2X higher than background are in bold)**

| | VOC Concentration (µg/m$^3$) | | | | |
|---|---|---|---|---|---|
| **Compound Name** | **Personal** | **Personal** | **On Turf AFAP 6 inch** | **On Turf AFAP 3 ft** | **Background 3 ft** |
| 1,2,4-Trimethyl Benzene | 1.32 | **2.16** | <0.49 | <0.49 | <0.49 |
| 1,2-Dichloropropane | <0.46 | **1.14** | <0.46 | <0.46 | <0.46 |
| 1,3,5-Trimethyl Benzene | <0.49 | **1.37** | <0.49 | <0.49 | <0.49 |
| 1-Ethyl-4-Methyl Benzene | <0.49 | **1.86** | <0.49 | <0.49 | <0.49 |
| Acetone[a] | **13.75** | **34.74** | 3.93 | 3.65 | 4.01 |
| Acrolein | **1.58** | **3.66** | <1.15 | <1.15 | <1.15 |
| Benzene | < 0.32 | **1.56** | <0.32 | <0.32 | <0.32 |
| Carbon Disulfide | <0.31 | **0.47** | <0.31 | <0.31 | <0.31 |
| Carbon Tetrachloride | 0.68 | <0.68 | 0.75 | 0.81 | 0.75 |
| Chlorobenzene | <0.46 | **0.78** | <0.46 | <0.46 | <0.46 |
| Chloromethane | 1.25 | 1.70 | 1.19 | 1.14 | 1.04 |
| Cyclohexane | **0.86** | **17.51** | **1.51** | <0.34 | <0.34 |
| Dichlorodifluoromethane | 2.42 | 2.13 | 2.52 | 2.57 | 2.42 |
| Ethyl Acetate | **1.30** | **11.87** | <0.36 | <0.36 | <0.36 |
| Ethylbenzene | <0.43 | **4.29** | <0.43 | <0.43 | <0.43 |
| Halocarbon 11 | 1.46 | 1.40 | 1.51 | 1.51 | 1.51 |
| Heptane | <0.41 | **5.72** | <0.41 | <0.41 | <0.41 |
| Hexane | <0.35 | **31.29** | <0.35 | <0.35 | 0.88 |
| M/P-Xylene | <0.87 | **10.83** | <0.87 | <0.87 | <0.87 |
| Methyl Ethyl Ketone | <0.29 | <0.23 | 1.41 | 1.21 | 1.30 |
| Methyl Isobutyl Ketone | **2.33** | **3.39** | <2.04 | <2.04 | <2.04 |
| Methylene Chloride | <0.34 | **14.08** | <0.34 | <0.34 | <0.34 |
| O-Xylene | <0.43 | **3.90** | <0.43 | <0.43 | <0.43 |
| Propene | **0.5** | **0.89** | <0.17 | <0.17 | <0.17 |
| Styrene | <0.43 | **1.96** | <0.43 | <0.43 | <0.43 |
| Tetrachloroethylene | <0.67 | **3.29** | <0.67 | <0.67 | <0.67 |
| Tetrahydrofuran | <1.48 | **2.47** | <1.5 | <1.5 | <1.5 |
| Toluene | 1.54 | **52.66** | 0.87 | 0.79 | 0.87 |
| Trichloroethylene | <0.53 | **23.39** | <0.53 | <0.53 | <0.53 |
| Total VOCs[*] | 28.99 | 240.51 | 13.69 | 11.68 | 12.78 |

A tentative ID match for 16 compounds was made using the NIST Library in personal samples. See Table 12. There was one tentative ID match in a background sample. See Table 13.
AFAP= away from active play of study team members.
[a]Acetone was detected in lab blank (1.5ppb) and all concentrations were corrected.
[*]Total VOCs is the sum of all the concentrations that were detectable (does not include values less than reporting limit).

**Table 9. Volatile Organic Compound (VOC) Concentrations in µg/m$^3$ at Field C. (personal and on-turf concentrations 2X higher than background are in bold)**

| | VOC Concentration (µg/m$^3$) | | | | |
|---|---|---|---|---|---|
| **Compound Name** | **Personal** | **Personal** | **On Turf 6 inch AFAP** | **On Turf 3 ft AFAP** | **Background 3 ft** |
| 1,1,2,2-Tetrachloroethane | <0.68 | <0.68 | <0.68 | <0.68 | 1.09 |
| 1,1,2-Trichlorotrifluorethane | <0.78 | <0.78 | <0.78 | 0.76 | 1.99 |
| 1,1-Dichloroethane | <0.40 | <0.40 | <0.40 | <0.40 | 0.80 |
| 1,1-Dichloroethene | <0.40 | <0.40 | <0.40 | <0.40 | 0.63 |
| 1,2-Dibromoethane | <0.80 | <0.80 | <0.80 | <0.80 | 1.84 |
| 1,3- Butadiene | <0.22 | <0.22 | <0.22 | <0.22 | 0.38 |
| 1,2-Dichlorobenzene | <0.60 | <0.60 | <0.60 | <0.60 | 1.37 |
| 1,3-Dichlorobenzene | <0.60 | <0.60 | <0.60 | <0.60 | 1.13 |
| 1,4-Dichlobenzene | <0.60 | <0.60 | <0.60 | <0.60 | 1.37 |
| Acetone | **30.83** | **26.08** | **23.71** | 10.67 | 11.14 |
| Benzene | 0.61 | 0.57 | 0.54 | 0.54 | 0.92 |
| Bromoform | 1.94 | <1.02 | <1.02 | <1.02 | 1.74 |
| Bromomethane | <0.38 | <0.38 | <0.38 | <0.38 | 0.69 |
| Carbon Disulfide | <0.31 | 0.50 | <0.31 | <0.31 | 0.62 |
| Carbon Tetrachloride | 0.68 | <0.62 | 0.87 | 0.93 | 1.43 |
| Chlorobenzene | <0.49 | <0.49 | <0.49 | <0.49 | 1.10 |
| Chloroethane | <0.26 | <0.26 | <0.26 | <0.26 | 0.55 |
| Chloromethane | 0.70 | 0.63 | 1.00 | 1.06 | 1.02 |
| Cis-1,3-Dichloropropene | <0.45 | <0.45 | <0.45 | <0.45 | 0.99 |
| Cyclohexane | 0.62 | <0.34 | <0.34 | <0.34 | <0.34 |
| Dibromochloromethane | <0.84 | <0.84 | <0.84 | <0.84 | 1.85 |
| Dichlorodifluoromethane | 1.43 | 1.19 | 2.23 | 2.42 | 2.33 |
| Ethyl Acetate | <0.36 | 0.61 | <0.36 | <0.36 | <0.36 |
| Ethylbenzene | <0.43 | <0.43 | <0.43 | <0.43 | 1.21 |
| Halocarbon 11 | 1.01 | 0.84 | 1.51 | 1.62 | 2.46 |
| Heptane | **0.49** | <0.41 | <0.41 | <0.41 | <0.41 |
| Hexane | **3.48** | 0.63 | 0.87 | 0.49 | 1.02 |
| Methyl Ethyl Ketone | 2.06 | 1.83 | 1.62 | 2.03 | 1.53 |
| Methylene Chloride | 1.20 | <0.43 | <0.43 | <0.43 | 0.76 |
| M/P-Xylene | 1.56 | <0.66 | <0.66 | <0.66 | 1.78 |
| o-Xylene | <0.43 | <0.43 | <0.43 | <0.43 | 0.91 |
| Propene | **0.34** | **0.24** | <0.17 | <0.17 | <0.17 |
| Styrene | <0.42 | <0.42 | <0.42 | <0.42 | 0.94 |
| Tetrachloroethylene | <0.67 | <0.67 | <0.67 | <0.67 | 1.27 |
| Toluene | **4.89** | 1.77 | 1.13 | 1.13 | 1.54 |
| Trans-1,2-Dichloroethylene | <0.39 | <0.39 | <0.39 | <0.39 | 0.82 |
| Vinyl Chloride | <0.25 | <0.25 | <0.25 | <0.25 | 0.48 |
| Total VOCs* | 51.84 | 34.89 | 33.48 | 21.66 | 48.43 |

A tentative ID match for 5 compounds was made using the NIST Library in personal samples. No tentative ID matches for compounds were found in other areas. See Table 13.
AFAP= away from active play of study team members.
*Total VOCs is the sum of all the concentrations that were detectable (does not include values less than reporting limit).

**Table 10. Volatile Organic Compound (VOC) Concentrations in µg/m$^3$ at Field D. (personal and on-turf concentrations 2X higher than background are in bold)**

| | VOC Concentration (µg/m$^3$) | | | | |
|---|---|---|---|---|---|
| **Compound Name** | **Personal** | **Personal** | **On Turf 6 inch AFAP** | **On Turf 3 ft AFAP** | **Background 3 ft** |
| 1,2,4-Trimethyl Benzene | 1.37 | <0.49 | <0.49 | <0.49 | <0.49 |
| Acetone | **28.45** | **23.71** | 5.69 | 6.64 | 7.35 |
| Bromoform | 1.02 | 13.29 | 1.02 | 1.02 | 1.02 |
| Chloromethane | 0.98 | 1.06 | 1.10 | 1.08 | 1.06 |
| Dichlorodifluoromethane | 2.23 | 2.33 | 2.42 | 2.47 | 2.47 |
| Ethyl Acetate | **1.15** | **1.22** | <0.36 | <0.36 | <0.36 |
| Halocarbon 11 | 1.40 | 1.40 | 1.40 | 1.46 | 1.46 |
| Heptane | **0.65** | **0.70** | <0.41 | <0.41 | <0.41 |
| Hexane | 0.77 | 0.77 | <0.35 | <0.35 | 1.05 |
| Methyl Ethyl Ketone | 1.59 | 1.44 | 1.09 | 1.12 | 1.06 |
| Methyl Isobutyl Ketone | **2.66** | **2.29** | <2.04 | <2.04 | <2.04 |
| Propene | **0.48** | **0.50** | <0.17 | <0.17 | <0.17 |
| Toluene | **1.39** | **1.47** | **0.71** | <0.38 | <0.38 |
| Total VOCs* | 44.14 | 50.18 | 13.43 | 13.79 | 15.47 |

A tentative ID match for 6 compounds was made using the NIST Library in personal samples. There were tentative ID matches 3 feet above the turf and in the background area. See Table 13.

AFAP= away from active play of study team members.

*Total VOCs is the sum of all the concentrations that were detectable (does not include values less than reporting limit).

**Table 11. Volatile Organic Compound (VOC) Concentrations in µg/m$^3$ at Field K. (personal and on-turf concentrations 2X higher than background are in bold)**

| | VOC Concentration (µg/m$^3$) | | | | |
|---|---|---|---|---|---|
| **Compound Name** | **Personal** | **Personal** | **On Turf 6 inch AFAP** | **On Turf 3 ft AFAP** | **Background 3 ft** |
| 1,1,-2Trichlorotrifluoroethane | <0.54 | <0.54 | <0.54 | <0.54 | 1.53 |
| 1,1,2-Trichloroethane | <0.54 | <0.54 | <0.54 | <0.54 | 0.76 |
| 1,2-Dichloropropane | <0.45 | <0.45 | <0.45 | <0.45 | 0.69 |
| 1,2,4-Trimethyl Benzene | **1.28** | **2.11** | <0.49 | <0.49 | <0.49 |
| 1,2-Dichloroethane | 1.04 | <0.40 | <0.40 | <0.40 | 0.68 |
| 1,3,5-Trimethyl Benzene | <0.49 | **1.18** | <0.49 | <0.49 | <0.49 |
| 1-Ethyl-4-Methyl Benzene | <0.49 | **1.37** | <0.49 | <0.49 | <0.49 |
| Acetone | **92.48** | <1.19 | 17.01 | 12.33 | 9.25 |
| Acrolein | **3.66** | **3.89** | <1.15 | <1.15 | <1.15 |
| Benzene | 1.15 | 1.18 | <0.32 | <0.32 | 0.64 |
| Bromodichloromethane | **0.62** | <0.62 | <0.66 | <0.66 | <0.66 |
| Bromoform | **34.75** | <1.02 | <1.02 | <1.02 | <1.02 |
| Carbon Disulfide | **0.87** | **0.84** | **0.90** | **0.90** | <0.31 |
| Carbon Tetrachloride | <0.62 | <0.62 | <0.62 | <0.62 | 1.30 |
| Chloroform | <0.48 | <0.48 | <0.48 | <0.48 | 0.68 |
| Chloromethane | 1.57 | 1.45 | 1.17 | 1.23 | 1.21 |
| Cyclohexane | **10.30** | **7.21** | **0.82** | **0.82** | <0.34 |
| Dichlorodifluoromethane | 3.02 | 2.87 | 2.77 | 2.87 | 2.72 |
| Ethyl Acetate | **10.07** | **11.87** | <0.36 | <0.36 | <0.36 |
| Ethylbenzene | **4.77** | **4.77** | **1.00** | **1.04** | <0.43 |
| Halocarbon 11 | 2.07 | 1.96 | 1.90 | 2.02 | 2.41 |
| Heptane | **10.22** | **7.36** | 0.98 | 0.98 | 0.53 |
| Hexane | 11.25 | 10.90 | 7.38 | 7.38 | 9.4 |
| M/P-Xylene | **12.13** | **11.70** | **2.17** | **2.17** | <0.87 |
| Methyl Ethyl Ketone | **44.15** | **44.15** | 2.09 | 2.00 | 1.83 |
| Methyl Isobutyl Ketone | 20.44 | **22.08** | **35.98** | **35.98** | <0.29 |
| Methylene Chloride | **10.30** | **9.96** | 1.10 | 1.17 | 1.10 |
| O-Xylene | **3.42** | **4.03** | **0.87** | **0.91** | <0.43 |
| Propene | **0.76** | **0.72** | <0.17 | <0.17 | <0.17 |
| Styrene | **1.45** | **3.53** | <0.43 | <0.43 | <0.43 |
| Tetrachloroethylene | 1.34 | 1.14 | <0.67 | <0.67 | 0.94 |
| Tetrahydrofuran | **3.53** | **3.24** | <1.42 | <1.42 | <1.47 |
| Toluene | **135.4** | **127.88** | **2.78** | **2.82** | 1.09 |
| Trichloroethylene | **2.23** | **2.13** | <0.53 | <0.53 | <0.53 |
| Vinyl Acetate | <0.35 | **2.95** | <0.35 | <0.35 | <0.35 |
| Total VOCs* | 424.27 | 292.47 | 78.92 | 71.80 | 36.76 |

A tentative ID match for 10 compounds was made using the NIST Library in personal samples. There were tentative ID matches for 5 compounds on turf and no matches were found in the background area. See Table 13.

[a]Concentration is an estimate. The value is above the upper calibration range.

AFAP= away from active play of study team members.

*Total VOCs is the sum of all the concentrations that were detectable (does not include values less than reporting limit).

**Table 12. Volatile Organic Compounds (VOC) Concentrations in µg/m$^3$ at Field L.**

| Compound Name | VOC Concentration (µg/m$^3$) |
|---|---|
| | 3 ft |
| Acetone | 7.11 |
| Carbon Tetrachloride | 0.75 |
| Chloromethane | 1.19 |
| Dichlorodifluoromethane | 2.28 |
| Halocarbon 11 | 1.46 |
| Hexane | 7.38 |
| Methyl Ethyl Ketone | 1.41 |
| Methylene Chloride | 0.48 |
| Propene | 0.48 |
| Toluene | 0.90 |
| Total VOCs | 23.44 |

No tentative ID matches for additional compounds were found using the NIST Library.
*Total VOCs is the sum of all the concentrations that were detectable (does not include values less than reporting limit).

**Table 13. Tentative identification of VOCs in personal, on-turf and background areas matched with the NIST Library at all fields (A-D, K-L).**

| Chemicals | Fields Personal | Fields On-Turf (height of sample) | Fields (Background) |
|---|---|---|---|
| 1-Bromo-propane | B, K | | |
| 1-Chloro-1,1-Difluoroethane | K | K (3') | |
| 1,1-Difluorethane | B | B (6" and 3') | B (3') |
| 1,2-diethylbenzene | D | | |
| 2-Methyl Butane | B, K | D, K (3') | |
| 2-Methyl Pentane | B | | |
| 3-Methyl Hexane | B | | |
| 3-Methyl Pentane | B | | |
| 1,3-Pentadiene | A, | | |
| 1R-Alpha-Pinene | D | | |
| Acetaldehyde | A, B, C | | |
| Acetonitrile | B, K | | |
| Beta-Pinene | D | | |
| Butane | | K (6" and 3') | |
| D-Limonen | B | | |
| Ethanol | K | K (6") | |
| Ethyl Alcohol | B | | |
| Fluorobenzene | D | | |
| Hexanal | B, K | | |
| Isobutane | B | | |
| Isobutene | K | | |
| Isopropyl Alcohol | A, B, C, D, K | K (6" and 3') | |
| Methyl-Cyclopentane | B | | |
| Nonanal | C | | |
| Octamethyl – Cyclotetrasiloxane | D | D (3') | D (3') |
| Octanal | A, B, C | | |
| Pentane | B, C, K | K (6" and 3') | |

### 3.4.2 Semi-Volatile Organic Compounds (SVOCs)

An SVOC is any organic compound having a vapor pressure of 1 mmHg or less at standard conditions (293 K and 760 mmHg). Three categories of SVOCs were included in this investigation:1) polyaromatic hydrocarbons (PAHs), 2) miscellaneous SVOCs associated with air pollution such as alkanoic acids (sources include road dust), hopanes/steranes (sources include diesel and gasoline vehicles), and other general compounds such as branched/n-alkanes [16] and 3) five targeted rubber-related SVOCs: benzothiazole, 2-mercaptobenzothiazole, 4-tert-(octyl-phenol, butylated hydroxanisole (BHA), and butylated hydroxytoluene (BHT).

*PAHs and Miscellaneous SVOCs Area Sampling:* PAHs and miscellaneous SVOCs associated with air pollution were collected with Polyurethane Foam Samplers (PS-1, Anderson Instruments, Inc., GA) according to EPA Method TO-13A. Air samples were collected for two hours at flow rates ranging from 207-237 liters per minute (lpm). At Field D, additional air sampling was conducted for 6 hours at flow rates ranging from 209-226 lpm. Samplers were placed on the turf near the middle of each field and in a location upwind and off the turf field (background). All of the samples were collected at a height of approximately 4 feet. The same sampler was used for each designated location (background or on-turf) at all fields. Several extension cords (100-150ft) were used to supply power to samplers from buildings near the sampling fields. The motor of each sampler was exhausted downwind and away from sampling equipment with a 15 foot flexible duct.

Sampler magnehelic gauges were calibrated for each sampling event using a calibrated critical orifice as a transfer standard. The orifices were connected to a slack tube manometer in the UCHC office in Farmington, CT. Manometer and magnehelic gauge readings were recorded, and flow rates were compared to the WOHL calibrations measurements recorded in the WOHL laboratory. Measurements were within $\pm$ 10% of one another. Calibration flow verifications were performed after use to ensure that the calculated magnehelic set point was accurate. Prior to each sampling event, sampling heads and samplers were cleaned with hexane.

Sampling heads were loaded with cylindrical glass PUF (polyurethane foam)/XAD-2 cartridge (PUF Plug Part #20038, Supelco, Bellefonte, PA) and filter (Whatman Quartz Microfiber Filters, 102 mm, NJ) in UCHC office. After loading, each head was placed in a ziplock bag, then placed in a travel bag, and transported to the field. In the field, samplers were turned on for five minutes. Leak checks were conducted on site prior to sampling. Sampling heads were placed in the PS-1 samplers and magnehelic gauge measurements were recorded on site at the beginning and end of sampling. Magnehelic gauge measurements were the same at the beginning and end of sampling at all fields. Sampling heads were transported to UCHC on ice. Media was processed out of the sampling heads and placed in glass jars at UCHC. All samples were shipped to WOHL/WSLH on ice on the same day as sampling.

During 2 hour sampling at Field D on July 14, 2009, the PS-1 Sampler was turned on for approximately ten minutes without the valve open (sample 217-background). Site coordinator corrected the problem, checked for air leaks, re-tightened seals, and re-checked for air leaks. During the 6-hour sampling session on July 28 at Field D, power was lost for approximately ten minutes (sample 221-background). The site coordinator reported the power problem, and facilities corrected it.

A total of 12 field samples were collected. The first set of samples collected from Field L (community) broke during shipment to WOHL/WSLH. Shipping procedures were modified to place the glass cartridges in foam and extra wrapping. Unfortunately, glass PUF/XAD cartridges broke during transportation of the media to UCHC and insufficient sampling media was available to collect samples from Fields B and C (upwind background location only). It was not possible to reschedule these sampling events to collect more data. Ten field samples were analyzed.

*Sample Preparation and Analysis:* Samples were prepared and analyzed according to EPA Method TO-13 by WSLH. All samples had all internal standards spiked pre-extraction. A rotovap was used in place of a K-D concentrator. Other parameters include: inlet temp 300 C, flow 1.0 ml/min, and average velocity 37cm/sec. Initial oven temperature 65C hold for 10 min, ramp up at 10 C/min until 300 C, then hold at 300 C for 26.50 minutes. Although laboratory spike recoveries of benzothiazole were acceptable on the PUF/XAD media, low levels of benzothiazole were observed in the high volume field samples in comparison to the personal sampler benzothiazole method. Since collection efficiency is unknown for benzothiazole on high volume sampler media, the high volume sampler results were determined to be non-reportable.

If an analyte in the method blank was greater than its reporting limit, the result for that analyte was flagged to indicate blank contamination. Concentrations were corrected for any blank contamination. Extraction of most chemicals was complete ranging from 75 to 125% as specified by the EPA Method TO-13A. Final concentrations were adjusted by extraction recoveries for analytes below 75% (Appendix H). Concentrations with recoveries exceeding 125% are not adjusted.

*Results:* Tables 1-6 in Appendix I provide the SVOC concentrations for Fields A-D and K. Final SVOC concentrations are reported as nanogram per cubic meter ($ng/m^3$). Analytes not detected are reported as nondetectable (ND). Target analytes positively detected but too far below the reporting limit are reported as DNQ. Values for analyte concentrations confirmed but measured below the reporting limit are reported with the footnote “a”. Values for analyte concentrations corrected by extraction recoveries are reported with the footnote “b”.

*SVOCs Six Hour vs. Two Hour Sampling Method:* Our sampling strategy included a 2 hour sampling time because it represents a typical activity period for athletes using turf fields. At Field D, an extra day of sampling was conducted for 6 hours using EPA Method TO-13A to increase the sensitivity (Tables 3 and 4 in Appendix I). The results suggest that the 2 hour sampling time period allowed for the collection of useful data. During both the 2 and 6 hour sampling periods, similar patterns were observed-nearly half of the SVOCs were either not detected or they were found in greater concentrations on turf than in background locations. Although additional PAHs were detected on turf during the 6 hour sampling (e.g. benz(a)anthracene, benzo(b)fluoranthene, benzo(e)pyrene, benzo(GHI)perylene, benzo(k)fluroanthene), their concentrations on turf were similar to background concentrations. Eight miscellaneous SVOCs were not detected during the 2 hour sampling but were reported with two fold greater concentrations on the turf than in background during the 6 hour sampling period (e.g. decycloclohexane , dodecane, dotriacontane, octacosane, pristine, tetratriacontane, triacontane, tritriacontane).

## Polyaromatic Hydrocarbons

The EPA Method TO-13A includes qualitative and quantitative analyses for certain categories of compounds, such as PAHs. The concentrations of PAHs are provided in Tables 14-16. Because PAHs may be found in crumb rubber made from tires, the following 22 were targeted:

Acenaphthene
Acenaphthylene
Anthracene
Benz(a)anthracene
Benzo(a)pyrene
Benzo(e)pyrene
Benzo(GHI)perylene
Benzo(k)fluoranthene
Benzo(b)fluoranthene
Chrysene
Coronene
Dibenz(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
Naphthalene
Phenanthrene
Perylene
1-Methylnaphthalene
2-Methylnaphthalene
2,6-Dimethylnaphthalene
Pyrene

**Table 14. PAH concentrations in ng/m$^3$ at Fields A-C (ng/m$^3$).**
**(on-turf concentrations 2X higher than background are in bold for field A only)**

| | SVOC Concentrations ng/m$^3$ | | | |
|---|---|---|---|---|
| **PAHs** | **Field A On Turf** | **Field A Background** | **Field B On Turf** | **Field C On Turf** |
| Acenaphthene | 2.14 | 2.95 | 2.74 [b] | 3.46 [b] |
| Benz(a)anthracene | ND <0.36 | ND <0.41 | 0.11 [a] | ND <0.41 |
| Benzo(a)pyrene | ND <0.20 | ND <0.22 | 0.19 [a] | 0.16 [a] |
| Benzo(b)fluoranthene | ND <0.65 | ND <0.74 | 0.22 [a] | 0.13 [a] |
| Benzo(e)pyrene | ND <0.21 | ND <0.24 | 0.26 | 0.12 [a] |
| Benzo(GHI)fluoranthene | ND <0.35 | ND <0.40 | 0.08 [a] | ND <0.39 |
| Benzo(GHI)perylene | **0.14** [a] | ND <0.67 | 0.05 [a] | 0.07 [a] |
| Benzo(k)fluoranthene | ND <0.32 | ND <0.40 | 0.04 [a] | 0.08 [a] |
| Chrysene | ND <0.26 | ND <0.30 | 0.34 | 0.13 [a] |
| Fluoranthene | 1.68 | 1.474 | 2.83 | 1.70 |
| Fluorene | 2.21 [b] | 2.87 [b] | 4.10 [b] | 2.62 [b] |
| Naphthalene | 5.99 | 7.72 | 6.17 | 12.51 |
| | | | | |
| Phenanthrene | 5.07 | 6.35 | 10.46 | 7.27 |
| Pyrene | 1.70 | 1.01 | 2.66 | 0.97 |
| 1-Methylnaphthalene | 3.96 [b] | 6.34 [b] | 3.72 [b] | 5.67 [b] |
| 2,6-Dimethylnaphthalene | 2.83 | 4.47 | ND <0.91 | 5.74 |

Abbreviations: ND= analytes not detected. DNQ= analytes positively detected but too far below the reporting limit.
[a]Values for analyte concentrations confirmed but measured below the reporting limit.
[b]Values for analyte concentrations corrected by extraction recoveries. See Appendix F.

**Table 15. PAH concentrations in ng/m$^3$ at Field D (2 and 6 hour sampling).**
**(on-turf concentrations 2X higher than background are in bold)**

| PAHs | Field D On Turf (2 hour) | Field D Background (2 hour) | Field D On Turf (6 hour) | Field D Background (6 hour) |
|---|---|---|---|---|
| Acenaphthene | 3.38 [b] | 2.95 [b] | **2.79** [b] | 2.47 [b] |
| Acenaphthylene | **6.60** [b] | ND <3.74 | ND <1.25 | 0.77 |
| Anthracene | ND <0.22 | ND <0.22 | ND <0.07 | 0.02 [a] |
| Benz(a)anthracene | ND <0.42 | ND <0.42 | **0.04** [a] | 0.03 |
| Benzo(a)pyrene | ND <0.23 | ND <0.23 | **0.07** [a] | 0.05 [a] |
| Benzo(b)fluoranthene | ND <0.75 | ND <0.76 | 0.07 [a] | 0.07 [a] |
| Benzo(e)pyrene | ND <0.24 | ND <0.25 | **0.07** [a] | 0.06 [a] |
| Benzo(GHI)fluoranthene | DNQ | ND <0.41 | **0.02** [a] | ND <0.13 |
| Benzo(GHI)perylene | ND <0.67 | ND <0.69 | 0.04 [a] | 0.06 [a] |
| Benzo(k)fluoranthene | ND <0.37 | ND <0.38 | **0.05** [a] | 0.04 [a] |
| Chrysene | **0.30** | 0.07 [a] | **0.12** | 0.08 [a] |
| Fluoranthene | **6.76** | 1.19 | 2.26 | 3.96 |
| Fluorene | 3.65 [b] | 3.59 [b] | **2.93** [b] | 2.43 [b] |
| Naphthalene | 6.32 | 4.51 | 14.57 | 16.94 |
| Phenanthrene | **14.34** | 6.11 | 11.48 | 13.05 |
| Pyrene | **6.92** | 0.47 | 2.42 | 3.16 |
| 1-Methylnaphthalene | **9.31** [b] | 4.08 [b] | **8.31** [b] | 6.91 [b] |
| 2-Methylnaphthalene | **4.237** [b] | 2.16 [b] | **3.76** [b] | 3.31 [b] |
| 2,6-Dimethylnaphthalene | ND <0.95 | ND <0.97 | **7.65** | 6.13 |

Abbreviations: ND= analytes not detected. DNQ= analytes positively detected but too far below the reporting limit.
[a]Values for analyte concentrations confirmed but measured below the reporting limit.
[b]Values for analyte concentrations corrected by extraction recoveries. See Appendix F.

**Table 16. PAH concentrations in ng/m$^3$ at Field K.**
**(on-turf concentrations 2X higher than background are in bold)**

| PAHs | Field K On Turf | Field K Background |
|---|---|---|
| Acenaphthene | **17.37** [b] | 3.99 [b] |
| Acenaphthylene | **6.79** | ND <3.20 |
| Chrysene | ND <0.26 | 0.04 [a] |
| Fluoranthene | **5.55** | 0.58 |
| Fluorene | **53.70** [b] | 3.42 [b] |
| Naphthalene | **112.99** | 7.05 |
| Phenanthrene | **32.26** | 7.56 |
| Pyrene | **11.84** | 0.37 |
| 1-Methylnaphthalene | **114.20** [b] | 6.16 [b] |
| 2,6-Dimethylnaphthalene | **28.70** | 10.37 |
| 2-Methylnaphthalene | **63.38** [b] | 2.72 [b] |

Abbreviations: ND= analytes not detected.
[a]Values for analyte concentrations confirmed but measured below the reporting limit.
[b]Values for analyte concentrations corrected by extraction recoveries. See Appendix F.
*Not in calibration standard mix but is quantitated.

### 3.4.2.3 Targeted Rubber-Related SVOCs

*Air Sampling:* Personal and area air samples were collected for the following five rubber-related SVOCs: benzothiazole, 2-mercaptobenzothiazole, 4-tert-(octyl-phenol, butylated hydroxanisole (BHA), and butylated hydroxytoluene (BHT). Air samples for these compounds were collected using sampling pumps fit with XAD-2 adsorbent media and 37mm, 2 micron PTFE pre filters. The pumps were pre and post calibrated for approximately 2 liters per minute (LPM). The samples were collected for two hours.

At Fields A-D and K, the personal samples were collected by placing the pumps at waist-height on two study team members involved in active play. Two area samples were collected at 6 inches and 3 feet above the ground at the following locations: on the field near active play (NAP), on the field away from active play (AFAP), and at the upwind background location. At Field L, an area sample was collected at 3 feet. At Field D during the six hour sampling event, two on field air samples were collected (6 inches and 3 feet). The two sampling pumps failed during the six hour sampling event. The data were considered unreliable and are not reported. A field blank was submitted for each field. Field spike samples were also submitted for Fields A, B, D (6 hr), and K. A total of 58 samples were collected including 7 field blanks and 6 field spikes.

*Sample Analysis:* All samples were analyzed by WOHL using NIOSH Method 2550 (modified). Bulk material or samples collected on XAD-2 (vapor) and/or PTFE pre-filter (particulate) filter air sampling devices were desorbed with 10 minutes of sonication performed with methanol. Desorption volumes were 2mL methanol for the particulate portion and 1mL methanol for vapor portion of each sample. Extracts were analyzed by reversed phase high-performance liquid chromatography employing a 0.1% formic acid:methanol linear gradient program. Detection was achieved by triple quadrupole mass spectrometry using multiple reaction monitoring (MRM). Quality control samples also included laboratory reagent blanks, laboratory method blanks, and laboratory control spikes. Calibration check standards were also analyzed after every 10 samples analyzed.

*Results:* Concentrations are reported in $ng/m^3$. Benzothiazole and 2-mercaptobenzothiazole recoveries were incomplete (below 75%). The field spike recovery for benzathiozole (vapor phase) was also incomplete (mean recovery = 72%). Therefore, results reported were corrected for incomplete recoveries. 4-tert-(octyl-phenol, Butylated hydroxanisole (BHA), and Butylated hydroxytoluene (BHT) recoveries were also adjusted when spike recoveries observed were below 75%. In cases where background signal was observed in reagent and/or method blanks, the reporting limit was raised to account for this. The reporting limit chosen for each analyte also represents the lowest calibration standard that resulted in acceptable back calculated recovery (within +/- 25% of theoretical value). Appendix I provides the WOHL analytical laboratory reports.

Tables 17-22 in Appendix I provide the results of the targeted rubber-related SVOCs.

**Table 17. Targeted Rubber-Related SVOC concentrations in ng/m$^3$ at Field A. (on turf concentations higher than two times background are in bold)**

| SVOCs | P1 | P2 | 6" on field NAP | 3' on field NAP | 6" on field AFAP | 3' on field AFAP | 6" back ground | 3' back ground |
|---|---|---|---|---|---|---|---|---|
| Benzothiazole | <81 | **130** | **160** | **240** | **230** | <81 | <84 | <82 |
| 2-mercapto benzothiazole | <81 | <81 | <83 | <84 | <82 | <81 | <84 | <82 |
| 4-tert-octyl | <40 | <40 | <41 | <42 | 22 | <41 | <42 | 26 |
| BHA | <40 | <40 | <41 | <42 | <41 | <41 | <42 | <41 |
| BHT | <81 | <81 | <83 | <84 | 86 | <81 | 150 | <82 |

Abbreviations: NAP=near active play;AFAP=away from active play

**Table 18. Targeted Rubber-Related SVOC concentrations in ng/m$^3$ at Field B. (on turf concentations higher than two times background are in bold)**

| SVOCs | P1 | P2 | 6" on field NAP | 3' on field NAP | 6" on field AFAP | 3' on field AFAP | 6" back ground | 3' back ground |
|---|---|---|---|---|---|---|---|---|
| Benzothiazole | <80 | <83 | **210** | **210** | **180** | <85 | <85 | <84 |
| 2-mercapto benzothiazole | <80 | <83 | <80 | <85 | <85 | <85 | <85 | <84 |
| 4-tert-octyl | <40 | <41 | <40 | <43 | <42 | <42 | <43 | <42 |
| BHA | <40 | <41 | <40 | <43 | <42 | <42 | <43 | <42 |
| BHT | <80 | <83 | <80 | <85 | <85 | <85 | <85 | <84 |

Abbreviations: NAP=near active play;AFAP=away from active play

**Table 19. Targeted Rubber-Related SVOC concentrations in ng/m$^3$ at Field C. (on turf concentations higher than two times background are in bold)**

| SVOCs | P1 | P2 | 6" on field NAP | 3' on field NAP | 6" on field AFAP | 3' on field AFAP | 6" back ground | 3' back ground |
|---|---|---|---|---|---|---|---|---|
| Benzothiazole | <82 | <81 | **220** | <74 | **220** | <82 | <81 | <80 |
| 2-mercapto benzothiazole | <82 | <81 | <73 | <74 | <82 | <82 | <81 | <80 |
| 4-tert-octyl | <41 | <41 | <36 | <37 | <41 | <41 | <40 | <40 |
| BHA | <41 | <41 | <36 | <37 | <41 | <41 | <40 | <40 |
| BHT | <82 | <81 | <73 | <74 | <82 | <82 | <81 | <80 |

Abbreviations: NAP=near active play;AFAP=away from active play

**Table 20. Targeted Rubber-Related SVOC concentrations in ng/m$^3$ at Field D. (on turf concentations higher than two times background are in bold)**

| SVOCs | P1 | P2 | 6" on field NAP | 3' on field NAP | 6" on field AFAP | 3' on field AFAP | 6" back ground | 3' back ground |
|---|---|---|---|---|---|---|---|---|
| Benzothiazole | **240** | <82 | 610 | **210** | 1200 | **280** | 700 | <77 |
| 2-mercapto benzothiazole | <81 | <82 | <78 | <80 | <82 | <84 | <79 | <77 |
| 4-tert-octyl | <40 | <41 | <39 | <40 | <41 | <42 | <40 | <38 |
| BHA | <40 | <41 | <39 | <40 | <41 | <42 | <40 | <38 |
| BHT | <81 | 97 | **160** | **130** | <82 | <84 | <79 | <77 |

Abbreviations: NAP=near active play;AFAP=away from active play

**Table 21. Targeted Rubber-Related SVOC concentrations in ng/m$^3$ at Field K. (on turf concentations higher than two times background are in bold)**

| SVOCs | P1 | P2 | 6" on field NAP | 3' on field NAP | 6" on field AFAP | 3' on field AFAP | 6" back ground | 3' back ground |
|---|---|---|---|---|---|---|---|---|
| Benzothiazole | **11000** | **13000** | **14000** | **12000** | **11000** | **12000** | <82 | <82 |
| 2-mercapto benzothiazole | <82 | <86 | <81 | <83 | <82 | <82 | <82 | <82 |
| 4-tert-octyl | <41 | <43 | <41 | <42 | <41 | <41 | <41 | <41 |
| BHA | <41 | <43 | <41 | <42 | <41 | <41 | <41 | <41 |
| BHT | **1300** | **1800** | **2100** | **3900** | **2100** | **1900** | 88 | <82 |

Abbreviations: NAP=near active play;AFAP=away from active play

**Table 22. SVOC concentrations in ng/m$^3$ at Field L.**

| SVOCs | 3' on grass |
|---|---|
| Benzothiazole | <83 |
| 2-mercapto benzothiazole | <83 |
| 4-tert-octyl | <42 |
| BHA | <42 |
| BHT | 280 |

### 3.4.3 Nitrosamines

*Air Sampling:* Personal and air samples for Nitrosamine were collected using sampling pumps fit with Thermosorb/N$^{TM}$ tubes. The pumps were pre and post calibrated at approximately 2 liters per minute. The samples were collected for two hours.

At fields A-D and K, the personal samples were collected by placing the pumps at waist-height on two study team members involved in active play. Two area samples were collected on the fields away from active (AFAP) at 6 inches and 3 feet above the ground, and two area samples were collected at the upwind background location at 6 inches and 3 feet above the ground. At Field L, one area sample was collected at 3 feet. At Field D during the six hour sampling event, two on field area samples (6 inches and 3 feet) were collected. A field blank was collected at each field. A total of 40 samples were collected including 7 field blanks. Upon arrival to WOHL, one field sample had a cracked inlet

*Analysis:* All samples were analyzed by WOHL using NIOSH 2522 for the following nitrosamines: N-nitrosodimethylamine (NDMA), N-nitrosomorpholine (NMOR), N-nitrosopyrrolidine (NPYR), N-nitrosodiethylamine (NDEA), N-nitrosopiperdine (NPIP), N-nitrosodipropylamine (NDPA), and N-nitrosodibutylamine (NDBA). Nitrosamines were not found in the field blanks.

*Results:* Table 23 provides the results of the nitrosamine sampling. Concentrations are reported in µg/m$^3$. All concentrations were below the reporting limits. Appendix J provides the WOHL analytical laboratory reports for nitrosamine sampling.

**Table 23. Nitrosamine concentrations in µg/m$^3$ at each field (A-D, K-L)**

| Field | Location | Nitrosamine µg/m$^3$ |
|---|---|---|
| A | 6" on field AFAP | <0.41 |
| A | 3' on field AFAP | <0.32 |
| A | 6" background | <0.42 |
| A | 3' background | <0.41 |
| A | Personal | <0.42 |
| A | Personal | <0.41 |
| B | 6" on field AFAP | <0.34 |
| B | 3' on field AFAP | <0.41 |
| B | 6" background | <0.35 |
| B | 3' background | <0.43 |
| B | Personal | <0.39 |
| B | Personal | <0.41 |
| C | 6" on field AFAP | <0.41 |
| C | 3' on field AFAP | <0.34 |
| C | 6" background | <0.39 |
| C | 3' background | <0.32 |
| C | Personal | <0.38 |
| C | Personal | <0.38 |
| D | 6" on field AFAP | <0.42 |
| D | 3' on field AFAP | <0.42 |
| D | 6" background | <0.38 |
| D | 3' background | <0.35 |
| D | Personal | <0.39 |
| D | Personal | <0.40 |
| D-6hr | 6" on field AFAP | <0.14 |
| D-6hr | 3' on field AFAP | <0.14 |
| K | 6" on field AFAP | <0.40 |
| K | 3' on field AFAP | <0.39 |
| K | 6" background | <0.31 |
| K | 3' background | <0.34 |
| K | Personal | <0.39 |
| K | Personal | <0.41 |
| L | 3' | <0.25[a] |

Abbreviations: AFAP=away from active play.
[a] The sampler had a cracked inlet upon arrival to WOHL.

### 3.4.3 Air Particulate Matter ($PM_{10}$)

*Air Sampling:* Area Air samples for particulate matter ($PM_{10}$) were collected using the Harvard Impactor (MS&T Area Sampler, Air Diagnostics and Engineering, Harrison, ME, USA). Samples were collected onto 37 mm Teflon filters (2.0 um) at a flow rate of 20 Liters/minute (Pump Model SP-280, Air Diagnostics and Engineering Inc., Harrison, ME;S/N 30637 and 30565). Two samples were collected at 3 feet above the ground per field: on turf near the middle of the field and upwind off-turf (background). Field blanks were collected and analyzed at every sampled field. Extension cords were connected to electrical outlets in external buildings to provide power to the sampling pumps. The airflow rate was measured with a rotameter (AALBORG, Orangeburg, NY, S/N 227-202-4) before and after sampling with a representative sample medium according to HSPH Type Impactor SOP Protocol (6-26-00-Air Diagnostics and Engineering, Harrison, ME, USA). Flow rates after sampling were within $\pm$ 5% of the initial flow rate at each sampling field.

Twelve field samples and six field blanks were collected (two field samples and one blank per field). Filters were shipped to the WOHL laboratory on the same day as sampling on ice and frozen upon receipt until weight analysis.

*Analysis:* Samples were weighed according to CFR Title 40 Part 50 (Appendix L) before and after sampling to determine $PM_{10}$ concentration. Tare (before sampling) and post sampling weights were measured three times on a Mettler Toledo Model MX5 Balance (weighs to 0.001mg). These measurements were averaged, and the difference between the average tare and post sampling concentrations were used to calculate $PM_{10}$ concentration as micrograms per cubic meter of air ($\mu g/m^3$). Final $PM_{10}$ concentrations for field samples were corrected by field blanks (samples at fields C and K were corrected).

*Results*: Table 24 provides the $PM_{10}$ concentrations for all fields. $PM_{10}$ concentrations were greater in background locations than on the turf at all fields with the exception of Field B. However, the concentration on turf at Field B, 5.89 $\mu g/m^3$, was within the range of background concentrations (4.96-17.79 $\mu g/m^3$). The protocol for sampling at Field A was not followed properly and, therefore, data is not available.

**Table 24. Concentrations of Airborne Particulate Matter ($PM_{10}$) at 3 feet above the surface at fields (A-D, K-L).**

| Field ID | Location Type | $Pm_{10}$Concentration ($ug/m^3$) | |
|---|---|---|---|
| | | On Turf | Background |
| A | Outdoor | ---[a] | ---[a] |
| B | Outdoor | 5.89 | <0.38 |
| C | Outdoor | 16.54[b] | 17.79[b] |
| D | Outdoor | 4.52 | 4.96 |
| L | Outdoor | NA[c] | 8.81 |
| | (non-turf site) | | 8.61 |
| K | Indoor | 7.22 | 9.04 |

[a] --- Sampling protocol was not followed during sampling.
[b]Pesticide application occurred adjacent to field during sampling day (~10 minutes)
[c]NA is non applicable because sampling occurred in an suburban grass field (non-turf).

### Air Particulate Matter ($PM_{10}$) Characterization

Following gravimetric analysis, samples were stored at room temperature until particulate characterization analyses. Six samples were selected for Microscopic Particle Identification and characterization by Polarized Light Microscopy (WP001.20 Analysis), Scanning Electron Microscopy, and Energy Dispersive X-Ray (EDXA) analyses. These samples were collected from Fields B, D, K (on turf) and L (suburban grass). Appendix K provides the WOHL analytical laboratory reports for $PM_{10}$. Other samples were not analyzed as planned because rubber fragments were not easily detected and identification of particles were inconclusive.

## 4.0 Summary Findings

This report identifies and measures chemicals across several synthetic crumb rubber turf fields and background locations. The measurements collected from background locations are necessary to better understand the data because many of these chemicals are present in ambient air as a result of air pollution.

The following algorithm was used to identify a possible turf-related VOC, targeted SVOC or nitrosamine: Chemicals found in: A) either 6" or 3' samples; or B) in both personal and either 6" or 3' samples, greater than two times the background concentration measured near the field, were considered to have originated from the turf. The attribution of a chemical to the turf was considered stronger if the chemical was also found in at least one field's crumb rubber head space.

For PAHs and general SVOC's the following algorithm was used to identify a possible turf related chemical: Chemicals found in turf air samples but: A) not in background air samples or B) at twice the field's background concentration, were considered to have originated from the turf. Attribution of a chemical to an origin in the turf was considered stronger if this finding held on at least two fields.

### 4.1 Crumb Rubber Infill Bulk VOCs

The most commonly found VOCs (range of concentrations in parts per billion-ppbV) detected in crumb rubber infill include: acetonitrile (60-300ppbV), methylene chloride (dichloromethane) (20-430ppbV), methyl alcohol (33-270ppbV), and methyl isobutyl ketone (21-150ppbV). Bulk crumb rubber from the newer fields (A, B and D) contained more than ten VOCs. Crumb rubber from other fields contained less than 5 VOCs.

Bulk crumb rubber can act as a sink for organic compounds in the environment. Some VOCs, such as methylene chloride, methyl alcohol and acetone, were also found in a laboratory blank where the crumb rubber field samples were processed for the head space analysis. Presence of a VOC in the head space of the bulk crumb rubber infill as well as in air samples at two times greater than background levels is considered more suggestive that crumb rubber infill is the source of the VOC.

### 4.2 Air VOCs-Possibly Turf-Related

Of the 60 VOCs tested, 4 VOCs appear to be associated with turf. The concentration of methyl isobutyl ketone (35.98 $\mu g/m^3$) was the highest VOC detected in area samples collected on the turf (Field K). Acetone was the second highest VOC found in area samples on the turf, and it was also found in the air of the background location at lower concentration. Inter-player variability of total VOC air concentrations was notable on fields B (28.99 vs. 240.51 $\mu g/m^3$) and K (292.47 vs. 424.27 $\mu g/m^3$). The highest air concentrations on the turf for most VOCs were found at Field K.

Table 25 summarizes one possible algorithm for determining which VOCs may be related to crumb rubber emissions. Chemicals meeting these criteria are bolded, and most frequently found in Field K, the indoor facility, and not in the outdoor fields. Chemicals found in personal samples (at two times greater concentrations than background) but not in 6" or 3' or any bulk crumb rubber head space sample are unlikely to be turf related.

The belts and aprons that held the personal samplers in place during simulated soccer play emit a number of chemicals. Trace levels of acrolein were detected seven months later in mesh belt and cloth apron. Other sources of VOCs, such as sweat or the players' use of personal care products (e.g. sunscreen, deodorant, etc,) may be contributing to the VOC levels found in the personal results; however, it is difficult to determine this. In the future, personal samples should also be collected on grass (non-turf) field in order to better interpret the data.

**Table 25. VOC exposure assessment- screening algorithm for chemicals' relationship to crumb rubber emissions.**

| Screen for each field | Chemical | Field |
|---|---|---|
| Either 6" or 3' two times > background for this field<br>Chemical in this field's crumb rubber head space | **Toluene** | **D** |
| Either 6" or 3' two times > background for this field<br>Chemical not in field's crumb rubber head space but in at least one other field's crumb rubber head space | **Acetone[c]**<br>**Ethyl Benzene**<br>**Methyl Isobutyl Ketone**<br>**Toluene** | **C**<br>**K**<br>**K**<br>**K** |
| Either 6" or 3' two times > background for this field<br>Chemical is not in any field's crumb rubber head space | Carbon Disulfide<br>Cyclohexane<br>M/P-Xylene<br>O-Xylene | K<br>B, K<br>K<br>K |
| Personal two times > background for this field<br>Chemical is two times background in 6" or 3' sample<br>Chemical is in this field's crumb rubber head space | **Toluene** | **D** |
| Personal two times > background for this field<br>Chemical is two times background in 6" or 3' sample<br>Chemical not in field's crumb rubber head space but in at least one other field's crumb rubber head space | **Acetone[c]**<br>**Ethyl Benzene**<br>**Methyl Isobutyl Ketone**<br>**Toluene** | **C**<br>**K**<br>**K**<br>**K** |
| Personal two times > background for this field<br>Chemical is two times background in 6" or 3' sample<br>Chemical is not in any field's crumb rubber head space | Carbon Disulfide<br>Cyclohexane<br>M/P-Xylene<br>O-Xylene | K<br>B, K<br>K<br>K |
| Personal two times > background for this field<br>Chemical is not two times > background in 6" or 3' sample<br>Chemical is in this field's crumb rubber head space | Acetone[c]<br>Hexane<br>Methylene Chloride<br>Methyl Isobutyl Ketone<br>Toluene<br>(Acetonitrile)^<br>(Isopropyl Alcohol)^ | A, B<br>B, C<br>B<br>B, D<br>A, B<br>B<br>A, B |
| Personal two times > background for this field<br>Chemical is not two times > background in 6" or 3' sample<br>Chemical not in field's crumb rubber head space but in at least one other field's crumb rubber head space | Acetone[c]<br>Benzene[c]<br>Ethyl Benzene<br>Hexane<br>Toluene<br>(Acetonitrile)^<br>(Isopropyl Alcohol)^ | D<br>B<br>B<br>A<br>B, C<br>K<br>C, D, K |
| Personal two times > background for this field<br>Chemical not two times > background in 6" or 3' sample<br>Chemical is not in any field's crumb rubber head space | Acrolein<br>Bromodichloromethane<br>Bromoform<br>Carbon Disulfide<br>Ethyl Acetate<br>Heptane<br>M/P-Xylene<br>O-Xylene<br>Propene<br>Styrene<br>Tetrachloroethylene<br>Tetrahydrofuran<br>Trichloroethylene<br>Vinyl Acetate<br>1,2-Dichloropropane<br>1-Ethyl-4-Methyl Benzene<br>1,2,4-Trimethyl Benzene<br>1,3,5-Trimethyl Benzene | A, B, K<br>K<br>A, K<br>B<br>A, B, C, D, K<br>B, C, D<br>B<br>B<br>B, C, D, K<br>B, K<br>B, K<br>B, K<br>B, K<br>K<br>B<br>B, K<br>B, K<br>B, K |

^ tentative identification with NIST Library

[c]Compound was detected in the background sample of the laboratory used to analyze the bulk crumb rubber head space.

### Air VOCs-Background

Twenty VOCs of 60 were found in upwind background locations (Table 26). Five of these VOCs (chloromethane, dichlorodifluormethane, halocarbon 11, hexane and methyl ethyl ketone) were found in the upwind background locations at all five fields. Air concentrations of acetone, carbon tetrachloride and toluene were found at four background sites, whereas benzene and methylene chloride were detected at three sites.

**Table 26. VOC Concentrations in upwind background locations at all fields.**

| VOCs | Fields | Range of VOC Concentrations $\mu g/m^3$ (parts per billion ppbV) | |
|---|---|---|---|
| 1,1,-2-Trichlorotrifluoroethane | K | 1.53 | (0.20) |
| 1,1,2-Trichloroethane | K | 0.76 | (0.14) |
| 1,2-Dichloropropane | K | 0.69 | (0.15) |
| 1,2-Dichloroethane | K | 0.68 | (0.17) |
| 1,1,2,2-Tetrachloroethane | A | 1.02 | 0.15) |
| Acetone | A, B, D, L | 7.11-12.33 | (3.0-5.2) |
| Benzene | A, D, L | 0.41-0.64 | (0.13-0.20) |
| Carbon Tetrachloride | A, B, K, L | 0.75-1.30 | (0.14-0.21) |
| Chloroform | K | 0.68 | (0.14) |
| Chloromethane | A, B, D, K, L | 1.06-1.33 | (0.52-0.65) |
| Dichlorodifluoromethane | A, B, D, K, L | 2.23-2.47 | (0.45-0.5) |
| Ethyl Acetate | A | 0.61 | (0.17) |
| Halocarbon 11 | A, B, D, K, L | 0.53-1.96 | (0.13-0.35) |
| Heptane | K | 0.53 | (0.13) |
| Hexane | A, B, D, K, L | 0.88-9.40 | (0.25-2.6) |
| Methyl Ethyl Ketone | A, B, D, K, L | 1.06-1.74 | (0.36-0.62) |
| Methylene Chloride | A, K, L | 0.48-1.83 | (0.14-0.32) |
| Propene | L | 0.48 | (0.28) |
| Toluene | A, B, K, L | 0.75-0.1.09 | (0.2-0.29) |
| Vinyl Acetate | A | 1.02 | (0.29) |

### 4.3 Air PAHs and SVOCs-Possibly Turf Related

The EPA Method TO-13A was followed to collect and analyze ten air samples for 115 SVOCs. Table 27 provides the range of concentrations of PAHs across all the fields on outdoor turf, indoor turf and upwind background locations.

Table 28 summarizes one possible algorithm for determining which miscellaneous SVOCs may be related to crumb rubber emissions. The criteria used to determine if a chemical is potentially turf-related includes: Chemicals found in turf air samples but : A) not in background air samples or B) at twice the field's background concentration, were considered to have originated from the turf. Attribution of a chemical to an origin in the turf was considered stronger if this finding held on at least two fields.

At Field K, several compounds were ten fold higher on turf than background including five PAHS (1-methylnaphthalene, 2-methylnaphthalene, fluorene, naphthalene, and pyrene) and 7 general SVOCs (dotriacontane, heptacosane, hexacosane, octanoic acid, pentacosane, tetracosane, and tetradecane).

**Table 27. Range Concentrations of PAHs in ng/m$^3$ On Outdoor Turf and Upwind Background Locations.**

| PAH | Outdoor On Turf Range ng/m$^3$ (n=5*) | Indoor On Turf Concentration ng/m$^3$ (n=1) | Background Range ng/m$^3$ (n=4) |
|---|---|---|---|
| 1-Methylnaphthalene | 3.72-9.31 | ND | 4.08.6.91 |
| 2,6 Dimethylnaphthalene | ND-7.65 | 28.70 | ND-10.37 |
| 2-Methylnaphthalene | 1.88-4.24 | 63.38 | ND-3.31 |
| Acenaphthene | 2.14-3.45 | 17.37 | ND-0.3.99 |
| Acenaphthylene | ND-6.59 | 6.78 | ND-0.77 |
| Anthracene | ND-ND | ND | ND-0.02 |
| Benz(a)anthracene | ND-ND | ND | ND-0.03 |
| Benzo(a)pyrene | ND-0.19 | ND | ND-0.05 |
| Benzo(b)fluoranthene | ND-0.21 | ND | ND-0.07 |
| Benzo(e)pyrene | ND-0.26 | ND | ND-0.06 |
| Benzo(GHI)fluoranthene | ND-0.08 | ND | ND-ND |
| Benzo(GHI)perylene | ND-0.14 | ND | ND-0.06 |
| Benzo(k)fluoranthene | ND-0.08 | ND | ND-0.04 |
| Chrysene | ND-0.34 | ND | ND-0.04 |
| Fluoranthene | 1.68-6.76 | 5.55 | 0.58-3.96 |
| Fluorene | 2.21-4.09 | 53.70 | 2.43-3.59 |
| Indeno(1,2,3-cd)pyrene | ND-0.05 | 8.90 | ND-0.05 |
| Naphthalene | 5.99-14.57 | 113.00 | 4.50-16.94 |
| Phenanthrene | 5.07-14.34 | 32.26 | 6.11-13.05 |
| Pyrene | 0.97-6.92 | 11.84 | 0.37-3.16 |

ND=nondetectable; see appendix for reporting limits.

*Four fields were sampled, and one field (D) was sampled twice.

**Table 28. SVOC exposure assessment- screening algorithm for chemicals' relationship to crumb rubber emissions.**

| Screen for each field | Chemical | Field |
|---|---|---|
| PAHs detected on the turf field and not detected in background, and found on at least 2 fields | **Acenaphthylene** | D and K |
| PAHs detected on the turf field at more than two times the concentration of background levels, and found on at least 2 fields | **1-Methylnaphthalene** | D and K |
| | **2- Methylnaphthalene** | D and K |
| | **Fluoranthene** | D and K |
| | **Phenanthrene** | D and K |
| | **Pyrene** | D and K |
| Miscellaneous SVOCs detected on the turf field at more than two times the concentration of background levels, and found on at least 2 fields | **Eicosane** | D and K |
| | **Eicosanic acid** | D and K |
| | **Heneicosane** | D and K |
| | **Hexadecanoic acid** | D and K |
| | **Octadecanoic acid** | A and D |
| | **Phytane** | D and K |
| | **Tetradecanoic acid** | D and K |
| | **Tetratriacontane** | A and K |
| | **Tricosane** | D and K |

### 4.4 Targeted SVOCs-Possibly Turf-Related

Of the five targeted SVOCs in air, Benzothiazole and BHT were the only chemicals detected above background (Table 29). Concentrations of benzothiazole were higher on the turf at six inches away from active play than in background locations at all fields. Most concentrations of benzothiazole and BHT were an order of magnitude lower among the outdoor turf fields than the indoor field, ranging from <80-1200 ng/$m^3$ and <80-130 ng/$m^3$, respectively. Indoor concentrations of benzothiazole and BHT on the turf range from 11000-14,000 and 1240-3900 ng/$m^3$, respectively. The indoor field contained the highest concentration of benzothiazole in the crumb rubber. 4-tert-(octyl)-phenol was detected in the crumb rubber head space in all fields (A-K), however, it was only found in two air samples (on turf level was less than background). BHT was detected in air at 3 feet at the grass background Site L (280 ng/$m^3$).

**Table 29. Field locations where air concentrations are greater than relative background concentration for each field.**

| | Personal | 6" NAP | 3'NAP | 6" AFAP | 3' AFAP |
|---|---|---|---|---|---|
| Benzothiazole | A*, D#, K | A, B, K | B, D, K | A, B, C, D, K | D, K |
| 2-mercaptobenzothiazole | none | none | none | none | none |
| 4-tert-octyl | none | none | none | none | none |
| BHA | none | none | none | none | none |
| BHT | D*, K | K | D, K | K | K |

Abbreviations: NAP=near active play;AFAP=away from active play
* one of two personal samples exceeded background
# one of two personal samples exceeded 6" background but not 3' background

Table 30 summarizes one possible algorithm for determining which targeted SVOC may be related to crumb rubber emissions. Chemicals found in: A) either 6" or 3' samples; or B) in both personal and either 6" or 3' samples, greater than the background concentration measured near the field, were considered to have originated from the turf. The attribution of a chemical to the turf was considered stronger if the chemical was also found in at least one field's crumb rubber head space. Chemicals meeting these criteria are bolded. Benzothiazole and BHT met this criteria.

**Table 30. Targeted SVOCs exposure assessment- screening algorithm for chemicals' relationship related to crumb rubber emissions.**

| Screen for each field | Chemical | Field |
|---|---|---|
| Either 6" or 3' two times > background for this field<br>Chemical in this field's crumb rubber head space | **Benzothiazole**<br>**BHT** | A, B, C, D, K<br>K |
| Either 6" or 3' two times > background for this field<br>Chemical not in field's crumb rubber head space but in at least another field's crumb rubber head space | **BHT** | D |
| Personal two times > 3' background for this field<br>Chemical is in 6" or 3' sample two times background<br>Chemical is in this field's crumb rubber head space | **Benzothiazole**<br>**BHT** | A, D, K<br>K |
| Personal two times > 3' background for this field<br>Chemical is in 6" or 3' sample two times background<br>Chemical not in field's crumb rubber head space but in at least another field's crumb rubber head space | **BHT** | D |

### Nitrosamine

All samples were below the reporting limit including the crumb rubber infill.

### Particulate Matter ($PM_{10}$)

$PM_{10}$ concentrations measured on the turf are typical levels found in background locations. Rubber fragments were not easily detected and analyses of particles were inconclusive.

### Lead

All of the composite samples of artificial turf fibers and crumb rubber were below the level EPA considers as presenting a "soil-lead hazard" in play areas (400ppm). This definition, however, applies to residential buildings and to soil rather than other surfaces.

## 5.0 Limitations

The primary objective of this project was to characterize human exposure via inhalation to a targeted group of chemicals that are associated with crumb rubber synthetic turf. Other routes of exposures, such as ingestion and contact, were not within the scope of this study. Some chemicals of potential concern, such as natural rubber latex, were not included as part of the targeted chemicals in our study but should be included in future studies. There are several limitations to this project. This project has a potential for selection bias because participation was voluntary and self-selected. The sample size was small (4 outdoor fields and 1 indoor field), however, goals of the project were met in recruiting outdoor turf fields, an indoor facility and a suburban grass field.

During the summer of 2009, temperature conditions for the sampling events were on average lower than normal. The 30-year monthly average maximum temperature for the month of July is 84.9 $^{o}$F, and during July 2009, the average was 79.9 $^{o}$F. Most notably, wind conditions were low, and little cloud overcast occurred on most sampling days.

Personal sampling occurred at waist height, and not in the normal breathing zone of the study team players. The placement of 1.4 L SUMMAs and personal sampling pumps at this height is not a conventional industrial hygiene personal sampling method. This method was chosen to better represent a child's height. Some VOCs (e.g. acrolein) were found in personal samples and not on the turf or in the background areas. Players wore the SUMMAs close to their bodies, and they were up against the sampling belts and plastic ties that players wore to hold all the sampling equipment. The belts were purchased new, and may have had some coatings on them. SUMMAs are a very sensitive air sampling method, and may have collected VOCs associated with personal care products and sampling belts worn by the team players. Players were asked not to wear products to limit any contamination. Because of the intense heat and sun exposure, some players wore sun protection and all players sweated. WOHL conducted a follow-up experiment to determine if the new belts and plastic ties were capable of releasing compounds. WOHL detected trace levels of several compounds in the 7 month old belt, apron and tie. Any future personal sampling must address these kinds of issues, and "control" team members playing on the grass (non turf setting) should be included in the sampling strategy. There are many factors to consider for "control" team members, including the type of player clothing, personal product use, personal characteristics (sweat and exhaled breath), laundering practices, and behavior.

Field coordination for this project was challenging at times. For example, it is unfortunate that background samples were not collected at two fields with the PS-1 Samplers as a result of media breakage issues during transportation. In addition, one of the fields (C) was contaminated by a pesticide application which may explain the larger number of VOCs found in comparison to the other outdoor fields. The indoor field had multiple uncharacterized potential point sources.

Sampling for two hours was a limitation. Although the 6-hour sampling at Field D allowed for greater sensitivity, similar patterns were observed with both strategies. Benzothiazole is not a targeted SVOC for the TO-13A Method, and more validation studies are needed to better understand how to collect air samples with the PS-1 Samplers and analyze them for benzothiazole. NIOSH Method 2550 (modified) was adequate to capture concentrations of benzothiazole at the three levels, and other targeted SVOCs.

The lab was not able to identify rubber particles on the Teflon filters from several fields, and therefore, SEM analysis was not completed for all field samples. U.S. EPA's study used polycarbonate filters with the same air sampling method and reported similar difficulties. More research is needed to better characterize particulate matter containing crumb-rubber.

The airborne concentrations of VOCs, Targeted SVOCs (e.g. benzothiazole) and SVOCs were highest in the indoor field. These data were collected from only one indoor facility. The crumb rubber of the indoor facility was manufactured by the same company as Field B, and installed one year earlier. The air in the indoor field was not influenced by outdoor factors that may degrade and off gas chemicals, such as sunlight, high temperatures, rain, and other weather conditions. Furthermore, potential point sources were identified in the facility, (electric carts, portable chargers, and maintenance supplies), and the indoor facility did not have its exhaust system operating on the day samples were collected. The use of the exhaust

system in this facility varies according to need. More research is needed to better understand chemical exposures in indoor facilities.

**6.0 Connecticut Academy of Science and Engineering Review (CASE):** CASE performed a peer review of this final report in June 2010. The scope of the technical review for this report included an examination of the appropriateness of the methods used to sample targeted compounds and the laboratory analytical methods. Based on CASE comments, this report was revised to: 1) clarify laboratory quality control and assurance laboratory procedures for VOCs by WSLH and WOHL, 2) strengthen the criteria of the algorithm used to identify a turf-related compound to take into account variability among concentrations (e.g. turf-related compound was reported as twice a field's background concentration), 3) move tables presenting concentrations of miscellaneous SVOCs commonly found in the environment to appendices and 4) include a description of the similarities and source locations of the bulk crumb rubber samples collected from UCHC and CAES. CASE also highlighted that the SVOC air contaminants found above the field are consistent between fields, and are also consistent with air contaminants reported in other similar studies. Issues raised by the CASE review are addressed below and incorporated into the report.

*Design of Experiment:* Analysis of crumb rubber for latex antigen was beyond the scope of the current investigation. This should be included in future studies.

*Explain why PM10 was measured and not PM2.5:* During our planning for this study, several states and US EPA were finishing reports related to synthetic turf. We discussed their findings, and used data that best represents inhalation exposure while playing on a turf field. In US EPA's scoping study, two kinds of PM10 integrated air samples were collected (one for particle mass and metals analysis and another for scanning electron microscopy analysis). NYCity did not reveal meaningful differences in concentrations between the results for the samples collected upwind and those on the field. In addition, they did not find rubber dust in the respirable range. Because of these findings, we decided to use the PM10 range.

*Concern with VOC Results:* Precautions used by the laboratories to prevent VOC contamination were added in the UCHC final report as recommended by CASE. The OEM UCHC sub-contracted laboratory analyses to three AIHA accredited laboratories: Wisconsin Occupational Health Laboratory (WOHL), the Wisconsin State Laboratory of Hygiene (WSLH) and the ESIS Environmental Health Laboratory (EHL) in Cromwell, Connecticut. WOHL is a full service industrial hygiene chemistry laboratory that is part of the Wisconsin State Laboratory of Hygiene (WSLH) at the University of Wisconsin-Madison. WSLH analyzed air samples for VOCs, SVOCs and $PM_{10}$. WOHL analyzed bulk crumb rubber head space for VOCs and targeted SVOCs (e.g. benzothiazole), and air samples for nitrosamines and targeted SVOCs. Additional bulk samples were analyzed for lead by the ESIS Environmental Health Laboratory (EHL).
The following precautions were taken for the personal and area VOC analysis by WSLH: WSLH followed the quality control and assurance protocols defined in the EPA TO-15 Method. Each analytical run included one method blank per batch of samples. If an analyte in the method blank was greater than its limit of detection (LOD), the result for that analyte was flagged to indicate blank contamination. As indicated in the report, one set up samples contained acetone in the blank sample (1.5 ppb), and concentrations were corrected. Duplicate analysis was performed on one sample per analytical batch. Duplicate analyses were always within 25% for each compound. Daily quality control checks were performed using a second source standard. Analytes in the quality control/QC check standard were always within 30% of the corresponding calibration standards.

The following precautions were taken for the bulk crumb rubber VOC analysis by WOHL and added to the final report: 1) bulk crumb rubber samples were stored in teflon lined screw capped jars and were opened only when removing sample for analysis;2) the 340mL LVSH were baked at 70$^{o}$C overnight; and 3) one of the LVSH units was analyzed empty with each analytical run as a method blank, and any VOCs detected above reporting limit noted in the analytical report. In addition, a laboratory background VOC air sample was collected in the storage cooler of the bulk crumb rubber samples. As indicated in the report, six VOCs were found and reported in this sample. These six VOCs were flagged as a footnote in tables presenting results.

*Criteria used to determine concentrations greater than background:* CASE recommended that qualifiers be included for the VOC and SVOC data for concentrations greater than background. UCHC agrees with CASE and modified the report. The criteria for identifying a possibly turf-related chemical of concern was changed: all concentrations greater than two times background were indicated in tables and bolded.

*Semivolatile Organic Compound (SVOC) Results:* CASE recommended leaving out the miscellaneous SVOCs since it appears that few, if any, of these pertain to crumb rubber or artificial turf. UCHC agrees with CASE, and moved the data into an appendix.

*Off-Gas Findings:* DPH risk assessment discusses the consistency of the SVOC concentrations across fields. The UCHC final report provides the data for the risk assessment.

*Reference Lead Levels:* CASE identified other reference levels for lead (e.g. Consumer Product Safety Commission standard for children's products). UCHC is referencing the EPA lead in soil standard (400ug/g) in the final report because it is the most comparable standard for athletic playing fields.

*Analytical Results- CAES versus WOHL:* CASE recommended including more information to describe the similarities and differences between CAES and WOHL samples. In the final report, UCHC included a description of the similarities and source locations of the bulk crumb rubber samples collected from UCHC and CAES. CAES collected and analyzed samples of crumb rubber material supplied by several manufacturers [5]. Their crumb rubber samples included material from only two of UCHC outdoor fields (A and D). These two crumb rubber fields were manufactured by two different companies. The results are difficult to compare between the two laboratories (WOHL and CAES) because they used different analytical methods.

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## 7.0 Appendices (available upon request)

Appendix A Sampling Map

Appendix B Meteorological Report

Appendix C Crumb Rubber Head Space VOC WOHL Reports

Appendix D Crumb Rubber Head Space Target SVOCs WOHL Reports

Appendix E Crumb Rubber Bulk Samples Lead EHL Reports

Appendix F Air VOC WOHL Reports

Appendix G Special Items Head Space WOHL Reports

Appendix H Air PAHs and Miscellaneous SVOCs EPA Method TO-13A WOHL Reports

Appendix I Air Targeted SVOCs NIOSH 2550 WOHL Reports

Appendix J Air Nitrosamine WOHL Reports

Appendix K Air $PM_{10}$ WOHL Reports

# FINAL REPORT

# Artificial Turf Study

## Leachate and Stormwater Characteristics

**Connecticut Department of Environmental Protection**

**July 2010**

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## APPENDICES

Appendix A: Stormwater Sampling and Analysis Documentation

Appendix B: Stormwater Treatment Measures, UNH Fact Sheets

## 1. PROJECT OVERVIEW

In December 2008, four Connecticut State agencies, the University of Connecticut Health Center, The Connecticut Agricultural Experiment Station, the Connecticut Department of Environmental Protection and the Connecticut Department of Public Health, agreed to jointly develop and implement a study to evaluate the health and environmental impacts associated with artificial turf fields. The overall objectives of the study were to:

1. Identify comprehensively substances, including organic compounds and elements, which derive from the crumb rubber infill used on synthetic turf fields, as well as currently available alternative infill products, through off-gassing and leaching pathways;
2. Establish the level of chemical variability for infill at individual synthetic turf fields and between different synthetic fields in Connecticut;
3. Measure levels of off-gassed compounds and airborne particulate matter in the normal breathing zone of children during a "simulated worse-case scenario" at athletic field(s) in Connecticut (inhalation risk);
4. Measure levels of leached compounds in storm water runoff collected in actual field conditions (environmental risk); and
5. Utilize collected data to make environmental and public health risk assessments regarding outdoor artificial turf fields.

The Department of Environmental Protection ("DEP") was specifically tasked with: (1) collecting stormwater runoff samples from the four artificial turf fields selected for the study; (2) analyzing the stormwater samples for levels of compounds leached from the artificial turf materials; (3) scientifically evaluating the laboratory analysis results; and (4) developing an environmental risk assessment for the artificial turf fields.

This report is not intended to be a comprehensive investigation of the environmental risks associated with artificial turf fields, but a basic assessment of water quality data collected from a limited number of fields during a three-month period. It should be understood, that the ultimate conclusions in the report are based on eight stormwater sampling events, essentially a "snapshot", of an ongoing chemical and physical process.

## 2. SITE SELECTION

The four artificial turf fields selected for DEP's stormwater sampling plan were the same fields sampled in the summer of 2009 by the University of Connecticut Health Center for airborne contaminants. Specific field selection criteria included: crumb rubber infill, owner permission, installation date, different manufacturers and site location. The owners of the selected four fields provided engineered drainage plans to DEP. DEP staff reviewed the drainage plans and established sampling points that only collected stormwater draining from the artificial turf field.

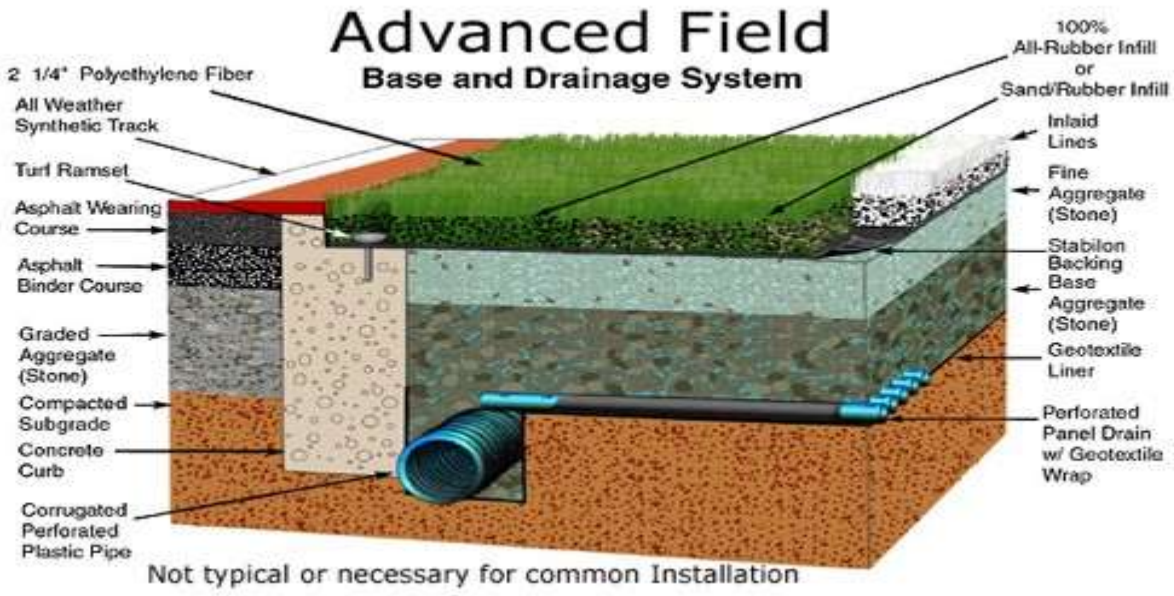
## 3. ARTIFICIAL TURF FIELD SYSTEMS

The artificial turf fields selected were installed by different engineering, synthetic turf and construction companies, but are similar in general design. The fields are composed of a top layer

of polyethylene or polypropylene grass fibers, with a crumb rubber (sometimes intermixed with sand) infill layer, and underlain by crushed stone/gravel with a piped drainage system (see Figures 1 and 2 below).

**Figure 1.**

**Figure 2.** (source: www.suncountrysystems.com/.../syntheticgrass.jpg)




The critical field component for this study is the infill layer, which includes crumb rubber materials produced from recycled tires. The infill layer can be composed of entirely styrene-butadiene rubber (SBR) granules, produced by ambient and/or cryogenic grinding process, or intermixed with quartz crystals (sand). The assumption for this study, and the sampling plan, is that precipitation lands on the surface of the artificial turf field, flows downward through the infill and rock/gravel layers, collects in the subsurface drain pipes and then ultimately discharges from the field. The artificial turf drainage pipes often discharge to existing subsurface drainage

systems at catch basin and/or manhole connections. The subsurface drainage pipes utilized under the fields can be solid or perforated.

## 4. SAMPLING PROTOCOLS

DEP staff reviewed EPA protocols and previous artificial turf leaching studies and established the following stormwater sampling plan:

1. Sampling Plan
    a. One sampling station was established at each of the four artificial turf fields;
    b. The sampling stations were located at a point where runoff was only from the artificial turf field;
    c. The size of the drainage area (in square feet) to each sampling station was calculated;
    d. Grab samples were collected and delivered to the laboratory by qualified individuals during the fall of 2009; and
    e. Samples were analyzed by an EPA certified laboratory.

2. Storm Event Criteria
    a. Samples were collected from discharges resulting from a storm event that was greater than 0.1 inch in magnitude and that occurred approximately 72 hours after any previous storm event of 0.1 inch or greater;
    b. Grab samples were collected during the first 30 minutes of a storm event discharge, or as close thereto as possible, and were completed as soon as possible;
    c. The following information was collected for the storm events monitored:
        i. The date, temperature, time of the start of the discharge, time of sampling, and magnitude (in inches) of the storm event sampled; and
        ii. The duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event.

3. Sampling Procedures
    a. Grab sample collection, chain of custody and laboratory delivery were performed in accordance with the EPA NPDES Stormwater Sampling Guidance Document (EPA 833-B-92-001, 7/92); http://www.epa.gov/npdes/pubs/owm0093.pdf
    b. Laboratory analysis of grab samples included the following:
        i. Acute Toxicity 48 hour LC50 *Daphnia pulex* & 48 hour and 96 hour LC50 *Pimephales promelas* (EPA 821-R-02-012).
        ii. EPA Method 130.1, Hardness, Total (mg/L as $CaCO_3$)
        iii. EPA Method 150.2, pH
        iv. EPA Method 200.7, (Antimony, Arsenic, Barium, Cadmium, Chromium, Cobalt, Copper, Lead, Manganese, Mercury, Molybdenum, Nickel, Selenium, Thallium, Vanadium and Zinc)
        v. EPA Method 624, Volatile Organic Compounds
        vi. EPA Method 625, Semivolatile Organic Compounds (TIC's for Benzothiazole, Butylated hydroxyanisole (BHA), n-hexadecane and 4-(t-octyl) phenol.

## 5. FIELD SAMPLING METHODS

In September of 2009, the stormwater sampling plan was implemented at the four artificial turf fields: Field A, Field B and Field D all constructed in 2007; and Field C constructed in 2005. Stormwater samples were successfully collected from Fields A, C and D. Field B was visited during five precipitation events and no discharge from the established sampling station was observed. A total of eight stormwater samples were collected from Fields A, C and D between 9/11/09 and 12/3/09. Based on DEP staff observations, Fields B and C did not appear to regularly discharge runoff during or after precipitation events, while Fields A and D discharged during and after every precipitation event monitored. For the one sample collected from Field C, DEP staff was fortunate to experience an extremely hard (downpour) rain event that exceeded the infiltration rate of the perforated underdrain system. DEP staff reviewed the engineered drainage plans and determined that Fields B and C utilized perforated drainage pipes causing the stormwater to normally infiltrate into the soil beneath the fields. Fields A and D utilized solid drainage pipes, which discharge the stormwater to local drainage systems at the sites, similar to an impervious surface.

For each precipitation event, stormwater collected at the fields was sampled for total metals, hardness, pH, volatile organic compounds, semi-volatile organic compounds (including rubber Tentatively Identified Compounds found by The Connecticut Agricultural Experiment Station in a 2007 study), pesticides/ polychlorinated biphenyls (PCBs) and acute aquatic toxicity (48 hours for *Daphnia pulex* (Dp)and 96 hours for *Pimephales promelas*(Pp)). Stormwater samples were analyzed at the Connecticut Department of Public Health Laboratory, Environmental Chemistry Division, Inorganic Chemistry Section, 10 Clinton Street Hartford, CT 06106 for pH, Hardness and Total Metals; at Phoenix Environmental Laboratories, Inc. 587 East Middle Turnpike, Manchester, CT 06040 for volatile organic compounds, semi-volatile organic compounds, pesticides, PCBs; and at GZA GeoEnvironmental, Inc., 120 Mountain Avenue, Bloomfield, CT 06002 for acute toxicity. A summary of the tests performed on the samples collected are shown in Table A below.

Table A

| Location | Date | pH | Hardness | Metals | Volatiles | Semivolatiles | Pesticides and PCBS | Aquatic Toxicity LC50 | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Dp 48 hrs | Pp 48 hrs | Pp 96 hrs |
| **Field C** | 9/11/09 | | | √ | √ | √ | √ | √ | | |
| **Field A** | 9/27/09 | √ | √ | √ | √ | √ | √ | √ | | √ |
| **Field A** | 10/7/09 | √ | √ | √ | √ | √ | √ | √ | | √ |
| **Field A** | 10/18/09 | √ | √ | √ | √ | √ | √ | √ | √ | |
| **Field D** | 10/18/09 | √ | √ | √ | √ | √ | √ | √ | √ | |
| **Field D** | 10/28/09 | √ | √ | √ | √ | √ | √ | √ | | √ |
| **Field D** | 11/20/09 | √ | √ | √ | √ | √ | | √ | | √ |
| **Field D** | 12/3/09 | √ | √ | √ | √ | √ | √ | √ | | √ |

## 6. DEP STORMWATER SAMPLING RESULTS

### a) Method 624/Method 625 and Tentatively Identified Compounds(TICs):

No standard volatile or semi-volatile organic compounds were detected in any sample using the EPA 624 and 625 analytical methods. All samples were analyzed for non-standard semi-volatile organic compounds, including the following rubber compounds benzothiazole, butylated hydroxyanisole (BHA), n-hexadecane and 4-(t-octyl) phenol. The semi-volatile analysis detected the analytical peaks of twenty-two compounds, of which nine were tentatively identified (see Table B below). The concentrations of these compounds ranged from 1 ug/l to 150 ug/l. The grey columns in Table B correspond to the three stormwater samples determined to be acutely toxic. Table C details the aquatic toxicity information found for the other tentatively identified compounds listed in Table B.

### b) Pesticides and PCBs (Method 608)

**Pesticides**

Pesticides were detected in the samples of stormwater collected on September 11, 2009 from Field C and on October 28, 2009 from Field D. DEET and heptachlor were detected at estimated concentrations of 6.9 ug/l and 0.18 ug/l, respectively. It is assumed that these substances were not derived from the artificial turf, but were a result of pesticide applications at the site.

**PCBs**

No PCBs were detected during the stormwater sampling events.

### c) pH, Hardness and Metals:

The results from the pH, hardness and metals analysis conducted on the stormwater runoff from the fields are presented in the table below.

**pH**

The pH of the stormwater samples ranged from 6.6 to 8.0. The pH of stormwater in Connecticut is generally considered to be between 5.6 and 6.0. Based on this fact, the pH of the stormwater samples are more alkaline than expected. It is possible that the crushed stone used as a sub-base in the fields affected the pH of the stormwater as it drained through the field.

The pH alone does not exhibit toxic effects unless it falls below 5 or is higher than 10. However, metals are often more soluble and toxic at lower pH's. The observed neutral pH in the stormwater may have reduced the concentrations and toxicity of the metals leaching from the fields.

TABLE B

| Location: | | | Field C | Field A | Field A | Field A | Field D | Field D | Field D | Field D |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample # | | | A | B | C | E | D | F | G | H |
| Sample date | | | 9/11/2009 | 9/27/2009 | 10/7/2009 | 10/18/2009 | 10/18/2009 | 10/28/2009 | 11/20/2009 | 12/3/2009 |
| Parameter: | Tentatively identified Compounds | CAS# | | | | | | | | |
| Heptachlor | | | | | | | <0.10 | 0.18 | NT | <0.05 |
| Retention Times (min) | | | | | | | | | | |
| 3.55 | | | 6.2 | | | | | | | |
| 5.04 | | | | | 150 | | | | | |
| 6.12 | | | 4.3 | | | | | | | |
| 6.63 | | | | | | | | | | 9.5 |
| 6.81 | | | | | 4.1 | | | | | |
| 6.83 | 2- propyl-methyl pentanoic acid | 22632-59-3 | | | 14 | 6.6 | | | | |
| 6.85 | Benzothiazole | 95-16-9 | | 1 | 4.9 | | | | | |
| 6.88 | | | | | 6.1 | | | | | |
| 7.07 | | | | | | | | | 5.1 | |
| 7.08 | methyl 2alpha -D-xylofuranoside | 32469-86-6 | | | | 5.8 | | | | |
| 7.10 | 2 ethyltetra hydro thiopene | 1551-32-2 | | | | 28 | | | | |
| 7.13 | 4-methyl4-Heptanol | 598-01-6 | | | | 7.4 | | | | |
| 7.15 | 2- butyl tetrathydrothiopene | 1613-49-6 | | | | 12 | | | | |
| 7.77 | | | | | | | | | | 10 |
| 7.96 | | | | | | | | 6.6 | | |
| 8.13 | | | | | 7.4 | | | | | |
| 8.23 | | | | | | | | | 7 | |
| 9.48 | Benzamide, N-N- diethyl-3-methyl | 134-62-3 | 6.9 | | | | | | | |
| 9.56 | 2(3H)- Benzo thiazolone | 934-34-9 | | | 5.7 | | | | | |
| 10.28 | | | | | | 4.1 | | | | |
| 12.60 | 2-2-7 trimethyl-3-Octyne | 55402-13-6 | | | | | 4.5 | | | |
| 16.88 | | | 8.4 | | | | | | | |

TABLE C

| Location:<br>Sample #<br>Sample date<br><br>Parameter:<br>Heptachlor<br>Retention Times (min) | Tenatively identifeid Compounds | CAS# | Max Concentration | Location | Acute Water Quality Criteria | Chronic Water Quality Criteria | Comments |
|---|---|---|---|---|---|---|---|
| | | | 0.18 | D | 0.26 | .0038 | CT WQS 2002 |
| 3.55 | | | 6.2 | A | | | |
| 5.04 | | | 150 | A | | | |
| 6.12 | | | 4.3 | | | | |
| 6.63 | | | 9.5 | D | | | |
| 6.81 | | | 4.1 | A | | | |
| 6.83 | 2- propyl-methyl pentanoic acid | 22632-59-3 | 14 | A | 2812.5 | 312.5 | Toxicity info on pentanoic acid tier 2 |
| 6.85 | Benzothiazole | 95-16-9 | 4.9 | A | | | One data point tier 2 |
| 6.88 | | | 6.1 | A | | | |
| 7.07 | | | 5.1 | D | | | |
| 7.08 | methyl 2alpha -D-xylofuranoside | 32469-86-6 | 5.8 | A | | | No data |
| 7.10 | 2 ethyltetra hydro thiopene | 1551-32-2 | 28 | A | | | No data |
| 7.13 | 4-methyl4-Heptanol | 598-01-6 | 7.4 | A | | | No data on Heptanol either |
| 7.15 | 2- butyl tetrathydrothiopene | 1613-49-6 | 12 | A | | | No data |
| 7.77 | | | 10 | D | | | |
| 7.96 | | | 6.6 | D | | | |
| 8.13 | | | 7.4 | A | | | |
| 8.23 | | | 7 | D | | | |
| | Benzamide, N-N- diethyl-3- | | | C | | | |
| 9.48 | methyl | 134-62-3 | 6.9 | | 89.3 | 9.9 | DEET tier 2 |
| 9.56 | 2(3H)- Benzo thiazolone | 934-34-9 | 5.7 | A | 47.3 | 8.1 | Different CAS # 149304 tier 2 |
| 10.28 | | | 4.1 | A | | | |
| 12.60 | 2-2-7 trimethyl-3-Octyne | 55402-13-6 | 4.5 | D | | | No data |
| 16.88 | | | 8.4 | | | | |

## Hardness

The hardness of the stormwater samples ranged from 8 to 59 mg/L. Hardness in the range of 0 to 60 mg/L is generally termed "soft". Hardness can also influence the toxicity of metals; the greater the hardness, the less toxic the metals. It is not expected that the observed hardness had much effect on metal concentrations in the stormwater.

## Metals

The metal parameters which had results reported above the detection limit are listed in Table C below. Silver, molybdenum, thallium and beryllium were analyzed but were below the detection limit for every sample. In Table C, the values bolded and underlined exceed Connecticut's acute aquatic life criteria. Metal concentrations in excess of the acute aquatic life criteria for more than one hour could cause mortality to the more sensitive organisms in the receiving surface waters. The values bolded meet or exceed Connecticut's chronic aquatic life criteria. Average metal concentrations which exceed the chronic life criteria for more than 4 continuous days are expected to impact the ability of organisms to survive, reproduce or grow. EPA recommends that neither of these criteria be exceeded more than once in three years (EPA TSD EPA/505/2-90-001). The samples highlighted in grey also exhibited acute toxicity. Since stormwater is an intermittent discharge, the acute criteria for aquatic toxicity are more applicable. A review of the data indicates that only zinc consistently violates the acute criteria.

TABLE D

| Location | Sample # | Sample date | pH | Hardness | Conductivity | Cu ug/l | Zn ug/l | Ba ug/l | Fe ug/l | Al ug/l | V ug/l |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Field C 2005** | **A** | 9/11/09 | 6.6 | NA | 18 | 4 | **150** | 4 | 320 | **210** | 40 |
| **Field A 2007** | **B** | 9/27/09 | 6.6 | 8 | 20 | 1.5 | **130** | 1.5 | 20 | 25 | 1.5 |
| **Field A 2007** | **C** | 10/7/09 | 7.5 | 29 | 65 | 1.5 | 10 | 6 | 50 | **160** | 5 |
| **Field A 2007** | **E** | 10/18/09 | 7.5 | 39 | 86 | 1.5 | 20 | 7 | 20 | 60 | 1.5 |
| **Field D 2007** | **D** | 10/18/09 | 7.6 | 53 | 130 | 5 | **260** | **220** | 170 | **120** | 6 |
| **Field D 2007** | **F** | 10/28/09 | 7.9 | 59 | 157 | 4 | 50 | 8 | 80 | 80 | 8 |
| **Field D 2007** | **G** | 11/20/09 | 8 | 56 | 153 | 4 | 30 | 7 | 160 | **110** | 9 |
| **Field D 2007** | **H** | 12/3/09 | 8 | 58 | 147 | 4 | 20 | 5 | 170 | **100** | 8 |
| | **acute standard** | | **<5.0 >10** | | | **14.3** | **65** | **2000** | | **780** | **150** |
| | **chronic standard** | | **<5.0 >10** | | | **4.8** | **65** | **220** | **1000** | **87** | **44** |

### d) Aquatic Toxicity

The toxicity tests conducted on the stormwater measured both an LC50 value (the concentration of stormwater that is lethal to 50% of the test organisms) and an NOAEL (No Observable Acute Effect Level, the concentration of stormwater where no acute toxicity is observed). Toxicity tests conducted on the samples of stormwater collected indicate that 3 out of 8 sampling events were acutely toxic. Acute toxicity is observed when there is less than 90% survival of the test organisms in the undiluted effluent. The frequency of occurrence for acute toxicity was at least one sample per field. Where both *Pimephales promelas*(Pp) and *Daphnia pulex*(Dp) toxicity tests were conducted, the fathead minnow (*Pimephales promelas*) seemed to be slightly more sensitive to the contaminants in the stormwater discharge. Due to laboratory issues, the test duration for the fish, *Pimephales promelas*, for the October 18, 2009 Field A and Field D samples was limited to only 48 hours. If the test duration was extended to 96 hours, both samples could have had an LC50 value less than the 100% reported. The results for the aquatic toxicity testing conducted are shown in Table E below.

TABLE E

| Location: | Sample # | Sample date | Dp % Surv 100% | Dp LC50 | Dp NOAEL | Pp % Surv in 100% | Pp LC50 | Pp NOAEL |
|---|---|---|---|---|---|---|---|---|
| **Field C 2005** | ***A*** | 9/11/2009 | 65.0 | >100 | 12.5 | NT | NT | NT |
| **Field A 2007** | ***B*** | 9/27/2009 | 70.0 | >100 | 50 | 45 | 93.89 | 50 |
| **Field A 2007** | ***C*** | 10/7/2009 | 100.0 | >100 | 100 | 100 | >100 | 100 |
| **Field A 2007** | ***E*** | 10/18/2009 | 100.0 | >100 | 100 | 96 | >100 | 100 |
| **Field D 2007** | ***D*** | 10/18/2009 | 70.0 | >100 | 6.25 | 50 | 100 | 25 |
| **Field D 2007** | ***F*** | 10/28/2009 | 100.0 | >100 | 100 | 95 | >100 | 100 |
| **Field D 2007** | ***G*** | 11/20/2009 | 100.0 | >100 | 100 | 100.0 | >100 | 100 |
| **Field D 2007** | ***H*** | 12/3/2009 | 100.0 | >100 | 100 | 95 | >100 | 100 |
| | | acutely toxic | | | | | | |

## 7. CAES LABORATORY HEADSPACE AND LEACHING RESULTS

The CAES performed both headspace (off-gassing) and SPLP (Standard Precipitation Leaching Procedure) evaluations on seventeen samples of crumb rubber materials used as infill for artificial turf fields. These studies indicated the primary contaminants likely to be found in the stormwater coming from these sites. Organic compounds were identified by head space analysis, with results shown in Table F below. The other organic compounds detected from the crumb rubber infill, but not quantified in the analysis, included hexadecane, fluoranthene, phenanthrene and pyrene.

TABLE F. (Table 2. From CAES 2009) Concentration (ng /ml) of Volatile Compounds in Headspace Over Crumb Rubber Samples Analyzed at CAES (average of two analyses per sample)

| DEP Sample ID | 1-methyl naphthalene | 2-methyl naphthalene | 4-(t-octyl)-phenol | benzothiazole | butylated hydroxytoluene | naphthalene | butylated hydroxyanisole |
|---|---|---|---|---|---|---|---|
| A1001 | 0.13 | 0.19 | 0.28 | 3.98 | n.d. | 0.42 | 0.50 |
| A1002 | 0.11 | 0.15 | 0.31 | 5.59 | n.d. | 0.31 | 0.61 |
| A1003 | 0.03 | 0.07 | 0.19 | 8.67 | n.d. | 0.10 | 0.68 |
| A1004 | 0.04 | 0.07 | 0.31 | 6.52 | 0.15 | 0.16 | 0.69 |
| A1005 | 0.08 | 0.09 | 0.23 | 2.35 | 0.09 | 0.23 | 0.46 |
| A1006 | 0.08 | 0.14 | 0.31 | 4.89 | 0.12 | 0.23 | 0.75 |
| A1007 | 0.13 | 0.20 | 0.52 | 3.50 | n.d. | 0.23 | 0.69 |
| A1008 | 0.06 | 0.10 | 0.18 | 1.93 | n.d. | 0.22 | 0.43 |
| A1009 | 0.03 | 0.06 | 0.13 | 2.89 | 0.13 | 0.08 | 0.50 |
| A1010 | 0.07 | 0.11 | 0.22 | 4.91 | 0.13 | 0.20 | 0.64 |
| A1011 | 0.04 | 0.06 | 0.30 | 3.94 | 0.16 | 0.11 | 0.62 |
| A1012 | 0.08 | 0.14 | 0.46 | 2.70 | 0.13 | 0.28 | 0.64 |
| A1013 | 0.09 | 0.12 | 0.45 | 4.45 | n.d. | 0.30 | 0.65 |
| A1014 | 0.10 | 0.15 | 0.49 | 4.25 | n.d. | 0.31 | 0.65 |
| B1002 | n.d. | n.d. | 0.43 | 1.21 | 0.67 | 0.09 | 0.36 |
| B1009 | n.d. | n.d. | 0.07 | 1.29 | 0.48 | 0.06 | 0.35 |
| B1010 | n.d. | n.d. | 0.06 | 1.03 | 0.40 | 0.05 | 0.34 |

CAES also performed simulated weathering experiments on the crumb rubber samples to determine trends in organic compound emissions over time. The weathering test results show that, except for 4-(t-octyl)-phenol, all other detected volatile compounds significantly decreased in concentration after only 20 days of outdoor exposure. By the end of the eight week study, benzothiazole, butylated hydroxanisole and 4-(t-octyl)-phenol were detected at the highest concentrations. The results are shown in Table G. below.

TABLE G: (Table 9 from CAES, 2009) Concentrations (ng /ml) of Volatile Compounds in Headspace Over Crumb Rubber Samples Aged at CAES (average of two analyses per sample)

| Sample ID (week) | benzothiazole | 1-methyl naththalene | 2-methyl naphthalene | naphthalene | 4-(t-octyl)-phenol | butylated hydroxyanisole |
|---|---|---|---|---|---|---|
| T0 | 3.75 | 0.12 | 0.24 | 0.40 | 0.35 | 0.77 |
| T1 | 1.95 | 0.05 | 0.09 | 0.12 | 0.28 | 0.45 |
| T2 | 0.97 | 0.04 | 0.06 | 0.06 | 0.31 | 0.40 |
| T3 | 1.56 | 0.04 | 0.07 | 0.08 | 0.31 | 0.44 |
| T4 | 1.77 | 0.04 | 0.08 | 0.08 | 0.30 | 0.43 |
| T5 | 1.59 | 0.05 | 0.07 | 0.10 | 0.30 | 0.48 |
| T6 | 1.20 | 0.04 | 0.06 | 0.05 | 0.25 | 0.36 |
| T7 | 0.99 | 0.04 | 0.06 | 0.04 | 0.24 | 0.33 |
| T8 | 1.17 | 0.05 | 0.05 | 0.06 | 0.23 | 0.41 |

CAES also performed an SPLP test on the same seventeen samples of the crumb rubber infill material. The resulting leachate was then analyzed for metals and organic compounds. Based on communications with CAES, the leachate contained the same organic compounds that were identified in the head space analyses, however, only benzothiazole concentrations were estimated for the test. A summary of compounds detected and their concentrations are listed in Table H below. Based on these results, the predominant contaminant leaching from artificial turf fields is

zinc, followed by barium, manganese and lead. It should be noted some metals associated with tires and rubber products were not analyzed in this experiment, such as iron and vanadium.

In Table H, the values which exceed Connecticut's acute aquatic life criteria are highlighted in yellow. The summary shows that zinc is present in the leachate at concentrations about 500 times greater than the toxicity criteria. The leachate study indicates that there is a high potential for the artificial turf to leach acutely toxic levels of metals especially copper and zinc. Certain samples of crumb rubber also leached acutely toxic levels of cadmium, barium, manganese and lead.

TABLE H

| | Benzothiazole | Cr | Mn | Ni | Cu | Zn | As | Cd | Ba | Pb |
|---|---|---|---|---|---|---|---|---|---|---|
| ug/l | | | | | | | | | | |
| **average** | 0.153 | 6.24 | 263.16 | 19.88 | 22.31 | 34170.5 | 3.35 | 1.60 | 313.88 | 11.57 |
| **80th** | 0.209 | 11.28 | 348.45 | 27.48 | 20.41 | 50269.8 | 1.50 | 0.50 | 463.62 | 7.77 |
| **Max** | 0.268 | 31.47 | 1443.19 | 57.15 | 143.32 | 71535.5 | 27.94 | 17.01 | 502.91 | 69.90 |
| | | | | | | | | | | |
| **Acute** | 21333.000 | 323 | 616 | 260.5 | 14.3 | 65 | 340 | 2.02 | 2000 | 30 |
| **Chronic** | 3200.000 | 42 | | 28.9 | 4.8 | 65 | 150 | 1.35 | 220 | 1.2 |

## 8. DISCUSSION

### a) Potential Contaminants

The analyses performed on the stormwater samples were focused on compounds previously documented to leach from crumb rubber material derived from recycled tires, primarily volatile organic compounds, semi-volatile organic compounds and metals. The stormwater samples were also assessed for whole effluent toxicity. Other potential parameters of concern in the stormwater were identified from the results of the CAES off-gassing and leaching laboratory studies performed on the crumb rubber material.

### b) Organic compounds

The stormwater generated at the artificial turf sites did not include many readily identifiable, volatile or semi-volatile organic compounds, as evidenced by no detections using EPA Methods 625 and 624. Additional semi-volatile compound investigations were performed on the stormwater samples, resulting in nine tentatively identified compounds and thirteen unidentified chromatograph peaks. Benzothiazole, which CAES also detected in their leaching analysis, was identified in the September 27 and October 7, 2009 samples from Field A at concentrations of 1 and 4.9 ug/l, respectively. Of the compounds that were tentatively identified such as benzothiazole, pentanoic acid, and thiopenes, none of these compounds are considered particularly toxic to aquatic organisms at the estimated concentrations.

Although it is not possible to determine the potential impact of the unidentified semi-volatile compounds, it is important to note, that the six highest concentrations of the unidentified semi-volatile compounds detected (150 ug/l, 28 ug/l, 14 ug/l, 12 ug/l, 10 ug/l and 9.5 ug/l) did not correspond to the three acutely toxic samples of stormwater determined in the study.

The results from the CAES laboratory headspace, leaching and simulated weathering tests suggest that benzothiazole, 4-(t-octyl)-phenol, 1-methyl naphthalene, 2-methyl naphthalene, naphthalene, butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) are the likely semi-volatile compounds to be found in the stormwater discharge from artificial turf fields. The test results also suggest that Benzothiazole, 4-(t-octyl)-phenol and butylated hydroxytoluene (BHT) would be the most persistent SVOCs in the crumb rubber as the artificial turf fields aged.

Comparing the VOCs and SVOCs results to EPA's Maximum Contaminant Levels for drinking water (MCLs) and DEP's Remediation Standards Regulations, Section 22a-133k-1 through 22a-133k-3of the Regulations of Connecticut State Agencies (June 1996), no exceedences of groundwater standards have been identified.

Based on our results, no VOCs or SVOCs have been identified as risks to surface and groundwater resources.

**c) Metals**

The laboratory leaching analyses performed by CAES as part of the State of Connecticut Artificial Turf Study detected the following metals: arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), lead (Pb), manganese (Mn), nickel (Ni), and zinc (Zn). Zinc was present in concentrations orders of magnitude greater than the other metals. CAES's leaching analyses indicated that both copper (Cu) and zinc (Zn) concentrations exceeded acute aquatic toxicity criteria for 80% of the tests, with limited (<20%) exceedences of acute criteria for cadmium (Cd), manganese (Mn) and lead (Pb).

The stormwater analysis results show that the artificial turf fields in our study leached significantly less contaminants, specifically zinc and copper, than predicted by the CAES leaching test results. The lower metal concentrations observed in the stormwater could be a result of alkaline pHs, the weathering (2-4 years since installation) of the crumb rubber infill, or the conservative approach inherent in the SPLP methodology.

The stormwater analysis results showed that zinc was the only metal to exceed the acute aquatic toxicity criteria (65 ug/l), with one exceedence at each of the three study fields. The overall mean concentration of zinc in the stormwater samples analyzed was 84 ug/l, with a maximum of 260 ug/l and a minimum of 10 ug/l. The stormwater analysis results showed that aluminum, barium, copper and zinc all exceeded chronic aquatic toxicity criteria at least once during the sampling. Since chronic toxicity criteria apply to four days of continuous discharge, these exceedences are not of significant concern for these intermittent discharges.

No metal concentrations exceeded EPA's and DEP's drinking water standards. However, the concentration of zinc in three stormwater samples did exceed the surface water protection

criteria of 123 ug/l established in the Appendix D to Sections 22a-133k-1 through 22a-133k-3 of the Regulations of Connecticut State Agencies Surface-water Protection Criteria for Substances in Ground Water (June 1996). Since the mean concentration of zinc in the stormwater samples (84 ug/l) is below the surface water protection criteria, the discharge from the artificial turf fields to groundwater is intermittent, and zinc is immobilized in soils by adsorption, absorption and precipitation, the potential for impacts to surface waters being recharged by this groundwater is minimal.

Based on our results, zinc has been identified as a potential risk to surface waters. No other metals have been identified as a risk to groundwater or surface waters.

## 9. ENVIRONMENTAL RISK ASSESSMENT

### a) Potential Risk to Surface Waters

The only potential risk to surface waters identified in the stormwater collected from the artificial turf fields is zinc, since it was the only chemical parameter that was detected above the acute aquatic life criteria of 65 ug/l. Acute toxicity is assumed to occur when the zinc concentration in-stream exceeds 65ug/l for one hour in any three year period. In three of the eight stormwater samples analyzed, zinc concentrations were detected at 130, 150 and 260 ug/l, well above the acute aquatic life criteria. It is important to note, that the three stormwater samples with acutely toxic levels of zinc were also determined to exhibit aquatic toxicity (<90% survivorship) for both species *Pimephales promelas* and *Daphnia pulex* in the whole effluent toxicity testing.

Other than the acute aquatic toxicity criteria, there are no specific zinc standards or permit limits that are applicable to artificial turf fields. For industrial sites that discharge to surface waters, DEP has set a stormwater general permit guideline (Section 5 (c) (1) (F) (i) of the General Permit) for total zinc of 200 ug/l. This industrial stormwater total zinc guideline assumes a default 5:1 dilution factor for the receiving surface water at the 7Q10 flow. The 7Q10 is the lowest flow expected to occur for seven continuous days at a frequency of every 10 years. The 7Q10 flow is the critical low flow used when evaluating toxicity and toxic impacts (CT WQS 2002). Based on the results of our study, the stormwater discharges from artificial turf fields would not be expected to regularly exceed this zinc limit.

However, the estimated 7Q10 flows for the receiving watercourse from Fields A, C and D did not meet the 5:1 dilution factor for stormwater discharges from artificial turf football fields (57,600 square feet), assuming a one inch rain storm over one hour with direct discharge to the watercourse over an hour. It is important to note, that this a conservative approach, which assumes the watercourse receives no other stormwater runoff from its representative watershed. For the three receiving streams in the study, the highest dilution factor at the DEP estimated 7Q10 flow was equivalent to a 0.14:1 ratio. Given this dilution ratio of the receiving streams in the study, there is a potential for acute toxicity due to zinc loading.

Since zinc concentrations in stormwater from artificial turf fields may pose a risk to surface waters, especially to smaller watercourses, it is important to note that these fields are not the only sources of stormwater runoff in any given watershed. During the sampling at Fields A, C and D,

DEP staff observed stormwater runoff, generated by acres of parking lots, roadways and buildings, entering the same drainage systems that collected runoff from the artificial turf fields. Based on these observations, it appears that stormwater runoff from the artificial turf fields is combined with the runoff from the adjacent impervious surfaces prior to ultimate discharge at the site.

This is an interesting phenomenon, since the levels of zinc in urban runoff are comparable to the concentrations detected in the discharge from artificial turf fields. It has been well established that urban runoff contains many contaminants such as nutrients, suspended solids, hydrocarbons and heavy metals, including zinc. The average concentration of zinc in urban stormwater runoff has been estimated at 129 ug/l in recent studies (Smullen 1998). EPA's Nationwide Urban Runoff Program (NURP) has collected runoff data and determined that for urban sites the median concentrations of total zinc ranged from 179 -226 ug/l. The National Stormwater Quality Database (NSQD, version 1.1), dated February 16, 2004, compiled zinc concentration data in runoff from various land uses across the United States, which is shown in Table L below.

TABLE I

| **Land Uses** | **Zinc Total (ug/l) Median** |
|---|---|
| Overall (All Uses) | 117 |
| Residential | 73 |
| Mixed Residential | 99.5 |
| Commercial | 150 |
| Mixed Commercial | 135 |
| Industrial | 210 |
| Mixed Industrial | 160 |
| Institutional | 305 |
| Freeways | 200 |
| Mixed Freeways | 90 |
| Open Space | 40 |
| Mixed Open Space | 88 |
| **CT Artificial Turf Stormwater** | **84 (mean)** |

Since zinc concentrations in the runoff from artificial turf fields are consistent with those associated with urban runoff, it would be a logical step to apply the same best management practices (BMPs) to mitigate the toxicity effects to surface waters. The 2005 Stormwater Management Manual for Western Washington specifically recommends the following BMPs to remove dissolved zinc (and other metals) from stormwater runoff: stormwater treatment wetlands, wet ponds, infiltration structures, compost filters, sand filters and biofiltration structures. The 2004 Connecticut Stormwater Quality Manual suggest the same measures since these treatment practices incorporate biological removal mechanisms that are more effective in removing pollutants than systems that strictly rely on gravity or physical separation of particles in the stormwater. The 2004 Connecticut Stormwater Quality Manual further recommends a treatment train approach, which provides a series of BMPs each designed to provide targeted pollution control benefits.

The University of New Hampshire Stormwater Center has field tested many of these stormwater BMPs that demonstrate significant removal of dissolved zinc. For example, the Retention Pond, Subsurface Gravel Wetland and Bioretention System (Bio II) stormwater treatment measures, over a two year period, removed between 90% and 100% of the soluble zinc, based on a median annual influent Event Mean Concentrations (EMC) of 60ug/l (see Appendix B for fact sheets). The three highest zinc concentrations detected in the stormwater from artificial turf fields in our study were 130, 150 and 260 ug/l, respectively. Assuming 80% removal of zinc from the stormwater prior to discharge to surface waters, all three of the highest zinc concentrations would meet the acute aquatic toxicity criteria (26, 30 and 52 ug/l, respectively). To mitigate the risk to aquatic life and surface waters, the DEP strongly recommends that the aforementioned stormwater best management practices be incorporated into the design of the drainage system for artificial turf fields.

## 10. ENVIRONMENTAL RISK ASSESSMENT IN RECENT STUDIES

Several other studies were conducted to determine the risk to surface waters and groundwater from the stormwater discharges from artificial turf fields**.** Since artificial turf fields can either discharge to groundwater or surface water, the ecological risks must be evaluated for both potential pathways. This was confirmed by Nillson et al (2008), that drainage from artificial turf fields can enter the environment by either seeping through the underlying soil and potentially contaminate the groundwater, or alternatively, by stormwater runoff entering the adjacent watercourses.

### a) Overall Surface Water Contamination Risk

### 1) Organic Compounds

The studies conducted by Plesser (2004) indicated that concentrations of the common polycyclic aromatic hydrocarbons (PAHs) anthracene, fluoranthene and pyrene, as well as nonylphenols, would exceed the limits for freshwater specified in the Canadian Environmental Quality Guidelines. Torsten (2005) from the Norwegian Institute for Water Research (2005) also predicted that concentrations of alkyl phenols and octylphenol in particular would exceed the limits for environmental effects in the scenario which was allowed a 10:1dilution of run-off. Torsten (2005) further determined that the leaching of chemicals from the materials in the artificial turf system would decrease slowly, so that environmental effects could occur over many years. However, Torsten (2005) anticipated only localized impacts due to the relatively small concentration of the leaching pollutants. The SVOCs analysis of the stormwater in our study, utilizing EPA Method 625, and a specific search for 4-(t-octyl)-phenol, detected no anthracene, flouranthene, pyrene or standard phenol compounds.

Kolitzus (2006) detected no appreciable PAHs concentrations in the runoff analyzed from artificial surface systems. The PAHs that were found above detection limit were ubiquitous substances in the environment. The PAH concentrations in the unbound supporting layer were determined to be in the range of analytic determination limit (0.02 µg/l). The sum of all 16 PAHs was 0.1 to 0.3 µg/l. Similarly, in a recent New York study (Lim et al 2009), no standard organics were detected utilizing EPA Method 624 and 625 in the stormwater sample collected. The

SVOC analysis of the stormwater in our study, utilizing EPA Method 625, detected no standard PAHs.

In surface systems with EPDM and recycled rubber infill, Kolitzus (2006) found several aromatic amino complexes and benzothiazole detected in the range of 10 – 300 µg/l. These concentrations were similar to the results of simulated normal tire wear tests. Lim et al (2009) reported a semi-volatile rubber compound, benzothiazole, at 1,000 ug/l as a Tentatively Identified Compound (TIC) in one stormwater sample. The SVOC analysis of the stormwater in our study, utilizing EPA Method 625, detected no standard aromatic amines, but further TIC analysis did detect identified and unidentified organic compounds. Benzothiazole was detected in two stormwater samples at estimated concentrations of 1.0 and 4.9 ug/l, respectively, which is significantly lower than concentrations found by Lim et al (2009). The Connecticut acute and chronic toxicity benchmark for benzothiazole are 21,333 ug/l and 3,200 ug/l, respectively, based on available toxicity information. The estimated concentrations of benzothiazole are insignificant compared to both the acute and chronic toxicity criteria. Also, a number of unidentified organic compounds were detected during the SVOC TIC analysis at concentrations ranging from 1 ug/l to 150 ug/l, with a median concentration of 6.6 ug/l. The 10/7/09 Field C stormwater sample, which the maximum unidentified compound concentration of 150 ug/l was detected in, was not found to be acutely toxic.

The results from our study appear to be consistent with the results from Kolitzus (2006) and Lim et al (2009), including the detection of benzothiazole in the stormwater samples. Overall, our study did not identify any organic compounds at sufficient concentrations to be considered a potential contamination risk to surface waters.

**2) Metals**

Based on our analysis of the stormwater collected from the artificial turf fields, zinc is the only metal detected in concentrations which could pose a risk to surface water resources. This finding is consistent with many recent studies which analyzed leachate and stormwater from crumb rubber infill, which indicate that zinc is the primary contaminant of concern coming from artificial turf sites. In sites with limited dilution both the Norwegian Pollution Control Authority (2005) and Verschoor (2007) conclude that the concentration of zinc in the leachate would exceed applicable water quality standards. The Norwegian Pollution Control Authority classifies artificial turf runoff as Environmental Quality Class V (very strongly polluted water) due to the high concentration of zinc in the leachate. The risk assessment conducted by Norwegian Institute for Water Research (2005) shows that the concentration of zinc poses a significant local risk of environmental effects in surface water which receives run-off from artificial turf fields.

Verschoor (2007) also conducted a risk assessment concluding that the estimated concentrations of zinc in the drainage water from artificial football fields to be between 1100-1600 ug/L. This concentration exceeded the Dutch legal criterion for surface water Maximum Permissible Chronic Concentration (MPC) of 40 ug/l by a factor of 27-40. Verschoor explained that drainage water concentrations would be diluted in the receiving surface waters, but indicated that zinc in "small ditches" could exceed MPA (Maximum Permissible Acute). Verschoor espoused a general discharge impact rule that only 10% of the permissible concentration of a contaminant (=

4 ug/l) may be consumed by a particular source. This would imply that the concentration of zinc in smaller receiving water would exceed the water quality criteria by a factor of 45-80. Verschoor identified zinc as a potential eco-toxicological risk to surface water, but did indicate that if the crumb rubber were to be replaced by infill materials with a lower zinc emission, the pollutant concentrations in runoff and adjacent surface water should drop quickly.

Lim et al (2009) conducted a mathematical assessment of the risks to aquatic life from crumb rubber leachate based on the SPLP test results for zinc, aniline and phenol. Based on these concentrations, NYSDEC's Division of Fish, Wildlife and Marine Resources concluded that there may be a potential aquatic life impact due to zinc being release from crumb rubber solely derived from truck tires. However, New York State also concluded that an impact is unlikely if the crumb rubber material is from mixed tires and concentrations of zinc from a column test were used rather than the SPLP. It should be noted, that for the column test to better simulate field conditions, the material in the column must reflect local soil conditions and pH.

Several recent studies analyzed stormwater samples collected from artificial turf fields for metals. Lim et al (2009) and Kolitzus (2006) detected concentrations of zinc at 59.5 ug/l and 20 ug/l, respectively. Milone and MacBroome (2008), conducted field studies and detected zinc in the stormwater from four of the six sampling dates , with a maximum concentration of 31 ug/l which is below acute aquatic toxicity criteria of 65 ug/l.

The zinc concentrations in our stormwater samples were significantly higher than those of Lim, Kolitzus and Milone and MacBroom, with three of the eight the samples tested exceeding acute surface water quality criteria. If not mitigated with appropriate stormwater treatment measures, the zinc concentrations found in our study could contribute to the environmental risk of aquatic organisms in surface waters.

**3) Aquatic Toxicity**

Wik (2006) studied the toxicity of various tire brands and determined that different formulas for rubber contributed to varying degrees of toxicity in the leachates to *Daphnia magna*. By conducting a toxicity identification evaluation on various tire leachates (EPA 600/6-91/003), Wik determined that although zinc was prevalent, the semi-volatile non polar organics also heavily influenced the toxicity of the resulting leachate. Passing the simulated tire leachates through carbon filters was the only manipulation that consistently reduced toxicity. Compared to the results from Milone and MacBroom (2008), this study reported significantly higher levels of both aquatic toxicity and zinc. This study found that three of the eight stormwater samples tested were acutely toxic to both the invertebrate (*Daphnia pulex*) and the fathead minnow (*Pimephales promelas*). These acutely toxic samples directly coincided with the exceedences of the acute aquatic life criteria for zinc. Consequently, zinc seems to be the primary pollutant of concern. This study indicates that there is risk associated with whole effluent toxicity and zinc.

**b) Overall Groundwater Contamination Risk**

Stormwater from the fields can impact groundwater directly by percolating through the artificial turf via an "open" underground drainage system (perforated pipes, coarse bedding materials, stone trenches). The stormwater discharges to the underlying soil layers, and ultimately, enters

the ground water. Based on the nature of the underlying soil and the depth to groundwater, the field stormwater is likely to physically and chemically interact with a mineral soil layer (vadose zone) prior to encountering groundwater. This stormwater/soil interaction would be affected by pH, volume of stormwater and soil characteristics, such as moisture, chemistry, mineralogy, soil texture, hydraulic conductivity and drainage class. These interactions would likely influence the concentrations of contaminants found in the groundwater.

There are two primary concerns with the contamination of groundwater in the environment - the threat to drinking water and the threat to surface water resources via groundwater recharge. Several other studies were conducted on the crumb rubber fill from 2004 to 2009; (Plesser(2004), Nillson et al (2008), the Norwegian Institute for Water Research (2005) , Verschoor, A.J., RIVM Report 601774011/2007(2007) Study, (Milone & MacBroom Study 2007),NYSDEC May 2009 an Kolitzus, Hans J. (2006). These studies compared the relative concentration of contaminants found in laboratory leachates and/or artificial turf generated stormwater with various drinking water and aquatic life criteria.

**1) Organic Compounds**

It should be noted that substances, to a varying degree, will be absorbed by the sand/clay layers which the drainage water passes. Although Nillson et al (2008) found that concentrations of nonylphenols in the contact water from leaching tests were in the order of 20-800 times above the threshold values for drinking water, it was uncertain as to whether this concentration would be significant in the actual groundwater. The EPA aquatic life acute criteria for nonylphenol for freshwater and saltwater resources are 28 ug/l and 7.0 ug/l, respectively. It is important to note that nonyphenol has been associated with the disruption of fish endocrine systems at concentrations below EPA's criteria. No data was available for phthalates and nonylphenols under such realistic conditions from lysimeter data. Nillson determined that the assessment of the impact on water systems also requires more realistic lysimeter tests or measurements on drainage water from artificial turf fields over time.

Plesser (2004) compared leachate results with Canadian Environmental Quality Guidelines for ground water. Groundwater guidelines are developed for both protection of drinking water and protection of surface water via groundwater recharge. Plesser identified anthracene, fluoranthene, pyrene and nonylphenols as compounds in the leachate that could exceed the more protective criteria for groundwater. Plesser also concluded that analyzing possible paths and changes in leaching properties over time is necessary to determine the degree to which the concentrations of these compounds are actually harmful to people and the environment.

Lim et al (2009) conducted a leachate (SPLP) test on rubber crumble material, and analyzed for zinc, phenol and aniline. The results from recent leaching studies indicated a potential for release of aniline, benzothiazole, phenol, and zinc to the groundwater. However, concentrations of the organic contaminants analyzed were below levels that would impose a risk to drinking water. Lim also collected 32 groundwater samples from wells installed downgradient of four artificial turf fields and analyzed them for SVOCs, including aniline and benzothiazole, using SW-846 Method 8270C. The wells were installed in sandy textured soils with depth to the groundwater ranging from 8.3 to 70 feet. All test results were below the limit of detection for all

groundwater samples analyzed. Based on test results of 32 samples, no organics were detected in the groundwater at the turf fields.

Our results are consistent with the leachate and groundwater sampling results in Lim et al (2009). The concentrations of organic compounds in our study did not exceed groundwater protection criteria.

**2) Metals**

In general, metals are immobilized in soils by adsorption, absorption and precipitation. All of these, mechanisms impede movement of the metals to ground water. Metal-soil interaction is such that when metals are introduced at the soil surface, downward transportation does not occur to any great extent unless the metal retention capacity of the soil is overloaded, or metal interaction with the associated waste matrix enhances mobility.

Zinc is the most prevalent contaminant in the leachate and stormwater studies. In several of these studies, zinc concentrations measured in leachate exceeded drinking water standards. Most of the zinc in soil is absorbed to the soil as zinc hydroxide or oxide and does not dissolve in water. Zinc does show moderate mobility under relatively acid soil conditions (pH 5–7) because of increased solubility and formation of soluble complexes with organic lignands (Elliott et al. 1986; Stevenson and Fitch, 1986; Klamberg et al. 1989). Zinc is retained in an exchangeable form at low pH in iron and manganese oxide dominated soils but becomes non-exchangeable as the pH was increased above 5.5 (Stahl and James, 1991). Therefore, depending on the acidity of the soil and water, some zinc may reach groundwater.

Nillson et al (2008) determined that although leachate concentrations of zinc were in excess of the drinking water quality standards, similar concentrations were not observed in (field) lysimeter tests. Nillson concluded that the concentration of zinc in the lysimeter tests were a more accurate reflection of zinc in the groundwater and, therefore, zinc concentrations would not exceed drinking water standards.

Lim et al (2009) was the only study that did not report concentrations of zinc in the SPLP leachate that exceeded drinking water standards.

Verschoor (2007) concluded that, for the majority of situations, the risks of zinc to public health are minimal since it is not very toxic to humans and the World Health Organization (WHO) drinking water criteria was not exceeded in tests. However, Verschoor (2007) did note that in sandy areas discharges to groundwater may exceed Dutch Intervention Values by a factor of 1.5 to 2.2. In sandy soils, infiltration of water with dissolved zinc will result in weak binding of zinc to the soil matrix and could cause protection criteria to be exceeded by a factor of 12. Verschoor concluded that zinc was a potential eco-toxicological risk to groundwater and soil.

Plesser (2004) and CAES (2009) indicated that zinc was the most likely contaminant to exceed drinking water standards in the leachate. All studies indicate that, although compounds were present in the leachate or stormwater, it was uncertain as to what affect the underlying soils and groundwater would have on the actual concentration of contaminants in the groundwater. Actual groundwater testing may be necessary to determine the impact.

The leachate results reported by CAES showed zinc concentrations up to ten times the drinking water standards and up to 500 times the surface water protection criteria. Our study detected concentrations of zinc in the stormwater significantly lower than CAES results, with no exceedences of drinking water standards and no significant concerns for groundwater quality. It is important to note that no groundwater samples were collected for our study.

## 11. CONCLUSIONS

The DEP concludes that there is a potential risk to surface waters and aquatic organisms associated with whole effluent and zinc toxicity of stormwater runoff from artificial turf fields. Zinc concentrations in the stormwater may cause exceedences of the acute aquatic toxicity criteria for receiving surface waters, especially smaller watercourses. The DEP suggests that use of stormwater treatment measures, such as stormwater treatment wetlands, wet ponds, infiltration structures, compost filters, sand filters and biofiltration structures, may reduce the concentrations of zinc in the stormwater runoff from artificial turf fields to levels below the acute aquatic toxicity criteria. Individual artificial turf field owners may want to evaluate the stormwater drainage systems at the fields and the hydrologic and water quality characteristics of any receiving waters to determine the appropriateness of a stormwater treatment measure.

This study did not identify any significant risks to groundwater protection criteria in the stormwater runoff from artificial turf fields. It is important to note, that the DEP study did not directly collect and analyze groundwater at these artificial turf fields. Consequently, this conclusion regarding consistency with groundwater protection criteria is an extrapolation of the stormwater results collected and the evaluation of data presented in recent studies, such as Nillson et al (2008) and Lim et al (2009). To make a final conclusion regarding the overall risk from exposure to groundwater affected by stormwater runoff from artificial turf fields, further sampling and analysis of groundwater at the artificial turf fields would be required.

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Attachment F
Natural and Artificial

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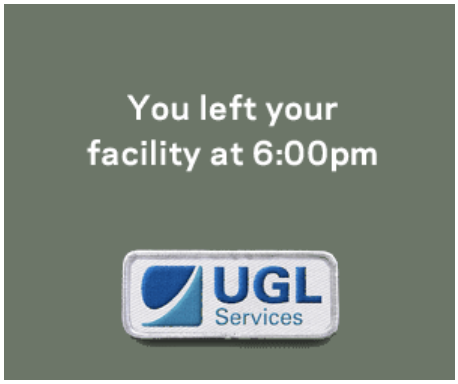
# Natural Landscaping and Artificial Turf: Achieving Water Use and Pesticide Reduction

*By Alex Wilson and Jessica Boehland*




## What's Wrong with the Conventional Lawn?

Throughout North America today, the dominant landscaping aesthetic is a broad, open lawn punctuated by trees and shrubs. While this landscaping system has been engrained into us through our culture and media, it creates an ecologically depleted landscape that requires significant amounts of resources and chemicals to maintain, especially in dry climates.

Conventional lawns require inputs of water and energy while causing air, water, and noise pollution. Annually in the U.S. we spend tens of billions of dollars caring for them. In some areas we use over half of our municipal freshwater to irrigate lawns, and we fortify them with millions of tons of fertilizer and thousands of tons of pesticides. What's wrong with this picture?

From an environmental, health, and even economic standpoint, a lot is wrong with conventional turf. Maintenance of turf necessitates regular mowing during the growing season, which is responsible for approximately 5% of the nation's air pollution, according to the U.S. Environmental Protection Agency (EPA)—and a good deal more in many metropolitan areas. A typical 3.5 horsepower gas mower emits about the same quantity of volatile organic compounds (VOCs) in one hour as a late-model car driven 340 miles (550 km), according to the California Air Resources Board. On top of that, EPA estimates that users of such equipment spill 17 million gallons of fuel each year—which is more than the Exxon Valdez oil spill!

Watering lawns consumes 30% of municipal freshwater in the eastern U.S. and 60% in the West. A *U.S. News & World Report* article reported that a 1,000 square-foot (93 m2) lawn requires, on average, 10,000 gallons (37,850 liters) per summer. With droughts continuing in the West and expected to increase in severity as a result of global climate change, this is a growing concern.

To maintain lush lawns, we use a lot of fertilizer—some 70 million tons (64 million tonnes) per year in the U.S. We use more fertilizer on our lawns in the U.S. than India uses on its food crops. Nitrogen fertilizers are produced by converting molecular nitrogen (N2) in the air into ammonia through the Haber-Bosch process, which is extremely energy-intensive, requiring approximately 18,000 Btus per pound (41 GJ/tonne) of primary energy input, which comes primarily from natural gas. Worldwide, ammonia production accounts for approximately 1% of global primary energy use.

Insecticides, herbicides, fungicides, and other pesticides are a growing concern with lawns. U.S. homeowners use 67 million pounds (30 million kg) of pesticides on lawns each year, according to EPA. Our suburban lawns and gardens receive heavier pesticide applications than our agricultural land: between 3.2 and 9.8 pounds per acre (3.6—11 kg/ha) vs. an average of 2.7 pounds per acre (3.0 kg/ha) for agricultural lands.

Along with the resource and environmental burdens of producing fertilizers and pesticides, a significant portion of these chemicals applied to lawns ends up in stormwater runoff and in groundwater. According to EPA, 40—60% of the nitrogen applied to lawns ends up in surface water or groundwater. Stormwater runoff from turf is one of North America's biggest sources of water pollution.

Noise pollution is another concern. Lawnmowers, weed whackers, hedge trimmers, and leaf blowers cause significant noise pollution, a very real but often overlooked health hazard.

Due to the need for all this maintenance, lawns are a huge expense. Homeowners spend roughly $27 billion per year on lawn care, according to the National Wildlife Federation (NWF)—ten times more than we spend on school textbooks. At the business level, the lawn care industry did approximately $61 billion in business in 1997 and has been experiencing roughly 20% annual growth in recent years. On a per-acre basis, maintenance costs for mowing, irrigation, and application of fertilizer and pesticides average $1,120 per year, according to the organization Wild Ones Natural Landscapers.

## Benefits of Natural Landscaping

**Natural prairie landscaping is projected to save the Metropolitan Water Reclamation District of Chicago thousands of dollars per year compared with the turf that is being replaced.**

Just as there are significant environmental burdens and costs associated with conventional turf landscaping, there are benefits associated with natural landscaping. The primary benefits are described below.

*Reduced air pollution.* Native landscaping generally does not require regular mowing, which eliminates or greatly reduces the air pollution resulting from turf landscapes. There can be pollution emissions from natural landscaping, however—see discussion below on pollution from fire management.

*Reduced nutrient runoff.* Native landscaping does not require fertilizer, so the runoff and infiltration of nutrients is eliminated. Buffers of natural landscaping can be used to capture runoff from hard surfaces or less permeable turf to keep the pollutants in that stormwater from entering surface waters. Keeping nutrients out of the groundwater also protects surface waters, because groundwater surfaces in springs and flows into streams and rivers.

*Reduced pesticide use.* Because natural landscaping involves the establishment of balanced ecosystems, the use of herbicides, insecticides, and other pesticides is generally not required (though herbicides are often used to remove invasive plants during the establishment of natural landscapes). Reduced operation of lawnmowers and other lawn-care-related power equipment reduces air pollution both locally and regionally, thus improving health. And keeping pollutants out of water supplies also protects our health.

*Increased biodiversity.* Natural landscapes inherently support greater biodiversity than conventional turf landscapes. Native plants provide diverse food and habitat for birds, small mammals, insects, reptiles, and amphibians. In heavily developed urban areas, even small patches of natural landscape can be critical in maintaining populations of native fauna and flora.

*Cost avoidance.* Significant savings in landscape management costs can be realized by converting lawns to natural landscapes. While the initial costs of creating natural landscapes can be relatively high, annual operating costs of established natural landscapes are generally far lower than annual operating costs of lawn area. Operating cost savings were a primary motivation for the Metropolitan Water Reclamation District of Chicago to convert turf area to tall-grass prairie—to date, approximately 20 acres (8 ha) of turf has been restored to natural landscape, with guidance from Conservation Design Forum of Elmhurst, Illinois.

### Downsides of Natural Landscaping

While the arguments for natural landscaping are compelling, there are some challenges:

- The aesthetic palette is more limited. Strict adherence to an all-native landscaping program restricts plant choices, which many property owners (as well as landscape architects and landscapers) object to.
- Establishing and maintaining natural landscapes requires new knowledge and skills. There are both direct and indirect costs associated with building these skills, and there is often inherent resistance to change in any profession.
- Fire management, a key component of many—if not most—natural landscapes, poses obvious risk and liability. These risks gained national attention when, on May 4, 2000, a prescribed burn at Bandelier National Monument in Los Alamos, New Mexico, got out of hand and burned nearly 48,000 acres (19,400 ha), destroying 400 homes and causing more than a billion dollars in damage.
- Fire management also generates air pollution. Depending on the type of landscape and the weather conditions during a prescribed burn, however, these emissions are usually fairly low.

### Establishing Natural Landscapes

The key to establishing natural landscapes is careful planning to ensure that adequate management and stewardship is carried out until the landscape is established, at which point maintenance requirements become fairly minimal. Natural habitat landscaping is not about individual plant species but about ecosystems. With natural landscaping, the goal is to create balanced, self-sustaining ecosystems, not just assemblages of individual native plants. Because almost any ecosystem existing today has been degraded to some extent, creating a healthy, largely self-sustaining landscape often

requires significant restoration work.

### Dealing with invasive plants

Invasive exotic plants are the bane of natural landscaping. Hundreds of plant species are wreaking havoc in ecosystems throughout North America. Each region of the country has particular invasive plant species that are problematic: from kudzu in the Southeast to honeysuckle and Japanese knotweed in the Northeast to cheatgrass and garlic mustard in the Midwest and West.

Strategies for removal of invasive plants all have advantages and disadvantages: hand-pulling is labor-intensive but safe for the environment; herbicides (such as Roundup©) are fast and easy but may have unintended consequences for other organisms in the ecosystem; turning over the soil (to kill turf grass, for example) avoids chemicals but may damage the soil structure and soil microorganisms; prescribed burns are often the best method to control invasives and allow the ecosystem to return to a pre-European settlement balance, but they cause safety concerns and air pollution.

The success of invasive plants is often related to changes in overall habitat conditions. When conditions that favor native species are restored through such restoration management tools as selective clearing to provide appropriate light levels and annual burn management, the invasive species are often gradually eliminated.

### Converting turf to natural landscapes

A number of approaches can be taken to convert turf or other invasive vegetation to natural (restored) ecosystems. Short-lived herbicides are effective, and have the advantage of keeping root systems in place to help prevent erosion while new species are being established. Mechanical strategies, including repeated discing and harrowing, are also effective, and do not present any toxicity concerns Sometimes simply easing off on mowing allows native species to gradually return—if native species are growing nearby—but this approach yields less certain results than complete replacement of the existing vegetation, and often nearby intact habitats do not exist.

In designing landscapes that will be managed with controlled burns, firebreaks often make sense. Roads can serve as firebreaks. Bands of turf grass along road corridors and around building can make sense to keep fire under control.

### Increasing people's comfort with natural ecosystems

Given the American infatuation with lawns, social and psychological factors often emerge as barriers to natural landscape designs. Joan Nassauer, Ph.D., FASLA, of the University of Michigan, has researched human responses to various landscape designs.

Her research suggests that most Americans (indeed, people in most Western cultures) are uncomfortable with landscapes that they perceive to be wild or unmaintained, but are attracted to natural plantings within an obviously managed context. Signs of human care and attention to a space, whether it is a recently mown lawn or a freshly painted picket fence, represent what Nassauer calls "cues to care." Thus, boundaries of well-maintained turf around naturally landscaped areas not only provide firebreaks but also increase most people's comfort level with the native plantings.

### Which Grass is Greener? Comparing Natural and Artificial Turf

Another alternative to the resource-intensive conventional lawn is artificial turf. Early adopters of plastic grass were professional sports teams, who had the cash to spend on the newest technologies. Artificial turf continues to replace natural playing fields not just for the pros but for college-level athletes and Little Leaguers alike.

And it doesn't stop there. Artificial turf is replacing grass in a variety of applications, ranging from community parks to parking-lot medians, and even outside American homes. Plastic grass sidesteps many of natural turf's downsides, but could it possibly be greener than grass itself?

### Early Artificial Turf

The first artificial turf, which would become known as AstroTurf, was made by the Chemstrand Company, a subsidiary of the Monsanto Company, and installed in 1964 at the Moses Brown School in Providence, Rhode Island. In 1965, Monsanto's artificial turf was laid in Houston's AstroDome, the largest indoor sports facility in the world at the time.

Popular for its convenience, early artificial turf was largely loathed by the athletic community. First-generation artificial turf was typically stiff, low-pile polypropylene or nylon fiber adhered to a concrete or asphalt base. The fibers caused "turf burn," the hard base was less forgiving than soil, and athletes are united in their claims that first-generation turf caused more injuries than grass. Although this primitive turf is still available, it has been largely superseded by softer, safer, more naturalistic surfaces.

In the early 1990s, artificial turf began expanding from playing fields to other uses. Increasing incidences of drought, concern over the dangers posed by pesticides, and the grasslike look and feel of modern artificial turf have led to increasingly use of plastic grass in parks, day care centers, dog runs, and the yards of homes and businesses.

### Second-Generation Artificial Turf

**FieldTurf ushered in the second generation of artificial turf. Unlike the original AstroTurf, this "infilled" turf includes a layer of sand and rubber pellets to surround polyethylene fibers. Infilled products are safer than earlier systems and feel remarkably similar to real turf grass.**

Second-generation artificial turf is significantly evolved from earlier products. The part of artificial turf that is the equivalent of the blades of natural grass is generally made of a green-colored, UV-stabilized polyethylene or polypropylene fiber in piles of two inches or higher. These blades are tufted into a porous backing, generally made of polyethylene, polypropylene, or polyurethane. Surrounding the blades of grass is a crumb layer of silica sand and/or rubber bits ranging in diameter from 0.5 to 1.5 millimeters. After the crumb layer is added, the blades typically stand about 3/ 4" tall (19 mm), though different heights can be specified for different applications. Many products include a shock pad. Finally, most manufacturers incorporate a drainage layer of crushed stone below the backing layer, and a few incorporate perforated-pipe drainage systems. Artificial turf systems are generally warranted for about eight years, but the actual life expectancy is unknown.

### Benefits of Artificial Turf

*Recycled Content and Reusability.*
The rubber bits in the crumb layer of artificial turf are often made from recycled tires. Memorial Stadium field at the University of Nebraska—Lincoln used 14,000 recycled Nebraska tires. Some artificial turf also incorporates recycled tennis shoes. If it is replaced before it is worn out, artificial turf can be reused. When Aloha Stadium, in Honolulu, Hawaii, upgraded its fields in 1999, and again in 2003, state officials donated the used AstroTurf to local high schools. RS Global, Inc., based in Carrollton, Texas, has removed artificial turf from more than one hundred used fields over the past three years. RS Global breaks the turf into pieces for use in smaller applications, such as batting cages.

*Reduced water use.*
From an environmental perspective, the potential for water savings is probably the most significant benefit of artificial turf. Plastic grass, of course, needs no irrigation to stay green. The only water used on artificial turf is to cool it down in extremely hot conditions or clean it, if necessary. The City of San Marcos, Texas awarded Southwest Texas State University with a Water Efficiency Achievement Award in 2003 for converting the natural field at Bobcat Stadium to SRI's AstroPlay ©, a move which the school estimates is saving more than 2 million gallons (7.5 million liters) of water each year.

*Reduced pesticide and fertilizer use.*
Since artificial turf needs no regular chemical treatment, it eliminates a major source of non-point-source groundwater pollution and human exposure to chemicals. For residential applications, artificial turf also offers the benefit of reducing the amount of chemicals (and dirt) tracked into homes. Artificial turf's chemical-free care may make it especially appropriate for daycare centers and dog yards, because children and pets spend more time than adults in close contact with grass, and they are affected more severely by contact with pesticides.

*Reduced maintenance.*
Artificial turf needs no mowing, watering, fertilizing, aerating, or reseeding, and it will not outgrow its painted field lines; synthetic grass, though, demands its own maintenance regimen. Caring for residential artificial turf generally involves just the occasional use of a leaf blower or a carpet rake. When necessary, artificial turf can be washed with a garden hose. Biological material, including leaves and feces, will not decompose as quickly on plastic as on natural grass, so when such materials find their way onto artificial turf, more maintenance is required to keep it tidy. Depending on its use, residential turf can often go six weeks or longer without any maintenance.

### Turf, Air Quality, and the Atmosphere

Through the process of photosynthesis, grass converts carbon dioxide to oxygen and other gases. Turfgrass Producers International (TPI) claims that a 2,500 ft Â² (230 m Â²) lawn releases "enough oxygen for a family of four to breathe." Simultaneously, the absorption of carbon dioxide mitigates to some extent the process of global climate change. Another argument for natural grass is its ability to cool the surrounding area through evapotranspiration. According to TPI, lawns are 14Â°F (8Â°C) cooler than bare soil on hot days, or 30Â° (17Â°C) cooler than asphalt. Natural grass also helps to clean the air: grass areas trap 12 million tons (10.8 million tonnes) of dust and dirt from the air each year, TPI reports, and some studies have shown that grass absorbs carbon monoxide.

Artificial turf, in contrast, frequently offgasses volatile organic compounds (VOCs). This could be a concern for children, who are often more sensitive to emissions, and especially for the rapidly growing number of Americans with asthma. Artificial turf also contributes to the urban heat-island effect. Although they look green from an angle, artificial fields are often closer to black when viewed from above, owing to the rubber layer surrounding the blades. Darren Gill, marketing manager for artificial turf company FieldTurf, says that in direct sun, artificial turf averages between 6 and 10Â°F (3—6Â°C) warmer than grass, though he's seen differences as high as 15Â°F (8Â°C). He also mentioned that in especially warm climates, maintenance staff sometimes spray sports fields with water once or twice a day to keep them cool. This tendency to heat up in hot weather makes artificial fields less appropriate in southern climates. Gill stresses that artificial turf cools quickly when it's not in direct sun.

### Ecology

Of the 50 species cultivated for use as turf, only a handful dominate the market. In colder climates, four or five species are typically mixed for each application, according to Joyce, while in warmer climates turf is generally close to a true monoculture. The species of grass we commonly use on our lawns did not evolve here and are not adapted to America's climates and ecologies. Left to their own devices, most of these grasses would happily go dormant and turn brown during dry spells. Even where these species are native, they do not naturally grow in a monoculture, bereft of other plant species, as we expect them to do on our lawns and golf courses. Intruding plants and animals are called weeds and pests, and we obliterate them with chemicals. DDT, once a popular turf grass pesticide, was actually marketed as "the atomic bomb of the insect world."

A new movement in turf management shows some promise of improvement for biodiversity. In order to avoid the need for pesticides, fertilizers, and irrigation, some homeowners are planting grass species that are drought-tolerant or native to their climates. Buffalo grass, for example, native to America's central and southern Great Plains, is gaining popularity in hot climates. The Prairie Nursery Corporation, based in Wisconsin, has been marketing a mix of native fescue grasses for lawns since 1993. Their No Mow mix, including cool-season fescue grasses native to Oregon and Canada, was designed for the colder, less sunny climate of the northern U.S.

Kim Sorvig, research associate professor at the University of New Mexico, and co-author of *Sustainable Landscape Construction: A Guide to Green Building Outdoors*, is concerned about the soil conditions under artificial turf. "It blocks both water and sunlight either completely or in very large degree," he said, "and without that, you can't have a living system in the soil." Sorvig thinks it is ironic that artificial turf is heralded as a solution to water shortages, since it diminishes the health of the underlying soil, thereby decreasing its ability to hold water. "When you remove the vegetation from an area so completely," he said, "you're actually, in the long term, contributing to drought."

The only application for which Sorvig believes artificial turf is appropriate is indoor stadiums, since they are "already separated from the soil system." Ecology may be one area where neither artificial nor conventionally maintained natural turf can claim victory.

### Biophilia

The biggest strength of artificial turf is also its biggest weakness. Artificial turf remains a "monofilament ribbon file product"; by definition, it can never be alive. So why bother to make it look or feel like the real thing? Nostalgia begins to explain our intangible trouble with artificial turf—gone are the stubborn grass stains and the smell of freshly mown grass. The best explanation, though, is that we feel an innate connection to good-old-fashioned grass.

Harvard biologist Edward O. Wilson sought to explain this phenomenon in his 1984 book *Biophilia: The Human Bond with Other Species.* Human beings, he argued, subconsciously seek a connection with other species and with life. Plastic grass will always feel foreign to us because it is not living and robs us of our cues to natural processes. It refuses to die—or even fade—as the seasons change.

So-called natural turf, it has been argued, is itself far from natural. Most turf grass yards and fields would be biological impossibilities without significant inputs of water, chemicals, and energy. Yet, grassy lawns feel natural. Perhaps our biophilic impulse is fooled by this seemingly natural landscape. Or perhaps it doesn't care—a living landscape is a living landscape, no matter how it came to be.

### Final Thoughts

Conventionally managed natural turf carries a plethora of environmental burdens, but it does support soil organisms to some degree. The grass and these organisms play a crucial ecological role by purifying water as it leaches into the earth. It is questionable, though, whether this function is positive enough to offset the repercussions of watering, pest treatments, fertilization, and mowing.

Playing fields subject to heavy use, especially where pristine appearance is a priority, may represent a setting in which artificial turf can be justified. But the fact that it doesn't support soil organisms, and therefore is a biologically dead zone, suggests that its use should be limited.

In many situations, the optimal choice, at least from an environmental perspective, is a natural landscape of native or adapted plants. Approaching the condition of a natural ecosystem, such a landscape minimizes maintenance while offering biological diversity.

In places where a uniform, cropped surface is needed, natural turf managed in an ecologically sound manner is a good choice. Natural lawns and fields can be maintained responsibly by beginning with native and adapted species that require little or no water, allowing them to go dormant (and turn brown) at times, and feeding them appropriate, organic fertilizers. Even mowing, when necessary, can be done using low-emitting and quiet machinery. The result may not live up to the standards of the Garden Club of America, but other species will approve.

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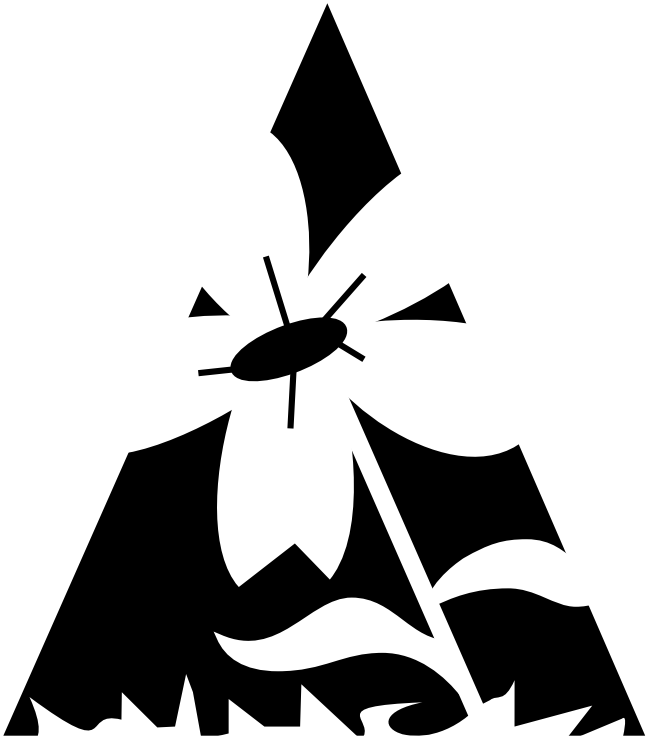

# low maintenance landscaping

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low maintenance landscaping low maintenance landscaping low maintenance landscaping low maintenance landscaping

Although the term Xeriscape* is relatively new in Kansas, the concept is not. It simply imitates nature's design: putting hardy, adapted plant materials in the places where they grow best. Once established, this kind of landscape requires little maintenance because it is designed to work in harmony with nature, not against it.

Estimates indicate that nearly 50 percent of water the average household uses is for outside landscape and turfgrass areas. You can reduce your water use by imitating nature with a low-maintenance landscape design. It is applicable to both homes and businesses, on new building sites or previously landscaped sites. To be successful, it requires careful consideration and planning.

Ultimately, you will realize a savings not only in water but also in time, labor, equipment, and materials such as fertilizers and herbicides, and that's dollars in your pocket. Furthermore, because of increasing demands on a limited water supply, a landscape with a record of low water bills may boost the resale value of your home.

A water-conserving landscape design involves using hardy, adapted plant materials which are suited to your particular location in Kansas, its soil and its climate. More specifically, it requires selecting plants according to soil type, slope and available rainfall. It means arranging these plant materials in such a way that they actually can contribute further to water conservation by reducing the evaporative effects of wind and sun in your yard or business site.

Typically the design would include native plant species, those that grow naturally in Kansas, but certainly is not restricted to them and is not boring. In fact, choosing this type of design can result in a greater diversity of plant materials from one yard to the next.

The seven Xeriscape principles are Planning and Design, Limited Turf Areas, Efficient Irrigation, Soil Improvement, Mulching, Lower Water-Demand Plants, and Appropriate Maintenance.

*Xeriscape is a trademark term of the National Xeriscape Council.

Designs can be simple or elaborate, but every plan should take into consideration factors that affect water use. Steep slopes or grades encourage water runoff and soil erosion. Drought-tolerant groundcovers, shrubs and trees can be used to slow down and absorb water, and to reduce evaporation by shading the soil. Terracing with plants is another possibility.

South- or west-facing exposures get maximum sunlight and can benefit from use of mulches or drought-tolerant plants. Wind increases the amount of plant moisture lost through evapotranspiration. Fences and screens can greatly reduce the amount of supplemental water needed by slowing or blocking the wind. Using trees and shrubs as windbreaks can be effective, if the species don't require watering.

As trees provide shade which reduces the soil temperature and lowers water lost through evaporation, they also reduce air temperatures, which reduces water loss. Trees such as maples should be avoided in the low water use landscape. Their invasive surface-feeding roots compete with nearby plants for water and nutrients.

Plant trees and shrubs in attractive compositions and arrange plant materials along water-need zones to prevent overwatering some plants while underwatering others.

Turfgrass areas usually require the most water and maintenance in a landscape. Limit irrigated turfgrass areas to places with high use. Use low-maintenance and native grasses for other areas. The lawn must fit the landscape, but avoid making it long and narrow, which is more difficult to irrigate effectively. Select hardy, adapted lawn grasses suited to the site. Manage your lawn for stress, deep watering when needed.

Warm-season grasses—bermudagrass, zoysiagrass and buffalograss—are drought resistant. Cool-season grasses—bluegrass, fescue and ryegrass—require watering for maintenance (See table). Keep in mind that warm-season grasses do not grow well in shade. When nature is left to take its course, warm-season grasses will dominate sunny areas and cool-season grasses will dominate shady

| Turfgrass | Drought Resistence |
|---|---|
| Burmudagrass | excellent |
| Buffalograss | excellent |
| Zoysiagrass | excellent |
| Tall fescue | good |
| Bluegrass | fair |
| Ryegrass | poor |

areas. You may see this as a patchwork look because the two types of grasses are different in texture and color. But the total water required will be reduced, and both types of grasses will grow best in the areas suited to them.

Cool-season grasses green up earlier in the spring and stay green later in the fall, which means a longer growing season. They also require more water than warm-season grasses during hot weather—most of the summer in Kansas.

An increased interest in using native grasses for lawns has developed in recent years due to their low water and maintenance requirements and naturalistic appearance. Most native grasses are warm-season grasses and must be planted in areas that receive full sunlight. Buffalograss is the most common native grass used in lawns. It grows best in areas with less than 25 inches of annual rainfall.

Native grasses should be watered and fertilized sparingly or not at all. Watering and fertilizing these grasses causes them to become weedy and you lose the low maintenance aspect of a native grass lawn. Under suitable conditions, native grasses can save water and maintenance, but the cost of seed is high and some watering to get them established is recommended. Weeds are the major problem in establishing a native grass lawn.

Lawn watering and maintenance reduction must be accompanied by a reduction in the amount of fertilizer applied and adjustment of other cultural practices. Taller mowing helps control weeds and reduces watering and mowing frequency. The amount of fertilizer you put on a lawn determines your maintenance program.

The amount of mowing, watering, problems and pests is largely related to the amount and timing of fertilizer

| Total Nitrogen per Year | | | |
|---|---|---|---|
| **Cool-season grasses** | **lbs.** | **Warm-season grasses** | **lbs.** |
| High maintenance | 4* | (low to high range) | |
| Good maintenance | 3 | Bermudagrass | 2-4* |
| Low maintenance | 2 | Buffalograss | 0-2 |
| Minimal maintenance | 1 | Zoysia | l-3 |

*lbs. AN/1000 sq. ft. (AN = actual nitrogen)

applications. The table above provides guidelines for the total seasonal nitrogen. Phosphorus and potassium should be applied as indicated by a soil test.

Efficient watering is part of the low-maintenance design. Your landscape design should incorporate zones for water need areas—high, medium, low or none at all.

Prevent runoff; harvest water! Collect or redirect water from the downspouts to areas of the landscape that need it. Select and combine different irrigation systems—drip, trickle, sprinkler. Water slowly, deeply and infrequently.

Each type of plant has a maximum depth to which its roots will grow. Roots will penetrate only to that depth where water, air and nutrients are present. Deep watering encourages deep rooting, increasing the reservoir of water so plants can go longer between watering. Deeply placed water is also less subject to loss by evaporation from the soil surface.

The roots of most small trees and shrubs may reach up to 6 feet deep, while smaller shrubs or flowers may root 2–4 feet deep. Consider grouping plants together that may be shallow rooted and require more frequent watering such as flower beds or a mixed border of small shrubs.

It is important to water only long enough to wet the soil to the depth of the root system and not beyond because this is a waste of water. A soil probe or thin rod pressed into the soil will go in easily until it reaches the dry zone.

The most critical factor in determining water use is weather—temperature, humidity, wind, sunlight, and precipitation. There is a constant flow of water through plants, bringing nutrients to the upper plant parts. This

transpiration flow of water increases as conditions cause greater movement of water through a plant.

Most of the absorption of water and nutrients occurs in the upper half of the root system, thus water should be applied directly to the soil surface or the root zone. Water applied to plant leaves and tops is wasted, especially in hot weather, because much of it will evaporate before it reaches the ground.

Most small trees and shrubs should be watered to wet the soil to a depth of 4 feet once a month or every 6 weeks. Plants with shallow roots require more frequent soaking, perhaps to a depth of 2–3 feet every 2–4 weeks. Remember, the water requirements for a mature landscape allow flexibility in this watering pattern; those of a newly planted landscape do not.

Know your soils. Improving the soil helps conserve water. Adding organic matter is by far the most important soil improvement affecting water use. A soil test, which is available through your county Extension office, will determine the organic matter level of your soil.

In sandy soils, organic matter slows down the rapid movement of water through the soil, making it more available to plant roots. In heavy clay soils, the addition of organic matter increases infiltration of moisture, which prevents runoff and wasted water.

Adding organic material is easiest and most effective before planting. Incorporate at least 2–3 inches of organic matter into the top 8 inches of the planting area unless your soil test indicates otherwise. Because organic matter continually decomposes, it needs to be replenished on a yearly basis. Applying an organic-type mulch is the most effective way to do this in an established landscape.

**Types of Organic Matter**

- Straw
- Well rotted manure
- Leaf mulch
- Peat moss
- Lawn clippings
- Compost
- Well rotted sawdust
- Wood chips
- Shredded bark
- Green manures

In areas with hardpan—an underlying layer of clay—subsoiling is recommended before planting. Plants growing on top of unbroken hardpan are more vulnerable to water fluctuations because of the shallow growing area. Planting a deep-rooted legume can be effective in breaking up hardpan, although it may take some time to accomplish.

Mulches can do much more than cut down on water use. They also can improve soil texture, suppress weeds, lower soil temperature, and add ornamental value to the landscape. How well a mulch conserves moisture is determined by its composition and how deeply it is applied.

Common mulches range from wood chips, stone and gravel to landscape fabric, plastic and polyethylene film. Deciding which mulch to use will depend on its cost, availability, ease of use, durability and appearance in your particular landscape. Each mulch has advantages and disadvantages.

Plastic or polyethylene film prevents moisture evaporation effectively; is thin, lightweight, and inexpensive. Perforated plastic is more expensive. Some disadvantages are you must punch holes to let in water and air; it is unsightly; must be covered with another material; doesn't improve soil; and can cause roots to concentrate at the soil surface, increasing drought susceptibility.

Landscape fabric—Geotextiles, Weed Barrier, Weed X, Weed Block—are water and air permeable; suppress most water-competing weeds; and are durable. They are, however, expensive; allow some weeds to grow; and must be covered by a top mulch layer.

Wood chips, tree trimmings, and shredded or chunk bark are relatively inexpensive; let in water and retain it in soil; break down to improve soil texture; and suppress weeds if the smaller size is used. The most effective depth for these mulches is 3–4 inches. These materials do break down in l–3 years, depending on particle size and type of tree used. Smaller sized particles may require addition of nitrogen for plants.

Stone and gravel allow moisture in and retain it in the soil; are long lasting; come in a variety of sizes; suppress weeds; and can have an ornamental appearance. Prices vary with size and type. They do not improve soil; are unattractive if used in a large area; increase soil temperature and glare; and tend to get scattered by lawn mowers and small children.

Selecting lower water use plant materials is essential. A partial list of plants appears at the end of this publication. Check with a nursery for your particular site needs.

Once the planning and planting are complete, maintenance becomes the key to a successful low water use landscape. Mowing, pruning, weeding, mulching and fertilizing will maintain your landscape in a healthy, productive and beautiful condition for years to come.

## Selecting Plant Materials

Consider the importance of turfgrass qualities such as drought, cold, heat and shade tolerances, wearability, and fertilizer requirements in your landscape plan; then choose the species that meet your needs. (The following turfgrass information adapted from "Conserving Water in the Landscape," Nebguide published by Cooperative Extension, Institute of Agriculture and Natural Resources, University of Nebraska—Lincoln.)

- Drought tolerance of popular turfgrasses, ranging from most to least tolerant: buffalograss, bermudagrass, zoysiagrass, tall fescue, Kentucky bluegrass, perennial ryegrass.
- Cold tolerance of popular turfgrasses, ranging from most to least tolerant: Kentucky bluegrass, buffalograss, tall fescue, perennial ryegrass, zoysiagrass, bermudagrass.
- Heat tolerance of popular turfgrasses, ranging from most to least tolerant: buffalograss, bermudagrass, zoysiagrass, tall fescue, Kentucky bluegrass, perennial ryegrass.
- Shade tolerance of popular turfgrasses ranging from most to least tolerant: tall fescue, perennial ryegrass, Kentucky bluegrass, zoysiagrass, bermudagrass, buffalograss.

The shade tolerance of a grass depends on many conditions. Check with your county Extension agent for more information on suitability of turfgrass species for your specific site.

- Wearability of popular turfgrasses, ranging from those that can withstand most wear to least wear: bermudagrass, zoysiagrass, tall fescue, perennial ryegrass, Kentucky bluegrass, buffalograss.
- Fertilizer requirements for popular turfgrasses, ranging from most to least: Kentucky bluegrass, perennial ryegrass, tall fescue, bermudagrass, zoysiagrass, buffalograss.

While a lawn may exist on low amounts of fertilizer, a high-quality lawn will require moderate amounts. The cultivar, soil type and climate greatly influence fertilizer needs.

The following plants are adapted to all parts of Kansas though some may need protection in certain areas of the state. All require regular watering until well-rooted and established. This may take l–2 years or more, depending on the type and size of plants. Only after the plants are established can water be reduced or, in some cases, eliminated. Remember, check with your nursery for your particular site needs!

- **Tall Deciduous Trees (over 45')—** Black Walnut, Chinkapin Oak, Common Hackberry ('Prairie Pride' and other cultivars), Green Ash, Honeylocust ('Skyline' and other cultivars), Kentucky Coffeetree, Sawtooth Oak, Bur Oak.
- **Medium Deciduous Trees (30–45')—** Aristocrat Pear, Goldenrain Tree, Lacebark Elm (True Chinese Elm), Osage Orange (thornless and fruitless), White Mulberry (fruitless).
- **Small Deciduous Trees (under 30')—** Amur Maackia, Amur Maple, Flowering Crabapple, Green Hawthorn 'Winter King', Redbud, Russian Hawthorn, Russian Olive, Sandhill Plum, Thornless Cockspur Hawthorn, Washington Hawthorn, Western Soapberry, Wild Plum.
- **Large Deciduous Shrubs (over 8')—** Autumn Olive, Beauty Bush, Border Privet, Chokecherry, Common Buckthorn, Elderberry, Lilac, Mountain Ninebark, Ninebark,

Peking Cotoneaster, Rose of Sharon, Rough-leafed Dogwood, Siberian Pea Shrub, Silver Buffaloberry, Staghorn Sumac, Wahoo, Western Sandcherry, Winter Honeysuckle.

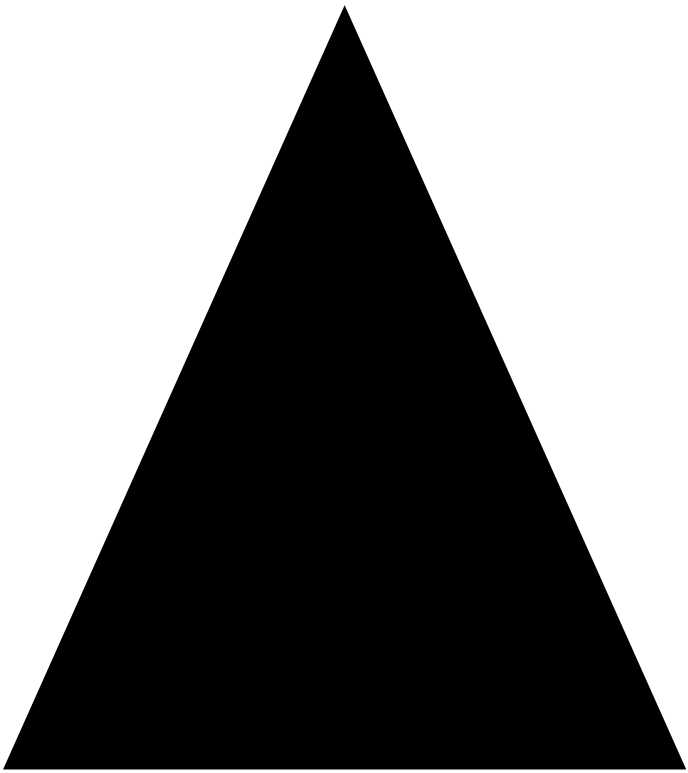
- **Medium Deciduous Shrubs (4–6')—** Butterfly Bush, Cherry Prinsepia, Dwarf Ninebark, Flowering Quince, Forsythia, Fragrant Sumac, Japanese Barberry, Korean Lilac, Mentor Barberry, Mockorange, Serviceberry, Shining Sumac, Spirea (Vanhoutte), Spreading Cotoneaster, Tartarian Honeysuckle, Three Leaf Sumac.
- **Small Deciduous Shrubs (under 4')—** Alpine Currant, Bluemist Spirea, Common Bladder Senna, Coralberry (Buckbrush), False Indigo, Golden Currant, Golden St. Johnswort, Gooseberry, Hardy Potentilla, Leadplant, New Jersey Tea, Prairie Rose, Pygmy Pea Shrub, Russian Sage.
- **Evergreen Trees—** Austrian Pine, Red Cedar, Limber Pine, Pinyon Pine, Ponderosa Pine.
- **Large Evergreen Shrubs—** Junipers, Mugho Pine.
- **Medium Evergreen Shrub—** Junipers, Mahonia, Manhattan Euonymus.
- **Small Evergreen Shrubs—** Compact Mahonia, Compact Mugho Pine, Juniper, Soapweed, Yucca.
- **Groundcovers for shade (beneath trees, shrubs, or along north walls)—** Bergenia, Bishop's Weed, Hall's Honeysuckle, Mahonia, Creeping Grape Holly, Periwinkle, Potentilla (Cinquefoil), Sweet Woodruff.
- **Groundcovers for full sun—** Baby's Breath (Creeping), Bachelor Buttons, Bird's Foot Trefoil, Crownvetch, Border Jewel (Himalayan), Buttercup (Creeping), Catmint, Creeping Junipers, Daylily (most species), Evergreen Candytuft, Gro-Low Fragrant Sumac, Hall's Honeysuckle, Hen and Chicks, Lilyturf, Mock Strawberry, Phlox (Creeping), Pussytoes, Ribbon Grass, Rock Soapwort, Sedum (Stonecrop), Silvermound, Snow in Summer, Spurge (Cushion), Spurge (Donkey-tail), Thyme (Creeping), Veronica (Rock Speedwell), Wintercreeper, Woolly Yarrow.

- **Ornamental Grasses—** Big Bluestem, Blue Fescue, Blue Oat Grass, Feather Reed Grass, Fountaingrass (annual), Fountaingrass (perennial), Indiangrass, Little Bluestem, Oat Grass, Quaking Grass (annual), Ravenna Grass, Ribbon Grass, Sideoats Grama, Weeping Lovegrass.
- **Perennials** (all grow in full sun; * indicates plant tolerates part shade)— Artemesia (Sagebrush), *Balloon Flower, Basket of Gold, Blanket Flower, Blue Star (Amsonia), Brown-eyed Susan (Rudbeckia), Butterfly Weed, Candy Tuft (Perennial), Coreopsis, Creeping Phlox, *Daylily, Euphorbia, Evening Primrose, *False Indigo, Gaura, *Globe Thistle, *Goldenrod, *Hibiscus (hardy), *Iris, *Kansas Gayfeather, Lambs' Ears, Lavender, *Mullein, Oriental Poppy, Pitcher's Salvia, Poppy Mallow, Prickly Pear Cactus, Purple Coneflower, Red Hot Poker (Torch Lily), Rock Rose, Sea Holly, Sea Lavender, Sea Thrift, *Sedum and 'Autumn Joy', Yarrow.
- **Annuals** (all grow in full sun; * indicates plant tolerates part shade)—Baby's Breath (annual), Bachelor Buttons, *California Poppy, Celosia, *Cleome, Coreopsis (annual), Cosmos, Dusty Miller, *Four O'clock, Gomphrena, Kochia, Marigold, Morning Glory, *Nicotiana, Portulaca, Sanvitalia, Sunflower, Vervain, *Vinca, Zinnia.

For assistance with identifying low-maintenance, drought-tolerant plants for your home or business landscape design, contact your county Extension office.

*Brand names appearing in this publication are used for product identification. No endorsement is intended, nor is criticism of similar products not mentioned.*

low maintenance landscaping low maintenance landscaping



**Kansas State University Agricultural Experiment Station and Cooperative Extension Service**

MF-1046 July 1992

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low maintenance landscaping low maintenance landscaping

**City of Punta Gorda**
**Urban Design**

**City Hall Annex**
**326 West Marion Avenue**
**Punta Gorda, Florida 33950**
**(941) 575-3372**

# REQUEST FOR SPECIAL EXCEPTION FOR ARTIFICIAL TURF CHECK LIST

☐ Signed & Notarized Special Exception Application

☐ Signed Authorization for Agent Affidavit (if applicable)

☐ $750.00 Application Fee

☐ A copy of the deed or other evidence of ownership.

☐ Date applicant met with the representatives of Urban Design staff prior to the submission of a Special Exception Application _____

☐ Two copies (2) of a detailed signed and sealed site survey of the property that is less than one year old that indicates the location of existing trees and shrubs and all other improvements on the property.

☐ Two copies (2) of the landscape plot plan indicating the proposed location of the artificial turf and other landscape materials. Setbacks to the seawall will be required to be shown for any trees, large shrubs, curbing, areas of rock beds or boulder type landscape material that is planned. All landscape plans must meet minimum standards as denoted in this Article.

☐ If the property is zoned commercial or multi-family, a copy of an approved Southwest Florida Water Management District Permit shall be included in the permit application.

☐ Evidence that the artificial turf proposed will have a minimum tufted weight of 56 ounces per square foot, be a natural green in color, and have a minimum 8 year warranty. A sample of the turf proposed that meets these standards shall be submitted with the Special Exception application including a copy of the manufacturers specifications and warranty information.

☐ Evidence that all artificial turf installations will have a minimum permeability of 30 inches per hour per square yard and provide anchoring information as to the size and location of anchors to ensure the turf will withstand the effects of wind.

☐ Consideration of the percentage of living plant materials versus percentage of artificial turf proposed for any property shall be part of the review process. Evidence that living plant material will be drought tolerant and consist of 50 percent Florida native species including shrubs, vines, trees, and ground covers.

☐ **Certificate of Appropriateness application and application fee if** property is located within the *National Register Historic Overlay District*, listed on the National Register, or property listed on the Florida Master Site File by the State of Florida Department of State, Bureau of Historic Preservation of the Division of Historical Resources.

Florida Master Site File No. _____Contributing Structure ☐ Yes ☐ No

# City of Punta Gorda
# Urban Design

**City Hall Annex**
**326 West Marion Avenue**
**Punta Gorda, Florida 33950**
**(941) 575-3372**

## REQUEST FOR SPECIAL EXCEPTION FOR ARTIFICIAL TURF

Date Received _____ File Number SE-_____

Application Fee: $750.00
Continuance: $500.00

This application, with all required supplemental data and information, must be completed in accordance with the specific instructions in the application, and returned to the Urban Design before same will be advertised for a hearing.

**IMPORTANT**: The applicant or his representative **MUST** be present at the hearing. There will be a fee of $500.00 for a Voluntary Continuance (a request by the applicant to continue a petition before the appropriate board or council, or by the failure of the applicant to attend or be represented at the appropriate meeting).

1. Name of Applicant(s): _____
   Address: _____ Phone: _____
2. Owner(s) of Record: _____
   Address: _____ Phone: _____
4. Attorney or Agent: _____
   Address: _____ Phone: _____
5. Property Address or Street Name: _____
6. Property Legal Description:

| Parcel ID / Account # | Lot # | Block # | Section | Total Sq Feet/ Acres | Existing Zoning |
|---|---|---|---|---|---|
| | | | | | |

7. Artificial Turf Use Location:

8. Written statement describing the proposed use:

9. What is the minimum tufted weigh per square foot_____

10. What is the permeability per hour per square yard:_____

11. What is the anchor size and location:_____

12. How long is the manufactures warranty:_____

13. Approval Criteria. The Planning Commission and City Council shall use the following criteria, in addition to other reasonable considerations, in making their decision please explain your position on the following:

    (1) The proposed use will not adversely affect the use of neighboring properties.

    (2) The use shall comply with applicable district regulations and applicable provisions of the adopted Comprehensive Plan and downtown plans.

    (3) The location, size and height of buildings structures, walls and fences, and the nature and extent of screening, buffering and landscaping shall be such that the use will not hinder or discourage the appropriate development and use of adjacent or nearby land and/or buildings.

    (4) The proposed use will be such that pedestrian and vehicular traffic generated will not be hazardous or conflict with the existing and anticipated traffic in the neighborhood and on the streets serving the site.

Any Special Exception granted to allow artificial turf shall include the following conditions:

1. Precautions for installation around existing trees shall be monitored and may be restricted to ensure tree roots are not damaged with the installation of the base material.
2. Rubber, sand and any other weighting or infill material is prohibited.
3. If artificial turf is planned to be installed next to the seawall, the artificial turf shall be pinned or staked behind the seawall. Nothing shall be attached directly to or placed on the seawall or seawall cap.
4. A copy of the Special Exception and conditions thereof shall be recorded in the Public Records of Charlotte County so that any subsequent purchaser will be on notice regarding the special rules relating to the artificial turf.
5. A landscape inspection shall be conducted after the installation of the artificial turf to ensure all living plant materials conform to the provided landscape plot plan and meet the drought tolerant and native species requirements.
6. If artificial turf is to be installed in the City right-of-way, a separate right-of-way permit must be obtained prior to commencing work.
7. Artificial turf shall be maintained in a green fadeless condition and shall be maintained free of dirt, mud, stains, weeds, debris, tears, holes, and impressions, as determined by Code Compliance. All edges of the artificial turf shall not be loose, and must be maintained with appropriate edging or stakes.
8. Artificial turf must be replaced if it falls into disrepair with fading or holes or loose areas, as determined by Code Compliance. Replacement shall be completed within 60 days of notification by Code Compliance.
9. If maintenance is required on the City right-of-way, or utility easement, it shall be the responsibility of the property owner to remove, replace and repair, at the owner's expense, any artificial turf that has been placed in the right-of-way or utility easement within 60 days.
10. If maintenance is required on the seawall and/or seawall cap, it shall be the responsibility of the property owner to remove, replace and repair, at the owner's expense, any artificial turf that has been placed in the rear yard of the property abutting the seawall within 60 days.
11. The City of Punta Gorda shall not be held liable for any damage to any artificial turf or other items placed within the right-of-way, within six feet of the seawall, or within any area covering any city utilities.

# Special Exception
# Affidavit

I, the undersigned, being first duly sworn, testify and say that I am the owner, attorney, attorney-in-fact, agent, lessee or representative of the owner(s) of all of the property described and which is the subject matter of the proposed hearing; that all answers to the questions in this application, and all sketches, data and other supplementary material attached to and made a part of the application are honest and true to the best of my knowledge and belief. I understand this application must be complete and accurate before the hearing can be advertised, and that I am authorized to sign the application by the owner or owners.

By submitting this application the owner(s) of the subject property does hereby grant his/her consent to the Zoning Official and his/her designee, to enter upon the subject property for the purposes of making any examinations, surveys, measurements, and inspections deemed necessary to evaluate the subject property relative to this application.

Sworn and subscribed before me this _____ day of _____, 20_____.

_____ _____

Signature of Applicant or Authorized Agent Type of Print Name and Title

Address: _____ Phone: _____

_____

**STATE OF _____ )**
**)**
**COUNTY OF _____ )**

**The foregoing instrument was acknowledged before me this _____ day of _____**

**_____, 20___, by_____, who is**

**personally known to me or who has produced _____ as identification and who did not take an oath.**

_____

**Notary Public, State of Florida (Seal)**

**My commission Expires: _____**

# AFFIDAVIT

## AUTHORIZATION FOR AGENT

I/We_____, property owner(s), hereby authorize _____to act as Agent on our behalf regarding a _____ application on the property described as: (legal description) _____, a/k/a _____ in Punta Gorda, Florida.

_____ _____

Owner Date

**STATE OF _____ )**
**)**
**COUNTY OF _____ )**

**The foregoing instrument was acknowledged before me this _____ day of _____ _____, 20___, by_____, who is personally known to me or who has produced _____ as identification and who did not take an oath.**

_____

**Notary Public, State of Florida (Seal)**

**My commission Expires: _____**

**SYNTHETIC TURF**
Response to applicant's memo and review of materials
Applicant's memo, July 21, 2011

The applicant and planning staff met on July 22, 2011 to discuss the proposed text amendment regarding the use of synthetic turf as a landscape material. The applicant provided a memo along with research materials. This document is a response to the issues raised in the memo and a review of the materials. The wording from the memo is noted below in bold print, with staff's comments following:

**"Many other localities encourage the use of artificial turf in landscaped areas and offer rebates for installing it and reducing water usage" (paragraph 1, memo)**
Some states which are experiencing severe water shortages, such as California and Arizona, have adopted strong water conservation measures which require their communities to reduce water usage per capita. From the State of California, Division 6 of the Water Code:

> "b) Growing population, climate change, and the need to protect and grow California's economy while protecting and restoring our fish and wildlife habitats make it essential that the state manage its water resources as efficiently as possible."
>
> "g) The Governor has called for a 20 percent per capita reduction in urban water use statewide by 2020."

California adopted a Model Water Efficient Landscape Ordinance, which many California communities have also adopted. The ordinance recommends the use of native plants. Many communities are permitting synthetic turf as a means to reduce the water consumption per capita while other communities prohibit the use of synthetic turf.

The Arizona Division of Water Resources has also established a set of conservation regulations. Plant lists have been developed to encourage the use of low-water usage plants. In 2008, Tucson became the first municipality in the county to require developers of commercial properties to harvest rainwater for landscaping. The city requires that new developments must meet 50% of their landscaping requirements by capturing rainwater. While many communities permit the use of synthetic turf, others do not.

The Kansas Water Plan notes that most communities in Kansas have adequate water at this time, but water conservation is important to insure water supplies in the future. (page 1, Kansas Water Plan, Water Conservation Policy and Institutional Framework, January 2009; http://www.kwo.org/Kansas_Water_Plan/KWP_Docs/VolumeII/Rpt_KWP_2009_Water_Conservation.pdf ) On page 5, the plan suggests that water needs could be reduced through the installation of low flow plumbing, low water need landscaping and reduction of runoff from watering and car washing and on page 9, the plan recommends water 'reuse' as a potentially significant conservation action.

Staff agrees that many communities, primarily those in states with mandated water conservation measures and set attainment measures, permit the use of artificial turf as a landscaping material. The Kansas Water Plan does not include a reduction of landscaped areas in the recommended conservation measures but does suggest the reuse of water.

**“Horizon 2020 encourages sustainable landscaping and a sustainable physical environment. Such goals include the use of artificial turf in many other circumstances.”**

**“It (artificial turf) can support Lawrence’s goal of sustainability through decreased water consumption, pesticide and herbicide runoff, emissions from mowers, and grass clipping waste.”**

**“The natural grass lawn is not sustainable”**
As discussed in the Staff Report and Follow-up Memo, traditional grass lawns do require watering and the use of chemicals; however, low-maintenance landscaping, landscaping which utilizes native or adapted plants, or Xeriscape require much less or none. With the proper selection of species natural landscaping, including grass, is sustainable.

**“Artificial turf reduces allergens such as pollen in the environment.”**
While artificial plants do not produce pollen, a significant portion of the city’s landscaping would need to consist of artificial plants for the reduction in allergens to be noticeable.

**The memo and supporting information speak to the issue of infections, latex allergies and chemical exposure associated with artificial turf.**
The staff report did not raise these points, but stated on page 5 that the NY Health Dept report found that turf surfaces are no more likely to harbor infectious agents than other surfaces, that tests did not find any relation between the crumb rubber used in synthetic turf and latex allergies. The NY study did report that some types of synthetic turf fibers contain elevated levels of lead which can form a dust posing a potential source of lead exposure. The CDC issued a health advisory in June 2008.

The memo states on page 4 that **“Zinc is not very toxic to humans so the danger is mostly to aquatic and plant life”.**
This danger justifies the best management practices for stormwater management as noted in the staff report.

Page 6 of the memo states that **“Artificial turf reduces water use, pesticides, herbicides, emissions, grass clipping waste.”**
Staff does not argue that artificial turf does not require as much water, pesticide, mowing or create as much grass clippings as a traditional lawn. Artificial turf is very similar to permeable pavement in these regards. Low maintenance landscaping utilizes native or adapted plants which are suited to the climate and characteristics of the area. This type of landscaping also requires less water, and requires pesticide only while being established. Depending on the species used, the amount of mowing could be reduced or eliminated. Xeriscape is a specific form of landscaping which uses drought tolerant plants and greatly reduces the water requirements. These types of landscaping are more suitable than the use of the artificial turf material in that they serve as a part of the green infrastructure, provide habitat, are part of the oxygen/carbon dioxide cycle, and maintain the natural character of the community.

## REVIEW OF APPLICANT MATERIALS

**"Synthetic Turf: Health Debate Takes Root—March 2008"**
Many of the arguments in this article are related to the use of artificial turf for recreational fields. The article states that artificial turf is more suited for these areas of high activity. These points are not discussed in this report, as the text amendment is proposing the use of artificial turf as a landscaping material, not as a surfacing material for athletic or recreational fields.

The following information from the article supports staff's view on synthetic turf as a landscape material:

HEALTH ISSUES
"On the basis of limited toxicity data, some reports have concluded the health risks are minimal. Most agree, however, that far more research is needed before the question can be definitely answered. "

OTHER IMPACTS
"Natural grass does offer tangible benefits, however. According to Turfgrass Producers International, these include increased pollution control, absorption of carbon dioxide, a cooling effect, water filtration, and prevention of soil erosion. There are also perhaps intangible benefits to a field of grass. Crain presents the idea that replacing grass with synthetic turf can hinder children's creative play and affect their development. "Today's children largely grow up in synthetic, indoor environments," he says. "Now, with the growing popularity of synthetic turf fields, their experience with nature will be less than ever." *( 'Crain' is identified earlier in the article as William Crain of the City College of New York Psychology Department)*

HEAT
"One drawback that both fans and critics of synthetic turf agree on is that these fields can get much hotter than natural grass. Stuart Gaffin, an associate research scientist at the Center for climate systems Research at Columbia University, initially became involved with the temperature issues of synthetic turf fields while conducting studies for another project on the cooling benefits of urban trees and parks. Using thermal satellite images and geographic information systems, Gaffin noticed that a number of the hottest spots in the city turned out to be synthetic turf fields.

Direct temperature measurements conducted during site visits showed that synthetic turf fields can get up to 60º hotter than grass, with surface temperatures reaching 160º on summer days. For example, on 6 July 2007, a day in which the atmospheric temperature was 78º in the early afternoon, the temperature on a grass field that was receiving direct sunlight was 85º while an adjacent synthetic turf field had heated to 140º F. "Exposures of ten minutes or longer to surface temperatures above 122º F can cause skin injuries, so this is a real concern." said Joel Forman, medical director of the Pediatric Environmental Health Specialty Unit at Mount Sinai School of Medicine, speaking at a 6 December 2007 symposium on the issue."

"Many physical properties of synthetic turf—including its dark pigments, low-density mass, and lack of ability to vaporize water and cool the surrounding air—make it particularly efficient at

increasing its temperature when exposed to the sun. This is not only a hazard for users, but also can contribute to the 'heat island effect', in which cities become hotter than surrounding areas because of heat absorbed by dark man-made surfaces such as roofs and asphalt."

WATER QUALITY
"Moreover, because synthetic turf is unable to absorb or filter rain-water, chemicals filter directly into storm drains and into the municipal sewer system without the beneficial filtration that live vegetation provides. "

**EPA: Limited EPA Study Finds Low Level of Concern in Samples of Recycled Tires from Ballfield and Playground Surfaces 12/10/2009**
"The limited study, conducted in August through October 1008, found that the concentrations of materials that made up tire crumb were below levels considered harmful. However, given the limited nature of the study (limited number of constituents monitored, sample sites, and samples taken at each site) and the wide diversity of tire crumb material, it is not possible, without additional data, to extend the results beyond the four study sites to reach more comprehensive conclusions."

This study is looking at synthetic turf which uses rubber crumb infill. If synthetic turf is approved as a landscaping material, more information would be necessary before rubber crumb infill would be permitted.

**NEWS FROM CPSC, US CONSUMER PRODUCE SAFETY COMMISSION**
**CPSC Staff Finds Synthetic Turf Fields OK to Install, OK to Play On (July 30, 2008)**
"The evaluation concludes that young children are not at risk from exposure to lead in these fields. CPSC staff evaluation showed that newer fields had no lead or generally had the lowest lead levels." "Staff recognizes that some conditions such as age, weathering, exposure to sunlight, and wear and tear might change the amount of lead that could be released from the turf. As turf is used during athletics of play and exposed over time to sunlight, heat and other weather conditions, the surface of the turf may start to become work and small particles of the lead-containing synthetic grass fibers might be released."

(See staff comment with following section)

**STC's Voluntary Commitment – from Synthetic Turf Council website**
"The STC (Synthetic Turf Council) voluntarily agrees to comply with the revised lead restrictions currently proposed for children's produces in H.R. 4049. Specifically, the level of lead will be reduced in all pigments used to color synthetic turf to 300 ppm or less by no later than January 1, 2010, and to 100 ppm or less by no later than January 1, 2012."

The CDC Health Advisory contains recommendations for the use of turf, especially as it ages. With the reduction in the lead in the pigments, the threat of lead contamination may become lower; however, it has not been demonstrated that the threat of lead is from the pigments. The CDC Advisory indicates it is from the materials in the grass blades themselves. The CDC does state that turf made from poly-ethelene only fibers should pose no risk.

If synthetic turf is approved, standards would need to be developed regarding lead levels.

**About Synthetic Turf—From Synthetic Turf Council website**

This article mentions the basic benefits of using synthetic turf as water conservation, elimination of pesticides and fertilizers, and reduction in emissions from gas-powered maintenance equipment. Staff's response is in the staff report and follow-up memo.

**Synthetic Turf Becomes Latest Celebrity Trend—From Synthetic Turf Council website**
"Synthetic turf for landscape and recreation is one of the fastest growing segments of the market. Able to be installed in places where grass can't grow or be effectively maintained, its numerous applications include residential, commercial and municipal landscape; airport grounds; pet parks; playgrounds and rooftops."

"The Southern Nevada Water Authority estimates that every square foot of natural grass replaced saves 55 gallons of water per year."

**Case Studies and Testimonials—from Synthetic Turf Council website**

1. Used in Hawaii for an area for people with wheelchairs to work with their assistance dogs. "Our new artificial lawn helps keep the dogs and the facility clean and the yard will be better for people to use when practicing with their dogs."

2. In New York, used to surface a 38th floor terrace yoga deck.

3. Twentynine Palms Marine Corps Base—Mojave Desert Region. "Located in the desert region of the Mojave Desert, conserving water at Twentynine Palms is a must." "It (synthetic turf) is softer and more inviting than hard surfaces and is non-allergenic, creating a safe area for children and pets.

**Synthetic Turf Installed in North America Conserves More than Three Billion Gallons of Water, Eliminates Nearly a Billion Pounds—from Tiger Turf website**
"As of 2011, the estimated total of synthetic turf installed in North America annually conserves more than three billion gallons of water, significantly reduces smog emissions and eliminates close to a billion pounds of harmful fertilizers and pesticides. The industry has also recycled more than 105 million used tires."

"An average lawn of 1,800 square feet will save 99,000 gallons of water a year if landscaped with synthetic turf – about 70% of a homeowner's water bill, or up to $500."

"Synthetic turf eliminates the need for nearly a billion pounds of harmful pesticides, fertilizers, fungicides and herbicides which are used to maintain grass."

"BASF Corporation performed an Eco-Efficiency Analysis measuring environmental and economical impacts of synthetic turf athletic fields with professionally installed and maintained grass alternatives. Released in November 2010, the life cycle assessment found that with typical field usage, synthetic turf had a lower consumption of energy, raw materials and solid waste generation than natural grass fields."

**Capitol*Alert*—The Sacramento BEE website**
"Gov. Jerry Brown has vetoed legislation that would have required homeowners associations to let people replace their lawns with artificial turf, the governor's office announced today."

**Should you fake the lawn? –from Sunset website**
Example of a couple installing artificial turf in their Los Angeles yard.

**Going the Extra yard—from Audubon website**

"They (lawns) have proven to be a very expensive ecologic and economic symbol," points out Bret Rappaport, the director of Wild Ones, a nonprofit organization that encourages landscaping with native plants as an alternative to the vast swaths of monoculture widespread today." The article points out that a typical US lawn requires 10 pounds of pesticide, 29 pounds of fertilizer and 170,000 gallons of water annually. "Natural landscaping, on the other hand, harmonizes a yard's plant life with the greater ecological community—the species already adapted to the local climate—while eliminating the need for costly maintenance. Whereas nitrogen and phosphorous fertilizers, along with chemical herbicides and pesticides, easily run off conventional lawns and into water sources, the varying root lengths of native plants actually reduce this 'non-point-source pollution" by anchoring soil and absorbing water. Natives also attract a variety of local wildlife and provide respite for millions of migrating birds."

"The Southwest Florida Water Management District now encourages area residents to replace grass with native vegetation."

**The Limpkin, Newsletter of the Space Coast Audubon Society of Brevard County, Florida**

This article provided the history of the traditional lawn and concluded: now we're beginning to recognize the need to reduce or eliminate lawns".

**Chemicals and particulates in the air above the new generation of artificial turf playing fields, and artificial turf as a risk factor for infection by methicillin-resistant Staphylococcus aureus (MRSA)California Environmental Protection Agency—July 2009**

This article reviewed studies that looked into whether the artificial turf playing fields emit levels of chemicals or particulates into the air that cause illness when inhaled and whether these fields infect athletes with the dangerous bacterium called methicillin-resistant *Staphylococcus aureus.* The report concluded that "While these estimated risks are low compared to many common human activities, they are higher than the negligible risk level of one cancer in a population of one million people. Data gaps exist that could lead to overestimates or underestimates of these risks."

"OEHHA, (Office of Environmental Health Hazard Assessment, California Environmental Protection Agency) is currently working to fill the above data gaps." "OEHHA will determine whether the new generation of artificial turf playing fields releases chemicals or particulates into the air that pose an inhalation risk to persons using the fields. OEHHA will also determine whether artificial turf fields increase the risk of infection by dangerous bacteria such as MRSA." (page 7)

No definitive answer on the questions were provided.

**Artificial Turf Study, Leachate and Stormwater Characteristics, Connecticut Department of Environmental Protection July 2010 (information was provided with June PC packet, 'Artificial Turf Field Investigation in Connecticut Final Report, dated July 27, 2010)**

"The DEP concludes that there is a potential risk to surface waters and aquatic organisms associated with whole effluent and zinc toxicity of stormwater runoff from artificial turf fields. Zinc concentrations in the stormwater may cause exceedences of the acute aquatic toxicity criteria for receiving surface waters, especially smaller watercourses." The DEP recommends the

use of stormwater treatment measures that may reduce the concentrations of zinc below the acute aquatic toxicity levels. Page 22

**Evaluation of the Environmental Effects of synthetic Turf Athletic Fields. Milone & MacBroom December, 2008**

This article agreed that the surface of the artificial turf gets much hotter than natural grass, but found that the air temperature above the surface was less than 5 degrees higher than surrounding area. The Missouri University study found air temperature at head level to be 138º Given the discrepancy in the two studies regarding the change in air temperature at a point above the artificial turf, it can be assumed that the amount of heat that dissipates to one specific area varies. The nature of heat is that if a hot surface is located next to the air, heat will dissipate into the air. The heat of the turf contributes to the 'heat island' effect, but due to the nature of heat transfer, it is not possible to locate the areas where the heat occurs; rather it is a contribution to the overall heat level.

The article also reviewed volatile chemicals and synthetic turf; however, it is typically agreed that Volatile chemicals are not an issue with outdoor artificial turf.

The article included a study on stormwater from synthetic turf which found that the amount of zinc is below the EPA standard for fresh water. If the use of synthetic turf is approved, further research into zinc and stormwater runoff would be necessary when developing standards.

**Synthetic Turf 360º a Guide for Today's Synthetic Turf—Synthetic Turf Council**

"In its report, "Municipal Solid Waste in the United States, 2009 Facts and Figures," the EPA estimates that 33.2 million tons of yard trimmings were generated in 2009, the third largest component of the Municipal Solid Waste in Landfills."

The City of Lawrence has a yard trimming pick up day and yard trimmings are recycled into compost. It is also recommended that grass clippings be left on the lawn to decompose and serve as natural fertilizer and organic matter.

Synthetic turf is more accessible for people with disabilities. "The surfaces that are universally accessible and go beyond ADA to be actually usable for children with disabilities include artificial grass with rubber underneath." "Wheelchairs roll easily and crutches won't sink into park and landscape surfaces like those used by the Miracle League nationwide to help youth with physical disabilities play baseball. Many retirement communities use extensive amounts of synthetic turf for landscaping to assist residents with mobility challenges."

The article states that the City of Lakeland, Florida installed over 25,000 sq ft of synthetic turf in play zones. The Lakeland Florida website states that: "On July 1, 2010, the City of Lakeland returned to the Year Round Water Conservation Measures set forth by the Southwest Florida Water Management District Rule 40D-22."

(The Florida Water Management Districts have established a year round set of conservation measures which include limitations on watering and irrigation.)

**What do the Experts Say,** a bibliography prepared by the Synthetic Turf Council, 2011.

**Review of the Impacts of Crumb Rubber in Artificial Turf Applications;** Rachel Simon, University of California, Berkeley, February, 2010. The study concluded, on page 48, that synthetic turf has greater all-weather availability than natural grass, increased playing hours, reduced maintenance, is a cost-effective investment, crumb rubber is generally considered safe use of tire rubber, synthetic turf fields had fewer injuries than natural grass fields, and that they are environmentally friendly.

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Articles which were not discussed as they focus on the use of artificial turf as a sports or playground area surfacing material

**Lawrence High School Sports Venues—Landplan Engineering, PA website**

**Lawrence Unified School District Selects Gameday Grass 3D from Astroturf for Eight New Atheltic Fields—from Astroturf website**

**Grass without limits---Foreverlawn website**

SUMMARY

Staff's opinion, after reviewing the applicant's materials and memo, remains that synthetic turf is not an appropriate landscaping material and staff recommends that the use be prohibited outright in the Development Code.

Other means are available to attain many of the environmental benefits associated with synthetic turf. These include

1. WATER CONSERVATION:
    - Water reuse (use of gray water for irrigation, plant watering)
    - use of captured rainwater for gardening,
    - Xeriscape,
    - use of native or adapted plants.

2. REDUCED OR ELIMINATED PESTICIDE AND/OR FERTILIZER USE:
    - Use of native or adapted plants.

3. REDUCED EMISSIONS DUE TO REDUCED MOWING
    - Use of short grass species, or ground covers that don't require mowing.
    - Use of higher quality lawnmowers with better emissions ratings
    - Less frequent mowing

STAFF RESPONSE TO APPLICANT LETTER DATED AUGUST 19, 2011

The page of the applicant's letter is noted with excerpts from the letter listed below in **blue print** followed by staff discussion.

Page 1

**"The City had routinely approved the use of synthetic turf in all of our playing fields at both high schools and at the Oread Hotel"**

Page 2

**"The reluctance to approve artificial turf at the Frontier Apartments appears to be a changing condition that requires clarification."**

Synthetic turf is viewed as a 'surfacing' material, not a landscape material. It has been approved for the surfacing of athletic field---not the landscaping of these fields.

Artificial turf was also installed at the Oread out of compliance with the approved site plan and the Planning Director approved the use through alternative compliance, given the specific site characteristics. The Code specifically states that each site is to be considered individually and that alternative compliance does *not set a precedent.* There has been no change in the Code or staff's position on the use of artificial turf.

Page 3

**"Its (artificial turf) use meets the policies of Horizon 2020 that encourage landscaping with reduced long-term maintenance costs, conservation of water, reduction of pesticides and fertilizers and reduction of emissions."**

Artificial turf does have the benefits noted: reduced water and chemical use and reduced need to mow. The use of all pervious surfacing materials...such as artificial turf, gravel, or pervious concrete... do not require any inputs as they are not living systems. They also require less maintenance than a living system. However, none of these surfacing methods provide the environmental benefits associated with living plants: they do not filter stormwater, reduce the heat island effect, contribute oxygen to the environment, provide habitat, etc.

Page 3

**"The use of artificial turf protects the environment by conserving water, reducing pesticides, fertilizers and emissions. Artificial turf increases the economic health of our community by requiring lower long-term maintenance costs."**

As noted in the staff report and follow-up memo, low maintenance landscaping has all the benefits noted for artificial turf, with the addition of the environmental benefits that is provided by living plants.

Page 4

**"Whether the landscape material is living or non-living, it should be of high quality and should decrease long-term maintenance costs."**

Staff does not disagree that high quality materials should be used.

Page 4

**"Decreasing the cost of long-term maintenance of turf areas with the use of artificial turf improves the economic vitality of the community as well as improving the environment."**

Staff is not qualified to state that reduced maintenance costs associated with turf will improve the economic vitality of the community; however, reduced costs are a worthwhile goal and should certainly increase the economic vitality of an individual project. However, low-maintenance landscaping would also decrease the maintenance cost and would have a more positive effect on the environment than the use of artificial turf.

Reducing chemical usage and emissions is a goal of the environment chapter which the applicant indicates that is achieved with the use of artificial turf. The negative impacts of artificial turf: the raw materials and energy used in its processing, its contribution to the heat island effect, and the fact that it neither takes up carbon dioxide or produces oxygen make it a less viable alternative than low maintenance landscaping. Low maintenance landscaping provides all the environmental benefits of artificial turf, and more.

Page 7

"Artificial turf may use recycled materials such as crumb rubber".

Concerns have been raised about the use of crumb rubber infill in synthetic turf. It is our understanding that the applicant does not intend to use crumb rubber infill.

"Artificial turf does not generate yard waste that may be dumped in a land fill."

The City has a compost program for yard waste. Yard waste is picked up and made into mulch or compost which is provided to citizens for free or very low prices. The mulch reduces evaporation from the soil and reduces the water needs of a planting area. The compost adds organic matter and nutrients to the soil. This is a truly sustainable practice.

Page 8

"Artificial turf generates no yard waste to be collected and taken away, thereby also reducing emissions from trash trucks. "

For this benefit to be realized, the City would need to require ALL landscaping in an area to be completely artificial. Tree limbs, shrubbery cuttings and leaves make up a large part of the yard-waste pickup. An environmentally conscious means of managing grass clippings is to mulch the clippings as you mow. Grass clippings should very seldom need to be included in the yard waste.

Page 8

"Green infrastructures are those that preserve the high quality agricultural soils, critical habitats for endangered species, wildlife habitats, native prairies, rural woodlands and urban forests. It is not consistent with urban development. It does not encourage development of any kind. The use of artificial turf is only appropriate on land that has or is developing to urban densities. Green infrastructures or open space networks may be appropriate for undeveloped land."

Green infrastructure is the use of natural systems to provide infrastructure functions. Some examples are detention ponds which detain water in the urban area before releasing it slowly into area streams; thereby reducing the amount of stormwater piping and underground facilities needed. Other examples are the use of trees to provide shade. The shade results in cooler

temperatures, reducing the need for air conditioning. Grass is an important component of the green infrastructure system in that it filters pollution when water percolates through; thereby maintaining the quality of our groundwater. It also aids in reducing energy needs by cooling the air through evapotranspiration. Turfgrass Producers, International (TPI) claims that a 2.500 ft A2 (230 m A2) lawn releases "enough oxygen for a family of four to breath." (Facilities Management Benchmarking Feature: Natural Landscaping and Artificial Turf: (page 4, staff report attachment f))

Green infrastructure is a very important part of the urban system and living plants are a crucial part of green infrastructure.

Page 9

The applicant pointed out that staff did not agree that the use of artificial turf meets the requirement of using high quality materials.
Artificial turf, in and of itself, is not 'high quality'. If artificial turf is approved, it would be necessary to develop standards so that the turf that is used is a high quality material in order to comply with this recommendation of the comprehensive plan.

Page 9

"However the Memo does not provide a single reference to Horizon 2020 that discourages artificial turf."
The memo was prepared in response to the Planning Commission's request for clarification of items in the staff report. The original staff report discussed the text amendment's compliance with the comprehensive plan, but no further clarification was requested so this was not repeated in the memo. Per Page 3 of the staff report:

**The comprehensive plan does not recommend the use or synthetic landscaping materials, but in several places emphasizes the importance of natural features and natural vegetation.**

- **"The Plan proposes the development of neighborhoods in a range of densities to provide a sense of community and to complement and preserve natural features in the area." (Page 3-1, Background Studies)**
- **"Natural environmental features within residential areas should be preserved and protected. Natural vegetation and large mature trees in residential areas add greatly to the appearance of the community as a whole and should be maintained. Changes to the natural topography should be minimal." (Policy 5.1, page 5-19 Residential)**
- **"Promote the integration of mature trees, natural vegetation, natural and environmentally sensitive areas whenever possible to buffer low-density developments from more intensive land uses. (Policy 6.1(c)(2)(a), page 5-21, Residential)**
- **"Site design and building features shall be reflective of the quality and character of the overall community and incorporate elements familiar to the local landscape." (Page 6-2, Commercial)**

- **"Encourage the use of existing vegetation, such as stands of mature trees, and other natural site features into the landscape design as natural buffers or focal points." (Policy 3.1(d)(4)(c). Page 7-16 Industrial and Employment)**

**Horizon 2020 does not specifically address synthetic landscaping materials, but does in several instances recommend the use of natural landscaping materials. The plan states in the residential chapter that natural vegetation 'adds greatly to the appearance of the community as a whole'. When discussing commercial development it recommends that site design should be reflective of the quality and character of the overall community and should incorporate elements familiar to the local landscape. The type of landscaping material used has an impact on the character of the area.**

Page 12

**The applicant discusses the Development Code requirement in Section20-1001(a)(2) which states that the regulations of this article are intended to "enhance environmental conditions by providing…air purification, oxygen regeneration, groundwater recharge, filtering of stormwater runoff…"**
Artificial turf provides groundwater recharge but does not meet any of the other intents noted in the Code for landscaping. It does not purify the air, regenerate oxygen or filter stormwater runoff as living landscapes do. Its benefits are more similar to permeable pavement surfacing than to a landscape material.

**The applicant also mentions that artificial turf has been approved as a surfacing material for the high school playing fields.**
The playing fields were surfaced with artificial turf, not landscaped. Artificial turf as a surfacing for play fields may be appropriate; but, this does not provide a basis for its use throughout the community as a landscape material and was not used at the high schools as a landscape material.

**The applicant also mentions that the staff report raised concerns about infection, latex allergy and chemical exposure**.
The portion of the staff report referenced by the applicant follows:

**Health and Environmental**

**The State of New York Health Department prepared a fact sheet on crumb-rubber infilled synthetic turf athletic fields in 2008. The items reviewed were: heat stress, injury, infection, latex allergy, chemical exposure.**

**HEAT STRESS: The fact sheet states that the average surface temperature on a synthetic turf field at Brigham Young University in June 2002 was reported to be 117°F while the average surface temperature on natural turf and asphalt were 78°F and 110°F respectively. The maximum temperature reported on the turf field was 200°F. Measurements taken at the University of Missouri field had a 138°F air temperature at 'head-level' height on a 98° F day. The surface temperature of the field was reported to be 178°F. A study at BYU found that watering synthetic turf**

**reduced the surface temperature from 174°F to 85°F but the temperature rose to 120°F in five minutes and 164°F in twenty minutes.**

**INFECTION: The review concluded that synthetic turf surfaces are no more likely to harbor infectious agents than other surfaces.**

**LATEX ALLERGY: Tire rubber is used in many synthetic turf products as the infill material. Some people are allergic to 'latex allergens' which are substances within the latex in rubber tires. Tests did not find any relation between the crumb rubber used in synthetic turf and latex allergies.**

**CHEMICAL EXPOSURE: Studies have been conducted on the various chemicals used in synthetic turf and no negative results were obtained with the exception of 'lead'. Some types of synthetic turf fibers contain elevated levels of lead. Degradation of these fibers can form a dust that presents a potential source of lead exposure. The Centers for Disease Control and Prevention addressed the potential for lead exposure in a June 2008 Health Advisory, attached.**

The staff report attempted to look at all aspects of synthetic turf and, as can be seen from the excerpt above, noted that synthetic turf was no more likely to harbor infectious agents than other surfaces and that tests did not find any relation between the crumb rubber used in synthetic turf and latex allergies. The chemicals used in turf were found to not be harmful with the possible exception of lead.

Page 13

**The applicant mentioned materials that were provided staff at our July meeting.**

The materials are included in the communication packet as attachments to the July 21 memo. Staff prepared a review of the materials provided and that is included at the end of this memo. Of particular note is the study by Milone & MacBroom. They agreed with the findings from the other studies, that the surface temperature gets much hotter than grass or pavement, but disagreed with the findings that the temperature was higher at head level. Our principal objections to the elevated temperatures of synthetic turf are 1) dangerous for children to walk on barefoot and 2) addition to the heat island effect. The heat may or may not dissipate before it reaches 4 or 5 ft from the surface, but the overall impact on the heat island effect remains the same.

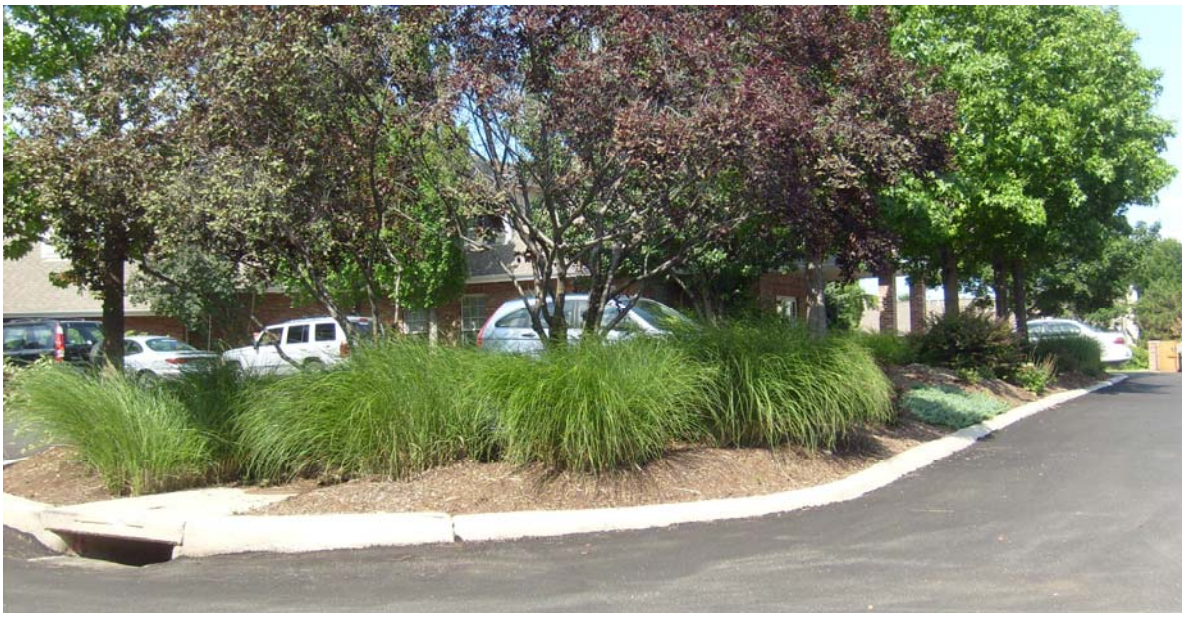
**Legends Place Apartments** 4100 W 24th Place

**The Grove Apartments 4301 W 24th Place**

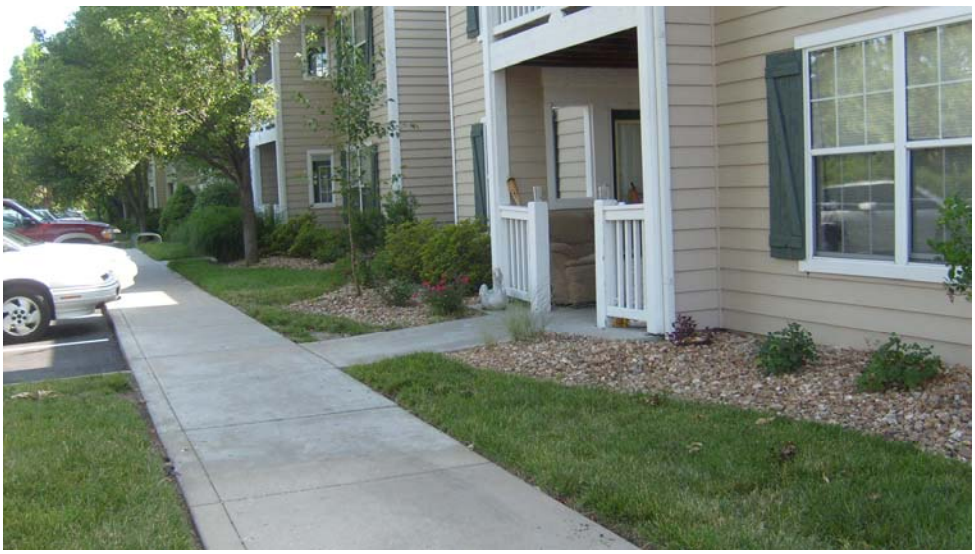
**Aberdeen Apartments -- 2300 Wakarusa Drive**

**Canyon Court Apartments 700 Comet Lane**

**Hobbs Taylor Loft Condominiums 730 New Hampshire Street**



**Tuckaway Apartments 2577 W 6th Street**



**Tuckaway Apartments 2577 W 6th Street**

**Frontier Apartments (Tuckaway 2) Synthetic Turf**

**Oread Hotel --1200 Oread Avenue**
**Synthetic turf approved with Alternative Compliance**

## OTHER COMMUNITIES

| Community | Provision | Comments |
|---|---|---|
| Garden Grove, CA | Permitted with regulations | 12.6" annual precipitation |
| La Palma, CA | Permitted with regulations | 12.0" annual precipitation |
| Santa Ana, CA | Permitted with regulations | 13.9" annual precipitation |
| Fullterton, CA | Permitted with regulations | 12.0" annual precipitation |
| Orange, CA | Permitted with regulations | 12.0 "annual precipitation |
| Laguna Hills, CA | Permitted in residential with regulations | 12.0" annual precipitation |
| Stanton, CA | Permitted in Residential Zones with regulations | 12.0" annual precipitation |
| | | |
| Englewood, CO | Permits but may not be counted toward 'live' landscaping requirements. 70% of required landscaping must be live material. | 15.0" annual precipitation |
| Punta Gorda, FL | Permitted as Special Exception | 56.49 "annual precipitation |
| El Paso, TX | Permitted with Alternative Compliance | 8.8" annual precipitation |
| | | |
| Austin, TX | Not permitted | 31.9 "annual precipitation |
| Omaha, NE | Not permitted. | 30.08" annual precipitation |
| Madison, WI | Not permitted | 31.0" annual precipitation |
| Olathe, KS | Not permitted | 40.1" annual precipitation |
| Greeley, Fort Collins CO | Not permitted | 14.2" & 15.8" annual precipitation |
| Windsor, CO | Not permitted | 15.0" annual precipitation |
| | | |
| Cerritos, CA | Specifically prohibits | 15.0" annual precipitation |

### Garden Grove, CA:

"The Amendment will promote the public interest, heath, safety, and welfare, as well as continue the City's General Plan vision for the continued effort for water conservation and decrease I water run-off by allowing the percolation of water into the ground."

Chapter 9.12: Multi-Family and Chapter 9.16: Commercial, Office Professional, Industrial and Open Space: "Artificial turf may be used as an alternative ground cover, subject to the standards in Section 9.12.40.090.L.:

Section 9.12.40.090L states that artificial plants, with the exception of artificial turf, are prohibited. Artificial turf shall be allowed within the front and rear yards in the R-2 and R-3 Multiple-Family Residential zones, subject to the following standards:

1) Artificial turf shall have a minimum 8-year 'no fade' warranty.

2) Artificial turf shall be installed by a licensed professional and shall be installed pursuant to manufacture's requirements.

3) Artificial turf shall be installed and maintained to effectively simulate the appearance of a well-maintained lawn. The turf shall be maintained in a green fadeless condition and shall be maintained free of weeds, debris, tears, holes, and impressions.

4) The use of indoor or outdoor plastic or nylon carpeting as a replacement of artificial turf or natural turf shall be prohibited. Artificial shrubs, flowers, trees, and vines in-lieu of living plant material shall be prohibited.

5) Areas of living plan material (i.e., flower beds, tree wells, etc) within the front yard, side, rear , and common areas shall be included within the overall landscape design when installing artificial turf. Living plant material shall include shrubs, vines, trees, and flowering ground covers.

6) Artificial turf shall be separated from flowerbeds by a concrete mow strip, bender board, or other barrier acceptable to the City in order to prevent intrusion of living plant material into the artificial turf.

7) Three sets of detailed landscape and irrigation plans shall be submitted to the Planning Division for review and approval prior to installation of the artificial turf in order to confirm compliance with City Code and any valid land use entitlement for the property.

**La Palma, CA:**

Ordinance 2009-04 **"WHEREAS,** the City Council of the City of La Palma recognizes the importance of water conservation within the State of California, and that methods exist which can lead to significant water saving opportunities for the residents and homeowners of the City of La Palma..."

Added a section to their Code [Section 17-6(x)] to prohibit artificial turf constituting unsightly appearance by reason of it being or having any of the following conditions or characteristics: Faded, Damaged, Improperly installed, Separated or visible seams, Damaged edges, Uneven and/or 'wavy appearance due to sunken or raised soil beneath, Lacking of a property barrier separating live landscaping, Stained, Comprising noncompliant infill materials, Use of noncompliant nylon fibers, or displaying a permanent image.

Standards:

1) All artificial turf visible from public rights-of-way or in a parkwayshall be maintained in a manner so as to mimic the appearance of a maintained, green, thriving lawn free of fading, visible seams, dents, ruts, trash, debris, damaged areas, stains, and/or exhibiting a worn out unnatural appearance.

2) Artificial turf shall have polyethylene monofilament fiber with a minimum grass zone pile height of 1.5 inches.

3) A minimum face weight of 42 ounces per square yard of unfilled artificial turf.

4) Nylon, polypropylene, and similar fibers can be permitted in the thatch zone provided that the thatch zone is a minimum .25 inches lower than the grass zone pile height.

5) Artificial turf installations requiring infill materials shall use infill of the silica sand variety. Rubber infill made form old tires is not acceptable for use as infill for artificial turf.

6) All electric, water, gas, and irrigation lines and conduits shall be run outside the perimeter of an artificial turf installation with the exception of those that provide direct service to the residence.

7) An appropriate solid barrier devise is required to separate artificial turf from soil and live vegetation.

8) Artificial turf shall be lead free.

9) Artificial turf shall be trimmed to fit against all regular and irregular edges to resemble a natural look.

10) Artificial turf shall be designed to allow water to percolate through the synthetic grass at a minimum drain rate of 30 inches per hour to an adequate drainage system installed underneath the artificial turf to prevent run-off, pooling, and flooding.

11) All artificial turf shall have a warranty that protects against color fading and a decrease in pile height. A minimum 4 year warranty is required for a 'do it yourself' homeowner's installation; and a minimum 8 year warranty is required for an installation certified by the manufacturer.

12) Installation shall be done at minimum to the manufacturer's specifications, and include the following: removal of all sod or existing groundcover, a synthetic porous filter fabric shall be installed, compacted and porous decomposed crushed granite and/or road base material (minimum 3 inches), all edges and seams of the artificial turf are to be anchored with nails and glue, all seams shall be nailed and glued, not sewn, and artificial turf shall be visually level with the grain pointing in a single direction.

13) Artificial turf shall be maintained by the property owner in an effective manner which includes cleaning, rushing, debris removal, repairing of depressions and ruts to maintain a level visual surface, elimination of any odors, flat or matted areas, weeds, evasive roots, looseness at edges, seams; and the replacement of the artificial turf when maintenance or repair is unable to simulate a natural thriving, green, grass appearance.

14) Any damaged or worn-out artificial turf areas shall be removed and appropriately replaced by the property owner. Repaired artificial turf areas shall be done so with like for like materials from the same manufacturer and done so in a manner that results in a repair that blends in with the existing artificial turf.

15) A permit shall be required for the installation of artificial turf in the single family residential zone.

16) Applications for artificial turf permits shall include a sample of the artificial turf material, a sample of the infill material (isf applicable); warranty information; installation details; material specifications; photographs of the site; and one copy of a landscape plan.

**Santa Ana.**

New Water Efficient Landscape Standards which included the option to incorporate synthetic turf as a landscape design feature.

STANDARDS:

1) Landscape plan must be submitted to Planning for review and approval.

2) Synthetic turf may be installed anywhere live landscaping is required, except with the front yard parkways. In a required front yard, synthetic turf shall be limited to a maximum coverage of 50% of the yard area. Remainder must consist of live plant material or hardscape in accordance with landscape provisions.

3) Installation of synthetic turf shall be performed by a contractor with a valid contractor's license. The contractor shall also have all permits and licenses necessary to conduct business in the City.

4) They synthetic turf shall have a minimum blade length of 1.24 inches. Nylon based grass blades are not permitted.

5) All existing sprinkler systems no longer in use must either be capped or removed. All existing landscaping must be removed where the synthetic turf will be located and a minimum of 3 inches of soil excavated.

6) The turf area shall be leveled, with a crushed stone sub base (such as decomposed granite) added to establish a foundation and facilitate drainage for the turf. The stone sub base shall be a minimum of 3 inches in depth and shall be compacted to ensure proper drainage.

7) A permeable geotextile (weed barrier) must be provided to prohibit the growth of weeds.

8) Synthetic turf shall be securely fastened to the ground. Seams shall be glued and stapled to minimize tears. The turf should be placed in patterns that emulate real grass.

9) An infill consisting of sand and rubber must be poured into the synthetic turf to keep the blades erect and to provide a natural feel and look.

10) The synthetic turf must be maintained at all times.

**STANTON, CA**

(Code Language)

Artificial Turf. The use of artificial turf shall be permitted in all zones as follows:

a. Single Family Residential, Buffer Zone, Public Institutional, Solid Waste Transfer Districts, and Planned Developments. Artificial turf may be used in-lieu of natural turf in all planting areas.

b. Medium and Multi-family Residential, Commercial, and Industrial Zones. Artificial turf may be used in-lieu of natural turf where turf is permitted as indicated in Section 20.30.030(A)(4).

c. Submission of Application. An application for the installation of artificial turf, consisting of a detailed site plan, shall be submitted to the planning division in triplicate for approval prior to issuance of permits and installation. Required details to be on the site plan shall be determined by the community development director.

STANDARDS

1) Materials. Artificial turf shall be of a type known as cut pile infill and shall be manufactured from polypropylene, polyethylene, or a blend of polypropylene and polyethylene fibers attached to a polypropylene or polyurethane backing, or the city may consider an alternative product if it is of equal or greater quality of product. Regulations pertaining to the materials may be amended by the community development director as manufacturing processes are updated.

2) Artificial turf shall have a minimum eight-year, no-fade warranty as issued by the manufacturer.

3) Artificial turf shall be maintained in a green fadeless condition and shall be maintained free of stains, weeds, debris, tears, holes, and impressions. Artificial turf shall be replaced once it is unable to be maintained as required.

4) General Appearance. Artificial turf shall be installed and maintained to effectively simulate the appearance of a well-maintained lawn. The planning division shall maintain and make available for public inspection a sample of various artificial turf products that meet this minimum standard of appearance.

5) Artificial turf surfaces shall be cleaned on a monthly basis, or as directed by the manufacturer with a sanitizing agent determined acceptable by the manufacturer.

6) Prohibited Uses. The use of indoor plastic or nylon carpeting as a replacement for artificial or natural turf shall be strictly prohibited. Artificial shrubs, flowers, trees, and vines in-lieu of living plant materials shall be strictly prohibited.

7) All artificial turf shall be installed over a minimum of two-inch compacted and porous road base or comparable material and shall be anchored at all edges and seams.

8) Seams. For products utilizing a polyurethane mesh with the blades stitched to the backing, the seams shall be glued and sewn. For products utilizing a non-woven polypropylene backing, the seams may be either glued or sewn. Regulations pertaining to the proper securing mechanism of the artificial turf may be amended by the community development director as the manufacturing processes are updated.

9) Infill medium, if required by the manufacturer to provide ballast, shall consist of ground rubber, clean washed sand, ground rubber and clean washed sand, rubber coated sand, or other mixtures as approved by the community development director. The infill medium shall be brushed into the fibers to ensure that the fibers remain in an upright position to provide ballast that will hold turf in place and provide a cushioning effect. The community development director may require or approve an alternative infill medium based on the comprehensive results of environmental studies, or as manufacturing processes are updated.

10) The installation of artificial turf on slopes greater than six and six tenths percent shall require the approval of the city engineer and shall meet the requirements of the public works department.

11) Installation shall be performed by a certified licensed professional through the Association of Artificial and Synthetic Grass Installers and shall be installed pursuant to the manufacturer's specifications.

12) Artificial turf shall be separated from live planting beds by a concrete mow strip, bender board, or other barrier approved by the community development director in order to prevent intrusion of living plant material into the artificial turf.

13) Areas of living plant material (i.e., flowerbeds, tree wells, etc.) shall be included within the overall landscape design when installing artificial turf within the single-family residential land uses. A minimum of ten percent of the total landscape area shall consist of live plant material. Living plant materials shall include a mixture of shrubs, vines, trees, and ground cover.

14) The community development director may require, for areas considered as high traffic, the utilization of artificial turf with spines in the blades, or spirochetes in addition to the infill in order to ensure that the look of natural turf is maintained.

15) Artificial turf areas shall be graded to adequately drain water run-off into a live planting area to the satisfaction of the public works department.

16) Artificial turf must consist of cut pile infill fibers a minimum height of one and one-quarters inch and a proper drainage system allowing a minimum of one quarter inch of water penetration per square foot shall be installed underneath the turf to prevent excessive run-off or pooling. All water run-off from the artificial turf areas must provide for site soil drainage to the satisfaction of the public works department.

17) The community development director may also add additional requirements in regards to the type of infill, the grade of artificial turf product depending on the location the product would be installed, and the amount of live planting areas in order to ensure sufficient drainage for run-off.

**FULLERTON, CA15.56.140 Synthetic turf**

Use of artificial plants and surfaces painted to appear as plant material are prohibited in landscape area except as provided in this section.

The use of synthetic turf on areas with slope percentage greater than 5% shall not be permitted.

**STANDARDS:**

1) Synthetic turf shall simulate the appearance of live turf.
2) Be of a type known as cut pile infill with pile fibers a minimum height of 1.75 inches.
3) Be manufactured from polyethylene.
4) Be affixed to a permeable backing
5) Minimum 8 year 'no fade' warranty.
6) Must be installed by a licensed professional pursuant to manufactures requirements
7) Be installed over a subgrade prepared to provide positive drainage and an evenly graded mass of compacted, porous crushed rock aggregate material
8) Be anchored at all edges and seams
9) The use of water to clean artificial turf is discouraged.
10) Submittal shall include a landscape plan, dimensioned cross section of proposed materials and installation details, including subgrade, drainage, base or leveling layer, and infill
11) Edge material and detail for treatment of seams

**Laguna Hills**

Similar requirements to others with this addition:

1) Artificial turf shall be maintained to prohibit any obnoxious odors caused by the accumulation of animal waste.

**ENGLEWOOD, CO**

Non-living landscape materials, such as mulch, rocks, artificial turf, may be used to meet up to 30% of the landscape requirement.

STANDARDS:

1) May not be installed on slopes greater than 6.6%
2) Non permitted within the public right-of-way
3) No artificial trees, shrubs, turf, or plants shall be used to fulfill the living material requirements of the Code.

**El Paso TX**

The Code recognizes the need to conserve water and the City has a water conservation plan. Synthetic turf is listed in the landscaping which may be used for alternative compliance.

Alternative compliance is determined on a point system and allows up to a 20% reduction in required landscaping. Artificial turf is listed in the alternative compliance point table as " Artificial turf with a permeable base used in parkways and narrow areas 33' or less in any dimension, including all areas of the parkway."

**CERRITOS, CA**

The City of Cerritos specifically prohibits the use of synthetic turf.

**Santa Cruz, CA**

Synthetic turf is permitted, but does not qualify for water conservation rebate.

Property & Homeowner Buyer Guide

Special Report :

Artificial Grass Guidelines for Property Owners

SR.04 - 2009

# Recommended Artificial Grass Guidelines

## The Value You Gain From Ordinances & Guidelines

Today, as property owners, 55 million homeowners invest in residential developments that are guided and governed by the rules and regulations of city, county community, co-op or homeowner associations.

These governing bodies help to insure, for the good of the whole community, that the development and overall look and feel of the property matures gracefully and grows in value, with time, protecting your investment.

They are also chartered with the responsibility of providing oversight regarding land and property development to insure that county, state and federal law, codes, covenants and restrictions are met.

One of the key elements a community, co-op or homeowner association is tasked with is to develop design guidelines that help property owners improve their properties while maintaining the consistency of the whole community. California communities also bear the burden of managing water resources and storm-water run-off.

Artificial grass and synthetic turf materials, professionally designed and installed are a viable option to consider. To help familiarize you with standard industry practices, we have published this guideline.

## Natural verses Artificial Lawn Costs

All common costs should be considered when comparing bid amounts for installing a natural lawn to installing synthetic grasses. If you are comparing, insist on balance … include professional services verses owner built efforts; time and effort are worth something! Value it!

- Excavation and site prep (dump/haul fees)
- Access to the area (time wasters like stairs)
- Compare natural lawn's need for soil amendments, preparation and additional materials to a synthetic lawn's base work.
- Natural lawns require additional trenching, pipes/fittings, electric, plumbing and timer costs. Of course, this would be optional for synthetic lawns.
- Compare warranties, get them in writing. What natural grass can last as long as the shortest of warranties on synthetic turf?
- Include long-term maintenance, repair & replacement of irrigation and lawn areas.

**Mac & PC Friendly PDF Buyer & Grooming Guidance at www.asgi.us**

We've saved water, reduced our use of chemicals for pest and weed control and we've gotten back enough time in our weekends to enjoy our gardening and time together!

## Artificial Grass for Landscape & Leisure Sports

Artificial grass and synthetic turf, long valued for their use for sports fields, have found their place among the masses. New fiber styles and natural colors, look and feel, provide property owners with one more option to use in landscape design and construction.

Artificial grass solutions can help reduce irrigation water use, pesticides and fertilizers. Properly installed, artificial grass surfaces can improve drainage, enhance the form and function of any area; virtually eliminate erosion, enhance storm-water management solutions, and decrease dust, weeds and other pests.

Artificial grass projects are customized to suit your needs.

**Please Note:** New projects and renovations generally require the property owner/member to submit an architectural application for review, including surface material samples, for an approval in accordance with the CC&R's of the association's general design guidelines.

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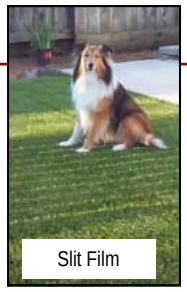
# Recommended Artificial Grass Product Use

## Popular Products, Styles and Their Uses

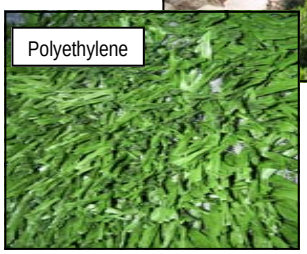


**Polyethylene (PE),** is a synthetic yarn fiber made from olefins and was developed to be used for artificial grass surfaces.

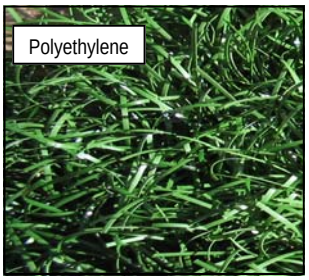
Soft and resilient, PE fibers are commonly used for lawn, landscape, chipping and tee lines projects. Most materials are tufted into porous backings.

They dry very fast, are resistant to stains, mold, mildew, UV and high traffic, if properly installed, groomed and maintained.

Many PE landscape, chipping and tee grass materials are now available in either slit film or monofilament fibers; from 1 to over 2 inches in height.




Fibrillated Slit Film



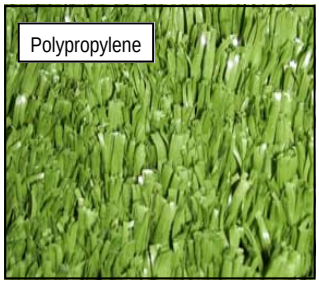

Monofilament

Slit film styles (made popular in sports field installations) tend to be a wider blade, resembling some natural fescue grasses or a Bermuda grass while monofilament fibers are more like a natural lawn of rye or blue-grass.

### General Properties of Artificial Grass Materials:

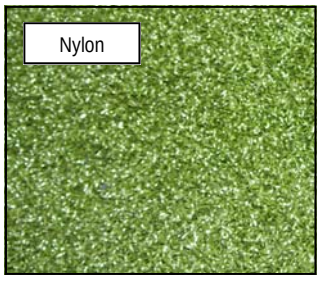
- **Common Yarn Fibers**
  - Polyethylene (PE)
  - Polypropylene (PP)
  - Nylon (PA)
- **Surface Specifications (Ranges)**
  - Face Weight:: 24 to 90 (+) ounces
  - Denier: 4600 to 11,000
  - Stitch Gauge: 3/8 to 1/2 inch
- **Common Yarn Styles**
  - Slit Film - Fibrillated Tape
  - Monofilament
  - Mono-Tape
  - Texturized
  - Knit de Knit
- **Common Fiber Uses**
  - PE - Lawns, Chipping, TEE
  - PP - Greens, Bocce, Cart Path
  - PA - Greens, Bocce, Cart Path

**Polypropylene (PP)** fibers were the first developed and used to simulate the performance of a bent-blade putting green surface. Many of the PP surface styles will be from 5/8 to 1.25 inches in blade height and once infilled* and rolled will stay bent and hold speed.




Fibrillated Slit Film

**Nylon (PA),** the first olefin fiber to be developed in the 1930s, and is most often used for putting green, chipping or field hockey surfaces. Nylon fibers are typically texturized and densely woven into non-permeable backing materials. Emerging styles include blades from 3/8 inch to over 2.5 inches and colors range from lite green to a richer, field green.




Texturized, & Fibrillated Slit Film

***Available in several styles of fiber, color and texture, artificial grass surface materials can be created to resemble fescue, rye and other common natural grass blades. Colors can range from dusty greens or multi-colored tones to new spring green or the rich, deep green of blue-grass sod.***

****All artificial grass surfaces benefit from the use of INFILL.***

Infilled Monofilament Lawn Grass

Infilling helps protect blades from UV damage, add weight to hold the grass in place and provide a natural feel to the surfaces. Infill Materials can help blades last longer.

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# Design & Engineering Permeable Surfaces For California Model Landscape Use

When you approach a synthetic grass project, it has to be with a mindset of longevity. How the job is engineered and built has a direct effect on your ability to achieve design objectives and deliver a solid, stable installation.

*Four basic installation techniques are shown, to your right.*

The ASGi Standard Installation Guideline for Landscape and Lawns will focus on how to achieve natural looking lawn installations. The tips and techniques learned here can be incorporated into any plan.

One of the first considerations is what type and amount of site preparation is required. It can be to your advantage to excavate out problem concrete, asphalt, soils or other existing materials and import appropriate base materials into the site to insure a stable outcome.

As a basic rule of thumb, the final grade of the project, use and accessibility requirements will have to be taken into consideration prior to job start.

If concrete or asphalt areas drain properly, synthetic grass and artificial turf can be place on top.

When installing over native soil conditions, fabrics are very important for the long-term stability of your projects. ALWAYS start with a durable and porous synthetic fiber (woven or non-woven) and install it over native soils and then add your imported base layers, as required by your design.

A minimum of 2 to 3 inches of compacted aggregate materials UNDER the synthetic grass surfaces are installed over soil stabilizing fabrics, on top of native soil conditions (sub-base materials). See Figure 1.

If your final grade needs to be LEVEL with existing hardscape elements such as walkways, patios or driveways, allow for adequate excavation and estimate base materials to raise the base, after compaction to approximately 1 inch below he grade of the hardscape element.

To achieve a CROWNED look against hardscape, import additional materials and shape the base, during compaction, appropriately. Your hardedge should still be set, after compaction, at approximately 1 inch below the grade of the hardedge. To provide for additional watershed, install a small channel of drain rock, prior to adding base materials, as shown. (See Figure 2) Combined with the proper use of soil stabilizing fabrics, the drain rock channel (French drain) will allow watershed to fall below the surfaces and channel out, without the risk of erosion.

When installing synthetic grasses against or in between large areas of concrete or asphalt that tends to shed water into the turf areas, allow for additional excavation, several layers of mixed base materials and the possibility of additional drain pipes, catch basins, connectors and drain rock as show to the right. See Figures 3 & 4.

Synthetic grass areas can accommodate any conditions as long as the site is engineered to perform, under the requirements of local weather, weight load, traffic and use.

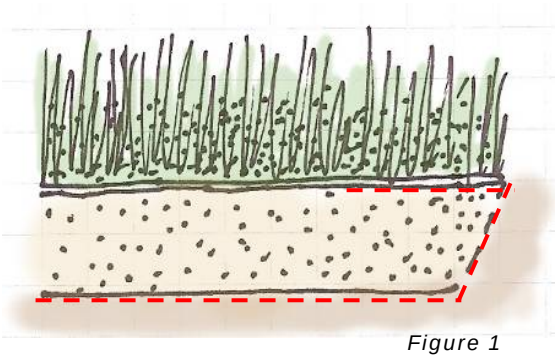
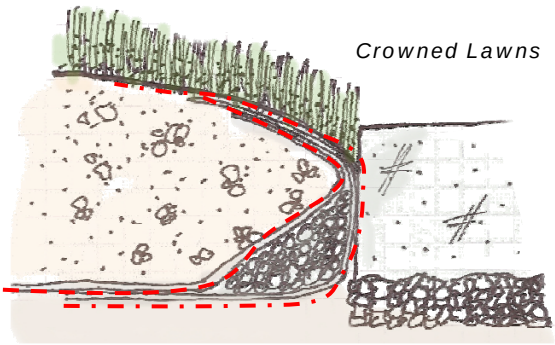


Figure 1



Crowned Lawns

Figure 2

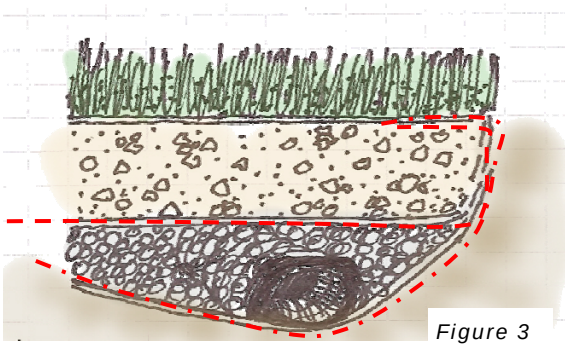


Figure 3

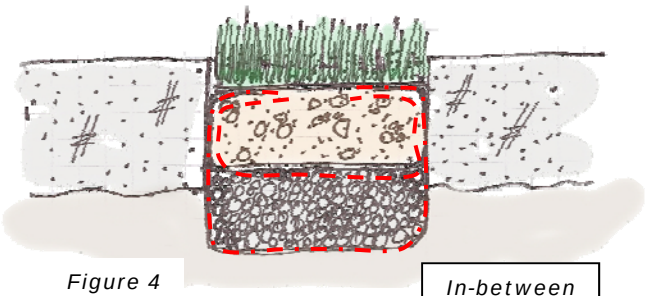


Figure 4

*In-between Flagstone & Concrete Slabs*



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# Professional quality artificial grass solutions, if installed properly, can be a *significant enhancement* to the homeowner's property.

## *The advantages of synthetic turf are:*

- reduces water usage and waste through irrigation or sprinklers.
- reduces dust, dirt and allergens around the property.
- does not require mowing, edging, trimming or fertilizer.
- stays green and beautiful year round with a minimum amount of care and grooming.
- reduces the need for pesticides and may reduce mosquitoes, fleas and other common pests.
- can stabilize slopes, increase usable backyard space, enhance the look and appeal of the property.
- can be installed on non-porous areas, reducing radiant heat and glare from side yards and patios.
- can increase the form and function of a property with entertaining amenities such as bocce, golf & yard games.
- easily rejuvenated if neglected, repaired if damaged and modified if changes are desired.

## *The disadvantages of synthetic turf are:*

- The initial investment is somewhat costly.
- If not installed and maintained properly (kept free of organic debris, blow off and brushed up to keep from matting down), the installation can become unsightly and repairs, like repairing carpets, tile or other colored items, may not match well, and can be labor intensive
- In full sun, on hot days, the surfaces can become uncomfortably hot - when enjoying the artificial turf area, keep cool by shading the area and/or wetting it down, prior and during extended use.
- If animals are allowed to defecate upon the surfaces, feces should be removed as soon as possible and the surfaces must be cleaned and sanitized with basic household products (enzymes, vinegar and green cleaners) and irrigated to keep fresh and clean, regularly. Solutions of bleach & water and many commercial products may be used, as well. Follow manufacturer's directions for handling and rinse well, after application.

## Artificial turf may be installed on homeowner's lots, with an approved architectural application, subject to the following conditions and restrictions:

**1. All installations must be approved by the Architectural Review Committee and submissions must include the following materials and information:**

a. Completed Home Improvement Application including plot plan:

b. A description of the Artificial Turf System that will be used including specific information on:

   i. Artificial Grass Surface including validation of total lead (Pb) content in yarn fibers*
   ii. Definition of type and depth of aggregate base materials & site construction plan
   iii. Definition of soil stabilizing fabric including permeability specification sheet & MSDS
   iv. Definition of infill materials including specification sheet & MSDS
   v. Definition of seaming materials and adhesives including specification sheet & MSDS
   vi. Copy of manufacturers warranty for all materials, workmanship and builder's warranty statement for workmanship for construction (California Contractor's are required to provide a minimum of 1 year workmanship warranty)

c. A description and proposed plan for drainage of the affected area; include materials lists and site plan.

d. A minimum 12" by 12" sample of the exact artificial turf or synthetic grass surface materials to be used - substitutions are not allowed without prior approval.

* ASTM maximum Voluntary Standards for lead (Pb), in artificial grass yarns and fibers, is 300ppm> : Determined by using ASTM & EPA acquisition and testing protocols - E1613 & 3050B/6010B. Total digested lead results should be notated in parts per million (ppm). Manufacturers, Suppliers and Installers that voluntarily comply to this ASTM standard can be found at Get-The-Lead-Out.Org.

## 2. Minimum requirements for Artificial Turf System Installations are as follows:

a. Primary layer on native soil: non-woven, highly-permeable soil stabilizing fabric for the soil type and conditions of the installation. Fabrics must be porous and not impede infiltration of normal watershed to appropriate drainage solutions required by any other related CC&R of property.

b. Minimum 3" – 5" of appropriate compactable aggregate base with subsequent or additional imported base materials and fabric layers, as required*

c. Acceptable artificial turf surface fibers include: Polyethylene (PE) Polypropylene (PP), Nylon (PA) with a minimum 6 year (Nylon (PA)) and 8 year (PE & PP) manufacturer warranty against UV degradation (fading and discoloration) and the style and color selection must compliment other adjacent natural lawn and landscaped grass within the community; must meet or exceed ASTM standards*.

Acceptable backing materials include perforated, vertically draining, latex or polyurethane coated materials to provide optimum tuft bind and maximum permeability. Horizontally draining backings must not be infilled; infill materials are prone to migrate into drainage systems.

Acceptable infill materials will include but are not limited to: recycled rubber crumb, acrylic coated silica sand, recycled PET bead lets, thermo-plastic elastomer coated silica sand, semi-round silica sand. Sub-angular silica sand may not be used as infill materials.

All materials submitted for approval must be accompanied by test documentation which declare that the artificial turf yarn and backing materials are disposable under normal conditions, at any US landfill station (Total Content Leach Protocol (TCLP) test)

d. Infill materials, type and amount, per square foot, installed, as suggested by the turf manufacturer or based upon standard industry guidelines*

e. Surfaces must appear seamless and edges must appear natural, and well groomed.

f. Total surface installation must be water permeable with minimum 25 inch/Hour Permeability Rating

g. All job materials used for surfaces must pass applicable fire retardancy ratings including pill burn test

## 3. Additional Requirements for Rear Yards that are not visible from common or public areas

a. Artificial surface must be of suitable materials, styles and color for the purpose intended and meet the minimum specifications noted above

b. Specialized surfaces for putting greens, play areas, bocce ball and other uses are allowed in rear yards, only and must be engineered and installed as permanent construction. The use of artificial turf materials on existing hardscape such as patios or side-yard concrete driveways or pathways is subject to the approval of the Landscape Committee.

## 4. Additional requirements for Front Yard uses in visible sites from common or public areas

a. Artificial surface must be of suitable materials, styles and color for the purpose intended and meet the minimum specifications noted above Appropriate uses are for lawns and landscape elements, only

b. Minimum pile height (individual turf blade height) is an average of 1.5 inches; classic slit film, monofilament or a combination of blade styles; including texturized and knit de knit materials used for thatch are allowed

Please note that all installations must appear natural at all times. Any deviation from a natural look due to improper installation or lack of maintenance will be in violation of these rules.

Product improvements may occur at any time; the Landscape Committee will remain open to review new products and solutions as they become available and may modify, from time to time, the Artificial Turf Minimum Specifications and Guidelines.

* ASTM maximum Voluntary Standards for lead (Pb), in artificial grass yarns and fibers, is 300ppm> : Determined by using ASTM & EPA acquisition and testing protocols - E1613 & 3050B/6010B. Total digested lead results should be notated in parts per million (ppm).

# MINIMUM JOB SPECIFICATIONS

**Special Report :**

Artificial Grass Guidelines for Associations

SR.04 - 2009

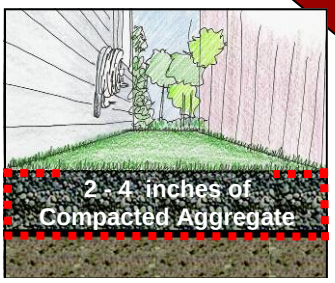
## Basic Lawn or Side Yard Installation

Illustration of a side view of the (above) construction at right.

ASGi has developed a minimum job specification and industry standard installation guideline based upon best-business-practices, sound construction techniques and the peer review of seasoned installers located throughout North America and abroad.

The minimum recommended job materials for a permanent, professional installation for lawn or landscape would include:

- Porous, Soil Stabilizing Fabrics
- 2-4 inches of Various Compactable Aggregate Base Materials
- Permeable Artificial Grass Surfaces
- Seaming Materials & Supplies
- Infill Materials




Over Well-Draining, Native Soil

**Installation Guides at www.asgi.us**

## MINIMUM CALIFORNIA INSTALLER CREDITIALS

The State of California requires that ALL contractors (operators) charging in excess of $500 per job (labor and materials included) be licensed by the Contractors State License Board, also known as the CSLB.

No one can borrow or lend a license - it is issued to either a person, a company or a corporation. Who you contract with should be the named licensed contractor or you may not have a bondable contract in the eyes of the CSLB. You can validate a license, bonds and insurance of a contractor at http://www.cslb.ca.gov or call 1-800-321-CSLB (2752)

To contract for the sale and installation of artificial grass materials, operators should have 4 (four) years of experience and must hold a valid, active C27 and/or a C61/D12 license in California. Always ask for references, referrals and check them to verify experience.

*Your contractor should be able to provide proof of required bonds, workman comp & general liability insurance.*

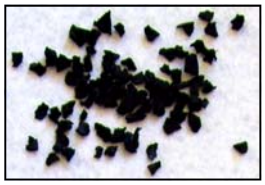
*If your contractor (or a sub-contractor) does not carry a valid workman's comp insurance policy - you may be liable for injuries that occur to laborers on your property during the construction of your project.*

***All artificial grass surfaces benefit from the use of INFILL.***

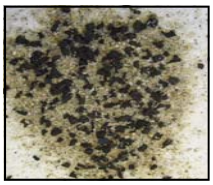
***Infill materials are used on top of the artificial grass surfaces, after they have been laid in place, seamed and edges trimmed. Infill materials are selected for their grade, size, shape and ability to fill up the voids between rows of yarn stitches of most turf styles and like any ballast materials, help to distribute weight across the installed surfaces, holding them in place; eliminating the surfaces from creeping, buckling or separating at the seams. All infill will contribute to the infiltration rate of the surfaces and be a determining factor in the surface fibers resiliency, wear and fall zone safety rating. The amount and type of infill used is determined, primarily, by the safety and effectiveness of the selected material which is based upon specifications and best-business-practices for the intended use, traffic, local weather and project expectations.***

Example of Infilled Monofilament Lawn Grass
Infilling helps protect blades from UV damage, add weight to hold the grass in place and provide a natural feel to the surfaces. Infill Materials can help blades last longer.

*Commonly used infill material selections:*



SBR Ambient Rubber Crumb (recycled)



SBR (Ambient) Rubber Crumb & Semi-Round Silica Sand

Elastomer-Coated Semi-Round Quartz Granules (silica sand)

Acrylic - Coated Semi-Round Quartz Granules (silica sand)

Infill Close Up

Infill Applied to Surfaces

Compliments of

www.HunnyDoGrass.com



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SCCNPS



## Why Native Plants?

**California's True Landscape**
Native vegetation evolved to live with the local climate, soil types, and animals. This long process brings us several gardening advantages.

**Save Water**
Take advantage of water-conserving plants in your landscape. Once established, many native plants need minimal irrigation beyond normal rainfall. Saving water conserves a vital, limited resource and saves money, too.

**Lower Maintenance**
Low maintenance landscaping methods are a natural fit with native plants that are already adapted to the local environment. Look forward to less pruning, eliminating chemical fertilizer, and saving time.

**Pesticide Freedom**
Native plants have developed their own defenses against many pests and diseases. Since most pesticides kill indiscriminately, beneficial insects become collateral victims in the fight against pests. Eliminating pesticides lets natural pest control take over and keeps garden toxins out of our watersheds and ocean.

**Invite Wildlife**
Native plants, birds, butterflies, beneficial insects, and interesting critters are “made for each other.” Research shows that native wildlife clearly prefers native plants. California's wealth of insect pollinators can improve fruit set in your garden, while a variety of native insects and birds will keep your landscape free of mosquitos and plant-eating bugs.

**Support Local Ecology**
While creating native landscapes can never replace natural habitats lost to development, planting gardens, parks, and roadsides with California natives can provide a “bridge” to nearby remaining wildlands.

Adapted from CNPS Horticulture Brochure

**Dune Buckwheat (hosting male El Segundo Blue)**
Eriogonum parvifolium

**Sawtooth Goldenbush**
Hazardia squarosa var. obtusa

**Toyon, California Holly, Christmas Berry**
Heteromeles arbutifolia

## Why Native Plants?

by Tony Baker, Horticulture Co-Chair, South Coast Chapter

From the time of the first Spanish settlers to the present, the natural habitat of Southern California has been hammered by overgrazing, conversion to agriculture, and unbridled development. Much of the land that still supports native vegetation has been compromised by disturbance and the introduction of plants from other locales.

Over 1,000 nonnative plant species have naturalized in California, meaning they are able to reproduce and spread on their own. Many of these plants are able to become dominant because of aggressive tendencies and they often have no natural enemies to keep them in check.

The most pressing threat to our native plant communities, however, is their conversion to housing tracts, mini-malls, parking lots and golf courses.

Our Mediterranean climate is rare on the planet Earth. It only occurs in five places: the coast of Southern California, the southern tip of Africa, the central coast of Chile, the southwestern coast of Australia and the coastal strip surrounding the Mediterranean Sea. Small in area, this climate supports one of the most important biomes on Earth.

In Southern California the most common plant communities are known as Coastal Scrub and Chaparral. In an example of co-evolution, the other areas mentioned have vegetation with the same adaptations and appear the same even though the plants are different.

Unfortunately, our native vegetation has not received the respect it deserves. Too often gardeners turn their back on the many beautiful and hardy California plant species even though they are usually very drought tolerant and often pest free.

**Deerweed (hosting male Palos Verdes Blue)**
Lotus scoparius

**Purple Nightshade (with Sonoran Bumblebee)**
Solanum xanti

**Photographer: Ann Dalkey**

The benefits of low water usage and little maintenance should be great incentives to plant natives, but the philosophy of controlling and/or excluding nature in gardens has been pervasive for centuries.

Most of the plants in the nursery trade have little value as habitat for wildlife. The standard lawn grasses are good examples. Not only does the gardener have to water the lawn constantly, but also needs to apply herbicides and pesticides, thus making the green plot sterile of most life except that of the grass.

I would like to suggest that instead of excluding nature from your garden, plant native plants and invite birds, bees and butterflies to visit. Many native plants, both annuals and perennials, have long tubular flowers to attract hummingbirds. It's a symbiotic relationship that benefits the hummingbird by providing nectar and the plant by providing pollination.

Some natives produce edible seeds or berries and are irresistible to birds, while the flowers of others attract butterflies. In fact, a number of butterflies, such as the Palos Verdes Blue Butterfly, are solely dependent on particular plants to carry out their life cycle. If some of these plants are used in the landscape, the butterflies, as well as birds and bees, will find them and you will be helping in their survival and can enjoy their presence in your yard.

I believe the time has come to appreciate and nurture the wonder that surrounds us. Let's bring some of the natural habitat back into our yards. It will benefit the environment and at the same time will allow us to feel a part of our natural heritage.



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**"Synthetic Surface Heat Studies"**

***C. Frank Williams and Gilbert E. Pulley***
***Brigham Young University***

Synthetic turf surfaces have long been regarded as a lower maintenance alternative to natural turf. However, synthetic surfaces like natural turf have their shortcomings. In the spring of 2002 a Field Turf synthetic surface was installed on one half of Brigham Young University's Football Practice Field. The other half of the installation is a sand-based natural turf field. Shortly after the Field Turf was installed football camps were started. The coaches noticed the surface of the synthetic turf was very hot. One of the coaches got blisters on the bottom of his feet through his tennis shoes. An investigation was launched to determine the range of the temperatures, the effect water for cooling of the surfaces, and how the temperatures compared to other surfaces.

On June of 2002 preliminary temperatures were taken at five feet and six inches above the surface and at the surface with an infrared thermometer of the synthetic turf, natural turf, bare soil, asphalt and concrete. A soil thermometer was used to measure the temperature at two inches below the surface of the synthetic turf. Also, water was used to cool the surface of the natural and artificial turf. It was determined that the natural turf did not heat up very quickly after the irrigation so only the artificial turf was tracked at five and twenty minutes after wetting. The results of the preliminary study are shocking. The surface temperature of the synthetic turf was 37º F higher than asphalt and 86.5º F hotter than natural turf. Two inches below the synthetic turf surface was 28.5º F hotter than natural turf at the surface. Irrigation of the synthetic turf had a significant result cooling the surface from 174º F to 85º F but after five minutes the temperature rebounded to 120º F. The temperature rebuilt to 164º F after only twenty minutes. These preliminary findings led to a more comprehensive look at the factors involved in heating of the artificial turf.

Three aspects of light were measured along with relative humidity. The synthetic surface was treated as two areas, the soccer field and the football field and the natural turf was one area. Four randomly selected sampling spots were marked with a measuring tape from reference points on the fields so it could be accessed for subsequent data collection. Bare soil, concrete, and asphalt sampling areas were selected and marked in a similar manner. The results are shown in table form below:

Table 1.

| **Surface** | **Average Surface Temperature between 7:00 AM and 7:00 PM** | |
|---|---|---|
| Soccer | 117.38º F | high 157º F |
| Football | 117.04º F | high 156º F |
| Natural Turf | 78.19º F | high 88.5º F |
| Concrete | 94.08º F | |
| Asphalt | 109.62º F | |
| Bare Soil | 98.23º F | |

Table 2.

| **Two inch depth** | **Average Soil Temperature between 7:00 AM and 7:00 PM** | |
|---|---|---|
| Soccer | 95.33º F | high 116º F |
| Football | 96.48º F | high 116.75º F |
| Natural Turf | 80.42º F | high 90.75º F |
| Bare Soil | 90.08º F | |

Table 3.

| **Shade** | **Average Temperature between 9:00 AM and 2:00 PM** | |
|---|---|---|
| Surface Temperature of Natural Turf | 66.35º F | high 75º F |
| Surface Temperature of Artificial Turf | 75.89º F | high 99º F |
| Average Air Temperature | 81.42º F | |

Surface Temperature of A.T. (Artificial Turf) is significantly higher than air or soil temperature of A.T. The amount of light (electromagnetic radiation) has a greater impact on temperature of A.T. than air temperature. The hottest surface temperature recorded was 200º F on a 98º F day. Even in October the surface temperature reached 112.4º F. This is 32.4º F higher than the air temperature. White lines and shaded areas are less affected because of reflection and intensity of light. Natural grass areas have the lowest surface and subsurface temperatures than other surfaces measured. Cooling with water could be a good strategy but the volume of water needed to dissipate the heat is greatly lessened by poor engineering (infiltration and percolation).

Average air temperature over natural turf in the late afternoon is lower than other surfaces. Soil temperature of A.T. is greater than bare soil and natural turf. Humidity appears to be inversely related to surface and soil temperature. It is likely that energy is absorbed from the sunlight by the water vapor.

The heating characteristics of the A.T. make cooling during events a priority. The Safety Office at B.Y.U. set 120º F as the maximum temperature that the surface could reach. When temperature reaches 122º F it takes less than 10 minutes to cause injury to skin. At this temperature the surface had to be cooled before play was allowed to continue on the surface. The surface is monitored constantly and watered when temperatures reach the maximum. The heat control adds many maintenance dollars to the maintenance budget.

A budget comparison was made using actual dollars spent and for every dollar spent on the A.T. maintenance one dollar and thirty cents was spent on the natural turf (N.T.) practice field. While construction costs are very unbalanced, for every dollar spent on the N.T. eleven dollars and seventy-seven dollars were spent on the A.T.

The area under the carpet of BYU's installation is designed to move water from the surface and into an extensive drain mat system. This part of the installation is two thirds of the overall cost of the A.T. Thus, for a 2.5 million dollars installation approximately 1.7 million dollars go for the subsurface and drainage. The most interesting thing about this is that the drain mat probably sees little or nº water. The surface is hydrophobic and the undersurface is poorly engineered to favor water retention rather than drainage. That seems like a high price to pay for something that does not work!

Artificial turf surfaces have their place in the turf industry. They can work in environments where grass will not grow and are marginal. However, they are costly and not maintenance free. It is important to take all the factors in to consideration before making a large investment. Don't take the manufacture's word for the factors of concern i.e. don't let the fox guard the hen house. The propaganda on BYU's installation is charts with surface temperatures less than the air temperature and claims for drainage of 60 inches per hour. The question still remains is A.T. 11.47 times better than natural turf?

RECEIVED
AUG 22 2011
City County Planning Office
Lawrence, Kansas

August 22, 2011

To: Chair and Members of the Lawrence/Douglas County Metropolitan Planning Commission

Re: ITEM NO. 11 TEXT AMENDMENT TO CITY OF LAWRENCE DEVELOPMENT CODE; CHP20; SYNTHETIC TURF AS LANDSCAPING MATERIAL

First we commend the Planning Staff for its excellent and comprehensive report on the use of artificial turf. The report is well documented and clearly has been thoroughly researched on the limited number of permitted uses of artificial turf as a landscape material.

Furthermore, the Jayhawk Audubon Society believes that the staff recommendation for denial of the amendment request has been thoroughly analyzed and we agree that the request for the use of artificial turf in this application is not appropriate. For all the reasons that staff has enumerated, artificial turf appears to have significantly more negative effects on the environment than the few potential benefits it may have.

We ask you to deny the request.

Thank you for your consideration of these comments.

Sincerely,

Gary E Anderson

Gary Anderson, President

Jayhawk Audubon Society

PO Box 3741

Lawrence, KS 66046-3741

**League of Women Voters of Lawrence-Douglas County**
P.O. Box 1072, Lawrence, Kansas 66044

RECEIVED
AUG 22 2011
City County Planning Office
Lawrence, Kansas

August 21, 2011

Mr. Richard Hird, Chairman
Members
Lawrence-Douglas County Metropolitan Planning Commission
City Hall
Lawrence, Kansas 66044

RE: AGENDA ITEM NO. 6: TA-4-6-11, A TEXT AMENDMENT TO THE CITY OF LAWRENCE DEVELOPMENT CODE; SYNTHETIC TURF AS LANDSCAPING MATERIAL (MKM)

Dear Chairman Hird and Planning Commissioners:

Please see the attached letter that we sent to you for your June 19, 2011 Planning Commission meeting regarding the use of synthetic turf in landscaping—Agenda Item No. 6 in this current Agenda. In our June letter we commended the staff for their report on its use and their recommendation for denial.

We reiterate our position, and have two other points to mention against the use of artificial turf.

(1) Because of its heat absorption and reflection, in order to avoid that effect, it needs water for cooling, negating the argument that it saves water.

(2) Depending on its location, the heat island effect that it produces is likely to increase energy use for air conditioning, in contrast to the cooling effect of natural vegetation for landscaping materials.

Again we thank the staff for their recommendation for denial of this proposed text amendment, and hope that you will not recommend approval of TA 4-6-11.

Sincerely yours,

Caleb Morse
Member of the Board

Alan Black

Alan Black, Chairman
Land Use Committee

*Attachment*

ATTACHMENT

**League of Women Voters of Lawrence-Douglas County**
P.O. Box 1072, Lawrence, Kansas 66044

RECEIVED
JUN 20 2011
City County Planning Office
Lawrence, Kansas

June 19, 2011

Mr. Charles Blaser, Chairman
Members
Lawrence-Douglas County Metropolitan Planning Commission
City Hall
Lawrence, Kansas 66044

RE. ITEM NO. 11: TEXT AMENDMENT TO CITY OF LAWRENCE DEVELOPMENT CODE; CHAPTER 20; SYNTHETIC TURF AS LANDSCAPING MATERIAL (MKM)

Dear Chairman Blaser and Planning Commissioners:

We would like to thank the Staff for providing the valuable background information on the use of artificial turf. We especially appreciate staff recommendation of denial for its use in landscaping, and in its place the use of "low maintenance (natural) landscaping."

The reference material, as did the Staff Report, made clear the important reasons why this material should not be substituted for natural vegetation as groundcover. When it is so important to save energy, conserve our soil and protect the environment from pollution, the use of artificial turf for landscaping is not only counterproductive, but also environmentally damaging. As one of our members pointed out, artificial turf doesn't even save water because the other portions of the landscaping such as trees and shrubs must still be watered.

Thank you for your valuable information and negative recommendation on the use of artificial turf in landscaping.

Sincerely yours,

Caleb Morse
Member of the Board

Alan Black

Alan Black, Chairman
Land Use Committee

LWV6-19-11pcAgenda Item 11 Artif.turf LTR 2.wpd

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GLEE S. SMITH, JR.
OF COUNSEL

Jane M. Eldredge
Email: jeldredge@barberemerson.com

August 19, 2011

VIA E-MAIL

Mr. Richard W. Hird, Chair
Lawrence-Douglas County Metropolitan Planning Commission
City Hall
6 East 6th Street
Lawrence, KS 66044

Re: Item 6 Synthetic Turf

Dear Mr. Hird:

We represent the applicant who requested the initiation of the text amendment. We appreciate the deferrals that you have provided to us. We have reviewed the June 22, 2011 Staff Report. We researched the current literature on artificial turf and Melissa Vancrum, a graduate student in law and urban planning, summarized that research in a Memorandum dated July 21, 2011.

Ms. Vancrum's research was presented to the Planning Staff on July 22, 2011 along with all of the supporting research documents. At the request of staff we also provided the memo and documentation electronically. Attached to this letter please find the Vancrum July 21, 2011 memo as Exhibit A. The staff has all of the supporting research documents in hard copy as well as electronically if you would like any of it.

Ms. Vancrum also reviewed the landscaping ordinances of 37 communities in this state and others. The communities in Arizona, California, Florida and Texas have had the most experience with permitting and regulating artificial turf. The communities in Colorado, Kansas and Nebraska generally have ordinances that are "silent" as to whether artificial turf is permitted as a landscaping material, which means the ordinances do not provide that artificial turf is permitted or prohibited. In most of the other Kansas communities where artificial turf has been requested, it has been permitted except in Salina where the subject landscape plan did not meet the minimum number of live plants. In other cases where there has been no request, the zoning official has said it would be permitted because it was not explicitly prevented. Ms. Vancrum's Other Community Comparison chart is attached as Exhibit B.

While we were disappointed that neither the Planning Staff, nor the Planning Commission was interested in a study session of artificial turf, we retained the two national experts on synthetic turf, Rusty Abell and Joseph W. DiGeronimo, to review and evaluate the evolving nature of the quality and use of artificial turf. They will both be present at the August 24, 2011 Planning Commission meeting. Their résumes are attached as Exhibits C and D respectively.

At our request Tim Bracciano, the facility director for Lawrence Public Schools, will be available at the Planning Commission meeting to report on our school district's selection of artificial turf for our athletic fields and their experience with it to date.

Lastly, we have prepared a letter reviewing and analyzing the legal requirements that must be followed in consideration of the requested text amendments. Please see Exhibit E. We submit that text amendments to the Lawrence Development Code are necessary to address the changing conditions in the evolution of artificial turf on athletic fields and landscaping and to address some apparent inconsistencies in the Development Code.

Thank you for your consideration. If there is any additional information that we may provide, please do not hesitate to contact us.

Sincerely,

BARBER EMERSON, L.C.

Jane M. Eldredge

Jane M. Eldredge

JME:dkh
Enclosures
cc: Planning Commission
Scott McCullough
Mary Miller

**MEMORANDUM**

To: Jane Eldredge
From: Melissa Vancrum
Re: Artificial Turf use as Landscaping in Lawrence
Date: July 21, 2011

---

The Lawrence Development Code appears to prohibit the use of artificial turf as part of any landscaping plan except as an alternative compliance element. However, many other localities encourage the use of artificial turf in landscaped areas and offer rebates for installing it and reducing water usage. Horizon 2020 encourages sustainable landscaping and a sustainable physical environment. Such goals include the use of artificial turf in many other circumstances.

Artificial turf has evolved dramatically in the last decade in safety, environmental friendliness, attractiveness, and durability. It has reserved LEED points in a number of projects. Artificial turf today can be indistinguishable from natural grass without close inspection. In addition, it can support Lawrence's goal of sustainability through decreased water consumption, pesticide and herbicide runoff, emissions from mowers, and grass clipping waste. The natural grass lawn is not sustainable and several alternatives need to be evaluated. Perhaps a focused study session would be helpful to more clearly analyze today's artificial turf products and determine if they should become a beneficial option of the local landscape.

**The Natural Grass Lawn**

The manicured grass lawn is a status symbol of the wealthy borrowed from European manor houses.[1] It is not "natural". It is highly cultivated. The grass lawn

[1] Donaldson, Cameron, History of the American Lawn, The Limpkin: Newsletter of the Spacecoast Audubon Society of Brevard County Florida.

proliferated in the U.S. after World War II as suburbia exploded. Americans previously used their yards primarily for growing food.

The natural grass yard is anything but natural. "[A] typical U.S. lawn, one-third of an acre in size, receives as much as 10 pounds of pesticides, 20 pounds of fertilizer, and 170,000 gallons of water annually. What's more, in a year a homeowner could spend the equivalent of a 40-hour workweek simply mowing that lawn (producing pollution equal to that created by driving a car 14,000 miles) and hundreds of dollars caring for it."[2] In the effort to cultivate a sustainable environment, it is difficult to support the natural grass lawn. However, many alternatives exist, including artificial turf.

Use

Artificial turf has evolved considerably since it was introduced in the 1960's for sports fields. Today artificial turf is used in parks, upscale residential yards, commercial developments, and golf courses. Its use is now widespread in professional sports and continually expanding for kids' athletic fields, including those of the Lawrence Unified School District. In recent years, artificial turf has become popular in celebrities' yards.[3] Walt Disney World, Disneyland and Epcot Center utilize artificial grass in some of their landscaping.[4] New York City uses the turf in some parks, and California agencies use it for some building landscaping.[5]

**Appearance**

---

[2] Bogo, Jennifer, Going the Extra Yard, Audubon Magazine, March 2002.
[3] Synthetic Turf Becomes Latest Celebrity Trend, A-Listers and Landmarks Conserve Water While Beautifying Grounds" Synthetic Turf Council, May 31, 2001.
[4] Id.
[5] See California utillitClaudio, Luz, Synthetic Turf: Health Debate Takes Root, Environmental Health Perspectives, March 2008,

One reason for the widespread adoption of artificial grass is the improvement in look. Artificial turf can be selected in different shades of green with variegated strands and even the look of dead thatch mixed within the green blades. [6] Artificial turf also comes in different lengths to mimic the look of different types of natural grass even up close.

**Health and Environmental Impacts**

Use of artificial turf in select applications provides a significant benefit in the form of a large reduction in water consumption and allergens. Artificial turf may require occasional cleaning with water to remove dust and debris. This consumption is minimal compared to the needs of natural grass. Water is used on artificial turf athletic fields to cool the surface and provide traction before games. However, this would be unnecessary for landscaping purposes. Artificial turf also reduces allergens such as pollen in the environment. Crumb rubber from recycled tires often provides a sublayer for the artificial turf which makes the surface of the turf softer. Concerns have been raised about the irritation to latex allergy suffers due to the crumb rubber infill used in some artificial turf installations. However, levels of latex in tires are much lower than in latex gloves and other consumer products. To date no study has confirmed an issue of latex allergens released from artificial turf.[7]

Scientific studies are in disagreement over the potential for environmental harm from artificial turf. A CDC report identified lead dust on decaying old artificial turf

[6] Synthetic Turf Council, http://www.syntheticturfcouncil.org/.
[7] *See, e.g.*, Evaluation of the Environmental Effects of Synthetic Turf Athletic Fields, Milone & MacBroom, December 2008.

fields as a potential health issue.[8] While old artificial turf may contain high lead content, the grass produced today must meet strict lead standards.[9] The industry has done this in part by utilizing organic pigments. The Synthetic Turf Council has agreed to further restrict lead content by complying with stringent lead standards proposed for children's products.[10] In 2008, the Consumer Product Safety Commission released a report that concluded that young children are not at risk of lead exposure from artificial turf in athletic fields.[11] In addition, an EPA study found that lead from recycled tires was not a concern in artificial athletic fields and playgrounds.[12]

Other potential issues including zinc continue to be studied. The EPA found levels in of zinc in the air and surface to be below levels considered harmful at athletic fields and playgrounds using recycled tires.[13] A 2008 study found levels of zinc in stormwater collected from artificial athletic field drainage systems to be below the Connecticut water quality standard.[14] Other chemicals such as lead, selenium and cadium were not detected in the drainage.[15] While some studies have found elevated zinc levels, risk to humans is minimal as most zinc is absorbed into soil and does not dissolve in water.[16] In addition, zinc is not very toxic to humans so the danger is mostly to aquatic

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[8] Artificial Turf, Centers for Disease Control and Prevention, http://www.cdc.gov/nceh/lead/tips/artificialturf.htm

[9] Good News about Lead Problems in Artificial Turf, Center for Environmental Health, Fall 2010 Newsletter, http://www.ceh.org/component/content/article/454.

[10] STC's Voluntary Commitment, Synthetic Turf Council, http://www.syntheticturfcouncil.org.

[11] CPSC Staff Finds Synthetic Turf Fields OK to Install, OK to Play On, News from CPSC, U.S. Consumer Product Safety Commission, July 30, 2008.

[12] Limited EPA Study Finds Low Level of Concern in Samples of Recycled Tires from Ballfield and Playground Surfaces, United States Environmental Protection Agency, December 10, 2009.

[13] Limited EPA Study Finds Low Level of Concern in Samples of Recycled Tires from Ballfield and Playground Surfaces, United States Environmental Protection Agency, December 10, 2009.

[14] Evaluation of the Environmental Effects of Synthetic Turf Athletic Fields, Milone & MacBroom, December 2008.

[15] Id.

[16] Artificial Turf Field Investigation in Connecticut, Final Report, University of Connecticut Health Center, Section of Occupational and Environmental Medicine, 21 July 27, 2010.

and plant life. The California Environmental Protection Agency released a report based on two New York studies of air quality showing that exposure was "unlikely to produce adverse health effects in persons using these fields."[17] "Extensive research has pointed to the conclusion that these fields result in little, if any, exposure to toxic substances."[18]

Some studies have indicated concern with elevated temperature on artificial athletic field surfaces. The surface temperature of the synthetic grass blades has been recorded upwards of 150 degrees on sunny days. However, in temperatures recorded at 5 feet above the surface is dramatically lower and in some cases shows little difference in temperature.[19] Also, athletic fields consist of a large expanse of unshaded open space. Landscaping includes smaller patches of artificial grass shaded by trees and buildings which will reduce temperatures.

**Summary**

Other cities have found artificial turf to be a beneficial part of their landscape encouraging it with rebates and laws and using it in city parks and building landscaping. California even passed a law banning Home Owner's Associations from prohibiting the use of artificial turf in landscaping.[20] It was recently vetoed by the governor who said the

[17] Chemicals and particulates in the air above the new generation of artificial turf playing fields, and artificial turf as a risk factor for infection by methicillin-resistant Staphgylococcus areus (MRSA) Literature review and data gap idenfication, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, July 2009.
[18] Review of the Impacts of Crumb Rubber in Artificial Turf Applications, Rachel Simon, University of California, Berkeley, Laboratory for Manufacturing and Sustainability, College of Engineering & Manex Consulting, February 2010.
[19] Evaluation of the Environmental Effects of Synthetic Turf Athletic Fields, Milone & MacBroom, December 2008.
[20] *See* Cal. S.B. 759 (2011).

decision was better left up to the associations.[21] New York Parks and California utilities have taken advantage of the benefits of artificial grass.

Use of artificial grass may provide a sustainable alternative to natural grass in landscaping in Lawrence. Artificial turf reduces water use, pesticides, herbicides, emissions, grass clipping waste. Lead use has been dramatically reduced through industry efforts such as using organic pigmentation. There does not appear to be a clear threat to human health through release of zinc or other chemicals though studies continue. In addition, artificial turf can provide an attractive look as it is used for upscale homes, building landscaping, and even Disney World.

**Recommendation**

In a study session to which USD #497 officials who have installed and used artificial turf athletic fields would be invited, Lawrence can better determine whether to permit artificial turf use in landscaping as most other communities have and as the local school district has chosen for children to play on.

[21] Jerry Brown vetoes artificial turf bill backed by conservationists, Capitol Alert, The Sacramento Bee, July 15, 2011.

| State | Community | Artificial Turf Allowed? | Requests to Use Artificial Turf? |
|---|---|---|---|
| **Arizona** | Buckeye | Permitted wherever grass allowed | |
| | Surprise | Permitted, protected | |
| **California** | Beverly Hills | Silent but permitted in places | |
| | Fullerton | Permitted, regulated * | |
| | Garden Grove | Permitted, regulated * | |
| | Glendale | Permitted, regulated | |
| | La Palma | Permitted, regulated * | |
| | Laguna Hills | Permitted, regulated * | |
| | Orange | Permitted, regulated * | |
| | Santa Ana | Permitted, regulated* | |
| | Santa Cruz | Silent but permitted | |
| | Stanton | Permitted, regulated * | |
| **Colorado** | Englewood | Permits, 70% live plants * | |
| | Ft. Collins | Silent | |
| | Greeley | Silent | |
| **Florida** | Clearwater | Directed staff to revise ordinance to allow 7/23/11 | |
| | Punta Gorda | Permitted as special exception | |
| **Kansas** | Fairway | Silent | No requests |
| | Greensburg | Silent but permitted | No requests |
| | Hays | Silent | |
| | Johnson County | Silent | |
| | Kansas City | Silent | No requests |
| | Leavenworth | Silent | |
| | Leawood | Silent | No requests |
| | Manhattan | Silent | No requests |
| | Mission | Silent | |
| | Mission Hills | Silent | One request, approved for backyard putting green |
| | Olathe | Silent | No requests |
| | Overland Park | Silent, "nothing preventing" | No requests |
| | Prairie Village | Silent | |
| | Roeland Park | Silent | |
| | Salina | Silent | One request, denied because didn't meet live plant minimum |
| | Shawnee | Silent | |
| | Topeka | Silent | No requests |
| **Nebraska** | Omaha | Silent | |
| **Texas** | Austin | Silent | |
| | El Paso | Permitted with alternate compliance | |

* See staff report for ordinance language

**City Ordinance Language on Artificial Turf**

**Surprise, AZ**

Sec. 58-596. - Artificial or synthetic turf.
Any person(s) or association(s) is prohibited from imposing private covenants, conditions, restrictions, deed clauses or other agreements between the parties, which prevents person(s) from utilizing artificial or synthetic turf as an alternative to any landscape. Artificial or synthetic turf shall be allowed on all surfaces where landscape can be applied.

**Glendale, CA**

30.31.010 – Regulations for the ROS, R1 and RIR Zones. The following regulations shall apply in the ROS, R1R and R1 zones. A. All street setback areas shall be landscaped with plant materials or a combination of plant materials and permeable surfaces and shall be permanently maintained in a neat and orderly manner. Nonliving materials may be used as ground cover including but not limited to: wood chips, bark, decorative rock, and stone. Plant materials shall compose a majority (more than 50%) of the street setback areas, exclusive of permitted driveways. Other than permitted hardscape, all areas not planted shall be covered (top dressed) with materials such as wood chips or approved alternative. Top dressing beneath tree canopies shall be to the satisfaction of the Director of Planning, and shall be calculated as area of live plant material. Permeable surface allows the movement of water through the surface material and include materials such as pavers, decomposed granite or grasscrete. Permeable surfaces are encouraged wherever possible in lieu of impermeable hardscape.

B. In the ROS and R1R zones artificial turf shall not be permitted. C. In the R1 zone, artificial turf may be used when not visible from the public street immediately adjacent to the property. Artificial turf shall be calculated toward the total lot area requirement for landscaping, but shall not be calculated toward the live plant material requirement. Additionally, artificial turf shall not be permitted beneath tree canopies. D. A minimum of forty (40) percent of the total lot area shall be permanently landscaped open space. Decorative design elements such as swimming pools, spas, fountains, sculptures, planters, rock gardens or other similar elements may be permitted where they are integral parts of a landscape plan composed of a majority (more than 50%) of live plant materials. Neither the interior nor the street setback areas shall be completely paved or covered with gravel. Any live plant material or permeable surface located in a required driveway shall not count toward required landscaping.

30.31.020 –Regulations for all Multi-family, Commercial, Industrial, and Mixed Use Zones, the CE Zone and the PS Overlay Zone A. The following regulations shall apply in the R-3050, R-2250, R-1650, R-1250, C1, C2, C3, CPD, CR, IND, IMU-R, SFMU and CE zones, and the PS Overlay Zone 6. Artificial Turf. Artificial turf shall not be used when visible from the public street immediately adjacent to the property.

**Greeley, CO**

18.44.070 General landscape standards for all properties (k) Required landscaping. (1) At least fifty percent (50%) of any required yard, excluding driveway and walkway to the front door, shall contain live plantings. (2) At least fifty percent (50%) of any parkway or right-of-way planting area, excluding driveways and public sidewalks, shall contain live plantings. (3) All yards not covered by an approved building, driveway, walkway or other permanent structure shall be landscaped. (4) Areas visible from a public right-of-way or adjacent property are required to be landscaped in accord with the provisions of this Chapter. Yards not visible from the right-of-way or adjacent property must be kept free from weeds and shall not be bare dirt.

Landscape area shall mean the area of required open space, according to the zoning district provisions in which the property is located, that is not allowed to be covered by buildings, paving or other impervious surface, whether within a lot, outlot or tract or within a public right-of-way, and shall not include any legally established area for storage or outdoor display.

Definitions of lawn and turf expressly do not include artificial turf.

**Ft. Collins, CO**

3.2.1 Landscaping and Tree Protection (2) Landscape Area Treatment. Landscape areas shall include all areas on the site that are not covered by buildings, structures, paving or impervious surface. Landscape areas shall consist only of landscaping. The selection and location of turf, ground cover (including shrubs, grasses, perennials, flowerbeds and slope retention), and pedestrian paving and other landscaping elements shall be used to prevent erosion and meet the functional and visual purposes such as defining spaces, accommodating and directing circulation patterns, managing visibility, attracting attention to building entrances and other focal points, and visually integrating buildings with the landscape area and with each other.

Landscaping shall mean any combination of living plants such as trees, shrubs, plants, vegetative ground cover or turf grasses, and may include structural features such as walkways, fences, benches, works of art, reflective pools, fountains or the like. Landscaping shall also include irrigation systems, mulches, topsoil use, soil preparation, revegetation or the preservation, protection and replacement of existing trees.

*Note: Pushes xeriscape, notes that xeriscape does not include artificial turf.

**Punta Gorda, FL**

The use of artificial turf may be considered by application for a Special Exception pursuant to Chapter 26, Section 16.8, as an alternative to grass and ground cover.

(1) The application for the Special Exception to allow the use of artificial turf must include the following information:

a. Two copies of a detailed, signed and sealed site survey of the property that is less than one year old that indicates the location of existing trees and shrubs and all other improvements on the property.

b. Two copies of the landscape plot plan indicating the proposed location of the artificial turf and other landscape materials. Setbacks to the seawall will be required to be shown for any trees, large shrubs, curbing, areas of rock beds or boulder type landscape material that is planned. All landscape plans must meet minimum standards as denoted in this Article.

c. If the property is zoned commercial or multi-family, a copy of an approved Southwest Florida Water Management District Permit shall be included in the permit application.

d. Evidence that the artificial turf proposed will have a minimum tufted weight of 56 ounces per square foot, be a natural green in color, and have a minimum 8 year warranty. A sample of the turf proposed that meets these standards shall be submitted with the Special Exception application including a copy of the manufacturers' specifications and warranty information.

e. Evidence that all artificial turf installations will have a minimum permeability of 30 inches per hour per square yard and provide anchoring information as to the size and location of anchors to ensure the turf will withstand the effects of wind.

f. Consideration of the percentage of living plant materials versus percentage of artificial turf proposed for any property shall be part of the review process. Evidence that living plant material will be drought tolerant and consist of 50 percent Florida native species including shrubs, vines, trees and ground covers.

(2) Any Special Exception granted to allow artificial turf shall include the following conditions:

a. Precautions for installation around existing trees shall be monitored and may be restricted to ensure tree roots are not damaged with the installation of the base material.

b. Rubber, sand and any other weighting or infill material is prohibited.

c. If artificial turf is planned to be installed next to the seawall, the artificial turf shall be pinned or staked behind the seawall. Nothing shall be attached directly to or placed on the seawall or seawall cap.

d. A copy of the Special Exception and conditions thereof shall be recorded in the Public Records of Charlotte County so that any subsequent purchaser will be on notice regarding the special rules relating to the artificial turf.

e. A landscape inspection shall be conducted after the installation of the artificial turf to ensure all living plant materials conform to the provided landscape plot plan and meet the drought tolerant and native species requirements.

f. If artificial turf is to be installed in the City right-of-way, a separate right-of-way permit must be obtained prior to commencing work.

g. Artificial turf shall be maintained in a green fadeless condition and shall be maintained free of dirt, mud, stains, weeds, debris, tears, holes and impressions, as determined by Code Compliance. All edges of the artificial turf shall not be loose and must be maintained with appropriate edging or stakes.

h. Artificial turf must be replaced if it falls into disrepair with fading or holes or loose areas, as determined by Code Compliance. Replacement shall be completed within 60 days of notification by Code Compliance.

i. If maintenance is required on the City right-of-way, or utility easement, it shall be the responsibility of the property owner to remove, replace and repair, at the owner's expense, any artificial turf that has been placed in the right-of-way or utility easement within 60 days.

j. If maintenance is required on the seawall and/or seawall cap, it shall be the responsibility of the property owner to remove, replace and repair, at the owner's expense, any artificial turf that has been placed in the rear yard of the property abutting the seawall within 60 days.

k. The City of Punta Gorda shall not be held liable for any damage to any artificial turf or other items placed within the right-or-way, within six feet of the seawall or within any area covering City utilities.

**Fairway, KS**

15-4-3.204 Required Landscape Material A. General Requirements. All land areas which are to be unpaved or not covered by buildings, parking areas, or other structures shall be brought to finished grade and planted with turf or native grass or other appropriate ground cover. In addition to the minimum number of trees required to be planted by this Part, an appropriate number or amount of shrubs, ground cover and/or turf area plantings shall be included in each project, to be determined by the design criteria for the project relating to visual safety, species and landscape function. When business uses are adjacent to residential property, the minimum tree and planting requirements shall be planted within the ten (10) feet of the setback area immediately adjacent to the residential property.

**Greensburg, KS**

7.4 Sustainable Landscaping A.Sustainable landscaping is encouraged. Raingardens, landscaped detention facilities, bio-swales, xeriscaping, and other such features (installed with Best Management Practices) may replace the detailed requirements. B.In all instances, stormwater runoff shall be directed from parking areas to landscaped areas (see Article 6, Low Impact Development). C.Suitable ground cover in landscape areas includes pervious materials such as larger rock, mulch, and the like.

From: Christy Pyatt [mailto:bldgclerk@greensburgks.org]
Sent: Friday, August 05, 2011 3:57 PM
To: Law Clerk 2
Subject: RE: Land Development Code

I checked with our zoning advisor. Artificial turf would be permitted as landscaping in Greensburg.

Christy Pyatt
City of Greensburg
Building Clerk
Municipal Court Clerk

**Hays, KS**

Sec. 71-1180. Other landscape standards. The following additional landscape standards shall also apply: (4) Required landscaped area shall consist of a minimum of 60 percent in ground surface covered by living plant materials or turf grass. The remaining 40 percent may be covered with bark, wood chips, rock, brick, stone or other similar nonliving materials; provided that an effective weed barrier is installed. (5) All land area not covered by landscaping, paved parking, drives and walkways, and structures shall be seeded with perennial grass and regularly mowed and maintained in a proper appearance.

**Johnson County, KS**

Section 3. DEFINITIONS OF BASIC TERMS: "Landscaping" The bringing of the soil surface to a smooth finished grade, installing trees, shrubs, ground cover or mulch of decorative stone or wood chips or similar materials to soften building lines, provide shade and generally enhance the appearance of the premises and produce an aesthetically pleasing effect

**Kansas City, KS**

Division 10 Landscape and Screening Sec. 27-696. - Definitions. Ground cover means landscape materials or living, or low-growing plants other than turf grass, installed in such a manner so as to provide a continuous cover on the ground surface.
Landscape materials means living plants, such as trees, shrubs, vines, ground cover, flowers and grass turf. It may include such nonliving features as stone, sand, bark and brick pavers (excluding pavement), and structural or decorative features such as fountains, pools, earthen berms or mounds, walls, fencing, benches, lighting, etc.
Sec. 27-699. - General requirements and guidelines.
(a) Landscaping. (1)The area between the curb of a public street and the property line shall be brought to finish grade and planted in grass. In no case may this area be paved or covered with materials other than grass or an appropriate ground cover, except at approved driveways that shall be paved. Approved street trees may also be planted.
(2) All areas not covered by buildings, paved area, or other acceptably improved areas shall be landscaped with such landscaping continuously maintained.

**Leavenworth, KS**

ArticleVIII. LANDSCAPINGANDSCREENING Section 8.04 Required Landscaping 1. Required Landscaping: A 20 - foot strip of landscaping shall be provided along the perimeter property line of all multifamily, commercial, and industrial development sites except for approved points of pedestrian or
vehicle access. Site perimeter landscaping shall be planted pursuant to the requirements for a 20 - foot buffer. ArticleXVIII. DEFINITION Landscape Material: Living material such as trees, shrubs, ground cover/vines, turf grasses, and non - living
material such as: rocks, pebbles, sand, bark, brick pavers, earthen mounds (excluding pavement), and/or other items of a decorative or embellishment nature such as fountains, pools, walls, fencing, sculpture, etc

**Leawood, KS**

16-4-7.3 Landscaping Requirements-Other Districts 6. Landscaped open space shall consist of a minimum of 60% living materials, the remaining areas may consist of non-living materials such as bark, wood chips, decorative rock or stone or other similar materials.

16-4-7.4 Installation and Maintenance of Landscaping and Screening
Lawn grass shall be maintained on all areas not covered by other landscaping, parking, drives, buildings, or similar structures. Existing yards shall be maintained with grass or other approved ground cover.

**Manhattan, KS**

ARTICLE IV DISTRICT REGULATIONS 4-112. M-FRO. Multi-Family Redevelopment Overlay District
(F) Compatibility Standards (1) Site Design Standards. (f)Building and Foundation Landscaping: Building and foundation
plantings, consisting of shrubs and bushes, shall be provided to accent and enhance residential buildings, and to soften the appearance of street-facing walls and/or fences. (g) Green Space: A minimum of fifteen (15) percent of the site shall
be maintained as green space, consisting of lawns and other living plant materials. In addition to lawns, front yard areas along streets shall include a minimum of one (1) shade tree of two and one-half (2 1/2) caliper size for every fifty (50) feet of street frontage.

**Mission, KS**

SECTION 405.020: DEFINITIONS GROUND COVER: Landscaping materials or living low-growing plant, other than turf grass, installed in such a manner so as to form a continuous cover over the ground surface. LANDSCAPE MATERIAL: Consists of such living material as trees, shrubs, ground cover/vines, turf grasses and non-living material such as rocks, pebbles, sand, bark, brick pavers, earthen mounds (excluding pavement) and/or other items of a decorative or embellishment nature such as fountains, pools, walls, fencing, sculpture, etc. SECTION 415.060: GENERAL CONDITIONS AND PLAN REQUIREMENTS In addition to the minimum number of trees to be planted as set forth in Section 415.090, the appropriate number or amounts of shrubs, ground cover and/or turf area plantings that shall be included within each project shall be determined by the design criteria within each project as established by the City Planning Commission as they relate to visual safety, species used and landscape function.

**Mission Hills, KS**

5-149 Powers. The ARB [Architectural Review Board] may within its power approve or deny a building permit application and in approving an application may attach such requirements and conditions as it deems appropriate under the circumstances, including but not limited to: G. Landscaping requirements which may include requiring new trees, shrubs, or other landscaping or replacing existing trees, shrubs or other landscaping.

**Olathe, KS**

18.62.020 General Requirements and Interpretations All land areas as approved by a final site development plan and issued a building permit, which are not to be paved or covered by buildings shall be brought to finished grade and planted with turf, native grasses, or other appropriate ground covers.

18.06.290 "Ground cover" means landscape materials, or living low-growing plants other than turf grass, installed in such a manner so as to form a continuous cover over the ground surface.

**Overland Park, KS**

18.110.290 Ground cover "Ground cover" means landscape materials, or living low-growing plants other than turf grass, installed in such a manner so as to form a continuous cover over the ground surface.
18.110.345 Landscape material "Landscape material" means such living materials as trees, shrubs, ground cover, vines, turf grasses, and non-living materials such as rocks, pebbles, sand, bark, brick pavers, earthen mounds (excluding pavement), and other items of a decorative or embellishment nature such as fountains, pools, walls, fencing, sculpture, etc.
18.450.030 General requirements All land areas which are to be unpaved or not covered by buildings shall be brought to finished grade and planted with turf or native grass or other appropriate ground cover. In addition to the minimum number of trees required to be planted by this Chapter, an appropriate number or amount of shrubs, ground cover and/or turf area plantings shall be included within each project, to be determined by the design criteria for the project relating to visual safety, species and landscape function.

Per Mark in Planning & Development Department, there is "nothing preventing" artificial turf use in the Code.

**Prairie Village, KS**

Sec. 27-696. - Definitions Ground cover means landscape materials or living, or low-growing plants other than turf grass, installed in such a manner so as to provide a continuous cover on the ground surface.
Landscape materials means living plants, such as trees, shrubs, vines, ground cover, flowers and grass turf. It may include such nonliving features as stone, sand, bark and brick pavers (excluding pavement), and structural or decorative features such as fountains, pools, earthen berms or mounds, walls, fencing, benches, lighting, etc.

**Roeland Park, KS**

ARTICLE 10. LANDSCAPING AND SCREENING 16-1003. GENERAL REQUIREMENTS. All land areas which are too be unpaved or not covered by buildings shall be brought to finish grade and planted with turf or native grass or other appropriate ground cover. In addition to the minimum number of trees required to be planted by this Chapter, appropriate number or amount of shrubs, ground cover and/or turf each plantings shall be included within each project, to be determined by the design criteria for the project relating to visual safety, species and landscape function.

**Salina, KS**

(3) Definitions. For the purpose of this section, the following words and terms as used herein are defined to mean the following: a. Landscape material: Shall consist of such living material as trees, shrubs, ground cover/vines, turf grasses, and nonliving material such as: rocks, pebbles, sand, bark, brick pavers, earthen mounds (excluding pavement), and/or other items of a decorative or embellishment nature such as: fountains, pools, walls, fencing, sculpture, etc. e. Ground cover: Landscape materials, or living low-growing plants other than agricultural crops and turf grass, installed in such a manner so as to form a continuous cover over the ground surface.

(5) Required landscaping for front yards c. The following design standards shall apply to required landscaping and trees in front yards: Shrubs, ground cover and other landscape plantings shall be selected from the Recommended Xeriscape Plant List for Salina. Comparable plantings may also be selected with the approval and consent of the City Forester and the Zoning Administrator, if the proposed plantings are demonstrated to meet the City of Salina's objective of providing attractive landscapes with minimal water usage. (8) Other landscape standards. The following additional landscape standards shall also apply: d. Required landscaped area shall consist of a minimum of sixty (60) percent in ground surface covered by living plant materials from the Recommended Xeriscape Plant List for Salina turf grass. The remaining forty (40) percent may be covered with bark, wood chips, rock, bricks, stone or similar nonliving materials provided an effective weed barrier is installed. e. All land area not covered by landscaping, paved parking, drives and walkways, and structures shall be seeded with warm sea

**Shawnee, KS**

17.57.015 Definitions. C. "Ground cover" shall mean landscape materials, or living low-growing plants other than turf grass, that is installed in such a manner so as to form a continuous cover over the ground surface.
E. "Landscape material" shall mean living plants such as trees, shrubs, ground cover/vines, and turf grasses; and nonliving material such as: rocks, pebbles, sand, bark, mulch, edging, brick pavers, earthen mounds (excluding pavement); and/or other items of a decorative or embellishment nature such as: fountains, benches, pools, walls, fencing, sculpture, geo-block drives, etc. 17.57.020 General Conditions.A. A landscape plan shall be submitted in support of a site plan, preliminary development plan for commercial, office, institutional, and multi-family residential developments, or and preliminary plats or final plats when a preliminary plat is not required, for single family residential subdivisions with tracts and/or lots abutting designated major streets for substantial new construction. All land areas which are not to be paved or covered by buildings shall be brought to finished grade and planted with turf or native grass or otl

**Omaha, NE**

Sec. 55-714. - Definitions. b) Landscaped area: That area within the boundaries of a given lot consisting primarily of plant material, including but not limited to grass, trees, shrubs, flowers, vines, groundcover, and other organic plant materials; or grass paver masonry units installed such that the appearance of the area is primarily landscaped. Inorganic materials such as brick, stone or aggregate may be used within landscaped areas, provided that such material comprises no more than 35 percent of the area of the required landscaped area. Flat concrete or asphalt, other than walkways five feet or less in width, may not be used within a required landscaped area.

**Topeka, KS**

Chapter 18.235 LANDSCAPE REQUIREMENTS 18.235.120 Size and quality requirements. (d) Grass shall be planted in such a manner as to completely cover all exposed soil after one full growing season. (e) No bare ground shall be left exposed. Grass or other groundcover or mulch, such as pine straw or tree bark, shall cover all bare ground.

**Austin, TX**

§ 25-2-1003 GENERAL REQUIREMENTS. (A) In this article, landscape yard means the area of a lot between the street right-of-way and a line that coincides with the front wall of the building and extends from the building corners to the side property lines. (B) At least 20 percent of the area of the landscape yard of a lot must be landscaped area. (D) A required landscaped area may include planters, brick, stone, natural forms, water forms, aggregate, and other landscape features, if inorganic materials do not predominate over the plants. Smooth concrete or asphalt may not be included in a required landscaped area.

**El Paso, TX**

18.46.140 - Alternative compliance. Artificial turf with a permeable base used in parkways and narrow areas 33' or less in any dimension, including all areas of the parkway.

Rusty Abell

Member - Partner
Director – Field Operations / Technical Advisor

Educational Background:

Texas Tech University, Lubbock, Texas. Chemistry

Professional Experience:

Directs the field operations and oversees numerous project superintendents on various athletic facility construction sites, both designed by us as well as others. Also serves as Technical Advisor for Sports Turf Design, Construction, Manufacture, Installation and Sports Field Functions. Has a strong background in the artificial turf and synthetic grass industry in turf manufacturing, development, and state of the art installation techniques of the various turf systems. Also has unmatched experience in the development of new millenium technologies for a variety of shock layer systems, field drainage systems, vertical to horizontal drainage applications, engineered rock base profiles, track and field layout and construction, as well as synthetic turf field design and installation for a variety of sport preferences. Also has a vast knowledge of turf maintenance, testing, repair, removal and total replacement. Has thirty-seven years of self employed experience in all facets of sports facilities construction, as a contractor, a technical consultant and an expert with turf life and usage applications.

Additional Professional Experience:

- Sport Rec Recreational Surfaces, Lubbock, Texas. Self employed 1974 thru present.
- DMA Sports Design Group, LLC. Member-Partner
- ISA – Sport USA Partner
  FIFA Certified field testing, analysis
- NFL – National Football League Certified testing and field analysis
- DMA Sports – Sturbridge, MA
  1999 – present
  Technical Advisor
  Construction Management
- Sprinturf, Inc. – Wayne, PA
  2002 - 2004
  Technical Advisor
  Project Manager

- Quest Sports - Muncie, IN — Technical Consultant
  2000 - 2002 — Technical Advisor

- Valley Crest Sports – Calabasas, CA. — National Manager- Sports Turf Division
  1996 – 1999 — Technical Advisor – Sports Turf

- Sportfield, Inc. – Dallas, TX — Technical Consultant
  1996 – 2001 — Project Manager

- U.S. Indoor Golf, Inc. – San Francisco,. — Director and Advisory Board
  1986 – present — Member

- Tour True Turf Technologies – San Francisco — Technical Consultant
  1986 – present

Professional Associations:

- Sports Turf Managers Association, 1997, 1998, 2009,2010,2011
- National Golf Foundation – Technical Advisor
- United Sates Tennis Court and Track Builders Association (USTC&TBA)
  Board of Directors - 9 years
  President – Track Division - 2 terms
  Chairman – Track Book Committee
  Track Construction Manual – Volume I & II, Co-author
  Chairman – Ethics Committee
  Chairman – Field Events Construction Committee
  Chairman – Awards Committee
  - Speaker – "One on One Conference with Experts in Sports Complex Construction" for Tennis Industry Magazine at the Atlanta Super Show.
- STC (Synthetic Turf Council)
- STA (Synthetic Turf Association)
- ASGI (Association of Synthetic Grass Installers)
  Board of Directors
- National Football League – Turf Consultant and field performance testing

Awards:

- Track of the Year (1988) USTC&TBA
- Distinguished Service Award (1987, 1989, 1990, 1991) USTC&TBA
- Grand Masters Award for Marketing and Achievement – PGA

Inventor / Manufacturer:

- Tour True Turf Technology

- Tour True adjustable golf cup replacement system
- Tour True Turf installation processes
- Tour True hydraulic undulation process
- Non compactable base and top dress systems for synthetic grass turf infill

Co-Inventor:

- "Jog Fog" – Presidential jogging track surface system
- Presidential HRX – Resilient tennis court surface system
- Dynamic Base – Synthetic simulated root zone shock absorption system
- Co-developer – NFL strategic field testing concept

Technical Consultant / Installer – (brief high profile list)

- National Football League – Turf Consultant
- The White House – Complete new tennis facility – Bush 41 Administration
- The White House – Truman Balcony, re-floor – Bush 41 Administration
- The White House – Horseshoe Landing Areas – Bush 41 Administration
- The White House – Construct new dedicated basketball court – Bush 41 Administration
- The White House – Construct Presidential golf green – Bush 41 Administration
- The White House – Presidential Situation Room Ceiling, re-floor – Clinton Administration
- The White House – Presidential jogging track, design-construction – Clinton Administration
- The White House – Presidential tennis court resurfacing – Clinton/Bush 43 transition
- The White House – Truman Balcony – resurface – Obama Administration
- Texas Stadium Corporation – Maintenance-technical advisor (1994-2003)
- Texas Stadium Corporation – New football field – design, install, technical advisor
- University of Colorado – Four new football fields – SportGrass
- Arizona State University – New artificial turf football
- PacBell Ballpark – New Baseball stadium (S.F.)
- Tennessee Titans – New football practice fields
- Southern Methodist University – New football stadium, SportGrass
- Seattle Seahawks – New football stadium
- Tarleton State University – Football
- University of California Monterey Bay – Baseball/softball fields
- City of Moreno Valley, CA – 320,000 sq. ft. synthetic turf soccer complex
- City of Los Angeles, CA – Synthetic turf soccer fields
- West LA College – New synthetic football/soccer field
- William Jewell College – New football stadium
- Monterrey, Mexico – New professional baseball stadium – synthetic grass
- London, England – New professional soccer/rugby complex – synthetic grass
- Titleist Golf Corporation – Research Center, Tour True
- Callaway Golf Corporation – Research Center, Tour True
- Ely Callaway – residence, Tour True

- Mt. Fugi, Japan – Mt. Fugi Golf Club, Tour True
- Chelsea Piers Golf Complex – Pier 59, Manhattan Island, NY., Tour True
- Coors Beer Family – residence, Tour True
- Tom Smothers Family – residence, Tour True
- Jack Nicholson Family – residence, Tour True
- Paul Azinger – PGA professional, Tour True
- Steve Elkington – PGA professional, Tour True
- Steve Pate – PGA professional, Tour True
- Larry Mize – PGA professional, Tour True
- Asao Aoki – PGA professional, Tour True
- Hank Haney – PGA professional, Hank Haney Golf Ranch, Tour True
- Michael Jordon – NBA professional, Tour True

And Numerous Others

# Joseph W. DiGeronimo

**DMA/DiGeronimo-Mikula Associates, LLC**
PO Box 524
Sturbridge, Massachusetts 01566
Tel: (508) 347-5184
Fax: (508) 347-5911


**MAIN OFFICE:**

DI GERONIMO ASSOCIATES, LTD.
Sturbridge, MA

**PROFESSIONAL CERTIFICATION**

International Synthetic Turf Council (STC)
2004-Present STC – Certified Independent Professional
Association of Synthetic Grass Installers (ASGi)
United States Tennis Court and Track Builders Association:
1979-1993 C.T.C.B. - Certified Tennis Court Builder
1981-1993 C.T.B. - Certified Track Builder

**EDUCATION**

University of Detroit
Civil Engineering, 1970-1973

St. Peter's College, NJ
Pre-Engineering Science, 1969-1970

Wm. L. Dickinson High School, 1968
Jersey City, NJ

**APPOINTMENTS**

Certified, Synthetic Turf Council, 2004-2010
Certified Instructor, Association of Synthetic Grass Installers (ASGI) 2009-Present
Chairman, U.S. Tennis Court and Track Builders Assoc., 1987-1990.
Chairman, Technical Committee and Specs, USTC&TBA, 1979-1989.
Technical Consultant/Director, USTC&TBA, 1984-1987.
Member, U.S. Tennis Association Facilities Committee, 1984-1987.
Technical Director, International Association of Sport Surface Sciences (I.S.S.S.), 1985-1989.
Consultant for Tennis and Golf Facilities at The White House (Bush Adm.)
Consultant for Tennis Facility at Camp David (Bush Adm.)
1996 Altanta Olympics - Design and Consultant for Synthetic Turf Field Hockey and Tracks
Consultant for Jogging Track at The White House (Clinton Adm.)
Speaker for the National Golf Foundation Seminars
Board of Directors - Jeremy Worrell Foundation (2006-Present)
ASTM F08 Subcommittee on Bat Speed

**MEMBERSHIPS**

Inrternational Synthetic Turf Council (STC), Mr. Richard Doyle III
Association of Synthetic Grass Installers (ASGI), Ms. Ann Costa, Pres.
United States Tennis Association (USTA). Reference: Miles DuMont
International Assoc. for Sport Surface Science (ISSS).
American Standards of Testing Materials (ASTM).
Construction Specification Institute (CSI).
United States Athletic Facilities Council (USAFC).
U.S. Tennis Court and Track Builders Association (USTC&TBA).
National Golf Foundation (NGF). Reference: Angelo Pularmo, Exec. V.P.
National Football Foundation/College Hall of Fame
Vince Lombardi Foundation
Jeremy Worrell Foundation

## PUBLICATIONS

Author of First Edition - Track Construction Manual for USTC&TBA and NFSHSA.
Contributor to Second Edition - Track Construction Manual for USTC&TBA
Author of Standard 400 Meter Track Layout for NFSHSA
Guideline Specifications for the Construction of Tennis
Courts and Running Tracks for USTC&TBA
Tennis Industry Magazine:
- "Bird Baths"
- "A Moment with Joe DiGeronimo""The President's Court"
- "Tennis Construction of the '90's"
- " Underground Watering for Soft Courts"

Athletic Business Magazine:
- "The Do's and Don't's of Athletic Facility Construction
- "What's in a Surface"
- "Everything You Wanted to Know About Tennis Surfaces"
- "Tennis Court Construction of the 90's"
- "How to Choose a Track System"
- "Synthetic Surfaces for Tennis"

National Parks Maintenance Magazine:
- "Winterizing Your Tennis Courts"
- "A Court Fit for a President"

Guideline Specifications for Track and Tennis Courts for USTC&TBA and USTA.

## PATENTS

May 1996 - Registered Inventor U.S. Patent received for Rubber/Polyurethane Shock Pad System (Elastic Layer).
June 2001 - Synthetic Turf designed combination fibers

## PROFESSIONAL EXPERIENCE

DMA/DI GERONIMO ASSOCIATES, LTD.
Sturbridge, MA - June 1975 to Present

Established independent office for Athletic Facility Design. Solely responsible for the design and development of plans and specifications for natural and synthetic sports surfaces.

D.A. has grown to a reputation of national recognition and is presently the leading consulting firm involved in more than 5 million square feet per year of sports surface construction.

I have designed or constructed over 900 tracks, 9,000 tennis courts and 300 natural turf football fields and 250 artificial turf fields nationally from 1973 to Present.

DI GERONIMO ASSOCIATES, LTD./Sturbridge, MA performs duties in engineering consultation, construction project management, and provides services for forensic engineering and expert witness testimony for litigation in the athletic construction industry. This office was retained by Presidential Sports Systems of Lubbock, Texas to design the track and artificial turf systems for the 1996 Olympics. This work was completed in August 1995.

**Special Assignments during this period:**

* 1983 to 1987 Establish Balsam in the US and research turf and track market.

* 1990 to 1994 Establish Martin Surfacing in the turf market. In charge of turf construction projects.

* 1989 to 1998 Remain as the sports facilities contractor for the White House. Work performed for President Bush and Clinton directly. Construction included a specially designed surface for tennis, synthetic golf green and jogging track on the south grounds.

* 1990 to 1998 Consulted with U.S. Indoor Golf on synthetic golf greens. Work included the design of the shock pad and turf system for Michael Jordan, Tom Smothers, Coors Beer Family, Chelsea Pier Golf Center (NYC), Callaway Golf Center and Titliest Research Center. In addition, was on site advisor at Mt. Fuji Country Club, Japan.

* 1996-1997 completed a consulting contract with the Sportfield and United States Sports Technology Group in Dallas, Texas. They were completing plans for the rehabilitation of the Texas Stadium artificial turf, home of the Dallas Cowboys.

- 1996-1999: Consulting for FieldTurf, synthetic grass systems. Projects included Ringgold H.S., PA, St. Benedict's soccer field, Chelsea Pier NYC soccer, Bergen Catholic H.S. football field.

ARCHITECTS DI GERONIMO, P.A.
Southfield, MI & Paramus, NJ - September 1979 to June 1986

Principal partner in charge of civil construction projects for the firm. Responsible for sports facility design for national program for the design of specialized track and field natural and synthetic surfaces.

During this period I consulted with Reslite and Tracklite track system assisting and designing asphalt mixtures for rubberized surfaces. Additionally, supervised installation of surface with various pavers throughout the USA.

The responsibility of marketing and presentation to clients for all related design commissions with emphases on sports facilities. Once the project was funded and construction contracts issued, I was responsible for the administration of this work and Representative to the Owner.

Architects DiGeronimo and DiGeronimo Associates maintain a continued joint-venture relation in sports facilities.

LEO CORPORATION
September 1976 to 1979

Project manager. Sports facility division. Project engineer.
Chiefly responsible for all sport facility construction projects. Established Company sports program and increased annual construction to twenty tracks. Annual construction of $14 million.

DOUGHERTY CONTRACTORS CORPORATION
Detroit, MI - May 1973 to September 1976

Project Engineer/Project Manager. Director of Field Operations. Corporate Vice President, Road Division. Survey and construction engineering. Project manager for the Sports Division for the leading builder of Track and Tennis facilities in the Midwest. Responsible for $7 million per year in athletic construction.

NEW JERSEY DEPARTMENT OF TRANSPORTATION
Newark, NJ - December 1970 to June 1971

Full-time co-operative engineer assigned to the Survey and Design Division.

As co-operative engineer, developed skills as
survey party member, party chief. In preliminary roadway design and layout assisted in coordination with independent consulting team. Assisted in State review.

JERSEY CITY BOARD OF EDUCATION
Jersey City, NJ - May 1967 to December 1970

Assistant to the Clerk-of-the-Works for School Construction Program.

Primary responsibility to prepare and file Daily Job reports for various
school construction projects. During this time I was involved in the construction of the new Ferris High School and Grammar School.

**APPOINTMENTS:**

1979-1987: Chairman, Technical and Specifications Committee for the USTC&TBA

1984-1990: Member, Facilities Committee for the United States Tennis Association

1985-1989: Member, USTA National Tennis Center (U.S. Open) sub-committee
1984-1987: Professional Director/Technical Consultant, Board of Directors-USTC&TBA

1985-1988: Technical Director (USA), Board of Directors of the International Federation of Sport Surface Sciences (I.S.S.S.)

1987-1990: National Chairman, United States Tennis Court and Track Builders Association (USTC&TBA)

1989-1991: Consultant for the White House Tennis Court

1989-1990: Consultant for Special Programs for Tennis Court Construction at Camp David

1990-1991: Member (Ex-Officio), Board of Directors - USTC&TBA

1990-1991: Chairman, Nominations and Personnel Committee for the USTC&TBA

1991-1993: ELECTED Member, Town of Sturbridge Parks and Recreation Commission

**1996-1999 Appointed to the Vince Lombardi Foundation**

**1996-1998: National Football Foundation/College Hall of Fame (Bergen County Chapter)**

**2004-Present:Certified Independent Professional, Synthetic Turf Council**

**2006-Present:Board of Directors (Member)Jeremy Worrell Foundation**

**2009 - Present: Certified Instructor with the Association of Synthetic Grass Installers**

**2010 - Present: FIFA Certified Field Testing**

**2011 - Present: Appointed the official testing lab for the NFL**

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August 19, 2011

Mr. Richard W. Hird, Chair
Lawrence-Douglas County Metropolitan Planning Commission
City Hall
6 East 6th Street
Lawrence, KS 66044

Re: TA 4-6-11 Synthetic Turf as Landscaping Material

Dear Chairman Hird:

On behalf of the applicant we request that Sections 20-1003(b), 20-1009(e)(4) and 20-1701 of the City of Lawrence Land Development Code ("Development Code") be amended as requested in the April 18, 2011 request for initiation of a text amendment to permit the use of artificial turf.

We request that your consideration of this request follow Development Code Section 20-1302(f) which requires:

> "(f) **Review and Decision-Making Criteria**
> In reviewing and making decisions on proposed zoning text amendments, review bodies shall consider at least the following factors:
>
> **(1)** whether the proposed text amendment corrects an error or inconsistency in the Development Code or meets the challenge of a changing condition; and
>
> **(2)** whether the proposed text amendment is consistent with the Comprehensive Plan and the stated purpose of this Development Code (See Section 20-104)."

## I. THE PROPOSED AMENDMENTS MEET THE CHALLENGE OF A CHANGING CONDITION.

A. Prior to the premature installation of artificial turf at Frontier Apartments, the City of Lawrence had routinely approved the use of synthetic turf in all of our playing

fields at both high schools and at the Oread Hotel. The reluctance to approve artificial turf at the Frontier Apartments appears to be a changing condition that requires clarification. Perceived inconsistencies in the Development Code definitions and perceived inconsistencies in the interpretation of Article 10 may have contributed to this changing condition.

B. The staff interpretation of the definition of "Landscape Materials" appears to be a changing condition that requires clarification.

C. The evaluation of artificial turf products as materials that are environmentally friendly, that earn LEED credits for the reduction or elimination of the use of water, pesticides, fertilizers, and emissions and the decreased long-term maintenance costs of artificial turf are changing conditions that should be addressed.

## II. THE PROPOSED AMENDMENTS ARE CONSISTENT WITH THE COMPREHENSIVE PLAN

A. The Comprehensive Plan is a policy guide that describes the community's vision for directing future land development. Horizon 2020, p. 1-1

B. The Overall Horizon 2020 Planning Goals balance public and private interests.

A. **"General Goal**

The overall community goal for planning is to provide, within the range of democratic and constitutional processes, for the optimum in public health, safety, convenience, general social and physical environment and individual opportunities for all the residents of the community, regardless of racial, ethnic, social or economic origin. It is the goal of the planning process to achieve a maximum of individual freedom, but public welfare must prevail. It is the intent to meet and safeguard individual rights and vested interests in a manner which will create the minimum disruption in individual freedoms and life values." Horizon 2020, p. 1-3

Artificial turf is an option available to owners of single family or duplex property who do not have to site plan any site improvements. Development Code, Section 20-1305(c)(1). It is not a threat to the public's health, safety or general welfare. It should be available to all land owners. Its use meets the policies of Horizon 2020 that encourage landscaping with reduced long-term maintenance costs, conservation of water, reduction of pesticides and fertilizers and reduction of emissions.

B. **"Sustainability**

> We will strive to ensure the sustainability of our physical environment, both natural and built, the health of our economy and the efficient and effective functioning of our community." Horizon 2020, p. 1-3

The use of artificial turf protects the environment by conserving water, reducing pesticides, fertilizers and emissions. Artificial turf increases the economic health of our community by requiring lower long-term maintenance costs. Artificial turf allows our society to enjoy a healthy and safe place to play and a pleasing setting for our homes and businesses.

C. Screening and Landscaping Policies of Horizon 2020 are contained in each separate land use chapter of Horizon 2020.

A. The land use chapters of Horizon 2020 are:

a. Residential - Chapter 5
   (a) Low Density Residential Land Use
   (b) Medium and Higher Density Residential Land Use
b. Commercial - Chapter 6
c. Industrial and Employment - Chapter 7

B. All four of the separate land use sections contain similar screening and landscape policies including the following:

> "c. Promote/encourage site design that uses existing vegetation, such as stands of mature trees, as natural buffers or focal points.

d. Encourage the use of high quality materials in the construction of screening and landscape areas to decrease long-term maintenance costs." Horizon 2020, pp. 5-22, 5-28, 6-28 and 7-16 – 7-17

C. "Landscape material" is defined in the Development Code to include both living and non-living elements. Development Code § 20-1701, p. 17-10

Horizon 2020 encourages both the use of mature trees and high quality landscape material. These two policies are neither inconsistent nor are they mutually exclusive. Whether the landscape material is living or non-living, it should be of high quality and should decrease long-term maintenance costs. Based on the documentation provided by the Planning Staff and that provided to the Planning Staff on July 22, 2011, it is an undisputed fact that the long-term maintenance costs of artificial turf is substantially less than that of live turf. When the Lawrence School District converted all of its playing fields to artificial turf, they estimated a significant annual decrease in maintenance costs.

D. Environmental Chapter 16 of Horizon 2020 expands on the overall Horizon 2020 goal of sustainability. Artificial turf is consistent with the chapter's emphasis on decreasing the use of water, reducing or eliminating emissions; and reducing our use of pesticides, fertilizers and herbicides.

1. The Overview of Chapter 16 recognizes that "land development is important to economic vitality." Horizon 2002, p. 16-1

Decreasing the cost of long-term maintenance of turf areas with the use of artificial turf improves the economic vitality of the community as well as improving the environment.

2. One important strategy of this chapter is to "establish effective incentives and regulations that promote sustainable and efficient management of environmental resources." Horizon 2020, p. 16-2

Reducing emissions promotes a sustainable management of the air we breathe. Reducing the use of pesticides, herbicides and fertilizers reduces long-term maintenance costs of turf which reduces the potentially negative impact of development.

3. An important issue in the Human and Built Environment Section of this chapter is sustainability which is defined as: "Creating a sustainable community protects and preserves the environment, natural and built for future generations. This can include minimizing negative impacts from development on the environment and promoting sustainable building and land use practices." Horizon 2020, p. 16-23

4. "Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable Development integrates the three pillars of environmental protection, economic development and social development in decision making." Horizon 2020, p. 16-23

> Policy 6.6 Promotes "the responsible use and conservation of energy, water and other natural resources." Horizon 2020, p. 16-25

Artificial turf conserves water, one of the most important natural resources. No being can live without it. .

> Policy 6.6(b) "Encourage water conservation...."
>
> Policy 6.6(c) "Provide education on the use of...other features which would reduce water consumption for landscaping."
>
> Policy 6.6(d) "Provide incentives for building and facility design which minimizes water usage...." Horizon 2020, p. 16-25

These policies emphasize the importance of the conservation of water in every way that we can and the importance of education about features, like artificial turf that conserve water.

5. An important issue in the Water Resources and Management Section is Water Quality including "Minimizing pollutants that can contaminate ground and surface water...."

   a. Policy 1.2(d) encourages continued alignment with the Kansas Water Plan. "Water conservation is essential for the effective

management of water resources in Kansas to assure that a sufficient, long term supply of water is available for the beneficial uses of the people of the state." Kansas Water Office, Kansas Department of Agriculture, Kansas Water Plan, Vol. II. Water Conservation Policy and Institutional Framework, 1 (Jan. 2008). Horizon 2020, p. 16-5.

The Kansas Water Plan also emphasizes conservation of water. Artificial turf is consistent with the Kansas Water Plan.

b. Policy 1.2(d)(2) "Use fewer chemicals on lawn(s), gardens, fields and forests to protect water quality." Horizon 2020, p. 16-5.

Artificial turf requires no chemicals, thereby reducing the chemicals that can seep into our groundwater or runoff into our stormwater.

c. Policy 1.5(b) "Develop programs and regulations, such as pesticide-free park programs...to minimize pollutants leaching into underlying groundwater systems to help ensure the quality of our groundwater resources." Horizon 2020, p. 16-6

Artificial turf protects the groundwater by not requiring any chemicals. Some parts of our country use artificial turf in parks, at garden shows and other public spaces. It protects the groundwater and the stormwater by not requiring any chemical applications.

d. Policy 1.7(a) "Encourage minimal and appropriate use of fertilizers, pesticides and other chemicals to reduce stormwater pollutants." Horizon 2020, p. 16-7

Artificial turf reduces stormwater pollutants because it does not require the use of any fertilizers, pesticides or other chemicals.

6. The Air Resources and Management Section of this chapter focuses on air quality because "The quality of air impacts human, plant and animal health.

a. **Outdoor air pollution**. Minimizing pollutants is critical to maintaining outdoor air quality. Outdoor air pollution can lead to negative health impacts.

b. **Excessive greenhouse gases**. Reducing greenhouse gases is necessary to limit their negative impacts on the climate."
Horizon 2020, p. 16-18

Artificial turf minimizes pollutants such as pesticides, herbicides and fertilizers that effect outdoor air quality because it does not need any of them. Artificial turf reduces greenhouse gases because it never needs mowing. Artificial turf may reduce allergic reactions to pollens and weeks in living turf.

The relevant polices of this chapter that emphasize the need to improve air quality by reducing emissions are:

a. Policy 3.1 "Improve air quality through reduction in emissions from vehicle exhaust." Horizon 2020, p. 16-18

b. Policy 3.2 "Reduce emissions from vehicle exhaust."
Horizon 2020, p. 16-19

c. Policy 3.3 "Reduce emission of non-vehicular air toxics..."
Horizon 2020, p. 16-19

By not needing mowers, tractors, weed-eaters, or other mechanized equipment to maintain the artificial turf we reduce the emissions and greenhouse gases that would be present with live turf.

7. Waste Management Section of this Chapter

a. Policy 5.1 "Manage solid waste through a program that emphasizes the principles of Reduce, Reuse, and Recycle."
Horizon 2020, p. 16-22

Artificial turf may use recycled materials such as crumb rubber. Artificial turf does not generate yard waste that may be dumped in a land fill.

b. Policy 5.1(d) "encourage the expansion of the yard waste collection programs in order to minimize the use of land fills."
Horizon 2020, p. 16-22

Artificial turf generates no yard waste to be collected and taken away, thereby also reducing emissions from trash trucks. Some artificial turf may itself be recycled.

8. The Land Resources Management section of the chapter discusses

> "...Douglas County's various land resources which consist of rural woodlands and urban forests, native prairies and agricultural soils. These resources provide wildlife habitats, viewsheds, and open spaces, as well as serving as 'Green Infrastructure'...." Horizon 2020, p. 16-11

> Green infrastructure is "...our open space network...that minimizes the fragmentation of natural areas and benefits the community by protecting natural habitats, providing appropriate stormwater management, providing open-air recreation areas and providing sustainable development practices." Horizon 2020, p. 16-11

Green infrastructures are those that preserve the high quality agricultural soils, critical habitats for endangered species, wildlife habitats, native prairies, rural woodlands and urban forests. It is not consistent with urban development. It does not encourage development of any kind. The use of artificial turf is only appropriate on land that has or is developing to urban densities. Green infrastructures or open space networks may be appropriate for undeveloped land.

**SUMMARY OF COMPLIANCE WITH HORIZON 2020**

1. The Staff Memorandum of July 27, 2011 ("Memo") readily concedes that artificial turf complies with the goals and policies of:

A. Water conservation, since no irrigation is necessary for artificial turf; and

B. Reducing emissions because no regular mowing is necessary for artificial turf; and

C. Reducing or eliminating the use of pesticides, fertilizers and herbicides.

2. The Memo fails to recognize that the use of artificial turf complies with Horizon 2020 and its screening and landscaping policies found in each of the separate land use sections of chapters 5, 6 and 7. These polices of preserving mature trees and using high quality materials in landscaping and screening to decrease long-term maintenance costs are not in conflict. The staff's underlying assumption appears to be that either artificial turf can not be a "high quality material" or that "decreasing long-term maintenance" is not a worthy goal. Neither assumption is correct.

3. The Memo concludes that despite the consistency with the stated goals and policies of Horizon 2020, artificial turf "as a landscaping material is not in compliance with the recommendations in the Environment Chapter." Memo, p. 8.

However, the Memo does not provide a single reference to Horizon 2020 that discourages artificial turf. Instead the Memo offers an opinion of the merits of artificial turf, "as compared to low maintenance landscaping" and "traditional lawns." The request for a text amendment was not a request for a good, better, best sort of comparison, but merely a request to consider the proposed text amendment in accordance with the factors identified in Development Code § 20-1302(f). Artificial turf is not prohibited. It should be considered as one option to meet the policies and goals of Horizon 2020. Horizon 2020 encourages high quality landscape material to be used with any existing vegetation such as mature trees that can be preserved in a landscape plan.

## III. DEVELOPMENT CODE

A. The proposed text amendments are consistent with the stated purpose of the Development Code which is found at Section 20-104 Purpose.

> "This Development Code is intended to implement the Lawrence/Douglas County Comprehensive Land Use Plan and other applicable plans adopted by the City Commission...in a manner that protects, enhances and promotes the **health, safety, and general welfare** of the citizens of Lawrence."

There is nothing in the comprehensive land use plan, Horizon 2020, that discourages artificial turf. When the Lawrence School District #497 designated artificial turf for their athletic fields, it was approved without comment or concern in three separate site plans. Horizon 2020 encourages high quality landscape material to be used with any existing vegetation such as mature trees that can be preserved in a landscape plan.

There was no prohibition against artificial turf or artificial plants in the Development Code's predecessor, The Lawrence Zoning Ordinance.

Such a prohibition was not recommended in the documentation from the consultant who assisted with the review and analysis of the Zoning Ordinance prior to the initial draft of the Development Code. The only documentation indicates that the Development Code should include all of the screening and landscape requirements in one place, rather than throughout the Development Code as they had been in the Zoning Ordinance.

Linda Finger, former planning director, was the staff person who handled the landscape portion of the Development Code. In an August 3, 2011 conversation she did not remember any discussion about artificial turf. She did remember adding the prohibition against artificial plants to the Development Code to discourage the use of artificial flowers and a front yard filled with rock mulch on Massachusetts Street.

B. The Development Code definition of **Landscape Material** includes both living and non-living elements:

> "Section 20-1701
>
> > **Landscape Material** - Such **living material** as trees, shrubs, ground cover, vines, turf grasses, and **non-living material** such as: pebbles, sand, bark, brick pavers, earthen mounds (excluding pavement), and/or other items of a decorative or embellishing nature such as: fountains, pools, walls, fencing, sculpture, etc." Horizon 2020, p. 17-10

This definition indicates with the "etc." that the list of elements is not exhaustive. For the sake of clarity, "artificial turf" should be specified along with rocks, pebbles, sand, etc. rather than just implied.

C. Artificial turf exceeds grass in meeting the purpose of the Development Code Article 10 Landscape and Screening. The stated purposes of landscaping and screening that apply to turf, whether artificial or living are:

> "Section 20-1001(a) **Purpose**
>
> The regulations of this article are intended to:
>
> > (1) maintain the City's quality, heritage and character by enhancing its visual appearance through the use of landscaping;
> >
> > (2) enhance environmental conditions by providing...air purification, oxygen regeneration, groundwater recharge, filtering of stormwater runoff...."

1. Visual Appearance

Although the terms "quality, heritage and character" are not defined terms in the Developmental Code, we know that "quality" does not mean artificial or living. As demonstrated in the many articles submitted by the staff and the applicant it is possible to have "high quality" living grass or artificial turf just as it is possible to have "poor quality" examples of each.

Our heritage is one of tents, sod houses and a dirt Massachusetts Street. We do not want to preserve this physical nineteen century heritage, but rather, if we are preserving our heritage of equal rights for all, support for entrepreneurial activities and respect for the environment; artificial turf surpasses living turf in that it reduces our consumption of the precious resource water; it eliminates the use of pollutants such as pesticides, herbicides and fertilizers into the air and into our groundwater and our stormwater runoff and thereby enhancing our environment by reducing or eliminating many of the negative effect of development.

Whether artificial turf enhances our visual appearance requires a subjective judgment of beauty. We submit that whether artificial or living, turf enhances our visual appearance if it is of high quality, properly installed and well maintained.

2. Environmental Conditions

Although artificial turf does not generate oxygen, it does not prevent the generation of oxygen by the trees, plants, shrubs and flowers that are part of a landscape plan. Artificial turf may heat up to higher temperatures than living turf, but it also cools down faster when it is shaded. The generation of heat is at the surface and not at the level of 4 feet to 5 feet above the surface level.

Artificial turf does a better job of reducing the use of water, eliminating pollutants and reducing the cost of long-term maintenance than living turf. It meets the general purpose of the Development Code and the specific purposes of Article 10 in more environmentally friendly ways than living turf.

Artificial turf has been approved by the Planning Staff and the City Commission on at least three separate occasions with the site plans approved for the athletic fields at Free State High School, the football field at Lawrence High School and the other athletic fields at Lawrence High School. Artificial turf has been administratively approved as an alternate compliance use for the Oread Hotel.

Current artificial turf systems enhance the city's visual appearance by providing a more uniform turf appearance in a more environmentally friendly way with lower long-term maintenance costs. Current artificial turf systems enhance environmental conditions by reducing the demand for water, by eliminating the negative effects of pollutants such as pesticides, herbicides and fertilizers that contaminate our air, our ground water and our streams through stormwater runoff.

D. The proposed text amendments **"protect, enhance and promote the health and safety of the citizens of Lawrence"** as required by Development Code Section 20-104.

1. The Staff Report of June 22, 2011 raises issues of heat, infection, latex allergy and chemical exposure based on a 2008 New York study that eliminated all of these concerns except heat. The study noted that artificial turf gets hotter than living grass and also cools off more quickly. Our local

experience with our high school activity fields and the Oread Hotel has not raised any heat related concerns even in this excessively hot summer.

2. The following additional studies have been provided to staff along with the July 21, 2011 memo from Melissa Vancrum to update the information about health and safety concerns associated with artificial turf:

   a. July 30, 2008, U.S. Consumer Product Safety Commission release "CPSC Staff Finds Synthetic Turf Fields OK to Install, OK to Play On"

   b. December 10, 2009, U.S. Environmental Protection Agency release, "Limited EPA Study Finds Low Level of Concern in Samples of Recycled Tires from Ballfield and Playground Surfaces"

   c. The Synthetic Turf Council's Voluntary Commitment to remove all or most lead from the pigments used to color the synthetic turf and to comply with the proposed revised restrictions concerning lead in children's products.

   d. April 2010 Munex and UC Berkeley Study on Recycled Rubber in Artificial Turf Applications

   e. December 2008, "Evaluation of the Environmental Effects of Synthetic Turf Athletic Fields by Milone & MacBroom, engineering, landscape architecture and environmental science. The summaries of the Milone & MacBrown studies included the following:

      1. "**<u>Summary</u>**

         The results of the temperature measurements obtained from the fields studied in Connecticut indicate that solar heating of the materials used in the construction of synthetic turf playing surfaces does occur and is most pronounced in the polyethylene and polypropylene fibers used to replicate natural grass. Maximum temperature of

approximately 156° F were noted when the fields were exposed to direct sunlight for a prolonged period of time. Rapid cooling of the fibers was noted if the sunlight was interrupted or filtered by clouds. Significant cooling was also noted if water was applied to the synthetic fibers in quantities as low as one ounce per square foot. **The elevated temperatures noted for the fibers generally resulted in an air temperature increase of less than five degrees even during periods of calm to low winds.**

The rise in temperature of the synthetic fibers was significantly greater than the rise in temperature noted for the crumb rubber. Although a maximum temperature of 156° F was noted for the fibers, a maximum temperature of only 101° F, or approximately 16 degrees greater than the observed ambient air temperature, was noted for the crumb rubber."

2. "**Summary**

The evaluation of the stormwater drainage quality from synthetic turf athletic fields included the collection and analysis of eight water samples over a period of approximately one year from three different fields, the collection and analysis of samples of crumb rubber in-fill from the same three fields plus a sample of raw crumb rubber obtained from the manufacturer, and the evaluation of the effect of the stone base material on the pH of the drainage water. The results of the study indicate that the actual stormwater drainage from the fields allows for the complete survival of the test species *Daphnia pulex*. An analysis of the concentration of metals in the actual drainage water indicates that metals do not leach in amounts that would be considered a risk to aquatic life as compared to

existing water quality standards. Analysis of the laboratory-based leaching potential of metals in accordance with acceptable EPA methods indicates that metals will leach from the crumb rubber but in concentration that are within ranges that could be expected to leach from native soil. Lastly, it can be concluded that the use of crushed basaltic stone as a base material in the construction of the athletic fields has a neutralizing effect on precipitation."

f. July 2009, study "Chemicals and particulates in the air above the new generation of artificial turf playing files, and artificial turf as a risk factor for infection by methicillin-resistant staphylococcus aureus (MRSA) literature review and data gap identification by the California Environmental Protection Agency Office of Environmental Health Hazard Assessment that concluded that there was not a serious public health concern.

g. "What Do the Experts Say," Synthetic Turf Council Survey of recent third party studies with

h. Announcements of synthetic turf on all Lawrence, Kansas high school athletic fields

I. Synthetic Turf Council 2010 Case Studies and Testimonials including awards for:

1. Kiowa County High School in Greensburg, Kansas, and

2. Junction City High School in Junction City, Kansas

j. Synthetic Turf Council, May 31, 2011 newsletter re synthetic turf as a celebrity trend.

k. Sunset Magazine article about the pros and cons of synthetic grass

l. History of the American Lawn

m. Summary of benefits of synthetic turf

There is no documented threat to the health or safety of our children who have played on our artificial athletic fields. There is no objective evidence of any health hazards with current high quality artificial turf.

E. The proposed text amendments meet the purpose of the Development Code, by clarifying the acceptance of artificial turf as a landscape material that will **protect, enhance and promote the general welfare of the citizens of Lawrence** as required by Section 20-104.

1. They specifically and clearly allow artificial turf not only in low density residential areas but also areas in high density residential, commercial and industrial areas.

2. They will allow the land owner to reduce the long-term maintenance costs of landscaping.

3. They will allow a turf that does not have the bugs, insects (including chiggers) that make their homes in live turf.

4. They will permit the reduction or elimination of the use of water.

5. They will allow the elimination of many pollutants such as pesticides and fertilizers that runoff live lawns protecting our groundwater and our stormwater.

## IV. CONCLUSION

The proposed text amendments are necessary to address the challenge of changing conditions and to clarify some portions of the Development Code as well as to support consistency in the City's judgments about the acceptance of artificial turf as activity fields in our schools and to acknowledge the current state of development of artificial turf as an environmentally friendly product that decreases the long-term maintenance costs of turf and provides a more sustainable landscape material than may have been previously available.

## V. Request Text Amendments

**20-1003(e) In addition to required Shade Trees and Shrubs, landscape areas within the Interior of off-street Parking Areas shall be planted with turf which can be synthetic or natural, Ground Cover, Ornamental Trees, or Shrubs.**

**20-1009(b) No artificial plants or vegetation other than synthetic turf may be used to meet any standards of this section.**

**ADD TO DEV CODE 20-1009(e)(4) Synthetic turf areas shall be installed per the manufacturers specification as permanent lawns in Lawrence.**

**20-1701 - Landscaping: Such living material as trees, Shrubs, Ground Cover/vines, turf grasses, and non-living material such as: rocks, pebbles, sand, bark, brick pavers, earthen mound (excluding payment), synthetic turf and/or other items of a decorative or embellishing nature such as: fountains, pools, walls, fencing, sculpture, etc.**

Thank you for your consideration.

Sincerely,

BARBER EMERSON, L.C.

Jane M. Eldredge

Jane M. Eldredge

JME:dkh

**MEMORANDUM**

To: Jane Eldredge
From: Melissa Vancrum
Re: Artificial Turf use as Landscaping in Lawrence
Date: July 21, 2011

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The Lawrence Development Code appears to prohibit the use of artificial turf as part of any landscaping plan except as an alternative compliance element. However, many other localities encourage the use of artificial turf in landscaped areas and offer rebates for installing it and reducing water usage. Horizon 2020 encourages sustainable landscaping and a sustainable physical environment. Such goals include the use of artificial turf in many other circumstances.

Artificial turf has evolved dramatically in the last decade in safety, environmental friendliness, attractiveness, and durability. It has received LEED points in a number of projects. Artificial turf today can be indistinguishable from natural grass without close inspection. In addition, it can support Lawrence's goal of sustainability through decreased water consumption, pesticide and herbicide runoff, emissions from mowers, and grass clipping waste. The natural grass lawn is not sustainable and several alternatives need to be evaluated. Perhaps a focused study session would be helpful to more clearly analyze today's artificial turf products and determine if they should become a beneficial option of the local landscape.

**The Natural Grass Lawn**

The manicured grass lawn is a status symbol of the wealthy borrowed from European manor houses.[1] It is not "natural". It is highly cultivated. The grass lawn

[1] Donaldson, Cameron, History of the American Lawn, The Limpkin: Newsletter of the Spacecoast Audubon Society of Brevard County Florida.

proliferated in the U.S. after World War II as suburbia exploded. Americans previously used their yards primarily for growing food.

The natural grass yard is anything but natural. "[A] typical U.S. lawn, one-third of an acre in size, receives as much as 10 pounds of pesticides, 20 pounds of fertilizer, and 170,000 gallons of water annually. What's more, in a year a homeowner could spend the equivalent of a 40-hour workweek simply mowing that lawn (producing pollution equal to that created by driving a car 14,000 miles) and hundreds of dollars caring for it."[2] In the effort to cultivate a sustainable environment, it is difficult to support the natural grass lawn. However, many alternatives exist, including artificial turf.

Use

Artificial turf has evolved considerably since it was introduced in the 1960's for sports fields. Today artificial turf is used in parks, upscale residential yards, commercial developments, and golf courses. Its use is now widespread in professional sports and continually expanding for kids' athletic fields, including those of the Lawrence Unified School District. In recent years, artificial turf has become popular in celebrities' yards.[3] Walt Disney World, Disneyland and Epcot Center utilize artificial grass in some of their landscaping.[4] New York City uses the turf in some parks, and California agencies use it for some building landscaping.[5]

**Appearance**

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[2] Bogo, Jennifer, Going the Extra Yard, Audubon Magazine, March 2002.
[3] Synthetic Turf Becomes Latest Celebrity Trend, A-Listers and Landmarks Conserve Water While Beautifying Grounds" Synthetic Turf Council, May 31, 2001.
[4] Id.
[5] See California utillitClaudio, Luz, Synthetic Turf: Health Debate Takes Root, Environmental Health Perspectives, March 2008,

One reason for the widespread adoption of artificial grass is the improvement in look. Artificial turf can be selected in different shades of green with variegated strands and even the look of dead thatch mixed within the green blades.[6] Artificial turf also comes in different lengths to mimic the look of different types of natural grass even up close.

**Health and Environmental Impacts**

Use of artificial turf in select applications provides a significant benefit in the form of a large reduction in water consumption and allergens. Artificial turf may require occasional cleaning with water to remove dust and debris. This consumption is minimal compared to the needs of natural grass. Water is used on artificial turf athletic fields to cool the surface and provide traction before games. However, this would be unnecessary for landscaping purposes. Artificial turf also reduces allergens such as pollen in the environment. Crumb rubber from recycled tires often provides a sublayer for the artificial turf which makes the surface of the turf softer. Concerns have been raised about the irritation to latex allergy suffers due to the crumb rubber infill used in some artificial turf installations. However, levels of latex in tires are much lower than in latex gloves and other consumer products. To date no study has confirmed an issue of latex allergens released from artificial turf.[7]

Scientific studies are in disagreement over the potential for environmental harm from artificial turf. A CDC report identified lead dust on decaying old artificial turf

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[6] Synthetic Turf Council, http://www.syntheticturfcouncil.org/.

[7] *See, e.g.,* Evaluation of the Environmental Effects of Synthetic Turf Athletic Fields, Milone & MacBroom, December 2008.

fields as a potential health issue.[8] While old artificial turf may contain high lead content, the grass produced today must meet strict lead standards.[9] The industry has done this in part by utilizing organic pigments. The Synthetic Turf Council has agreed to further restrict lead content by complying with stringent lead standards proposed for children's products.[10] In 2008, the Consumer Product Safety Commission released a report that concluded that young children are not at risk of lead exposure from artificial turf in athletic fields.[11] In addition, an EPA study found that lead from recycled tires was not a concern in artificial athletic fields and playgrounds.[12]

Other potential issues including zinc continue to be studied. The EPA found levels in of zinc in the air and surface to be below levels considered harmful at athletic fields and playgrounds using recycled tires.[13] A 2008 study found levels of zinc in stormwater collected from artificial athletic field drainage systems to be below the Connecticut water quality standard.[14] Other chemicals such as lead, selenium and cadium were not detected in the drainage.[15] While some studies have found elevated zinc levels, risk to humans is minimal as most zinc is absorbed into soil and does not dissolve in water.[16] In addition, zinc is not very toxic to humans so the danger is mostly to aquatic

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[8] Artificial Turf, Centers for Disease Control and Prevention, http://www.cdc.gov/nceh/lead/tips/artificialturf.htm
[9] Good News about Lead Problems in Artificial Turf, Center for Environmental Health, Fall 2010 Newsletter, http://www.ceh.org/component/content/article/454.
[10] STC's Voluntary Commitment, Synthetic Turf Council, http://www.syntheticturfcouncil.org.
[11] CPSC Staff Finds Synthetic Turf Fields OK to Install, OK to Play On, News from CPSC, U.S. Consumer Product Safety Commission, July 30, 2008.
[12] Limited EPA Study Finds Low Level of Concern in Samples of Recycled Tires from Ballfield and Playground Surfaces, United States Environmental Protection Agency, December 10, 2009.
[13] Limited EPA Study Finds Low Level of Concern in Samples of Recycled Tires from Ballfield and Playground Surfaces, United States Environmental Protection Agency, December 10, 2009.
[14] Evaluation of the Environmental Effects of Synthetic Turf Athletic Fields, Milone & MacBroom, December 2008.
[15] Id.
[16] Artificial Turf Field Investigation in Connecticut, Final Report, University of Connecticut Health Center, Section of Occupational and Environmental Medicine, 21 July 27, 2010.

and plant life. The California Environmental Protection Agency released a report based on two New York studies of air quality showing that exposure was "unlikely to produce adverse health effects in persons using these fields."[17] "Extensive research has pointed to the conclusion that these fields result in little, if any, exposure to toxic substances."[18]

Some studies have indicated concern with elevated temperature on artificial athletic field surfaces. The surface temperature of the synthetic grass blades has been recorded upwards of 150 degrees on sunny days. However, in temperatures recorded at 5 feet above the surface is dramatically lower and in some cases shows little difference in temperature.[19] Also, athletic fields consist of a large expanse of unshaded open space. Landscaping includes smaller patches of artificial grass shaded by trees and buildings which will reduce temperatures.

**Summary**

Other cities have found artificial turf to be a beneficial part of their landscape encouraging it with rebates and laws and using it in city parks and building landscaping. California even passed a law banning Home Owner's Associations from prohibiting the use of artificial turf in landscaping.[20] It was recently vetoed by the governor who said the

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[17] Chemicals and particulates in the air above the new generation of artificial turf playing fields, and artificial turf as a risk factor for infection by methicillin-resistant Staphgylococcus areus (MRSA) Literature review and data gap idenfication, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, July 2009.

[18] Review of the Impacts of Crumb Rubber in Artificial Turf Applications, Rachel Simon, University of California, Berkeley, Laboratory for Manufacturing and Sustainability, College of Engineering & Manex Consulting, February 2010.

[19] Evaluation of the Environmental Effects of Synthetic Turf Athletic Fields, Milone & MacBroom, December 2008.

[20] *See* Cal. S.B. 759 (2011).

decision was better left up to the associations.[21] New York Parks and California utilities have taken advantage of the benefits of artificial grass.

Use of artificial grass may provide a sustainable alternative to natural grass in landscaping in Lawrence. Artificial turf reduces water use, pesticides, herbicides, emissions, grass clipping waste. Lead use has been dramatically reduced through industry efforts such as using organic pigmentation. There does not appear to be a clear threat to human health through release of zinc or other chemicals though studies continue. In addition, artificial turf can provide an attractive look as it is used for upscale homes, building landscaping, and even Disney World.

**Recommendation**

In a study session to which USD #497 officials who have installed and used artificial turf athletic fields would be invited, Lawrence can better determine whether to permit artificial turf use in landscaping as most other communities have and as the local school district has chosen for children to play on.

[21] Jerry Brown vetoes artificial turf bill backed by conservationists, Capitol Alert, The Sacramento Bee, July 15, 2011.

# NEWS from CPSC

## U.S. Consumer Product Safety Commission

Office of Information and Public Affairs Washington, DC 20207

FOR IMMEDIATE RELEASE
July 30, 2008
Release #08-348

**CPSC Hotline: (800) 638-2772**
CPSC Media Contacts: (301) 504-7908

# CPSC Staff Finds Synthetic Turf Fields OK to Install, OK to Play On

WASHINGTON, D.C. - The U.S. Consumer Product Safety Commission (CPSC) staff today released its evaluation of various synthetic athletic fields. The evaluation concludes that young children are not at risk from exposure to lead in these fields.

CPSC staff evaluation showed that newer fields had no lead or generally had the lowest lead levels. Although small amounts of lead were detected on the surface of some older fields, none of these tested fields released amounts of lead that would be harmful to children.

Lead is present in the pigments of some synthetic turf products to give the turf its various colors. Staff recognizes that some conditions such as age, weathering, exposure to sunlight, and wear and tear might change the amount of lead that could be released from the turf. As turf is used during athletics or play and exposed over time to sunlight, heat and other weather conditions, the surface of the turf may start to become worn and small particles of the lead-containing synthetic grass fibers might be released. The staff considered in the evaluation that particles on a child's hand transferred to his/her mouth would be the most likely route of exposure and determined young children would not be at risk.

Although this evaluation found no harmful lead levels, CPSC staff is asking that voluntary standards be developed for synthetic turf to preclude the use of lead in future products. This action is being taken proactively to address any future production of synthetic turf and to set a standard for any new entrants to the market to follow.

As an overall guideline, CPSC staff recommends young children wash their hands after playing outside, especially before eating.

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A Video News Release will feature b-roll of synthetic turf in use, on-site and laboratory testing, and soundbites in English and Spanish.

**Video Feed Satellite Coordinates**

**Wednesday, July 30, 2008**
**2:30 PM – 3:00PM ET**
**Galaxy 25**
**Transponder 13**
**C-Band**
**Downlink Freq: 3960V**

**Thursday, July 31, 2008**
**10:30 AM – 11:00AM ET**

**Galaxy 3**
**Transponder 21**
**C-Band**
**Downlink Freq: 4120H**

For Technical Information, DURING FEED ONLY, contact Daniel Conboy at (800) 920-6397 x 221.

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Send the link for this page to a friend! The U.S. Consumer Product Safety Commission is charged with protecting the public from unreasonable risks of serious injury or death from more than 15,000 types of consumer products under the agency's jurisdiction. Deaths, injuries and property damage from consumer product incidents cost the nation more than $800 billion annually. The CPSC is committed to protecting consumers and families from products that pose a fire, electrical, chemical, or mechanical hazard. The CPSC's work to ensure the safety of consumer products - such as toys, cribs, power tools, cigarette lighters, and household chemicals - contributed significantly to the decline in the rate of deaths and injuries associated with consumer products over the past 30 years.

To report a dangerous product or a product-related injury, call CPSC's hotline at (800) 638-2772 or CPSC's teletypewriter at (800) 638-8270, or visit CPSC's web site at www.cpsc.gov/talk.html. To join a CPSC email subscription list, please go to https://www.cpsc.gov/cpsclist.aspx. Consumers can obtain this release and recall information at CPSC's Web site at www.cpsc.gov.

# EPA: United States Environmental Protection Agency

## Limited EPA Study Finds Low Level of Concern in Samples of Recycled Tires from Ballfield and Playground Surfaces

Release date: 12/10/2009

Contact Information: Dale Kemery kemery.dale@epa.gov 202-564-7839 202-564-4355

**FOR IMMEDIATE RELEASE**
December 10, 2009

**WASHINGTON** - The U.S. Environmental Protection Agency has released results of a limited field monitoring study of artificial-turf playing fields and playgrounds constructed with recycled tire material or tire crumb. The study was intended to gain experience conducting field monitoring of recreational surfaces that contain tire crumb. EPA will use the information to help determine possible next steps to address questions regarding the safety of tire crumb infill in recreational fields.

"The limited data EPA collected during this study, which do not point to a concern, represent an important addition to the information gathered by various government agencies," said Peter Grevatt, director of EPA's Office of Children's Health Protection. "The study will help set the stage for a meeting this spring, where EPA will bring together officials from states and federal agencies to evaluate the existing body of science on this topic and determine what additional steps should be taken to ensure the safety of kids who play on these surfaces."

Recycled tire material, or "tire crumb," is used in many applications, including as a component in synthetic turf fields and playground installations. In response to concerns raised by the public, EPA conducted a limited "scoping study" of tire crumb, which consisted of collecting air and wipe samples at three locations near EPA laboratories at Raleigh, N.C., Athens, Ga., and Cincinnati, Ohio. Sampling also was conducted in the Washington, D.C. area.

The limited study, conducted in August through October 2008, found that the concentrations of materials that made up tire crumb were below levels considered harmful. However, given the limited nature of the study (limited number of constituents monitored, sample sites, and samples taken at each site) and the wide diversity of tire crumb material, it is not possible, without additional data, to extend the results beyond the four study sites to reach more comprehensive conclusions.

The study confirmed that most of the methods tested were accurate, reproducible and appropriate for measuring concentrations of tire crumb constituents and therefore can be used in future studies.

## Study findings

- Particulate matter, metals and volatile organic compound concentrations were measured in the air samples and compared with areas away from the turf fields (background levels). The levels found in air samples from the artificial turf were similar to background levels.
- No tire-related fibers were observed in the air samples.
- All air concentrations of particulate matter and lead were well below levels of concern.
- More than 90 percent of the lead in the tire crumb material was tightly bound and unavailable for absorption by users of the turf fields.
- Zinc, which is a known additive in tires, was found in tire crumb samples. However, air and surface wipe monitoring levels of zinc were found to be below levels of concern.

EPA is aware that studies by other agencies were undertaken or completed while this survey was under way. EPA is planning a 2010 meeting with federal and state agencies to review all new study data and determine next steps.

Read the full 123 page report: http://www.epa.gov/nerl/documents/tire_crumbs.pdf

More information on artificial turf: http://www.epa.gov/nerl/features/tire_crumbs.html

# STC's Voluntary Commitment

Throughout the years, the synthetic turf industry has developed and tested new pigment formulations to enable the removal of all or most of the lead from over 90% of the pigments used to color synthetic turf. Now the STC plans to reduce lead levels in the remaining 10% of all colored fibers that still require lead chromate to meet the consumer's demand for longterm colorfastness.

The STC voluntarily agrees to comply with the revised lead restrictions currently proposed for children's products in H.R. 4040. Specifically, the level of lead will be reduced in all pigments used to color synthetic turf to 300 ppm or less by no later than January 1, 2010, and to 100 ppm or less by no later than January 1, 2012.

**Related Links**

- Guidelines and Professional Standards
- Technical Guidelines
- ASTM Standards
- Voluntary Lead Standards
- Business Conduct and Ethical Standards




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# Manex and UC Berkeley Issue Study on Recycled Rubber in Artificial Turf Applications

*Review of studies from past 12 years combined with independent analysis yields most comprehensive report to date.*

*SAN RAMON, CA – April 5, 2010* -- The Corporation for Manufacturing Excellence (Manex) and the Laboratory for Manufacturing and Sustainability (LMAS) at the University of California, Berkeley, have released the results of their study on the impact, effectiveness, and safety of recycled tire crumb in artificial turf applications.

The Manex/UC Berkeley study reviews the benefits of recycled crumb rubber in artificial turf applications, providing insight for the material's growth in popularity and addressing common issues surrounding its efficacy and safety. The research also analyzes the primary features, economic benefits and other advantages that have led to the widespread expansion and adoption of artificial turf using recycled crumb rubber infill.

The research conducted by Manex and Berkeley is among the most comprehensive reports to date, reviewing and assessing existing studies from the past 12 years, as well as containing independent analysis. The conclusions of this study validate key findings from other recent studies, demonstrating the materials are both cost-effective and safe. Reasons for the dramatic growth in popularity of this material include excellent playability, all-weather availability, increased playing hours, significantly reduced maintenance, cost-effective investment, safe application, fewer injuries and positive environmental impacts, through the creative re-use of materials.

Jonathan Lee, Vice President at Manex adds perspective to misconceptions about crumb rubber. "Prior studies have been limited in scope, often assessing artificial turf and crumb rubber in and of themselves rather than in comparison to their real-world substitutes. Instead of focusing entirely on the potential hazards, these materials should be compared against the popular alternative, such as natural turf, for a balanced perspective. For example, even natural turf is not necessarily a benign or sterile material, and may contain chemicals, pesticides, chemical and organic fertilizer (such as manure) and other potential hazards. Grass fields are almost always maintained using equipment that generates pollution. In other words, artificial turf containing recycled crumb rubber is quite safe and cost-effective when compared to natural turf alternatives."

According to Rachel Simon of UC Berkeley who led the study for LMAS, "People tend to think that products more closely derived from nature are safer and better for the environment than those that are synthetic based. However, in many cases synthetic materials perform better than their 'more natural' counterparts across the various metrics used in evaluations. This has been shown to be the case with artificial turf, which offers several distinct advantages over grass, while using materials that are already prevalent in peoples' lives, such as recycled tires."

As part of this study, independent product test results were obtained and reviewed for crumb rubber produced by BAS Recycling of Moreno Valley, CA, a high-volume producer of cryogenic crumb rubber for synthetic turf. The test results confirmed that crumb rubber is safe for use in sports and athletic field environments.

***About Manex***
*Founded in 1995, The Corporation for Manufacturing Excellence (Manex) provides a broad array of proven advisory and implementation solutions exclusively to manufacturers, distributors and their supply chains, enabling them to increase growth, productivity, quality and profitability. Manex delivers high-impact solutions in four key areas: strategy, people, process and performance. Meaningful, rapid impact and ROI are achieved through a modular-yet-holistic approach encompassing corporate strategy and planning, marketing strategy, training and development, Lean Manufacturing, supply chain and logistics, Six Sigma, ISO, and performance management systems. Manex is the Northern California affiliate of the NIST Manufacturing Extension Partnership.*

*For more information about Manex, visit www.manexconsulting.com.*

***About UC Berkeley's Laboratory for Manufacturing and Sustainability (LMAS)***
*Research at LMAS is concerned with the analysis and improvement of manufacturing processes, systems and enterprises and the development of tools to analyze their sustainability. Research is focused on: metrics and analytical tools for assessing the impact of processes, systems and enterprises, modeling sustainable, environmentally-conscious*

*manufacturing processes andsystems, green supply chains, manufacturing technology for reduced impact manufacturing, technology for producing advanced energy sources or storage, cleantech and sustainable products and systems. Specific projects include: design for sustainability, green machine tools, sustainable packaging, impact and life cycle assessment tools for manufacturing (including embedded energy, materials, water, consumables), metrics for assessing green technology ROI (e.g. GHG ROI, Energy payback time, etc.), risk assessment for energy and resource use and enterprise carbon accounting.*

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UNIVERSITY OF CALIFORNIA, BERKELEY
LABORATORY FOR MANUFACTURING AND SUSTAINABILITY
COLLEGE OF ENGINEERING

# Review of the Impacts of Crumb Rubber in Artificial Turf Applications

**Rachel Simon**
*University of California, Berkeley*

**February 2010**

**Prepared For:**
The Corporation for Manufacturing Excellence (Manex)

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Business Transformation. Delivered.

**Prepared By:**
UNIVERSITY OF CALIFORNIA, BERKELEY
LABORATORY FOR MANUFACTURING AND SUSTAINABILITY

LMAS

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Manex is a public-private partnership and the Northern California affiliate of the National Institute of Standards and Technology (NIST) Manufacturing Extension Partnership (MEP) program. We work in concert with MEP to solve industry challenges by advancing best practices in manufacturing strategy, innovation, operations, methods and processes.

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## EXECUTIVE SUMMARY

There are many characteristics of infill systems that have lead to resurgence in the popularity of synthetic turf. The industry has been experiencing a period of growth with the development of crumb rubber infill system, which initially debuted in 1997. These systems are preferable to the carpet-like turf of the past because they more closely resemble natural grass.

Crumb from used tires have been used in artificial turf fields for over a decade, and even longer in playgrounds and tracks. The EPA's view is that scrap tires are not hazardous waste and approves the use of crumb from used tires for sports fields. Recycled tires that were used in this capacity prevented an estimated 300 million pounds of ground rubber from scrap tires from ending up in landfills in 2007 (Rubber Manufacturers Association, 2009). In addition, this application uses recycled material; scrap tires, which otherwise would have to be handled as waste. It typically takes between 20,000 and 40,000 scrap tires to produce enough infill to cover a football field (City of Portland, 2008). The EPA's decree has afforded the opportunity for 4.5% of U.S. scrap tire to be applied as crumb rubber in sports surfacing in 2007 (Rubber Manufacturers Association, 2009).

The Corporation for Manufacturing Excellence (Manex), a National Institute of Standards and Technology Manufacturing Extension Partnership (NIST MEP), in collaboration with the Laboratory of Manufacturing and Sustainability (LMAS) at the University of California, Berkeley have studied the benefits of crumb rubber in artificial turf applications, and provide research and insight as to why this material has grown in popularity. This analysis will also include the primary features, economic benefits and other advantages that have led to the widespread expansion and adoption of artificial turf that includes the crumb rubber.

Playability is one of the primary benefits of synthetic turf, with the newer generation of infill systems exhibiting improved playability over traditional synthetic varieties. The play quality of a field is most impacted by aspects of construction and maintenance. Irrespective of the field type, the quality of play can vary dramatically according to factors such as: moisture, hardness, grass cover and root density (Orchard, 2002), naps in the turf, the distribution and compaction of infill, and infill depth (James and McLeod, 2008). Most literature comparing the play quality of natural and synthetic fields suggests that the differences between them have miniscule affects on playability in comparison with variance in the set-up of the field itself. Where differences do emerge, data is out of date and not applicable to current generations of turf technology.

Research indicates that artificial turf provides a greater number of playable hours than natural turf. Studies suggest that average hours of playability in a three-season year for synthetic turfs range between 2,000 and 3,000 hours, with most research pointing towards 3,000 hours. Natural fields, on the other hand, provide far less playability, with studies estimating a range between 300 and 816 hours in a three-season year on average. Studies show, furthermore, that switching from natural to synthetic turf results in a drastic increase of play-time. This is due, in part, to the vulnerability of natural fields to fluctuations in weather. In addition, natural fields require rest, with managers recommending against using fields more than 20-24 hours a week. Natural fields are also vulnerable to poor management, which can detract significantly from use-time.

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Synthetic turf is praised for its availability in all weather conditions: more use per year, and a quick install. This factor influenced the amount of use that can be had on the turf, and thus the payback on investment on the turf. It can be used quickly after installation, usually within a few days, rather than the weeks it takes for a sod to become robust enough for use. Also, it can be used in snow, and in general is not affected by precipitation due to the drainage system involved. However, high heat can create an obstacle for synthetic turf use, as the surface can become uncomfortable to play on. It has been shown that the difference between turf temperatures and the surrounding air can be significant. However, there are means to temper such effects, and the field can still be made useable. Also, the use of turfs are not typically greatest during the hottest parts of the year, as sports seasons typically fall in the late summer through the spring. These impairments do not compare to the degree to which natural fields are compromised during rain and snow. With all weather considered, artificial turf has greater availability over natural grass when taking weather into account.

The value of a field can be determined by its availability and by amount of maintenance a field requires. The Sports Turf Managers Association (2005) states that these costs depend on: the amount of use; the type of use (i.e. sports played); climate and weather; existing soil and terrain; irrigation and water needs; labor; field type; and field security (protection against vandalism, non-regulated play, etc.). Activities that can be classified as grooming are the most important components of maintenance for both turf types. In addition, debris control, additional cleaning, and needs-specific maintenance may be required. A brief review of suggested maintenance practices produced a list of over 22 possible pieces of equipment, and 8 possible supplies for field maintenance. In general the maintenance that is necessary for a synthetic field has a similar maintenance requirement on a natural field. However, natural fields require a more nuanced balance of activities such as mowing, fertilization, and aeration to ensure their health.

One of the primary concerns for organizations considering the implementation of synthetic turf is whether it poses any significant health or injury risks. Numerous studies have been conducted assessing the likelihood of injury on natural grass and synthetic turf. Some studies reveal that there is very little difference in the rate, type, severity, or cause of injuries obtained on natural grass or synthetic turf (Fuller et al. 2007a, 2007b). A more recent study by Meyers (2010) shows that the latest generation of synthetic surface, FieldTurf, is safer to play on than natural grass fields. Through the analysis of the various injuries that occurred over the course of 465 collegiate games, Meyers shows that FieldTurf has lower incidence of: total injuries, minor injuries (0-6 days lost), substantial injuries (7-21days lost), and severe injuries (22 or more days lost). FieldTurf also had significantly lower injury rates that natural turf when comparing across play or event type, grade of injury, or various field conditions and temperatures. In addition, there was no significant difference found in head, knee, or shoulder trauma between the two playing surfaces. Meyers' (2010) research is the most comprehensive study to date, and it addresses previous inconsistencies in findings on injury patterns.

The use of athletic fields made of recycled tires has also been called into question because of concerns regarding toxicity. Authorities are worried that because of the chemical content of the material, exposure by various means could endanger the health of field users, especially children. However, extensive research has pointed to the conclusion that these fields result in little, if any, exposure to toxic substances.

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A review of existing literature points to the relative safety of crumb rubber fill playground and athletic field surfaces. Generally, these surfaces, though containing numerous elements potentially toxic to humans, do not provide the opportunity in ordinary circumstances for exposure at levels that are actually dangerous. Numerous studies have been carried out on this material and have addressed numerous different aspects of the issue. For the most part, the studies have vindicated defenders of crumb rubber, identifying it as a safe, cost-effective, and responsible use for tire rubber. As part of this study, independent product test results were obtained and reviewed for crumb rubber produced by BAS Recycling of Moreno Valley, CA, a high volume producer of cryogenic crumb rubber for synthetic turf. Test results confirm that crumb rubber is safe for use in sports and athletic field environments.

In general, the environmental impacts of natural grass are more complex than those of synthetic turf. This is due in large part to the fact that natural grass requires the continual addition of inputs to sustain a field's health. As with any agricultural practice, draws on water and the addition of agrochemicals can become problematic. These practices draw on scarce resources and have the potential to effect surrounding ecosystems. Additionally, the maintenance of grass is associated with the use of large quantities of fuel, to mow grass down to the appropriate length. The Athena Institute sufficiently shows the weight of these impacts in regards to global warming. However it is recommended that a more comprehensive inclusion of material inputs into grass maintenance be calculated in any future life cycle assessments.

The environmental issues related to synthetic turf mainly revolve around the use and disposal of materials. Many see the use of recycled waste products for field infill as one of the primary benefits of artificial systems. However, such systems also require the use of many virgin materials. As such, the greatest greenhouse gas emissions of either two system types are the impacts associated with the production of synthetic turf components. These material impacts increase the total emissions by a multiplicative factor when considering the entire life cycle, due to related increases in processing and transportation needs.

## 1.0 INTRODUCTION

### 1.1 Background

Growth in the popularity of synthetic turf has been followed by increased scrutiny of its usage. The industry has been experiencing a period of growth with the development of crumb rubber infill system, which initially debuted in 1997. These systems are preferable to the carpet-like turf of the past because they more closely resemble natural grass. They consist of longer simulated grass blades that do not compact because of the infill material that supports it. As of 2008 over 3,500 new-generation synthetic turf fields had been implemented (Jackson, 2008). In addition over half of all NFL teams currently play on synthetic turf (Synthetic Turf Council, 2008a).

There are many characteristics of infill systems that have lead to resurgence in the popularity of synthetic turf. First, it is believed that infill systems perform better than traditional synthetic turf for athletic applications (Popke, 2002). Also, artificial turf is available year around and requires less monetary and natural resources than natural grass.

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Crumb from used tires have been used in artificial turf fields for over a decade, and even longer in playgrounds and tracks. The EPA's view is that scrap tires are not hazardous waste and approves the use of crumb from used tires for sports fields. Recycled tires that were used in this capacity prevented an estimated 300 million pounds of ground rubber from scrap tires from ending up in landfills in 2007 (Rubber Manufacturers Association, 2009). In addition this application uses recycled material: scrap tires, which otherwise would have to be handled as waste. It typically takes between 20,000 and 40,000 scrap tires to produce enough infill to cover a football field (City of Portland, 2008). The EPA's decree has afforded the opportunity for 4.5% of U.S. scrap tire to be applied as crumb rubber in sports surfacing in 2007 (Rubber Manufacturers Association, 2009).

### 1.2 Objectives

The Corporation for Manufacturing Excellence (Manex) in collaboration with the Laboratory of Manufacturing and Sustainability (LMAS) at the University of California, Berkeley has been enlisted to study the benefits of crumb rubber in artificial turf applications, and provide research and insight as to why this material has grown in popularity. This analysis will also include the primary features, economic benefits and other advantages that have led to the widespread expansion and adoption of artificial turf that includes the crumb rubber.

### 1.3 Scope of Work

This study identified and assessed existing research on the benefits, advantages and safety concerns of crumb rubber. A sample from a California scrap tire recycler was also assessed to support and confirm key conclusions. Material was provided from a leading cryogenic crumb rubber producer, BAS Recycling, primarily for the purpose of reviewing and assessing safety concerns. Test results from an independent lab were obtained, and then reviewed, against some of the key health concerns regarding contamination. The research provided by Berkeley sought to confirm or invalidate the following findings from existing research/studies:

- **Excellent Playability** – synthetic turf does not inhibit or deflect the bounce or roll of balls. Traction, rotation and slip resistance, surface abrasion and stability meet the rigorous requirements of the most respected sports leagues and federations.

- **All-weather Availability** – synthetic turf can be used within hours of installation, in all types of weather. No significant downtime is required in case of rain, drought or other climate conditions. Increased availability equates to higher return on investment for owners, and more practice and skill development for players. Additional questions to be answered are: whether artificial turf can be utilized more per year without the rest that grass fields require, and what the maximum hour of playing time is for the two field types.

- **Increased Playing Hours** – in most climates, synthetic turf fields can be used 3,000 hours per year over a four-season window, with no damage to the turf. Natural turf fields become unplayable after 680 to 816 hours per year, and are typically available only for three seasons.

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- **Reduced Maintenance** – natural turf fields require approximately 70,000 gallons of irrigation water each week, approximately 15 to 20 pounds of fertilizer each year per 1,000 square feet of turf, plus herbicides and pesticides. Synthetic turf maintenance costs are two to three times less than natural turf. No mowing, irrigation or chemicals are required.

- **Cost-effective Investment** – synthetic turf fields are typically warranted for about 3,000 hours of play per year, with no "rest" required. For schools with sufficient land, it would take three or four natural fields to withstand the usage of one synthetic turf field. Because of its consistent availability, a synthetic turf field is also a reliable source of rental revenue for schools and communities. In addition, the total cost of ownership for fields will be explored, including all of the maintenance resources (water, fertilizer, pesticides, labor, and equipment) needed to upkeep a field.

- **Generally Safe Application** – for most common and typical uses, the materials (e.g. crumb rubber) is a safe alternative to natural materials and landscaping. While the general public is exposed to articles suggesting the need to further assess the material, no conclusive study has proven these materials as unhealthy, nor have high incidences of physical harm occurred from approved and proper uses. Recent issues that have surfaced relate to Carbon Black and Lead, however, for the vast majority of applications, serious physical harm has not occurred from these particulates.

- **Fewer Injuries** – synthetic turf fields are far more uniform and consistent than the natural turf fields most schools and communities are able to maintain. Also, they are made of resilient materials that provide a level of impact attenuation that is difficult to obtain on hard, over-used natural turf fields. An NCAA study comparing injury rates during the 2003-2004 academic year showed that the injury rate during practice was 4.4% on natural turf and 3.5% on synthetic turf.

- **Environmentally Friendly** – using synthetic turf eliminates the need for water, pesticides, herbicides and fertilizers. The used auto tire rubber used as infill recycles 25 million used auto tires per year that would otherwise end up in U.S. landfills. The EPA encourages the use of recycled auto tires for playgrounds, running tracks and sports fields.

## 2.0 IMPACT ANALYSIS

### 2.1 Playability

Playability is one of the primary benefits of synthetic turf, with the newer generation of infill systems exhibiting improved playability over traditional synthetic varieties. Research suggests that the play quality of any particular field is determined more by how the field is constructed and maintained than by the type of field material that is used. Factors such as moisture, soil compactness, and root or infill density can cause wide variance in play quality, playing a greater role in determining quality than the type of field. Components of qualitative play factors can be

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organized into ball-surface interactions and player-surface interactions. (Bell, Baker, and Canaway, 1985; Schmidt, 1999)

A surface can decrease play performance and prevent players from achieving their objectives. Pasanen et al. (2007a) note that there are two factors that influence surface-related injuries: shoe-surface friction and surface hardness. Schmidt (1999) also includes surface evenness as a factor affecting player-surface quality.

Friction can impact play by leading to slippage, foot fixation, and increased running speeds resulting in collisions and ankle and knee injuries. Surface friction depends on multiple factors. Orchard (2002) notes that moisture, hardness, grass cover, and root density are turf properties that influence shoe-surface traction. Existing research comparing the rate of surface traction injuries on synthetic and natural fields is outdated, as it considers previous generations of synthetic turf rather than the current infill systems. For instance, Powell and Schootman (1992) compare injury rates of natural and synthetic fields from 1980-1989, and Orchard and Powell (2003) consider rates from 1989-1998. These studies predate the newer generation of turf, which was first implemented in 1997. In addition evaluations that attempt to compare field types may be difficult, as it has been shown other factors, such as weather, affect injury rates (Orchard and Powell, 2003). Findings such as these support the notion that shoe-surface traction impacts injury rates and play in general, but there is not sufficient evidence evaluating the affects of traction in the newer generations of synthetic turf.

Similarly, surface hardness can affect player-surface interactions. Ground reaction force is the impact energy caused by an athlete's foot striking the playing surface. This force has been cited as a risk factor in causing acute and long-term injuries (Boden et al., 2000; Chappell et al., 2007; LaStayo et al., 2003). Surface hardness is one measure used to assess the ability of the surface to absorb foot striking impacts. Brosnan and McNitt (2008a, 2008b) note that natural and synthetic turfs have comparable surface hardness values. For natural surfaces, hardness is related to the amount of soil moisture, while for infilled synthetic surfaces, infill depth is a major factor in determining surface hardness. Synthetic turf tends to provide a fairly consistent playing surface. This is partially because surfaces are leveled before the application of synthetic turf. Furthermore, synthetic surfaces are less vulnerable than natural turf to play-related damage such as divots. While factors such as the distribution of infill can impact the uniformity of synthetic fields, synthetic turfs tend to be more even throughout.

Several aspects of ball-surface interactions have been identified for evaluating play quality. Schmidt (1999) cites rebound, spin, and roll as the principle characteristics of ball-surface interaction. Meanwhile, James and McLeod (2008) list roll, bounce, spin, and deceleration as important measures of playability. Holms and Bell (1986) note the interrelationship between eleven factors on play characteristics such as rebound resilience, traction, and deceleration for natural fields.

The play quality of a field is most impacted by aspects of construction and maintenance. Irrespective of the field type, the quality of play can vary dramatically according to factors such as: moisture, hardness, grass cover and root density (Orchard, 2002), naps in the turf, the distribution and compaction of infill, and infill depth (James and McLeod, 2008). Most

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literature comparing the play quality of natural and synthetic fields suggest that the differences between them have miniscule affects on playability in comparison with variance in the set-up of the field itself. Where differences do emerge, artificial turf appears to be equal to or better than natural turf, due to its greater consistency. While such findings are incomplete, because of the lack of studies that evaluate the newer generations of turf technology, there were no studies that contradicted the superiority of synthetic turf.

**2.2 All-weather Availability**

Playability can also be evaluated according to its availability to users. Maintenance, weather, and resting periods are all factors influencing the amount of time that can be spent on a field. In addition, use-time plays a role in evaluating its value and the return on investment for owners. Synthetic turf has been praised for its superior availability to natural turf, their quick installation, and accessibility in all climates and weather types.

Synthetic turf can be installed quickly and is usable within hours of installation. Several professional installers quote an installation time of about two to three days, a time that can be significantly longer if the field is initially in poor condition (e.g. requires the removal of a considerable portion of the existing field). The European Synthetic Turf Organization (2010) estimates that an installations can take as long as two to three weeks. Yet once a synthetic field is installed, it can be used almost immediately, unlike sod fields, which can take up to a month to be fully functional, and seeded fields, which take considerably longer to become fully rooted.

Additionally, synthetic turf can be used in almost any climate and weather, while natural turf is more limited. Natural turf has reduced availability during rain or snow, and precipitation can cause grass turfs to become soggy or muddy. Meanwhile, snow can be difficult to remove from these fields, and may permanently damages grasses. Comparatively, winter weather conditions and precipitation are not harmful to synthetic surfaces, and if necessary snow and ice can be removed for play.

However, the playability of synthetic turfs may be hampered by hot weather conditions. The New York City Department of Health and Mental Hygiene (2010) reports that synthetic turf fields may become too hot to play on when temperatures are high. The material in synthetic turf absorbs heat, resulting in surface temperatures that are greater than surrounding air and other surfaces. However, these affects can be mitigated. Williams and Pulley (2002) found that increases in surface temperature were more impacted by solar radiation than ambient temperatures. As a result, surfaces can be made cooler when they receive less direct light exposure, like when they are painted lighter colors or are shaded. Temperature increases can also be assuaged by irrigation. Yet these solutions do not entirely mitigate hot temperatures. The difference between turf temperatures and the surrounding air can be significant. In one study, Brakeman (2004) found turf temperatures to be over 100 degrees hotter than surrounding air temperatures. In another, Williams and Pulley (2002) found synthetic surface temperatures as high as 200 degrees. Cooling effects have brief results (Williams and Pulley, 2002; McNitt, Petrunak, and Serensits, 2008) and can result in a large increase in resource use and costs.

While high heat can create an obstacle for synthetic turf use, there are means to temper such effects. Also, use of turfs are not typically greatest during the hottest parts of the year, as sports

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seasons typically fall in the late summer through the spring. These impairments do not compare to the degree to which natural fields are compromised during rain and snow. With all weather considered, artificial turf has greater availability over natural grass when taking weather into account.

### 2.3 Increased Playing Hours

Artificial turf provides a greater number of playable hours than natural turf. The Synthetic Turf Council (2008), an artificial turf advocacy group, estimates that natural fields provide 680-816 hours of play in a three-season year, as compared with 3,000 hours for synthetic turf. Kay and Vamplew (2006) offer an alternative estimate with approximately 300 hours of play time for natural grass, 800 for reinforced turf, and 3,000 for artificial turf. James and McLeod (2008) calculate the usable hours of synthetic turf to be closer to 2,000 hours per year on average, with a range from 450 to 4,200 hours. They also note that the typical weekly hours of use for synthetic turf pitches were 44 hours, as compared to 4.1 hours for natural turf. In direct applications of synthetic turf, many note a measured increase in use-time of these field types. For instance, with a switch from natural to synthetic turf, the City of Newport Beach (2009) found a 49% increase in field availability, and the Charlottesville City Schools reported a 60% increase in available playing time.

Weather is an important factor in use-times for natural turf. While artificial turf fields recover quickly after precipitation, natural fields may take days before they become playable again. Weather-related losses in use-time can be considerable. Even in the relatively temperate climate of Newport Beach (2009), Recreation and Senior Services Department staff estimates that fields are unavailable an average of ten days a year because of rain. In addition to weather-related use-time loss, all natural fields must be given time to "rest" to allow for growth. The Synthetic Turf Council (2008) states that the managers of natural fields recommend against the use of natural fields beyond 20-24 hours per week, to avoid overburdening them. In addition, poor management can impact the availability of fields. If elements such as drainage systems and watering and maintenance schedules are improperly planned they can unnecessarily impede on the use-time of fields.

### 2.4 Maintenance

The maintenance required, along with the number of playing hours a surface can provide, are key factors in assessing the value that a certain turf type provides. Reduced maintenance is often cited as one of the major benefits for synthetic turf. However, artificial turf does require a minimum level of upkeep. The savings in maintenance are apparent when considering the useful hours that are returned on the cost and time required for maintenance. One estimate for an ideal level of maintenance for a synthetic field is one hour for each ten hours of use (James and McLeod (2008)). Below is a comparison of the typical maintenance requirements and their estimated durations for synthetic and natural turf.

The amount of maintenance that is needed for any field type can vary depending on a multitude of factors. The Sports Turf Managers Association (2005) states that these costs depend on: amount of use; type of use (i.e. sports played); climate and weather; existing soil and terrain; irrigation and water needs; labor; field type; and field security (protection against vandalism, non-regulated play, etc.). The proper upkeep of a field will ensure that it reaches its lifetime

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potential, thereby yielding a greater return on investment. Both natural and synthetic turfs require a minimum level of upkeep to preserve surface quality. Activities that can be classified as grooming are the most important components of maintenance for both turf types. In addition, debris control, additional cleaning, and needs-specific maintenance may be required.

For synthetic fields, grooming is needed to maintain optimal play quality and proper functionality. Grooming practices include upkeep of seams, fibers, infill, and the drainage system. A broom or brush can be implemented to align the direction of fibers. Top dressing equipment and spiking equipment are employed to re-dress, redistribute, and de-compact the crumb rubber. Debris removal is also extremely important and should be done as quickly as possible to prevent more complicated problems, such as blockages in the drainage system. Sweepers, blowers, and vacuums are used to remove these materials. Additional cleaning steps may be necessary to get rid of the contaminants that cannot easily be eliminated. Pressure washing and spraying can flush the field or apply chemical agents and disinfectants. Also, depending on the specific needs of a particular field, other maintenance and equipment may be necessary. For instance, painters and scrubbers might be required to add and remove painted lines for various sports. In more severe climates and weather, snow removal is done with a plow. Irrigation systems can be helpful in environments with high temperatures, or when specified in warranty agreements. Additionally, any chemicals needed for the weed control, cleaning, and static-minimization are applied through spraying equipment.

Maintenance for natural turfs is also primarily focused on grooming. Mowing, watering, fertilizing, plant-protectant application, aeration, and irrigation should be carried out as necessary to ensure the proper growth of grass. In addition, debris may need to be removed, although the impact of debris is generally of less consequence than for artificial systems. Again, much like synthetic turf, there may be special equipment required for the specifics use needs of a field, such as painters, plows and sprayers.

An expanded list of possible maintenance requirements and their associated equipment has been complied in Table 1 below. The information in this table has been collected from various studies that discuss the possible maintenance entailed for a synthetic or natural turf system. For the purpose of identification each reference was assigned a number, which is then listed in the table when the reference suggests a specific type of maintenance. Maintenance needs can be categorized into seven types: general needs; debris removal, grooming, surface maintenance, systems, turf restoration, and user specific needs. From these, 13 specific needs were identified, with 22 pieces of associated equipment and 8 supplies. Additional maintenance factors that were suggested for inclusion were labor, weeding, and seam repairs. We will assume that all maintenance will require labor, and the differences in labor costs are included in Section 2.5.3, Table 2.6. Weeding is an activity that has been suggested for synthetic turfs by the Turfgrass Resource Center (2008) and Patton (2009). This activity does not need to be individually considered, as it is covered by the inclusion of labor and hand tool equipment. Lastly, seam repairs may be necessary, but are assumed to occur only a few times over the life span of a synthetic turf. If such repairs are necessary, it is assumed that they will be done by a contractor, so as to not violate any warranty on the turf. These three aspects will not be considered for the remainder of this section.

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| Table 2.1: Equipment and Supplies Recommended for the Maintenance of Fields | | | | |
|---|---|---|---|---|
| **Category** | **Purpose** | **References that Recommend Maintenance Type** | | **Equipment & Supplies** |
| | | **Synthetic** | **Natural** | |
| General | Transport | 1, 3, 4, 5, 9 | 1, 4, 9 | **Equipment**: tractor/utility cart for operating equipment |
| | Small Tasks | 3, 4 | 4 | **Equipment**: assorted hand tools (i.e. rakes, hammers, edger, etc) |
| Debris Removal | Clearing of Objects | 1, 3, 4, 5, 6, 9 | 1, 4*, 9 | **Equipment**: sweepers/blowers to remove surface debris |
| | | 1 | 4*, 9 | **Equipment**: vacuum to remove small items |
| | | 5, 9 | | **Equipment**: field magnet dragged to capture metal objects |
| | Cleaning/ Clearing of Contaminants | 1*, 3, 4* | | **Equipment**: pressure washers/flushing equipment remove unwanted fluids or contaminants |
| | | 6, 9 | | **Supply:** chemical disinfectants |
| Grooming | Grass & Fiber Blades upkeep | 1, 2, 3, 4, 5, 6, 9 | 9 | **Equipment**: broom, brush or tine dragged to realign fibers and to distribute the crumb rubber |
| | | 5, 9 | 9 | **Equipment**: roller keep fibers from forming grain |
| | | | 1, 4, 9 | **Equipment**: mower |
| Surface | Soil/Infill Compaction, Reapplication & Redistribution | 1*, 3* | | **Equipment**: spiking equipment: de-compaction, redistribution of crumb rubber |
| | | 1, 4, 9 | 1*,4*, 9 | **Equipment**: top dressing equipment: for crumb rubber loss |
| | | 6, 9 | 9 | **Supply:** top dressing (additional crumb/sand) |
| | Fertilizing | | 8, 9 | **Equipment**: seed/fertilizer spreader |
| | | | 1, 4, 9 | **Supply:** fertilizer |
| | Aeration | | 1* | **Equipment**: de-thatching equipment |
| | | | 1*, 4*, 9 | **Equipment**: (deep tine) aerator |
| | | | 4* | **Equipment**: core harvester: collect cores that are pulled to the surface following aeration. can be used to gather thatch, similar to a sweeper. |
| | Protectant application (Weeds, Static) | 1, 4, 5, 9 | 1, 4 | **Equipment**: spraying equipment: for the application of weed control, pest control, cleaning agents, wetting agents to lessen the static charge to aid in drainage. |
| | | | 9 | **Supply:** pesticides |
| | | 2, 6 | | **Supply:** sprays to reduce static (fabric softener) |
| Systems | Watering | 1*, 4* | 1*, 4*, 9 | **Equipment**: irrigation system: for watering, cooling, and warranty requirements |
| | | 4* | 4* | **Equipment**: hoses/nozzles: small scale irrigation (syringing) |
| | | 7, 9 | 9 | **Supply:** water |
| Restoration | Lawn Renovation | | 1* | **Equipment**: groove or slit seeder |
| | | 7 | 8, 9 | **Supply:** seeds/sod replacement |
| Needs Specific: Weather, Play Type | Painting | 1*, 4*, 5, 9 | 1*, 4*, 9 | **Equipment**: painters: adding lines |
| | | 6, 9 | 8, 9 | **Supply:** paint |
| | | 4* | | **Equipment**: mechanical scrubbers: cleaning painted lines on the synthetic turf. |
| | Snow Removal | 3* | 1*, 4* | **Equipment**: special rubber blade snow plow |

*indicates the item was suggested as optional

References for Table 2.1


1) Sports Turf Managers Association (2005)
2) Patton (2009)
3) FIFA (2001)
4) Sports Turf Managers Association (2006)
5) "Synthetic Turf Maintenance Equipment" (Brakeman 2005)
6) "2004-2005 Maintenance Budget Synthetic Infill Field" (Brakeman 2005)
7) Chirillo (2008)
8) New Yorkers for Parks (2006)
9) Turfgrass Resource Center. (2008)


The primary purpose of Table 2.1 is to show the breadth of equipment that has been suggested for both field types. The inclusion of any item is not meant to suggest that it is a necessary item for the maintenance of a field. The next section will be dedicated to identifying which of these accessories are needed for the specific maintenance requirements of each field type. The premises upon which an inventory of equipment and supplies will be created is that it should: 1) be as comprehensive as possible; 2) identify items that are needed at a regular frequency; 3) identify items that are of environmental or financial consequence; 4) highlight the differences in requirements between the two field types.

Without financial constraints, the accessories that can be purchased to care for a field are virtually limitless. Therefore, some practicality must be employed to limit this analysis to the items and practices that are required to secure the health of the field, and thereby increasing its longevity. In addition, it is assumed that beyond what is identified, supplementary items will be needed to deal with unforeseeable circumstances. However, these instances will not be accounted for because they cannot be predicted to occur at any regular interval - or at all. Also, precautions can often be taken by turf managers to help minimize the risks and impacts of such occurrences that would require additional maintenance needs.

Table 2.2 below outlines the items deemed necessary for the maintenance for artificial and natural turfs. Also included is a discussion of the rational for the inclusion of any given items. Much of the equipment needed is necessary for both field types. Where differences in the equipment needs do occur between the two fields, it is generally because natural grass requires maintenance practices that artificial turfs do not (e.g. such as mowing, fertilization, and aeration) to keep them healthy.

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| Table 2.2: Equipment and Supplies Recommended for the Maintenance of Fields | | |
|---|---|---|
| Maintenance Equipment & Supplies | | Discussion |
| Synthetic | Natural | |
| Tractor/utility cart | Tractor/utility cart | A tractor or utility vehicle is useful for maintenance, and is often used as the primary machinery to which other equipment is attached. |
| Assorted hand tools | Assorted hand tools | Hand tools are the easiest way to ensure quick fixes to problematic spots in the field. |
| Broom, brush or tine | | The regular dragging of a synthetic field is a key to the maintenance of its fibers. Similarly, drag brushes are useful to evenly spread infill. Equipment, such as a brush, broom, or tine is needed to carry out these tasks. |
| Sweepers/blowers | Sweepers/blowers | A sweeper or blower ensures the proper removal of debris for optimal play quality. While the accumulation of organic debris is more problematic on synthetic fields, inorganic debris is equally problematic for both turf types. |
| Roller | | Frequent rolling is recommended to keep synthetic fibers from standing up and forming a grain. |
| | Mower | Blades of natural grass must be trimmed to ensure proper play quality. A mower is a necessary piece of equipment to keep blades at the appropriate length. |
| Top dressing | Top dressing | Top dressing for natural and synthetic fields is occasionally necessary, as soil and infill can be lost or displaced. On natural fields, topdressing promotes stronger root systems, a more resilient surface, and improved playing surfaces. On synthetic fields, infill and sand must be added when these materials get displaced. |
| | Fertilizer | Fertilizer is applied to most natural fields to ensure the growth of a robust and deep rooted field. |
| | Aerator | It is recommended that a lawn be aerated once or twice a year. Aeration needs depend on the presence of problematic elements (e.g. thatches), and the degree of soil compaction. |
| Spraying equipment | Spraying equipment | Spraying equipment serves a very particular purpose (i.e. liquid cannot be applied by hand with a shovel). Each field type requires the application of numerous liquids. For natural fields it is used to apply agrochemicals such as weed control and pest control. For synthetic turf it is used for cleaning, wetting, and static control of the surface. |
| Water | Water | Water is necessary for the survival of natural turf. In addition, synthetic turfs are often watered down to control temperatures, lubricate the surface, and stabilize infill and reduce migration. |
| Irrigation system | Irrigation system | In order to apply water, a method of irrigation is necessary. |
| | Seed/sod | One of the primary benefits of artificial turf is the infrequency with which it must be replaced. Thus, to fully consider the potential of artificial turf, the impacts of seed and sod replacement should be taken into account. Many lawns will benefit from a scattering of grass seed after top dressing and this will thicken the grass for the next year creating a dense healthy green lawn. |
| | Paint | For natural grass, field lines must be painted on. Also, these lines must be re-painted after as the painted lines are grown out and mowed away. For artificial fields, paint is used to make temporary lines when the field is used for diverse purposes. Permanent lines can be laid into the system, or can be painted on with fairly infrequent re-application. |

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In considerations of turf maintenance, the majority of the equipment suggested by the various authors was not deemed necessary for field maintenance or consequential to maintenance evaluations. Several items were excluded because they are needed relatively infrequently or on a circumstantial basis. For day to day upkeep, the needed equipment is fairly evident. However, for items that might only be used on an occasional basis or that serve to alleviate the build of long term problems, their necessity is highly subjective. Often, such items can be rented, or a contractor can be hired to do the job that the equipment is meant to serve. As such, the capital investment and storage required of these items may not be prudent. Examples of equipment used fairly irregularly are: field magnet, vacuum, and pressure washers or flushing equipment. Supplies that are used in small enough quantities in the long run to render any associated impacts negligible are: chemical disinfectants and liquids to minimize static on artificial turf. Similarly, on natural fields, pesticides should only be applied when needed, and are not recommend for application at regular intervals as a preventative measure. Bruneau et al. (2001) of North Carolina State University's Center for Turfgrass Environmental Research & Education notes that when a field is properly maintained, insects are seldom a problem.

Some of the suggested items that were disregarded serve very real field needs. However, in several cases, these needs can also be served by other equipment or additional labor. This is the case for devices such as spiking equipment, a groove or silt seeder, a core harvester, top dressing equipment, and a seed and fertilizer spreader. Other equipment is only needed in certain circumstances, which may not necessarily occur for any given field. For example, the need for painters, mechanical scrubbers, and rubber blades to plow snow and de-thatching equipment will vary from field to field.

*Supply Use Rates*

Equipment that is needed for maintenance will only have to be purchased a few times over the life time of a turf. On the other hand, supplies must be acquired at regular intervals. Quantities and associated impacts for any given supply can vary greatly. For a true comparison of turf requirements, the rate of use for each of these supplies will be evaluated below.

*Fertilizer*

Fertilizer requirements are determined primarily by the type of grass, climate conditions, and the percentage of nitrogen that a fertilizer contains. There is a slight variation in the suggested amounts of nitrogen per year. Multiple applications are usually necessary, as fertilizer can damage a field if applied in quantities greater than one pound of nitrogen per one thousand square feet. Pettinelli (2007) of the University of Connecticut suggests two to three pound of nitrogen per thousand square feet, depending on whether clippings are left on the field. Similarly, Johnson et al. (2002) suggests two to four pounds per thousand square feet. Reicher and Throssell recommend fertilizing 0.75-1.5 pounds per thousand square feet four times a year. For this study, we will assume a fertilization rate of three pounds of nitrogen per thousand square feet, broken up into two applications. Based on our assumptions, 225 pound of nitrogen should be applied to an 85,000 square foot field annually.

*Water*

The precise amount of water required for a natural field can vary dramatically. Irrigation needs will differ based on the climate the turf is located in: humidity, precipitation, and the

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temperature all play a role in determining the amount of moisture that must be added to a field. The condition of a natural field will also figure into its irrigation needs. Minimum levels of maintenance prevent the creation of problems such as thatches, which can impede water from reaching the soil. If systems are not kept in working order, the efficiency of irrigation will be compromised. Lastly, the way in which irrigation is carried out can change the amount of water needed. Demand on fresh water will change based on the time of day irrigation takes place (due to evaporation), and if alternative sources can be utilized. All of these factors can result in more or less water needed to achieve a static level of moisture. Duble (1993) provides a range of 12 to 36 gallons per square foot needed in Texas, depending on the irrigation needs for different regions. The Sonoma County Water Agency (2009) uses 22.5 gallons per square foot when watering city lawns.

***Topdressing***

Topdressing is the addition of sand, soil, compost, or other material to the turf surface. It serves to level the playing surface, promote stronger root systems, and create a more resilient surface. This is accomplished by the added material promoting the decomposition of the organic matter that is between the soil surface and the grass blades.

Generally the application of topdressing should be done following fertilization, especially in the spring. Chirillo (2008) notes that some fields might call for 2 to 3 applications per year. The Sports Turf Managers Association (2009) cites five applications per year for a sand based soccer field. For our purposes one application per year should be accounted for, while we acknowledge that additional applications may be necessary.

Rolawn (2010), a European supplier of topsoil and producer of cultivated turf, suggests that based on the time of year different quantities of topdressing be applied. They recommend that 1.5 liters of topsoil per square meter be applied in the summer, and twice that amount be applied in the spring and autumn.

For synthetic fields, topdressing consists of the addition of crumb rubber infill. Additional infill may be periodically necessary, as over time large quantities can be displaced. The Sports Turf Managers Association (2009) gives an estimated application rate of 10 tons of dressing, applied once during the year.

***Paint***

Field markings must be repainted on occasion to maintain the field's usefulness for various sports. Hall (2004), of TruMark Athletic Field Marker, notes that five gallons of diluted acrylic latex paint will cover 1,000 linear feet that is four inches wide. He also estimates that a standard football field requires 4,600 linear feet of paint to apply four sets of hash marks, and five yard lines. This equates to around 25 gallons of paint that is needed, according to his approximations. However, for a NCAA Division I Football game, he calculates paint needs for basic lines are 60% higher, with 27.5 gallons necessary for out of bounds lines, and 12.5 gallons for yard lines. In addition, in this instance 55 gallons of colored paint was also used.

Hall's (2004) figure may be a bit high when compared to the recommendations of others. The Sports Turf Managers Association (2007) suggests that for a regulation size football field seven and a half gallons of paint are needed for the hashes and field numbers. This figure is five

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gallons less than Hall's calculation. In another publication, the Sports Turf Managers Association (Natural Grass Athletic Fields 2009) suggests that for an 114,000 square foot sand based soccer field, around 100 gallons of paint are needed for 6 applications annually. Meanwhile, a provider of aerosol paint, the California Field Supply Company (2007), offers an even more conservative figure. They estimate that 3.36 gallons of aerosol paint is needed for the initial layout of the field—which must be reapplied a second time per year—and 1.68 gallons are needed for weekly over markings in a 30 week year (or half of that for lower volume fields). Although the California Field Supply Company does not indicate the size and purpose of the field they are considering, only indicating that it was a field of "standard dimensions."

The amount of paint required for an application of field markings becomes even more muddled when considering the actual materials that go into the painting of Florida State University's Football Field. Theacc.com (2005) estimates that 460 gallons of paint are applied to the field prior to each game. They note that approximately 100 gallons is used to apply white lines, numbers and hash marks. An additional 360 gallons is used on the sidelines, and to paint the team emblem midfield and in the end zones.

The amount of paint needed per application is difficult to determine, given the broad range of estimates suggested. However, the slight differences in the amount and type of paint needed for natural and synthetic fields are insignificant when comparing the number of applications required. Since natural grass is mowed frequently to maintain its proper length as it grows, lines must be reapplied at regular intervals. Most literature seems to suggest that paint should be reapplied to grass prior to each event. On the other hand, a synthetic turf needs far fewer applications of paint. In fact, the Sports Turf Managers Association (Natural Grass Athletic Fields 2009) only accounts for two applications per year on artificial fields. However, a field manager may choose to apply paint more frequently to meet more rigorous aesthetic needs.

*Replacement Seed and Sod*

It is assumed that over time natural grass will get old and need to be replaced. With that, new seed or sod will be required once the old turf is removed. The frequency with which this is expected to occur can also affect the costs and life cycle of the field. Another practice that consumes an excess of seeds is over seeding. Over seeding is done to make the surface greener in the winter, and to support sports that go later into the season (i.e. that are played late into the winter or in the spring). However, this practice is not recommended for general maintenance, as it can compromise the health of the existing grass that must compete with the additional seed grass variety.

## 2.5 Cost

In this section the cost of natural and synthetic fields will be explored for comparison. Estimates will be based on a sample field of 85,000 square feet. This field size is large enough for a regulation size American Football (57,600 sq. ft.) or International Soccer (69,300 sq. ft.) field plus side lines.

### 2.5.1 Installation Costs

The cost of turf construction varies dramatically based on numerous factors. As to be expected, the needs requirements for a field determine its associated cost. The size and type of play that will occur are the principle considerations when calculating construction

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costs. The drainage and irrigation systems necessary to suit the capacity of any particular field also must be taken into account when gauging expenses. The location of a field installation also factors into its total price, determining its costs related to labor and the difficulty of installation based on factors like soil and climate. For example, additional costs may result from the labor necessary to prepare a difficult surface or to offset weather-related delays in the construction schedule.

The construction price for a natural field can span a wide range depending on the properties of the land it is built on. If native soils are very sandy, they can support the installation of new turf without additional materials to improve the surface stability. Native soil fields are the least expensive of all natural fields. Of native soil fields, there are two options: seeding and sod. Seeding is the less expensive option, because it does not require the purchasing of sod or top soil. This option runs at about $1.20 per square foot. (Sports Turf Managers Association, 2008; Turfgrass Resource Center, 2008). Sod, on the other hand, costs about $2.25-$5.25 per square foot (Sports Turf Managers Association, 2008). Other types of natural turf require the addition of sand, and possibly other materials, to improve the robustness of the root zone for greater availability. The Turfgrass Resource Center estimates that basic sand-based field installations cost between $2.94 and $4.12 per square foot. However, they note that more elaborate sand-based systems can cost over $7 per square foot to install. Meanwhile, the Sports Turf Managers Association estimates the average cost of construction for sand based systems as $5.25 for a sand cap and $8.50 for a sand and drainage. Using these figures, estimates for a sample 85,000 square foot field are calculated in Table 2.3 below:

**Table 2.3: Installation Cost for a 85k Square Foot Grass Field**

| Natural Field Type | Cost |
|---|---|
| Seed | $102,000 |
| Sod | $191,250 - $446,250 |
| Basic Sand | $250,000 - $350,000 |
| High-End Sand | $722,500 |

Meanwhile, the cost of a synthetic turf varies based on many of the same aspects as natural turf. The existing condition of the field affects the cost of surface preparation, including: excavating the site, adding any necessary foundational materials, and compacting the foundation. The more material that must be removed, the greater the cost of installation will be. A proper drainage system is critical for artificial fields; without it, damage typically occurs from moisture that is trapped in the turf components. This is true even of indoor turfs, as liquids are often applied to clean and maintain their surface. Choices of turf components also influence price, including: the quality of fibers, padding, backing, and infill. In addition, specialized logos or sports lines have associated costs based on whether they are painted or sewn in. The price range of synthetic turf per square foot is $6 to $11.76. The Sports Turf Managers Association (2008) estimates that the construction cost for a synthetic turf runs between $6.50 to $11 per square foot. The Turfgrass Resource Center (2008) approximates installations to be on the higher end from $10 to $11.76 per square foot. Meanwhile, Sporturf, a synthetic turf provider, estimates that installing an artificial turf field costs from $6 to $8 per square foot. However, they also note that a

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10,000 square foot "state-of-the-art fake grass" turf was installed in Shaw Park, GA for $30,000 (a price of $3 per square foot). Using these figures, the cost of an 85,000 square foot synthetic turf field ranges from $510,000 to $999,600. This figure is significantly higher than the range of $102,000 to $722,500 found for natural fields.

Comparisons of the costs to install natural and artificial fields in other studies show similar differences in price between the two field types. Several case studies provide estimates of the installation costs for the two types of fields without noting the size of the field. Despite this omission, these works provide insight into the potential construction costs of fields, as well as the difference in costs between synthetic and natural turfs. The price estimates from these various works are listed in Table 2.4. Of note is the minimum of all of these costs for natural fields, which has been estimated to be about half of the cost calculated above, at $50,000. Meanwhile, the prices quoted for synthetic turfs are on the higher end of the range found earlier. Furthermore, our calculations show synthetic field installations as costing from 0.7 to 9.8 times more than a natural field. Several of the additional studies show artificial fields as ranging from twice the cost of grass to 20 times the cost.

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| Table 2.4: Price Estimates for the Total Costs of Installation for Natural and Synthetic Fields | | | | |
|---|---|---|---|---|
| **Resource** | **Context of Research** | **Synthetic** | **Natural** | **Number Of Times Greater Cost Of Synthetic Turf Installation as Compared To Natural Turf** |
| Turfgrass Resource Center (2008) | A publication that addresses concerns about synthetic turf using scientifically backed data for a non-profit trade association that represents the turfgrass sod industry. | $850,000 – $1,000,000 | $50,000 – $600,000 | 1.4 to 20 |
| Williams and Pulley (2002) | An investigation conducted at Brigham Young University for their football field, half of which is synthetic, and the other half which is sand-based natural field. | n/a | n/a | 11.8 |
| Powell (2005) | A conference presentation aimed at athletic field managers addressing the complexities of natural and synthetic turf. Powell is a turfgrass agronomist with the University of Kentucky. | *Basic:* $600,000<br><br>*High End:* $1,000,000 | *Soil:* $50,000<br><br>*Sand:* $1,000,000 | 0.9 to 18:1 |
| Claudio (2008) | A journal article in *Environmental Health Perspectives (EHP)*, a monthly peer-reviewed research and news publication by the U.S. National Institute of Environmental Health Sciences, National Institutes of Health, Department of Health and Human Services. | $1,400,000 | $690,000 | 2.0 |
| Skindrud (2005) | A case study for a installation at Springfield College in Springfield, Massachusetts, in an informational article comparing natural and synthetic fields for landscape contractors. | $800,000 | $400,000 | 2 |

Using the information provided above, a precise estimate for the installation costs of different turf options will be determined for use in total system cost calculations. The range of comparative proposed prices can be seen graphically in Figure 2.1 below. This figure shows the minimum and maximum prices provided by various authors, as well as the mean price calculated for each proposed turf type. For our purposes, a single value is needed for a comparative analysis of the total cost of synthetic and natural turf systems. For this objective, the price per unit (i.e. per square foot) value is a more credible estimate because: 1) it is known to be a comparison of two fields of equivalent size, and 2) it is scalable by a known factor to achieve a specific case study field size. It should be noted

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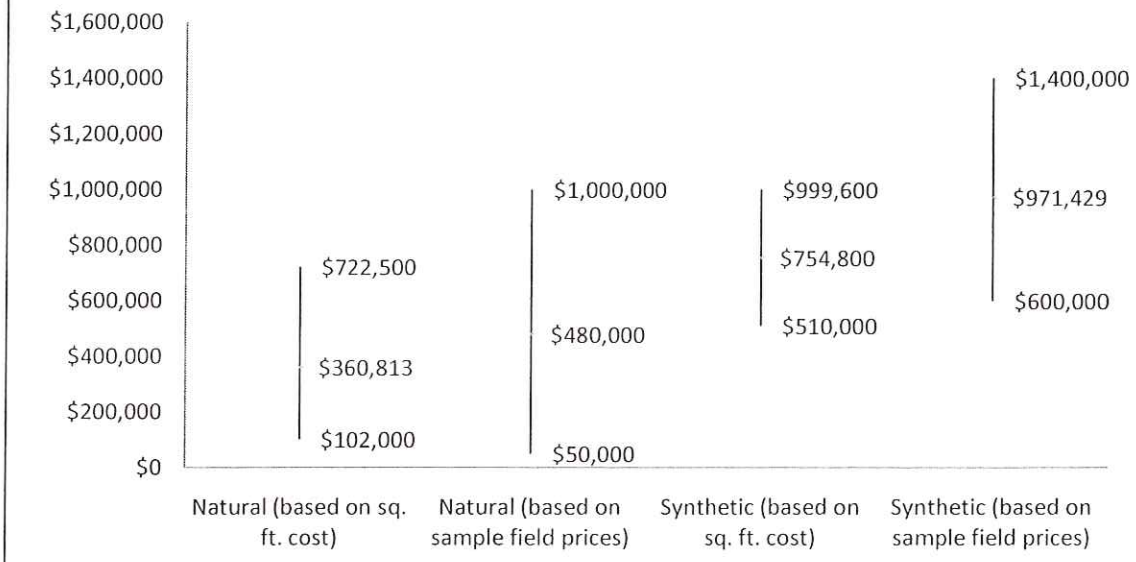
that, regardless of whether the price per square foot or total price is used, the average cost for a synthetic field is twice that of a natural field. Using the square foot cost, the mean value of the research investigated will be used for cost calculations. Specifically, this is $8.88 per square foot of synthetic turf and $4.24 per square foot of natural turf, or $754,800 and $360,813 respectively for an 85,000 square foot field.

**Figure 2.1: Initial Cost of Various Turfs**




### 2.5.2 Equipment Costs

Equipment costs are calculated in large part by the equipment and supplies identified in the maintenance section of this report (see Section 2.4: Maintenance). The average cost associated with each of the identified items has been collected from various studies. These prices have been listed in Table 2.5 below. These estimates will be used to calculate the capital costs of maintenance.

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| Table 2.5: Suggested Cost for Equipment Based on Field Type | | |
|---|---|---|
| **Equipment:** | **Synthetic** | **Natural** |
| **Tractor/Utility Cart** | $7,000 to $16,000 (a)<br>$2,500 to $16,000 (b) | $7,000 to $18,500 (a) |
| **Assorted Hand Tools** | No cost estimate given | No cost estimate given |
| **Sweepers/Blowers** | $1,500 to 20,000 (a)<br>$1,500 (c)<br>$1,500 to $20,000 (b) | No cost estimate given |
| **Broom, Brush Or Tine** | $500-3,000 (a)<br>$500 (c)<br>$500 to $3,000 (b) | |
| **Roller** | $250 to $2,000 (a)<br>$250 to $2,000 (b) | |
| **Mower** | | $13,000 to $69,000 (a)<br>$107* (d) |
| **Spraying equipment** | $1,000 to $35,000 (a)<br>$1,000 to $35,000 (c) | No cost estimate given |
| **Aerator** | | $3,500 to 17,000 (a) |

*yearly cost for a five year lifetime

References for Table 2.5

a) Turfgrass Resource Center(2008)
b) "Synthetic Turf Maintenance Equipment" (Brakeman 2005)
c) "2004-2005 Maintenance Budget Synthetic Infill Field" (Brakeman 2005)
d) New Yorkers for Parks (2006)

The range of estimated prices given by any author can be quite large. For instance, spraying equipment is expected to run somewhere between $1000 and $35,000 (Brakeman, 2005). The equipment that is needed for the maintenance of both field types is assumed to be similar in price. These items—tractor/utility carts, hand tools, sweeper/blowers, and spraying equipment—are similar enough that for the purposes of estimations, they do not need to be differentiated , despite possible differences in the specific devices. In general, cost estimates will be made for equipment using the mean of prices provided. Where this is not the case, this will be noted. The specific price estimates that will be used are:

- A tractor/utility cart will be assumed to be around $10,375, the mean value of all suggested figures that range from $2,500 to $16,000.
- No estimates were given for the total price of hand tools. However, it is assumed that the cost of these is inconsequential in the comparative costs of artificial and natural fields. Therefore, these costs will not be included.
- The cost of a sweeper/blower will be assumed to be $7,667. The suggested prices range from $1,500 to $20,000.

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- Some combination of a boom, brush, or twine will be assumed to be $1,333.
- A roller will be assumed to be $1,125, the mean value of all suggested figures that range from $250 to $2,000.
- It will be assumed that a quality mower will be needed given the frequency with which it will be used. The estimate given by New Yorkers for Parks (2006) will be disregarded, as it is questionable that the type of mower needed can be obtained for such a figure (i.e. $107 per year for five years). The midpoint price of $41,000 will be used in calculations.
- Spraying equipment is assumed to be $18,000.
- The suggested price for an aerator is $3,500 to $17,000. The mean of this, or $10,250, will be used in calculations.

Using these figures, the total equipment cost will be $38,500 for a synthetic field and $87,292 for a grass field.

### 2.5.3 Total Cost of Ownership

The table below provides examples of a 10-year total cost of ownership, comparing the cost to install and maintain natural sod turf versus synthetic turf. The example uses a 78,000 square foot field, private stadium.

**Table 2.6: Total Cost of Ownership**

| | Artificial Turf | Sod |
|---|---|---|
| Installation Cost | $692,640 | $330,720 |
| Year 1 Costs | 14,900 | 65,258 |
| Year 2 Costs | 14,900 | 65,258 |
| Year 3 Costs | 14,900 | 65,258 |
| Year 4 Costs | 14,900 | 65,258 |
| Year 5 Costs | 14,900 | 65,258 |
| Year 6 Costs | 14,900 | 65,258 |
| Year 7 Costs | 14,900 | 65,258 |
| Year 8 Costs | 14,900 | 65,258 |
| Year 9 Costs | 14,900 | 65,258 |
| Year 10 Costs | 14,900 | 65,258 |
| **10-Year Life cycle Cost** | **$841,640** | **$ 983,300** |
| | | |
| Uses during 10-Year Cycle | 1,400 | 350 |
| Cost per use | $ 601.17 | $ 2,809.43 |

**Key Assumptions:**

Artificial turf cost of $8.88 per sq ft, $4.24 for natural turf (sod)
Includes general maintenance, equipment, and water costs (annualized average amounts)
Assumes field does not already consist of natural grass
Does not include "replacement" costs, which may or may not occur during mid-point of life of installation

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## 2.6 Risk of Injury

One of the primary concerns for organizations considering the implementation of synthetic turf is whether it poses any significant health or injury risks. Numerous studies have been conducted assessing the likelihood of injury on natural grass and synthetic turf. Some studies reveal that there is very little difference in the rate, type, severity, or cause of injuries obtained on natural grass or synthetic turf (Fuller et al. 2007a, 2007b). A more recent study by Meyers (2010) shows that the latest generation of synthetic surface, FieldTurf, is safer to play on than natural grass fields. Through the analysis of the various injuries that occurred over the course of 465 collegiate games, Meyers shows that FieldTurf has lower incidence of: total injuries, minor injuries (0-6 days lost), substantial injuries (7-21days lost), and severe injuries (22 or more days lost). FieldTurf also had significantly lower injury rates that natural turf when comparing across play or event type, grade of injury, or various field conditions and temperatures. In addition, there was no significant difference found in head, knee, or shoulder trauma between the two playing surfaces.

Meyers' (2010) research is the most comprehensive study to date, and it addresses previous inconsistencies in findings on injury patterns. Prior studies on injuries suggest that rates for the two surfaces are similar, but that the type of injury varies (Meyers and Barnhill 2004; Steffen et al. 2007). Furthermore, there was no consensus amongst researchers on the difference in type and severity of injuries. Meyers and Barnhill (2004) found that injuries on natural turf tend to be more severe, with greater incidence of head concussions and ligament tears. Steffen et. al (2007), however, found that injuries on synthetic turf tend to be more long-term but occur at a lower rate than injuries on natural turf. Given this conflicting evidence, no major conclusions could be drawn about differences in risk levels between the two fields before the publication of Meyers' work.

The following section will discuss the specific health and injury risks posed by: surface hardness and traction, rates of abrasion, risk of staff infection, heat-related stress and injuries, and material safety.

### 2.6.1 Traction

Forces that resist shoe-surface motion have been termed traction forces, as they do not always obey the classical laws of friction (Shorten et al., 2003). If traction forces are too high, foot fixation may occur, placing a great deal of stress on lower extremity ligaments during movement (Shorten et al., 2003). This can result in an increased rate of knee injuries and collisions (Pasanen et al. 2007b). Several authors have noted that surface to shoe traction is correlated with increased incidence of injury (Pasanen et al. 2007A; Powell and Schootman 1992; Orchard and Powell 2003). Orchard and Powell show that cold weather reduced traction, leading to a lower injury rate, supporting the claim that traction plays a role in increased risk.

Research clearly points to a correlation between increased traction and greater rates of injury. Several researchers have noted that the more consistent, compliant surface that artificial turf offers is associated with lower shoe-surface traction (Noyes 1988; Schootman 1994). Meyers (2010) notes a lower incidence of injuries attributed to shoe-surface interaction during contact with synthetic turfs over natural grass turfs. In addition, Meyers

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attributes the lower incidence of ligament sprains on FieldTurf found by Ekstrand, Timpka, and Hagglund (2006) to the possibility of lower shoe-surface traction.

### 2.6.2 Hardness

Increased hardness is correlated with increased likelihood of severe head trauma. However, the hardness levels of synthetic fields, if set up correctly, fall well below these dangerous levels (McNitt and Petrunak, 2007c). Furthermore, it is easier to maintain an existing level of hardness on synthetic fields because hardness is related to infill depth. On the other hand, the hardness of natural fields varies according to soil-moisture, which is more labor-intensive to manipulate on an ongoing basis.

However, the solution is not to make fields as soft as possible. A surface that is not at the correct hardness level will affect athletes' performance, particularly by bringing on early onset of leg muscle fatigue (New York City Department of Health and Mental Hygiene, 2008). Set up should be carefully carried out to ensure proper hardness levels.

### 2.6.3 Abrasion

One of the major criticisms about synthetic turf is that it is seen by many to be more abrasive than natural turf. The old versions of synthetic turf elicited public complaint about incidence of abrasion (New York City Department of Health and Mental Hygiene, 2008). However, the newer versions have longer and softer fibers, making them less abrasive. At Penn State's Department of Crop and Soil Sciences, a study on synthetic turf systems included a measurement of the abrasiveness of the surface by pulling foam blocks over the turf's surface (ASTM Method F1015). The results, reported by McNitt and Petrunak (2007a), states that infill systems are less abrasive than older carpet-like turf generations. The abrasiveness was also affected by the grooming of the field surface (McNitt and Petrunak, 2007a).

Comparisons of the impacts of abrasions between natural and synthetic turfs are slightly favorable towards artificial fields. Unfortunately, the abrasiveness of natural fields has not been measured for contrast, as the ASTM Method F1015 is only applicable to synthetic surfaces. However, Meyers (2010) found that the rate of epidermal injuries caused by interaction with the surface were slightly lower on artificial turfs (1%) than on natural grass (1.3%). This research investigates some of the irregular injury patterns initially observed on artificial turf (Meyers and Barnhill, 2004). In this preliminary study, abrasion occurs more frequently on synthetic turf than natural turf (Meyers and Barnhill, 2004).

It should be noted that in and of themselves, abrasions are not usually severe injuries. However, these types of injuries can lead to more severe complications, including staph infections.

### 2.6.4 Staph Infections

Concerns have been expressed about the role that synthetic turf plays in facilitating staph infections. Methicillin-resistant Staphylococcus aureus (MRSA) is a drug-resistant bacterium that can result in severe, and sometimes fatal, infections. Due to increased outbreaks of MRSA in athletes, concerns have developed about whether turf fields increase

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the risk of such infections. While research suggests that abrasions from injury may play a role in the contraction of such infections, there has been no evidence of a causal relationship between synthetic turf and staph infections.

There are a variety of studies about the role that synthetic turf plays in the contraction of MRSA. All research indicates that synthetic turf is not a cause of MRSA. However, several authors point out that abrasions caused by turf may provide a means of entry for the outbreak of infection (Kazakova et al. 2005; The New York City Department of Health and Mental Hygiene 2008; McNitt 2008). The New York City Department of Health and Mental Hygiene claims that other factors are the primary cause of bacterial infections. Begier et al. (2004) reached similar conclusions, despite noting a seven-fold increase in the risk of MRSA contraction for athletes with turf burns. They concluded that it is not possible to assess the risk of outbreak associated with the playing surface because all players used artificial turf, and other factors, such as use of a poorly maintained whirlpool, which played a role in MRSA contraction. Furthermore, The New York City Department of Health and Mental Hygiene (2008) dismisses the associations that Begier et al. (2004) and Kazakova et al. (2005) make between synthetic turf and MRSA, because they did not compare them with abrasions caused by different sources. McNitt, Petrunak D, and Serensits (2008) determined that synthetic turf—and fields in general—do not provide an environment that is hospitable for hosting bacteria.

While infections may be associated with abrasions, not all abrasions result in MRSA. In addition, cases of MRSA have occurred in individuals who have not generally had contact with synthetic turf, such as dancers, wrestlers, fencers, and non-athletes. Furthermore, given that turf surfaces themselves do not harbor such bacteria, it is doubtful that there is an increased risk associated with abrasions that originate from synthetic turf surfaces over abrasions from other surfaces (McNitt, Petrunak D, and Serensits, 2008). However, since abrasions provide a means of entry for staph infections, rates of abrasion can be important to bear in mind (see the section on abrasion injuries).

Behavioral factors play a far greater role in determining whether staff infections will develop, including: the covering of wounds, physical contact with other players, and hygiene practices (McNitt 2008; Benjamin, Nikore, and Takagishi 2007; Nguyen, Mascola, and Bancroft 2005; Kazakova et al. 2005; Begier et al. 2004; Srinivasan and Kazakova 2004; Tobin-D'Angelo et al. 2003; Stacey et al. 1998).

### 2.6.5 Heat

There are two major concerns about the affect of heat on synthetic turf. The first is the material toxicity that can result from increased temperatures, a concern that will be discussed in the material safety section that follows. The second is the heat-related stress that can be caused by increased temperatures, such as heat exhaustion, heatstroke, burns, and blisters. We will examine these problems here.

Temperatures of synthetic turf do get higher than the surrounding air (see section on all-weather availability), which can play a factor in heat-related stress. There are two studies indicating that synthetic turf has resulted in heat blisters on players' feet (Williams and

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Pulley, 2002; SI.com, 2007). However, behaviors play a more significant role in creating heat-related injuries, such as: reducing playtime and preventing dehydration (Anderson et al., 2000; New York City Department of Health and Mental Hygiene, 2008b). It has also been suggested that humidity plays a greater role in heat stress than temperature (New York City Department of Health and Mental Hygiene, 2008b).

As can be seen, there are a variety of concerns about the safety of synthetic turf for players. Evaluation of these concerns finds that these risks, in many instances, can be mitigated. There are some risks that people should be aware of, but there is no evidence that the dangers of synthetic turf greatly outweigh those of natural fields.

### 2.6.6 Injury Conclusions

Despite these findings which are generally favorable towards synthetic turf, there is still a strong public perception that it is more likely than natural turf to cause injury. A study shows that 91.2 percent of NFL players thought that artificial turf would be more likely to contribute to injury (NFL Association, 2004). However, this public perception could be rooted in a variety of factors beyond the grasp of science. Players may be used to other fields or associate new technologies with their earlier, less-developed versions.

## 2.7 Material Safety

The use of athletic fields made of recycled tires has also been called into question because of concerns regarding toxicity. For example, the state of New York has recommended a moratorium on future construction of such fields pending additional research. Authorities are worried that because of the chemical content of the material, exposure by various means could endanger the health of field users, especially children. However, extensive research has pointed to the conclusion that these fields result in little, if any, exposure to toxic substances.

On the face of it, concerns about the toxicity of crumb rubber fields is quite warranted. The raw material from which they are made – used car tires – is known to contain numerous toxic and potentially carcinogenic compounds. These chemicals include polynuclear aromatic hydrocarbons (PAHs), phthalates, volatile organic compounds (VOCs), zinc, iron, manganese, nickel, PCB, copper, mercury, lead, cadmium, volatile nitrosamines, benzothiazole, isononylphenol, and more.

These chemicals are of concern for various reasons. Many of the metals have been associated with damage to the nervous system, as well as irritation of the eyes, nose, and throat. PAHs have been identified as a cancer risk and as causing substantial organ damage. And VOCs have been implicated in causing organ damage, or symptoms of lesser consequence such as nausea, headaches, and sense organ irritation.

However, the mere presence of a substance is not necessarily cause for concern. For the most part, when these chemicals are present in tires, they occur in very small concentrations. Also, their presence does not automatically equal exposure. Tires are relatively, though not entirely, inert, and the vulcanization process that they undergo to prepare them for their second life as artificial turf, renders them more, rather than less, stable. Further, many of the chemicals of concern are already present at relatively high levels in urban environments, as a result of

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numerous human activities which are not presently considered controversial: driving, heating and cooling systems, and regular production of household and industrial waste. Even the consumption of certain foods has been noted to raise a person's exposure to substances such as PAHs (van Rooij and Jongeneelen, 2010).The primary issue is not whether artificial turf contains such materials, for this is undoubtedly true, but, whether there is sufficient human exposure to elevate the risk above accepted levels. While small increases in risk may not be insignificant, a generally accepted measure of danger should be adopted, namely the general scientific consensus in determining whether an elevated level of risk ought to be deemed significant.

Being in proximity to a substance is not in itself a risk. There needs to be a means through which one's body comes into contact with the substance – a path of exposure, if you will. For crumb rubber, as it is not radioactive, there are numerous possible paths of exposure through which a human could conceivably be subjected to potentially noxious chemicals. The first and most direct route of exposure would be through actual oral ingestion of pieces of the crumb rubber itself. Now, it is highly unlikely that most field users will decide to consume a chunk of the playing field. However, this is a valid concern when considering the most vulnerable portion of the population – very small children. It is entirely possible, and perhaps inevitable, that some small children will pick up infill pieces and swallow them.

Secondly, and more likely, would be hand-to-mouth exposure, especially of dust or small particles of crumb-rubber. If such matter got on the hands of a user of the field, and the user then touched his hand to his mouth, he could ingest infinitesimal amounts of crumb rubber particulate.

Thirdly, dermal exposure is highly likely. The skin of field users is bound to come into contact with the field's surface. Given the naturally protective qualities of skin, this is an unlikely route of exposure, unless the substance is abrasive to skin itself.

Fourth, there is concern about chemicals leaching off of the fields – especially if the fields are outdoors and subjected to periodic rainstorms (Moretto, 2007). Such chemicals, if water-soluble, could come to enter the groundwater or drinking water supply.

Finally, and perhaps most significantly, there is the possibility of inhalation of toxins from the field. Such inhalation would generally come about through one of two possible phenomena. The first is a process known as "out-gassing" or off-gassing." As noted above, recycled tires are substantially, though not entirely, inert. Some compounds within the material will, over time, come to be released from the material and to enter the air. This is a particular concern with so-called "volatile organic compounds," but also with PAHs. Secondly, repeated use of the field could cause atomized particles of the field to be produced as barely noticeable dust, or "particulate". Such particulate could be inhaled by users of the field.

The potential of toxic exposure along each of these pathways has been the subject of repeated inquiry. Numerous governmental agencies have carried out independent research into the toxic potential of crumb rubber, and we will review the results of this below. Generally, it has been found that crumb rubber fields do not present an elevated risk to health through exposure to

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toxic substances, but researchers have noted some areas of concern. More typically, though, they have noted the present existence of "knowledge gaps"; a lack of full understanding at the general theoretical level which renders the inquiries to some degree inconclusive.

### 2.7.1 Direct Ingestion

Two major studies of the potential for toxic transference through direct ingestion have been carried out. The first, by Birkholz, Beton and Guidotti (2003), involved immersing tire particulate in chemical solvent and testing the resulting chemical for increases in carcinogens. This test did not clearly demonstrate a significant increase in carcinogenic levels.

A similar study, by the California Integrated Waste Management Board (CIWMB, 2007), subjected 10mg of tire shred samples to a chemical environment that replicated the human digestive system. In all, 22 chemicals were released by the samples, but none at levels that were associated with significantly elevated risk levels. Scientists performing this experiment were particularly concerned with an elevated risk of cancer in children. The study found, though, that ingestion of a significant quantity of tire shred did not elevate a child's risk of developing cancer, relative to the overall cancer rate of the population.

### 2.7.2 Hand-to-Mouth Contact

This same study, by the CIWMB (2007), also evaluated increased risks due to hand-to-mouth exposure. For hand-to-mouth exposure, researchers took wipe samples from field surfaces and were able to identify five chemicals present in rates significantly higher than the general environment. Calculations were then made to determine the frequency with which these chemicals would or could enter the body through hand-to-mouth contact. Though a high degree of variability and uncertainty was acknowledged, researchers found that, on average, the degree of toxic exposure due to hand-to-mouth contact would be well below acceptable levels.

Lead ingestion is a matter of concern with crumb rubber fields, for it is well-known that lead is used in tire production. However, one mitigating factor should be pointed out: tires do not contain uniform amounts of lead, and it is therefore possible to selectively choose particles from tires with low lead concentrations.

The New Jersey Department of Health and Senior Services (2008) carried out a study subjecting tire particulate to a simulated gastric environment. This was done to determine whether the amount of lead which could be absorbed by human beings as a result of casual ingestion through hand-to-mouth contact with crumb rubber dust would release significant quantities of lead. The findings were that the amount of lead released through gastric processes was not significantly different from that of ordinary soil samples. However, in certain types of fields, particularly those which used nylon fibers, elevated lead levels were observed.

A similar study was undertaken by the Consumer Product and Safety Commission (2008). The CPSC analyzed wipes taken from various crumb rubber fields and assessed the risk of exposure to minors who might be using these fields. It was determined that in no case

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would exposure ever exceed chronic levels of ingestion of lead that could cause lead poisoning.

The Norwegian Building Research Institute's (2006) analysis of lead exposure similarly found that lead levels fell well within an acceptable range.

The US Center for Disease Control and Prevention (2008) has advised the careful selection of material for crumb-rubber fields. It is possible to select crumb rubber in which lead concentrations are low, and it is strongly advised that this be carried out.

PAHs are a source of concern for hand-to-mouth ingestion from artificial turf fields. The CIWMB (2007) investigated the possibility that four PAHs – such as the carcinogen chrysene—could be present at levels dangerous to humans. The study failed to show that this was the case.

### 2.7.3 Dermal Contact

In addition, PAHs have been studied for their risk associated with the dermal contact of crumb rubber. Such risks of PAH uptake have been determined as low amongst athletes (Hofstra 2007), based on certain assumptions regarding the circumstances of exposure and dermal bioavailability. Additional testing of real life exposure was conducted by Van Rooij and Jongeneelen (2010). Their study used biological monitoring (i.e. urine samples) to assess exposure. This method of assessment is advised when exposure can occur through multiple pathways, as is the case with PAHs. Their findings show that the uptake of PAH by athletes who have contact with crumb rubber synthetic turf is negligible. Additionally, diet and other environmental factors were identified as having the same level of PAH uptake as field exposure.

As far as dermal contact is concerned, the Norwegian Institute of Public Health and radium Hospital (2006) carried out an extensive analysis of possible health concerns. The only concern which they highlighted as potentially significant was the risk of allergic reaction to crumb rubber that contains latex, a well-known allergen. The study found, though, that there was no evidence to suggest that allergic reactions were caused by exposure to crumb rubber and speculated that latex in car tires was either "less available for uptake" or was "deactivated" as an allergen. The study acknowledges, however, the existence of knowledge gaps that make a full risk assessment in this particular area provisional.

### 2.7.4 Water Contamination

The question of whether chemicals will leach off of playing fields and enter the drinking or groundwater supply is of broader concern. Once again, the matter of whether or not such leaching ever takes place should not be the focus of concern. The question is: At what concentrations do chemicals leach off of fields, and will the natural environment be able to break down the chemicals at those concentrations?

Zinc is a metal of particular concern in this regard. Now, the simple presence of zinc is not necessarily problematic. Zinc is already present in significant concentrations in urban

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environments, and is in fact essential to the metabolism of most plants and animals. However, zinc at high concentrations can be quite toxic.

Three studies have looked into the presence of zinc as a result of leaching from crumb-rubber athletic fields. The first, carried out by the Norwegian Building Research Institute (NBRI)(Plesser, 2004), was the most critical. It noted that the concentration of zinc in granulate particles exceeded the Norwegian Pollution Control Authority's guidelines for "most sensitive land use." However, it should be noted that Norway's standard for this particular pollutant is unusually stringent; the report noted that the same concentration is deemed by Canadian Water quality guidelines to be well within acceptable range.

California's Integrated Waste Management Board (2007) tested the concentrations of zinc leaching from crumb rubber fields. Its analysis seemed to indicate that the levels detected were not a significant health or environmental concern.

New Jersey's Department of Environmental Protection (2007) carried out a review of the safety of crumb rubber fields that took careful account of the presence of zinc in water leaching from these fields. They noted that a Dutch study from 2007 indicated that the amount of zinc that could leach into water supplies would not be injurious to human health. It would fall below the level of toxicity advised against by the World Health Organization. However, the same study noted that the amount of zinc potentially leached into groundwater exceeded limits set by New Jersey's own environmental standards.

The Swedish Chemicals Inspectorate (2006) has confirmed this finding, noting that zinc levels exceed what is acceptable in runoff, for it could damage ground-dwelling organisms. For this reason the Inspectorate advised against the construction of new crumb-rubber fields, but did not urge the elimination of existing fields.

The Norwegian Institute for Water Research (2005) has indicated that not only zinc, but also but alkylphenols, and octylphenol in particular, are also predicted to exceed the limits acceptable for environmental health.

Birkholz, Belton, and Guidotti (2003) performed toxicity tests on four different aquatic species using crumb-rubber leachate. They determined that undiluted samples produced a moderate risk to all four species, but that diluted samples did not. Noting that the likelihood of undiluted rainwater runoff was slim to entirely unlikely, they concluded that crumb rubber leachate does not pose a risk to aquatic species. However, it should be noted that they specifically looked at toxin levels of lauryl sulfate and sodium chloride. Zinc exposure was not tested.

### 2.7.5 Inhalation

A particular concern when it comes to the potential of inhalation of toxins from crumb rubber fields is Volatile Organic Compounds, or VOCs. As discussed above, VOCs have been implicated in causing organ damage, nervous system problems, and irritation of eyes, throat and airways.

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As pointed out by the New Jersey Department of Environmental Protection (2007), the likelihood of significant emission of VOCs from recycled tires is very low. This is because most VOCs would have already been emitted from tires while they were used for their original purpose of enabling automobile transit. The combination of frequently raised temperatures and long-term use would serve to eliminate most volatile gases from the material. Further, most tires spend up to a year in a scrap-yard between being discarded as tires and before being shredded for use in athletic fields. This additional year provides more opportunity for VOCs to be out-gassed. Studies serve to confirm these speculations.

The French National Institute for Industrial Environment and Risks (2007) carried out a study of the risk of exposure to VOCs from recycled tire athletic fields. The study found that the concentrations of VOCs emitted by such fields were low enough to not pose a risk to athletes using the fields, to officials, or to spectators.

The Norwegian Pollution Control Authority (2006) analyzed the levels of VOCs emitted from indoor fields to determine if a health hazard was indeed present. The finding was that, with adequate ventilation, these fields would not pose a health concern.

The New York City Department of Health and Mental Hygiene (2008b) commissioned a study of a number of the city's already-constructed athletic fields to determine if VOCs or metals were being out-gassed from the fields at significant levels. Though eight different VOCs were detected in the air, they were not at levels high enough to threaten human health. Additionally, it was not clear that the VOCs detected were indeed from the fields themselves, as there was no uniformity in the scores for the different fields, and VOCs were detected in control locations upwind from the sites.

The Norwegian Institute of Public Health and Radium Hospital (2006) analyzed the presence of VOCs emitted from fields and determined that there was no cause for concern. This includes the substance known as carbon black. Recent discussions have included the topic of carbon black, and the potential damage to the respiratory system. Carbon black is used in tires to provide the pigmentation, as well as to dissipate heat and maintain the shape (and life) of the tire. However, there have been no findings that carbon black in crumb rubber has been a serious health issue to users of playground surfacing. Similar research was performed by the California Integrated Waste Management Board in a subsequent, related study in 2007.

A preliminary test by the Connecticut Agricultural Experiment Station (Mattina et al., 2007.) showed that VOCs were indeed released from rubber pellets made from ground-up tires, the raw material for crumb rubber fields. Though the study noted that the levels of released VOCs did not appear to occur at a level clearly injurious to humans, further study was recommended.

The same study looked into the presence of volatile nitrosamines emitted by a sample of twenty different fields. Volatile nitrosamines are chemicals such as benzothiazole and 4-(tert-octyl) phenol. The study did not indicate that such chemicals were emitted at levels of

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concern. A similar Dutch study looked into the levels of nitrosamines emitted from vulcanized crumb rubber and determined that such levels did not pose a risk to humans.

Both the Norwegian Building Research Institute (2006) and the California Integrated Waste Management Board (2007) have carried out tests of exposure to numerous potentially toxic metals present in tires, such as mercury, PCBs, nickel, cadmium, and chromium. Both studies identified levels that were either below detection limit or were at levels insignificant to health considerations. However, concerns were raised about levels of chemicals such as dibutylphthalate (DBP) and diisononylphthalate (DINP), whose presence can exceed EU standards.

### 2.7.6 Sample Testing

To investigate the issue of the content of lead and other metals in cryogenically produced crumb rubber, samples were sent out for laboratory evaluation. Materials were provided by a market leader, BAS Recycling of Moreno Valley, CA, from one of its primary customers, Environmental Molding Concepts (EMC). Synthetic field samples were sent to St. Louis Testing Laboratories, Incorporated, an independent third-party commercial testing laboratory, and analysis was conducted in February, 2009. Evaluations were carried out to ensure compliance with the U.S. Consumer Product Safety Improvement Act for Children's Products Containing Lead (i.e. CPSIA, Section 101), which places limits on the heavy metals content in children's product. The metals regulated by this act include: lead, antimony, arsenic, barium, cadmium, chromium, mercury, and selenium. Testing was done in accordance with American Standard Testing Method (ASTM) E1613, "Standard Test Method for Determination of Lead by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES), Flame Atomic Absorption Spectrometry (FAAS), or Graphite Furnace Atomic Absorption Spectrometry (GFAAS) Techniques."

In total, 40 tests were conducted, for each of the eight metals on five different color samples. Five colors (i.e. blue, green, rust, black, and gray) of turf were evaluated in order to account for possible variability of outcomes from different source contributions. All testing for lead indicated that sample contents were below problematic detection levels. For the remaining tests, all but one came back in compliance with regulation standards. In a single instance, the sample with blue colorization had slightly elevated levels of Barium. This test measured barium at 1228 ppm, which is 328 ppm above the limit. High levels of barium exposure can be troublesome. However, it should once again be noted that the mere presence of a substance is not necessarily cause for concern. It simply indicates a possibility of a risk of exposure. Further testing would be needed to measure the risk of contact. On the other hand, the absence of above limit concentrations precludes the possibility of exposure. In other words, a person cannot be at risk of exposure, if a substance is not present. As such, our testing found that the presence of lead—which was previously identified as being potentially problematic— does not pose a significant risk to people, and children in particular. In fact, the samples provided by BAS contained virtually no lead, at 20 parts per million, which surpasses the upper threshold limit of 400. Levels of lead even in soil are also acceptable at up to 400 parts per million, which signifies the insignificance of lead in the recycled rubber based material. Overall, cryogenically produced crumb rubber performed well against product safety standards.

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### 2.7.7 Material Safety Conclusions

A review of existing literature points to the relative safety of crumb rubber fill playground and athletic field surfaces. Generally, these surfaces, though containing numerous elements potentially toxic to humans, do not provide the opportunity in ordinary circumstances for exposure at levels that are actually dangerous. Numerous studies have been carried out on this material and have addressed numerous different aspects of the issue. For the most part, the studies have vindicated defenders of crumb rubber, identifying it as a safe, cost-effective, and responsible use for tire rubber.

There remain a few objects of concern, though. First, the allergen potential of latex in tires used for athletic fields remains obscure. Though there has not been experimental confirmation of the risk of crumb rubber triggering a latex allergy, the possibility cannot be ruled out and needs to be investigated more thoroughly.

Second, lead exposure remains an object of some concern. The results of experimental evaluation of lead in these fields have been thus far inconclusive. Most studies have cleared the fields as safe in terms of lead risk, but others have noted an elevated presence of lead. Given the fact that lead levels in tires varies significantly according to production processes, it seems safe to conclude that given judicious selection of crumb rubber fill prior to constriction – that is, selection of material with low lead concentrations – lead exposure could be minimized significantly.

Finally, and most significantly, repeated testing has shown that the presence of zinc in leachate from crumb rubber fields remains problematically high. In many communities, these levels exceed what is allowable according to present environmental standards. Some studies have shown these levels to be acceptably low, and others have noted that certain governance areas – Canada's, for example – allow for higher levels of zinc in groundwater. However, generally speaking, it would appear that levels of zinc leaching into groundwater from crumb rubber fields are significant. Further research needs to be conducted into this question to determine whether it is a real concern, and if it is, greater innovation needs to be carried out at the level of product development to eliminate this concern. If this does not occur, the market for crumb rubber fields will be constricted to areas with relatively more relaxed groundwater-quality standards.

## 2.8 Environmental Impact

There are several issues that are encompassed in discussions of the environmental impact of a product or activity. Largely, these can be categorized into global warming impact, risks to human health (including toxicity), and disruption to ecosystems. The potential toxicity of synthetic turf, as well as its possible effects on human health was largely discussed in the previous sections (see Section 2.6: Injury, and 2.7: Material Safety). In addition, some of the aspects of ecological toxicity were also discussed in Section 2.7: Material Safety. The following section addresses additional environmental concerns related to natural and synthetic fields. The life cycle global warming impacts will be addressed specifically.

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### 2.8.1 Environmental Concerns

*Fertilizer*

The environmental impact of fertilizers has garnered much attention in recent years, with growing concerns about bio-fuels. Fertilizers are made using very energy-intensive manufacturing processes to produce nitrogen. The basic feedstock for making nitrogen fertilizer is a petroleum product, natural gas. As a result, fertilizers can be the largest component of an agricultural product's energy consumption (Pimentel 1991; Shapouri et al., 1995; Pimentel 2002; Shapouri et al., 2002; Kim and Dale, 2004). With greater embodied energy, these products have a high global warming potential.

Given this, the amount of fertilizers needed for natural fields is an important environmental consideration. The global warming impact per pound of nitrogen in fertilizers has been shown to be 0.8 to 1.2 pounds of CO2 (West 2002, Robertson 2000, Snyder 2007). Therefore, the carbon footprint associated with the fertilization of a natural turf field is between 204 and 306 pounds of CO2 equivalent. This is between 0.092532 and 0.138799 tons.

*Fuel Consumption*

In assessments of global warming impacts, evaluations are often done by means of energy use as a proxy. While energy consumption alone does not account for all of the aspects of green house gas emissions, it is one of the major contributors of direct and indirect emissions. In an inventory of natural turf emissions, Townsend-Small and Czimczik (2010) find that the single greatest source of emissions is fuel use. For turf maintenance, fuel is used in transport, for mowing, and leaf blowing. Some of these emissions can be reduced by selecting electrically based machinery.

Grass grows quickly, and it must be mowed regularly to maintain optimal play quality. It is often assumed that such fields are cut on a weekly basis. Townsend-Small and Czimczik (2010) estimate that 2700 gallons of gasoline were used by the city of Irvine per month to maintain two million square meters of park area. The impacts associated with fuel use were greater than any other impact considered by about a factor of three or more.

*Recycled Content*

Products made from recycled content are generally preferable to those made from virgin material in two respects: 1) they do not draw on resources that may be limited; and 2) they address issues of waste. The crumb rubber used as infill in artificial turf fields is made from used tires. Recycled tires that were used in this capacity prevented an estimated 300 million pounds of ground rubber from scrap tires from ending up in landfills in 2007 (Rubber Manufacturers Association, 2009). It typically takes between 20,000 and 40,000 scrap tires to produce enough infill to cover a football field (City of Portland, 2008). The EPA's decree has afforded the opportunity for 4.5% of U.S. scrap tire to be applied as crumb rubber in sports surfacing in 2007 (Rubber Manufacturers Association, 2009).

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*Water*

With over two-fifths of the world's population currently facing serious fresh water shortages, water scarcity is becoming an increasingly important issue. This figure is expected to get worse, as populations maintain growth, and glacier derived supplies continue to dwindle as a result of climate change. Water shortage has become the single greatest threat to food security, human health, and natural ecosystems (Seckler, 1999). In addition, irrigation not only requires the resource of water, but also needs energy to deliver it to the end user.

From a water standpoint, synthetic surfaces are advantageous over natural grass. Irrigation is a key component in maintaining natural turf. Artificial fields, on the other hand, do not usually require irrigation. Depending on their location and use, synthetic turfs may need to be watered down for cooling in hot temperatures, but the amount of water used for cooling is far less than that used to irrigate grass fields.

In addition to irrigation demands for water, a field's ability to take in storm water is another environmental consideration. There are several environmental problems associated with storm water runoff. In general, natural habitats are better able than impermeable surfaces to absorb storm water. However, synthetic turfs include drainage systems that compensate for their inability to take in water, while grass is poor at absorbing large quantities of water. Duble (1993) notes that runoff can vary greatly due to the seasonal distribution of rainfall. For a mean annual precipitation of 30 inches, runoff can be measured for the following amount at different locations: 3 inches in Nebraska, 6 inches in Tennessee, 12 inches in New York, and 22 inches in the Rockies. The resulting runoff that is created can lead to polluted ecosystems, as the flowing water picks up sediment, petroleum products, pesticides, fertilizers, bacteria, and metals. For example, in 2004, the water quality at San Francisco city beaches fell below quality standards 12 times in a single month, and storm water overflow contributed to over 40 closures during that year (Heal the Bay, 2004). This pollution, as well as other water capacity issues, such as flooding and the need for infrastructure, places stress on financial resources which may be lessened by a natural surface.

While natural turf may result in greater runoff than synthetic surfaces, they result in less aggregate waste water because they are able to absorb and use some of the precipitation. When viewed at a national level, the accumulated affects of water distribution and removal are not inconsequential. In aggregate, 3% of national energy, or a 56 billion kilowatt hours annually, goes to water deliverance and removal (EPRI 2002). This results in the release of approximately 45 million tons of greenhouse gas, when assuming the average mix of energy sources in the country (USEPA 2008). So, between the two field types there is a tradeoff of impacts: natural turfs may contribute to the problematic aspects associated with storm water runoff, while synthetic turfs play a role in issues regarding wastewater management.

*Heat Island*

One concern with synthetic turf is its role in the heat island effect - the increase of urban temperatures due to the replacement of vegetation with impervious surfaces that radiate

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heat. (New York City Department of Health and Mental Hygiene, 2008; Turfgrass Resource Center, 2008; Rosenzweig et al. 2006; New Yorkers for Parks, 2006). This effect occurs when heat from direct sunlight is absorbed by surfaces and then dissipated, raising ambient air temperatures. Urban heat island has an adverse impact on the environment because it increases the demand for cooling energy, intensifies air pollution—such as ground level ozone, and increases heat-related health problems (New York City Department of Health and Mental Hygiene, 2008; Rosenzweig et al. 2006; San Francisco Recreation and Park Department, 2008). Since synthetic turf has been shown to be hotter than the surrounding air and other surfaces (see Section 2.2: All-weather availability), it is a contributor to the heat island effect. However, the New York City Department of Health and Mental Hygiene (2008) notes that in New York, where summer temperatures can be about seven degrees higher than surrounding areas, synthetic turfs only make up a small portion of absorbent surfaces in the city, and therefore is not the primary culprit for this phenomenon.

### 2.8.2 Life Cycle Analysis

Various researchers have considered the emissions impact associated with turf systems, with much of this work focusing on calculating the capacity of natural grass to sequester carbon (Milesi, et al., 2005; Bandaranayake, et. al., 2003; Qian and Follett, 2002; Pouyat etal., 2009). Additional studies have investigated the N2O emissions of turfgrass (Guilbault and Matthias, 1998; Kaye et al., 2004; Bijoor et al., 2008; Hall et al., 2008). Townsend-Small and Czimczik (2010) note a lack of research investigating impacts of organic carbon storage and greenhouse gas (ghg) emissions. Additionally, studies exploring the emissions impacts of synthetic systems are lacking. One study by the Athena Institute (2007), a Canada-based nonprofit, compares the global warming impacts of natural and synthetic turf systems over the lifespan of the systems. This exploration of greenhouse gas inventories over the entirety of their life cycle will be utilized below to evaluate the emissions impacts of natural and synthetic turf systems. Given the scope of this study, our purpose here is not to conduct a comparative life-cycle analysis on turf systems, but rather, to provide some rough estimates of the comparative global warming impacts of natural and synthetic fields to see if we can clearly identify which field system has a lower impact.

The Athena Institute (2007) study considers the entire scope of the product's life-cycle by means of SimaPro 7 LCA Software (2006). Assessments take into account various aspects of a playing field's life-cycle, including: the manufacturing of system components; transportation; surface preparation; maintenance; and end of life considerations. Impacts were calculated using various databases in conjunction with the SimaPro 7 LCA Software, based on the location where impacts occurred. For instance, the primary backing material, "Thioback Pro," is made from substances manufactured in the Netherlands, and is evaluated using the prominent European Life Cycle Inventory database, EcoInvent Library v.1.2, to estimate associated emissions. The Franklin 98/01-update Life Cycle Inventory database from the SimaPro 7 LCA Software was also used in calculations.

The data for this research was gathered from a case study on the installation of a synthetic field in 2006 for Upper Canada College, a school serving elementary and secondary

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students. The size of the field being considered was nine thousand square meters, or approximately 96,875 square feet. Five pieces were identified in construction of synthetic turf fields: the turf itself, primary backing material, a secondary elastomeric coating, rubber granule infill, and PVC piping for drainage. Meanwhile, the only components determined for natural fields are seeds and sod. Transportation includes all emissions from supplier to installation. Maintenance levels for artificial turf systems are adopted from the FIFA (2001) Guide. These include the brushing and removal of debris and contaminants using equipment such as: drag brushes, mats, and nets, hand tools, high-pressure cleanser, and sweeping machines. In addition, watering is recommended as needed, as is the removal of any snow, weeds, algae, and moss. In contrast, the maintenance considered for grass was irrigation and cutting, although the specifics about the methodology, amount, and frequency were not explicitly stated. Lastly, it is assumed that at the end of the artificial turf's life, the system is recycled.

Figure 2.2 below shows a summary of the comparative impacts found by the Athena Institute. Following that is a discussion of their findings.

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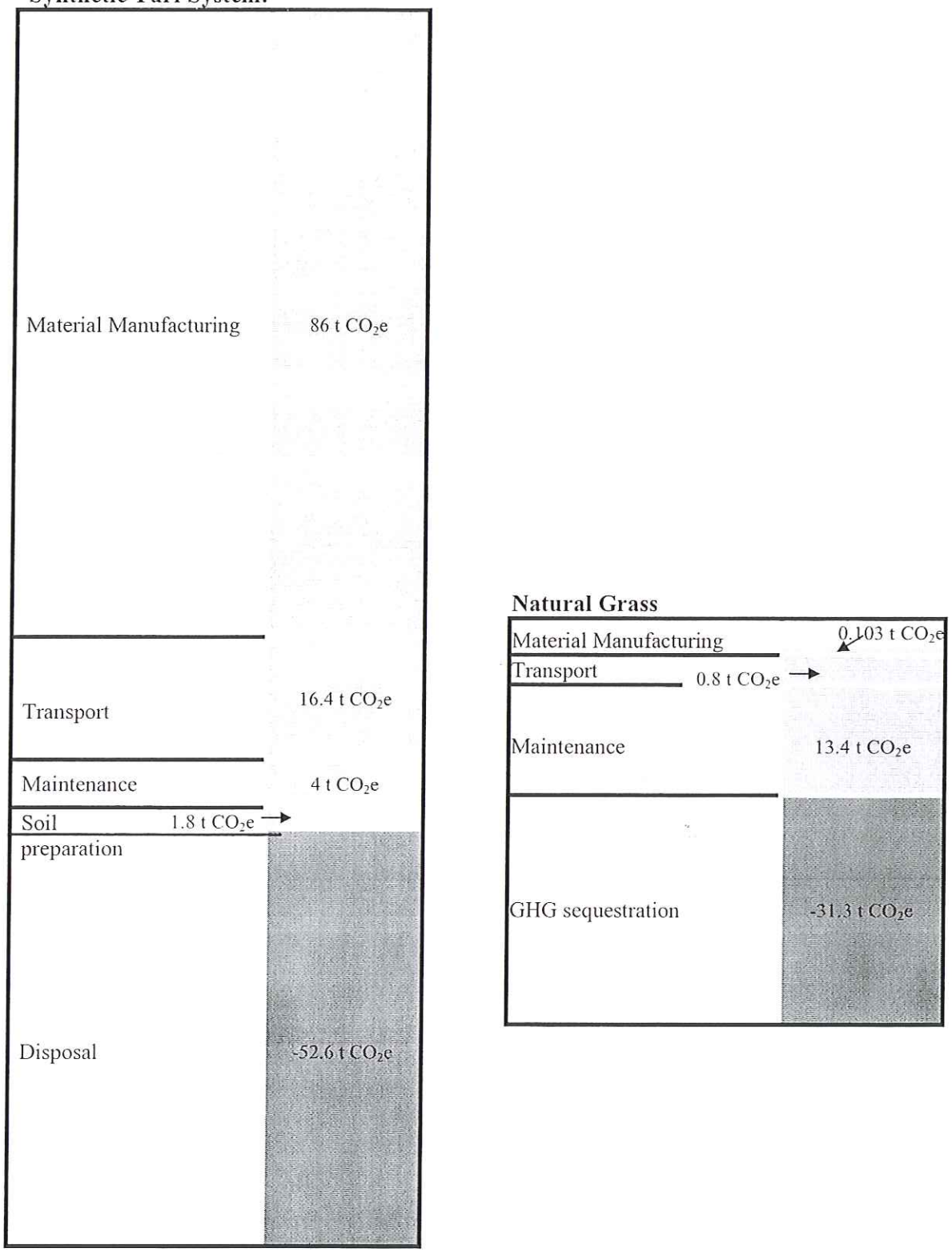
**Figure 2.2: Athena Institute's Green House Gas Emissions Assessment for Field Turf Systems**

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*Material Manufacturing & Transport*

The Athena Institute considers the embodied energy for the components of natural and synthetic turf installations. In addition, transportation impacts for these components are calculated via the Upper Canada College case study.

For synthetic fields, the Athena Institute's calculations provide a good estimate for the impacts associated with the production of turf components. The parts that they considered were consistent with other descriptions of artificial turf systems. Also, evaluations for these impacts were conducted using widely accepted LCA software. At present, there is no other literature that considers the global warming impacts of synthetic turf systems. As such, it will be assumed that the Athena Institute's analysis of the impacts for manufacturing synthetic turf components has been adequately executed, and is equivalent to 86 t $CO_2$e.

For natural grass fields, meanwhile, the only components considered are the production of seeds and sod. The impacts of seed production have generally not been accounted for in research analyzing crop cultivation. This is especially true with urban fields. When evaluating the energy requirements of crop inputs, Moerschner and Gerowitt (2000) find that the effects of seed production are only a mere fraction of the total environmental impacts of fertilizer production. Flessa et al. (2002) cites the negligible contribution of seed production compared to the other agricultural product inputs as the reason for their exclusion in analysis. While attempts have not been made to account for the global warming emissions associated with seed production in grass fields, proposals for the inclusion of seed production have been made in the field of livestock production (Schils et al., 2007; Olesen et al., 2006), as well as in agricultural analysis in Europe (Weiske A., 2006; Kaltschmitt and Reinhardt, 1997).

It is unclear whether the entire scope of sod production is considered in the Athena Institute's analysis (i.e. whether the maintenance that goes into the production of sod is included). Much like seed production, there has been very little discussion of the emissions impacts associated with sod production. However, unlike seed production, the embodied global warming potential (gwp) of sod can be extrapolated from the maintenance requirements for grass fields. The next section will be dedicated to investigating whether Athena Institute's figure provides a good approximation based on some simplifying assumptions. First, to address their assessment, we must first explore the work of Townsend-Small and Czimczik (2010) for the data on the various maintenance impacts associated with natural grass turf.

In their study, Townsend-Small and Czimczik (2010) calculate the gwp of urban natural grass turfs, considering their organic carbon storage, direct N2O emissions, and the emissions associated with maintenance. The outcomes of these evaluations vary based on a number of factors, including: fertilization practices, soil moisture, temperature, and the existing soil organic carbon content. Their analysis of existing fields shows that the amount of organic carbon that is stored in natural grass fields is not enough to offset the direct and indirect emissions associated with the field. In fact, they found that in fields that absorb potential greenhouse gases, associated emissions are approximately three to four times

greater. This is especially true in athletic fields, where it is assumed that turfs are installed with sod, instead of seeds--which is often used for ornamental fields. Based on this assumption, athletic fields offer no net sequestration of CO2. More specifically, the addition of transplanted sod results in the addition of organic carbon to the system. While the original soil where the sod was planted is capable of storing organic carbon, the soil on a field with transplanted sod can take up to three decades before it begins to store organic carbon. In addition, maintenance practices such as tilling, aeration, and the re-sodding of dead grass disrupt the storage of organic carbon. The estimates for this study are listed in the table below:

**Table 2.8: Townsend-Small and Czimczik' (2010) gwp of Urban Natural Grass Turfs**

| Impact Considered | Description | GWP (g CO2/m2/yr) |
|---|---|---|
| Organic carbon storage | Estimates of the sequestration of organic carbon based on an analysis of physical samples. | 513 |
| N2O emissions | A measurement used to estimate some of the impacts of greenhouse gas emissions from turf soil. | 45-145 |
| Fuel | This figure includes the emissions associated with the actual fuel requirements to maintain the turf being sampled, totaling about 2x10 6 m2 of park area. The amount of fuel was estimated to be approximately 2700 gallons of gasoline per month. This fuel covers the transport, mowing, and leaf blowing for weekly trimmings and mulching. The global warming potential from this fuel use was then calculated using the EPA's (2005) estimates of 2421 g C for a gallon of gasoline, and Lal's (2004) assessment of combustion efficiency of 85%, which is similar to farm equipment. | 1469 |
| Water conveyance | The fields for this study were watered regularly, using recycled wastewater. Impacts associated with irrigation consider the energy required to pump water. Calculations are made using Schlesinger (1999) estimate of 53 g C/m2/yr for associated energy. | 193 |
| Fertilizer production | Fields are assumed to be fertilized from two to 15 times per year. Figures provided by Schlesinger (1999), of 1.436 moles of C per mole of N produced, were used in the calculation of embodied emissions associated with the production of fertilizers. The range of emissions impacts varies based on the number of fertilizations. | 45-339 |
| **Total** | | **1752-2146** |

We will use the data provided by Townsend-Small and Czimczik's (2010), together with Athena Institute's assessments, to make an approximation of what seed and sod production impacts should be. We begin by stating the assumptions used in our analysis. First, we assume that sod is grown for about a year before it is transplanted to a new field. Powell (1999) estimates that a sod crop can be harvested six months to two years after establishment. Next, we assume that, at the very least, sod requires irrigation to grow. If we assume that Athena Institute's measurements for the watering and cutting (i.e. the "maintenance") of a grass field are correct, then the emissions for growing sod should be at

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least one year's worth of the watering impacts (sod impacts should be higher than this figure, as there are additional maintenance requirements that have associated emissions). Townsend-Small and Czimczik's (2010) ratio of impacts from fuel and water conveyance are 1469:193 g $CO2e/m^2/yr$; or more simply put, the fuel related impacts are 7.6 times greater than those from watering. Then, if we apply this ratio to Athena Institute's maintenance associated emission of 13.4 t $CO_2e$, watering impacts should be 1.56 t $CO_2e$ for 10 years. If, as stated, we assume that the average sod production period is one year, the rough estimate just proposed suggests that the calculation of 0.103 t $CO_2e$ for seed and sod production might be a slight underestimate, when compared to one year of watering. This figure appears to be an even greater underestimate when considering that Athena Institute's estimate includes the impacts from seed production, and that sod is generally fertilized multiple times prior to being transplanted (Powell, 1999a). The apparent under-estimation of these impacts suggests that a more accurate estimate of emissions associated with seed and sod production should be investigated. However, in the scale of the natural turf's life cycle, the production stage emissions will always be dwarfed by the global warming potential of grass maintenance. Thus, research into more precise measurements of seed and sod production emissions will not be addressed within the scope of this paper, and will be left to future research.

*Soil Preparation*

Depending on the existing condition of a field, significant efforts might be required to excavate topsoil in preparation of turf installation. For the purpose of this report, it is assumed that emissions associated with excavation are significant, and that they should be incorporated into impact inventories. The Athena Institute's analysis includes impacts related to topsoil excavation. However, they do not explicitly outline what is considered in the accounting of these emissions. We speculate that these impacts are associated with the operation of machinery to dig up and haul away topsoil. This theory is supported by the fact that hauling-related emissions do not appear to be included with transport emissions, which are instead focused on the delivery of components to the location of installation. Therefore, having identified possible impacts related to the excavation of topsoil, which are not covered in other aspects of Athena Institute's evaluations, and without alternative assessments available from other research, we will assume that their calculations are an acceptable estimate for excavation related impacts. However, it should be noted that it might be possible to obtain a more accurate measurement from further investigation.

*Maintenance*

The maintenance requirements considered by the Athena Institute vary dramatically for the two turf types. The maintenance tasks for artificial turf were adopted from the FIFA (2001) guide. These include the brushing and removal of debris and contaminants using equipment such as: drag brushes, mats, nets, hand tools, high-pressure cleanser, and sweeping machines. In addition, watering is recommended as needed, as is the removal of any snow, weeds, algae, and moss. In aggregate, the emissions associated with these activities are 4 t $CO_2e$ over ten years. In contrast, the maintenance considered for grass is irrigation and cutting. The emissions associated with these activities are 13.4 t $CO_2e$.

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The Athena Institute does not state the underlying assumptions that were made in calculations of maintenance related emissions. It is therefore assumed that all of the various aspects relating to these activities were considered, and that calculations are as comprehensive as possible. For instance, evaluations can change based on factors such as: the frequency with which activities are carried out, the methodology used to accomplish a maintenance task, the quantity of materials applied, and the scope of the supply chain considered (i.e. transportation and embodied energy associated with any material used).

While far more maintenance activities are considered for synthetic fields, the global warming potential for the maintenance of natural fields is greater. The differences in these impacts are partially due to grass fields' continual need for additional supplies to sustain their health. Emissions related to the continual input of supplies accumulate over time. The findings of Townsend-Small and Czimczik (2010) show that much of the global warming impacts of grass maintenance are associated with fuel use. On the other hand, the maintenance of synthetic fields only generally requires a capital investment in equipment and labor to carry out tasks. It is customary in LCA research to exclude the impacts of labor. This means that any work done by hand on a field has no associated emissions.

To achieve a more comprehensive analysis, additional maintenance requirements should be considered, as per the maintenance related equipment and supplies identified in Section 2.4: Maintenance. Of particular interest are the additional impacts associated with the application of fertilizer to natural fields. However, it should be noted, that even with the additional consideration of these elements, the general finding by the Athena Institute will remain largely unchanged. That is, the maintenance impacts of natural turfs will be larger than those of synthetic turf, only to a greater degree. However, these impacts will still be much less than the material related emissions associated with the manufacturing of the components of synthetic turf. Any considerations of additional maintenance practices will result in greater emissions being associated with natural systems. This increase will result from the input of materials that are needed in greater quantities, and with greater frequency than for synthetic turfs.

Table 2.9 below lists the maintenance needs and materials identified by the Athena Institute, as well as additional recommendations obtained from the maintenance materials identified in Section 2.4.

**Table 2.9: Maintenance Needs and Materials**

| | Synthetic | Natural |
|---|---|---|
| **Activities Considered** | Watering | Irrigation |
| | Brushing | Mowing |
| | High-Pressure Cleaning | |
| | Sweeping | |
| | Dragging | |
| **Material Inputs Needed** | Water | Water |
| | | Fuel |
| **Additional Recommended Input Considerations** | Paint | Paint |
| | Top Dressing | Top Dressing |
| | | Fertilizer |

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*Green House Gas Sinks*

*Natural Grass*

For natural grasses, the photosynthesis process involves the intake of carbon dioxide and results in carbon compounds that enter the soil with root growth or when a plant sheds or dies. These compounds can be stored long-term as soil organic carbon, as well as other soil organic matter. This is significant in the evaluation of global warming impacts because it results in a more permanent removal of carbon dioxide from the atmosphere. Also, in aggregate, the ability of turf to sequester carbon is not insignificant: in 2005, turfgrass covered approximately 1.9% of land in the continental U.S., making it the most widespread irrigated crop (Milesi et al., 2005). As such, any evaluation of the emissions of natural turfgrass should involve the most current and relevant measure that has been proposed for these impacts.

For the measurement of organic carbon storage, the Athena Institute uses the mean value of sequestration rates proposed by Qian and Follett's (2002) of between 0.9 and 1.0 tons of carbon per hectare per year. These estimates come from soil testing data on golf courses in Denver and Fort Collins, Colorado (Qian and Follett, 2002). Bandaranayake, et al., (2003) found similar sequestration rates when modeling organic carbon sequestration in various geographically-based scenarios. The average rate of accumulation over a 30 year period was found to be 1.2 and 0.9 t C/ha/yr for Fort Collins and Denver, respectively. As previously noted, the ability of soil to store organic carbon can be influenced by a multitude of factors. Post and Kwon (2002) showed this to be true in the case of soils that were previously disturbed, which were found to have a lower C sequestration rate of 0.33 t C/ha/yr. These studies indicate that the figure for organic carbon sequestration used by the Athena Institute may be a bit high for a newly installed field, but are acceptable for a life time analysis of the field.

However, one aspect that the Athena Institute neglects in their calculations is the direct ghg emissions that occur from natural grass. While research on the total impacts of greenhouse gases, including absorption and direct emissions, are somewhat nascent, several studies have looked into the N2O emissions of urban turfgrass. Considerations of these emissions do not measure the full impacts of the direct emissions from grasses. However, they do serve to account for some of the impacts of urban grass, and to illustrate the complexities involved in modeling their global warming impacts. Much like organic carbon storage, there are numerous factors that create variability in emissions rates. Several researchers have modeled annual fluxes of $N_2O$ emissions based on their relationship to temperature, soil moisture, and soil organic carbon content (Scanlon and Kiely, 2003; Flechard et al., 2007). Spikes in $N_2O$ emissions have been shown to occur in urban turfs after irrigation or fertilization of the field (Guilbault and Matthias, 1998; Kaye et al., 2004; Bijoor et al., 2008; Hall et al., 2008). Estimates of $N_2O$ fluxes from urban turfs range between 0.05 to 0.6 g N per meters squared per year (Guilbault and Matthias, 1998; Kaye et al., 2004; Groffman et al., 2009; Townsend-Small and Czimczik, 2010). For our purposes, we will use the estimates provided by Townsend-Small and Czimczik for annual N2O emissions, which is the mean of 0.1 to 0.3 g N/m2/yr.

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*Recycling of Synthetic Turf at the End of Life*

Calculations for the end of life of a synthetic turf are based on the assumption that all components, except the rubber granule infill, are 100% recyclable. Based on this assumption, an emissions credit is awarded by the Athena Institute for the end of life of the system. Calculations are made using ICF Consulting's (2005) report on the ghg emissions factor for plastic. The materials that are assumed to be recyclable in synthetic turf are: polyethylene from the turf and primary backing material; polyurethane from a secondary coating; and PVC piping.

The flaw in Athena Institute's estimates for the end of life emissions for synthetic fields is that materials may not be recycled just because they are capable of being recycled. In fact, the San Francisco Recreation and Park Department (2008) notes that the cost and a lack of infrastructure are an issue with the end-of-life recycling of artificial turf. They note that at the time of the report's publishing only one company in the industry recycled turf material. When turf is not recycled, a large amount of waste must be disposed of at the end of the field's useful life. According to the City of Larchmont, California, 400 tons of debris is created when an 80,000 sq. ft. field is replaced (San Francisco Recreation and Park Department, 2008). Given these concerns, the actual rate of recycling is highly questionable, suggesting that emissions credit should not be accounted for in synthetic turf systems.

### 2.8.3 Environmental Impact Conclusions

In general, the environmental impact of natural grass is more complex than those of synthetic turf. This is due in large part to the fact that natural grass requires the continual addition of inputs to sustain a field's health. As with any agricultural practice, draws on water and the addition of agrochemicals can become problematic. These practices draw on scarce resources and have the potential to effect surrounding ecosystems. Additionally, the maintenance of grass is associated with the use of large quantities of fuel, to mow grass to the appropriate length. The Athena Institute sufficiently shows the weight of these impacts in regards to global warming. However it is recommended that a more comprehensive inclusion of material inputs into grass maintenance be calculated in any future life cycle assessments.

The environmental issues related to synthetic turf mainly revolve around the use and disposal of materials. Many see the use of recycled waste products for field infill as one of the primary benefits of artificial systems. However, such systems also require the use of many virgin materials. As such, the greatest greenhouse gas emissions of either two system types are the impacts associated with the production of synthetic turf components. These material impacts increase the total emissions by a multiplicative factor when considering the entire life cycle, due to related increases in processing and transportation needs.

The validity of the greenhouse gas emissions sinks identified by the Athena Institute is in need of further consideration. It appears that the evaluations associated with these credits are either based on some faulty assumptions or do not take all considerations into account.

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## 3.0 CONCLUSIONS

This report explored the various aspects of crumb rubber and addressed some of the claims made by various researchers. A look into the existing literature and data supported many of the assertions made about crumb rubber. Crumb rubber and synthetic turf have many traits that make it a beneficial choice for athletic surfaces. Some of the findings that were found indicated that synthetic turf has:

- **Excellent Playability** – Most literature comparing the play quality of natural and synthetic fields suggest that the differences between them have miniscule affects on playability in comparison with variance in the set-up of the field itself. Where differences do emerge, artificial turf appears to be equal to or better than natural turf, due to its greater consistency. While such findings are incomplete, because of the lack of studies that evaluate the newer generations of turf technology, there were no studies that contradicted the superiority of synthetic turf.

- **All-weather Availability** – Synthetic turf is praised for its availability in all weather conditions: more use per year, and a quick install. It can be used quickly after installation, usually within a few days, rather than the weeks it takes for a sod to become robust enough for use. Also, it can be used in snow, and in general is not affected by precipitation due to the drainage system involved. However, high heat can create an obstacle for synthetic turf use, as the surface can become uncomfortable to play on. Since there are means to temper such effects, the field can still be made useable. Also, the use of turfs are not typically greatest during the hottest parts of the year, as sports seasons typically fall in the late summer through the spring. These impairments do not compare to the degree to which natural fields are compromised during rain and snow. With all weather considered, artificial turf has greater availability over natural grass when taking weather into account.

- **Increased Playing Hours** – Studies suggest that average hours of playability in a three-season year for synthetic turfs range between 2,000 and 3,000 hours, with most research pointing toward 3,000 hours. Natural fields, on the other hand, provide far less playability, with studies estimating a range between 300 and 816 hours in a three-season year on average. Weather is an important factor in the reduction of use times for natural turf. Beyond the weather related losses in the capacity of grass fields, all natural fields must be given time to "rest" to allow for growth.

- **Reduced Maintenance** – The value of a field can be determined by its availability and by the amount of maintenance a field requires. Activities that can be classified as grooming are the most important components of maintenance for both turf types. In addition, debris control, additional cleaning, and needs-specific maintenance may be required. In general, natural fields require a more nuanced balance of activities such as mowing, fertilization, and aeration to ensure their health.

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- **Cost-effective Investment** – synthetic turf fields are typically warranted for about 3,000 hours of play per year, with no "rest" required. For schools with sufficient land, it would take three or four natural fields to withstand the usage of one synthetic turf field. Because of its consistent availability, a synthetic turf field is also a reliable source of rental revenue for schools and communities. The study found that the total cost of ownership over a ten year period is 10% - 20% less than a natural turf field, while being 70% or even 80% less on a cost-per-use basis.

- **Generally Safe Application** – Extensive research has pointed to the conclusion that these fields result in little, if any, exposure to toxic substances. A review of existing literature points to the relative safety of crumb rubber fill playground and athletic field surfaces. Generally, these surfaces, though containing numerous elements potentially toxic to humans, do not provide the opportunity in ordinary circumstances for exposure at levels that are actually dangerous. Numerous studies have been carried out on this material and have addressed numerous different aspects of the issue. For the most part, the studies have vindicated defenders of crumb rubber, identifying it as a safe, cost-effective, and responsible use for tire rubber.

- **Fewer Injuries** – Numerous studies have been conducted assessing the likelihood of injury on natural grass and synthetic turf. A more recent study by Meyers (2010) shows that the latest generation of synthetic surface, FieldTurf, is safer to play on than natural grass fields. Through the analysis of the various injuries that occurred over the course of 465 collegiate games, Meyers shows that FieldTurf has lower incidence of: total injuries, minor injuries (0-6 days lost), substantial injuries (7-21days lost), and severe injuries (22 or more days lost). FieldTurf also had significantly lower injury rates that natural turf when comparing across play or event type, grade of injury, or various field conditions and temperatures. In addition, there was no significant difference found in head, knee, or shoulder trauma between the two playing surfaces.

- **Environmentally Friendly** – In general, the environmental impacts of natural grass are more complex than those of synthetic turf. This is due in large part to the fact that natural grass requires the continual addition of inputs to sustain a field's health. These practices draw on scarce resources and have the potential to effect surrounding ecosystems. Additionally, the maintenance of grass is associated with the use of large quantities of fuel, to mow grass to the appropriate length. The environmental issues related to synthetic turf mainly revolve around the use and disposal of materials. Many see the use of recycled waste products for field infill as one of the primary benefits of artificial systems. However, such systems also require the use of many virgin materials. As such, the greatest greenhouse gas emissions of either two system types are the impacts associated with the production of synthetic turf components. These material impacts increase the total emissions by a multiplicative factor when considering the entire life cycle, due to related increases in processing and transportation needs.

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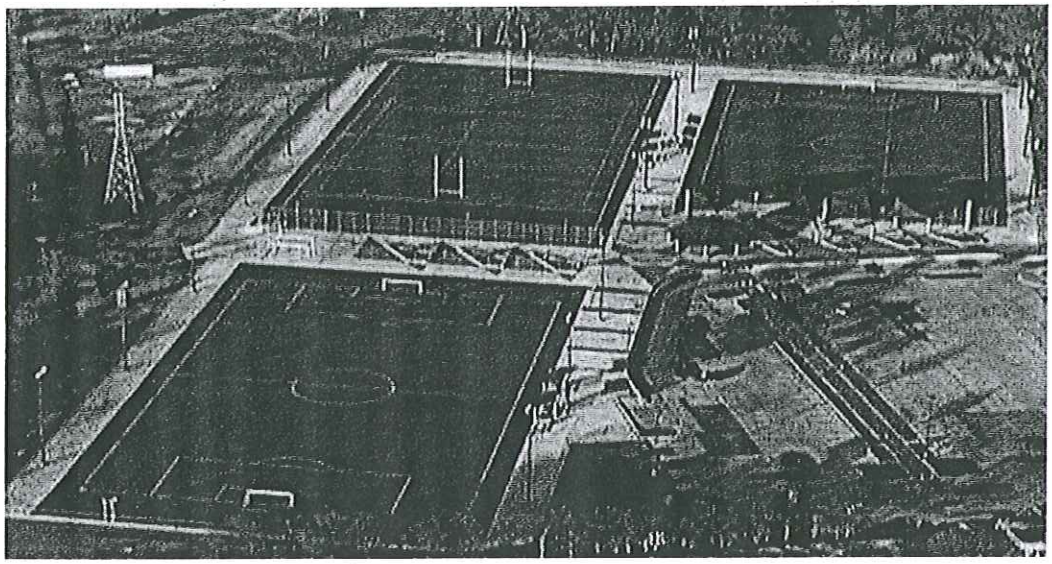
# FINAL REPORT

# Artificial Turf Study

## Leachate and Stormwater Characteristics



**Connecticut Department of Environmental Protection**

**July 2010**

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APPENDICES

Appendix A: Stormwater Sampling and Analysis Documentation

Appendix B: Stormwater Treatment Measures, UNH Fact Sheets

## 1. PROJECT OVERVIEW

In December 2008, four Connecticut State agencies, the University of Connecticut Health Center, The Connecticut Agricultural Experiment Station, the Connecticut Department of Environmental Protection and the Connecticut Department of Public Health, agreed to jointly develop and implement a study to evaluate the health and environmental impacts associated with artificial turf fields. The overall objectives of the study were to:

1. Identify comprehensively substances, including organic compounds and elements, which derive from the crumb rubber infill used on synthetic turf fields, as well as currently available alternative infill products, through off-gassing and leaching pathways;
2. Establish the level of chemical variability for infill at individual synthetic turf fields and between different synthetic fields in Connecticut;
3. Measure levels of off-gassed compounds and airborne particulate matter in the normal breathing zone of children during a "simulated worse-case scenario" at athletic field(s) in Connecticut (inhalation risk);
4. Measure levels of leached compounds in storm water runoff collected in actual field conditions (environmental risk); and
5. Utilize collected data to make environmental and public health risk assessments regarding outdoor artificial turf fields.

The Department of Environmental Protection ("DEP") was specifically tasked with: (1) collecting stormwater runoff samples from the four artificial turf fields selected for the study; (2) analyzing the stormwater samples for levels of compounds leached from the artificial turf materials; (3) scientifically evaluating the laboratory analysis results; and (4) developing an environmental risk assessment for the artificial turf fields.

This report is not intended to be a comprehensive investigation of the environmental risks associated with artificial turf fields, but a basic assessment of water quality data collected from a limited number of fields during a three-month period. It should be understood, that the ultimate conclusions in the report are based on eight stormwater sampling events, essentially a "snapshot", of an ongoing chemical and physical process.

## 2. SITE SELECTION

The four artificial turf fields selected for DEP's stormwater sampling plan were the same fields sampled in the summer of 2009 by the University of Connecticut Health Center for airborne contaminants. Specific field selection criteria included: crumb rubber infill, owner permission, installation date, different manufacturers and site location. The owners of the selected four fields provided engineered drainage plans to DEP. DEP staff reviewed the drainage plans and established sampling points that only collected stormwater draining from the artificial turf field.

## 3. ARTIFICIAL TURF FIELD SYSTEMS

The artificial turf fields selected were installed by different engineering, synthetic turf and construction companies, but are similar in general design. The fields are composed of a top layer

of polyethylene or polypropylene grass fibers, with a crumb rubber (sometimes intermixed with sand) infill layer, and underlain by crushed stone/gravel with a piped drainage system (see Figures 1 and 2 below).

**Figure 1.**

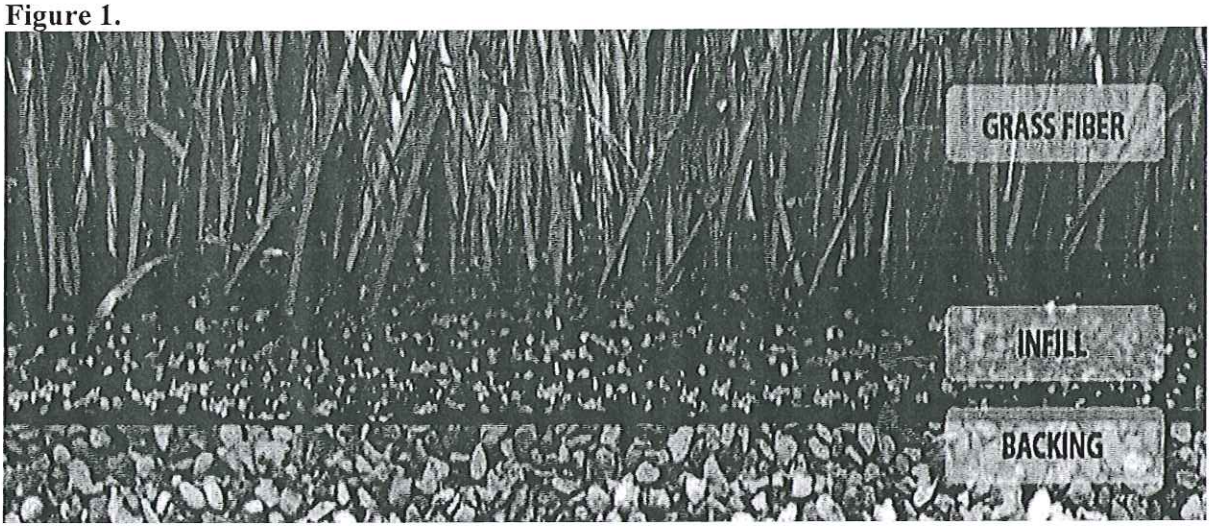
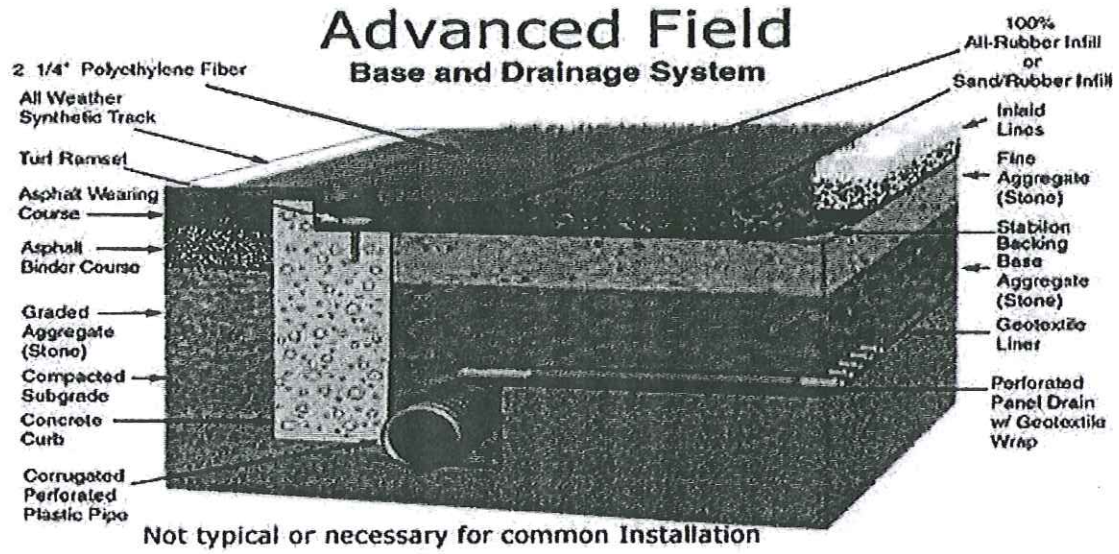



**Figure 2.** (source: www.suncountrysystems.com/.../syntheticgrass.jpg)




The critical field component for this study is the infill layer, which includes crumb rubber materials produced from recycled tires. The infill layer can be composed of entirely styrene-butadiene rubber (SBR) granules, produced by ambient and/or cryogenic grinding process, or intermixed with quartz crystals (sand). The assumption for this study, and the sampling plan, is that precipitation lands on the surface of the artificial turf field, flows downward through the infill and rock/gravel layers, collects in the subsurface drain pipes and then ultimately discharges from the field. The artificial turf drainage pipes often discharge to existing subsurface drainage

systems at catch basin and/or manhole connections. The subsurface drainage pipes utilized under the fields can be solid or perforated.

## 4. SAMPLING PROTOCOLS

DEP staff reviewed EPA protocols and previous artificial turf leaching studies and established the following stormwater sampling plan:

1. Sampling Plan
    a. One sampling station was established at each of the four artificial turf fields;
    b. The sampling stations were located at a point where runoff was only from the artificial turf field;
    c. The size of the drainage area (in square feet) to each sampling station was calculated;
    d. Grab samples were collected and delivered to the laboratory by qualified individuals during the fall of 2009; and
    e. Samples were analyzed by an EPA certified laboratory.

2. Storm Event Criteria
    a. Samples were collected from discharges resulting from a storm event that was greater than 0.1 inch in magnitude and that occurred approximately 72 hours after any previous storm event of 0.1 inch or greater;
    b. Grab samples were collected during the first 30 minutes of a storm event discharge, or as close thereto as possible, and were completed as soon as possible;
    c. The following information was collected for the storm events monitored:
        i. The date, temperature, time of the start of the discharge, time of sampling, and magnitude (in inches) of the storm event sampled; and
        ii. The duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event.

3. Sampling Procedures
    a. Grab sample collection, chain of custody and laboratory delivery were performed in accordance with the EPA NPDES Stormwater Sampling Guidance Document (EPA 833-B-92-001, 7/92); http://www.epa.gov/npdes/pubs/owm0093.pdf
    b. Laboratory analysis of grab samples included the following:
        i. Acute Toxicity 48 hour LC50 *Daphnia pulex* & 48 hour and 96 hour LC50 *Pimephales promelas* (EPA 821-R-02-012).
        ii. EPA Method 130.1, Hardness, Total (mg/L as $CaCO_3$)
        iii. EPA Method 150.2, pH
        iv. EPA Method 200.7, (Antimony, Arsenic, Barium, Cadmium, Chromium, Cobalt, Copper, Lead, Manganese, Mercury, Molybdenum, Nickel, Selenium, Thallium, Vanadium and Zinc)
        v. EPA Method 624, Volatile Organic Compounds
        vi. EPA Method 625, Semivolatile Organic Compounds (TIC's for Benzothiazole, Butylated hydroxyanisole (BHA), n-hexadecane and 4-(t-octyl) phenol.

## 6. DEP STORMWATER SAMPLING RESULTS

### a) Method 624/Method 625 and Tentatively Identified Compounds(TICs):

No standard volatile or semi-volatile organic compounds were detected in any sample using the EPA 624 and 625 analytical methods. All samples were analyzed for non-standard semi-volatile organic compounds, including the following rubber compounds benzothiazole, butylated hydroxyanisole (BHA), n-hexadecane and 4-(t-octyl) phenol. The semi-volatile analysis detected the analytical peaks of twenty-two compounds, of which nine were tentatively identified (see Table B below). The concentrations of these compounds ranged from 1 ug/l to 150 ug/l. The grey columns in Table B correspond to the three stormwater samples determined to be acutely toxic. Table C details the aquatic toxicity information found for the other tentatively identified compounds listed in Table B.

### b) Pesticides and PCBs (Method 608)

**Pesticides**

Pesticides were detected in the samples of stormwater collected on September 11, 2009 from Field C and on October 28, 2009 from Field D. DEET and heptachlor were detected at estimated concentrations of 6.9 ug/l and 0.18 ug/l, respectively. It is assumed that these substances were not derived from the artificial turf, but were a result of pesticide applications at the site.

**PCBs**

No PCBs were detected during the stormwater sampling events.

### c) pH, Hardness and Metals:

The results from the pH, hardness and metals analysis conducted on the stormwater runoff from the fields are presented in the table below.

**pH**

The pH of the stormwater samples ranged from 6.6 to 8.0. The pH of stormwater in Connecticut is generally considered to be between 5.6 and 6.0. Based on this fact, the pH of the stormwater samples are more alkaline than expected. It is possible that the crushed stone used as a sub-base in the fields affected the pH of the stormwater as it drained through the field.

The pH alone does not exhibit toxic effects unless it falls below 5 or is higher than 10. However, metals are often more soluble and toxic at lower pH's. The observed neutral pH in the stormwater may have reduced the concentrations and toxicity of the metals leaching from the fields.

TABLE B

| Location: | | | Field C | Field A | Field A | Field A | Field D | Field D | Field D | Field D |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample # | | | A | B | C | E | D | F | G | H |
| Sample date | | | 9/11/2009 | 9/27/2009 | 10/7/2009 | 10/18/2009 | 10/18/2009 | 10/28/2009 | 11/20/2009 | 12/3/2009 |
| | Tentatively identified | | | | | | | | | |
| Parameter: | Compounds | CAS# | | | | | | | | |
| Heptachlor | | | | | | | <0.10 | 0.18 | NT | <0.05 |
| Retention Times (min) | | | | | | | | | | |
| 3.55 | | | 6.2 | | | | | | | |
| 5.04 | | | | | 150 | | | | | |
| 6.12 | | | 4.3 | | | | | | | |
| 6.63 | | | | | | | | | | 9.5 |
| 6.81 | | | | | 4.1 | | | | | |
| 6.83 | 2- propyl-methyl pentanoic acid | 22632-59-3 | | | 14 | 6.6 | | | | |
| 6.85 | Benzothiazole | 95-16-9 | | 1 | 4.9 | | | | | |
| 6.88 | | | | | 6.1 | | | | | |
| 7.07 | | | | | | | | | 5.1 | |
| 7.08 | methyl 2alpha -D-xylofuranoside | 32469-86-6 | | | | 5.8 | | | | |
| 7.10 | 2 ethyltetra hydro thiopene | 1551-32-2 | | | | 28 | | | | |
| 7.13 | 4-methyl4-Heptanol | 598-01-6 | | | | 7.4 | | | | |
| 7.15 | 2- butyl tetrathydrothiopene | 1613-49-6 | | | | 12 | | | | |
| 7.77 | | | | | | | | | | 10 |
| 7.96 | | | | | | | | 6.6 | | |
| 8.13 | | | | | 7.4 | | | | | |
| 8.23 | | | | | | | | | 7 | |
| | Benzamide, N-N- diethyl-3- | | | | | | | | | |
| 9.48 | methyl | 134-62-3 | 6.9 | | | | | | | |
| 9.56 | 2(3H)- Benzo thiazolone | 934-34-9 | | | 5.7 | | | | | |
| 10.28 | | | | | | 4.1 | | | | |
| 12.60 | 2-2-7 trimethyl-3-Octyne | 55402-13-6 | | | | | 4.5 | | | |
| 16.88 | | | 8.4 | | | | | | | |

TABLE C

| Location:<br>Sample #<br>Sample date | | | Max Concentration | Location | Acute Water Quality Criteria | Chronic Water Quality Criteria | Comments |
|---|---|---|---|---|---|---|---|
| Parameter: | Tenatively identifeid Compounds | CAS# | | | | | |
| Heptachlor | | | 0.18 | D | 0.26 | .0038 | CT WQS 2002 |
| Retention Times (min) | | | | | | | |
| 3.55 | | | 6.2 | A | | | |
| 5.04 | | | 150 | A | | | |
| 6.12 | | | 4.3 | | | | |
| 6.63 | | | 9.5 | D | | | |
| 6.81 | | | 4.1 | A | | | |
| 6.83 | 2- propyl-methyl pentanoic acid | 22632-59-3 | 14 | A | 2812.5 | 312.5 | Toxicity info on pentanoic acid tier 2 |
| 6.85 | Benzothiazole | 95-16-9 | 4.9 | A | | | One data point tier 2 |
| 6.88 | | | 6.1 | A | | | |
| 7.07 | | | 5.1 | D | | | |
| 7.08 | methyl 2alpha -D-xylofuranoside | 32469-86-6 | 5.8 | A | | | No data |
| 7.10 | 2 ethyltetra hydro thiopene | 1551-32-2 | 28 | A | | | No data |
| 7.13 | 4-methyl4-Heptanol | 598-01-6 | 7.4 | A | | | No data on Heptanol either |
| 7.15 | 2- butyl tetrathydrothiopene | 1613-49-6 | 12 | A | | | No data |
| 7.77 | | | 10 | D | | | |
| 7.96 | | | 6.6 | D | | | |
| 8.13 | | | 7.4 | A | | | |
| 8.23 | | | 7 | D | | | |
| | Benzamide, N-N- diethyl-3-methyl | | | C | | | |
| 9.48 | | 134-62-3 | 6.9 | | 89.3 | 9.9 | DEET tier 2 |
| 9.56 | 2(3H)- Benzo thiazolone | 934-34-9 | 5.7 | A | 47.3 | 8.1 | Different CAS # 149304 tier 2 |
| 10.28 | | | 4.1 | A | | | |
| 12.60 | 2-2-7 trimethyl-3-Octyne | 55402-13-6 | 4.5 | D | | | No data |
| 16.88 | | | 8.4 | | | | |

## Hardness

The hardness of the stormwater samples ranged from 8 to 59 mg/L. Hardness in the range of 0 to 60 mg/L is generally termed "soft". Hardness can also influence the toxicity of metals; the greater the hardness, the less toxic the metals. It is not expected that the observed hardness had much effect on metal concentrations in the stormwater.

## Metals

The metal parameters which had results reported above the detection limit are listed in Table C below. Silver, molybdenum, thallium and beryllium were analyzed but were below the detection limit for every sample. In Table C, the values bolded and underlined exceed Connecticut's acute aquatic life criteria. Metal concentrations in excess of the acute aquatic life criteria for more than one hour could cause mortality to the more sensitive organisms in the receiving surface waters. The values bolded meet or exceed Connecticut's chronic aquatic life criteria. Average metal concentrations which exceed the chronic life criteria for more than 4 continuous days are expected to impact the ability of organisms to survive, reproduce or grow. EPA recommends that neither of these criteria be exceeded more than once in three years (EPA TSD EPA/505/2-90-001). The samples highlighted in grey also exhibited acute toxicity. Since stormwater is an intermittent discharge, the acute criteria for aquatic toxicity are more applicable. A review of the data indicates that only zinc consistently violates the acute criteria.

TABLE D

| Location | Sample # | Sample date | pH | Hardness | Conductivity | Cu ug/l | Zn ug/l | Ba ug/l | Fe ug/l | Al ug/l | V ug/l |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Field C 2005 | A | 9/11/09 | 6.6 | NA | 18 | 4 | **150** | 4 | 320 | **210** | 40 |
| Field A 2007 | B | 9/27/09 | 6.6 | 8 | 20 | 1.5 | **130** | 1.5 | 20 | 25 | 1.5 |
| Field A 2007 | C | 10/7/09 | 7.5 | 29 | 65 | 1.5 | 10 | 6 | 50 | **160** | 5 |
| Field A 2007 | E | 10/18/09 | 7.5 | 39 | 86 | 1.5 | 20 | 7 | 20 | 60 | 1.5 |
| Field D 2007 | D | 10/18/09 | 7.6 | 53 | 130 | 5 | **260** | **220** | 170 | **120** | 6 |
| Field D 2007 | F | 10/28/09 | 7.9 | 59 | 157 | 4 | 50 | 8 | 80 | 80 | 8 |
| Field D 2007 | G | 11/20/09 | 8 | 56 | 153 | 4 | 30 | 7 | 160 | **110** | 9 |
| Field D 2007 | H | 12/3/09 | 8 | 58 | 147 | 4 | 20 | 5 | 170 | **100** | 8 |
| | | acute standard | <5.0 >10 | | | **14.3** | **65** | **2000** | | **780** | **150** |
| | | chronic standard | <5.0 >10 | | | **4.8** | **65** | **220** | **1000** | **87** | **44** |

### d) Aquatic Toxicity

The toxicity tests conducted on the stormwater measured both an LC50 value (the concentration of stormwater that is lethal to 50% of the test organisms) and an NOAEL (No Observable Acute Effect Level, the concentration of stormwater where no acute toxicity is observed). Toxicity tests conducted on the samples of stormwater collected indicate that 3 out of 8 sampling events were acutely toxic. Acute toxicity is observed when there is less than 90% survival of the test organisms in the undiluted effluent. The frequency of occurrence for acute toxicity was at least one sample per field. Where both *Pimephales promelas*(Pp) and *Daphnia pulex*(Dp) toxicity tests were conducted, the fathead minnow (*Pimephales promelas*) seemed to be slightly more sensitive to the contaminants in the stormwater discharge. Due to laboratory issues, the test duration for the fish, *Pimephales promelas*, for the October 18, 2009 Field A and Field D samples was limited to only 48 hours. If the test duration was extended to 96 hours, both samples could have had an LC50 value less than the 100% reported. The results for the aquatic toxicity testing conducted are shown in Table E below.

TABLE E

| Location: | Sample # | Sample date | Dp % Surv 100% | Dp LC50 | Dp NOAEL | Pp % Surv in 100% | Pp LC50 | Pp NOAEL |
|---|---|---|---|---|---|---|---|---|
| Field C 2005 | A | 9/11/2009 | 65.0 | >100 | 12.5 | NT | NT | NT |
| Field A 2007 | B | 9/27/2009 | 70.0 | >100 | 50 | 45 | 93.89 | 50 |
| Field A 2007 | C | 10/7/2009 | 100.0 | >100 | 100 | 100 | >100 | 100 |
| Field A 2007 | E | 10/18/2009 | 100.0 | >100 | 100 | 96 | >100 | 100 |
| Field D 2007 | D | 10/18/2009 | 70.0 | >100 | 6.25 | 50 | 100 | 25 |
| Field D 2007 | F | 10/28/2009 | 100.0 | >100 | 100 | 95 | >100 | 100 |
| Field D 2007 | G | 11/20/2009 | 100.0 | >100 | 100 | 100.0 | >100 | 100 |
| Field D 2007 | H | 12/3/2009 | 100.0 | >100 | 100 | 95 | >100 | 100 |
| | | acutely toxic | | | | | | |

## 7. CAES LABORATORY HEADSPACE AND LEACHING RESULTS

The CAES performed both headspace (off-gassing) and SPLP (Standard Precipitation Leaching Procedure) evaluations on seventeen samples of crumb rubber materials used as infill for artificial turf fields. These studies indicated the primary contaminants likely to be found in the stormwater coming from these sites. Organic compounds were identified by head space analysis, with results shown in Table F below. The other organic compounds detected from the crumb rubber infill, but not quantified in the analysis, included hexadecane, fluoranthene, phenanthrene and pyrene.

TABLE F. (Table 2. From CAES 2009) Concentration (ng /ml) of Volatile Compounds in Headspace Over Crumb Rubber Samples Analyzed at CAES (average of two analyses per sample)

| DEP Sample ID | 1-methyl naphthalene | 2-methyl naphthalene | 4-(t-octyl)-phenol | benzothiazole | butylated hydroxytoluene | naphthalene | butylated hydroxyanisole |
|---|---|---|---|---|---|---|---|
| A1001 | 0.13 | 0.19 | 0.28 | 3.98 | n.d. | 0.42 | 0.50 |
| A1002 | 0.11 | 0.15 | 0.31 | 5.59 | n.d. | 0.31 | 0.61 |
| A1003 | 0.03 | 0.07 | 0.19 | 8.67 | n.d. | 0.10 | 0.68 |
| A1004 | 0.04 | 0.07 | 0.31 | 6.52 | 0.15 | 0.16 | 0.69 |
| A1005 | 0.08 | 0.09 | 0.23 | 2.35 | 0.09 | 0.23 | 0.46 |
| A1006 | 0.08 | 0.14 | 0.31 | 4.89 | 0.12 | 0.23 | 0.75 |
| A1007 | 0.13 | 0.20 | 0.52 | 3.50 | n.d. | 0.23 | 0.69 |
| A1008 | 0.06 | 0.10 | 0.18 | 1.93 | n.d. | 0.22 | 0.43 |
| A1009 | 0.03 | 0.06 | 0.13 | 2.89 | 0.13 | 0.08 | 0.50 |
| A1010 | 0.07 | 0.11 | 0.22 | 4.91 | 0.13 | 0.20 | 0.64 |
| A1011 | 0.04 | 0.06 | 0.30 | 3.94 | 0.16 | 0.11 | 0.62 |
| A1012 | 0.08 | 0.14 | 0.46 | 2.70 | 0.13 | 0.28 | 0.64 |
| A1013 | 0.09 | 0.12 | 0.45 | 4.45 | n.d. | 0.30 | 0.65 |
| A1014 | 0.10 | 0.15 | 0.49 | 4.25 | n.d. | 0.31 | 0.65 |
| B1002 | n.d. | n.d. | 0.43 | 1.21 | 0.67 | 0.09 | 0.36 |
| B1009 | n.d. | n.d. | 0.07 | 1.29 | 0.48 | 0.06 | 0.35 |
| B1010 | n.d. | n.d. | 0.06 | 1.03 | 0.40 | 0.05 | 0.34 |

CAES also performed simulated weathering experiments on the crumb rubber samples to determine trends in organic compound emissions over time. The weathering test results show that, except for 4-(t-octyl)-phenol, all other detected volatile compounds significantly decreased in concentration after only 20 days of outdoor exposure. By the end of the eight week study, benzothiazole, butylated hydroxanisole and 4-(t-octyl)-phenol were detected at the highest concentrations. The results are shown in Table G. below.

TABLE G: (Table 9 from CAES, 2009) Concentrations (ng /ml) of Volatile Compounds in Headspace Over Crumb Rubber Samples Aged at CAES (average of two analyses per sample)

| Sample ID (week) | benzothiazole | 1-methyl naththalene | 2-methyl naphthalene | naphthalene | 4-(t-octyl)-phenol | butylated hydroxyanisole |
|---|---|---|---|---|---|---|
| T0 | 3.75 | 0.12 | 0.24 | 0.40 | 0.35 | 0.77 |
| T1 | 1.95 | 0.05 | 0.09 | 0.12 | 0.28 | 0.45 |
| T2 | 0.97 | 0.04 | 0.06 | 0.06 | 0.31 | 0.40 |
| T3 | 1.56 | 0.04 | 0.07 | 0.08 | 0.31 | 0.44 |
| T4 | 1.77 | 0.04 | 0.08 | 0.08 | 0.30 | 0.43 |
| T5 | 1.59 | 0.05 | 0.07 | 0.10 | 0.30 | 0.48 |
| T6 | 1.20 | 0.04 | 0.06 | 0.05 | 0.25 | 0.36 |
| T7 | 0.99 | 0.04 | 0.06 | 0.04 | 0.24 | 0.33 |
| T8 | 1.17 | 0.05 | 0.05 | 0.06 | 0.23 | 0.41 |

CAES also performed an SPLP test on the same seventeen samples of the crumb rubber infill material. The resulting leachate was then analyzed for metals and organic compounds. Based on communications with CAES, the leachate contained the same organic compounds that were identified in the head space analyses, however, only benzothiazole concentrations were estimated for the test. A summary of compounds detected and their concentrations are listed in Table H below. Based on these results, the predominant contaminant leaching from artificial turf fields is

zinc, followed by barium, manganese and lead. It should be noted some metals associated with tires and rubber products were not analyzed in this experiment, such as iron and vanadium.

In Table H, the values which exceed Connecticut's acute aquatic life criteria are highlighted in yellow. The summary shows that zinc is present in the leachate at concentrations about 500 times greater than the toxicity criteria. The leachate study indicates that there is a high potential for the artificial turf to leach acutely toxic levels of metals especially copper and zinc. Certain samples of crumb rubber also leached acutely toxic levels of cadmium, barium, manganese and lead.

TABLE H

| | Benzothiazole | Cr | Mn | Ni | Cu | Zn | As | Cd | Ba | Pb |
|---|---|---|---|---|---|---|---|---|---|---|
| ug/l | | | | | | | | | | |
| average | 0.153 | 6.24 | 263.16 | 19.88 | 22.31 | 34170.5 | 3.35 | 1.60 | 313.88 | 11.57 |
| 80th | 0.209 | 11.28 | 348.45 | 27.48 | 20.41 | 50269.8 | 1.50 | 0.50 | 463.62 | 7.77 |
| Max | 0.268 | 31.47 | 1443.19 | 57.15 | 143.32 | 71535.5 | 27.94 | 17.01 | 502.91 | 69.90 |
| Acute | 21333.000 | 323 | 616 | 260.5 | 14.3 | 65 | 340 | 2.02 | 2000 | 30 |
| Chronic | 3200.000 | 42 | | 28.9 | 4.8 | 65 | 150 | 1.35 | 220 | 1.2 |

## 8. DISCUSSION

### a) Potential Contaminants

The analyses performed on the stormwater samples were focused on compounds previously documented to leach from crumb rubber material derived from recycled tires, primarily volatile organic compounds, semi-volatile organic compounds and metals. The stormwater samples were also assessed for whole effluent toxicity. Other potential parameters of concern in the stormwater were identified from the results of the CAES off-gassing and leaching laboratory studies performed on the crumb rubber material.

### b) Organic compounds

The stormwater generated at the artificial turf sites did not include many readily identifiable, volatile or semi-volatile organic compounds, as evidenced by no detections using EPA Methods 625 and 624. Additional semi-volatile compound investigations were performed on the stormwater samples, resulting in nine tentatively identified compounds and thirteen unidentified chromatograph peaks. Benzothiazole, which CAES also detected in their leaching analysis, was identified in the September 27 and October 7, 2009 samples from Field A at concentrations of 1 and 4.9 ug/l, respectively. Of the compounds that were tentatively identified such as benzothiazole, pentanoic acid, and thiopenes, none of these compounds are considered particularly toxic to aquatic organisms at the estimated concentrations.

Although it is not possible to determine the potential impact of the unidentified semi-volatile compounds, it is important to note, that the six highest concentrations of the unidentified semi-volatile compounds detected (150 ug/l, 28 ug/l, 14 ug/l, 12 ug/l, 10 ug/l and 9.5 ug/l) did not correspond to the three acutely toxic samples of stormwater determined in the study.

The results from the CAES laboratory headspace, leaching and simulated weathering tests suggest that benzothiazole, 4-(t-octyl)-phenol, 1-methyl naphthalene, 2-methyl naphthalene, naphthalene, butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) are the likely semi-volatile compounds to be found in the stormwater discharge from artificial turf fields. The test results also suggest that Benzothiazole, 4-(t-octyl)-phenol and butylated hydroxytoluene (BHT) would be the most persistent SVOCs in the crumb rubber as the artificial turf fields aged.

Comparing the VOCs and SVOCs results to EPA's Maximum Contaminant Levels for drinking water (MCLs) and DEP's Remediation Standards Regulations, Section 22a-133k-1 through 22a-133k-3of the Regulations of Connecticut State Agencies (June 1996), no exceedences of groundwater standards have been identified.

Based on our results, no VOCs or SVOCs have been identified as risks to surface and groundwater resources.

**c) Metals**

The laboratory leaching analyses performed by CAES as part of the State of Connecticut Artificial Turf Study detected the following metals: arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), lead (Pb), manganese (Mn), nickel (Ni), and zinc (Zn). Zinc was present in concentrations orders of magnitude greater than the other metals. CAES's leaching analyses indicated that both copper (Cu) and zinc (Zn) concentrations exceeded acute aquatic toxicity criteria for 80% of the tests, with limited (<20%) exceedences of acute criteria for cadmium (Cd), manganese (Mn) and lead (Pb).

The stormwater analysis results show that the artificial turf fields in our study leached significantly less contaminants, specifically zinc and copper, than predicted by the CAES leaching test results. The lower metal concentrations observed in the stormwater could be a result of alkaline pHs, the weathering (2-4 years since installation) of the crumb rubber infill, or the conservative approach inherent in the SPLP methodology.

The stormwater analysis results showed that zinc was the only metal to exceed the acute aquatic toxicity criteria (65 ug/l), with one exceedence at each of the three study fields. The overall mean concentration of zinc in the stormwater samples analyzed was 84 ug/l, with a maximum of 260 ug/l and a minimum of 10 ug/l. The stormwater analysis results showed that aluminum, barium, copper and zinc all exceeded chronic aquatic toxicity criteria at least once during the sampling. Since chronic toxicity criteria apply to four days of continuous discharge, these exceedences are not of significant concern for these intermittent discharges.

No metal concentrations exceeded EPA's and DEP's drinking water standards. However, the concentration of zinc in three stormwater samples did exceed the surface water protection

criteria of 123 ug/l established in the Appendix D to Sections 22a-133k-1 through 22a-133k-3 of the Regulations of Connecticut State Agencies Surface-water Protection Criteria for Substances in Ground Water (June 1996). Since the mean concentration of zinc in the stormwater samples (84 ug/l) is below the surface water protection criteria, the discharge from the artificial turf fields to groundwater is intermittent, and zinc is immobilized in soils by adsorption, absorption and precipitation, the potential for impacts to surface waters being recharged by this groundwater is minimal.

Based on our results, zinc has been identified as a potential risk to surface waters. No other metals have been identified as a risk to groundwater or surface waters.

## 9. ENVIRONMENTAL RISK ASSESSMENT

### a) Potential Risk to Surface Waters

The only potential risk to surface waters identified in the stormwater collected from the artificial turf fields is zinc, since it was the only chemical parameter that was detected above the acute aquatic life criteria of 65 ug/l. Acute toxicity is assumed to occur when the zinc concentration in-stream exceeds 65ug/l for one hour in any three year period. In three of the eight stormwater samples analyzed, zinc concentrations were detected at 130, 150 and 260 ug/l, well above the acute aquatic life criteria. It is important to note, that the three stormwater samples with acutely toxic levels of zinc were also determined to exhibit aquatic toxicity (<90% survivorship) for both species *Pimephales promelas* and *Daphnia pulex* in the whole effluent toxicity testing.

Other than the acute aquatic toxicity criteria, there are no specific zinc standards or permit limits that are applicable to artificial turf fields. For industrial sites that discharge to surface waters, DEP has set a stormwater general permit guideline (Section 5 (c) (1) (F) (i) of the General Permit) for total zinc of 200 ug/l. This industrial stormwater total zinc guideline assumes a default 5:1 dilution factor for the receiving surface water at the 7Q10 flow. The 7Q10 is the lowest flow expected to occur for seven continuous days at a frequency of every 10 years. The 7Q10 flow is the critical low flow used when evaluating toxicity and toxic impacts (CT WQS 2002). Based on the results of our study, the stormwater discharges from artificial turf fields would not be expected to regularly exceed this zinc limit.

However, the estimated 7Q10 flows for the receiving watercourse from Fields A, C and D did not meet the 5:1 dilution factor for stormwater discharges from artificial turf football fields (57,600 square feet), assuming a one inch rain storm over one hour with direct discharge to the watercourse over an hour. It is important to note, that this a conservative approach, which assumes the watercourse receives no other stormwater runoff from its representative watershed. For the three receiving streams in the study, the highest dilution factor at the DEP estimated 7Q10 flow was equivalent to a 0.14:1 ratio. Given this dilution ratio of the receiving streams in the study, there is a potential for acute toxicity due to zinc loading.

Since zinc concentrations in stormwater from artificial turf fields may pose a risk to surface waters, especially to smaller watercourses, it is important to note that these fields are not the only sources of stormwater runoff in any given watershed. During the sampling at Fields A, C and D,

DEP staff observed stormwater runoff, generated by acres of parking lots, roadways and buildings, entering the same drainage systems that collected runoff from the artificial turf fields. Based on these observations, it appears that stormwater runoff from the artificial turf fields is combined with the runoff from the adjacent impervious surfaces prior to ultimate discharge at the site.

This is an interesting phenomenon, since the levels of zinc in urban runoff are comparable to the concentrations detected in the discharge from artificial turf fields. It has been well established that urban runoff contains many contaminants such as nutrients, suspended solids, hydrocarbons and heavy metals, including zinc. The average concentration of zinc in urban stormwater runoff has been estimated at 129 ug/l in recent studies (Smullen 1998). EPA's Nationwide Urban Runoff Program (NURP) has collected runoff data and determined that for urban sites the median concentrations of total zinc ranged from 179 -226 ug/l. The National Stormwater Quality Database (NSQD, version 1.1), dated February 16, 2004, compiled zinc concentration data in runoff from various land uses across the United States, which is shown in Table L below.

TABLE I

| **Land Uses** | **Zinc Total (ug/l) Median** |
|---|---|
| Overall (All Uses) | 117 |
| Residential | 73 |
| Mixed Residential | 99.5 |
| Commercial | 150 |
| Mixed Commercial | 135 |
| Industrial | 210 |
| Mixed Industrial | 160 |
| Institutional | 305 |
| Freeways | 200 |
| Mixed Freeways | 90 |
| Open Space | 40 |
| Mixed Open Space | 88 |
| **CT Artificial Turf Stormwater** | **84 (mean)** |

Since zinc concentrations in the runoff from artificial turf fields are consistent with those associated with urban runoff, it would be a logical step to apply the same best management practices (BMPs) to mitigate the toxicity effects to surface waters. The 2005 Stormwater Management Manual for Western Washington specifically recommends the following BMPs to remove dissolved zinc (and other metals) from stormwater runoff: stormwater treatment wetlands, wet ponds, infiltration structures, compost filters, sand filters and biofiltration structures. The 2004 Connecticut Stormwater Quality Manual suggest the same measures since these treatment practices incorporate biological removal mechanisms that are more effective in removing pollutants than systems that strictly rely on gravity or physical separation of particles in the stormwater. The 2004 Connecticut Stormwater Quality Manual further recommends a treatment train approach, which provides a series of BMPs each designed to provide targeted pollution control benefits.

The University of New Hampshire Stormwater Center has field tested many of these stormwater BMPs that demonstrate significant removal of dissolved zinc. For example, the Retention Pond, Subsurface Gravel Wetland and Bioretention System (Bio II) stormwater treatment measures, over a two year period, removed between 90% and 100% of the soluble zinc, based on a median annual influent Event Mean Concentrations (EMC) of 60ug/l (see Appendix B for fact sheets). The three highest zinc concentrations detected in the stormwater from artificial turf fields in our study were 130, 150 and 260 ug/l, respectively. Assuming 80% removal of zinc from the stormwater prior to discharge to surface waters, all three of the highest zinc concentrations would meet the acute aquatic toxicity criteria (26, 30 and 52 ug/l, respectively). To mitigate the risk to aquatic life and surface waters, the DEP strongly recommends that the aforementioned stormwater best management practices be incorporated into the design of the drainage system for artificial turf fields.

## 10. ENVIRONMENTAL RISK ASSESSMENT IN RECENT STUDIES

Several other studies were conducted to determine the risk to surface waters and groundwater from the stormwater discharges from artificial turf fields. Since artificial turf fields can either discharge to groundwater or surface water, the ecological risks must be evaluated for both potential pathways. This was confirmed by Nillson et al (2008), that drainage from artificial turf fields can enter the environment by either seeping through the underlying soil and potentially contaminate the groundwater, or alternatively, by stormwater runoff entering the adjacent watercourses.

### a) Overall Surface Water Contamination Risk

### 1) Organic Compounds

The studies conducted by Plesser (2004) indicated that concentrations of the common polycyclic aromatic hydrocarbons (PAHs) anthracene, fluoranthene and pyrene, as well as nonylphenols, would exceed the limits for freshwater specified in the Canadian Environmental Quality Guidelines. Torsten (2005) from the Norwegian Institute for Water Research (2005) also predicted that concentrations of alkyl phenols and octylphenol in particular would exceed the limits for environmental effects in the scenario which was allowed a 10:1dilution of run-off. Torsten (2005) further determined that the leaching of chemicals from the materials in the artificial turf system would decrease slowly, so that environmental effects could occur over many years. However, Torsten (2005) anticipated only localized impacts due to the relatively small concentration of the leaching pollutants. The SVOCs analysis of the stormwater in our study, utilizing EPA Method 625, and a specific search for 4-(t-octyl)-phenol, detected no anthracene, flouranthene, pyrene or standard phenol compounds.

Kolitzus (2006) detected no appreciable PAHs concentrations in the runoff analyzed from artificial surface systems. The PAHs that were found above detection limit were ubiquitous substances in the environment. The PAH concentrations in the unbound supporting layer were determined to be in the range of analytic determination limit (0.02 µg/l). The sum of all 16 PAHs was 0.1 to 0.3 µg/l. Similarly, in a recent New York study (Lim et al 2009), no standard organics were detected utilizing EPA Method 624 and 625 in the stormwater sample collected. The

SVOC analysis of the stormwater in our study, utilizing EPA Method 625, detected no standard PAHs.

In surface systems with EPDM and recycled rubber infill, Kolitzus (2006) found several aromatic amino complexes and benzothiazole detected in the range of 10 – 300 µg/l. These concentrations were similar to the results of simulated normal tire wear tests. Lim et al (2009) reported a semi-volatile rubber compound, benzothiazole, at 1,000 ug/l as a Tentatively Identified Compound (TIC) in one stormwater sample. The SVOC analysis of the stormwater in our study, utilizing EPA Method 625, detected no standard aromatic amines, but further TIC analysis did detect identified and unidentified organic compounds. Benzothiazole was detected in two stormwater samples at estimated concentrations of 1.0 and 4.9 ug/l, respectively, which is significantly lower than concentrations found by Lim et al (2009). The Connecticut acute and chronic toxicity benchmark for benzothiazole are 21,333 ug/l and 3,200 ug/l, respectively, based on available toxicity information. The estimated concentrations of benzothiazole are insignificant compared to both the acute and chronic toxicity criteria. Also, a number of unidentified organic compounds were detected during the SVOC TIC analysis at concentrations ranging from 1 ug/l to 150 ug/l, with a median concentration of 6.6 ug/l. The 10/7/09 Field C stormwater sample, which the maximum unidentified compound concentration of 150 ug/l was detected in, was not found to be acutely toxic.

The results from our study appear to be consistent with the results from Kolitzus (2006) and Lim et al (2009), including the detection of benzothiazole in the stormwater samples. Overall, our study did not identify any organic compounds at sufficient concentrations to be considered a potential contamination risk to surface waters.

**2) Metals**

Based on our analysis of the stormwater collected from the artificial turf fields, zinc is the only metal detected in concentrations which could pose a risk to surface water resources. This finding is consistent with many recent studies which analyzed leachate and stormwater from crumb rubber infill, which indicate that zinc is the primary contaminant of concern coming from artificial turf sites. In sites with limited dilution both the Norwegian Pollution Control Authority (2005) and Verschoor (2007) conclude that the concentration of zinc in the leachate would exceed applicable water quality standards. The Norwegian Pollution Control Authority classifies artificial turf runoff as Environmental Quality Class V (very strongly polluted water) due to the high concentration of zinc in the leachate. The risk assessment conducted by Norwegian Institute for Water Research (2005) shows that the concentration of zinc poses a significant local risk of environmental effects in surface water which receives run-off from artificial turf fields.

Verschoor (2007) also conducted a risk assessment concluding that the estimated concentrations of zinc in the drainage water from artificial football fields to be between 1100-1600 ug/L. This concentration exceeded the Dutch legal criterion for surface water Maximum Permissible Chronic Concentration (MPC) of 40 ug/l by a factor of 27-40. Verschoor explained that drainage water concentrations would be diluted in the receiving surface waters, but indicated that zinc in "small ditches" could exceed MPA (Maximum Permissible Acute). Verschoor espoused a general discharge impact rule that only 10% of the permissible concentration of a contaminant (=

4 ug/l) may be consumed by a particular source. This would imply that the concentration of zinc in smaller receiving water would exceed the water quality criteria by a factor of 45-80. Verschoor identified zinc as a potential eco-toxicological risk to surface water, but did indicate that if the crumb rubber were to be replaced by infill materials with a lower zinc emission, the pollutant concentrations in runoff and adjacent surface water should drop quickly.

Lim et al (2009) conducted a mathematical assessment of the risks to aquatic life from crumb rubber leachate based on the SPLP test results for zinc, aniline and phenol. Based on these concentrations, NYSDEC's Division of Fish, Wildlife and Marine Resources concluded that there may be a potential aquatic life impact due to zinc being release from crumb rubber solely derived from truck tires. However, New York State also concluded that an impact is unlikely if the crumb rubber material is from mixed tires and concentrations of zinc from a column test were used rather than the SPLP. It should be noted, that for the column test to better simulate field conditions, the material in the column must reflect local soil conditions and pH.

Several recent studies analyzed stormwater samples collected from artificial turf fields for metals. Lim et al (2009) and Kolitzus (2006) detected concentrations of zinc at 59.5 ug/l and 20 ug/l, respectively. Milone and MacBroome (2008), conducted field studies and detected zinc in the stormwater from four of the six sampling dates , with a maximum concentration of 31 ug/l which is below acute aquatic toxicity criteria of 65 ug/l.

The zinc concentrations in our stormwater samples were significantly higher than those of Lim, Kolitzus and Milone and MacBroom, with three of the eight the samples tested exceeding acute surface water quality criteria. If not mitigated with appropriate stormwater treatment measures, the zinc concentrations found in our study could contribute to the environmental risk of aquatic organisms in surface waters.

**3) Aquatic Toxicity**

Wik (2006) studied the toxicity of various tire brands and determined that different formulas for rubber contributed to varying degrees of toxicity in the leachates to *Daphnia magna*. By conducting a toxicity identification evaluation on various tire leachates (EPA 600/6-91/003), Wik determined that although zinc was prevalent, the semi-volatile non polar organics also heavily influenced the toxicity of the resulting leachate. Passing the simulated tire leachates through carbon filters was the only manipulation that consistently reduced toxicity. Compared to the results from Milone and MacBroom (2008), this study reported significantly higher levels of both aquatic toxicity and zinc. This study found that three of the eight stormwater samples tested were acutely toxic to both the invertebrate (*Daphnia pulex*) and the fathead minnow (*Pimephales promelas*). These acutely toxic samples directly coincided with the exceedences of the acute aquatic life criteria for zinc. Consequently, zinc seems to be the primary pollutant of concern. This study indicates that there is risk associated with whole effluent toxicity and zinc.

**b) Overall Groundwater Contamination Risk**

Stormwater from the fields can impact groundwater directly by percolating through the artificial turf via an "open" underground drainage system (perforated pipes, coarse bedding materials, stone trenches). The stormwater discharges to the underlying soil layers, and ultimately, enters

the ground water. Based on the nature of the underlying soil and the depth to groundwater, the field stormwater is likely to physically and chemically interact with a mineral soil layer (vadose zone) prior to encountering groundwater. This stormwater/soil interaction would be affected by pH, volume of stormwater and soil characteristics, such as moisture, chemistry, mineralogy, soil texture, hydraulic conductivity and drainage class. These interactions would likely influence the concentrations of contaminants found in the groundwater.

There are two primary concerns with the contamination of groundwater in the environment - the threat to drinking water and the threat to surface water resources via groundwater recharge. Several other studies were conducted on the crumb rubber fill from 2004 to 2009; (Plesser(2004), Nillson et al (2008), the Norwegian Institute for Water Research (2005) , Verschoor, A.J., RIVM Report 601774011/2007(2007) Study, (Milone & MacBroom Study 2007),NYSDEC May 2009 an Kolitzus, Hans J. (2006). These studies compared the relative concentration of contaminants found in laboratory leachates and/or artificial turf generated stormwater with various drinking water and aquatic life criteria.

**1) Organic Compounds**

It should be noted that substances, to a varying degree, will be absorbed by the sand/clay layers which the drainage water passes. Although Nillson et al (2008) found that concentrations of nonylphenols in the contact water from leaching tests were in the order of 20-800 times above the threshold values for drinking water, it was uncertain as to whether this concentration would be significant in the actual groundwater. The EPA aquatic life acute criteria for nonylphenol for freshwater and saltwater resources are 28 ug/l and 7.0 ug/l, respectively. It is important to note that nonyphenol has been associated with the disruption of fish endocrine systems at concentrations below EPA's criteria. No data was available for phthalates and nonylphenols under such realistic conditions from lysimeter data. Nillson determined that the assessment of the impact on water systems also requires more realistic lysimeter tests or measurements on drainage water from artificial turf fields over time.

Plesser (2004) compared leachate results with Canadian Environmental Quality Guidelines for ground water. Groundwater guidelines are developed for both protection of drinking water and protection of surface water via groundwater recharge. Plesser identified anthracene, fluoranthene, pyrene and nonylphenols as compounds in the leachate that could exceed the more protective criteria for groundwater. Plesser also concluded that analyzing possible paths and changes in leaching properties over time is necessary to determine the degree to which the concentrations of these compounds are actually harmful to people and the environment.

Lim et al (2009) conducted a leachate (SPLP) test on rubber crumble material, and analyzed for zinc, phenol and aniline. The results from recent leaching studies indicated a potential for release of aniline, benzothiazole, phenol, and zinc to the groundwater. However, concentrations of the organic contaminants analyzed were below levels that would impose a risk to drinking water. Lim also collected 32 groundwater samples from wells installed downgradient of four artificial turf fields and analyzed them for SVOCs, including aniline and benzothiazole, using SW-846 Method 8270C. The wells were installed in sandy textured soils with depth to the groundwater ranging from 8.3 to 70 feet. All test results were below the limit of detection for all

groundwater samples analyzed. Based on test results of 32 samples, no organics were detected in the groundwater at the turf fields.

Our results are consistent with the leachate and groundwater sampling results in Lim et al (2009). The concentrations of organic compounds in our study did not exceed groundwater protection criteria.

**2) Metals**

In general, metals are immobilized in soils by adsorption, absorption and precipitation. All of these, mechanisms impede movement of the metals to ground water. Metal-soil interaction is such that when metals are introduced at the soil surface, downward transportation does not occur to any great extent unless the metal retention capacity of the soil is overloaded, or metal interaction with the associated waste matrix enhances mobility.

Zinc is the most prevalent contaminant in the leachate and stormwater studies. In several of these studies, zinc concentrations measured in leachate exceeded drinking water standards. Most of the zinc in soil is absorbed to the soil as zinc hydroxide or oxide and does not dissolve in water. Zinc does show moderate mobility under relatively acid soil conditions (pH 5–7) because of increased solubility and formation of soluble complexes with organic lignands (Elliott et al. 1986; Stevenson and Fitch, 1986; Klamberg et al. 1989). Zinc is retained in an exchangeable form at low pH in iron and manganese oxide dominated soils but becomes non-exchangeable as the pH was increased above 5.5 (Stahl and James, 1991). Therefore, depending on the acidity of the soil and water, some zinc may reach groundwater.

Nillson et al (2008) determined that although leachate concentrations of zinc were in excess of the drinking water quality standards, similar concentrations were not observed in (field) lysimeter tests. Nillson concluded that the concentration of zinc in the lysimeter tests were a more accurate reflection of zinc in the groundwater and, therefore, zinc concentrations would not exceed drinking water standards.

Lim et al (2009) was the only study that did not report concentrations of zinc in the SPLP leachate that exceeded drinking water standards.

Verschoor (2007) concluded that, for the majority of situations, the risks of zinc to public health are minimal since it is not very toxic to humans and the World Health Organization (WHO) drinking water criteria was not exceeded in tests. However, Verschoor (2007) did note that in sandy areas discharges to groundwater may exceed Dutch Intervention Values by a factor of 1.5 to 2.2. In sandy soils, infiltration of water with dissolved zinc will result in weak binding of zinc to the soil matrix and could cause protection criteria to be exceeded by a factor of 12. Verschoor concluded that zinc was a potential eco-toxicological risk to groundwater and soil.

Plesser (2004) and CAES (2009) indicated that zinc was the most likely contaminant to exceed drinking water standards in the leachate. All studies indicate that, although compounds were present in the leachate or stormwater, it was uncertain as to what affect the underlying soils and groundwater would have on the actual concentration of contaminants in the groundwater. Actual groundwater testing may be necessary to determine the impact.

The leachate results reported by CAES showed zinc concentrations up to ten times the drinking water standards and up to 500 times the surface water protection criteria. Our study detected concentrations of zinc in the stormwater significantly lower than CAES results, with no exceedences of drinking water standards and no significant concerns for groundwater quality. It is important to note that no groundwater samples were collected for our study.

## 11. CONCLUSIONS

The DEP concludes that there is a potential risk to surface waters and aquatic organisms associated with whole effluent and zinc toxicity of stormwater runoff from artificial turf fields. Zinc concentrations in the stormwater may cause exceedences of the acute aquatic toxicity criteria for receiving surface waters, especially smaller watercourses. The DEP suggests that use of stormwater treatment measures, such as stormwater treatment wetlands, wet ponds, infiltration structures, compost filters, sand filters and biofiltration structures, may reduce the concentrations of zinc in the stormwater runoff from artificial turf fields to levels below the acute aquatic toxicity criteria. Individual artificial turf field owners may want to evaluate the stormwater drainage systems at the fields and the hydrologic and water quality characteristics of any receiving waters to determine the appropriateness of a stormwater treatment measure.

This study did not identify any significant risks to groundwater protection criteria in the stormwater runoff from artificial turf fields. It is important to note, that the DEP study did not directly collect and analyze groundwater at these artificial turf fields. Consequently, this conclusion regarding consistency with groundwater protection criteria is an extrapolation of the stormwater results collected and the evaluation of data presented in recent studies, such as Nillson et al (2008) and Lim et al (2009). To make a final conclusion regarding the overall risk from exposure to groundwater affected by stormwater runoff from artificial turf fields, further sampling and analysis of groundwater at the artificial turf fields would be required.

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December 1, 2008

**To Our Clients and Friends in the Athletic and Parks Community**

Over the past year, Milone & MacBroom, Inc. has been studying the water quality, temperature, and air quality of three scholastic athletic fields constructed using synthetic surfaces in-filled with crumb rubber and silica sand. The results of our findings are contained in the attached document.

We hope you find the information useful when considering what type of field surface is appropriate for your program.

Should you have questions, please feel free to contact us.

Sincerely,

MILONE & MACBROOM, INC.

Scott G. Bristol, LEP
Project Manager

scottgb@miloneandmacbroom.com

Vincent C. McDermott, FASLA, AICP
Senior Vice President

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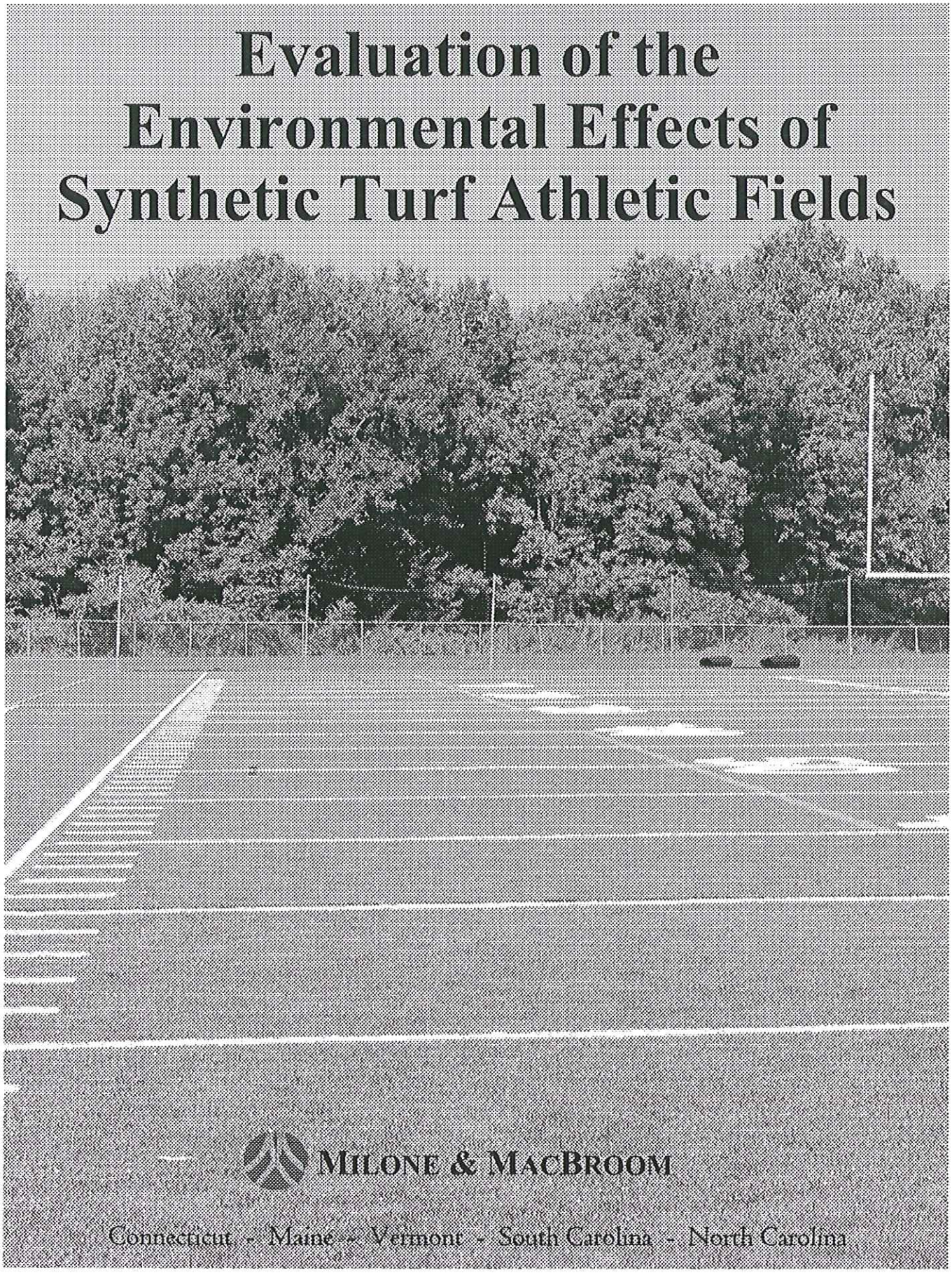
# Evaluation of the Environmental Effects of Synthetic Turf Athletic Fields



MILONE & MACBROOM

Connecticut - Maine - Vermont - South Carolina - North Carolina

# PREFACE

## Evaluation of the Environmental Effects of Synthetic Turf Athletic Fields

Over the past year or so, Milone & MacBroom, Inc. (MMI) conducted a variety of tests of synthetic athletic fields in Connecticut in an attempt to contribute to the discussion regarding potential risks to the environment and human health associated with such facilities. In 2007, laboratory tests at the Connecticut Agricultural Experiment Station (CAES) raised a number of questions concerning the safety of such fields. As a company that advises clients and designs athletic fields using both natural grass and synthetic surfaces, Milone & MacBroom, Inc. believed that it would be prudent to undertake some first-hand observations and to become more confident that published literature was applicable to synthetic surfaces in the northeast.

When reading these papers, there are two points that should be clearly understood. First, by undertaking these studies, we are not promoting the installation of synthetic fields but recognize that they are a legitimate alternative to natural grass in some instances. Second, the cost of the testing was totally paid by Milone & MacBroom, Inc. and that the synthetic turf industry has had no involvement whatsoever in our testing program. We did consult, however, with representatives of the Connecticut Department of Public Health regarding testing protocols to be sure that our methodologies and the results of our efforts would be useful to the regulatory community.

The three areas of concern that Milone & MacBroom, Inc. addressed were water quality from the runoff that passes through the synthetic turf, the temperature of the surface of the turf, and the air quality on and surrounding the synthetic field. The questions we sought to answer are:

- Does the temperature of the synthetic field become excessively hot in summer months?
- Does the crumb rubber infill material have an effect on air quality?
- Do metals leach from the crumb rubber infill material at a level that would adversely affect the quality of water?

To address these issues, Milone & MacBroom, Inc. conducted three separate studies at locations where synthetic fields had been recently installed. The sites were selected for two reasons. First, we were able to secure permission from the owner of the fields to conduct the necessary tests. Second, we were familiar with the sites and understood how the fields were constructed and the materials that were used in the construction. The water quality monitoring was initiated in late 2007 and continued into the fall of 2008. The testing and observation of the temperature and the sampling of the air were done in mid-summer 2008. The results of the testing are presented in three separate documents as follows:

- **Thermal Effects Associated with Crumb Rubber In-filled Synthetic Turf Athletic Fields**
- **Evaluation of Benzothiazole, 4-(tert-octyl) Phenol and Volatile Nitrosamines in Air at Synthetic Turf Athletic Fields**
- **Evaluation of Stormwater Drainage from Synthetic Turf Athletic Fields**

We hope that our efforts will be useful to public officials and the consumer when evaluating which type of playing surface best suits their athletic field program needs.

Please contact Vince McDermott with any questions or to request additional copies of the research conducted by Milone & MacBroom, Inc.

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# About Milone & MacBroom, Inc.

Milone & MacBroom, Inc. is a privately-owned, multidisciplinary consulting firm founded in 1984. The firm maintains a staff of over 145 technical and administrative personnel, with its main office located in Cheshire, Connecticut, and regional offices in Stamford and Branford, Connecticut; Greenville, South Carolina; Raleigh, North Carolina; Freeport, Maine; and South Burlington, Vermont. The team of professionals at Milone & MacBroom, Inc. is committed to building strong partnerships with our clients to deliver creative solutions that are technically sound, cost-effective, and environmentally sensitive. We strive to integrate the disciplines of engineering, landscape architecture, and environmental science in an exceptional work environment that is founded upon respect among ourselves, our clients, and our professional colleagues.

**Thermal Effects Associated with Crumb Rubber In-filled Synthetic Turf Athletic Fields**

Scott G. Bristol, LEP
Vincent C. McDermott, FASLA, AICP

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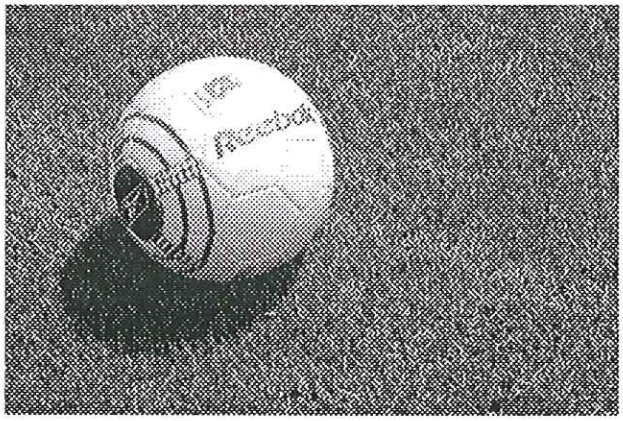
Substantial focus has been given to possible environmental effects associated with the installation of synthetic turf athletic fields. Questions concerning the potential health effects have been raised by several groups. Generally, these questions have been related to claims that insufficient data has been collected to reach a conclusion regarding possible detrimental health effects. One component of these claims is the question concerning the effect of solar heating on the fields and in particular upon the crumb rubber that is used as in-fill material (Figure 1). A temperature evaluation study was designed and conducted to determine the temperature rise of the synthetic materials under a number of conditions.



Two fields within Connecticut were selected for this study. Both fields were constructed by FieldTurf in 2007. One field, identified as Field F, is located in the northern portion of the state, while Field G is located in the southern portion of the state. Selection of the fields was based upon the ability to obtain permission to perform the testing and was not based upon manufacturer or geographic location. Temperature monitoring occurred on June 10 and July 11, 2008, at Field F and on June 17, 2008, at Field G.

During the testing procedure, the air temperature was monitored at two elevations directly over the synthetic playing surface and at a location adjacent to the synthetic surface but within an area of natural grass. Also measured during the testing were the temperatures of the crumb rubber

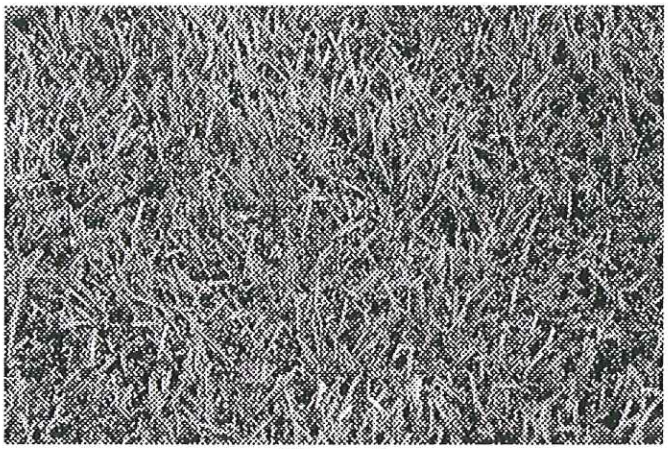


**Figure 1**

and the surface temperature of the polyethylene and polypropylene blended fibers used to simulate grass. Additional measurements were made of the soil at various depths in the area of the natural grass and the surface temperature of the natural grass itself. The air temperatures were measured using six-inch Enviro-Safe Easy Read Armor Case thermometers with a protective plastic jacket. These thermometers have a working temperature range of 0 degrees Fahrenheit (° F) to 220° F with two-degree graduations and are National Institute of Standards and Technology (NIST) certified. The thermometers were suspended within Styrofoam insulating cylinders. The inside dimensions of the cylinders were approximately $3^3/_8$ inches in diameter by 7¼ inches tall. Outside dimensions were approximately 4¼ inches in diameter by 7¾ inches tall. Twelve one-half inch holes were drilled into four sides of the cylinders to allow for airflow through the cylinder while still providing protection from the heating effect of the sunlight (Figures 2 and 3).

**Figure 2**

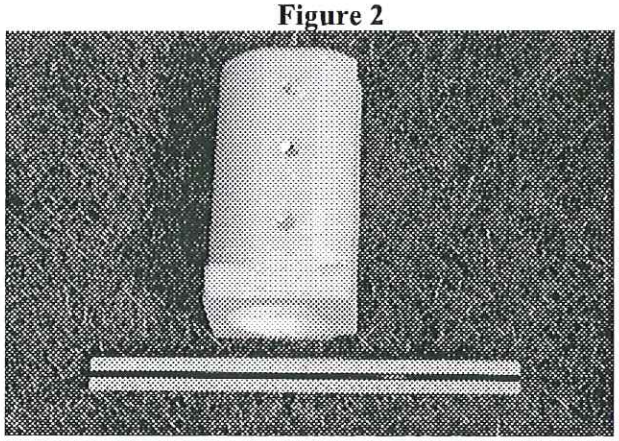
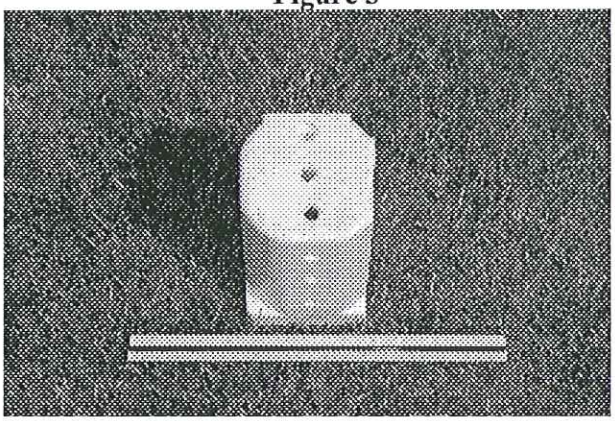


**Figure 3**



The Styrofoam cylinders were then mounted to a wooden pole measuring approximately 1¾ inch x 1¾ inch x 5½ feet tall using plastic wire ties (Figure 4). Each pole was then mounted to a metal and wooden surveyor's tripod (Figure 5).

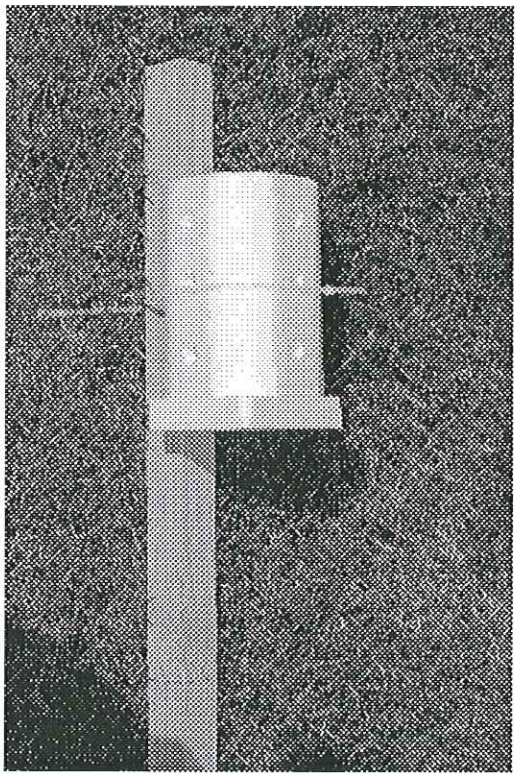


**Figure 4**

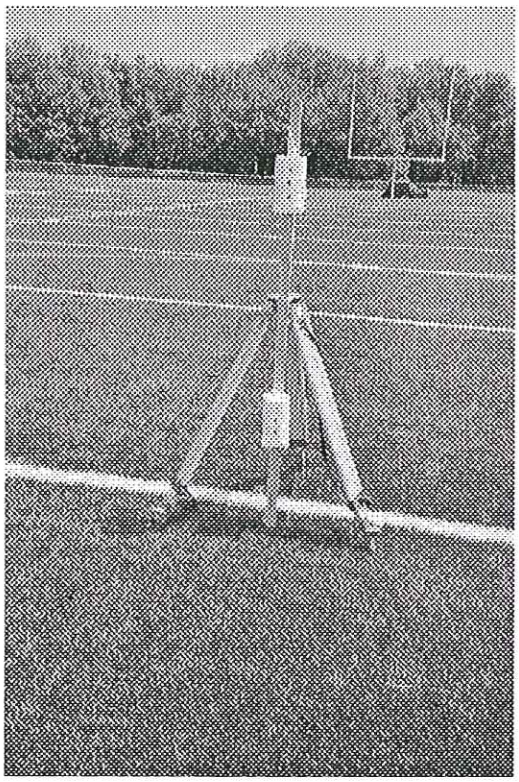


**Figure 5**

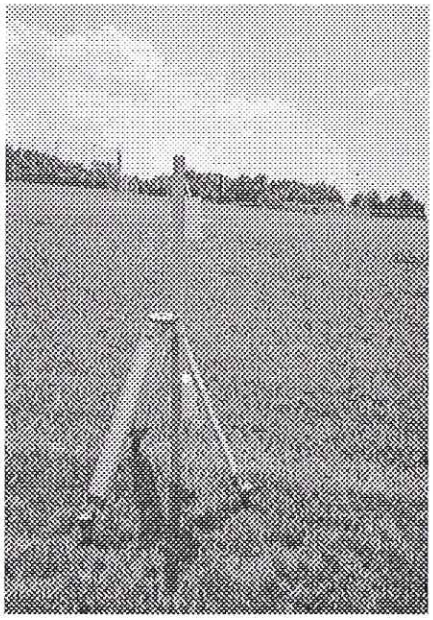
The surface temperatures of the natural grass and the synthetic fibers were measured using an infrared thermometer manufactured by EXTECH Instruments (EXTECH Pocket IR thermometer). The thermometer has a stated sensing range of -58° F to 518° F with an accuracy of +/- 2.5% of reading plus three degrees.

The temperature of the soil and the crumb rubber in-fill material was measured using a digital pen thermometer with a stated sensing range of -58° F to 536° F in 0.1-degree divisions with an accuracy of one degree. The sensing probe measured eight inches long and was constructed of stainless steel.

## Methodology

The temperature monitoring stations were placed to allow a comparison of temperatures between the synthetic and natural turf surfaces. One station was placed in the center of the synthetic turf field, while the second station was placed approximately 50 feet (Field G) or 125 feet (Field F) away from the synthetic surface on natural turf. The natural turf monitoring station was located based upon the location of nearby structures (bleachers, parking lots, synthetic running track surfaces) that had the potential to affect the temperature readings (Figure 6).

**Figure 6**



Air temperatures were measured at two feet and five feet above the ground surface during the June 10 and June 17, 2008, monitoring events. The methodology was adjusted for the July 11, 2008, event, at which time the temperatures were measured at one foot and five feet.

Surface temperatures of both the synthetic "grass" fibers and the natural grass were measured using the infrared thermometer, while soil and crumb rubber temperatures were measured using the digital pen thermometer.

The air temperature measured at a distance of five feet above the natural turf was assumed to best approximate the actual ambient air temperature at the location of the monitored field.

## Results

June 10, 2008

Temperature measurements were obtained at Field F on June 10, 2008. Official temperature data for this date was obtained from Weatherunderground.com for Bradley International Airport in Windsor Locks, Connecticut. The official high temperature was 98° F. Additional temperature and wind data was obtained from a private weather station associated with Weatherunderground.com. This weather station is located approximately 2.3 miles from Field F. A high temperature of 95.6° F and maximum winds of three miles per hour (mph) were recorded at this station during the study time period. Skies were clear throughout the study.

Collected data indicated that the air temperature as measured at a distance of two feet above the synthetic turf surface ranged from one to five degrees greater than the observed ambient air temperature, while the temperature at the same height above the natural turf ranged from 3° F lower to 1° F greater than the ambient air temperature (Figure 7).

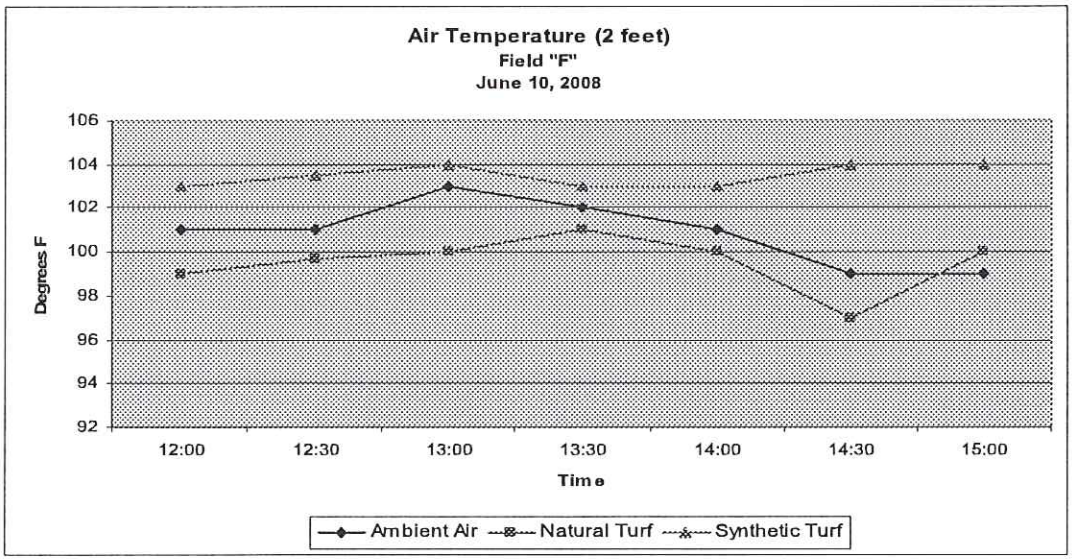



**Figure 7**

The measured air temperature at a height of five feet above the synthetic turf more closely approximated the ambient air temperature. Measured air temperatures ranged from 2° F lower to 2° F greater than the ambient air temperature (Figure 8).

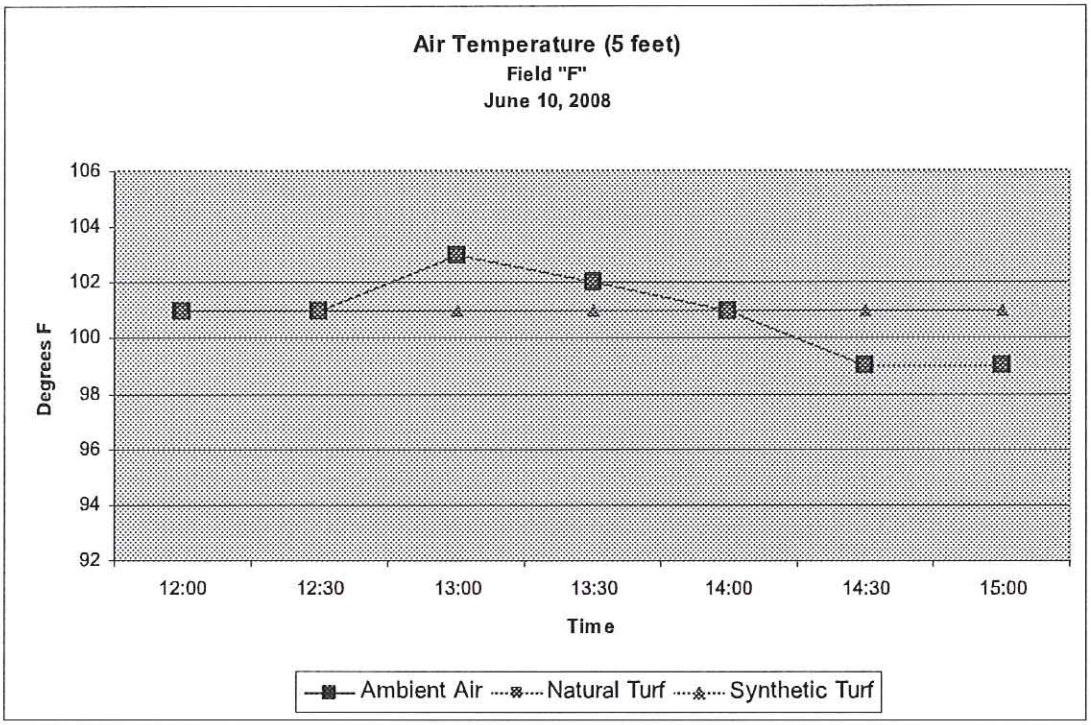



**Figure 8**

Note in Figure 8 the temperature identified as the ambient air temperature is the same as the temperature measured at a distance of five feet above the natural turf.

The temperature observed for the surface of the synthetic "grass" fibers was measured using an infrared thermometer and compared to the observed air temperatures and also the temperature of the crumb rubber in-fill material as measured at a depth of one inch. The surface of the synthetic fibers reached a maximum temperature of 156° F. The crumb rubber reached a maximum temperature of 111.5° F or approximately 44 degrees cooler than the surface temperature of the synthetic "grass" fibers. As noted above, the elevated temperature of the fibers did not result in a significant elevation of the air temperature above the synthetic field as compared to the air temperature over the natural grass field (Table 1 and Figure 9).

**Table 1**

| Time of Day (hrs) | Ambient Temperature | Synthetic Turf Temperatures | | | |
|---|---|---|---|---|---|
| | | Surface Temperature Synthetic "Grass" Fibers | Crumb Rubber Temperature (1 inch depth) | Air Temperature 2 feet above surface | Air Temperature 5 feet above surface |
| | °F | °F | °F | °F | °F |
| 12:00 | 101 | 153 | 102.5 | 103 | 101 |
| 12:30 | 101 | 155 | 103 | 104 | 101 |
| 13:00 | 103 | 151 | 104.5 | 104 | 101 |
| 13:30 | 102 | 156 | 111.5 | 103 | 101 |
| 14:00 | 101 | 154 | 109.5 | 103 | 101 |
| 14:30 | 99 | 138 | 107.2 | 104 | 101 |
| 15:00 | 99 | 149 | 105.8 | 104 | 101 |

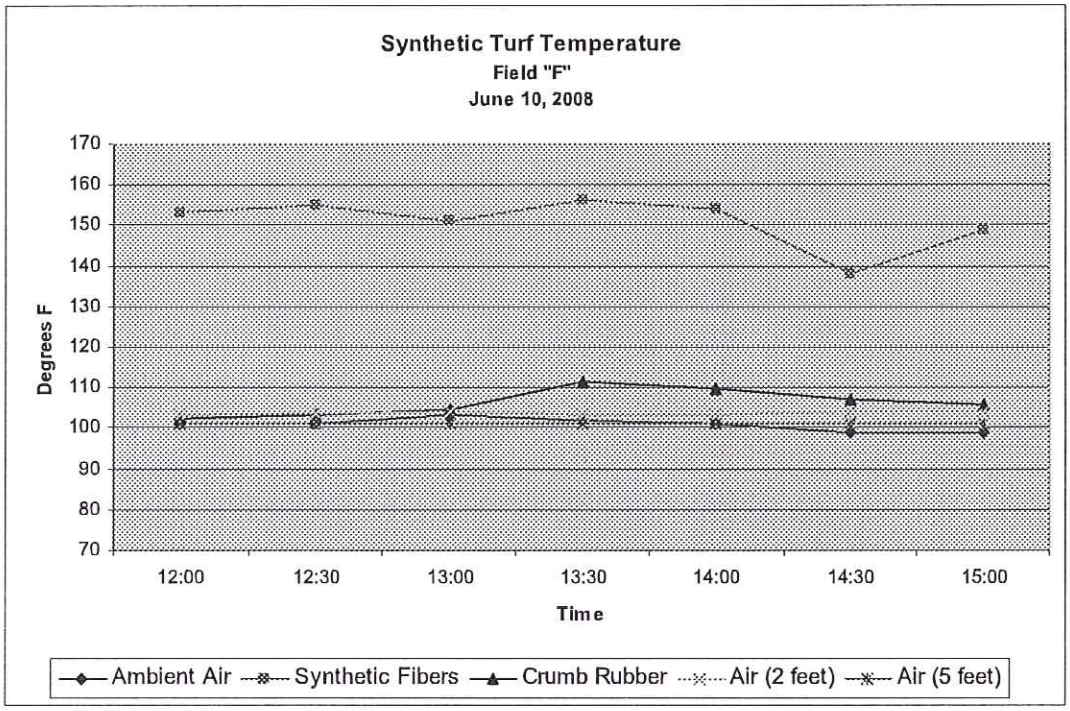



**Figure 9**

Temperatures measured in the area of the natural turf indicated that the surface of the natural grass blades closely approximated the ambient air temperature. The grass blades ranged from 3° F cooler to 5° F warmer than the measured ambient temperature. Soil temperatures were determined to decrease with increasing depth. The highest soil temperatures were noted at the end of the study period with a maximum temperature of 90.1° F being measured at 15:00 at a depth of one inch below the surface. The temperature of the soil at that depth increased approximately nine degrees over a span of three hours, while the temperature at a depth of six inches increased just two degrees.

**Table 2**

| Time of Day (hrs) | Ambient Temperature | Natural Turf Temperatures | | | | | |
|---|---|---|---|---|---|---|---|
| | | Surface Temperature Natural Grass | Soil Temperature | | | Air Temperature 2 feet above surface | Air Temperature 5 feet above surface |
| | | | 1 inch depth | 3 inch depth | 6 inch depth | | |
| | °F | °F | °F | °F | °F | °F | °F |
| 12:00 | 101 | 100 | 81.5 | 78.8 | 77.3 | 99 | 101 |
| 12:30 | 101 | 101 | 86.5 | 79 | 77.3 | 99.7 | 101 |
| 13:00 | 103 | 102 | 89.2 | 79.8 | 77.3 | 100 | 103 |
| 13:30 | 102 | 99 | 86 | 81.6 | 78.2 | 101 | 102 |
| 14:00 | 101 | 101 | 89.4 | 82.5 | 79.5 | 100 | 101 |
| 14:30 | 99 | 104 | 87 | 81 | 78.9 | 97 | 99 |
| 15:00 | 99 | 100 | 90.1 | 85.1 | 79.3 | 100 | 99 |

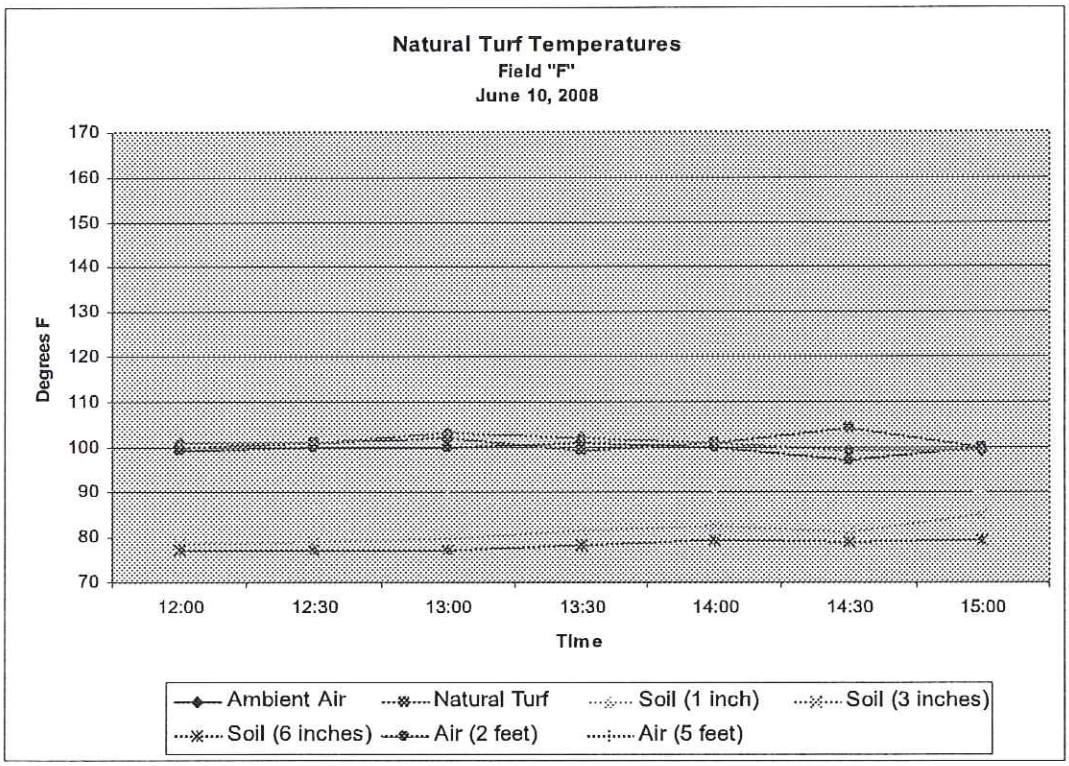



**Figure 10**

June 17, 2008

Temperature measurements were obtained at Field G on June 17, 2008. Field G is located in the southern portion of Connecticut and is believed by the authors to be susceptible to localized weather variations caused by Long Island Sound. Once again, temperature and wind data were obtained from a private weather station associated with Weatherunderground.com and located approximately 1.5 miles from Field G. A high temperature of 75.7° F and maximum winds of four mph were recorded at this station during the study time period. Intermittent clouds and sunshine were noted during the study period.

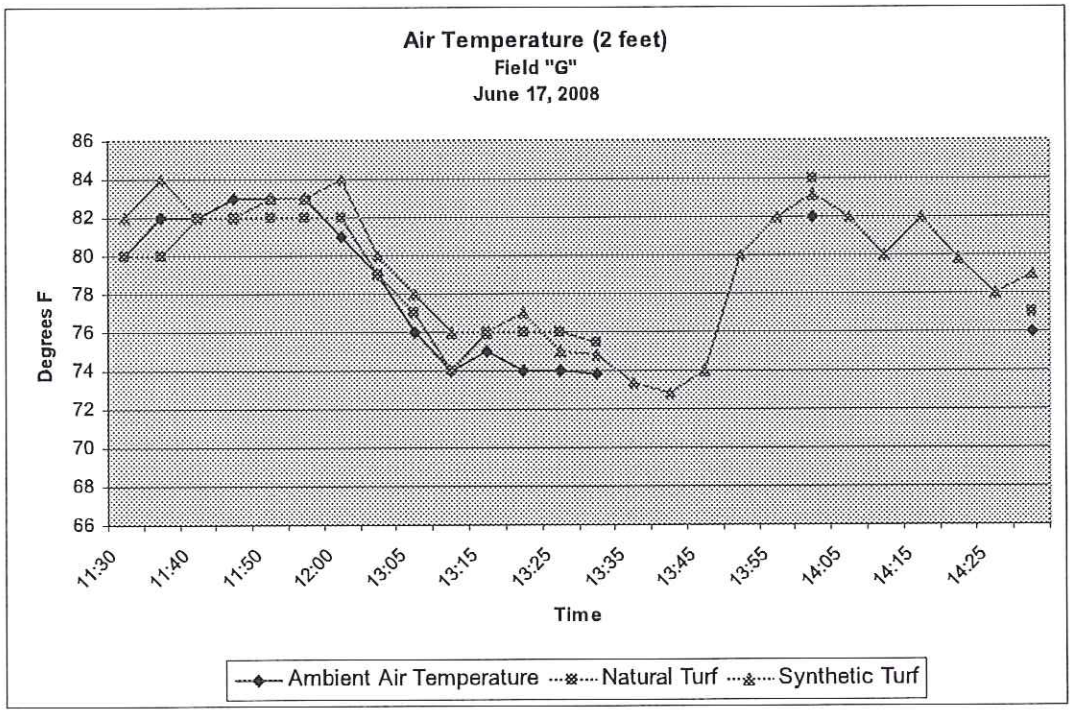



**Figure 11**

Collected data indicated that the air temperature as measured at a distance of two feet above the synthetic turf surface ranged from 1 degree lower to three degrees greater than the observed ambient air temperature, while the temperature at the same height above the natural turf ranged from 2° F lower to 2° F greater than the ambient air temperature (Figure 11). The air temperature two feet above the synthetic turf field was generally two degrees to four degrees greater than the temperature above the natural turf.

The time period between approximately 13:00 and 13:45 was characterized by clouds. The cooling effect of the cloud cover can be clearly noted in the data. This effect is also noted in the graph of the air temperature at five feet above the fields. At this height, the air temperature above the synthetic turf was generally two to three degrees greater than the natural turf field.

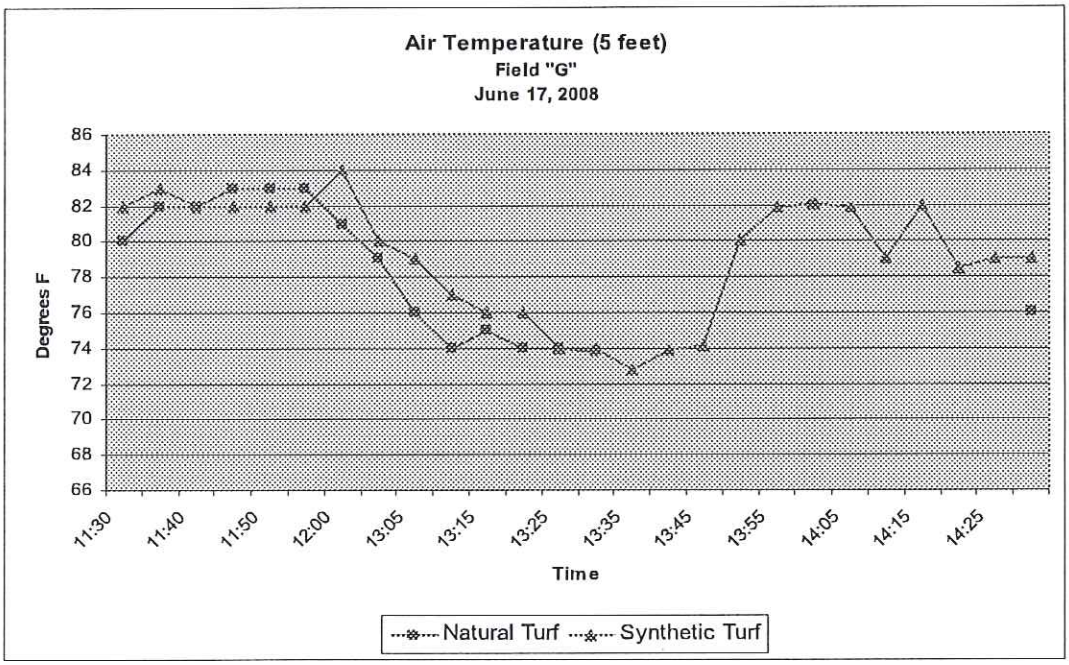



**Figure 12**

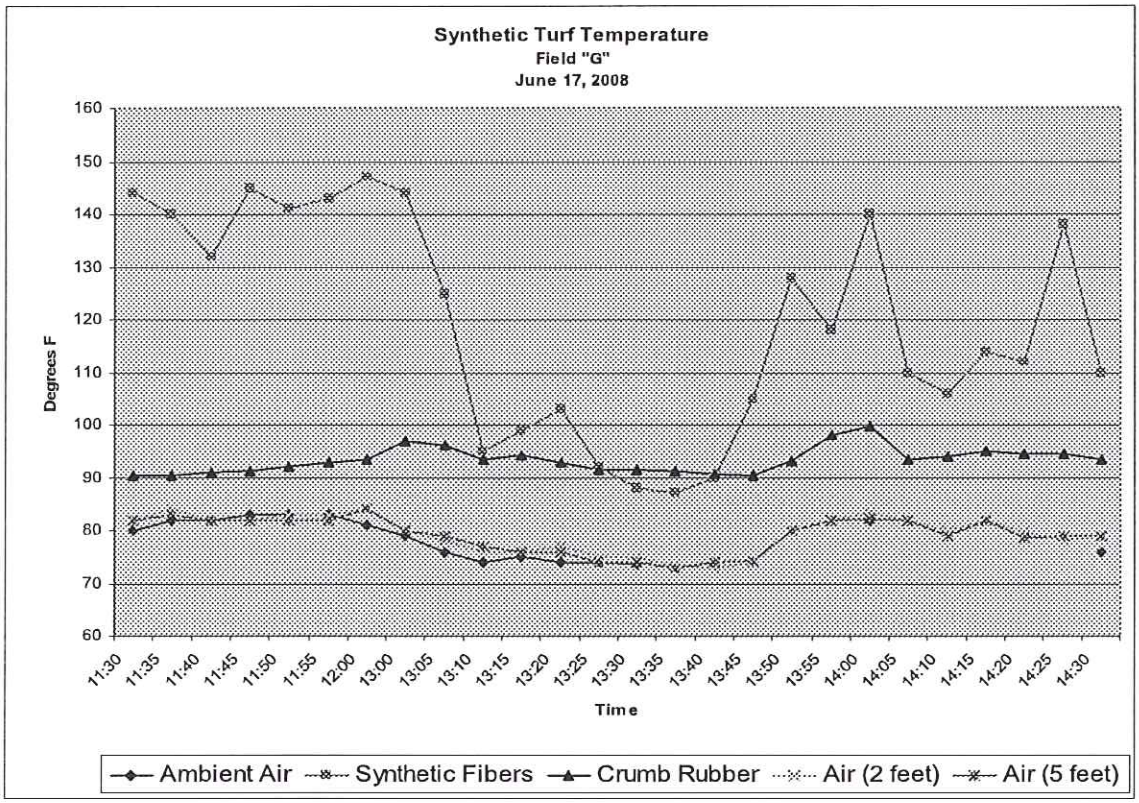



**Figure 13**

The results of the measurements of the temperature of surface of the synthetic "grass" fibers were similar to those obtained for Field F. A maximum temperature of 147° F was noted during periods of sunshine. The temperature dropped rapidly during cloudy periods and reached a minimum temperature of 87° F or approximately 15 degrees greater than the observed ambient air temperature. The crumb rubber in-fill material maintained a relatively steady temperature and averaged approximately 93° F or approximately 15 degrees greater than the average ambient air temperature (Figure 13). Once again, the elevated temperature of the fibers did not result in a significant elevation of the air temperature above the synthetic field as compared to the air temperature over the natural grass field.

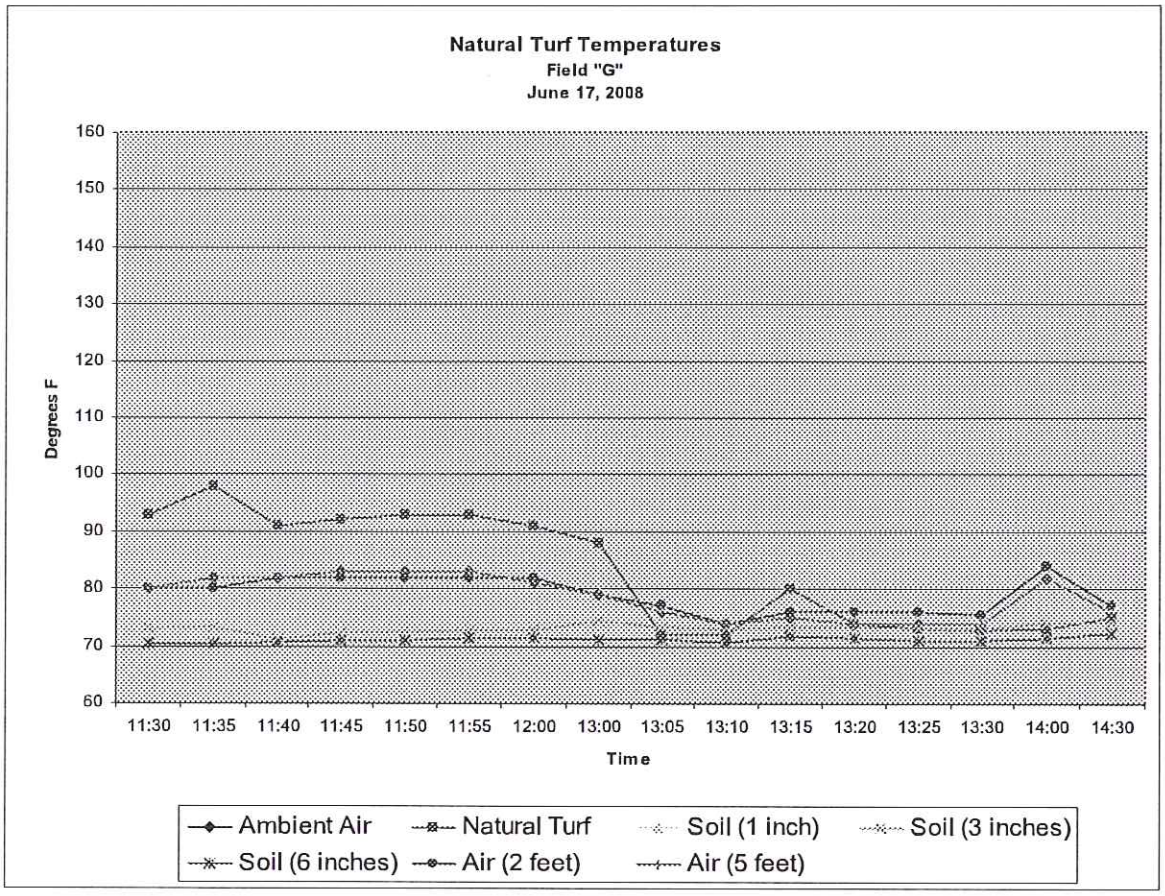



**Figure 14**

Measurements in the area of the natural turf near Field G indicated that the surface temperature of the natural grass blades was approximately 10 to 15 degrees greater than the ambient air

temperature during periods of sunshine. The temperature decreased quickly to nearly the ambient air temperature once cloud cover was present. The soil temperatures were nearly constant throughout the monitoring period and averaged approximately 74° F (Figure 14).

July 11, 2008

The temperature monitoring was repeated at Field F on July 11, 2008. The exception to the above procedures was that the air temperature was measured at heights of one foot and five feet above the synthetic turf and the natural turf fields. The results are detailed in Figures 15 through 19 below. As noted previously, the elevated surface temperature of the synthetic "grass" fibers appeared to have minimal effect on the air temperature directly over the synthetic turf field. Likewise, only a moderate rise in the temperature of the crumb rubber was noted. The temperature rise noted at one foot above the synthetic turf field was generally two to four degrees as compared to the measured ambient air temperature, although a maximum of a nine-degree rise was noted to occur over a short time period early in the study. The temperature rise noted at five feet above the synthetic turf surface was generally between one to five degrees, which is comparable to the previously observed measurements.

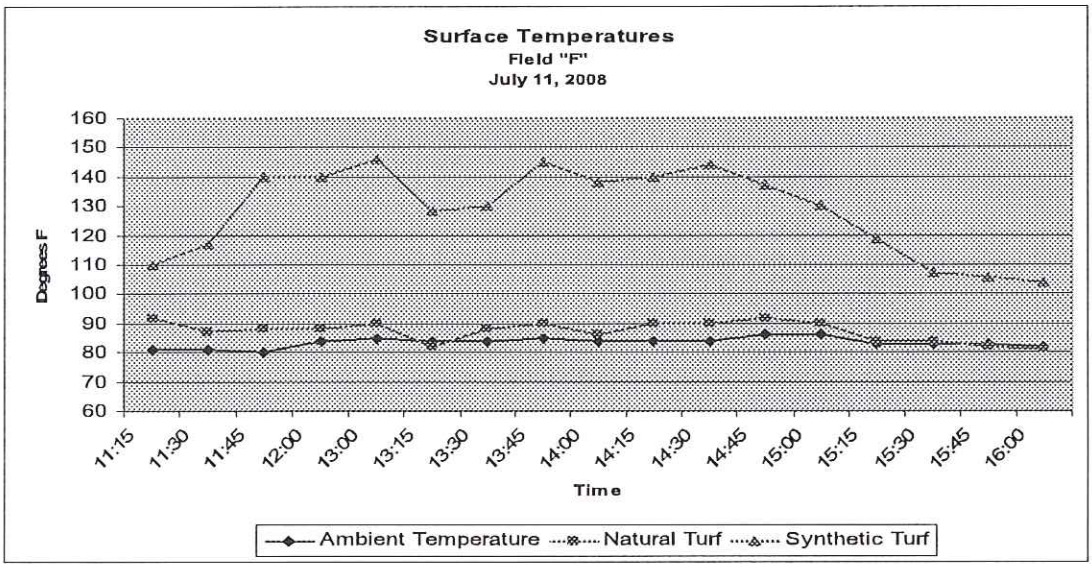



**Figure 15**

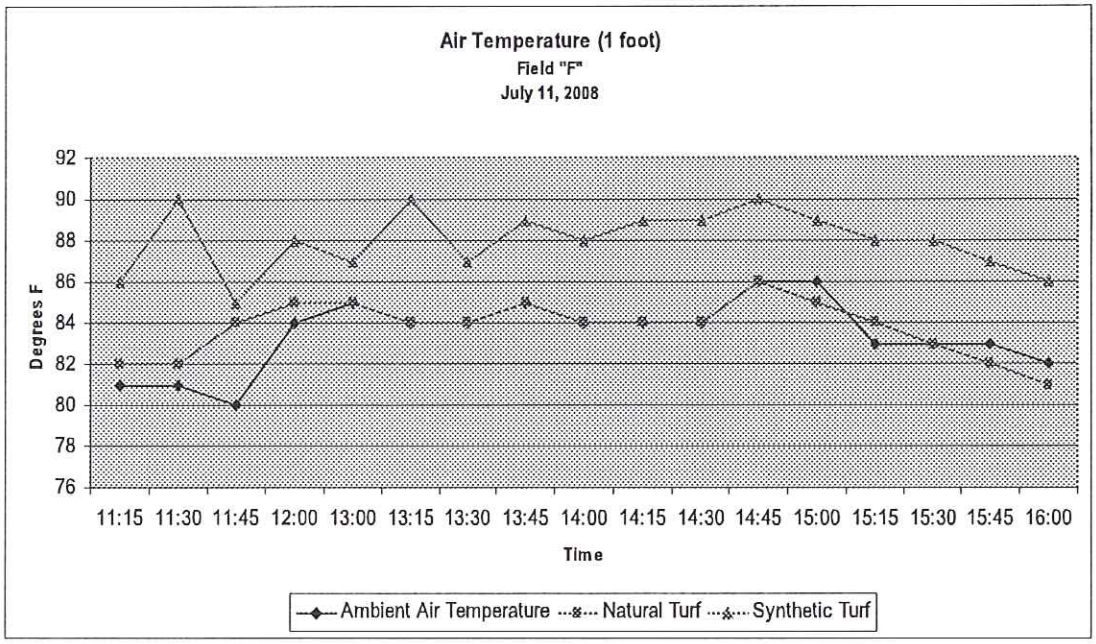



**Figure 16**

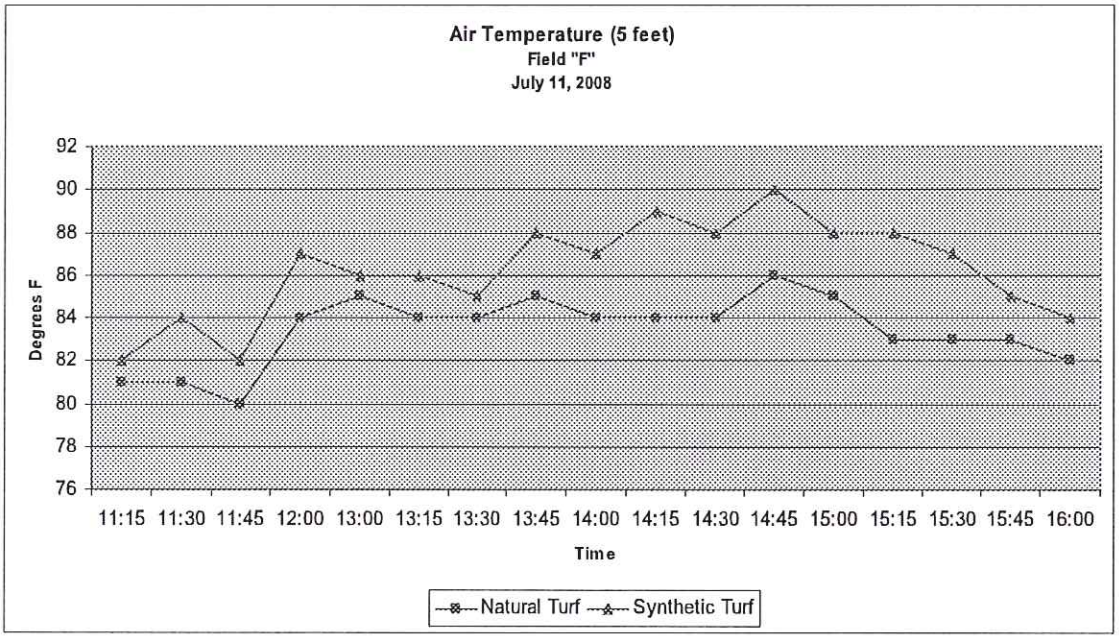



**Figure 17**

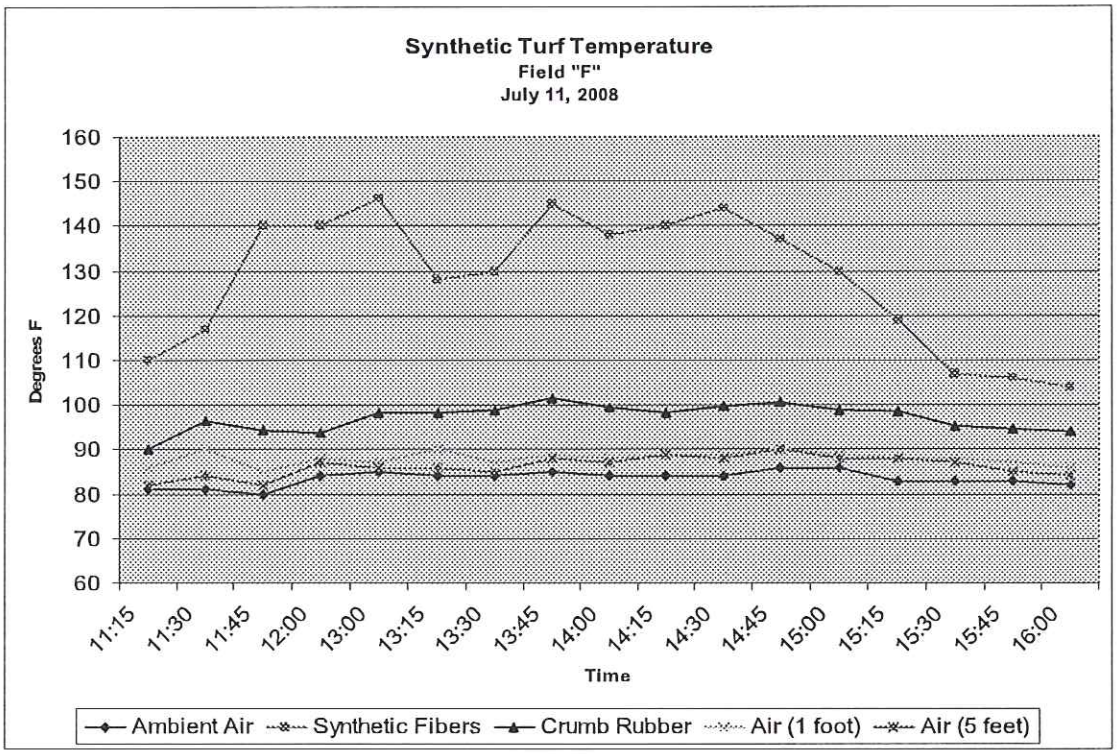



**Figure 18**

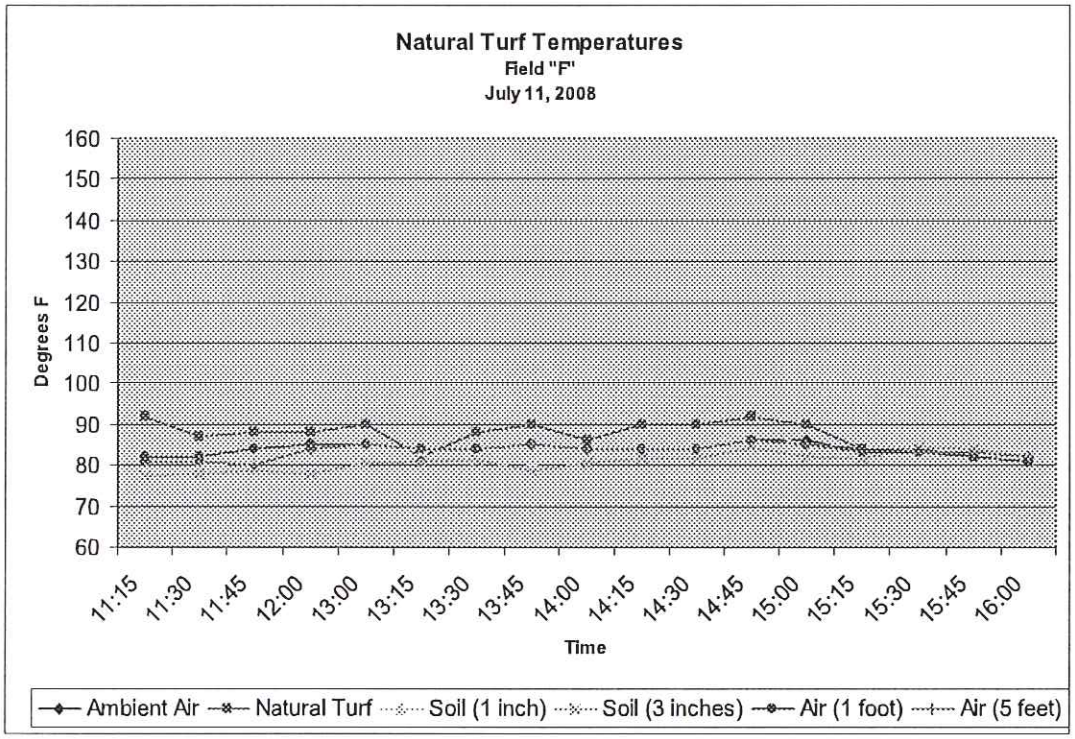



**Figure 19**

The sampling methodology on this date was also adjusted to evaluate the potential cooling effect due to the evaporation of water from the synthetic "grass" fibers. Two squares measuring one foot square were cut from a single sheet of white foam board (Figure 20). The surface temperature of the synthetic fibers was then measured using an infrared thermometer. One square was kept dry while the other side was wetted with one ounce of water using a spray bottle. The surface temperatures were measured and recorded over a period of 20 minutes. The foam board was then moved to a dry location, and the measurements were repeated using two ounces and then three ounces of water.

The results indicated that the applied water provided at least 20 minutes of effective cooling to the synthetic fibers. The amount of the cooling effect was generally between 10 and 20 degrees although slightly more of a cooling effect was noted when three ounces of water were used.

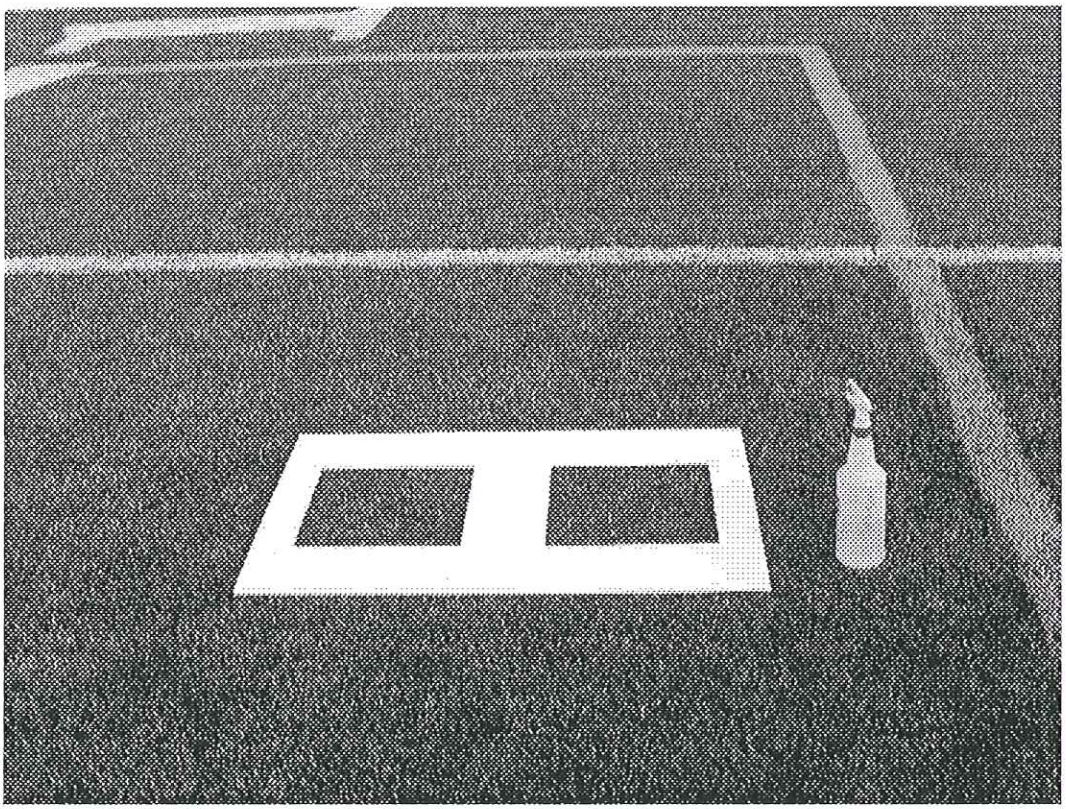


**Figure 20**

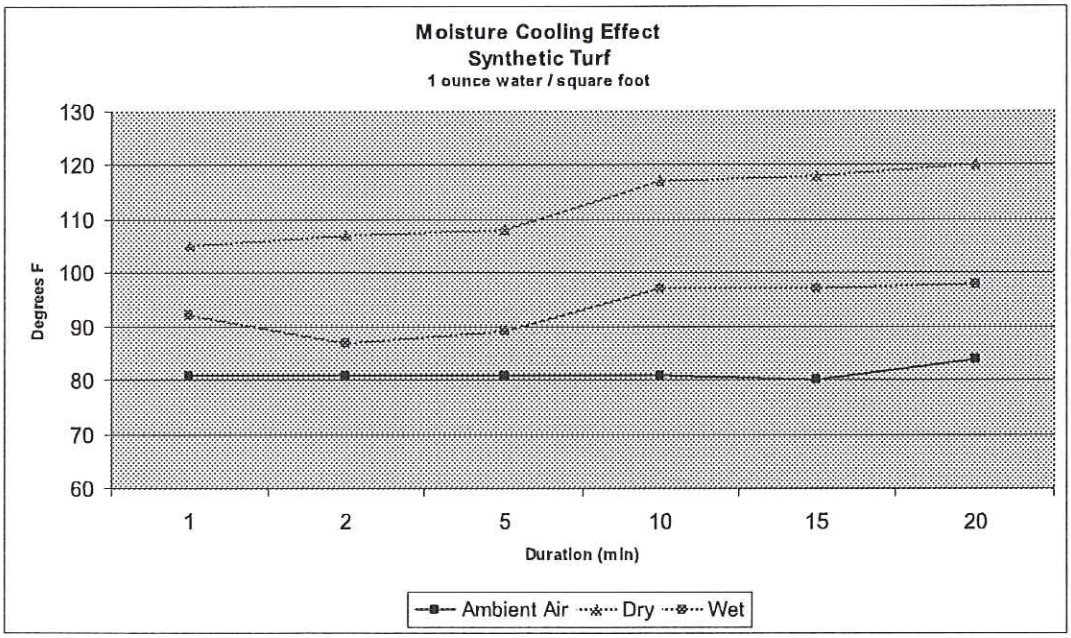



**Figure 21**

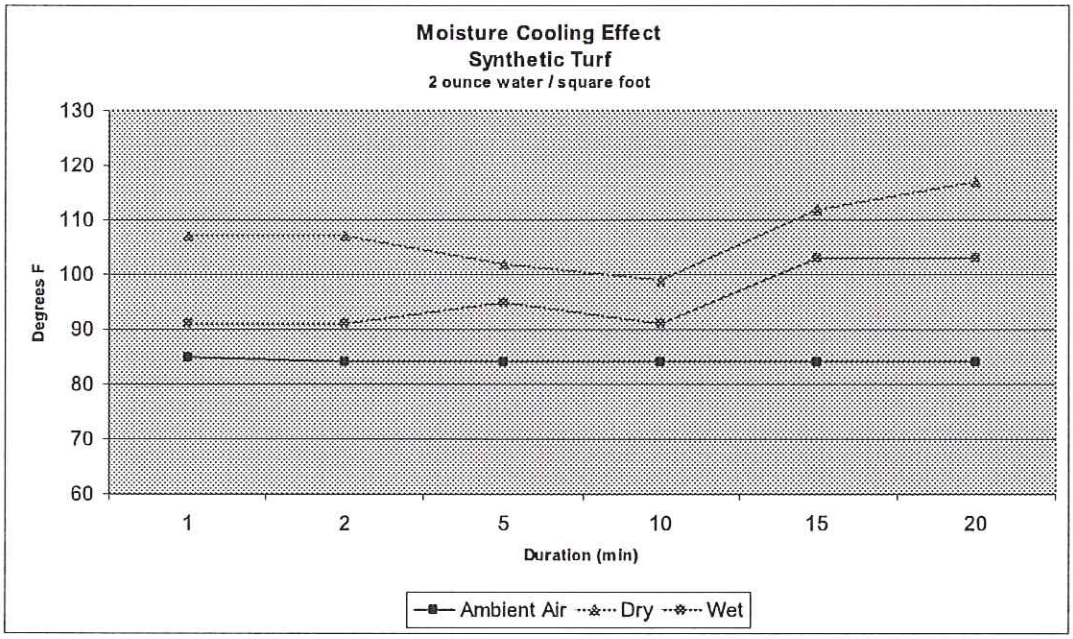



**Figure 22**

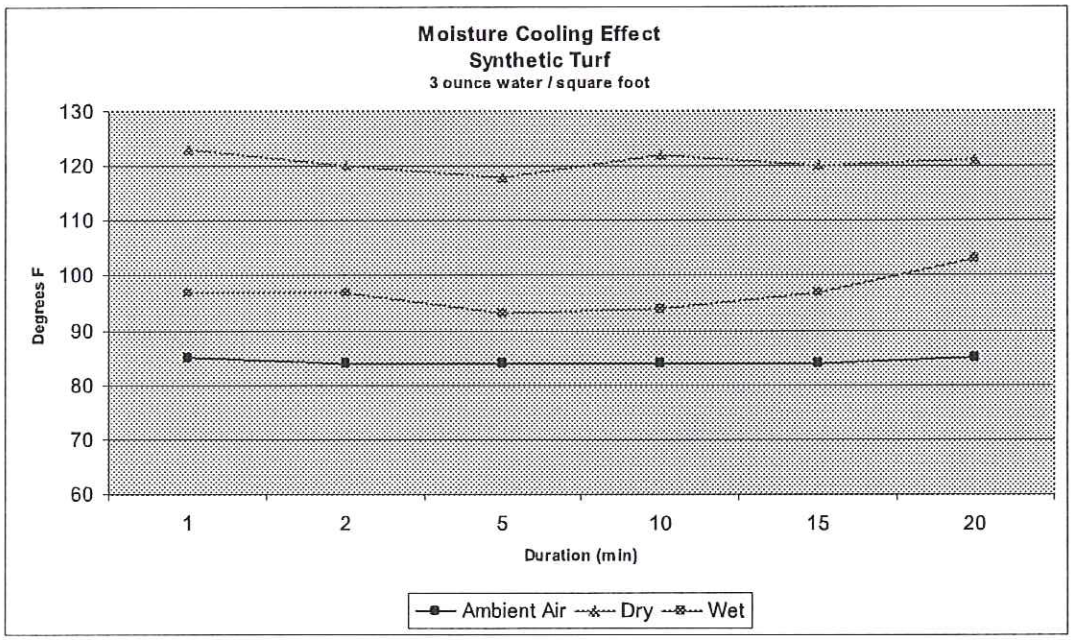



**Figure 23**

## Summary

The results of the temperature measurements obtained from the fields studied in Connecticut indicate that solar heating of the materials used in the construction of synthetic turf playing surfaces does occur and is most pronounced in the polyethylene and polypropylene fibers used to replicate natural grass. Maximum temperatures of approximately 156° F were noted when the fields were exposed to direct sunlight for a prolonged period of time. Rapid cooling of the fibers was noted if the sunlight was interrupted or filtered by clouds. Significant cooling was also noted if water was applied to the synthetic fibers in quantities as low as one ounce per square foot. The elevated temperatures noted for the fibers generally resulted in an air temperature increase of less than five degrees even during periods of calm to low winds.

The rise in temperature of the synthetic fibers was significantly greater than the rise in temperature noted for the crumb rubber. Although a maximum temperature of 156° F was noted for the fibers, a maximum temperature of only 101° F, or approximately 16 degrees greater than the observed ambient air temperature, was noted for the crumb rubber.

**Evaluation of Benzothiazole, 4-(tert-octyl) Phenol and Volatile Nitrosamines in Air at Synthetic Turf Athletic Fields**

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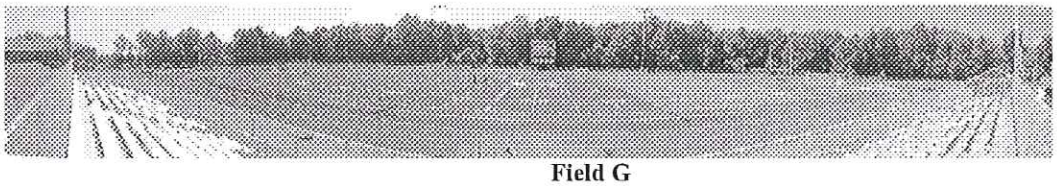
The growing popularity of crumb rubber in-filled synthetic turf playing surfaces has resulted in questions concerning the potential resulting human health effects from the inhalation of volatile chemicals by users of those fields. A limited number of studies have attempted to identify and quantify these chemicals. One such study, conducted in 2007 by the Connecticut Agricultural Experiment Station[1] identified benzothiazole, butylated hydroxyanisole, n-hexadecane, and 4-(tert-octyl) phenol as potential chemicals of concerns. This study, however, was laboratory based and did not include collection and analysis of samples from installed fields. Another study, conducted by the Norwegian Institute for Air Research[2], evaluated the air quality at three different indoor fields.

A study was designed and conducted to specifically evaluate the possible presence of benzothiazole, 4-(tert-octyl)phenol, and volatile nitrosamines in air above recently installed outdoor, crumb rubber in-filled synthetic turf playing surfaces in Connecticut.



**Field G**

## Methodology

Two fields in Connecticut were selected for this study. Both fields were constructed in 2007 by FieldTurf using polyethylene fiber with cryogenically produced rubber and silica sand infill. One field, identified as Field F, is located in the northern portion of the state, while Field G is

located in the southern portion of the state. Selection of the fields was based upon the ability to obtain permission to perform the testing and not based upon manufacturer or geographic location. Both fields are multipurpose fields used for sports such as football, soccer, field hockey, and/or lacrosse among others and are encircled by synthetic running track surfaces. These two fields were previously the subject of a separate study by the authors entitled "Thermal Effects Associated with Crumb Rubber In-filled Synthetic Turf Athletic Fields." The air sampling activities were conducted on August 15, 2008, at Field F and on August 18, 2008, at Field G.

Five sample locations were selected at each of the sampled fields. One location at each field was directly over the center portion of the playing surface, while the remaining four were located off the playing surface at either end or sides of the fields. These later locations were selected to provide "background" results to account for potential transport of vapors by wind and to evaluate the possible volatilization of target compounds from the running track surfaces.

A Davis Vantage Pro2 automated meteorological station was utilized to measure temperature, relative humidity, wind speed, and wind direction at the fields throughout the sampling period. The station was erected near the sampling location in the center portion of the field (Figure 1). The temperature sensor portion of the instrument was located approximately five feet above the synthetic turf surface.

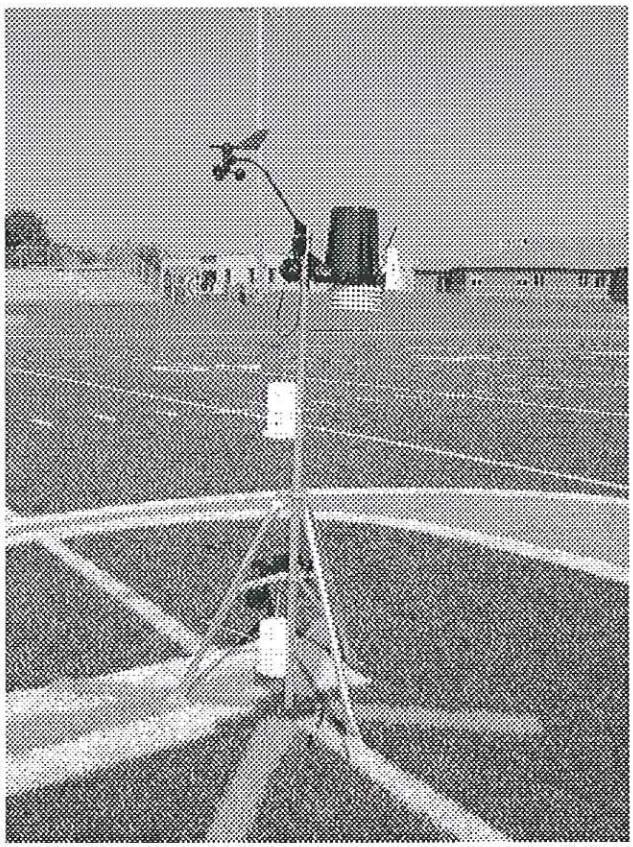


**Figure 1 - Meteorological Station**

Additional measurements were made of the air temperature at heights of one foot and four feet above the synthetic turf surface using six-inch Enviro-Safe, Easy Read Armor Case thermometers with a protective plastic jacket. These thermometers have a working temperature range of 0 degrees Fahrenheit (° F) to 220° F with two-degree graduations and are National Institute of Standards and Technology (NIST) certified. The thermometers were suspended within Styrofoam insulating cylinders. The inside dimensions of the cylinders were approximately $3^{3}/_{8}$ inches diameter by 7¼ inches tall. Outside dimensions were approximately 4¼ inches diameter by 7¾ inches tall. Twelve one-half inch holes were drilled into four sides of the cylinders to allow for airflow through the cylinder while still providing protection from the heating effect of the sunlight (Figure 2).

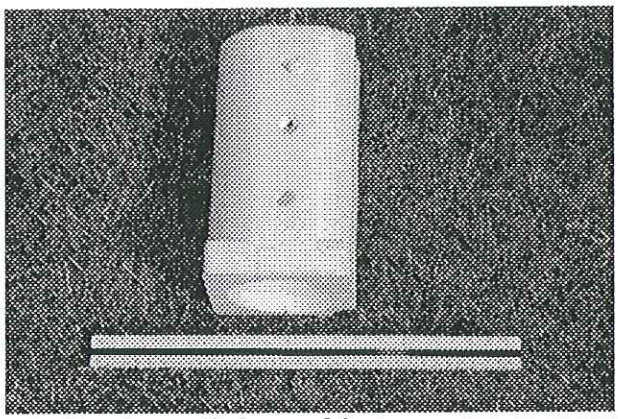


**Figure 2 - Styrofoam cylinders used for temperature measurements**

The Styrofoam cylinders were then mounted to the metal pole supporting the weather station. The mounted cylinders can be seen in Figure 1.

The temperature of crumb rubber in-fill material was measured using a digital pen thermometer with a stated sensing range of -58° F to 536° F in 0.1 degree divisions with accuracy of one degree. The sensing probe measured eight inches long and was constructed of stainless steel.

Air samples were collected through dedicated adsorbent media with the intakes set at approximately four feet above ground surface (Figures 2 through 5). The samples to be analyzed for benzothiazole and 4-(tert-octyl) phenol were collected using XAD-2 adsorbent media (Catalog #226-30, lot 4501, expiration date April 2012) produced by SKC Inc. of Eighty Four, Pennsylvania. A minimum of 480 liters of air was pumped through the adsorbent media at an approximate rate of two liters per minute using an SKC Airlite sampling pump. A 37 mm, 2 micron PTFE filter was placed inline before the adsorbent media tube.

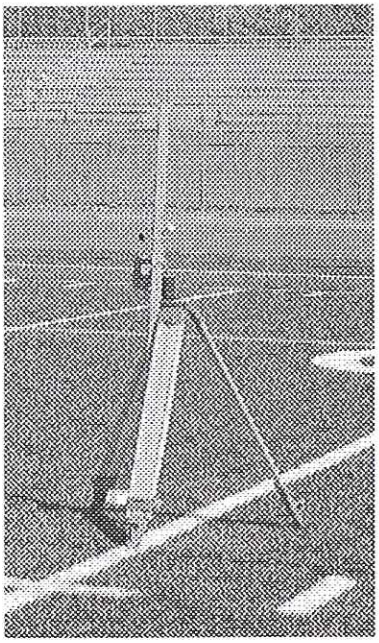


**Figure 3 - Field Sample Location**

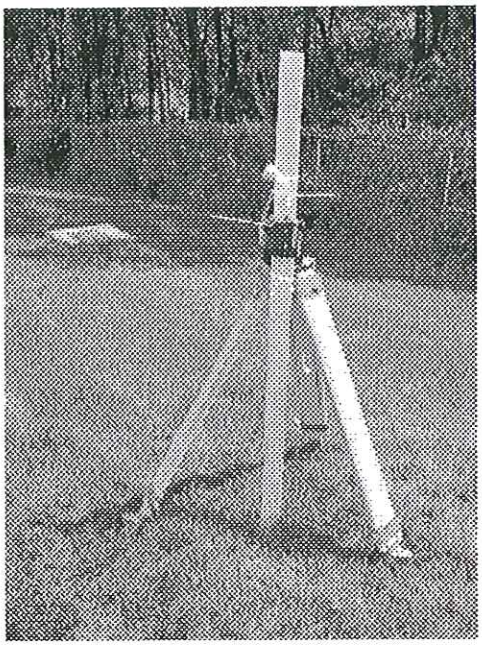


**Figure 4 - "Background" Sample Location**

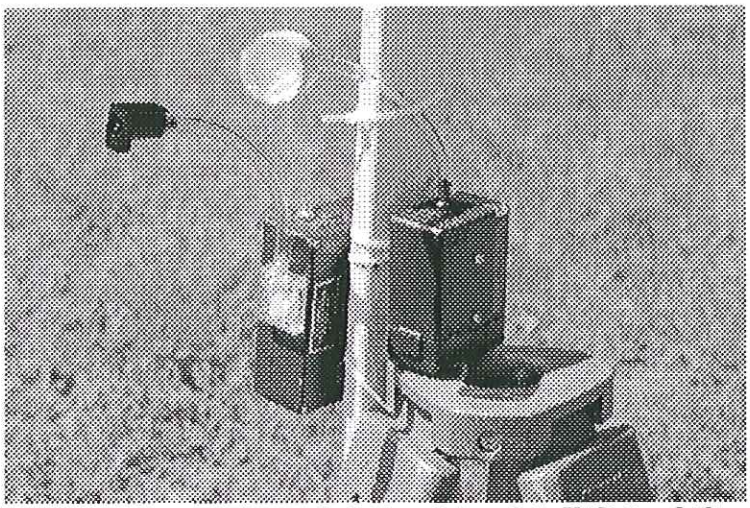


**Figure 5 - Sampling Pumps. ThermoSorb N module on left; XAD-2 and filter on right**

The samples to be analyzed for volatile nitrosamines were collected using ThermoSorb N adsorbent media produced by Advanced Chromatography Systems of Johns Island, South Carolina. A minimum of 75 liters of air was pumped through the adsorbent media at an

approximate rate of one liter per minute using an SKC Universal Pump 224-PCXR8 sampling pump.

Both models of sampling pumps have a manufacturer's stated flow rate accuracy of +/- 5%.

The intakes for all samples were set at approximately four feet above either the playing surface or the grass surface surrounding the playing field. The sampling media was connected to the sampling pumps using approximately six inches of ¼ I.D. x 3/8 OD poly tubing. The pump was calibrated prior to sampling utilizing a BIOS DryCal DC-Lite air pump calibrator. A sacrificial media tube and poly tubing was used during the pump calibration.

All samples were delivered to the Wisconsin Occupational Health Laboratory at the University of Wisconsin via overnight courier service for analysis. The analytical methods employed for benzothiazole and 4-(tert-octyl) phenol analysis were based upon NIOSH Method 2550. The samples were desorbed with 10 minutes of sonication performed three times with three milliliters (mL) of methanol. The combined methanol fractions were then evaporated to approximately 0.5 mL with nitrogen and brought to a final volume of 1.0 mL with methanol. The extracts were then analyzed by reversed phase high-performance liquid chromatography employing a 0.1 percent formic acid:methanol linear gradient program. Detection was achieved by triple quadruple mass spectrometry using multiple reaction monitoring. A reporting limit of 100 nanograms was established for the analytes based upon statistical data analysis.

The analytical methods employed for the nitrosamine analysis were based upon OSHA Method 27. The samples were with approximately three mL of methylene chloride:methanol (75:25 v/v). Extracts were analyzed by reversed phase high-performance liquid chromatography employing a 0.1 percent formic acid:methanol linear gradient program. Detection was achieved by turbo ion spray triple quadruple mass spectrometry using multiple reaction monitoring in positive ionization mode. A reporting limit of 100 nanograms was established for the analytes based upon statistical data analysis; however, any discernable peak for n-nitrosodimethylamine was reported with appropriate comment.

## Results

Field F

Air sampling activities were conducted at Field F on August 15, 2008. Five discrete sample locations were chosen. One location (SF-1) was near the center to the playing surface while the remaining four locations (SF-2, SF-3, SF-4, and SF-5) were around the perimeter of the synthetic running track. The sample locations are graphically presented in Figure 6. Sampling activities were initiated at 11:40 and were completed at 16:07.

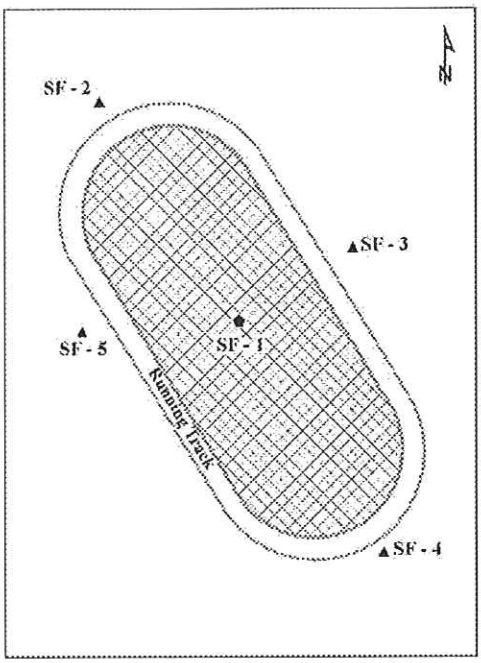



**Figure 6 – Sample Locations Field F**

Weather conditions on August 15, 2008, at the sample site were generally a mix of clear and partly cloudy skies with ambient air temperatures between 75° F and 80° F. Winds were generally light to calm. The late morning and early afternoon winds were measured

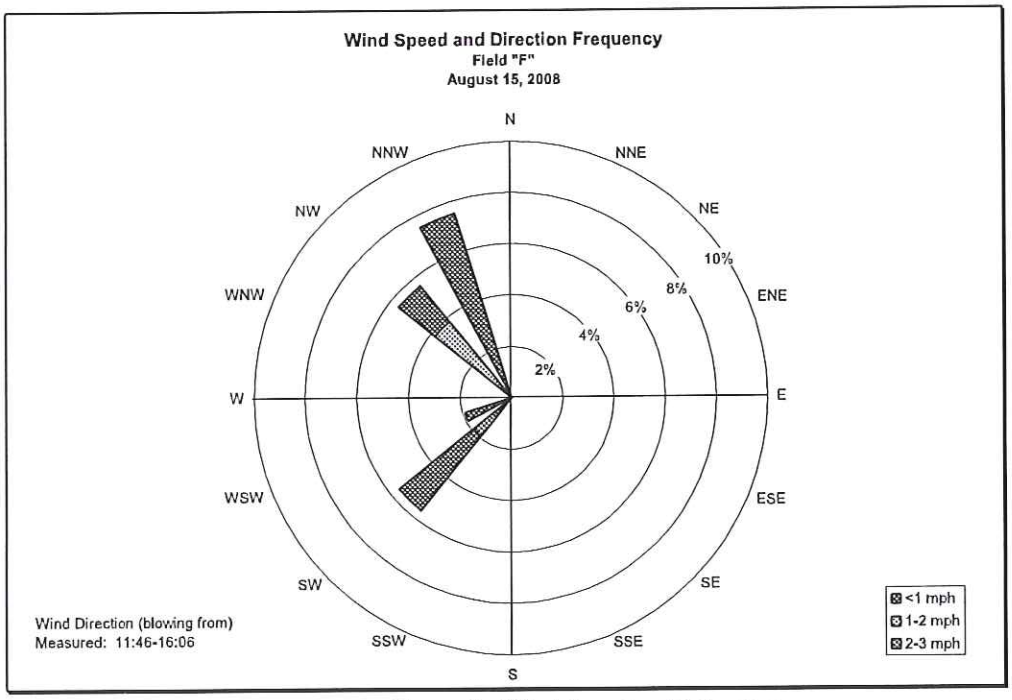



**Figure 7 - Wind Speed and Direction**

to be less than two miles per hour and were from the north and northwest. At approximately 15:30, the winds shifted to the southwest and increased to a maximum of three miles per hour. Figure 7 depicts the wind speed, direction, and frequency noted during the testing period. A brief rain shower occurred at approximately 14:45.

The air temperature was measured at three different heights (one foot, four feet, and five feet) directly over the playing surface near sample location SF-1. In addition, the temperature of the crumb rubber in-fill material was measured at a depth of approximately one inch. The measured temperatures are shown in Figure 8. The air temperature was noted to increase with decreasing height above the playing surface. The average air temperature measured at a height of five feet was 76.6° F, while the average temperatures at one foot and four feet were 85.7° F and 81.7° F, respectively. The average temperature of the crumb rubber was 91.7° F. Significant cooling of the crumb rubber and the air column at one foot and four feet above the surface was noted following the brief rain shower that occurred at 14:45.

Periodic measurements of the surface temperature of the synthetic "grass" fibers were measured using an infrared thermometer manufactured by EXTECH Instruments (EXTECH Pocket IR thermometer). A maximum temperature of 127° F was noted at 12:00.

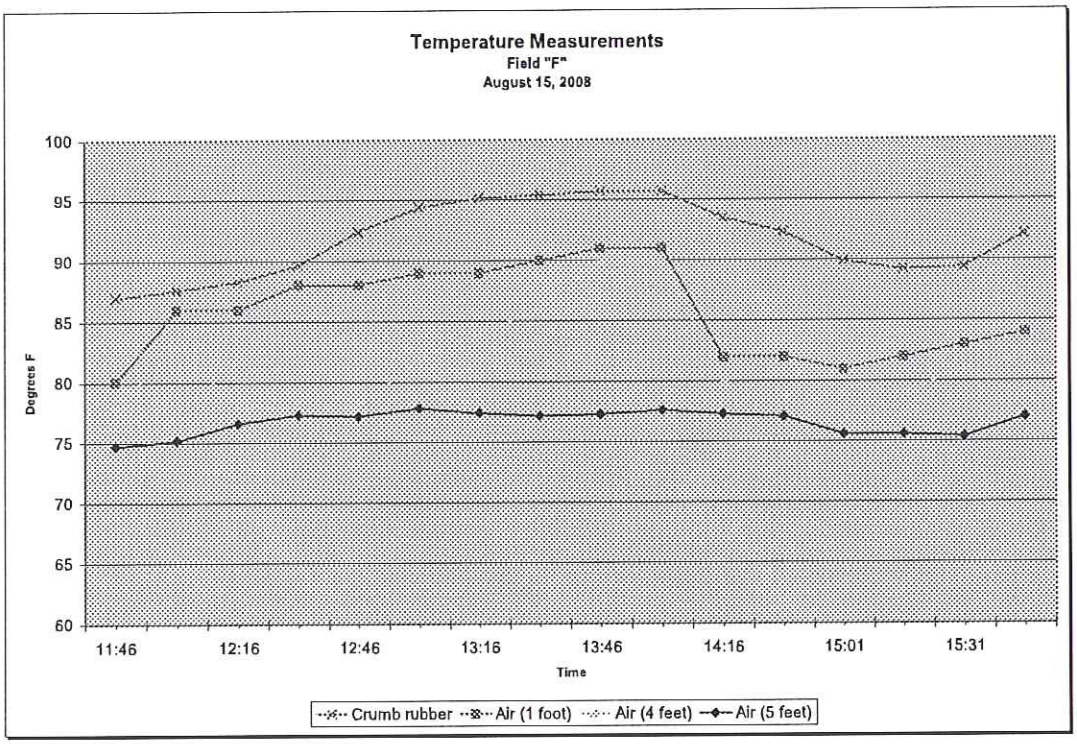



**Figure 8 – Temperature Measurements Field F**

All air sampling pumps were activated between 11:40 and 11:49. The pumps connected to the ThermoSorb N media were allowed to run at a flow rate of approximately one liter per minute for approximately 75 minutes. At the conclusion of the appropriate time interval, the SKC Universal Pump 224-PCXR8 was deactivated and the ThermoSorb N module was removed and sealed using the supplied caps. After approximately four hours, the SKC Airlite sampling pumps were also deactivated and the XAD-2 adsorbent tubes were removed and sealed using the supplied caps. The PTFE filters were capped and placed into plastic zip bags.

**Table 1**
Sampled Air Volumes - Field F
August 15, 2008

| | ThermoSorb N Module | | | XAD-2 Module | | |
|---|---|---|---|---|---|---|
| Sample ID | Start Time | End Time | Air Volume (L) | Start Time | End Time | Air Volume (L) |
| SF-1 | 11:49 | 13:04 | 76.13 | 11:49 | 16:08 | 519.04 |
| SF-2 | 11:42 | 12:57 | 75.90 | 11:42 | 15:57 | 512.04 |
| SF-3 | 11:45 | 13:00 | 75.98 | 11:45 | 16:04 | 519.55 |
| SF-4 | 11:47 | 13:03 | 77.82 | 11:47 | 16:07 | 521.30 |
| SF-5 | 11:40 | 12:55 | 78.75 | 11:40 | 15:46 | 493.23 |

The samples were packaged for delivery to the Wisconsin Occupational Health Laboratory at the University of Wisconsin. The analytical methods employed are described in the "Methodology" section above.

The volatile nitrosamine analysis indicated that there were no detectable concentrations of nitrosamines in the air directly above the synthetic turf playing surface (Table 2). The results also indicate that the air upwind and downwind of the playing surface lacked detectable concentrations of nitrosamines.

**Table 2**
Volatile Nitrosamines Results – Field F

| | SF-1 | | SF-2 | | SF-3 | | SF-4 | | SF-5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | µg/m³ | ppbv | µg/m³ | ppbv | µg/m³ | ppbv | µg/m³ | ppbv | µg/m³ | ppbv |
| Nitrosodibutylamine (n-) | <1.1 | < 0.18 | <1.1 | < 0.17 | <1.4 | < 0.22 | <1.1 | < 0.17 | <1.0 | < 0.16 |
| Nitrosodiethylamine (n-) | <1.1 | < 0.27 | <1.1 | < 0.26 | <1.4 | < 0.34 | <1.1 | < 0.27 | <1.0 | < 0.24 |
| Nitrosodimethylamine (n-) | <1.1 | < 0.38 | <1.1 | < 0.36 | <1.4 | < 0.46 | <1.1 | < 0.37 | <1.0 | < 0.34 |
| Nitrosodipropylamine (n-) | <1.1 | < 0.21 | <1.1 | < 0.20 | <1.4 | < 0.26 | <1.1 | < 0.20 | <1.0 | < 0.19 |
| Nitrosomorpholine (n-) | <1.1 | < 0.24 | <1.1 | < 0.23 | <1.4 | < 0.30 | <1.1 | < 0.23 | <1.0 | < 0.21 |
| Nitrosopiperidine (n-) | <1.1 | < 0.24 | <1.1 | < 0.24 | <1.4 | < 0.30 | <1.1 | < 0.24 | <1.0 | < 0.22 |
| Nitrosopyrrolidine (n-) | <1.1 | < 0.28 | <1.1 | < 0.27 | <1.4 | < 0.34 | <1.1 | < 0.27 | <1.0 | < 0.25 |

µg/m³ = mircograms per cubic meter
ppbv = parts per billion per volume

The laboratory analysis of the air directly above the synthetic turf playing surface also lacked detectable concentrations of benzothiazole and 4-(tert-octyl) phenol (Table 3). The upwind and downwind samples yielded similar results. No detectable concentrations of either compound were noted upon extraction of the two micron PTFE filters.

**Table 3**
Benzothiazole and 4-(tert-octyl) Phenol Results – Field F

| | SF-1 µg/m$^3$ | SF-2 µg/m$^3$ | SF-3 µg/m$^3$ | SF-4 µg/m$^3$ | SF-5 µg/m$^3$ |
|---|---|---|---|---|---|
| Benzothiazole | <0.19 | <0.20 | <0.19 | <0.19 | <0.20 |
| 4-(tert-octyl)phenol | <0.19 | <0.20 | <0.19 | <0.19 | <0.20 |

µg/m$^3$ = mircograms per cubic meter

Field G

Air sampling activities were conducted at Field G on August 18, 2008. The same procedures that were used in sampling at Field F were employed for the sampling at Field G. A potentially significant change in the sampling conditions was encountered during the activities at Field G. The owner of the field had groomed, or raked, the field three days prior to the air sampling activities. As a result of the grooming, the crumb rubber infill had not yet settled within the synthetic grass 'fibers" and was, therefore, more exposed at the surface.

As with the previous sampling, five discrete sample locations were chosen. The sample locations are graphically presented in Figure 9. Sampling activities were initiated at 11:17 and were completed at 15:33.

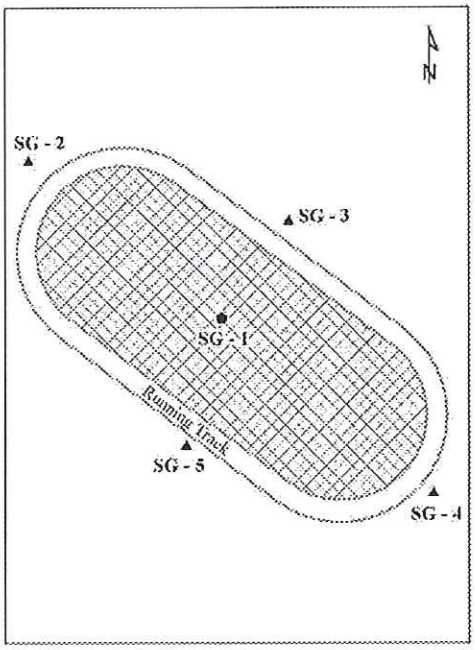



**Figure 9 – Sample Locations Field G**

Weather conditions on August 18, 2008, at the sample site were generally sunny with ambient air temperatures between 80° F and 85° F. Winds were generally light to calm and were variable in direction although were generally from a southerly direction. The maximum measured wind speed was three miles per hour. Figure 10 depicts the wind speed, direction, and frequency noted during the testing period.

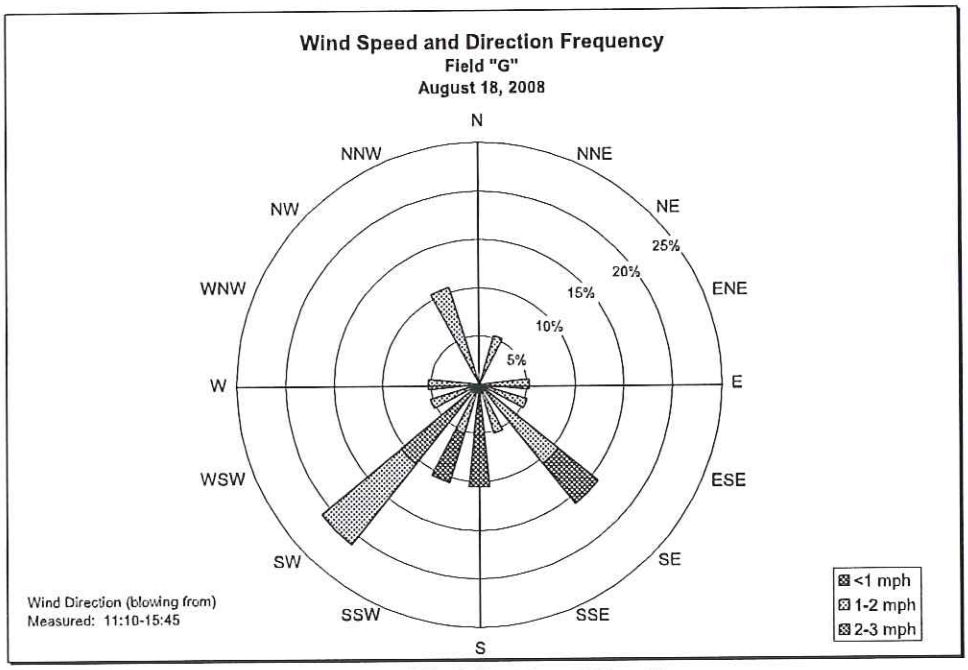



**Figure 10 - Wind Speed and Direction**

The air temperatures measured during the sampling at Field G are shown in Figure 11. As with Field F, the air temperature was noted to increase with decreasing height above the playing surface. The average air temperature measured at a height of five feet was 84.6° F while the average temperatures at one foot and four feet were 92.3° F and 88.4° F, respectively. The average temperature of the crumb rubber was 99.6° F. The surface temperature of the synthetic grass blades averaged 139° F.

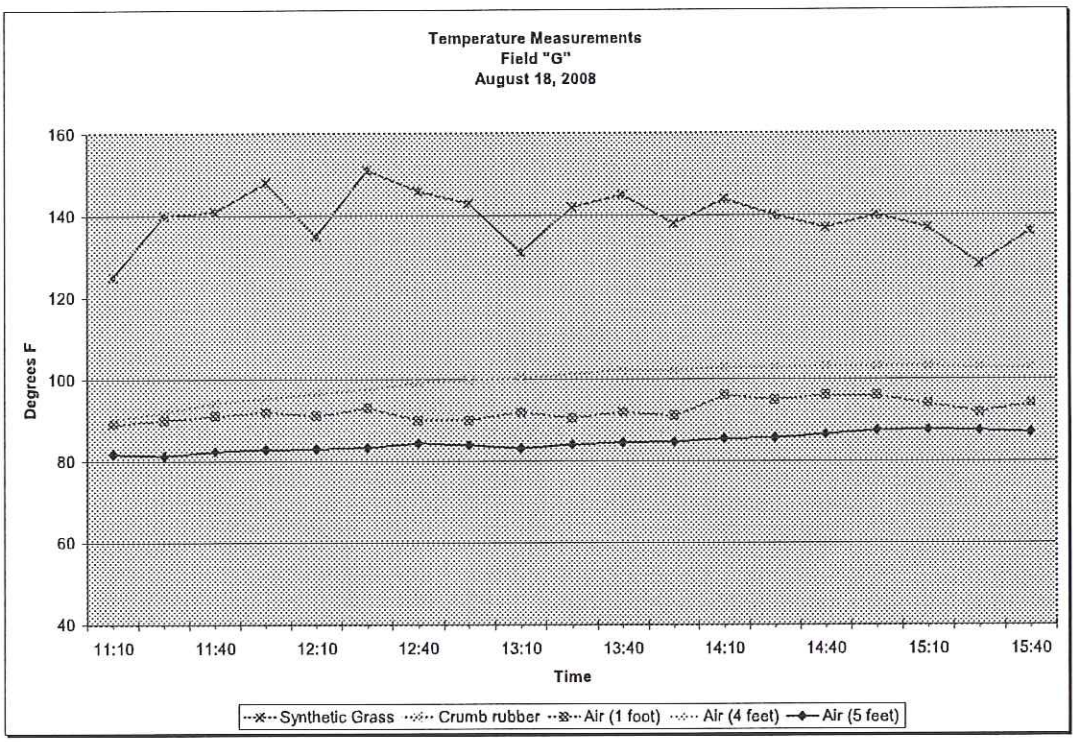



**Figure 11 - Temperature Measurements Field G**

All air sampling pumps were activated between 11:40 and 11:49. Table 4 details the start and stop times of the various sampling pumps and the volumes of air pumped during the sampling at Field G.

**Table 4**
Sampled Air Volumes - Field G
August 18, 2008

| | ThermoSorb N Module | | | XAD-2 Module | | |
|---|---|---|---|---|---|---|
| Sample ID | Start Time | End Time | Air Volume (L) | Start Time | End Time | Air Volume (L) |
| SG-1 | 11:22 | 12:37 | 75.75 | 11:22 | 15:23 | 480.96 |
| SG-2 | 11:17 | 12:32 | 75.75 | 11:17 | 15:18 | 480.72 |
| SG-3 | 11:25 | 12:40 | 75.15 | 11:25 | 15:25 | 481.44 |
| SG-4 | 11:28 | 12:43 | 75.225 | 11:28 | 15:28 | 480.96 |
| SG-5 | 11:33 | 12:48 | 75.525 | 11:33 | 15:33 | 481.20 |

The samples were packaged for delivery to the Wisconsin Occupational Health Laboratory at the University of Wisconsin. The analytical methods employed are described in the "Methodology" section above.

The volatile nitrosamine analysis indicated that there were no detectable concentrations of nitrosamines in the air directly above the synthetic turf playing surface (Table 5). The results also indicate that the air upwind and downwind of the playing surface lacked detectable concentrations of nitrosamines.

**Table 5**
Volatile Nitrosamines Results – Field G

| | SG-1 | | SG-2 | | SG-3 | | SG-4 | | SG-5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | µg/m³ | ppbv | µg/m³ | ppbv | µg/m³ | ppbv | µg/m³ | ppbv | µg/m³ | ppbv |
| Nitrosodibutylamine (n-) | <1.3 | < 0.20 | <1.4 | < 0.21 | <1.4 | < 0.21 | <1.4 | < 0.21 | <1.4 | < 0.21 |
| Nitrosodiethylamine (n-) | <1.3 | < 0.32 | <1.4 | < 0.33 | <1.4 | < 0.33 | <1.4 | < 0.33 | <1.4 | < 0.33 |
| Nitrosodimethylamine (n-) | <1.3 | < 0.44 | <1.4 | < 0.45 | <1.4 | < 0.45 | <1.4 | < 0.45 | <1.4 | < 0.45 |
| Nitrosodipropylamine (n-) | <1.3 | < 0.24 | <1.4 | < 0.25 | <1.4 | < 0.25 | <1.4 | < 0.25 | <1.4 | < 0.25 |
| Nitrosomorpholine (n-) | <1.3 | < 0.28 | <1.4 | < 0.29 | <1.4 | < 0.29 | <1.4 | < 0.29 | <1.4 | < 0.29 |
| Nitrosopiperidine (n-) | <1.3 | < 0.28 | <1.4 | < 0.29 | <1.4 | < 0.29 | <1.4 | < 0.29 | <1.4 | < 0.29 |
| Nitrosopyrrolidine (n-) | <1.3 | < 0.32 | <1.4 | < 0.33 | <1.4 | < 0.34 | <1.4 | < 0.34 | <1.4 | < 0.33 |

µg/m³ = mircograms per cubic meter
ppbv = parts per billion per volume

The laboratory analysis of the air directly above the synthetic turf playing surface indicated a concentration of benzothiazole of 0.39 micrograms per cubic meter of air. No 4-(tert-octyl) phenol was detected (Table 6). The upwind and downwind samples yielded similar results. No detectable concentrations of either compound were noted upon extraction of the two micron PTFE filters.

**Table 6**
Benzothiazole and 4-(tert-octyl) Phenol Results – Field G

| | SG-1 | SG-2 | SG-3 | SG-4 | SG-5 |
|---|---|---|---|---|---|
| | µg/m³ | µg/m³ | µg/m³ | µg/m³ | µg/m³ |
| Benzothiazole | 0.39 | <0.21 | <0.21 | <0.21 | <0.21 |
| 4-(tert-octyl)phenol | <0.21 | <0.21 | <0.21 | <0.21 | <0.21 |

µg/m³ = mircograms per cubic meter

Although the concentration of benzothiazole was quantified at 0.39 $\mu g/m^3$, the three trip spikes that were used as quality control recovered low for benzothiazole. The average recovery was 39% of the known spiked concentration, indicating that some degradation of the sample may have occurred prior to laboratory extraction. Assuming a similar degradation occurred for sample SG-1, the actual concentration of benzothiazole in the air directly above the synthetic playing surface may have been as high as 1.00 $\mu g/m^3$.

## Summary

Twenty air samples were collected above and around two synthetic turf playing surfaces in Connecticut. Ten of the samples were analyzed for volatile nitrosamine content and 10 were analyzed for benzothiazole and 4-(tert-octyl) phenol content. The samples were collected on warm, late summer days during periods of light to calm winds. In one case, the synthetic turf surface had been groomed three days prior to the sampling. The sampling was conducted during periods when the temperature of the crumb rubber in-fill material was elevated due to exposure to the sun. The average temperatures of the crumb rubber were 91.7° F and 99.6° F. The surface temperature of the synthetic grass blades was noted to climb as high as 151° F. The combination of air temperatures, surface temperatures, wind speed and, in the case of Field G, the recent maintenance, are believed to be conditions favorable for generating maximum concentrations of the analytes in the air column above and around the playing surfaces.

This study determined that under favorable conditions for vapor generation, no detectable concentrations of volatile nitrosamines or 4-(tert-octyl) phenol existed in the air column at a height of four feet above the tested synthetic playing surfaces or in the air either upwind or downwind of the fields. The study did not evaluate if any of these two compounds were off-gassed from the fields, but simply that if they did, sufficient dilution within the air column existed to render them undetectable using methods based upon accepted OSHA and NIOSH procedures. The study also determined that benzothiazole, a common compound used in the manufacturing of rubber and plastics, was present at a very low concentration directly above one of the two fields sampled. This compound was not detected at the second of the two fields sampled nor was it detected in any of the upwind or downwind locations at either field. The field where benzothiazole was detected had recently been groomed, thereby bringing significant

quantities of crumb rubber nearer to the surface of the field resulting in greater exposure to both the sunlight and air.

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**Evaluation of Stormwater Drainage Quality From Synthetic Turf Athletic Fields**

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Each year, millions of scrap tires are generated in the United States. The Rubber Manufacturers Association estimates that in 2005 seven-eighths of the scrap tires generated were ultimately consumed or recycled in end-use markets.[1] Approximately 290 million new scrap tires are generated each year.[2] Beneficial reuses of scrap tires include use as tire-derived fuel, landfill leachate collection systems, septic system drain fields, various civil engineering applications related to roadway and bridge construction, various stamped and punched rubber products, and use in athletic field and other recreational applications. The potential environmental effects resulting from the reuse of scrap tires in civil engineering applications have been evaluated by Humphrey[3, 4] and Brophy[5], among others. While these studies have concluded that the use of tire chip has a negligible effect upon ground water quality, few, if any, studies have been conducted concerning the effect on water quality resulting from the installation of synthetic turf athletic fields containing cryogenically treated crumb rubber produced from scrap tires.

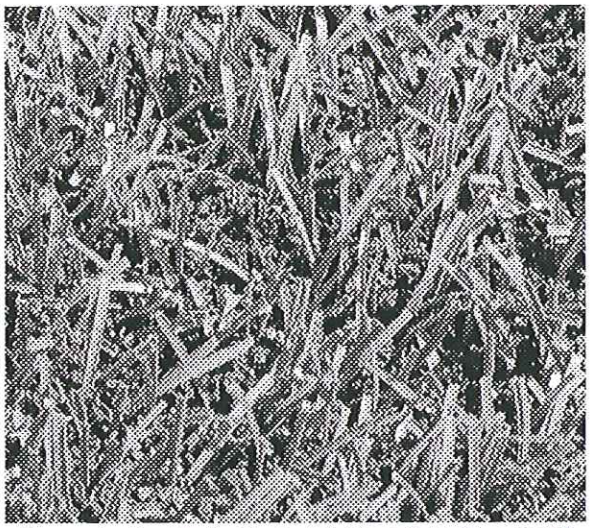

**Figure 1 - Synthetic Turf with Crumb Rubber Infill**

This paper presents the results of a study in which the stormwater drainage from crumb rubber and silica sand in-filled synthetic turf athletic fields was analyzed over a period of approximately one year.

## Methodology

Three fields within Connecticut were selected for this study. Two of the fields are located in the northern portion of the state while the third is located in the southern portion of the state. Fields F and G were constructed by FieldTurf in 2007, and Field E was constructed in 2008. All fields are multipurpose fields used for sports such as football, soccer, field hockey, and lacrosse, among others, and are encircled by synthetic running track surfaces. In all cases, edge drains were present to capture the stormwater runoff from the running track surfaces (Figure 2).

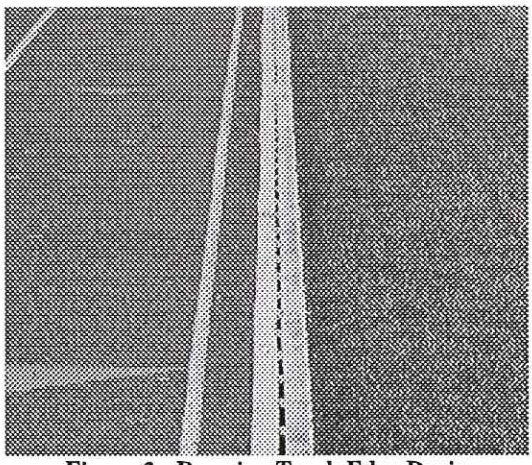

**Figure 2 - Running Track Edge Drain**

This allowed for sampling to be conducted of solely the stormwater that infiltrated the field surface and migrated downward through the in-fill material, through the polyethylene fiber backing, and into the underlying stone prior to entering the dedicated drainage piping. A typical cross section of a synthetic turf athletic field is shown in Figure 3.

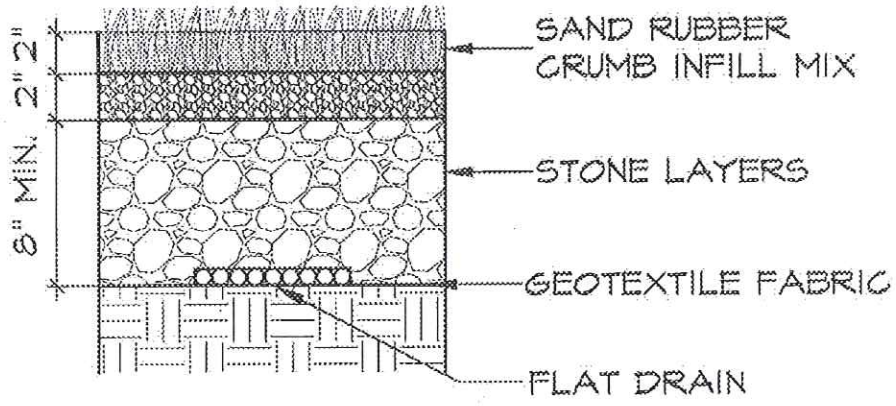


**Figure 3 - Typical Field Cross Section**

The use of the stone base and the flat drain systems is intended to drain stormwater out of and away from the playing surface as quickly as possible.

Each of the three sampled fields was constructed using nonmetallic underdrain systems that discharged directly to either a nearby catch basin or manhole. Grab samples of the discharge water were collected directly from the discharge pipe at the discharge location. Samples were generally collected on a calendar-quarter basis and were collected as soon as practical after the start of a rainfall event. The samples were collected using a high-density polyethylene dipper manufactured by Bel-Art and obtained from Forestry Suppliers, Inc. (catalog number 53915). The dipper was equipped with a six-foot polyethylene handle to allow for sampling without the need for entry into confined spaces. Tests performed included acute aquatic toxicity, dissolved metals (zinc, lead, selenium, and cadmium), and pH.

The aquatic toxicity monitoring was performed by GZA GeoEnvironmental, Inc. (GZA), of Bloomfield, Connecticut, in accordance with Method EPA-821-R-02-012. The water sample for this analysis was collected from Field F on October 12, 2007.

The analysis for dissolved metals content and pH was performed by Complete Environmental Testing (CET) of Stratford, Connecticut. The water samples for this analytical method were collected from Field F on October 12, 2007, October 20, 2007, November 6, 2007, February 5,

2008, April 28, 2008, and October 1, 2008. A single sampling event was conducted at Field G (April 29, 2008) and at Field E (July 24, 2008).

Subsequent to initiation of the study, the scope was expanded to include laboratory analysis of samples of the crumb rubber in-fill material. The laboratory analysis included the evaluation of metals content in an extract produced in accordance with EPA Method 1312. This methodology is referred to as the Synthetic Precipitation Leaching Procedure or SPLP. The purpose of the testing was to evaluate the potential to leach metals under acidic conditions in the controlled environment of a laboratory. The expectation was that the results would not be directly comparable to the actual in-place field conditions but would provide a useful check on the results of the drainage sampling. The analysis was performed by CET. Samples of the crumb rubber were collected from Field F on February 28, 2008, April 28, 2008, and October 1, 2008. A sample was collected from Field G on April 29, 2008, and from Field E on October 1, 2008. A sample of unused crumb rubber was also obtained from FieldTurf on October 23, 2007, and analyzed in accordance with the SPLP procedure.

Additional bench-scale testing was performed to evaluate the effect upon drainage water pH due to the stone layer that is installed under the synthetic surface materials. The tested fields were constructed using a stone layer consisting of broken basalt rock. A sample of basalt was obtained during the installation of Field E in order to perform the pH testing. The pH testing was conducted by first creating solutions of known pH. Five samples of stone, each having a mass of approximately 300 grams, were placed in separate glass jars. The known pH solution was then placed in contact with the stone samples, and the solution was monitored at five intervals up to 15 minutes. Separate control samples of tap water were prepared and served as quality control samples. Solutions of pH 4.2 and 5.2 were prepared for this evaluation.

## Results

### Aquatic Toxicity Evaluation

On October 12, 2007, a sample of stormwater was collected from the drainage system at Field F. The sample was placed into a container supplied by GZA and immediately delivered to GZA for an evaluation of the aquatic toxicity using *Daphnia pulex* as the test organism. The testing was conducted in accordance with EPA Method EPA-821-R-02-012. The results indicated >100% survival at both the 24- and 48-hour intervals at $LC_{50}$ using copper nitrite as the reference toxicant.

### Metals Content in Drainage Water

Samples of the stormwater were collected from Field F on October 12, 2007, October 20, 2007, November 6, 2007, February 5, 2008, April 28, 2008, and October 1, 2008. The samples were chilled and delivered to CET for analysis of the dissolved fraction of zinc, lead, selenium, and cadmium. The results were compared to the lowest aquatic life criterion for each element as established by the Connecticut Department of Environmental Protection. Table 1 summarizes the results of the laboratory analysis. The results of the laboratory analysis indicated that lead, selenium, and cadmium were not present in the drainage water. Zinc was determined to be present on four of the six sampling dates at a maximum concentration of 0.031 mg/L. The Water Quality Standard established by the Connecticut Department of Environmental Protection is 0.065 mg/L.

**Table 1**
**Metals Content in Drainage Water - Field F**

| Constituent | Water Quality Standard[1] | Sample Date | | | | | |
|---|---|---|---|---|---|---|---|
| | | 10/12/2007 | 10/20/2007 | 11/6/2007 | 2/5/2008 | 4/28/2008 | 10/1/2008 |
| *metals (all units in mg/L)* | | | | | | | |
| Zinc | 0.065 | <0.020 | 0.022 | 0.012 | <0.002 | 0.019 | 0.031 |
| Lead | 0.0012 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Selenium | 0.005 | <0.010 | <0.005 | <0.002 | <0.002 | <0.002 | <0.002 |
| Cadmium | 0.00135 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| pH | -- | 7.30 | 7.41 | 7.34 | 7.48 | 7.85 | 7.83 |

[1] CT Department of Environmental Protection Standard for fresh water

A sample of stormwater was collected from the drainage system of Fields G and E on April 28, 2008, and July 24, 2008, respectively. The results, which are summarized in Tables 2 and 3, again indicated levels of dissolved zinc but at concentrations less than the applicable Water Quality Standard. Lead, selenium, and cadmium were not detected in the drainage from either Field E or Field G.

**Table 2**
**Metals Content in Drainage Water - Field G**

| Constituent | Water Quality Standard[1] | Sample Date 4/29/2008 |
|---|---|---|
| *metals analysis (all units in mg/L)* | | |
| Zinc | 0.065 | 0.005 |
| Lead | 0.0012 | <0.001 |
| Selenium | 0.005 | <0.002 |
| Cadmium | 0.00135 | <0.001 |
| pH | -- | 8.7 |

[1]CT Department of Environmental Protection Standard for fresh water

**Table 3**
**Metals Content in Drainage Water - Field E**

| Constituent | Water Quality Standard[1] | Sample Date 7/24/2008 |
|---|---|---|
| *metals analysis (all units in mg/L)* | | |
| Zinc | 0.065 | 0.036 |
| Lead | 0.0012 | <0.001 |
| Selenium | 0.005 | <0.002 |
| Cadmium | 0.00135 | <0.001 |
| pH | -- | 7.62 |

[1]CT Department of Environmental Protection Standard for fresh water

Laboratory Leaching Potential Evaluation

Samples of the crumb rubber and silica sand in-fill material were collected from Fields E, F, and G. The samples were collected on three different dates for Field F and on one occasion from Fields E and G. Approximately 150 grams of the in-fill material were collected on each date and delivered to CET for metals analysis in accordance with the SPLP extraction protocols. The results were compared to the criteria established by the Connecticut Department of Environmental Protection for the evaluation of the leaching potential of environmentally contaminated soil. The results, which are summarized in Table 4, demonstrate that the crumb rubber has the potential to leach metals but at concentrations less than the criteria established by the CT DEP for geographic areas that rely upon ground water as the source of potable water.

**Table 4**
**Synthetic Precipitation Leaching Procedure - Crumb Rubber In-fill**

| | | Date | | | | | |
|---|---|---|---|---|---|---|---|
| | | 10/23/2007 | 2/8/2008 | 4/28/2008 | 4/29/2008 | 10/1/2008 | 10/1/2008 |
| | | Raw Crumb Rubber | Field F | Field F | Field G | Field F | Field E |
| Constituent | Approximate "Age" | 0 month | 4 months | 6 months | 6 months | 1 year | 4 months |
| | Connecticut Pollutant Mobility Criteria | all units in mg/l | | | | | |
| Mercury | 0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| Lead | 0.015 | <0.013 | <0.013 | 0.006 | 0.004 | <0.013 | <0.013 |
| Selenium | 0.05 | <0.01 | <0.01 | <0.002 | <0.002 | <0.01 | <0.01 |
| Cadmium | 0.005 | <0.005 | <0.005 | <0.001 | <0.001 | <0.005 | <0.005 |
| Chromium | 0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Arsenic | 0.05 | <0.004 | <0.004 | <0.004 | <0.004 | <0.004 | <0.004 |
| Barium | 1.0 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Silver | 0.036 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Copper | 1.3 | <0.04 | <0.04 | <0.04 | <0.04 | na | na |
| Nickel | 0.1 | <0.05 | <0.05 | <0.05 | <0.05 | na | na |
| Zinc | 5 | 1.6 | 0.91 | 1.9 | 1.1 | 2.4 | 4.7 |

na: not analyzed

Bench-Scale pH Analysis

The measurements obtained as part of the sampling of the drainage water discharge indicated a pH that was higher than anticipated. Measurements obtained of the pH of rainfall in the town of Cheshire, Connecticut during the study period indicated a pH of rainfall that was generally between five and six units. It was theorized that the basaltic stone base used in the construction of the athletic fields had a neutralizing effect on the infiltrated rainfall at the field locations. A limited bench-scale test was developed and performed to evaluate the effect of the stone on the pH level of various prepared solutions. The stone used for the performance of these tests was obtained during the construction of Field E.

In the first test, approximately 300 grams of crushed basaltic stone were place in each of five nine-ounce glass jars. The glass jars were then filled with tap water, and the pH was measured as a function of time by sequentially pouring the water out of each sample jar and into a separate clean glass jar for evaluation. A parallel set of jars was used containing just tap water as a set of control samples. The crushed stone was determined to have minimal effect on the tap water.

**Table 5**
**pH Evaluation - Tap Water**

| Jar # | Weight of Stone (g) | Duration (min.) | pH | Water | Duration (min.) | pH |
|---|---|---|---|---|---|---|
| 1 | 318 | 1:00 | 7.2 | Control | 1:55 | 7.4 |
| 2 | 272 | 2:00 | 7.7 | | 2:05 | 7.8 |
| 3 | 304 | 5:00 | 8 | | 6:00 | 7.8 |
| 4 | 312 | 10:00 | 7.9 | | 11:00 | 7.9 |
| 5 | 322 | 15:00 | 7.9 | | 16:30 | 8 |

The test was then repeated using a solution with a pH of 5.2 units. This test determined that the stone tended to raise the pH of the slightly acidic solution by nearly one full unit within the first minute of the test and then by approximately one-half unit at the conclusion of the test.

**Table 6**
**pH Evaluation - Prepared Solution of pH 5.2**

| Jar # | Weight of Stone (g) | Duration (min.) | pH | Water | Duration (min.) | pH |
|---|---|---|---|---|---|---|
| 1 | 306 | 1:00 | 6.3 | Control | 3:00 | 5.4 |
| 2 | 326 | 2:00 | 6.4 | | 6:00 | 5.6 |
| 3 | 308 | 5:00 | 6.2 | | 13:00 | 5.8 |
| 4 | 286 | 10:00 | 6.4 | | 18:00 | 5.8 |
| 5 | 286 | 15:00 | 6.4 | | 22:00 | 5.9 |

The test was repeated once again using a solution with a pH of 4.2 units. The stone was once again determined to have a neutralizing effect on the pH of the solution. A rise of over two units was noted immediately. The final pH was similar to the end point of the test that was conducted using a starting solution of pH 5.2.

**Table 7**
**pH Evaluation - Prepared Solution of pH 4.2**

| Jar # | Weight of Stone (g) | Duration (min.) | pH | Water | Duration (min.) | pH |
|---|---|---|---|---|---|---|
| 1 | 312 | 1:00 | 6.6 | Control | 3:00 | 4.2 |
| 2 | 290 | 2:00 | 5.9 | | 6:00 | 4.2 |
| 3 | 304 | 5:00 | 6.2 | | 13:00 | 4.8 |
| 4 | 304 | 10:00 | 6.2 | | 18:00 | 4.8 |
| 5 | 304 | 15:00 | 6.5 | | 22:00 | 4.4 |

## Summary

The evaluation of the stormwater drainage quality from synthetic turf athletic fields included the collection and analysis of eight water samples over a period of approximately one year from three different fields, the collection and analysis of samples of crumb rubber in-fill from the same three fields plus a sample of raw crumb rubber obtained from the manufacturer, and the evaluation of the effect of the stone base material on the pH of the drainage water. The results of the study indicate that the actual stormwater drainage from the fields allows for the complete survival of the test species *Daphnia pulex*. An analysis of the concentration of metals in the actual drainage water indicates that metals do not leach in amounts that would be considered a risk to aquatic life as compared to existing water quality standards. Analysis of the laboratory-

based leaching potential of metals in accordance with acceptable EPA methods indicates that metals will leach from the crumb rubber but in concentrations that are within ranges that could be expected to leach from native soil. Lastly, it can be concluded that the use of crushed basaltic stone as a base material in the construction of the athletic fields has a neutralizing effect on precipitation.

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# Chemicals and particulates in the air above the new generation of artificial turf playing fields, and artificial turf as a risk factor for infection by methicillin-resistant *Staphylococcus aureus* (MRSA)
## Literature review and data gap identification

Office of Environmental Health Hazard Assessment
California Environmental Protection Agency
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## Executive Summary

The Office of Environmental Health Hazard Assessment (OEHHA) is evaluating the safety of the new generation of artificial turf playing fields. This new generation of turf contains artificial soil termed "infill." Infill helps to soften the surface and prevent injuries. Infill also improves drainage.

Rubber crumb made from finely ground, recycled tires is commonly used as infill in the new generation of artificial turf. Tire rubber is a complex material, containing many naturally-occurring and man-made chemicals. Therefore, as part of its stewardship of tire recycling in California, the California Integrated Waste Management Board (CIWMB) has asked OEHHA to evaluate the following aspects of artificial turf playing fields:

1. Whether these fields emit levels of chemicals or particulates into the air that cause illness when inhaled.
2. Whether these fields infect athletes with the dangerous bacterium called methicillin-resistant *Staphylococcus aureus* (MRSA).

The following is our review of the published literature covering these two topics. In addition, we have attempted to identify data gaps that, when filled, will allow performance of a more accurate safety assessment.

### *Chemicals and Particulates Measured in the Air Above Artificial Turf Fields*

Published studies were located that measured chemicals and particulates in the air above artificial turf playing fields. In all cases these fields contained crumb rubber infill. Prior to 2009, the most complete dataset was published by Dye et al. (2006). They identified almost 100 different chemicals and particulates. Another 200 chemicals were detected but not identified. This study covered fields in ***indoor*** stadiums.

Many of the chemicals identified by Dye et al. (2006) were also emitted into air by rubber flooring made of recycled tires. Similarly, laboratory studies of chemicals emitted into the air by crumb rubber made from recycled tires identified many of the same chemicals. A list of the chemicals and particulates emitted into the air during rubber manufacturing also overlapped with those identified by Dye et al. (2006). Therefore, the published literature suggests the data from Dye et al. (2006) are reliable.

In the spring of 2009 two studies were released that measured chemicals and particulates in the air above ***outdoor*** artificial turf fields containing recycled rubber crumb (New York State, 2009; TRC, 2009). Both studies targeted the same two fields in New York City. Totals of 65 and 85 chemicals were identified at relatively low concentrations in the air above the two fields. Many of these occurred at similar concentrations in the air sampled upwind of the fields. Concentrations of particulates above the fields were similar to the levels upwind of the fields. Both reports concluded that these fields did not constitute a serious public health concern, since cancer or non-cancer health effects were unlikely to result from these low-level exposures.

A comparison of the chemicals detected in the air above the same two artificial turf fields that comprised the studies by New York State (2009) and TRC (2009) shows that chemical concentrations were consistently higher in the New York State (2009) study, ranging from 1.7-fold to 85-fold higher. The reasons for these differences are unknown. These variable results highlight the difficulties faced in obtaining consistent results from potential point sources of outdoor air pollution. Despite this variability, both studies found that the chemical concentrations they measured were unlikely to produce adverse health effects in persons using these fields.

***Is the Air Above Artificial Turf Fields Hazardous to Human Health?***

OEHHA constructed a test scenario for an athlete playing soccer from ages 5 to 55 years on the new generation of artificial turf fields containing crumb rubber infill. The data from Dye et al. (2006) were used for chemical concentrations in the air above the fields, since this was the most comprehensive data set available at the time. Breathing rates were based on published data. Time spent on the fields for soccer games and practices was estimated.

From among the chemicals identified by Dye et al. (2006), eight appear on the California Proposition 65 list of chemicals known to the state to cause cancer. Exposure to five of these via inhalation (benzene, formaldehyde, naphthalene, nitromethane, styrene) gave increased lifetime cancer risks that exceeded one in one million ($10^{-6}$), generally considered the negligible risk level. In other words, more than one cancer case could be expected to occur in a hypothetical population of one million people regularly playing soccer on these artificial turf fields between the ages of 5 and 55. The highest risk was from nitromethane, which could cause about nine cancer cases in a hypothetical population of one million soccer players. While these estimated risks are low compared to many common human activities, they are higher than the negligible risk level of one cancer in a population of one million people. Data gaps exist that could lead to overestimates or underestimates of these risks.

Two of the chemicals identified by Dye et al. (2006) appear on the California Proposition 65 list as developmental/reproductive poisons (toluene and benzene). Using the same exposure scenario described above for soccer players, concentrations of both chemicals in the air above artificial turf soccer fields were below the Proposition 65 screening levels, suggesting a negligible risk of developmental or reproductive toxicity via the inhalation route of exposure.

From among the 20 chemicals detected at the highest levels by Dye et al. (2006), seven were also detected in the New York State (2009) study. Concentrations of these seven chemicals were from 5- to 53-fold higher in the air above indoor fields (Dye et al., 2006) compared to the air above outdoor fields (New York State, 2009). Concentrations of particulates were also higher in the indoor study. Therefore, using indoor data to calculate health risks from outdoor play overestimates the outdoor risks.

***Does Artificial Turf Promote Infection of Athletes by the Bacterium Methicillin-Resistant Staphylococcus aureus (MRSA)?***

***MRSA Outbreaks in Sports***

*Staphylococcus aureus* is a bacterium that can cause serious infections in humans. A strain has developed that is resistant to the antibiotic methicillin, termed methicillin-resistant *Staphylococcus aureus* (MRSA). This strain has caused a number of outbreaks in team sports including football, wrestling, rugby and soccer. Participation in contact sports increases the risk of infection by MRSA. Skin abrasions and other types of skin trauma also increase the risk of infection by MRSA. Person-to-person contact is the primary way MRSA is spread. Whether transmission occurs via inanimate objects (including playing surfaces) is less certain.

***Artificial Turf and MRSA***

It is not known if the new generation of artificial turf causes more MRSA infections than natural turf. However, one study of high school football demonstrated more "surface/epidermal injuries" for games played on the new generation of artificial turf compared to natural turf. Since skin trauma increases the risk of infection by MRSA, careful monitoring and treatment of such wounds may help prevent MRSA outbreaks.

It seems unlikely that the new generation of artificial turf is itself a source of MRSA, since MRSA has not been detected in any artificial turf field.

***Data Gaps***

- Using indoor data to estimate the health risks from outdoor fields probably overestimates those risks.
- Only two outdoor artificial turf fields were evaluated in the New York State (2009) study. The same two fields comprised the TRC (2009) study. Testing additional outdoor fields for the release of chemicals and particulate matter is warranted.
- Dye et al. (2006) did not determine what amount of each chemical was released by the artificial turf field and what amount was present in the ambient air. Therefore, future studies of artificial turf fields should include measurements from both above the fields and off of the fields.
- No study has measured the metals content of the particulates released by artificial turf fields. In addition, it is not known if field use increases particulate release.
- The variables of field age and field temperature should be monitored to determine whether they influence the release of chemicals and particulates into the air above these fields.
- Data are needed for the amount of time athletes spend on artificial turf playing fields. Data are needed for a variety of sports, age groups, and for both men and

women. Other subgroups with potentially heavy exposure to fields include coaches, referees, and maintenance workers.

- Only a single study was located that compared the rate of skin abrasions on the new generation of artificial turf to natural turf. This was for high school football. Similar studies are needed for other sports, age groups, and for both male and female athletes.
- No data were located on the seriousness of the skin abrasions suffered by athletes on the new generation of artificial turf compared to natural turf.
- The bacterium MRSA has not been detected in artificial turf fields. However, fields in California have not been tested. Therefore, fields from different regions of the state should be tested to verify that the new generation of artificial turf does not harbor MRSA or other bacteria pathogenic to humans.

***Work in Progress***

OEHHA is currently working to fill the above data gaps. OEHHA will sample air from above the new generation of artificial turf fields in outdoor settings and measure concentrations of potentially hazardous chemicals and particulates. Coaches will be surveyed to determine how much time athletes spend on these fields. Rates of skin abrasion will be measured on artificial and natural turf. Various components of the artificial turf, as well as soil and grass from natural turf, will be assayed for bacteria. Using these new data, OEHHA will determine whether the new generation of artificial turf playing fields releases chemicals or particulates into the air that pose an inhalation risk to persons using the fields. OEHHA will also determine whether artificial turf fields increase the risk of infection by dangerous bacteria such as MRSA.

particulates in the air above artificial turf are used to estimate the risk of cancer or developmental toxicity to soccer players using these fields. This screen only addresses the inhalation route of exposure. As mentioned above, since Dye et al. (2006) did not measure the metals content of inhalable particulates, this screen does not address the hazards posed by the inhalation of heavy metals such as lead.

OEHHA is currently performing a study to fill the data gaps identified in this report. OEHHA will sample air from above the new generation of artificial turf fields in outdoor settings and measure concentrations of potentially hazardous chemicals and particulates. Coaches will be surveyed to determine how much time athletes spend on these fields. Rates of skin abrasion will be measured on artificial and natural turf. Various components of the artificial turf, as well as soil and grass from natural turf, will be assayed for bacteria. Using these new data, OEHHA will determine whether the new generation of artificial turf playing fields releases chemicals or particulates into the air that pose an inhalation risk to persons using the fields. OEHHA will also determine whether artificial turf fields increase the risk of infection by dangerous bacteria such as MRSA.

## Part I: Chemicals and Particulates in the Air above Artificial Turf

### Studies that measured chemicals and particulates in the air above the new generation of artificial turf playing field

Table 1 shows five studies that measured chemicals and particulates in the air above the new generation of artificial turf playing field. For the studies by Dye et al. (2006), the Instituto De Biomecanica De Valencia (IBV, 2006), van Bruggen et al. (2007) and Milone & MacBroom (2008), the fields contained rubber crumb manufactured from recycled tires. The rubber crumb in the fields measured by Broderick (2007) was also likely recycled material, although this was not specifically stated in the reports. All fields were outdoors except those in Dye et al. (2006), which were soccer pitches in three indoor stadiums in Norway. Therefore, it is likely that the concentrations of chemicals and particulates measured by Dye et al. (2006) were higher than what would have been measured had the fields been outdoors.

*Study quality and characteristics*

The studies by Dye et al. (2006) and van Bruggen et al. (2007) were performed by governmental institutes located in Norway and The Netherlands, respectively. The study by IBV was performed by a university-affiliated research institute in Spain. Broderick (2007) refers to J.C. Broderick & Associates, Inc., an environmental consulting and testing firm located in New York State. Milone & MacBroom refers to an environmental consulting firm located in Connecticut.

The study by Dye et al. (2006) is the most detailed of the five, presented in a formal institute report. Multiple air samples were collected from above three indoor soccer pitches, two of which contained infill of ground rubber; however, samples from outside the stadiums were not collected, so that no conclusions can be drawn concerning the concentrations of chemicals and particulates in the vicinities of these stadiums. Thus, it is difficult to assess which chemicals were released by the artificial turf and which were already present in the ambient air. The study included data on the environmental conditions during sampling such as temperature, relative humidity and barometric pressure. Indoor ventilation rates were not measured. The chemical and particulate sampling height(s) above the pitches were not indicated. This study measured volatile organic chemicals (VOCs), polycyclic aromatic hydrocarbons (PAHs) in the gas phase and associated with particulate matter ($PM_{10}$), phthalates in the gas phase, and particulate matter ($PM_{2.5}$ and $PM_{10}$). Thirty-eight PAHs were assayed. Comparing the two fields containing infill made of ground rubber, there is generally good agreement between the chemicals and particulates detected over the two fields. For example, Table 6a in the report lists the concentrations of benzothiazole, toluene, 4-methyl-2-pentanone and total volatile organic compounds (TVOCs) measured over the two fields; the concentrations measured over the first field were within 0.7-, 5.6-, 1.0- and 2.5-fold, respectively, of the concentrations measured over the second field. For the three PAHs occurring at the highest concentrations over both fields (naphthalene, 2-methylnaphthalene, acenaphthylene), the values from the first field were within 2.7-fold of the values from

the second field. With regard to particulate matter, the concentration of $PM_{10}$ collected from the two fields was 40.1 and 31.7 micrograms per cubic meter ($\mu g/m^3$), while $PM_{2.5}$ was 17.3 and 18.8 $\mu g/m^3$, again demonstrating good agreement between the two fields.

Dye et al. (2006) also measured the air above a field containing infill made of "thermoplastic elastomer." Comparing this field to the other two fields containing recycled rubber infill, the air above the field containing thermoplastic elastomer contained lower levels of VOCs, PAHs (both in the gas phase and associated with particulates), total $PM_{2.5}$ and the $PM_{2.5}$ fraction consisting of rubber dust.

van Bruggen et al. (2007), also presented in a formal institute report, collected multiple samples from above four outdoor soccer fields made of artificial turf, as well as samples upwind of the fields to measure the ambient environmental levels. Weather data included wind speeds, and the heights above the fields where sampling was performed were also reported. This study only measured nitrosamines. Eight were assayed.

The short report from Broderick (2007) shows that while duplicate samples were collected from above two outdoor artificial turf fields, as well as off of the fields, no weather data (including wind speed) were presented. In addition, the reports do not indicate the height above the fields at which sampling was performed. This study only measured PAHs (in the gas phase and in particulates collected on a 2.0 µm filter). Sixteen PAHs were assayed.

The IBV (2006) study was in the form of a meeting presentation, available online at the Web site for the 2006 Dresden Conference entitled, "Impact of Sports Surfaces on Environment and Health." Six samples were collected over a single outdoor artificial soccer pitch. No background air samples were collected from off the pitch. Thus, it is difficult to assess which chemicals were released by the artificial turf and which were already present in the ambient air. No weather data were reported, and few other methodological details were provided. This study measured VOCs, PAHs (whether in gas or particulate phase was not indicated), and hydrogen sulfide.

The most recent study (Milone & MacBroom, 2008) collected a single air sample from above each of two artificial turf fields in Connecticut. Four additional samples were collected from off of each field. Temperature, humidity and wind speed/direction data were included, and a sampling height of 4 feet above the surface was utilized. Analysis was for seven nitrosamines, 4-(tert-octyl)phenol and benzothiazole. These last two chemicals had been detected volatilizing from recycled rubber crumb analyzed under laboratory conditions (see study by Environment & Human Health, Inc. (EHHI, 2007) in Table 4).

*Comparing studies*

Dye et al. (2006) identified 94 chemicals in the air above artificial turf fields located in indoor stadiums. Over 200 additional VOCs were detected in this study (13 to 16 percent by weight), but not identified. By comparison, the IBV (2006) study detected 13

Table 1. Air measurements above artificial turf fields

| Reference | Scenario | Chemicals/particulates measured |
|---|---|---|
| Dye et al., 2006 | Three indoor soccer stadiums<br><br>10-18°C<br><br>42-53% humidity<br><br>One field 2 months old (other 2 ages not indicated)<br><br>Two fields contained recycled rubber crumb (yielding values shown on right) | VOCs : 69 detected at $\geq$ 0.8 $\mu g/m^3$<br><br>PAHs: 22 detected at $\geq$ 1.0 $ng/m^3$ (mostly in the gas phase, some in the particulate fraction)<br><br>Phthalates: 3 detected at $\geq$ 0.06 $\mu g/m^3$ (in the gas phase)<br><br>$PM_{2.5}$: total = 18.8 $\mu g/m^3$, rubber = 8.8 $\mu g/m^3$<br>$PM_{10}$: total = 40.1 $\mu g/m^3$, rubber = 9.3 $\mu g/m^3$<br><br>Twenty highest VOCs were (in $\mu g/m^3$): toluene (85), butenylbenzene (82.5), benzoic acid (81), diethenylbenzene (41), benzothiazole (31.7), p- and m-xylene (25.5), ethylbenzaldehyde (19.7), acetonitrile (16.8), acetone (15.3), o-xylene (13.1), 4-methyl-2-pentanone (12.7), alpha pinene (10.5), 3-phenyl-2-propenal (10.2), cyclohexanone (9.8), pentenyl benzene (7.3), pentanedioic acid dimethylester (6.8), ethylbenzene (6.7), formaldehyde (6.5), hexenylbenzene (6.1), styrene (6.1)<br><br>Ten highest PAHs (total in gas phase plus $PM_{10}$-associated) were (in $ng/m^3$): naphthalene (2700 or 56 for two different methods), acenaphthylene (78.1), 2-methylnaphthalene (57.8), 1-methylnaphthalene (42.6), biphenyl (32.8), phenanthrene (25), fluorene (19.2), dibenzofurane (17), acenaphthene (14.2), pyrene (4.4)<br><br>Three phthalates were (in $\mu g/m^3$): dibutylphthalate (DBP, 0.38), diisobutylphthalate (DiBP, 0.13), diethylphthalate (DEP, 0.06) |
| IBV 2006 | One outdoor soccer field | VOCs: 5 detected (highest value in $\mu g/m^3$): p- and m-xylene (4.4), toluene (3.1), o- |

| Reference | Scenario | Chemicals/particulates measured |
|---|---|---|
| | containing recycled rubber crumb | xylene (2.5), ethylbenzene (2.2), benzene (0.4)<br><br>PAHs: 8 detected (highest value in ng/m$^3$): phenanthrene (6.9), pyrene (4.2), fluoranthene (1.1), fluorene (0.92), anthracene (0.46), acenaphthene (0.32), naphthalene (0.3), acenaphthylene (0.21) |
| Broderick 2007 | Two outdoor high school athletic fields containing rubber crumb | All 16 PAHs assayed were below the minimum detection level of 6.0 µg/m$^3$ |
| van Bruggen et al., 2007 | Three outdoor fields containing recycled rubber crumb and one containing new rubber<br><br>For fields with recycled rubber, one recently installed and two older than one year<br><br>Sampling performed between 11-20°C on sunny days at 30-100 cm above pitch | All eight nitrosamines assayed were below the minimum detection limit of 8-16 ng/m$^3$ |
| Milone & MacBroom 2008 | Two outdoor fields containing recycled rubber crumb<br><br>Sampling performed on | Seven nitrosamines were assayed: samples from both fields were below the minimum reporting limit of 1.0 to 1.4 µg/m$^3$<br><br>4-(tert-octyl)phenol: samples from both fields were below the minimum reporting |

| Reference | Scenario | Chemicals/particulates measured |
|---|---|---|
| | summer days between 75 and 85°F with light winds<br><br>Samples taken at 4 feet above surface | limit of 0.19 to 0.21 $\mu g/m^3$<br><br>Benzothiazole: one field's sample was below the minimum reporting limit of 0.19 to 0.21 $\mu g/m^3$; the other field's sample was 1.0 $\mu g/m^3$ (includes correction for 39% sample spike recovery) |

chemicals and Milone & MacBroom (2008) detected one. The two remaining studies utilized detection levels that were too high; as a consequence, no chemicals were detected.

The failure to detect PAHs in the study by Broderick (2007) is consistent with the data in Dye et al. (2006). The individual PAH levels in Dye et al. (2006) were all $\leq 2.7$ $\mu g/m^3$, while the individual PAH detection levels in Broderick (2007) were 6.0 $\mu g/m^3$. Utilizing nitrosamine detection levels of 8-16 $ng/m^3$, van Bruggen et al. (2007) did not detect nitrosamines above three outdoor fields containing recycled rubber. Some nitrosamines volatilize readily from soil and water surfaces, while others are considered nonvolatile. Their study was initiated after a single air measurement above an artificial turf field containing recycled rubber detected N-nitrosodimethylamine (NDEA) at 93 $ng/m^3$. Similarly, Milone & MacBroom (2008) did not detect nitrosamines above two fields (reporting limits 1.0 to 1.4 $\mu g/m^3$). Dye et al. (2006) also did not report any nitrosamines above two indoor fields containing recycled rubber, although the nitrosamine detection levels were not indicated in the report.

Table 2 shows a comparison of the concentrations of the eight PAHs and five VOCs detected by IBV (2006) to the highest values reported by Dye et al. (2006). Despite uncontrolled variables such as field age and temperature during sampling, all 13 chemicals detected by IBV (2006) were detected by Dye et al. (2006). For 12 of the 13, the concentrations were lower in IBV (2006). This might be expected, since the field in the IBV (2006) study was outdoors, while the fields in the Dye et al. (2006) study were indoors. For the eight PAHs, concentrations measured in IBV (2006) ranged from similar (pyrene) to 9000-fold (naphthalene) lower than the corresponding concentration measured in Dye et al. (2006). For the five VOCs the differences were less, ranging from 3-fold (ethylbenzene) to 27-fold (toluene) lower in the IBV (2006) study. The VOC benzothiazole was also detected over an outdoor field by Milone & MacBroom (2008); its concentration was 32-fold lower over this outdoor field compared to the concentration reported over indoor fields by Dye et al. (2006). Therefore, the data in IBV (2006) and in Milone & MacBroom (2008) support those of Dye et al. (2006) in that all 13 chemicals detected over outdoor fields were detected at higher levels over indoor fields. This suggests that persons using the new generation of artificial turf in outdoor settings are exposed to many of the same chemicals as persons exposed indoors, albeit at lower concentrations. Thus, exposure calculations for outdoor play based on the data from Dye et al. (2006) would probably overestimate exposure to most chemicals. Since neither the IBV (2006) study nor the Dye et al. (2006) study measured the background level of chemicals, it remains possible that the 13 chemicals discussed above were not emitted from the artificial turf, but were already present in the ambient air. However, due to the presence of a number of VOCs that Dye et al. (2006) considered to be typical rubber components (such as benzothiazole, 4-methyl-2-pentanone and styrene), the authors believed that the rubber infill was the source of many of the VOCs they detected.

Unfortunately, since the report of Dye et al. (2006) contained the only published values for $PM_{2.5}$ and $PM_{10}$ from above artificial turf fields, there are no other studies for comparison. As discussed above, the good agreement between the PM values from the

two fields measured in the study by Dye et al. (2006) provide some assurance that the data are reliable. However, it is difficult to use these indoor data from Dye et al. (2006) to predict the concentrations of PM over outdoor artificial turf fields.

Table 2. Comparison of chemical concentrations measured in the studies of Dye et al. (2006) and IBV (2006)

| Chemical | Concentration in IBV (2006) ($\mu g/m^3$) | Concentration in Dye et al. (2006) ($\mu g/m^3$)[1] | [Dye]/[IBV] |
|---|---|---|---|
| PAHs | | | |
| Acenaphthene | 0.00032 | 0.014 | 44 |
| Acenaphthylene | 0.00021 | 0.078 | 371 |
| Anthracene | 0.00046 | 0.002 | 4.3 |
| Fluoranthene | 0.0011 | 0.004 | 3.6 |
| Fluorene | 0.00092 | 0.019 | 21 |
| Naphthalene | 0.0003 | 2.7 or 0.056 | 9000 or 187 |
| Phenanthrene | 0.0069 | 0.025 | 3.6 |
| Pyrene | 0.0042 | 0.004 | 1 |
| VOCs | | | |
| Benzene | 0.4 | 2.4 | 6 |
| Ethylbenzene | 2.2 | 6.7 | 3 |
| Toluene | 3.1 | 85 | 27 |
| o-Xylene | 2.5 | 13.1 | 5.2 |
| p and m-Xylene | 4.4 | 25.5 | 5.8 |

[1]Highest value reported

*Conclusions*

- Only five studies were located which quantified the chemicals and particles in the air above the new generation of artificial turf playing fields.
- The study by Dye et al. (2006) of indoor soccer stadiums provides the largest dataset: 69 VOCs at $\geq$ 0.8 $\mu g/m^3$, 22 PAHs at $\geq$ 1.0 $ng/m^3$ (mostly in the gas phase), 3 phthalates at $\geq$ 0.06 $\mu g/m^3$ (in the gas phase), $PM_{2.5}$ at 18.8 $\mu g/m^3$ and $PM_{10}$ at 40.1 $\mu g/m^3$ were detected.
- The chemicals identified by Dye et al. (2006), as well as their concentrations, are consistent with the other four studies.

*Data Gaps*

- A study similar to that of Dye et al. (2006), that assays a large range of VOCs and particulates over multiple fields, is needed for outdoor artificial turf fields, since use of the Dye et al. (2006) data for estimating the health risks from outdoor fields probably overestimates those risks.
- Dye et al. (2006) did not sample air from outside the stadiums for comparison to the indoor samples. Therefore, it is not possible to know what amount of each

chemical was contributed by the artificial turf field and what amount was present in the ambient air.

- Approximately 200 of the 300 VOCs (13 to 16 percent by weight) detected by Dye et al. (2006) were not identified, but were only reported as peaks on a graph. Therefore, potential health risks posed by these chemicals cannot be estimated.
- Many of the chemicals identified in the study of Dye et al. (2006) have no associated health-based screening levels, so that their health risks cannot be estimated. Thus, any attempt to classify these chemicals as carcinogens or developmental/reproductive toxicants will be an underestimate.
- The Dye et al. (2006) study provides the only data on particulate levels from above artificial turf playing fields. Data from above outdoor fields are needed, where the values are likely to be lower.
- Dye et al. (2006) did not measure the metals content of the airborne particulate matter ($PM_{2.5}$ and $PM_{10}$). Thus, the health risks posed by inhaled particulates and the metals they contain, such as lead, cannot be determined.
- The effect of temperature on chemical and particulate levels has not been measured.
- The contribution of field age to chemical and particulate levels has not been measured.
- The effect of field use on the levels of either VOCs or particulates has not been measured. Thus, it is possible that air sampling before or during games would give different results.

**Studies that measured chemicals emitted by rubber flooring made from recycled tires**

CIWMB sponsored two studies (2003 and 2006) that measured chemical emissions from tire-derived rubber flooring. This type of flooring is used in indoor applications such as auditoriums and classrooms. The flooring contained at least 80 percent tire-derived rubber, making it chemically very similar to the crumb rubber infill used in many new generation artificial turf fields, including those in the study of Dye et al. (2006) and the other studies in Table 1. Emissions of individual chemicals were measured in environmental chambers and normalized to the surface area of flooring in each chamber, yielding chemical-specific emission factors. The data cannot be directly compared to the air concentrations from Dye et al. (2006). However, the emission factors were used to model the chemical concentrations expected to occur in a variety of indoor settings. Table 3 shows those concentrations for the largest rooms modeled: an auditorium and a classroom. The results for the largest rooms are presented since these are closest to the dimensions of the indoor stadiums in the Dye et al. (2006) study.

Table 3. Indoor emissions from tire-derived rubber flooring

| Reference | Indoor area modeled | Modeled room chemical concentrations (µg/m$^3$) based on measured emission factors |
|---|---|---|
| CIWMB, 2003 | State auditorium, 70x70x15 ft, 73,500 ft$^3$<br><br>3.5 air changes per hour<br><br>Flooring samples tested contained at least 80% recycled styrene butadiene rubber and ethylene propylene diene monomer<br><br>Chemical emission rates were determined at 14 days, modeled concentrations in right column are based on the highest measured emission rate for each chemical | VOCs 21 identified:<br>α, α-dimethylbenzenemethanol (420), acetophenone (160), diethyl propanedioate (80), propylene glycol (47), 1-ethyl-3-methylbenzene (43), 1,2,4-trimethylbenzene (40), α-methyl-styrene (38), benzothiazole (37), 1-ethyl-4-methylbenzene (22), 1,2,3-trimethylbenzene (18), triethylphosphate (18), 1-ethyl-2-methylbenzene (13), 2-ethylhexyl acetate (11), cumene (5.5), 2-ethyl hexanoic acid (3.9), 1-methyl-2-pyrrolidinone (1.8), dodecane (1.4), naphthalene (0.99), nonanal (0.74), decanal (0.5), ethyl benzene (0.5) |
| CIWMB, 2006 | State classroom, 960 ft$^2$ x8.5 ft high, 8160 ft$^3$<br><br>0.9 air changes per hour<br><br>Most flooring samples contained ≥ 81% tire-derived rubber<br><br>Chemical emission rates were determined at 14 days, modeled concentrations in right column are based on the highest measured emission rate for each chemical | VOCs 31 identified:<br>benzothiazole (1677), methyl isobutyl ketone (154), m-/p- xylene (142), carbon disulfide (116), acetophenone (86), cyclohexanone (77), toluene (60), acetone (43), ethyl benzene (32), benzene (24), chlorobenzene (23), nonanal (22), n-undecane (21), octanal (18), styrene (17), acetaldehyde (16), butyraldehyde (14), α-methylstyrene (12), phenol (10), decanal (9), isopropyl alcohol (9), 1,2,4-trimethylbenzene (9), formaldehyde (7), n-decane (6), 1-ethyl-4-methylbenzene (6), 1,3,5-trimethylbenzene (6), naphthalene (4), hexanal (3), 4-phenylcyclohexene (3), 1,2,3-trimethylbenzene, o-xylene (2) |

In the 2003 CIWMB study, eight of 21 chemicals emitted by the tire-derived flooring were also detected above artificial turf fields in indoor stadiums (Dye et al., 2006). Half of these (4/8) were modeled as occurring at higher concentrations in the auditorium compared to the stadiums. In the 2006 CIWMB study, 18 of 31 chemicals emitted by the flooring were also detected above artificial turf fields in indoor stadiums (Dye et al., 2006), with 16 of the18 occurring at higher concentrations in the modeled state classroom compared to the indoor stadiums. For those chemicals detected in CIWMB (2003) or (2006) but not in Dye et al. (2006), it is not known if they were even assayed in the latter study. There were six chemicals detected in both CIWMB studies and by Dye et al. (2006): 1,2,4-trimethylbenzene, 1-ethyl-4-methylbenzene, benzothiazole, ethylbenzene, naphthalene and nonanal. Three of these were emitted by 100 percent rubber crumb heated under laboratory conditions: 1,2,4-trimethylbenzene, benzothiazole and ethylbenzene (see Table 4). This suggests that these three chemicals in the air are reliable markers for the crumb rubber from recycled tires used as infill in artificial turf. Ethylbenzene and naphthalene were also detected by IBV (2006) and benzothiazole was detected by Milone & MacBroom (2008) in outdoor air above artificial turf fields (Table 1), while all except 1-ethyl-4-methylbenzene were emitted by sections of artificial turf maintained in environmental chambers (see next section, Moretto, 2007).

It should be mentioned that recycled tire rubber used as indoor flooring (CIWMB 2003) emitted hundreds of low-level VOCs that were not identified. Hundreds of low-level VOCs were also detected in the air over artificial turf in indoor stadiums (Dye et al., 2006). When all VOCs were totaled (TVOCs), they reached up to 716 $\mu g/m^3$ in the Dye et al. study (2006) and exceeded one milligram (mg)/$m^3$ in the CIWMB study (2003). The health effects from breathing low levels of many volatile organic chemicals have not been adequately studied. This lack of information should be noted when calculating the health risks from individual chemicals that were identified in these studies.

*Conclusions*

- Twenty of the VOCs released by tire-derived indoor rubber flooring (CIWMB 2003 and 2006) were also detected in the air above indoor soccer pitches made of the new generation of artificial turf containing rubber infill.
- For the more recent flooring study (CIWMB, 2006), 18 of 31 chemicals emitted by the flooring were also detected in the air above the turf (Dye et al., 2006). This demonstrates good agreement between the studies and supports using the data from Dye et al. (2006) for making health risk estimates via inhalation.
- Three VOCs were consistent markers for tire-derived rubber: 1,2,4-trimethylbenzene, benzothiazole and ethylbenzene.

*Data Gaps*

- Tire-derived flooring emitted hundreds of low-level VOCs that were not identified, while other identified chemicals had no associated health-based

screening levels. Therefore, the health risks posed by these chemicals cannot be estimated.

- Total VOCs (TVOCs) emitted by tire-derived flooring exceeded one $mg/m^3$. Similar measurements of TVOCs should be made above artificial turf fields, since breathing low levels of a mixture of many VOCs may pose a health risk.

**Laboratory studies of the emission of volatile chemicals from tire-derived crumb rubber infill**

Three studies were located which analyzed the gaseous emissions from tire-derived crumb rubber infill in laboratory settings (Table 4). The studies by Plesser and Lund (2004) and EHHI (2007) analyzed samples of 100 percent rubber infill heated to 60-70°C, while Moretto (2007) used whole sections of artificial turf (containing recycled crumb rubber infill) maintained at 23°C in environmental chambers.

Moretto (2007) identified 112 VOCs emitted from the artificial turf. This is more than reported in any other study. Twenty-seven of these were also detected by Dye et al. (2006) over artificial turf fields in indoor soccer stadiums. Moretto (2007) did not provide quantitative data on the amounts of chemicals that were released by the sections of artificial turf. Of the 12 VOCs identified by Plesser and Lund (2004), five were also detected by Dye et al. (2006). From among the four VOCs identified in EHHI (2007), only benzothiazole was also identified by Dye et al. (2006).

*Conclusions*

- The study by Moretto (2007) of artificial turf in environmental chambers confirmed 27 of the chemicals detected in indoor soccer stadium air by Dye et al. (2006). This supports the use of the data from Dye et al. (2006) for estimating the health risks posed by artificial turf playing fields.
- Benzothiazole was detected in two of three emissions studies in Table 4 (EHHI, 2007; Moretto, 2007), in both indoor flooring studies in Table 3 (CIWMB 2003 and 2008), and in air above artificial turf fields (Table 1; Dye et al., 2006; Milone & MacBroom, 2008). It appears to be a consistent and relatively high-level off-gassing product of rubber crumb made from recycled tires.

*Data Gaps*

- Many of the chemicals identified in the chamber emission study of Moretto (2007) were not detected in stadium air by Dye et al. (2006). This may be due to the conditions used by Moretto (2007): a sealed environmental chamber, maintained at 23°C, in which chemicals emitted at low levels have a chance to accumulate. Since chemical concentrations in the chambers were not provided in the report, this cannot be determined.

Table 4. Gaseous emissions per gram of tire-derived rubber in laboratory studies

| Reference | Conditions | VOCs detected (in ng/g of rubber) |
|---|---|---|
| Plesser and Lund, 2004 | Samples heated at 70°C for 30 minutes | Twelve VOCs detected:<br>1,2,4-trimethylbenzene (102), toluene (80), m/p-xylene (37), o-xylene (35), cis-1,2-dichloroethene (32), n-butylbenzene (31), p-isopropyltoluene (23), 1,3,5-trimethylbenzene (23), ethylbenzene (18), propylbenzene (15), iso-propylbenzene (12), trichloromethane (8) |
| EHHI, 2007 | Samples heated at 60°C for 42 minutes | Four VOCs detected:<br>benzothiazole (867), butylated hydroxyanisole or BHT alteration product (53), 4-(tert-octyl)-phenol (22), hexadecane (1.58) |
| Moretto, 2007 | Samples off-gassed for 28 days in chambers at 23°C | 112 VOCs detected, but emissions per gram of rubber not indicated |

**Chemicals and particulates emitted during rubber manufacturing**

Due to the large numbers of chemicals and materials used to manufacture rubber, many occupational health studies have examined the safety of various steps in the manufacturing process. The studies listed in Table 5 measured the concentrations of volatile chemicals and particulates to which rubber workers have been exposed. While it is to be expected that the levels of these chemicals would be higher in factory air during the rubber manufacturing process compared to a setting where the rubber end product is used, such as in artificial turf infill, some of the more prevalent chemicals should be detected in both situations. Such a comparison can be a useful test of the validity of the studies presented in Table 1 that attempted to identify the chemicals and particulates above artificial turf fields containing recycled tire rubber as infill.

With respect to VOCs, Rappaport and Fraser (1977) measured six VOCs in a vulcanization area of a tire manufacturing plant. Three of these, toluene, ethylbenzene and styrene, were also detected by Dye et al. (2006) in indoor stadium air above new generation artificial turf containing recycled crumb rubber infill; the stadium concentrations were 51-fold, 73-fold and 78-fold lower than the factory concentrations, respectively. Cocheo et al. (1983) measured VOCs in the vulcanization and extrusion areas of a tire retreading factory. From among the 60 VOCs they identified, 15 were also detected by Dye et al. (2006) in the indoor stadium study; concentrations of the 15 VOCs were from 4-fold to 625-fold lower in the artificial turf application. Van Ert et al. (1980) investigated eight organic solvents used in a tire and tube manufacturing plant. Measurements were performed in the tire building and final inspection areas. Five of the eight solvents were also detected by Dye et al. (2006): heptane, toluene, octane, benzene and xylene. The concentrations ranged from 34-fold to 10,750-fold lower in the indoor stadium air compared to the factory air. Armstrong et al. (2001) identified five VOCs in rubber tire manufacturing plants. Of these, three (formaldehyde, benzene and toluene) were also identified by Dye et al. (2006), but at 34-fold to 238-fold lower concentrations. Lastly, two of four VOCs identified by Correa et al. (2004) in the outdoor air circulation area of a tire recapping unit were also identified by Dye et al. (2006); toluene and styrene were 131-fold and 7-fold lower in the air above indoor artificial turf fields compared to the tire recapping area. Thus, five separate studies of rubber manufacturing have detected VOCs that were also in the air over the new generation of artificial turf fields; in each case the chemical was at a lower concentration above the fields compared to the manufacturing setting. These findings support the use of the data from Dye et al. (2006) for estimating chemical exposures to persons using the new generation of artificial turf fields, at least until similar measurements can be performed in outdoor settings.

Nitrosamines have been detected by sampling air in rubber manufacturing plants (Table 5). Oury et al. (1997) measured total nitrosamines in tire factory air. The highest concentration detected was 2.3 $\mu g/m^3$. Monarca et al. (2001) detected two nitrosamines (N-nitrosodimethylamine [NDMA] and N-nitrosomorpholine [NMOR]) in the range of 1-2 $\mu g/m^3$ inside a styrene-butadiene rubber factory. Iavicoli and Carelli (2006) sampled air in a rubber manufacturing plant. While the great majority of air samples had no

Table 5. Chemicals and particulates released into the air during rubber manufacturing

| Reference | Work area sampled | Chemicals and particulates measured |
|---|---|---|
| Nutt, 1976 | Tire factory areas including mixing, extrusion, curing, pressing, trimming | Benzo[a]pyrene was Soxhlet-extracted from particulates: mean concentration of 49 factory air samples (12.3 ng/m$^3$) was not significantly different from outside air B[a]P concentration |
| Rappaport and Fraser, 1976 | Rubber vulcanization performed in the lab | Fourteen VOCs were identified, with the highest relative concentrations being methylbenzene, 4-vinylcyclohexene, styrene, tert-butylisothiocyanate, and 1,5,9-cyclododecatriene |
| Rappaport and Fraser, 1977 | Tire vulcanization area in a factory | Six VOCs measured (mean values in µg/m$^3$): toluene (4,371), ethylbenzene (486), styrene (473), 4-vinylcyclohexene (408), 1,5,9-cyclododecatriene (105), 1,5-cyclooctadiene (28.5) |
| Van Ert et al., 1980 | Tire building and final inspection areas in two tire and tube manufacturing plants | Eight organic solvents measured (highest mean values in mg/m$^3$): hexane (64), heptane (8.6), isopropanol (7.9), toluene (3.2), pentane (2.2), octane (1.9), benzene (1.3), xylene (1.3) |
| Cocheo et al., 1983 | Vulcanization and extrusion areas in a tire retreading factory | Sixty VOCs measured, the following being the ten highest in concentration (mg/m$^3$): diisobutyl phthalate (2.5), cyclohexene-1-methyl-4-(1-methylvinyl) (1.7), benzene (1.2), toluene (0.8), methylcyclohexane (0.8), dibutyl phthalate (0.5), heptane (0.5), 1-isopropyl-4-methylbenzene (0.45), 2,6-di-ter-butyl-4-ethylphenol (0.42), cyclododecatriene (0.4) |
| Heitbrink and McKinnery, 1986 | Tire manufacturing plants: mixing and milling areas | Mean total aerosol ranges (in mg/m$^3$): for mixing (0.08 to 1.54), for milling (0.2 to 1.22); mean respirable aerosol ranges (in mg/m$^3$): for mixing (0.06 to 0.34), for milling (0.08 to 0.4) |
| Oury et al., 1997 | Tire factory including steps of mixing, pressing, quality control and storage | Total nitrosamines (NDMA, NDEA, NDBA, NPIP, NMOR) were between 0.01 and 2.3 µg/m$^3$ (range of 45 measurements) |
| Meijer et al., 1998 | Rubber manufacturing areas in belt factory (compounding and mixing, calendaring, extruding, repair, curing) | "Inhalable dust" mean values ranged from 0.9 to 9.4 mg/m$^3$ |
| Fracasso et al., 1999 | Rubber manufacturing areas included weighing, mixing, calendaring, compounding, | PAH concentration ranges (in µg/m$^3$): phenanthrene (not detected), pyrene (0.006 to 0.213), benzo(a)anthracene (not detected to 0.005), chrysene (0.01 to 0.05), benzo(a)pyrene (not detected to 0.012), dibenzo(a,h)anthracene (0.003 to 0.106) |

| Reference | Work area sampled | Chemicals and particulates measured |
|---|---|---|
| | extruding | |
| Armstrong et al., 2001 | Five rubber tire manufacturing plants | Aerosol particle concentrations (means in $\mu g/m^3$): $PM_1$ [<1 μm] (120); $PM_1$ to $PM_5$ [1 to 5 μm] (123); $PM_5$ to $PM_{10}$ [5 to 10 μm] (109); VOCs (means in $mg/m^3$) formaldehyde (0.22), benzene (0.57), furfural (< 0.91), isopropyl alcohol (5.66), toluene (12.38) |
| Monarca et al., 2001 | Styrene-butadiene rubber factory | Total mean $PM_{10}$=0.23 $mg/m^3$; mean nitrosamines (in $\mu g/m^3$): NDMA (0.98), NMOR (2.28); 17 PAHs were Soxhlet-extracted from $PM_{10}$, with the 10 highest (in $ng/m^3$): dimethylnaphthalene (1200), naphthalene (400), pyrene (29), benzo(ghi)perylene (20), indeno(1,2,3-cd)pyrene (18), phenanthrene (12), benzo(b)fluoranthene (7.3), fluoranthene (7.0), benzo(a)pyrene (5.7), benzo(a)anthracene (2.3) |
| Ward et al., 2001 | Rubber manufacturing plant: high exposure areas (reactor, recovery, tank farm, lab); low exposure areas (blending, baling, packaging, coagulation, water plant) | 1,3-butadiene concentrations, mean 12 hour time weighted averages (in $mg/m^3$) for: high exposure areas = 3.8, for low exposure areas = 0.15 |
| Chien et al., 2003 | Two tire shredding plants-chopping, shredding, granulating and storage areas | $PM_{10}$, means ranged from 0.23 to 1.25 $mg/m^3$ |
| Correa et al., 2004 | Outdoor circulation area of a tire-recapping unit | In $\mu g/m^3$ : toluene (11,100), styrene (44.3), 4-chlorotoluene (7.6), 4-chlorostyrene (9.0), benzo(a)anthracene (16.7 extracted from particulates), chrysene (17.5 extracted from particulates) |
| de Vocht et al., 2006 | Tire factory: milling and mixing/curing departments | "Inhalable particulate matter" mean value was 0.3 $mg/m^3$ |
| Iavicoli and Carelli, 2006 | Rubber manufacturing (e.g., belts, no tires) | Great majority of nitrosamine samples were below the limit of detection (0.06 $\mu g/m^3$); however, some values were higher (in $\mu g/m^3$): N-nitrosodimethylamine (0.35 for one sample), N-nitrosomorpholine (0.16, mean of 4 samples), N-nitrosodiethylamine (0.15, mean of 5 samples), N-nitrosodi-n-butylamine (0.06 for one sample) |
| de Vocht et al., 2008a | Polish rubber tire plant; | Geometric mean concentrations for the different departments ranged from: 1.7 to |

| Reference | Work area sampled | Chemicals and particulates measured |
|---|---|---|
| | departments sampled included crude materials, milling and mixing, pre-treating, assembly, curing, finishing, storage | 5.8 $mg/m^3$ for inhalable aerosols, <1.0 to 578 $\mu g/m^3$ for aromatic amines |
| de Vocht et al., 2008b | Rubber manufacturing in five European countries | Inhalable dust measured with personal samplers on workers, means ranged from 0.72 to 1.97 $mg/m^3$ |

detectable nitrosamines (detection limit = 0.06 $\mu g/m^3$), some had detectable levels, the highest being 0.35 $\mu g/m^3$ for N-nitrosodimethylamine. All the above nitrosamine concentrations are above the minimum detection level of 8-16 $ng/m^3$ used by van Bruggen et al. (2007) to analyze air samples from above outdoor artificial turf fields containing recycled rubber crumb (Table 1). There are at least two possible reasons for the failure of van Bruggen et al. (2007) to detect the volatile nitrosamines, given that they were present at detectable levels during manufacturing. First, most of the more volatile nitrosamines may have been emitted by the rubber crumb prior to field installation. Second, volatilization may be so rapid that the chemicals rapidly dissipate into the atmosphere.

PAHs have also been detected in the air of factories producing rubber (Table 5). Surveying the levels in factory air, all were well below the detection level of 6.0 $\mu g/m^3$ used by Broderick (2007) when sampling the air above outdoor artificial turf fields containing recycled rubber crumb (Table 1). Thus, it is not surprising that Broderick (2007) failed to detect PAHs. Using lower detection levels, Dye et al. (2006) reported 22 PAHs at $\geq$ 1.0 $ng/m^3$ in the air above artificial turf fields in indoor stadiums (Table 1). Comparing the PAHs detected by Dye et al. (2006) to those reported in the occupational studies in Table 5 yields the following: two of six PAHs detected by Fracasso et al. (1999), ten of 16 detected by Monarca et al. (2001), and none of two detected by Coorea et al. (2004) were also identified by Dye et al. (2006). The agreement between Monarca et al. (2001) and Dye et al. (2006) seems close; however, while six of the PAHs were at higher levels in factory air compared to the indoor stadium air, four were at higher levels in the stadium air. A possible explanation is that Dye et al. (2006) analyzed PAHs occurring in both the gas and particulate phases, while Monarca et al. (2001) only assayed the particulate phase. Thus, the more volatile PAHs might be expected at higher levels in the former case. The four PAHs detected at higher levels by Dye et al. (2006) were in fact the relatively volatile PAHs acenaphthylene, fluorene, phenanthrene and anthracene.

Values for respirable particulate ($PM_{10}$; particles capable of penetrating deeply into the lungs, into the region where gas exchange occurs) concentrations in factory air were distributed over a fairly narrow range: up to 400 $\mu g/m^3$ in a tire manufacturing plant (Heitbrink and McKinnery, 1986), up to 352 $\mu g/m^3$ in five tire manufacturing plants (Armstrong et al., 2001), and up to 1250 $\mu g/m^3$ in two tire shredding plants (Chien et al., 2003). The $PM_{10}$ concentrations were roughly ten-fold lower in the indoor stadium air measured by Dye et al. (2006), ranging up to 40.1 $\mu g/m^3$, of which 9.3 $\mu g/m^3$ was identified as rubber particulate. Inhalable particulate (relatively large particles, capable of being inhaled but not penetrating deeply into the lungs) concentrations in factory air were generally higher than respirable concentrations, ranging as high as 5800 and 9400 $\mu g/m^3$ in the studies by de Vocht et al. (2008) and Meijer et al. (1998). These results for respirable particulates are similar to those for VOCs, in that concentrations above indoor artificial turf fields were much lower than those in the factories, including the tire shredding plant (Chien et al., 2003).

*Conclusions*

- A number of VOCs detected above third generation artificial turf fields by Dye et al. (2006) were also detected in the air of rubber manufacturing plants. In all cases, the concentrations were lower in the air over the artificial turf fields compared to the factory settings.
- For the nitrosamines, their levels in air above artificial turf fields and in rubber factory air suggest that either these chemicals volatilize from the rubber crumb prior to installation in a field, or their levels over a field are too low to detect.
- Air sampling data from rubber factories confirm most of the PAHs detected by Dye et al. (2006) in the air over artificial turf fields.
- Air sampling in rubber factories and tire shredding plants detected levels of respirable particulates ($PM_{10}$) that were approximately ten-fold higher than the levels measured above third generation artificial turf fields containing rubber crumb infill (Dye et al., 2006).

*Data Gaps*

- Measure the time dependence (as the fields age) of respirable particulate ($PM_{2.5}$ and $PM_{10}$) release from artificial turf fields containing rubber crumb.
- Determine if levels of respirable particulates ($PM_{2.5}$ and $PM_{10}$) vary with field use; i.e., are the levels in the air higher during games compared to periods when the fields are idle?

**Estimating the risk of cancer and developmental/reproductive toxicity via inhaled air in soccer players on the new generation of artificial turf.**

The purpose of this section is to estimate the increased lifetime cancer risk and increased risk of developmental/reproductive toxicity due to the inhalation of volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs) by soccer players using the new generation of artificial turf playing fields. To perform this screen, the chemicals detected above artificial turf fields were compared to the California Proposition 65 list of chemicals known to the state to cause cancer or developmental/reproductive toxicity.

As described earlier in this report, Dye et al. (2006) published a study analyzing the air above three artificial turf playing fields located indoors in Norwegian soccer stadiums. This section uses these values, along with published values for age-specific breathing rates, and estimated lifetime play scenarios for soccer players on artificial turf, to calculate the following for those chemicals that also appear on the California Proposition 65 list:

1. daily chemical intake rates averaged over a lifetime to estimate the increased lifetime cancer risk, and

2. daily chemical intake rates not averaged over a lifetime, for comparison to maximum allowable dose levels (MADLs) to estimate the increased risk of developmental/reproductive toxicity.

*Estimating the daily intake of air above artificial turf playing fields*

Table 6 estimates the daily intake of air by soccer players from above artificial turf playing fields. The breathing rates are recommended for persons in the indicated age group engaged in "heavy" activities over "short-term" intervals. The 1.5 and 2.0 hour intervals seem to us to be reasonable estimates for the time a soccer player spends playing a timed game or practicing.

Table 6. Intake of field air on days of artificial turf field use.

| Age interval | Breathing rate[1] | Time of field use per day (soccer game or practice session)[2] | Total intake of field air per day of field use[3] |
|---|---|---|---|
| 5-15 years | 1.9 $m^3$/hr | 1.5 hr/day | 2.85 $m^3$/day |
| 16-18 years | 1.9 $m^3$/hr | 2 hr/day | 3.8 $m^3$/day |
| 19-55 years | 3.2 $m^3$/hr | 2 hr/day | 6.4 $m^3$/day |

[1] For 5-18 years: recommended mean value for short-term exposures to a child $\leq$ 18 years and performing heavy activities (US EPA Child-Specific Exposure Factors Handbook, September 2002, Table 7-14); for 19-55 years: recommended mean value for short-term exposures to adults performing heavy activities (OEHHA Technical Support Document for Exposure Assessment and Stochastic Analysis, September 2000, Table 3.9).
[2] Estimates based on length of timed game or practice session for ages < 16 years (1.5 hours) or $\geq$ 16 years (2 hours).
[3] Calculated by multiplying the value in column two by the value in column three.

*Estimating the daily intake of air from above artificial turf playing fields averaged over a 70 year lifetime*

The play scenarios shown in Table 7 are our best estimates for a lifetime of soccer play by a soccer enthusiast. The scenarios are not based on data. The daily intakes of air from above artificial turf fields were averaged over a 70-year lifetime, including 51 years of organized soccer play (from age 5 to 55). The daily intakes were also averaged over an entire year, since it was estimated that at most, 102 days per year (for the 19 to 22 year-old age group) would include use of artificial turf (Table 7). We consider this lifetime exposure rate of 0.464 $m^3$/day (Table 7) a heaviest use scenario for soccer players, since this assumes all organized soccer games and practices over a lifetime would be on artificial turf.

Table 7. Intake of field air for 51 years of artificial turf field use (soccer) averaged over a 70-year lifetime.

| [1]Age inter-val | [2]Soccer play scenario on artificial turf fields | [3]Field air intake per day of field use (practice or game) for this play scenario | [4]Days of use per year for this play scenario | [5]Years of use per 70 year lifetime for this play scenario | [6]Daily field air intake for this play scenario averaged over a 70 year lifetime | [7]Daily field air intake normalized to body weight in $m^3$/kg-d |
|---|---|---|---|---|---|---|
| 5-15 | Two 15-game club seasons/year with 30 associated practice days | 2.85 $m^3$/day | 60 day/365 days | 11 years/70 years | 0.074 $m^3$/day | 0.0021 |
| 16-18 | One 15-game club season/year with 15 associated practice days; one 10-week high school season (6 days/week) | 3.8 $m^3$/day | 90 days/365 days | 3 years/70 years | 0.040 $m^3$/day | 0.0006 |
| 19-22 | One 15-game club season/year with 15 associated practice days; one 12-week college season (6 days/week) | 6.4 $m^3$/day | 102 days/365 days | 4 years/70 years | 0.102 $m^3$/day | 0.0015 |
| 23-55 | One 15-game club season/year with 15 associated practice days | 6.4 $m^3$/day | 30 days/365 days | 33 years/70 years | 0.248 $m^3$/day | 0.0034 |
| Total | | | | | 0.464 $m^3$/day | |

[1] Estimated age intervals for each soccer play scenario.
[2] Estimated play scenarios, with game or practice times as shown in Table 6.
[3] From fourth column of Table 6.
[4] Estimated games and practices per year for the corresponding play scenario.
[5] Estimated years of play for the corresponding play scenario.
[6] Calculated by multiplying columns three, four and five.
[7] Body weight means for combined males and females over each interval were: 35.6 kg for the 5-15 interval, 67.5 kg for the 16-18 interval (US EPA, 2002); 67.2 kg for the 19-22 interval, 74.0 kg for the 23-55 interval (US EPA, 1997).

*Estimating the increased cancer risk from inhaling air above artificial turf fields*

Eight of the chemicals identified in the air above indoor artificial turf fields (Dye et al., 2006) also appear on the California Proposition 65 list of chemicals known to the state to cause cancer (PAHs below 0.001 $\mu g/m^3$ were not included). Table 8 shows the increased lifetime cancer risks from breathing each of these during soccer play on artificial turf fields. The risk for each chemical was calculated using the highest air concentration from among eight independent measurements over three different artificial turf fields (Dye et al., 2006). This may overestimate the true chemical concentration in the air. Risks for two age intervals per chemical were calculated, so that a safety factor of three could be added for the 5-15 year interval (US EPA, 2005). Five of the eight chemicals were associated with increased lifetime cancer risks that exceeded the broadly accepted negligible risk level of $10^{-6}$: benzene, formaldehyde, naphthalene, nitromethane and styrene. Their increased cancer risks ranged from $1.6 \times 10^{-6}$ for formaldehyde to $8.7 \times 10^{-6}$ for nitromethane. Since these risks exceeded the $10^{-6}$ benchmark, it is important for future studies to measure the concentrations of these chemicals above outdoor artificial turf fields. In addition, their concentrations should be measured in the ambient air in the vicinities of the fields. Comparing the concentrations in the air over and off of the fields will establish which carcinogenic chemicals are emitted by artificial turf, and whether mitigation measures are required.

Table 8. Inhalation of chemicals from above artificial turf fields in indoor stadiums in Norway that also appear on the California Proposition 65 list of chemicals known to the state to cause cancer: increased lifetime cancer risks from soccer play.

| Chemical | Age interval in years | [1]Daily field air intake in $m^3/kg\text{-}d$ | [2]Indoor field air concentration of chemicals in $mg/m^3$ | [3]Daily chemical intake in mg/kg-d | [4]Safety Factor | [5]Cancer Slope Factor in $(mg/kg\text{-}d)^{-1}$ | [6]Increased lifetime cancer risk |
|---|---|---|---|---|---|---|---|
| Acetaldehyde | 5-15 | 0.0021 | 0.0043 | $9.03 \times 10^{-6}$ | 3 | 0.01 | $5.0 \times 10^{-7}$ |
| Acetaldehyde | 16-55 | 0.0055 | 0.0043 | $2.37 \times 10^{-5}$ | 1 | 0.01 | |
| | | | | | | | |
| Benzene | 5-15 | 0.0021 | 0.0024 | $5.04 \times 10^{-6}$ | 3 | 0.1 | $2.8 \times 10^{-6}$ |
| Benzene | 16-55 | 0.0055 | 0.0024 | $1.32 \times 10^{-5}$ | 1 | 0.1 | |
| | | | | | | | |
| Benzo[a]pyrene | 5-15 | 0.0021 | $1.2 \times 10^{-6}$ | $2.52 \times 10^{-9}$ | 3 | 3.9 | $5.5 \times 10^{-8}$ |
| Benzo[a]pyrene | 16-55 | 0.0055 | $1.2 \times 10^{-6}$ | $6.6 \times 10^{-9}$ | 1 | 3.9 | |
| | | | | | | | |
| Ethylbenzene | 5-15 | 0.0021 | 0.0067 | $1.41 \times 10^{-5}$ | 3 | 0.0087 | $6.8 \times 10^{-7}$ |
| Ethylbenzene | 16-55 | 0.0055 | 0.0067 | $3.69 \times 10^{-5}$ | 1 | 0.0087 | |

| Chemical | Age interval in years | [1]Daily field air intake in $m^3$/kg-d | [2]Indoor field air concentration of chemicals in mg/$m^3$ | [3]Daily chemical intake in mg/kg-d | [4]Safety Factor | [5]Cancer Slope Factor in $(mg/kg-d)^{-1}$ | [6]Increased lifetime cancer risk |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Formaldehyde | 5-15 | 0.0021 | 0.0065 | $1.37 \times 10^{-5}$ | 3 | 0.021 | $1.6 \times 10^{-6}$ |
| Formaldehyde | 16-55 | 0.0055 | 0.0065 | $3.58 \times 10^{-5}$ | 1 | 0.021 | |
| | | | | | | | |
| Naphthalene | 5-15 | 0.0021 | 0.0027 | $5.67 \times 10^{-6}$ | 3 | 0.12 | $3.8 \times 10^{-6}$ |
| Naphthalene | 16-55 | 0.0055 | 0.0027 | $1.49 \times 10^{-5}$ | 1 | 0.12 | |
| | | | | | | | |
| Nitromethane | 5-15 | 0.0021 | 0.0041 | $8.61 \times 10^{-6}$ | 3 | 0.18 | $8.7 \times 10^{-6}$ |
| Nitromethane | 16-55 | 0.0055 | 0.0041 | $2.26 \times 10^{-5}$ | 1 | 0.18 | |
| | | | | | | | |
| Styrene | 5-15 | 0.0021 | 0.0061 | $1.28 \times 10^{-5}$ | 3 | 0.026 | $1.9 \times 10^{-6}$ |
| Styrene | 16-55 | 0.0055 | 0.0061 | $3.36 \times 10^{-5}$ | 1 | 0.026 | |

[1] From last column in Table 7. For the 16-55 interval, the value of 0.0055 is the sum of the values for the 16-18, 19-22 and 23-55 age intervals in Table 7.
[2]Dye et al., 2006; highest value from among eight independent measurements over three different artificial turf fields in indoor stadiums.
[3]Calculated by multiplying column three by column four.
[4]Safety factor for the increased sensitivity of 2-15 year old children to carcinogens (US EPA, 2005).
[5]All cancer slope factors were taken from the OEHHA Toxicity Criteria Database available at www.oehha.ca.gov except for nitromethane and styrene; nitromethane cancer slope factor is available at www.oehha.ca.gov/prop65/law/pdf_zip/NitromethaneNSRL120707.pdf ; styrene cancer slope factor from OEHHA, 2009, Public Health Goal for Styrene, under review.
[6]Increased lifetime cancer risks due to each chemical were calculated by multiplying columns five, six and seven and adding together the resulting risks for the two age intervals.

*Estimating the risk of developmental/reproductive toxicity from inhaling air above artificial turf fields*

Benzene and toluene were the two chemicals identified in Dye et al. (2006) that also appear on the California Proposition 65 list of chemicals known to the state to cause developmental/reproductive toxicity. Toluene is listed as a developmental toxicant, while

benzene is listed as a developmental and male reproductive toxicant. For developmental toxicants, the subpopulation most at risk is pregnant females. Were a pregnant female to use these fields for a two hour interval, her exposure to benzene and toluene via inhaled air would be below the corresponding maximum allowable dose level (MADL, Table 9).

Table 9. Daily intake rates of chemicals inhaled via air from above artificial turf fields in indoor stadiums in Norway that also appear on the California Proposition 65 list of chemicals known to the state to cause developmental/reproductive toxicity: comparison to maximum allowable dose levels (MADLs).

| Chemical | Indoor field air concentration detected in Norwegian study ($ug/m^3$)[1] | Chemical intake via field air (not averaged over lifetime) (ug/day)[2] | MADL (ug/day)[3] |
|---|---|---|---|
| Benzene | 2.4 | 15.4 | 49 |
| Toluene | 85 | 544 | 13,000 |

[1] Dye et al., 2006; highest value from among eight independent measurements over three different artificial turf fields in indoor stadiums.
[2] Calculated by multiplying the daily intake of field air for 19 to 55 year-olds (6.4 $m^3$/day, Table 6) by the field air concentration shown in column two of this table.
[3] MADL = maximum allowable dose level, accessed 6/08 at http://www.oehha.ca.gov/prop65/pdf/2008MayStatusReport.pdf .

This section estimates the risk of cancer or developmental/reproductive toxicity in soccer players using the new generation of artificial turf playing field. A single study (Dye et al., 2006) was used as the source of VOC and PAH concentrations from above this type of field. Since Dye et al. (2006) was performed in indoor soccer stadiums, we believe it likely that the chemical concentrations over outdoor fields would be significantly lower, due to the dispersion of the chemicals into the atmosphere. Comparing Dye et al. (2006) to IBV (2006), as shown in Table 2 of this report, suggests that this is indeed the case. Support also comes from comparing the benzothiazole concentration measured indoors by Dye et al. (2006) to that measured by Milone & MacBroom (2008) outdoors: 31.7 compared to 1.0 $\mu g/m^3$. Thus, the daily chemical intakes calculated in Tables 8 and 9 probably overestimate the intakes that would result from breathing air over outdoor artificial turf fields. More accurate estimates of the cancer and developmental/reproductive hazards will be possible when air from above additional outdoor synthetic turf fields is analyzed, along with background levels from off of the fields.

The lifetime soccer play scenarios are not based on data but on personal experience and informal discussions. Relevant data may exist that will help reduce the uncertainty in this component of the exposure assessment. Until those data are located, we consider this cumulative play scenario from ages 5 through 55 exclusively on artificial turf to represent a heaviest use scenario for soccer players. However, soccer is only one of many sports played on today's artificial turf fields. Football, lacrosse, baseball, softball and rugby are some others, along with the unorganized, informal play that predominates for young

children under the age of five. All these modes of play have characteristic ages for participants, years of expected play, and time spent on the field per game. This will result in chemical exposures via inhalation that are different from those calculated above for soccer. In addition, the people who coach, supervise or referee these sports will each have different exposures, as will the people who maintain artificial turf fields. Therefore, the risks calculated for soccer players in Tables 8 and 9 should not be interpreted as covering the risks for other sports, age groups or occupations.

Lastly, it should be noted that most of the VOCs detected above artificial turf fields in the Dye et al. (2006) study were never identified. For example, for the field yielding the highest level of total volatile organic compounds (TVOCs, 716 ug/$m^3$), 85 percent of the individual chemicals (representing about 20 percent of the mass of TVOCs) were not identified. This remains a significant source of uncertainty in assessing the health risks posed by these fields.

*Conclusions*

- The Dye et al. (2006) study provided the most complete dataset from which to calculate inhalation exposures to chemicals in the air above artificial turf playing fields.
- Lacking published data, the time that soccer players spend on artificial turf over a lifetime was estimated.
- Dye et al. (2006) quantified eight chemicals that appear on the California Proposition 65 list of chemicals known to the state to cause cancer.
- Estimated inhalation exposures of soccer players to five of these (benzene, formaldehyde, naphthalene, nitromethane and styrene) gave theoretical increased lifetime cancer risks that exceeded the insignificant risk level of $10^{-6}$ (OEHHA, 2006).
- Data from indoor fields were used to estimate outdoor exposures and calculate these cancer risks. In addition, it was assumed that all organized soccer play over a lifetime occurred on artificial turf fields. Together, these assumptions tend to overestimate the cancer risks for soccer players using artificial turf fields.
- Benzene and toluene were the two chemicals quantified by Dye et al. (2006) that also appear on the California Proposition 65 list of chemicals known to the state to cause developmental/reproductive toxicity. Their concentrations in the air over indoor artificial turf fields were below the associated screening levels for developmental/reproductive toxicity. This suggests there is a low risk for such health effects due to inhalation exposures in soccer players.

*Data Gaps*

- To calculate the inhalation health risks from outdoor artificial turf fields, an air sampling study similar to Dye et al. (2006) is needed, but it should be performed over outdoor fields, including ambient air samples from off of the fields.

- For more accurate exposure estimates, better data are needed for the hours per day, days per year, and years per lifetime that athletes spend using artificial turf playing fields. Data are needed for a variety of sports, ages and for both female and male athletes. Use of these fields for informal play by children under the age of five should also be considered.
- Exposures to professionals such as coaches, referees and maintenance workers should also be estimated.
- Approximately 300 of 400 VOCs detected by Dye et al. (2006) were not identified, so that their health risks cannot be determined.
- Since the airborne particulates measured by Dye et al. (2006) were not analyzed for metals, including lead, the health risks they pose via inhalation cannot be determined.
- While most of the VOCs identified by Dye et al. (2006) do not have MADLs developed under Proposition 65, data exist indicating that some cause developmental/reproductive effects in test animals. Thus, additional screening is required to more fully evaluate these risks.
- Health risks due to high levels of total volatile organic compounds (TVOCs) have not been adequately assessed.
- The variable of field age should be investigated since chemical release may decrease with time, leading to lower health risks. Conversely, particulate release may increase with time.
- One possible mitigation measure that should be investigated for indoor fields is to increase the ventilation rate.

## Part II: Artificial Turf as a Possible Risk Factor for Infection by Methicillin-resistant *Staphylococcus aureus* (MRSA)

### Is artificial turf a risk factor for infection by MRSA?

*Staphylococcus* is a genus of gram positive bacteria commonly found on the surface of human skin. These bacteria can infect the skin, causing diseases such as impetigo and boils. *Staphylococcus aureus* (*S. aureus*) is a species that is particularly pathogenic to humans. Besides infecting skin, it can also cause food poisoning. If *S. aureus* from a skin infection moves internally, it can spread throughout the body, causing serious organ damage. Normally, only a small percentage of *S. aureus* skin infections progress to the point where hospitalization is required.

Methicillin is a broad spectrum antibiotic often used to treat *S. aureus* infections. However, methicillin-resistant *S. aureus* (MRSA) has developed. A number of outbreaks of MRSA have occurred in athletic teams, including high school, college, professional and club teams. Thus, it is important to identify modes of transmission of MRSA and other risk factors for infection.

MRSA outbreaks in human populations are considered to be one of two kinds. Outbreaks in hospitals often occur in persons with weakened immune systems. This is considered healthcare-associated MRSA. Outbreaks in the general community, in otherwise healthy individuals, are considered community-associated MRSA. Risk factors for community-associated MRSA include young age and playing a contact sport (Boucher and Corey, 2008). In the case of athletes, this may be due in part to the frequent physical contact that occurs during play, as well as the propensity of these athletes to have skin cuts and abrasions.

A number of community-associated outbreaks of *S. aureus* and MRSA have been described in sports settings (Table 10; Lindenmayer et al., 1998; MMWR, 2003; Huijsdens et al., 2006; Turbeville et al., 2006; Kirkland and Adams, 2008). The outbreaks included boils (furunculosis), other types of skin abscesses such as impetigo, and cellulitis. In a review of the sports medicine literature (59 infectious disease outbreaks between 1922 and 2005) by Turbeville et al. (2006), the most common causes of outbreaks were *S. aureus* (often MRSA, 22 percent of outbreaks) and herpes simplex virus (22 percent of outbreaks). The sports with the most outbreaks were football (34 percent of outbreaks), wrestling (32 percent of outbreaks), rugby (17 percent of outbreaks) and soccer (3 percent of outbreaks). These are all considered contact sports, with player-to-player contact that ranges from incidental to violent. However, these sports also result in forceful impacts between the players and the playing surface. In the cases of football, rugby and soccer, the surface would usually be an outdoor field of natural or artificial turf. For wrestling, the surface would most often be a vinyl-covered wrestling mat.

The outbreaks mentioned above suggest two possibilities for the high incidence of *S. aureus* skin infections in contact sports: the bacteria are transferred by player-to-player contact or by player contact with a contaminated playing surface. The data from health-care associated MRSA outbreaks, as well as those from sports-associated MRSA outbreaks (Turbeville et al., 2006; Benjamin et al., 2007; Boucher and Corey, 2008; Cohen, 2008; Kirkland and Adams, 2008), suggest that person-to-person contact is a major mode of MRSA transmission. Whether contact with outdoor playing surfaces, such as occurs during falls to the surface, promotes transmission of MRSA is less certain.

An association between MRSA infection and player-to-playing surface contact could have at least two different explanations. Such contacts could cause relatively long-lasting skin abrasions that serve as efficient portals of entry for MRSA, perhaps during subsequent player-to-player contacts. Alternatively, the playing surface itself might be a carrier of MRSA, such that player contact with the surface transfers MRSA to the previously uncontaminated skin.

An association between skin abrasions due to falls to the turf (termed turf burns) and skin infection by MRSA has been tested in two MRSA outbreaks among football teams. In a college football team, players with MRSA-induced boils were 7.2-fold more likely to have had skin abrasions from artificial turf (new generation) than uninfected players (Begier et al., 2004). Comparative data for burns received from natural turf were not presented. In a professional football team, eight of eight MRSA-induced skin abscesses occurred at the site of a turf burn. Whether the turf burn was received on artificial (old generation Astroturf®) or natural turf was not reported. The results of these two studies demonstrated an association between skin trauma due to falls to the playing surface and skin infections by MRSA. This suggests that traumatized skin is more susceptible to MRSA entry and infection. An association between skin trauma and MRSA infection has been suggested in other outbreaks among competitive sports teams, where skin trauma was produced by other means, including irritation by protective equipment (MMWR, 2003), body shaving (Begier et al., 2004) and falls to wrestling mats (Lindenmayer et al., 1998). Other studies also support an association between skin trauma and MRSA infection during contact sports (Bartlett et al., 1982; Sosin et al., 1989; Cohen, 2008; Kirkland and Adams, 2008). In consideration of these data, it seems justified to consider skin trauma in general, and turf burns in particular, to be risk factors for MRSA infection during competitive contact sports. Whether the incidence or severity of turf burn is greater on the new generation of artificial turf compared to natural turf is discussed below.

As mentioned above, a second possible explanation for why player-to-playing surface contact might be a risk factor for MRSA infection in competitive sports is that the playing surface itself is a source of MRSA. An inanimate object capable of transmitting infectious bacteria to humans is called a fomite. While player-to-player contact is considered the most important mode of sports-associated MRSA transmission, possible

Table 10. Sports-related skin abrasions and infections on artificial and natural turf

| Reference | Sport | Turf type | Endpoint | Findings |
|---|---|---|---|---|
| Keene et al., 1980 | American football at U. of Wisconsin | Old-generation Tartan Turf® | "Scrapes" | Significantly more ($p<0.001$) scrapes on artificial turf than on natural grass |
| Bartlett et al., 1982 | High school American football | Not indicated | Boils (furunculosis) caused by *S. aureus* | Frequent open wounds or bruises were risk factors ($p<0.05$) for boils; concluded wounds and bruises are portals of entry for *S. aureus* into the body |
| Ekstrand and Nigg, 1989 | Soccer played at different levels | Old-generation artificial and natural turf | "Abrasion injuries" | In three different studies, there were more abrasion injuries on artificial turf than on natural turf (severity not indicated) |
| Sosin et al., 1989 | High school American football and basketball | Natural turf (wood floors for basketball) | Boils (furunculosis) caused by *S. aureus* | Players with >2 skin abrasions/week had 2.7-fold higher risk of infection ($p<0.01$); fomite contact not a risk factor |
| Begier et al., 2004 | American football, one college team | New (third) generation artificial turf | MRSA-induced cellulitis and skin abscesses | Infected players were 7.2-fold more likely to have "turf burns" from artificial turf than uninfected players |
| Meyers and Barnhill, 2004 | High school American football | New (third) generation artificial turf and natural turf | Injuries, including 0-day time loss (i.e., mild) and 1-22+ days time loss injuries | "Surface/epidermal injuries"(abrasions, lacerations and puncture wounds) were 9-fold more common on artificial turf compared to natural turf |
| Kazakova et al., 2005 | Professional American football, one team | Old-generation Astroturf® and natural turf | MRSA-induced skin abscesses | 8/8 infections occurred at site of turf burn; players reported more and more serious turf burns for games on artificial turf (2-3 per week); field swabs of artificial turf were negative for MRSA |
| Ekstrand et al., 2006 | Elite soccer in Europe (male only) | New (third) generation artificial turf and natural turf | Time loss injuries | No difference in overall injury rate on artificial and grass; did not report skin abrasions, most of which are probably 0-day time loss |
| Benjamin et al., 2007 | Various sports | Not indicated | MRSA infection | There is little evidence that MRSA infection occurs via fomite transmission; infection probably due to skin-to-skin contact |
| Fuller et al., 2007a | Collegiate soccer, male and female, matches only | New (third) generation artificial turf and natural turf | Time loss injuries occurring during matches | Overall injury incidence and severity similar on artificial and natural turf; only lacerations/skin lesions in men were higher (2.95-fold, $p<0.01$) on |

| Reference | Sport | Turf type | Endpoint | Findings |
|---|---|---|---|---|
| | | | | artificial turf (relatively serious since they were time loss) |
| Fuller et al., 2007b | Collegiate soccer, male and female, training only | New (third) generation artificial turf and natural turf | Time loss injuries occurring during training | All injuries similar incidence and severity on artificial and natural turf |
| Steffen et al., 2007 | Female soccer, under-17 league | Second and third generation artificial turf and natural turf | Acute, time loss injuries | Overall injury rate was the same on the artificial and natural turf; did not report skin abrasions, most of which are probably 0-day time loss |
| Andersson et al., 2008 | Male elite soccer | New (third) generation artificial turf and natural turf | Number of standing and sliding tackles per player per game | Fewer sliding tackles on artificial turf compared to natural turf ($p<0.05$), possibly related to the risk of turf burn |
| Cohen, 2008 | Various sports | Not indicated | MRSA infection | Risk factors identified: 1)skin-to-skin contact, 2)skin damage (such as mat burns in high school wrestling), 3)sharing equipment (e.g., towels) |
| McNitt et al., 2008 | Not discussed | New (third) generation artificial turf and natural turf in Pennsylvania | Bacterial colony forming units (CFUs) cultured from turf samples | Rubber crumb from artificial turf yielded fewer CFUs on a per gram basis than soil from natural turf; no colonies were positive for *Staphylococcus aureus* |
| FIFA, undated | Male soccer, under-17 world championship games | New (third) generation artificial turf and natural turf | Time loss and total injuries during games | Overall injury incidence similar on the two surfaces |

instances of fomite transmission have been reported. A MRSA outbreak in fencers is noteworthy, since this sport does not involve person-to-person contact (MMWR, 2003). The fencers used sensor wires under their protective clothing, which were shared by multiple fencers without cleaning. The wires were possible fomites for MRSA transmission in this outbreak. Shared soap bars were identified as a risk factor in a MRSA outbreak in a collegiate football team (odds ratio, 15.0; 95 percent confidence interval 1.69-180) (Turbeville et al., 2006). A shared weight room was the only common point of contact between a high school football team and the dance team (Kirkland and Adams, 2008). While only two football players and one dance team member became infected with MRSA, this may represent an example of fomite transmission. In a MRSA outbreak among members of a high school wrestling team, no risk factors for infection could be identified (Lindenmayer et al., 1998). Nonetheless, the study authors speculated that although most cases of transmission were probably due to wrestler-to-wrestler contact, the sharing of towels and locker room equipment, as well as shared wrestling mats, may have contributed. In emphasizing that fomite transmission of MRSA should be prevented, the National Collegiate Athletic Association (NCAA) medical guidelines recommend disinfecting wrestling mats before use.

One way to determine whether artificial turf is a reservoir for infectious MRSA is to inoculate bacterial cultures with various turf components or wipe test the components to measure bacterial growth. Very few such data have been collected from potential fomites associated with outbreaks of sports-associated MRSA, including artificial and natural turf. Following an outbreak of MRSA in a high school wrestling team, environmental sampling of the wrestling facilities failed to detect any MRSA (Lindenmayer et al., 1998). During a MRSA outbreak in a professional football team, environmental sampling included the stadium's artificial turf field, weight-training equipment, towels, saunas, steam rooms and whirlpool water (Kazakova et al., 2005). For the field sampling, one-foot square areas of Astroturf® located in the parts of the field with the highest numbers of tackles were wipe-sampled. No MRSA was detected; however, methicillin-sensitive *S. aureus* (MSSA) was detected in two samples of whirlpool water and on a gel-applicator stick used for taping ankles. The most recent test of whether artificial turf harbors MRSA is a study in which twenty new generation artificial turf fields were sampled at two locations per field (McNitt et al., 2008). The artificial blades of grass and infill material (crumb rubber or crumb rubber/sand mix) were sampled separately for bacterial culture. All field samples were negative for *S. aureus*. Quantitative data were only presented for the infill samples. Those samples contained unidentified bacteria at levels ranging from 0 to 80,000 colony forming units (CFUs) per gram of infill. In comparison, two samples of natural soil yielded 260,000 and 310,000 CFUs per gram of soil. *S. aureus* was detected on a number of surfaces including football blocking pads, weight equipment, a stretching table and used towels, demonstrating that the detection method for *S. aureus* was functional. Thus, considering the three studies described above, there is no evidence that artificial turf fields harbor *S. aureus* in general, or MRSA in particular. While these conclusions are based on a small number of samples, an absence of *S. aureus* from artificial turf playing fields is not unexpected, given the dry and often hot conditions of that environment.

As discussed above, skin trauma is a likely risk factor for MRSA infection in contact sports (Begier et al., 2004; Kazakova et al., 2005). Therefore, it would be informative to determine if falls to the new generation of artificial turf put players at greater risk for turf burns than falls to natural turf. It is also important to determine if the turf burns caused by artificial turf are more long-lasting or more prone to infection by *S. aureus* compared to burns received from natural turf.

Unfortunately, most injury studies comparing artificial and natural turf have concentrated on so-called "time-loss" injuries (Table 10). These are relatively serious injuries that cause at least some loss of practice or game time. The great majority of turf burns are not time-loss injuries, and would not have been monitored in those studies. However, some data on skin abrasions are available. In a study of college football played on the old generation of Tartan Turf®, players were described as acquiring significantly ($p<0.01$) more "scrapes" on artificial turf compared to natural grass (Keene et al., 1980). This was the only injury type that was significantly increased on artificial turf compared to natural turf. In a 5-year prospective study of injuries occurring on the new generation of artificial turf, both time-loss and 0-day time-loss (i.e., no playing time lost) injuries were recorded for eight high school football teams (Meyers and Barnhill, 2004). The latter category included "surface/epidermal injuries" that covered abrasions, lacerations and puncture wounds, but not contusions (i.e., bruises). This type of surface/epidermal injury had a 9-fold higher incidence on artificial turf (injury incidence rate = 0.9; 95% confidence interval = 0.5-1.4) compared to natural turf (injury incidence rate = 0.1; 95% confidence interval = 0.0-0.6). Players for a professional football team suffering a MRSA outbreak reported that skin abrasions happened more frequently and were more severe on first-generation Astroturf® (i.e., without infill) compared to natural turf, although no supporting data were presented (Kazakova et al., 2005). In a study of collegiate male and female soccer players that recorded time-loss injuries during official matches, only the incidence of "lacerations/skin lesions" in males was significantly higher (2.95-fold, $p<0.01$) on new generation artificial turf (i.e., with infill) compared to natural turf (Fuller et al., 2007a). However, this finding was not replicated in an identical study that covered injuries sustained during training (Fuller et al., 2007b). Lastly, male soccer players at the 2005 Federation Internationale de Football Association U-17 Championship in Peru played 86 matches on natural grass and 42 on new generation artificial turf (FIFA, undated). While skin abrasion incidences were not presented, the incidences of total injuries (0-day time-loss and time-loss) per player-hour were similar on the two surfaces.

Considering the small database presented above, two studies (one soccer and one football) found increased incidences of skin abrasions on the new generation of artificial turf compared to natural turf (Meyers and Barnhill, 2004; Fuller et al., 2007a), while two studies (both soccer) measured similar rates on both surfaces (Fuller et al., 2007b; FIFA, undated). No data were located on the relative severity of skin abrasions caused by the artificial and natural surfaces. Given that both studies by Fuller et al. (2007a and 2007b) only monitored time-loss injuries, these studies almost certainly missed the majority of skin abrasions, which do not cause loss of playing time. Furthermore, the FIFA (undated) study did not provide data on the incidence of skin abrasions, only on total

injury incidence. This leaves only the football study by Meyers and Barnhill (2004) as evidence that new generation artificial turf puts football players at increased risk for skin abrasions relative to natural turf. Whether this conclusion is specific for male football players competing at the high school level is unknown, until studies can be performed for other sports and age groups.

*Conclusions*

- Participation in contact sports is a risk factor for infection by MRSA. Football and wrestling have recorded the most outbreaks.
- Person-to-person transmission of MRSA is the major mode of infection. Transmission by inanimate objects (termed fomites), such as the playing surface, is less well established.
- Skin abrasions and other types of skin trauma are risk factors for MRSA infection in contact sports.
- Whether the new generation of artificial turf causes more skin abrasions than natural turf has only been carefully addressed in a single study (Meyers and Barnhill, 2004) of male high school football players. In that study, artificial turf was associated with a 9-fold higher incidence of "surface/epidermal injury" compared to natural turf.
- Only one study has tested whether new generation artificial turf fields harbor MRSA (McNitt et al., 2008); none was detected in 20 fields in Pennsylvania.

*Data Gaps*

- Additional studies are needed to test the finding of Meyers and Barnhill (2004) that new generation artificial turf is associated with more skin injuries than natural turf. Studies should cover additional sports, age groups, and female participants.
- No study has reported on the severity of turf burn by the new generation of artificial turf compared to natural turf. Severity could include susceptibility to infection as well as the time required to heal.
- Additional new generation artificial turf fields should be sampled for MRSA and other bacteria pathogenic to humans, at different depths in the fields, and from different climatic regions in California.

**Part III: Summary**

Five studies were located that measured chemicals and particulates in the air above the new generation of artificial turf containing crumb rubber infill from recycled tires. The chemicals and particulates in the air over artificial turf were similar to those emitted by tire-derived rubber flooring, during rubber manufacturing, and in laboratory studies of rubber crumb heated in vessels. The most complete dataset, covering indoor artificial soccer fields in Norway (Dye et al., 2006), was used to estimate the risk of cancer or developmental toxicity. This screen only addressed the inhalation route of exposure in

athletes using artificial turf fields for a lifetime of organized soccer play. Exposure estimates were used to calculate the increased lifetime cancer risk or risk of developmental toxicity for those chemicals appearing on the California Proposition 65 list. From among eight chemicals listed as carcinogens on the Proposition 65 list, exposure to five of these (benzene, formaldehyde, naphthalene, nitromethane and styrene) during a lifetime of organized soccer play exceeded the $10^{-6}$ negligible risk level. Since these risks exceeded the $10^{-6}$ benchmark, it is important for future studies to measure the concentrations of these chemicals above outdoor artificial turf fields. In addition, their concentrations should be measured in the ambient air in the vicinities of the fields. Comparing the concentrations in the air over and off of the fields will establish which carcinogenic chemicals are emitted by artificial turf, and whether mitigation measures are required.

Dye et al. (2006) also identified two chemicals appearing on the California Proposition 65 list as developmental/reproductive toxicants: toluene and benzene. Their concentrations in the air over indoor artificial turf fields were below the associated screening levels for developmental/reproductive toxicity, suggesting a low risk for such effects due to these two chemicals. This screen contains two steps that tend to overestimate the risks for both cancer and developmental toxicity. First, the screen utilizes data from indoor artificial turf fields to estimate exposures from outdoor fields. Second, the screen assumes that all organized soccer play from the ages of 5 to 55 occurs on artificial turf fields.

The scientific literature was also searched for studies addressing the possibility that artificial turf playing fields promote infection of athletes by methicillin-resistant *Staphylococcus aureus* (MRSA). While the data suggest that skin trauma is a risk factor for MRSA outbreaks in contact sports, it is less certain whether the new generation of artificial turf causes more skin trauma than natural turf. Whether artificial turf fields harbor MRSA has been tested in only a few studies. No MRSA has been detected in any indoor or outdoor natural or artificial turf field.

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# Addendum, July 2009

**Review of two studies released in the spring of 2009 that measured chemicals and particulates in the air above the new generation of artificial turf playing fields**

*Study quality and characteristics*

The study of artificial turf fields containing recycled crumb rubber infill performed by New York State (2009) is the most comprehensive to date. To measure the chemicals released into the air by these fields, air sampling was performed over two fields, along with a sample taken upwind of each field to measure the ambient background. One field was four years old and one was less than one year old. Samples were analyzed for VOCs and sVOCs. Off-gassing experiments performed in the laboratory with recycled rubber crumb identified five chemicals which were added to the target list of chemicals: aniline, 1,2,3-trimethylbenzene, 1-methylnaphthalene, benzothiazole and tertbutylamine. Acceptable weather conditions for sampling were prescribed and followed (see Table 11). Particulate matter ($PM_{10}$ and $PM_{2.5}$) in air was measured in real-time with monitors placed over or upwind of each field. In addition, particulate matter was collected by wipe and vacuum sampling of field surfaces and analyzed by microscopy.

A total of 65 chemicals were identified in the air over the four-year-old field and 85 over the one-year-old field (twenty highest concentrations shown in Table 11). For many chemicals the upwind air sample contained similar concentrations. Since eight samples were collected over each field compared to only a single upwind sample, it is likely that had more upwind samples been collected, more chemicals would have been detected in the upwind air. Most of the chemicals were tentatively identified compounds (TICs), i.e., identified by their gas chromatography/mass spectrometry (GC/MS) peaks. TICs with match qualities of less than 85 percent of the GC/MS peaks were considered "unknowns" and not included in the health evaluation (see below). Of the 19 TICs shown in Table 11, 17 fell into this category. Therefore, from among the chemicals occurring at the twenty highest concentrations, only benzothiazole, octane and nonane were evaluated for health effects. The "unknowns" in Table 11 are indicated by asterisks.

Comparing the two fields shows good agreement for VOCs and sVOCs on the target list. Air samples from over the four-year-old field contained 17 chemicals on the target list. Air samples from above the one-year-old field contained the same 17 plus an additional three. For TICs the agreement was not as close. From among the 20 largest TIC peaks corresponding to air samples from either field (Table 11), only five were reported for both fields.

Chemicals of potential concern for adverse health effects were chosen for health evaluation based on three criteria: 1) low levels in laboratory and field blanks, 2) a concentration that was at least 35 percent higher in at least one field sample compared to the upwind sample, 3) match quality of the GC/MS peaks of at least 85 percent for TICs. These criteria yielded 15 and 16 chemicals of potential concern for calculation of inhalation health risks for the four-year-old and one-year-old fields, respectively.

Table 11. Air measurements above artificial turf fields: New York State (2009) and TRC (2009)

| Reference | Scenario | Chemicals/particulates measured |
|---|---|---|
| New York State Department of Environmental Conservation and Department of Health, May 2009 | Two outdoor playing fields made of new generation artificial turf containing recycled crumb rubber infill.<br><br>One field was less than one year old, the second was four years old.<br><br>No precipitation the day before sampling and during sampling, sampling on two consecutive days of light to moderate winds out of a constant direction, 77 to 84°F, sampling at multiple heights above the field (a few inches, three feet, six feet), a total of eight samples collected from each field.<br><br>One sample collected upwind of each field (six foot height) to measure ambient background. | VOCs and sVOCs: 65 detected over one field, 85 detected over the second field.<br><br>PAHs detected (in µg/m$^3$): 2-dibenzofuranamine* (12), 3-dibenzofuranamine* (11), 4-dibenzofuranamine* (9), benzo[b]thiophene, 6-methyl-* (8.7).<br><br>Phthalates: none detected.<br><br>$PM_{2.5}$ and $PM_{10}$: both classes of particulates detected by real-time monitoring at approximately 15 µg/m$^3$, similar concentrations over field and upwind of field; microscopy of wipe and vacuum field samples detected rubber particles in the millimeter range but not in the micron range.<br><br>Twenty highest VOCs and sVOCs were (in µg/m$^3$): cyclohexanol* (27), 5-hexen-2-ol, (.+/-.)-* (24), cyclopropane, 1-chloro-2-ethenyl-1-methyl* (23), 2-hexen-1-ol, (z)-* (22), pentanamide, 4-methyl-* (15), 1H-benzotriazole-5-amine, 1-methyl-* (13), benzenemethanol, arethenyl-* (13), nonanamide* (13), 2-dibenzofuranamine* (12), 3H-indazol-3-one, 1,2-dihydro-2-methyl-* (12), 3-dibenzofuranamine* (11), 4-dibenzofuranamine* (11), cyclopentanone-2* (10), benzene, 1-methoxy-4-(1-propenyl)-* (9.9), methanimidamide, N,N-dimethyl-N'-phenyl-* (9.6), benzo[b]thiophene, 6-methyl-* (8.7), benzothiazole (6.5), octane (6.2), nonane (3.2), 2-butene, (z)* (2.7). |

*indicates tentatively identified compound (TIC) with a GC/MS peak match quality of less than 85 percent.

Table 11. (continued)

| Reference | Scenario | Chemicals/particulates measured |
|---|---|---|
| TRC, 2009 | Two outdoor playing fields made of new generation artificial turf containing recycled crumb rubber infill; | VOCs, sVOCs and metals: 8 VOCs and 1 metal were detected at the following highest concentrations (in µg/m$^3$): acetone (51), ethanol (22), methylene chloride (9), 2-butanone (MEK) (3), chloroform (2.9), toluene (2.7), n-hexane (2.1), chromium (1.4), chloromethane (1.1); seven tentatively identified compounds |

| Reference | Scenario | Chemicals/particulates measured |
|---|---|---|
| | one grass field for comparison.<br><br>One artificial turf field was less than three years old, the other was less than one year old.<br><br>Air sampling was during the summer with temperatures from 79 to 94°F, sampling performed at three feet above the surface, 4-6 air samples collected from above each field.<br><br>Two air samples collected from upwind of each field to measure ambient background. | (TICs) included isobutane, pentane, 2-methyl-1,3-butadiene (a.k.a., isoprene), 2-methylbutane.<br><br>PAHs: none detected.<br><br>Phthalates: none detected.<br><br>$PM_{2.5}$ and $PM_{10}$: both classes of particulates detected by real-time monitoring at 3 to 50 $\mu g/m^3$, similar concentrations over fields and upwind of fields. |

Chemical concentrations in the air above the fields were compared to health-based screening levels, assuming continuous, lifetime exposures for athletes using the fields. These assumptions overestimate the risks, since athletes do not spend their entire lives on these fields. Non-cancer health effects were evaluated by calculating hazard quotients using the highest on-field concentrations. Most hazard quotients were very low, indicating a very low risk of non-cancer health effects. The highest ranged from 0.1 to 0.6 for the compounds 1,3-pentadiene, 1,4-pentadiene, (E)-1,3-pentadiene and 2-methyl-1,3-butadiene. Hazard quotients of less than one suggest that non-cancer health effects are unlikely.

Eight potential chemicals of concern were evaluated for their cancer risks based on their highest on-field air concentrations. The highest excess lifetime cancer risk was $4 \times 10^{-5}$ for 1,3-pentadiene (using the cancer potency of 1,3-butadiene as a surrogate). However, the concentration of 1,3-pentadiene in the air upwind of the field corresponded to a $2 \times 10^{-5}$ cancer risk. Thus, it was judged that the cancer risks posed by this chemical due to its occurrence in field air and ambient air were similar. Other potential carcinogens were either below the air concentration associated with the $10^{-6}$ cancer risk level or occurred in only one of eight field samples (as TICs). The report concluded that these chemical exposures did not constitute a serious public health problem, and posed small risks of either cancer or non-cancer health effects.

For the particulate matter size classes of $PM_{2.5}$ and $PM_{10}$, real-time monitoring of one field showed no meaningful differences between the air concentrations over the field compared to upwind of the field. Technical problems were encountered in real-time monitoring of the second field. These data suggest these fields are not a source of $PM_{2.5}$ or $PM_{10}$. Samples collected by wipe sampling and vacuuming both fields were analyzed by microscopy. Rubber particles were in the millimeter range. Particles small enough to be inhaled, in the 5-7 micrometer range, were crustal minerals such as quartz and calcite. Rubber particles were not in the respirable range. Both the wipe data and the air monitoring data indicate that recycled crumb rubber infill in new generation artificial turf fields is not a significant source of $PM_{2.5}$ or $PM_{10}$.

TRC is an engineering and consulting firm which performed a study of artificial turf fields for the New York City Department of Health and Mental Hygiene (TRC, 2009). The study included air sampling from above and upwind of the same two artificial turf fields that were sampled for the New York State (2009) study. A single grass field was also sampled for comparison. Eight VOCs and one metal were detected in the air over the artificial turf fields. Three of the VOCs (2-butanone, chloroform, and n-hexane) were not detected in any of the upwind samples or over the grass field. In addition, seven TICs were detected, with four being specific to the artificial turf (isobutane, pentane, 2-methyl-1,3-butadiene, 2-methylbutane).

Monitoring of the air over and upwind of the artificial turf fields for $PM_{2.5}$ yielded the same concentration range. $PM_{2.5}$ concentrations ranged between 3 and 50 $\mu g/m^3$ for both.

Comparing the target list chemicals detected over the artificial turf fields to those detected in the upwind samples or over the grass field, three were specific to the on-field samples: 2-butanone, n-hexane and chloroform. The concentrations of the first two chemicals were well below the corresponding New York State short-term and annual air guideline levels. Therefore, the

chemicals were not considered for risk assessment. While the chloroform concentration was above the annual guideline level, the chemical was not considered for risk assessment because its presence over the single artificial turf field was thought to have resulted from drift from a nearby swimming pool commonly treated with chlorine. From among the four TICs that were specific to the artificial turf fields, three were well below their corresponding guideline values. The fourth, isoprene, does not have a guideline value. However, since it was detected in only one air sample as a TIC, and it was not detected when a bulk sample of crumb rubber was analyzed in the laboratory, it was not considered for risk assessment. Thus, a formal risk assessment was not performed for any chemical detected by air sampling. The report concluded that health effects were unlikely to result from the types of inhalation exposures expected to occur at these artificial turf fields.

*Comparing studies*

Table 12. Comparison of the chemical concentrations measured in air above artificial turf fields in the studies by Dye et al. (2006) and New York State (2009)

| Chemical | Concentration in Dye et al. (2006) ($\mu g/m^3$)[1] | Concentration in NY State report (2009) ($\mu g/m^3$)[1] | [Dye]/[NY State] |
|---|---|---|---|
| Toluene | 85 | 1.6 | 53 |
| Benzothiazole | 31.7 | 6.5 | 5 |
| p- and m-Xylene | 25.5 | 0.8 | 32 |
| Acetone | 15.3 | 0.6 | 26 |
| o-Xylene | 13.1 | 0.3 | 44 |
| 4-Methyl-2-pentanone | 12.7 | 1.2 | 11 |
| Ethylbenzene | 6.7 | 0.3 | 22 |

[1]Highest value reported

Table 12 compares the concentrations of seven VOCs detected in air samples from above indoor and outdoor artificial turf fields. From among the 20 chemicals detected at the highest levels by Dye et al. (2006) (see Table 1), these seven were also detected by New York State (2009) (see Table 11). The concentrations can be compared to determine if the indoor study measured consistently higher concentrations compared to the outdoor study. The last column in Table 12 shows that the concentrations of these seven VOCs were from 5- to 53-fold higher in the air over indoor fields compared to outdoor fields. Therefore, as discussed in this report, using the indoor values from Dye et al. (2006) to calculate health risks overestimates the risks athletes face from inhaling the air above outdoor artificial turf fields containing crumb rubber infill.

Similar to the chemical concentrations discussed above, the concentrations of particulate matter ($PM_{2.5}$ and $PM_{10}$) were somewhat higher for the indoor study by Dye et al. (2006). The indoor study detected $PM_{2.5}$ and $PM_{10}$ concentrations as high as 18.8 and 40.1 $\mu g/m^3$, respectively. Ambient, background levels of particulates were not measured. Therefore, it was not possible to determine whether the particulates were released by the turf or were already present in the ambient, outdoor air. The outdoor studies by New York State (2009) and TRC (2009) did not detect these particulates above ambient, background levels (about 15 and 3-50 $\mu g/m^3$, respectively). The indoor study used a chemical marker for tire rubber (N-cyclohexyl-2-

benzothiazolamine) to quantify the rubber in the particulate matter. Rubber comprised from 23 to 50 percent of the $PM_{2.5}$ or $PM_{10}$. Using microscopy, the New York State (2009) study ruled out rubber as the source of the microscopic particles in the 5-7 micrometer range. Considering all three studies together, it appears that $PM_{2.5}$ and $PM_{10}$ were at background levels in the air over outdoor artificial turf fields, but may have been present at above-background concentrations in the air above indoor fields.

Table 13 below shows a comparison of the chemicals detected in the air above the same two artificial turf fields that comprised the studies by New York State (2009) and TRC (2009). These are the eight chemicals that were specific to the air above artificial turf in the TRC (2009) study. Sampling for both of these studies was performed at the end of August and beginning of September 2008. The chemical concentrations were consistently higher in the New York State (2009) study, ranging from 1.7-fold to 85-fold higher. The reasons for these differences are unknown. These variable results highlight the difficulties faced in obtaining consistent results from potential point sources of outdoor air pollution. Despite this variability, both studies found that the chemical concentrations they measured were unlikely to produce adverse health effects in persons using these fields.

Table 13. Comparison of the chemical concentrations measured in air above the same two artificial turf fields in the studies by New York State (2009) and TRC (2009)

| **Chemical** | **Concentration in NY State report (2009) ($\mu g/m^3$)[1]** | **Concentration in TRC report (2009) ($\mu g/m^3$)[1]** | **[TRC]/[NY State]** |
|---|---|---|---|
| 2-Butanone (MEK) | - | 3.0 | - |
| Acetone | 0.6 | 51.0 | 85 |
| Chloroform | 0.2 | 2.9 | 15 |
| Chloromethane | 0.1 | 1.1 | 11 |
| Ethanol | - | 22.0 | - |
| n-Hexane | 0.4 | 2.1 | 5 |
| Methylene chloride | 3.0 | 9.0 | 3 |
| Toluene | 1.6 | 2.7 | 1.7 |
| Isobutane* | - | 2.4 | - |
| Pentane* | 0.5 | 11.8 | 24 |
| Isoprene (a.k.a., 2-methyl-1,3-butadiene)* | 0.9 | 2.8 | 3 |
| 2-Methylbutane* | 0.7 | 3.0 | 4 |

[1]Highest value reported, - not reported, * TIC

*Conclusions*

- The New York State (2009) report describes the most comprehensive study performed to date on the new generation of artificial turf containing recycled crumb rubber infill. Air sampling above two fields measured VOCs, sVOCs, $PM_{10}$ and $PM_{2.5}$.

- A total of 65 chemicals were identified in the air above a four-year-old field and 85 over a one-year-old field. Many of these were detected at similar concentrations in the air samples taken upwind of the fields.
- Most of the chemicals detected were tentatively identified compounds (TICs), as identified by their GC/MS peaks, with match qualities of less than 85 percent of the peaks. Therefore, these were considered "unknown" chemicals and not evaluated for health effects.
- $PM_{2.5}$ and $PM_{10}$ levels were the same over one field and upwind of the field, suggesting the fields are not sources of PM release.
- Chemicals of potential concern were selected and evaluated for cancer and non-cancer health effects based on their measured air concentrations and assuming continuous, lifetime inhalation by athletes using the fields. These latter two assumptions tend to overestimate the health risks.
- Hazard quotients were all less than one, indicating a low risk of non-cancer health effects. Excess, lifetime cancer risks were either below the $10^{-6}$ risk level, were similar for the upwind and on-field samples, or the chemical was only detected in one of eight on-field samples. Therefore, the report concluded that these fields do not constitute a serious public health problem since the risks of health effects are low.
- The study by TRC (2009), monitoring the same two artificial turf fields as the New York State (2009) study, also concluded that health effects were unlikely to result from the types of chemical inhalation exposures expected to occur to athletes using these fields.
- The concentrations of chemicals in the air over indoor fields (Dye et al., 2006) were from 5- to 53-fold higher than their concentrations over outdoor fields (New York State, 2009). This demonstrates that using data from indoor fields to calculate the health risks from outdoor fields overestimates those risks.

*Data Gaps (some of which are being addressed in the current OEHHA study of artificial turf)*

- Only two artificial turf fields were evaluated in the New York State (2009) study. The same two fields comprised the TRC (2009) study. Testing additional fields for the release of chemicals and particulate matter is warranted.
- Testing fields of different ages and at different temperatures would help determine how those variables affect chemical and particulate release. In particular, fields near the end of their useful lifetime should be evaluated.
- More air samples from upwind of the fields should be collected on the same days as field samples to determine if chemicals measured over the fields are also present at similar concentrations in the ambient air.
- The air above fields was not tested for airborne metals. The previously reported finding of lead in dust sampled from some artificial turf fields indicates a potential for lead and other metals to become suspended in the air and possibly inhaled. Testing field air samples for metals is warranted.
- To estimate inhalation exposures it was assumed that athletes used the artificial turf fields continuously over their entire lifetimes. This overestimates the health risks. Data covering the time athletes spend on these fields would allow more accurate exposure and risk calculations and result in reduced risk estimates.

- In the study by New York State (2009), the relatively large number of TICs with peak match qualities below 85 percent indicates that these fields release many unidentified VOCs and sVOCs ("unknowns"). Some of these were at $\mu g/m^3$ levels (Table 11). It is likely that the health risks posed by these chemicals, if any, will not be known for the foreseeable future. The presence of a relatively large number of unidentified organic chemicals in the air over these fields is a potential health risk that cannot be evaluated at present.

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54. New York State (2009) An assessment of chemical leaching, releases to air and temperature at crumb-rubber infilled synthetic turf fields. New York State Department of Environmental Conservation and New York State Department of Health, May 2009.
55. TRC (2009) Air quality survey of synthetic turf fields containing crumb rubber infill. TRC, Windsor, Connecticut, prepared for New York City Department of Health and Mental Hygiene, March 2009.

# What Do the Experts Say?

As the popularity of synthetic turf escalates, so does scrutiny about its usage. That's why we actively collect research and studies from independent, third-party organization about synthetic turf and its components. Review the latest thinking below from outside groups and our association.

Synthetic Turf Council - Media Alerts, News Releases and Position Statements

Official Position Statements - Federal or State Agencies, Sports Authorities, Academic Organizations

Current and Independent Research, Technical and Academic Papers:

- Environmental and Health Risk
- Staph / MRSA
- Risk of Injury
- General Information
- Other Relevant Studies

**Related Links**

- About Synthetic Turf
- Synthetic Turf 360°
- Case Studies and Testimonials
- Synthetic Turf FAQ's
- Research and Latest Thinking
- Synthetic Turf Video
- Guidance for Athletic Directors
- Independent Guidance
- Photos of Synthetic Turf Uses

## Current and Independent Research, Technical Academic Papers

### Environmental and Health Risk

"Safety Study of Artificial Turf Containing Crumb Rubber Infill Made from Recycled Tires: Measurements of Chemicals and Particulates in the Air, Bacteria in the Turf, and Skin Abrasions Caused by Contact with the Surface" Full study. Summary presentation by OEHHA and Cal/EPA.
*California Office of Environmental Health Hazard Assessment (OEHHA)*
*Pesticide and Environmental Toxicology Branch*
*Funded by the Department of Resources Recycling and Recovery (CalRecycle)*
*October 2010*

Conclusions: No public health concerns were identified regarding the inhalation of volatile organic compounds (VOCs) or particulates (PM2.5) above artificial turf;
Artificial turf harbored fewer bacteria (including MRSA and other Staphylococci) than natural turf;

The rate of skin abrasions per 1,000 player hours was two- to three-fold higher on artificial turf compared to natural turf;
The sum of these latter two effects on the skin infection rate for athletes competing on artificial turf relative to natural turf cannot be predicted from these data alone.

"An Evaluation of the Health and Environmental Impacts Associated with Synthetic Turf Playing Fields"
*University of Connecticut Health Center*
*The Connecticut Agricultural Experiment Station*
*Department of Public Health*
*Connecticut Department of Environmental Protection*
*July 2010*

The headline from the July 30, 2010 News Release from the Connecticut Department of Public Health announced, "Result of State Artificial Turf Fields Study: No Elevated Health Risk." Comprising separate reports from the four state agencies listed above, the Final Report presents the results of an extensive study into the health and environmental risks associated with outdoor and indoor synthetic turf fields containing crumb rubber infill. "This study presents good news regarding the safety of outdoor artificial turf fields," stated Department of Public Health Commissioner Dr. J. Robert Galvin. The above link is to the Overall Executive Summary, which includes links to the News Release, the four separate reports from the state agencies, and the report by the Peer Review Committee from The Connecticut Academy of Science and Engineering.

"Review of the Impacts of Crumb Rubber in Artificial Turf Applications"
*University of California, Berkeley, February 2010*
*Laboratory for Manufacturing and Sustainability*
*Prepared for: The Corporation for Manufacturing Excellence (Manex)*

"The research conducted by Manex and Berkeley is among the most comprehensive reports to date, reviewing and assessing existing studies from the past 12 years, as well as containing independent analysis. The conclusions of this study validate key findings from other recent studies, demonstrating the materials are both cost-effective and safe." From Manex/UC Berkeley Press Release posted April 5, 2010. Click here for full Press Release.

"A Scoping-Level Field Monitoring Study of Synthetic Turf Fields and Playgrounds"
*U.S. Environmental Protection Agency, November 2009*

This study and statements of safety by the U.S. EPA of synthetic turf

fields and playgrounds containing crumb rubber from recycled tires complements the study and statement of safety by the CPSC in 2008 (see below). In its Press Release, the EPA summarized its findings, including the following:

- The levels of particulate matter, metals, and volatile organice compound concentrations in the air samples above the synthetic turf were similar to background levels;
- All air concentrations of particulate matter and lead were well below levels of concern;
- Zinc, which is a known additive in tires,...was found to be below levels of concern.

See December 10, 2009 EPA Press Release, "Limited EPA Study Finds Low Level of Concern in Samples of Recycled Tires from Ballfield and Playground Surfaces"

"Chemicals and Particulates in the Air Above the New Generation of Artificial Turf Playing Fields, and Artificial Turf as a Risk Factor for Infection by Methicillin-Resistant Staphylcoccus Aureus (MRSA)"
*Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, July 2009*

There is a negligible human health risk from inhaling the air above synthetic turf, and, though data gaps exist, it is "unlikely that the new generation of artificial turf is itself a source of MRSA...." (Significantly the OEHHA did not review the January 2009 results of the study into the lifespan of staph on grass and synthetic turf sponsored by the STC and the Pennsylvania Turfgrass Council - see below.) The OEHHA summary of the results is posted on its website. The full report includes an important Addendum that references reports by the New York State Department of Environmental Conservation and Department of Health (May 2009) and the New York City Department of Health and Mental Hygiene (March 2009) - see below.

"An Assessment of Chemical Leaching, Releases to Air and Temperature at Crumb-Rubber Infilled Synthetic Fields"
*New York State Department of Environmental Conservation and New York State Department of Health, May 2009*

In its Press Release, the NYSDEC announced that this new comprehensive study concludes that crumb rubber infilled synthetic fields "poses no significant environmental threat to air or water quality and poses no significant health concerns."

"Air Quality Survey of Synthetic Turf Fields Containing Crumb Rubber Infill"
*TRC, March 2009. Prepared for NY City Department of Health and Mental Hygiene*

"In summary, an analysis of the air in the breathing zones of children above synthetic turf fields do not show appreciable impacts from COPCs [Contaminants of Potential Concern] contained in the crumb rubber. Therefore, a risk assessment was not warranted from the inhalation route of exposure." Of 69 VOCs, 17 PAHs, including Benzothiazole, 10 metals, and a range of particulate matter tested, the COPCs that were detected in the ambient air samples above the crumb rubber synthetic turf fields were found in similar concentrations in the air samples above the grass field and the background locations.

"CPSC Staff Finds Synthetic Turf Fields OK to Install, OK to Play On,"
*U.S. Consumer Product Safety Commission, NEWS from CPSC, July 30, 2008*

The CPSC staff conducted tests of synthetic turf products for analysis of total lead content and accessible lead. In the above News Release it concludes that, "young children are not at risk from exposure to lead in these fields."

For a summary of the analytical methods used and the test results, see "CPSC Staff Analysis and Assessment of Synthetic Turf 'Grass Blades"

"A Review of the Potential Health and Safety Risks from Synthetic Turf Fields Containing Crumb Rubber Infill"
*Prepared for New York City Department of Health and Mental Hygiene by TRC, May 2008*

A comprehensive 180-page review of available scientific literature and research on synthetic turf with crumb rubber infill covering such topics as chemical composition and human health risks from crumb rubber infill, risks of physical injury, heat-related illness, staph, etc. A summary of the available research is also included.

"Review of the Human Health & Ecological Safety of Exposure to Recycled Tire Rubber found at Playgrounds and Synthetic Turf Fields"
*Prepared for Rubber Manufacturers Association by ChemRisk, Inc., July 17, 2008*

A report by an independent environmental firm on the human health and ecological risks from ground rubber in playgrounds and sports fields, and based on a thorough review of studies from advocates and opponents to the use of recycled tire materials.

"Environmental Effects of Synthetic Turf Athletics Fields"
*Milone & MacBroom, December 2008*

HEAT: On hot sunny days, surface temp of the fibers was 40-50

degrees hotter than ambient temp; air temp at 2' above surface or under cloud cover was near ambient. Crumb rubber was only a few degrees hotter than ambient. Watering the field had a short-term effect.

OFF-GASSING: EHHI identified certain compounds of concern in its very limited 2007 laboratory study of the chemicals contained in crumb rubber – benzothiazole, volatile nitrosamines, and 4-(tert-octyl) Phenol. MMI tested for these compounds in the air above the synthetic turf fields with crumb rubber infill at several locations. A "very low concentration" of benzothiazole was found at 1 of 2 fields -- the other compounds were not detected.

LEACHING: Testing done over 1 year period. Test for zinc, lead, selenium, and cadmium, and compared to lowest aquatic life criterion for each element. Only zinc detected, and then well below water quality standard.

"Follow-up Study of the Environmental Aspects of Rubber Infill, A Laboratory study (perform weathering tests) and a field study, rubber crumb from car tyres as infill on artificial turf"
*INTRON, commissioned by two tyre associations, and supervised by the National Institute for Public Health and the Environment and by the Ministry of Housing, Spatial Planning and the Environment in the Netherlands, April 2008*

"The impact of weathering of the rubber crumb for the technical lifetime of an artificial turf field (approx. 10 to 15 years) does not cause the leaching of zinc from the rubber crumb...to exceed the threshold values..."

Environmental and Health Evaluation of the Use of Elastomer Granulates (Virgin and from Used Tyres) as Filling in Third-Generation Artificial Turf"
*Author: Dr. Robert Moretto (EEDEMS) 1*
*ADEME/ALIAPUR/FIELDTURF TARKETT 2007*
*Scientific long-term study for French organizations*

Study of quality of water passing through SBR, TPE and EPDM granules, and of gases emitted by the sports fields. No impact from these materials on water resources; no effect on health from inhaling VOC and aldehydes emitted by materials in close, poorly ventilated indoor facility or outdoors; ecotoxicologically, no impact on the environment. Extensive bibliography.

"Evaluation of Health Effects of Recycled Waste Tires in Playground and Track Products"
*Office of Environmental Health Hazard Assessment of Califomia EPA. Januarv 2007*

Evaluation of toxicity due to ingestion based on existing literature - risk is well below de minimus level considered an acceptable cancer risk.

Evaluation of toxicity due to ingestion based on gastric digestion simulation - same as above.

Evaluation of toxicity due to chronic hand-to-surface-to-mouth activity - low risk of adverse noncancer health effects. Slightly higher than de minimus level for chronic ingestion of chrysene, but low enough to be considered an acceptable cancer risk.

Skin sensitization - no sensitization observed.

Evaluating the potential for damage to the local environment and ecology - soil samples under a playground surface burned in a fire contained levels of metals, VOCs, PAHs, dioxins and furans at or below background, suggesting low risk. Air above the burn site was judged by the U.S. EPA as posing no health risk. Concentrated leachate from tire shreds produced in a lab was toxic to several organisms, but a rain event would not likely produce leachate in such concentrations to cause toxicity to these organisms. Shredded tires used above the ground water table produced no toxicity in sentinel species.

## Staph / MRSA

"Survival of Staphylococcus aureus on Synthetic Turf"
*By Andy McNitt, Ph.D., Associate Professor of Soil Science, Penn State University*
*December 2008. A research project funded by the Synthetic Turf Council and the Pennsylvania Turfgrass Council.*

A study to examine the survival of S. aureus on infilled synthetic turf systems and natural turfgrass under different environmental conditions and to evaluate the effectiveness of various control agents applied to the synthetic turf.

S. aureus survived for as long on natural turfgrass as it did on synthetic turf systems in both indoor and outdoor settings. S. aureus lived longest indoors, but can be effectively treated with commercially available antimicrobial treatments as well as detergents. Outdoors S. aureus has a very low rate of survival, particularly when exposed to UV light and higher temperatures.

"Environmental Management of Staph and MRSA in Community Settings"
*Centers for Disease Control and Prevention, July 2008*

"A Survey of Microbial Populations in Infilled Synthetic Turf Fields"
*By Andy McNitt, Ph.D., Associate of Professor of Soil Science, Penn State University, and Dianne Petrunak, M.S., and Thomas Serensits, M.S.*
*June 2007*

A survey to determine the microbial population of several crumb rubber infilled synthetic turf systems and natural turfgrass fields.

Official Statement on Community-Acrquired MRSA Infections (CA-MRSA)
*National Athletic Trainers' Association, March 1, 2005*

## Risk of Injury

"Epidemiology of Patellar Tendinopathy in Elite Male Soccer Players"
*Hagglund, M., PT, PhD; Zwerver, J., MD, PhD; Ekstrand, J., MD, PhD*
*American Journal of Sports Medicine, June 2011, 0363546511408877*

Patellar tendinopathy is a relatively mild but fairly common condition among elite soccer players, and the recurrence rate is high.

This study investigated the epidemiology of patellar tendinopathy in 2,229 elite male soccer players from 51 European elite soccer clubs playing on natural grass and synthetic turf between 2001 and 2009.Objective: To compare the risk for acute injuries between natural grass (NG) and third-generation artificial turf (3GAT) in male professional football.

Conclusion: "Exposure to artificial turf did not increase the prevalence or incidence of injury."

"Risk of injury on third generation artificial turf in Norwegian professional football"
Bjørneboe J, Bahr R, Andersen TE (2010)
*British Journal of Sports Medicine, 44: 794-798.*

Methods: All injuries sustained by players with a first-team contract were recorded by the medical staff of each club, from the 2004 throughout the 2007 season. An injury was registered if the player was unable to take fully part in football activity or match play.

Results: A total of 668 match injuries, 526 on grass and 142 on artificial turf, were recorded. The overall acute match injury incidence was 17.1 (95% CI 15.8 to 18.4) per 1000 match hours; 17.0 (95% CI 15.6 to 18.5) on grass and 17.6 (95% CI 14.7 to 20.5) on artificial turf. Correspondingly, the incidence for training injuries was 1.8 (95% CI 1.6 to 2.0); 1.8 (95% CI 1.5 to 2.0) on grass and 1.9 (95% CI 1.5 to 2.2) on artificial turf respectively. No significant difference was observed in injury

location, type or severity between turf types.

Conclusion: No significant differences were detected in injury rate or pattern between 3GAT and NG in Norwegian male professional football.

"Comparison of injuries sustained on artificial turf and grass by male and female elite football players"
Ekstrand J, Hägglund M, Fuler CW (2010)
*Scandinavian Journal of Medicine and Science in Sports, DOI: 10.1111/j.1600-0838.2010.01118.x*

The objective of this study was to compare incidences and patterns of injury for female and male elite teams when playing football on artificial turf and grass. Twenty teams (15 male, 5 female) playing home matches on third-generation artificial turf were followed prospectively; their injury risk when playing on artificial turf pitches was compared with the risk when playing on grass. Individual exposure, injuries (time loss) and injury severity were recorded by the team medical staff. In total, 2105 injuries were recorded during 246 000 h of exposure to football. Seventy-one percent of the injuries were traumatic and 29% overuse injuries. There were no significant differences in the nature of overuse injuries recorded on artificial turf and grass for either men or women. The incidence (injuries/1000 player-hours) of acute (traumatic) injuries did not differ significantly between artificial turf and grass, for men (match 22.4 v 21.7; RR 1.0 (95% CI 0.9–1.2); training 3.5 v 3.5; RR 1.0 (0.8–1.2)) or women [match 14.9 v 12.5; RR 1.2 (0.8–1.8); training 2.9 v 2.8; RR 1.0 (0.6–1.7)]. During matches, men were less likely to sustain a quadriceps strain ($P$=0.031) and more likely to sustain an ankle sprain ($P$=0.040) on artificial turf.

"Injury risk on artificial turf and grass in youth tournament football"
Soligard T, Bahr R, Andersen TE (2010)
*Scandinavian Journal of Medicine and Science in Sports*, DOI: 10.1111/j.1600-0838.2010.01174.x

The aim of this prospective cohort study was to investigate the risk of acute injuries among youth male and female footballers playing on third-generation artificial turf compared with grass. Over 60000 players 13–19 years of age were followed in four consecutive Norway Cup tournaments from 2005 to 2008. Injuries were recorded prospectively by the team coaches throughout each tournament. The overall incidence of injuries was 39.2 (SD: 0.8) per 1000 match hours; 34.2 (SD: 2.4) on artificial turf and 39.7 (SD: 0.8) on grass. After adjusting for the potential confounders age and gender, there was no difference in the overall risk of injury [odds ratio (OR): 0.93 (0.77–1.12), P=0.44] or in the risk of time loss injury [OR: 1.05 (0.68–1.61), P=0.82] between artificial turf and grass. However, there was a lower risk of ankle injuries [OR: 0.59 (0.40–0.88), P=0.008], and a higher risk of back and spine [OR: 1.92 (1.10–3.36), P=0.021] and shoulder and collarbone injuries [OR: 2.32 (1.01–5.31), P=0.049], on artificial turf compared with on grass. In conclusion, there was no difference in the overall risk of acute injury in youth footballers playing on third-generation artificial turf compared with grass.

"Very Positive Medical Research on Artificial Turf"

*Turf Roots Magazine 01, pp. 8-10*
www.fifa.com

A report of medical research conducted by FIFA's Medical Assessment and Research Centre (F-MARC) comparing injuries sustained at the FIFA U-17 tournament in Peru, which was played entirely on "football turf" (synthetic turf) with the injuries sustained at previous U-17 tournaments, which were played mainly on well-manicured grass. "The research showed that there was very little difference in the incidence, nature and causes of injuries observed during those games played on artificial turf compared with those played on grass."

"Risk of injury in elite football played on artificial turf versus natural grass: a prospective two-cohort study"
*J Ekstrand, T Timpka, M Hagglund*
*British Journal of Sports Medicine 2006; **40**:975-980*

Objective: "To compare injury risk in elite football [soccer] played on artificial turf compared with natural grass."

Conclusion: "No evidence of a greater risk of injury was found when football was played on artificial turf compared with natural grass. The higher incidence of ankle sprain on artificial turf warrants further attention, although this result should be interpreted with caution as the number of ankle sprains was low."

"Risk of injury on artificial turf and natural grass in young female football [soccer] players"
*Kathrin Steffen, Thor Einar Andersen, Roald Bahr*
*British Journal of Sports Medicine 2007; **41**:i33-i37*
http://bjsm.bmj.com

Objective: "To investigate the risk of injury on artificial turf compared with natural grass among young female football [soccer] players."

Conclusion: "In the present study among young female football [soccer] players, the overall risk of acute injury was similar between artificial turf and natural grass."

"Comparison of the incidence, nature and cause of injuries sustained on grass and new generation artificial turf by male and female football players"
*Colin W Fuller, Randall W Dick, Jill Corlette, Rosemary Schmalz*
*British Journal of Sports Medicine 2007; **41** (Supplement 1):i20-i26 (Part 1: match injuries)*
*British Journal of Sports Medicine 2007; **41** (Supplement 1):i27-i32 (Part 2: training injuries)*
Abstracts available at http://bjsm.bmj.com

Abstracts available at http://bjsm.bmj.com
Objective: "To compare the incidence, nature, severity and cause of match injuries (Part 1) and training injuries (Part 2) sustained on grass and new generation turf by male and female footballers."

Methods: The National Collegiate Athletic Association Injury Surveillance System was used for a two-season (August to December) prospective study of American college and university football teams (2005 season: men 52 teams, women 64 teams; 2006 season: men 54 teams, women 72 teams).

Conclusion of both Part 1 and Part 2: There were no major differences in the incidence, severity, nature or cause of match injuries or training injuries sustained on new generation artificial turf and grass by either male or female players.

## General Information

"Evaluation of Playing Surface Characteristics of Various In-Filled Systems"
*By Andy McNitt, Associate Professor of Soil Science, Penn State University, and Dianne Petrunak*
*December 2006*

Table of Contents reflects the scope of the research:

The research:

- Introduction and Objectives
- Construction of Experimental Area
- Characterization of Infill Systems
- Simulated Foot Traffic and Grooming
- Surface Hardness (G-Max)
- Infill Media and Underlying Pad
- Traction
- Abrasion
- Microbial Populations in Synthetic Turf
- Temperature and Color
- Summary and Considerations

## F. Other Relevant Studies

"Evaluation of Potential Environmental Risks Associated with Installing Synthetic Turf Fields on Bainbridge Island"
*D. Michael Johns, Ph.D., Windward Environmental LLC, Seattle, WA, February 2008*

Review of available scientific literature and publications in order to provide an assessment about potential risks to the environment from

zinc and chemicals contained in crumb rubber infill. "...water that percolates through turf fields with tire crumb is not toxic..."

"Initial Evaluation of Potential Human Health Risks Associated with Playing on Synthetic Turf Fields on Bainbridge Island"
*D. Michael Johns, Ph.D., Windward Environmental LLC, Seattle, WA, January 2008*

Review of available scientific literature and publications in order to provide an assessment about potential risks of human health to children and teenagers and the risks to the environment from precipitation runoff.

"Ambient Air Sampling for PAH's, Comsewogue High School Football Field"
"Ambient Air Sampling for PAH's, Schreiber High School Football Field"
*Broderick & Associates, Inc., October 2007*

In response to a news report that the above fields had three cancer-causing chemicals that were in excess of state (NY) safety levels, this independent environmental consulting and testing firm tested the fields to determine the potential routes of exposure for athletes, coaches, etc. using these fields. Broderick & Associates concluded that the potential for exposure to PAH's (sometimes referred to as an exposure to out-gassing or off-gassing of chemicals from crumb rubber infill) is "minimal or insignificant."

"Rubber - Its Implications to Environmental Health"
*A FIFA presentation, Dr. Eric Harrison, Zurich, June 2007*

Presentation on the chemical composition of SBR rubber and its health and environmental risks. Summary of relevant studies, and comments about the risks of SBR rubber relative to risks already present in the environment.

"Twenty Questions [and Answers] on Rubber Granulate"
*Dr. Bryan B. Willoughby, March 2007*
*Prepared for the Sports and Play Construction Association (SAPCA)*

Q & A summary in layman's terms. Published in conjunction with British Standards Institute and SAPCA.

"Environmental and Health Risks of Rubber Infill, rubber crumb from car tyres as infill on artificial turf"
*INTRON, commissioned by two tyre associations, and supervised by the National Institute for Public Health and the Environment and by the Ministry of Housing, Spatial Planning and the Environment in*

*the Netherlands, January 2007*

"Based on the available literature on exposure to rubber crumb by swallowing, inhalation and skin contact and our experimental investigations on skin contract we conclude that there is not a significant health risk due to the presence of rubber infill…from used car tyres."

"Synthetic Turf Sports Fields and the Environment"
*Written to Westford Township (Mass) by John Amato, P.E., STC Certified Independent Consultant, 2007*

Excellent and practical discussion on synthetic vs. natural turf.

"Rubber - Its Implications to Environmental Health (Hydrocarbon Rubbers)"
*Dr. Bryan Willouby, Independent Consultant in Polymer Chemistry, 2006*
*Presented by Synthetic Turf Council at its November 2006 Annual Membership Meeting*

Presentation of chemical analysis of SBR rubber, and the likelihood that leachate containing PAHs, benzene, phthalates and alkyphenols, and zinc present a health or environmental hazard. Zinc presents a localized environmental risk, but all other risks judged insignificant.

"Assessing the Health and Environmental Impact from the Use of End-of-Life Tire Rubber Crumb as Artificial Turf in Sports Arenas"
*D.A. Birkholz, Director, Research & Development, ALS Laboratory Group, Edmonton, Alberta, October 18-20, 2006*

Overview of various health and environmental questions, including exposure to carcinogenic PAHs, amines, and N-nitrosamines from skin contact and ingestion of toxic chemicals, leaching of toxic chemicals, releasing of toxic chemicals and particulates with use.

"Artificial turf pitches - an assessment of the health risks for football players and the environment" - A Summary
*Norwegian Institute of Public Health, Oslo, October 2006*
*Presentation by Dr. Christine Bjorge at the ISSS Technical Meeting 2006 in Dresden*

See above. No elevated human health risk from use of indoor synthetic turf halls, from VOCs (more study needed), from benzene, from PAHs. Environmental risk is local. Perhaps risks from latex rubber, but not enough research.

"PAHs and Other Organics in Tyres - Origins and Potential for Release"

*Dr. Bryan G. Willoughby, Independent Consultant in Polymer Chemistry, June 23, 2006*

Summary of exposure risks from inhalation, leachates, and skin contact.

"Artificial turf pitches - an assessment of the health risks for football players"
*Norwegian Institute of Public Health and Radium Hospital, Oslo, January 2006*

Nine exposure scenarios - inhalation, skin, and oral exposures to adults, juniors, older children and children.

"Toxicological Evaluation for the Hazard Assessment of Tire Crumb for Use in Public Playgrounds"
*Detlef A. Birkholtz, Enviro-Test Laboratories, Edmonton, Alberta, Canada*
*Kathy L. Belton, Alberta Centre for Injury Control and Research, Edmonton, Alberta, Canada*
*Tee L. Guidotti, Department of Public Health Sciences, University of Alberta, Edmonton, Alberta, Canada*
*Journal of the Air & Waste Management Association, July 2003*

Oral ingestion - low hazard
Inhalation of toxic vapors - inconsequential and negligible
Dermal exposure - low overall hazard
Cancer hazard through ingestion - small amounts will not result in unacceptable hazard
Species - specific lethality from leachate - moderate toxic risk, but not significant




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# LAWRENCE UNIFIED SCHOOL DISTRICT SELECTS GAMEDAY GRASS™ 3D FROM ASTROTURF® FOR EIGHT NEW ATHLETIC FIELDS

***Lawrence and Free State High School Get New, Advanced Synthetic Turf Systems***

**RALEIGH, NC. (March 18, 2009)** – Lawrence Unified School District (USD) selected GameDay Grass™ 3D by AstroTurf®, one of the most advanced synthetic turf products, featuring best-in-class performance benefits, and characteristics that closely mimic the look and feel of natural grass, for eight district athletic fields. Installation of the new synthetic turf football, soccer, baseball and softball fields at Lawrence High School and Free State High School, is underway by AstroTurf®. In addition to the renovation of the athletic fields, AstroTurf® will install its XPLODE™ polyurethane competition track system and new tennis courts at Lawrence High School this summer.

For district officials, the decision to select GameDay Grass™ 3D from AstroTurf® was simple.

"There were a number of factors that proved GameDay Grass™ 3D was the best product for Lawrence USD," said Tom Bracciano, division director of operations and facility planning. "The proprietary Root Zone® aiding with traction, Sustain™ all rubber infill eliminating sand that hardens over time and scientific data on player performance and safety made it clear GameDay Grass™ 3D from AstroTurf® was the best choice for our high schools and community."

The eco-friendly benefits and AstroTurf®'s "green" manufacturing initiatives also came into play for the environmental conscious town. The new synthetic turf fields remove the need for fertilizers, pesticides and herbicides and cut down on pollution resulting from gasoline-powered motors.

"We take great pride in having the opportunity to work with Lawrence Public Schools to provide innovative, durable and safe playing surfaces for the athletes and community groups to use," said GSV CEO Jon Pritchett. "Lawrence made it clear they wanted nothing but the best for all the new sports venues and we are proud they selected the GameDay Grass™ 3D system by AstroTurf®."

AstroTurf® is the approved synthetic turf and athletic supplier of the U.S Communities Government Purchasing Alliance™, a nonprofit organization that helps government agencies, school districts (K-12), higher education, and other nonprofits reduce the cost of purchased goods by pooling the purchasing power of public agencies nationwide. As a registered participant of U.S. Communities, Lawrence USD benefited from the variety and quality of products and services offered by AstroTurf®.

Work on the new football fields at each high school has wrapped up and installation of the turf for the baseball fields is in progress. All remaining elements of the project including the construction and installation of the track system and tennis courts will be completed this summer.

**--more--**

**About AstroTurf®**

The iconic AstroTurf® brand offers advanced, state-of-the-art, multi-sport and specialized synthetic turf systems with proprietary engineered technologies, leveraging the industry's only vertically integrated manufacturing system. The relaunch of AstroTurf®, including the enlistment of football legend Archie Manning as ambassador for the brand, has positioned it again as the leading innovator in the synthetic turf industry, with a growing number of high schools, colleges, professional sports teams and municipalities selecting AstroTurf®-branded products for their premium quality, technical superiority and safety. AstroTurf® is a registered trademark of Textile Management Associates, Inc.

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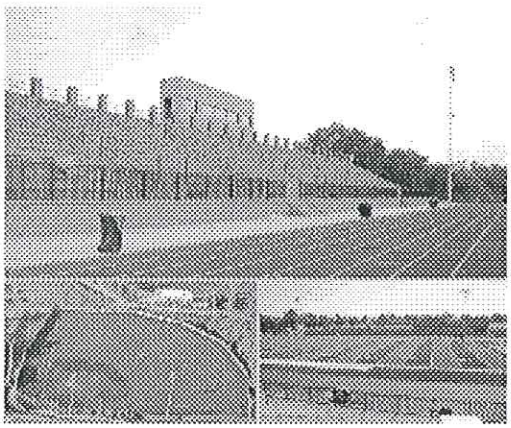


## LAWRENCE HIGH SCHOOL SPORTS VENUES

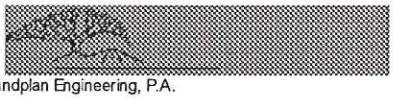
**Lawrence, Kansas**

As an outgrowth of the 2007 PLAY Feasibility Study, which evaluated the adequacy of playing fields in the City of Lawrence, USD 497, in 2008, undertook a significant improvement project to upgrade the playing fields at both Lawrence high schools. Phase I of the project improved the conditions at eight sports fields at three different District locations. Landplan Engineering provided project coordination, design, construction documentation, and construction observation/inspection for all projects. Landplan designed the various venues utilizing first-of-their-kind structures, with designs that harken back to stadiums of old, but with delivered costs below equivalent aluminum bleacher facilities.

Free State High School had existing football field/track, soccer field, baseball field, softball field and tennis courts. As lead consultant, Landplan coordinated efforts to provide new synthetic turf surface on all fields and lighting for the football and soccer fields and tennis courts. Grandstands with seating for 4,000 and storage beneath were developed for the football field.

The Lawrence High School site had existing football field/track and eight tennis courts. Landplan Engineering worked with the School District to develop a new synthetic turf football field/track, softball field and soccer field. Lighting was added to all sports fields. Grandstands with seating for 4,000 and storage beneath were developed for the football field. The existing tennis courts were converted to new parking (350 stalls); an additional 600 stalls were also placed at the Lawrence High School site.

The third site, the location of the Lawrence Virtual School, had an existing area that was used for soccer practice and 45 parking stalls. Landplan developed plans that provided a full-size synthetic turf baseball field with lights and seating for 200 people and eight tennis courts with lights and seating for 200 people, along with 150 parking stalls and underground stormwater detention.



Landplan Engineering, P.A.
Lawrence, Kansas; Kansas City, Missouri; The Woodlands, Texas; Columbus, Ohio; Farmington Hills, Michigan

# Case Studies and Testimonials

## See the Impact Synthetic Turf Has on Schools and Communities:

### Athletic Fields

- Wister Elementary School - Philadelphia, PA
- Kiowa County High School - Greensburg, KS
- William Dick School - Philadelphia, PA
- Tri-Valley High School - Dresden, OH
- Salesian High School - Richmond, California
- Junction City High School - Junction City, Kansas
- Germantown High School - Philadelphia, Pennsylvania
- Old Dominion University – Norfolk, Virginia

### Playgrounds & Parks

- City of Lakeland Parks & Recreation Department (Common Ground Park) - Lakeland, FL
- City of Wauwatosa - Wauwatosa, WI
- Geneva Area Recreational, Educational, Athletic Trust (GaREAT)
- West Hollywood Sports Complex – Hollywood, Florida

### Landscape

- Hawaii Canines For Independence – Maui, Hawaii
- Mandarin Oriental Hotel – New York, New York
- Twentynine Palms Marine Corps Base – Mojave Desert Region, Twentynine Palms, California

**Related Links**

- About Synthetic Turf
- Synthetic Turf 360°
- Case Studies and Testimonials
- Synthetic Turf FAQ's
- Research and Latest Thinking
- Synthetic Turf Video
- Guidance for Athletic Directors
- Independent Guidance
- Photos of Synthetic Turf Uses

## Athletic Fields Case Study: Wister Elementary School, Philadelphia, PA

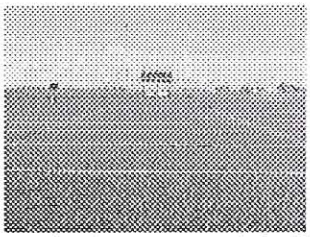
### 2010 Grand Prize Winner of the Search for the Real Field of Dreams

John Wister Elementary School is located in the heart of Philadelphia, in an economically challenged area plagued by gunshots and murder that lacked safe play places. Like many city schools, there is no grassy area on the school yard and no field nearby for the children to play. As a result, Wister was a bare yard, void of life. Students were often hurt when trying to play football or gymnastic stunts and trips to the nurse were constant. With nothing to do, students often ended up fighting with each other for menial reasons and mostly due to boredom. The new field has had an immediate positive effect on everyone – the school, the students and the surrounding community. It has provided an incentive for students to not only come to school but to arrive on time to play on the turf. There is no more fighting because students have so much to do. Students are much more respectful of each other and automatically break themselves into groups to play in different areas simultaneously. The field provides the closest thing to grass that many of these children see day to day. It allows students to exert energy and release their frustration which helps to prepare them for the rest of their academic day. This once barren field is a place of opportunity, where students take ownership and pride in their schoolyard. Read Full Story

## Athletic Fields Case Study: Kiowa County High School,

## Greensburg, KS

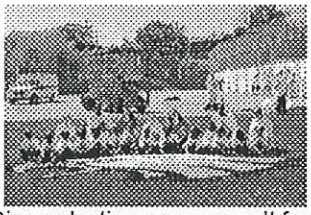
### 2010 Grand Prize Winner of the Search for the Real Field of Dreams



On May 4, 2007, an EF-5 tornado obliterated 95% of Greensburg, Kansas. The schools and facilities were a total loss. All that was left of its football stadium was the field itself, and its surface was riddled with holes, gouges, and debris. Gone were the bleachers, the concession area, the lights, the goalposts and the fencing. Despite enormous challenges, school started in August of 2007, as previously planned. Trying to decide where to practice and where to play were issues that continually plagued administrators. For two years, competing at home was out of the question. While the school was very appreciative of neighboring towns that shared their sports facilities, small towns count on home games to build community pride and bring all ages together for a common goal. With so much loss, townspeople desperately needed a place to rally. Galvanized by this goal, a dream began to form in the minds of our school leaders: the dream of having not only a "home" field again, but the only synthetic 8-man turf in the state of Kansas. School administration, construction crews and everyone in town worked around the clock to finish before their home opener on September 4, 2009. Today the school proudly hosts sports competitions and the community youth football league uses it for their Saturday games. It truly shows what can happen when people dare to dream big. Read Full Story

## Athletic Fields Case Study: William Dick School, Philadelphia, PA

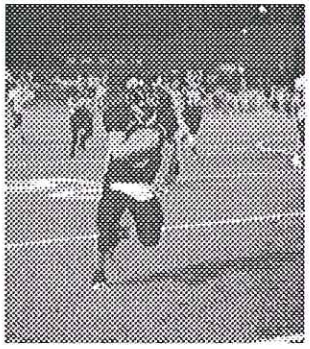
### 2010 Top Winner of the Search for the Real Field of Dreams (Athletic Fields Category)



Ranging in age from five to 13, the students at William Dick School in Philadelphia arrive from homes with a poverty rate of over 90%. The empty school yard was filled with almost a full city block of broken concrete. When the Philadelphia Eagles Youth Partnership asked students what their dreams were for the school year, the children overwhelmingly said they wanted "grass."They longed to be able to play their games on a safer surface when they had recess and came to play – during school, weekends, evenings and summer vacation. Since planting grass wasn't feasible, a synthetic turf field was installed in the far corner of the schoolyard in June 2007. The goal was to offer these children an area where students and the community could come to play football, tag and other games without worry of skinned knees or even worse injuries that had been seen so many times before. Opportunities for students to play against staff in games as well as physical education activities on the turf became part of the everyday experience. When students wanted more space to play, a local synthetic turf company sponsored a reading challenge at the school to make this happen. The field helps the school raise the bar with students academically and provide incentives for good behavior. It has also lead to strong social responsibility, as parents and neighbors monitor and keep the play area in great share during after-hours recreation. Read Full Story

## Athletic Fields Case Study: Tri-Valley High School, Dresden, OH

### 2010 National Finalist of the Search for the Real Field of Dreams (Athletic Fields Category)

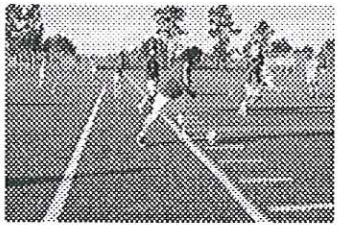


The small town of Dresden, Ohio prospered for many years because of the Longaberger basket company. But In the last ten years, that prosperity has turned to despair as Longaberger has to cut its workforce from 8,000 to just over 1,000. Unemployment in our county is nearly 16% compared to the state average of 10%. The town needed a shot of adrenaline, something to rally around and be proud of again – Tri-Valley High School's football program. The program had begun to build with three winning seasons, but now the game field was in bad shape after overuse and severe drainage issues. It constantly drew the ire of opposing coaches because they feared their athletes would get injured as a result of the field conditions. At the end of 2008, we decided to build on the momentum created by the football program and propose the field turf project to our school and community. Six months later we had our new

synthetic turf field and everything has changed. Our student athletes have all reaped the benefits of such a great surface. The football team is now able to play and practice on a perfect surface every day. From soccer and band in the fall, to baseball, softball and track in the spring, our turf gets used on a daily basis. The drainage problems that were so prevalent on our old field are now non-existent. Every Friday night in the fall, townspeople forget about their problems and share in the thrill of success that our completed project has provided. This year, they watched Tri-Valley Football complete a perfect 5-0 home record on the new synthetic turf field. Read Full Story

## Athletic Fields Case Study: Salesian High School, Richmond, California

### 2009 Grand Prize Winner of the Search for the Real Field of Dreams



In a true story of David vs. Goliath, the football team at Salesian High School in Richmond, California went from the brink of closure to defeating an "unbeatable" team with players twice its size. It was Salesian's first game on their brand new synthetic turf field – a field that is now being hailed the Grand Prize Winner of the Search for the Real Field of Dreams. Salesian High School unveiled its field for the varsity football Homecoming game in 2007. They were up against a school with three times as many students and an offensive line that looked like an NFL team. Nearly 1,000 fans packed the stands as Salesian High School defeated its opponent 40-37. The headline in the next day's newspaper read, 'David Slays Goliath.'

Located in a city with one of the country's highest murder rates, the students at Salesian High focused their efforts on academics – the school boasts a graduation rate near 100 percent. And although 70 percent of students are involved in athletics, the conditions of their grass field were so poor that the soccer and football teams were on a three-year notice to be shut down. That all changed when the school raised funds to install a synthetic turf field. Salesian's inspirational story stood out among the winning entries selected by an independent panel of judges as winners of the STC 2009 Search for the Real Field of Dreams. Read Full Story

## Athletic Fields Case Study: Junction City High School, Junction City, Kansas

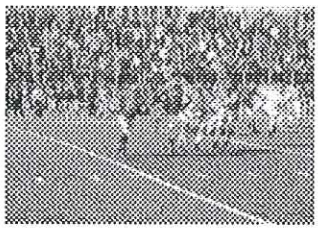
### 2009 First Runner-Up of the Search for the Real Field of Dreams

The varsity football team at Junction City High School squashed a 40 year dry spell and won the 2008 State Championship after replacing its run-down playing field with synthetic turf. The school's inspirational story has now helped it win First-Runner Up in the 2009 Search for the Real Field of Dreams. Located in the small military town of Junction City, Kan., the old field could only be used once or twice a week. Now the new synthetic turf field is used nearly every day, all year round. The school's award-winning band now has a place to practice, the soccer team has a place to play home games and the "Ultimate Blue" Frisbee team is able to use the fields, too. From a fundraiser flag football game hosted by area firefighters to a "Tribute to Our Troops" night recognizing military members and their families, the field at Junction City High School has truly helped bring the entire community together. Read Full Story

## Athletic Fields Case Study: Germantown High School,

## Philadelphia, Pennsylvania

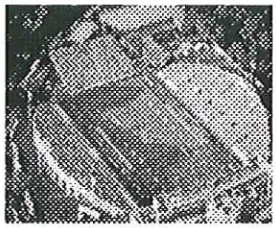
### 2009 National Finalist of the Search for the Real Field of Dreams



Benjamin L. Johnston Memorial Field is one of five "super sites" that serve Philadelphia high school athletics. Germantown High School runs the facility, which provides athletic field space for schools that lacked on-premises outdoor space, a typical problem in urban settings. Overuse had turned the field into a desolate eyesore which became a complete quagmire during rain. Then the Local Initiatives Support Corporation in Philadelphia helped arrange for a $200,000 grant from the NFL's Grassroots program as part of a major renovation project. The Philadelphia Eagles and School District of Philadelphia also came together to give area's youth a better place to play. Together, these efforts lead to the install of a synthetic turf field that has transformed the community. It hosts football, soccer, field hockey and track teams from more than 10 local schools, and most mornings over 100 people are exercising n the field before the school day even begins. Student athletes take care of the field, raking leaves, washing the neighbor's sidewalks and painting the fencing. Recognized as a national finalist in the 2009 Search for the Real Field of Dreams, the field is now a place that creates healthy minds, healthy bodies and opportunities for a bright future. Read Full Story

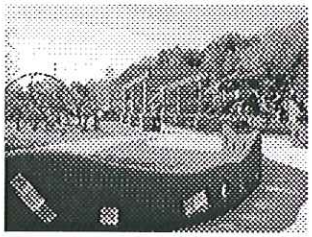
## Athletic Field Case Study: Old Dominion University - Norfolk, Virginia

After 70 years of hibernation, Old Dominion University decided to build a football program with a new synthetic turf field. The project meant a lot to this tight-knit community, who took their time to do things right. They faced challenges ranging from raising funds and dealing with weather problems to the sheer magnitude of the construction project. But the team prevailed and began their inaugural season in September 2009. All of their extra play and practice time on the synthetic turf field made a big difference – the football team finished with a 9-2 record, the best record ever for a first year program in NCAA history.



## Public Parks Case Study: City of Lakeland Parks & Recreation Department (Common Ground Park), Lakeland, FL

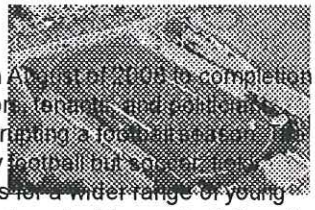
### 2010 Top Winner of the Search for the Real Field of Dreams (Community Parks and Fields Category)



Experts have found that encouraging social interactive play builds physical, emotional, social and cognitive development for children. With this in mind, the City of Lakeland Parks & Recreation Department in Florida opened Common Ground in 2009, its first inclusive playground featuring unique play experiences for children of varying physical and cognitive abilities. The park features over 25,000 square feet of synthetic turf play zones to connect barrier free play elements and edging to ensure kids remain as safe as possible. In the shape of a butterfly, Common Ground provides play opportunity for all kids including over 17,000 children with physical and cognitive challenges in the Lakeland community. Thousands of volunteers donated their time and fundraised for four years to make it a reality. Community partnerships and collaborations collected over $1.8 million dollars to fund Common Ground. All four Lakeland Rotary Clubs sponsored community runs. Butterflies in Flight, a public art project, raised awareness and dollars. State, county and municipal government matched funds with grants and in kind support. Common Ground is truly a community dream come true. Read Full Story

## Public Parks Case Study: City of Wauwatosa, Wauwatosa, WI

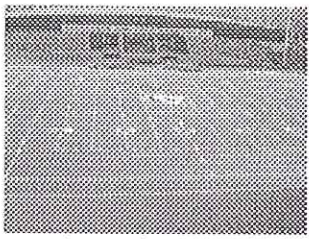
### 2010 National Finalist of the Search for the Real Field of Dreams (Community Parks and Fields Category)



Wauwatosa's new athletic field is located in Hart Park, which is owned and maintained by the City. The previous football field was a clay-based natural turf field, which deteriorated from overuse by five high schools and one semi professional football team. Between the loss of major tenants and constant construction, the park was being used less and less by residents. Something had to be done to demonstrate the City's commitment to the park as a destination and a positive contributor to the quality of life. The Hart Park field and athletic complex represented a true cooperative effort. From its inception in August of 2008 to completion in September of 2009, City staff, consultants, general contractors, sub contractors, tenants, and politicians collaborated closely to complete this project in less than 12 months without interrupting a football season. The results have been amazing. The synthetic field has generated interest in not only football but soccer, field hockey, lacrosse, and rugby as well. It provides new and expanded opportunities for a wider range of young athletes. Since 2009 the semi pro league has contracted to return and one of its tenants, Marquette University High School, completed an undefeated football season culminating in the state Division I championship. It will now be the home field for a NCAA Division III college lacrosse team and serve as the local site for the Regional USA Field Hockey Futures Program, which is the primary feeder program for the Olympics. Field rental requests have increased exponentially because the surface can withstand much more frequent use than the old natural turf field. With all these changes, Hart Park is a testament to what can be accomplished when a community pulls together toward a common goal. Read Full Story

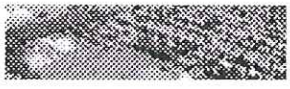
## Public Parks Case Study: Geneva Area Recreational, Educational, Athletic Trust (GaREAT), Geneva, OH

### 2010 National Finalist of the Search for the Real Field of Dreams (Community Parks and Fields Category)



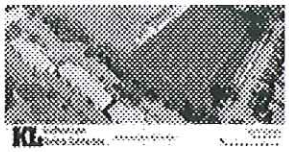
Geneva Area Recreational, Educational, Athletic Trust (GaREAT) is a non-profit corporation created to focus both energy and funding towards creating a world-class multipurpose facility. The GaREAT Sports Complex, announced in May 2008, sits on a 175-acre campus in Geneva, Ohio about 50 miles east of Cleveland. Focused on serving members from all ages and a variety of athletic abilities, the complex has three turf fields that can be used for football, soccer, lacrosse, baseball and softball. It's impact has been tremendous in the Northeast Ohio region, giving athletes and locals a place to work-out, train and compete year-long. It promotes public wellness with senior walking routes to regional competitions. Nationally recognized teams now have the chance to practice full field to help their game while local teams can compete and train in an environment that was not available before. Throughout their first year of opening, the facility has helped many teams from Ohio, Michigan, Indiana, Pennsylvania and New York train and compete. The GaREAT Sports Complex looks forward to creating more success stories in the future. Read Full Story

## Public Parks Case Study: West Hollywood Sports Complex – Hollywood, Florida

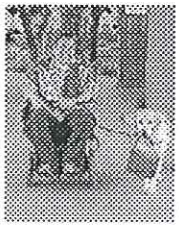


The West Hollywood Sports Complex in Hollywood, Florida provides services to the community in an area with limited recreational facilities. In renovating their 30 year old complex, they selected synthetic turf for the new community center's two

year old complex, they selected synthetic turf for the new community center's two playing fields – one for softball and baseball games, and the other for soccer and football. Switching away from natural grass yielded immediate cost savings and environmental benefits. The complex now saves $80,000/year in maintenance fees. They conserve eight million gallons of water annually and have eliminated the need for mowing, fertilization, pest control and returfing of wear areas. Now nearby residents have access to premier playing surfaces on a daily, year round basis.



## Landscape Case Study: Hawaii Canines for Independence – Maui, Hawaii

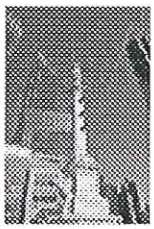


Hawaii Canines for Independence (HCI) is a charitable organization that provides disabled residents with specially trained dogs that give them the freedom and confidence to live more independent lives. When they needed more green space to train their assistance dogs, a leading industry provider donated a 3,000 square foot artificial grass system. Now HCI volunteers spend less time cleaning and maintaining the grounds and more time training dogs.

"Our new artificial lawn helps keep the dogs and the facility clean and the yard will be better for people in wheelchairs to use when practicing with their dogs," said Mo Maurer, founder and owner of HCI. "We are so thankful to have this big improvement."

## Landscape Case Study: Mandarin Oriental Hotel – New York, New York

"Every inch matters," is a term most New Yorkers have grown accustomed to. With limited room that costs a small fortune, using space efficiently is a must. The Mandarin Oriental Hotel understands this concept well. They installed a beautiful, 38th floor terrace yoga deck with an artificial grass system to maximize its outdoor space. Now hotel visitors have the opportunity to take pleasure in a lush green space overlooking the city. They're not the only ones. Other hotels, residential rooftops and parking decks in the bustling Big Apple are being covered in state-of-the-art synthetic grass products.



## Landscape Case Study: Twentynine Palms Marine Corps Base – Mojave Desert Region; Twentynine Palms, California

Located in the desert region of the Mojave Desert, conserving water at Twentynine Palms is a must. The world's largest Marine Corps base recently installed 12,000 square feet of state-of-the-art synthetic grass to help suppress water usage. That move allows them to save an average of 600,000 gallons of water per year - enough to fill 20 large swimming pools!

Now when military personnel and their families visit the amphitheatre and dog park areas, they can enjoy a lush, great looking green space year round. Synthetic grass also eliminates the need for fertilizers and pesticides which pollute the environment. It is softer and more inviting than hard surfaces and is non-allergenic, creating a safe area for children and pets.

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**NEWS RELEASE**

**DATE:** May 31, 2011

**MEDIA CONTACT:** Shira Miller/678-392-1785
Shira@shiramiller.com

## Synthetic Turf Becomes Latest Celebrity Trend

*A-Listers and Landmarks Conserve Water While Beautifying Grounds*

**(Atlanta, Ga.)** – The term "celebrity trend" typically conjures up images of $5,000 handbags, private airplanes or dancing on a reality show. But the latest A-Lister must-have is actually coming right out of their backyards. A growing number of celebrities like Jessica Alba, Kristen Bell and David Basche are going green by turning to synthetic turf for their landscape needs.

"I chose synthetic grass for Jessica Alba's backyard doggie oasis and use it at clients' homes as often as possible," said Kari Whitman, celebrity designer. "The eco-friendly synthetic turf looks so realistic and stands up to pet messes, wear and tear. I also love that it eliminates the need for pesticides and fertilizers, making your yard healthier for you and your pets. Plus it saves water and some cities will even give you a rebate on your utility bill. It's a win-win."

Synthetic turf is also helping landmarks and pop culture icons beautify landscape while saving water. In contrast to its famed "grotto" and legendary parties, the synthetic grass at the Playboy Mansion looks serene. The Pixie Hollow Fairy Garden at Epcot's International Flower & Garden Festival featured a lush, realistic synthetic grass lawn, which was accessible for wheelchairs and walking braces, and easily withstood the event's heavy foot traffic. Disney World and Disneyland also feature synthetic turf in designated areas throughout their resorts.

Synthetic turf for landscape and recreation is one of the fastest growing segments of the market. Able to be installed in places where grass can't grow or be effectively maintained, its numerous applications include residential, commercial and municipal landscape; airport grounds; pet parks; playgrounds and rooftops. The Southern Nevada Water Authority estimates that every square foot of natural grass replaced saves 55 gallons of water per year.

### About the Synthetic Turf Council

Based in Atlanta, the Synthetic Turf Council was founded in 2003 to promote the industry and to assist buyers and end users with the selection, use and maintenance of synthetic turf systems in sports field, golf, municipal parks, airports, landscape and residential applications. The organization is also a resource for current, credible, and independent research on the safety and environmental impact of synthetic turf. Membership includes builders, landscape architects, testing labs, maintenance providers, manufacturers, suppliers, installation contractors, infill material suppliers and other specialty service companies. For more information, visit www.syntheticturfcouncil.org.

###

"Our players love playing on the artificial turf surface. The change has been extremely beneficial to Tennessee Tech, the football program and to the student athlete experience. When we have a field that can maintain all that wear and tear, that's what is beneficial for a long-term financial investment."

**Mark Wilson**
**Athletic Director, Tennessee Tech**

# About Synthetic Turf

These days, synthetic turf seems to be everywhere. More than 5,500 athletic sports fields are currently in use throughout the United States. Millions of students have new opportunities to practice and play on a sports field that can always be counted upon. It has helped teams go from worst to first, intensified school pride and brought together entire communities.

Thousands of homes, businesses, golf courses, municipalities, playgrounds and public spaces have also turned to synthetic grass. This lush, attractive landscape solution requires minimal resources and maintenance while saving millions of gallons of water each year.

The positive environmental impact of synthetic turf is tremendous. Billions of gallons of water are conserved annually. Potentially harmful pesticides and fertilizers are eliminated, while emissions from gas-powered maintenance equipment is significantly reduced.

**Related Links**

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Grass without limits.

## Playground Artificial Turf

### Pixie Hollow Fairy Garden comes alive with synthetic Turf

**Epcot International Flower & Garden Festival showcases ForeverLawn**

March 2, 2011 (Albuquerque, NM) -- The Epcot International Flower & Garden Festival opens today at Walt Disney World in Orlando, Fla. The spring special event offers many surprises for visitors such as Disney character topiaries, a colorful array of flowers, and live music events, but guests may be most surprised to learn that the lush, green grass beneath their feet may be fake.

The Pixie Hollow Fairy Garden features a gorgeous green lawn, but like most attractions at the theme park, this grass is not what it seems. The playground's artificial turf is an incredibly realistic synthetic grass offering from ForeverLawn and DuPont that is not only accessible to wheelchairs and braces, but is also a beautiful, durable landscaping solution that can withstand the festival's heavy foot traffic.

If walking on this playground artificial turf isn't enough, the park also offers a playground where guests can roll, tumble, and play on it. Part of an overall safety system called Playground Grass, the playground artificial turf is safe for children to play on and safety rated to fall heights of 12 feet, so children lucky enough to visit the park can play safely.

ForeverLawn calls their Playground Grass product "the new generation of playground safety surfacing." A soft, accessible surface, Playground Grass provides children of all abilities the opportunity to play. Even children with allergies can romp on the playground's artificial grass, since the non-organic surface does not harbor allergens or insects.

This marks the fifth year that ForeverLawn's playground artificial grass has been part of the festival. The turf originally appeared in a DuPont display in 2007, and continues to draw amazement and attention from guests. "People ask us all the time if the grass is real," said Jim Davis, product portfolio manager, DuPont Landscape Systems. According to Davis, visitors at the display would bend down to touch the grass to make sure it is, in fact, artificial. "They don't believe us when we tell them it's artificial," he said.

More information about Playground Grass can be found at playgroundgrass.com. Visitors to the Epcot International Flower &

EPCOT INTERNATIONAL FLOWER & GARDEN FESTIVAL

Special Thanks to
**ForeverLawn, Inc.**
**www.foreverlawn.com**
for their participation in the Epcot International Flower & Garden Festival

Garden Festival can experience the unique playground artificial turf for themselves from March 2 through May 15, 2011.

**About ForeverLawn**

ForeverLawn provides innovative synthetic grass products to create better landscapes worldwide. In areas where real grass is difficult to grow or maintain—due to high traffic or poor conditions—ForeverLawn offers a realistic alternative that is beautiful, functional, and durable. In addition to its landscape lines, ForeverLawn also offers specialty products including K9Grass, SportsGrass, Playground Grass, GolfGreens, and SplashGrass.

ForeverLawn—Grass without limits. foreverlawn.com

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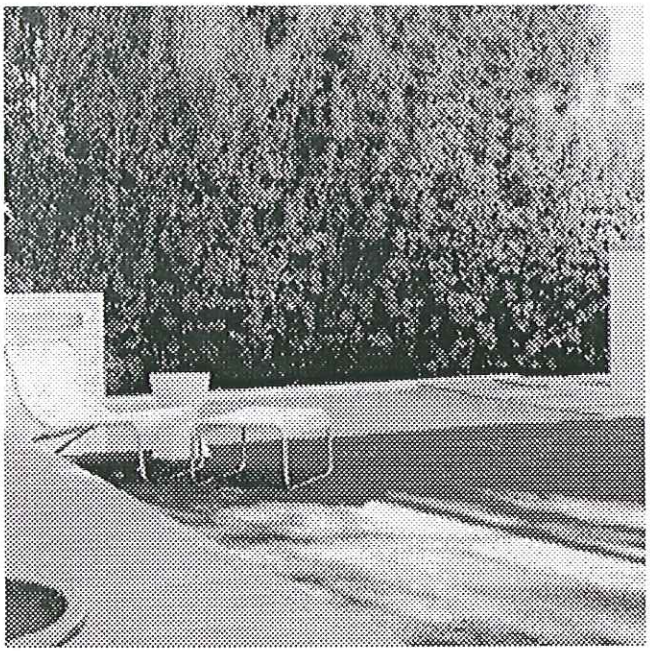
# Should you fake the lawn?

Get the pros and cons of synthetic grass and other low-care alternatives



Architect Tom Schaller installed a modern dipping pool in his Venice, CA, front yard. He envisioned lawn to complete the design. But Schaller didn't want to consume that much water. So he installed fake turf and got the look without the guilt. More in our blog

Tom Schaller

Lawns and the alternatives
Traditional lawn, synthetic lawn, native grasses, and drought-tolerant blends — the pros and cons

**more**

How to lose the lawn
Beautiful, easy-care alternatives to turf grass

**more**

Save water and $
Here's how to lessen your water footprint, save cash, and still have a beautiful yard

**more**

By Maile Meloy

There's just something beautiful and comforting about mown grass. Whether you're throwing a ball, lying in the shade on a hot day, or sitting outside on a warm night, a green lawn is a pleasure.

Writer Wallace Stegner, having grown up in dry, wild Saskatchewan, Canada, first saw a lawn at age 11 in Montana. "I stooped down and touched its cool nap in awe and unbelief. I think I held my breath — I had not known that people anywhere lived with such grace."

Lawns are also an environmental nightmare if you live in a dry climate, and Stegner did try hard to remind people of the natural aridity of the West. I live in Los Angeles, where millions of gallons of drinkable water are dumped into lawns every day, year-round.

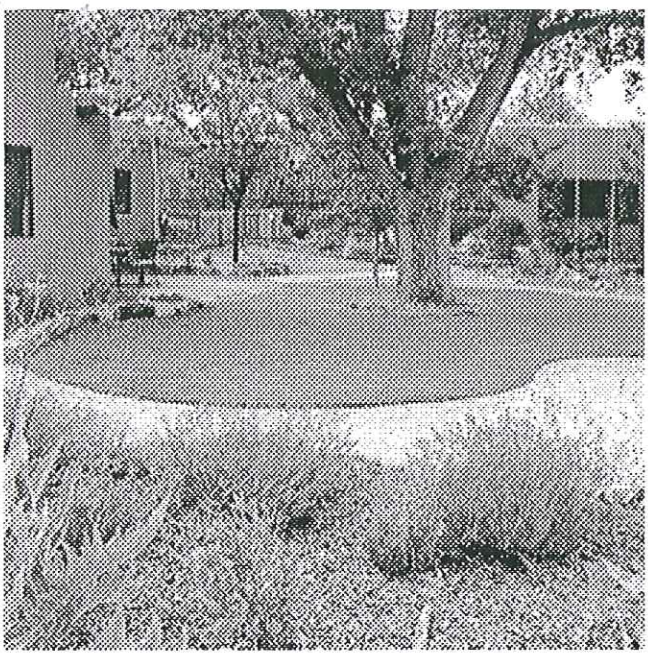
**Compare:** Lawns and the alternatives

Each of the hundreds of thousands of gas-powered push mowers that whine away, cutting that lushly watered grass, puts 11 times more pollution into the air every hour than a car. The leaf blowers — illegal in many areas but widely used anyway — are just as bad. The carbon footprint of L.A.'s lawns is enormous.

And then there's the constant, nerve-racking noise from all those mowers and blowers, on different lawns, on different days.

For a while, my husband and I dealt with the problem by not watering our lawn. Call it default xeriscaping: If you don't water, you miraculously don't have to mow. But it's not pretty. The weeds start to take over, and people stop picking up after their dogs, figuring that you don't really care. We did care about the grass — we just didn't want it to grow.

Then we went to a party at the house of a landscape designer who watered, she said, for only eight minutes a week, and did her own gardening, with no mowing. This was real xeriscaping: She had succulents, and drought-tolerant trees, and pink-flowering



This example is from the home of Nate Downey and Melissa McDonald of Santa Fe, NM. They are very aware of water scarcity but wanted a soft surface for their sons to play on. Artificial turf under their big Siberian elm was their solution. More in the garden blog
Sharon Cohoon

Real grass: soft, pretty, and thirsty
Leigh Beisch

Lawns and the alternatives
Traditional lawn, synthetic lawn, native grasses, and drought-tolerant blends — the pros and cons

**more**

How to lose the lawn
Beautiful, easy-care alternatives to turf grass

cactus, and Mexican beach pebbles — and two stunning green rectangles of perfect lawn in the back. "The grass," another guest whispered to me. "It's not real."

"It's not?" I asked. It looked gorgeously real.

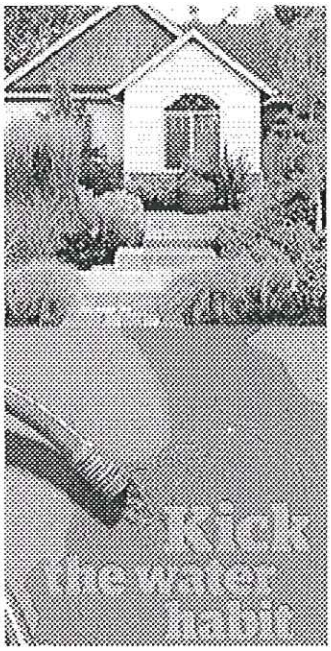
"Touch it," she said.

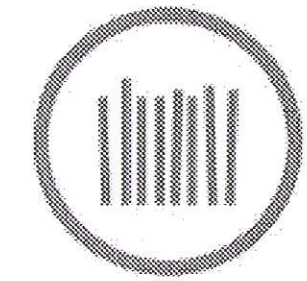
I did, and it was true: The grass was fake.

It wasn't Astroturf, exactly, but long, smooth blades of grass that looked exactly like real grass but happened to be plastic. It had been laid down like a carpet, over prepared ground. She hosed it off sometimes, and it drained itself. It wasn't cheap, but given that she didn't have to mow, water, reseed, or fertilize, it would pay for itself in eight years. And then there was the peace of mind, the quiet, and the conservation of water. We had a solution.

**Next: The backlash**

**more**





What we weren't prepared for was the backlash. We told a friend our plan, and she was horrified. It wasn't natural, she said. It was weird. A house should be surrounded by living things, not plastic. We should let what naturally grew there grow. But what naturally grows in my Southern California yard is scratchy stuff that snakes and lizards like to live in. Kids don't like to play on it, and our neighbors would run us out.

So we put in the plastic lawn. First the installers had to take out our pathetic weedy grass — no regrets there — and put down sand, so nothing would grow up from below. Then they compressed the sand, which is loud; we told ourselves we were doing all our noise polluting at once.

**More:** Kick the water habit

They rolled out the lawn in sheets, so cleverly that it's impossible to see the seams or the darts at the corners. It looks like we just put in the world's most pristine sod. My husband's brother came over soon after it was finished, and called me from his cell phone. He said, "I'm standing outside, but I'm not sure if I have the right house. It has this incredibly beautiful lawn." He was unconvinced that two people so lackadaisical about landscaping could grow such perfect grass. And he was right, of course.

My father has remained skeptical about the whole idea. He admits that it looks beautiful, but he can't get over the sound. The grass makes a plastic rustle that makes him laugh out loud. I'm told that if you hose it down, that sound goes away, but then you wouldn't be saving water. And the truth is, my father burns so many hours and so much gasoline mowing his lawns in Montana that he has no earthly right to laugh at a whispery rustle.

**Have a fake lawn?** Post a photo

You can get synthetic lawn that's late-summer long, or putting-green short, or somewhere in between. You can get dark green or light green, depending on the kind of grass that grows near you. You can even choose the color of the springy underlayer. Ours has variegated strands — some dark, some light — and looks especially real.

The best part? No pouring clean water into the grass. No burning gasoline to mow it. No fertilizer running into the sea.

People will stop and stare, and say how magnificent your lawn is. And you don't have to tell anyone it's fake. I always do, in the same way I blurt out that the dress I've been complimented on cost $19. But you can just let people think you have a very green thumb, and a silent, invisible mower. You can act like a girl in a real designer dress, and just say thank you.

**More:** Lawns and the alternatives

**Maile Meloy** | *From the* July 2009 Issue

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# *The Limpkin*

Newsletter of the
*Space Coast Audubon Society of Brevard County, Florida*

Space Coast Audubon Welcomes Dr. Ross McCluney to April Meeting

Florida Native Plant Society Welcomes Roger Hammer to April Meeting

Auction Items Needed

Birding World Series Needs Pledges

History of the American Lawn

Boreal Conservation Framework Lays Out Vision for Protecting Vital Breeding Grounds for Billions of North American Birds

*Chicken Soup for the Nature Lover's Soul* Features Foreword by John Flicker

Meeting Program and Field Trip Schedule

Archive


## History of the American Lawn

**By Cameron Donaldson**

Reprinted with permission from the Guide for Real Florida Gardeners, a free publication for homeowners, available at your local native nursery or Florida Native Plant Society chapter, or by calling Just Cause Media, 321-951-2210.

Some scientists believe that humans may be genetically encoded with a need to surround ourselves with low-growing turf grass. Tens of thousands of years ago in Africa, our ancestors stayed fit by chasing and being chased by big wild animals. The African savannas, large areas of low grasses, enabled human hunters to easily stalk their prey and spot predators at a distance.

Historians, however, believe that the human desire for lawns came about much later, in 17th century Europe, when the ruling royals flaunted their wealth by surrounding themselves with lawns. Lawns did a great job of showing off castles and manor homes. They also let the neighbors know that the lawn owner was so wealthy that he could afford to use the land as a playground, rather than a source of food. Thus, the lawn became a status symbol.

In the United States, early colonists were far too busy to be bothered with something as time-consuming and useless as a lawn. Their yards were cottage gardens planted with edible and medicinal plants and surrounded by paths and storage areas of hard-packed dirt, swept clean daily. And so it remained until enough wealth and leisure time was accumulated to start decorating the yard and creating play areas. Naturally our immigrant ancestors brought with them their Old World ideas-and Old World plants.

By the mid 1800s, the desire to emulate upper-crust Europe was in full swing. Literate Americans began to see magazine articles and books touting the lawn as essential for beautiful homes. At first, only the wealthy could afford the labor provided by hired staff to maintain lawns. Of course, this further cemented the idea of lawn as a status symbol. The push mower came on the scene in 1870 and suddenly almost any property owner who wanted to could have a lawn.

Seizing on this opportunity to push forward an "improved" lifestyle and supporting industry, the Garden Clubs of America, U.S. Department of Agriculture, and U.S. Golf Association jointly spread the gospel of grass

throughout the country in the early 1900s. Contests were held to reward lawn

owners. Garden writers focused on the neighborly desire to conform and acquire status. Lawns became not just an aesthetic issue but a moral imperative.

With ever-improving technology, gas-powered lawnmowers came on the scene and after World War II, chemical weapons manufacturers turned their attention to the lawn and the formidable perceived enemy: insects. Warehouses of potent chemicals turned into fertilizer and pesticide products. This came at the perfect time for the postwar boom era, when Americans everywhere became suburbanites and felt they needed lawns.

Fortunately for all of us, scientists like Rachel Carson (author of Silent Spring) came along to explain the danger that such chemicals presented to all life, including ours, and the modern environmental movement was born. Scientists and activists battled to institute legal protections for public health and welfare and continue to do so today. Thanks to their efforts, many homeowners already want to reduce or eliminate the use of chemicals in their home. Now we're beginning to recognize the need to reduce or eliminate lawns!

Read more on your own:

- The Landscaping Revolution, Garden with Mother Nature Not Against Her, Andy Wasowski, Contemporary Books, Contemporary Gardener Series, Chicago, 2000.
- The Lawn: A History of an American Obsession, Virginia Scott Jenkins, Smithsonian Institution Press, Washington D.C., 1994.
- Redesigning the American Lawn: a Search for Environmental Harmony, F. Herbert Bormann, Diana Balmori, and Gordon T. Geballe, Yale University Press, 1993.

Online:

- http://magazine.audubon.org/backyard/backyard0105.html
- http://www.primalseeds.org/lawns.htm
- http://www.traditionalgardening.com/Spring97/lawnbody.htm
- A number of interesting reference links are provided by AFNN member All Native Garden Center & Plant Nursery at: http://www.nolawn.com/moreaboutnolawns.html

# News

« News Listing « Previous Article Next Article »

## Synthetic Turf Installed in North America Conserves More Than Three Billion Gallons of Water,Eliminates Nearly a Billion Pounds

02/01/2011
Synthetic Turf Council

While millions of people, businesses, schools and homeowners use synthetic turf for landscape and play, one of its major beneficiaries is the environment. As of 2011, the estimated total amount of synthetic turf installed in North America annually conserves more than three billion gallons of water, significantly reduces smog emissions and eliminates close to a billion pounds of harmful fertilizers and pesticides. The industry has also recycled more than 105 million used tires.

"Synthetic turf has made a very positive impact on the environment," said Rick Doyle, President of the Synthetic Turf Council. "The synthetic turf industry continues to innovate to enhance synthetic turf's numerous eco-friendly benefits that empower users to reduce their carbon footprint."

**Significant Environmental Impact**

* Conserves over three billion gallons of water. Water is one of our most precious resources. More than 6,000 synthetic turf fields are currently being used in the United States, with each full-sized field saving between 500,000 to 1,000,000 gallons plus of water each year. During 2010, that meant at least three billion gallons of water, and perhaps as much as six billion or more, was saved through the use of synthetic turf fields.

* Eliminates the need to water lawns. According to the U.S. Environmental Protection Agency (EPA), over one-third of residential water is used for lawn irrigation nationwide, totaling more than 4 billion gallons of water a day. The Southern Nevada Water Authority also estimates that every square foot of grass replaced with synthetic turf saves an additional 55 gallons of water per year. Therefore, an average lawn of 1,800 square feet will save 99,000 gallons of water a year if landscaped with synthetic turf – about 70% of a homeowner's water bill, or up to $500.

* Eradicates the use of almost a billion pounds of pesticides and fertilizers. The EPA has identified runoff of toxic pesticides and fertilizers as a principal cause of water pollution. In Florida alone, the EPA estimates that about 1,000 miles of rivers and streams, 350,000 acres of lakes and 900 square miles of estuaries are impaired by runoff of pesticides and fertilizers. Synthetic turf eliminates the need for nearly a billion pounds of harmful pesticides, fertilizers, fungicides and herbicides which are used to maintain grass.

* Keeps more than 105 million used tires out of landfills. Most of the synthetic turf sports fields and landscape applications in use incorporate crumb rubber infill recycled from used tires, keeping more than 105 million used tires out of landfills.

* Depending on field usage, synthetic turf can lower consumption of energy, raw materials and solid waste generation. BASF Corporation performed an Eco-Efficiency Analysis measuring environmental and economical impacts of synthetic turf athletic fields with professionally installed and maintained grass alternatives. According to BASF, among the major findings of the study was that the average life cycle costs over 20 years of a natural grass field are 15 percent higher than the synthetic turf alternatives, even when factoring in a replacement synthetic turf field during that time. Released in November 2010, the life cycle assessment found that with typical field usage, synthetic turf had a lower consumption of energy, raw materials and solid waste generation than natural grass fields. BASF's eco-efficiency analysis is an award-winning and strategic tool, based on the ISO 14040 standard for lifecycle analysis, which quantifies the sustainability of products or processes.

* Prevents smog and noxious emissions. According to the EPA, lawn mowers are a significant source of pollution that impairs lung function, inhibits plant growth, and is a key ingredient of smog. A gas-powered push mower emits as much hourly pollution as 11 cars, and a riding mower emits as much as 34 cars. In addition, the EPA estimates that over 17 million gallons of gas and oil are spilled each year from refueling lawn equipment; that is more oil than was spilled by the Exxon Valdez.

* Reduces grass clippings. The EPA estimated in 2002 that 12% of what goes into landfills is yard waste. During the summer months, clippings can account for nearly half of a community's waste. Switching to synthetic turf reduces this significant source of environmental pollution.

Schools, parks, businesses, municipalities, homeowners, golf courses and others using synthetic turf can

Synthetic Grass Warehouse and Tiger Express Landscape Opens Mexico Division - 05/03/2011

Synthetic Turf Installed in North America Conserves More Than Three Billion Gallons of Water,Eliminates Nearly a Billion Pounds - 02/01/2011

McAnany Construction Upgrades Rockhurst High School Athletic Field with TigerTurf - 01/26/2011

New Leadership at TigerTurf Americas - 01/13/2011

TigerTurf to be Honored in Austin Reagan High School Field Unveiling - 01/11/2011

Austin Reagan High School to unveil renovated field - 01/04/2011

Boyle County Wins Second Straight 4A State Crown! TigerTurf Surface of Choice for Rebel Stadium - 12/03/2010

Improvements Continue at Turkey Hughes Field - 11/22/2010

TigerTurf Australia goes the Distance - 11/12/2010

Academy Charter School dedicates new turf field - 09/16/2010

Brecksville will host soccer field dedication at Blossom Hill on August 9 - 08/08/2010

Turf field helps Centre soccer camp - 07/14/2010

Ferncroft Country Club – Home of World TeamTennis Boston Lobsters – Opens for Season Sporting TigerTurf - 07/06/2010

TigerTurf Tennis Now Available through Newest Dealer, RhinoSports - 06/29/2010

Goals Soccer Center Chooses California Ultimate Turf to Install 80,000 Sq Feet of TigerTurf for 11 Fields at First U.S. Facility - 06/02/2010

Project of the Year Features 1.2 Million Square Feet of TigerTurf! - 05/13/2010

receive Leadership in Energy and Environmental Design (LEED) credits for Water Efficient Landscaping, Stormwater Design, Recycled Content and Rapidly Renewable Materials from the U.S. Green Building Council. Many synthetic turf companies have also created products that are 100% recyclable. 'Green' options also exist for recycling, reusing and disposing of infill and the synthetic turf itself. The industry is working hard to develop further eco-friendly end-of-life disposal solutions.

About the Synthetic Turf Council

Based in Atlanta, the Synthetic Turf Council was founded in 2003 to promote the industry and to assist buyers and end users with the selection, use and maintenance of synthetic turf systems in sports field, golf, municipal parks, airports, landscape and residential applications. The organization is also a resource for current, credible, and independent research on the safety and environmental impact of synthetic turf. Membership includes builders, landscape architects, testing labs, maintenance providers, manufacturers, suppliers, installation contractors, infill material suppliers and other specialty service companies. For more information, visit www.syntheticturfcouncil.org.

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TigerTurf™, Cal Turf a Roaring Success for Arena Soccer Park - 04/21/2010

Cardinal Newman High School Chooses Advanced ProTrophy Turf™ by TigerTurf - 04/07/2010

Southern Ideal Home Show Chooses TigerTurf to Showcase Featured Home - 03/29/2010

EKU's home field advantage on TigerTurf - 03/25/2010

TigerTurf Proudly Announces New Authorized Representative: GreenCreation - 03/09/2010

TigerTurf - World Leading Synthetic Turf Manufacturer - Announces Latest Authorized Dealer: New England's 360 Sports Systems - 03/02/2010

Kentucky's Centre College Campus transformations include TigerTurf in Farris Stadium! - 01/28/2010

Lake Erie Crushers Win Frontier League Crown! TigerTurf Surface of Choice for Crusher's All Pro Freight Stadium - 09/24/2009

Soccer Complex Debuts In OP - 08/30/2009

New soccer park is a big score in the eyes of Overland Park - 08/23/2009

TigerTurf, Eurograss unveil Brickell Rooftop Soccer in Miami - 07/21/2009

New turf surface at Roy Kidd Stadium near completion - 07/20/2009

New OP soccer complex gets national tournament - 06/16/2009

Developing a Winner - 06/01/2009

TigerTurf installation begins at Elgin - 05/27/2009

Stadium on schedule: Future home of the Crushers set to open June 2 - 04/30/2009

Weather is tough opponent for spring sports - 04/22/2009

All Pro Freight Stadium Uncovered - 04/13/2009

Hanger Field to Undergo Change in Playing Surface - 04/08/2009

Men work non-stop on All Pro Freight Stadium for Crushers' home opener - 03/11/2009

Hawks ready for season to start Sunday - 02/10/2009

Practice time: Lehigh laxers set to begin season - 01/16/2009

TigerTurf Takes the Field - 10/20/2008

TCNJ's football triumphs on Homecoming, 24-7 - 10/18/2008

Heisman Winner Mike Rozier to Participate in TCNJ Homecoming - 10/17/2008

Heisman Winner Mike Rozier to Appear at North Allegheny High School Dedication - 10/16/2008

Texas Sports Builders Tabbed with ASBA Award - 10/16/2008

Former Area of Tragedy Turned into "Green" Recreational Area with TigerTurf EnviroField - 10/16/2008

Royse City High School's New TigerTurf Is "Number One Field" in Texas - 10/09/2008

Legendary All-Star Game Inaugurates Bradford High's New TigerTurf - 09/22/2008

Spring-Ford set to debut turf field - 09/19/2008

Stadium welcomes new turf - 09/10/2008

Edwardsville opens new field in style - 09/10/2008

Women's Soccer Opens New Finnesey Field with 3-0 Win Over Saint Peter's - 09/05/2008

Finnesey Field Facelift Construction Completed - 09/03/2008

City of Castle Rock Selects TigerTurf for Two Fields at Bison Park - 07/18/2008

TCNJ Hosts the Sunshine Classic on Trophy Turf - 07/07/2008

TigerTurf's Most Advanced Product -- Trophy Turf™ – to be Inaugurated at The College of New Jersey - 07/02/2008

Finnesey Field Facelift Proceeds as Planned - 06/06/2008

Special Exhibit – TigerTurf's Most Advanced Synthetic Turf Presented at the NACDA Convention! - 06/03/2008

TigerTurf™, Challenger Sports Joining to Raise Bar for Soccer and Make Camps Available to Disadvantaged Youth in U.S., Canada - 02/25/2008

TigerTurf Proudly Announces Texas Sports Builders as Authorized Representative - 01/07/2008

Edison High Announces Grand Opening of New TigerTurf™ Field System! - 12/18/2007

Texas High Schools Find TigerTurf More Grass Like, Better Quality - 11/12/2007

Vigalli Joins TigerTurf International Network of Full Service Synthetic Turf Manufacturing Facilities - 10/31/2007

Big Mexico contract for TigerTurf - 09/10/2007

Sports Construction Group, TigerTurf Coming to Ohio's Medina City School District - 06/18/2007

In New Canaan, Conn., Waveny Park Sports "Top of the Line" TigerTurf - 05/15/2007

Global Synthetic Turf Manufacturer - TigerTurf - Bringing State-of-the-Art Manufacturing Facility to Americas - 03/20/2007

TigerTurf Synthetic Field System "Exceeds Expectations" at Concord University - 01/23/2007

SCG's Latest Partner Has a World-Renowned Roar when it comes to Turf - 11/12/2006

TigerTurf International Now a Licensee to the FIFA Quality Concept - 06/06/2006

Global Turf Manufacturer - TigerTurf International Enters Americas to Produce High Technology Synthetic Turf Surfaces Locally - 05/16/2006

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CapitolAlert®

The latest on California politics and government

July 15, 2011

# Jerry Brown vetoes artificial turf bill backed by conservationists

Gov. **Jerry Brown** has vetoed legislation that would have required homeowners associations to let people replace their lawns with artificial turf, the governor's office announced today.

Senate Bill 759, by Sen. **Ted Lieu**, D-Torrance, was supported by water conservationists and passed by the Legislature with some bipartisan support. It would have prohibited associations, which often govern the aesthetics of a neighborhood, from banning artificial turf.

"A decision to choose synthetic turf over natural vegetation is best left to individual homeowners associations, not mandated by state law," the Democratic governor said in his veto message.

Lieu fired a testy Twitter message or two at Brown last month after the governor vetoed the first budget passed by Democratic lawmakers. But Lieu said this afternoon that he didn't think the veto was in retribution.

"It does appear to me that Jerry Brown is looking at each bill on its merits and then making his decision," he said.

***PHOTO CREDIT:*** *Artificial turf at Granite Park, January 22, 2007. Florence Low / Sacramento Bee file photo*

**Categories:** Bills (2011-2012 session) , Gov. Jerry Brown

Posted by **David Siders**
3:50 PM | 28 Comments | Share

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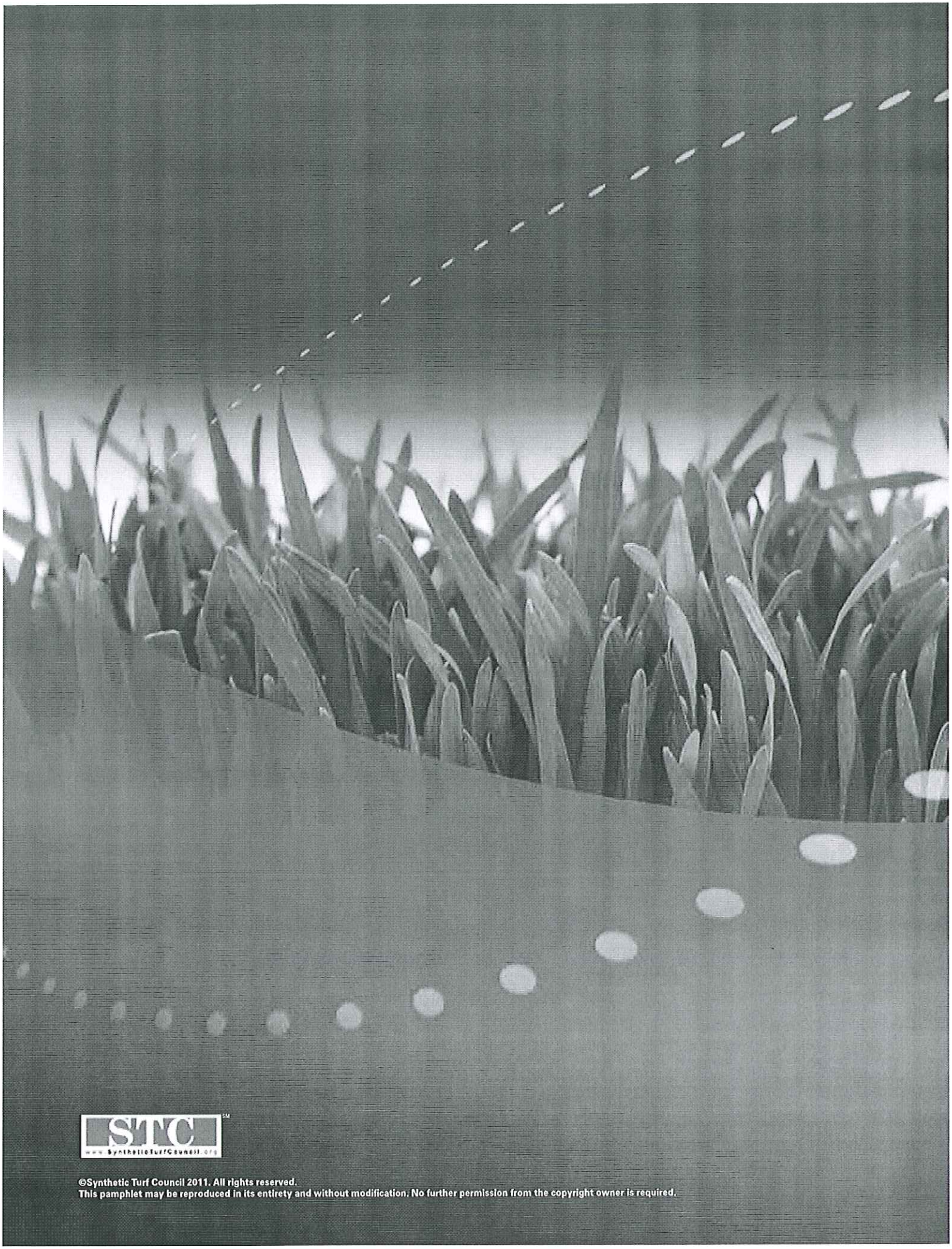
STC℠
www.SyntheticTurfCouncil.org

# Synthetic Turf 360°

## A Guide for Today's Synthetic Turf



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# Synthetic Turf 360°

A Guide for Today's Synthetic Turf

2011

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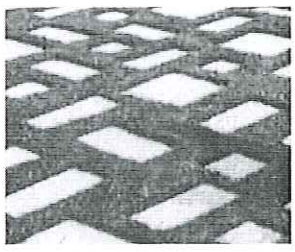


# Why Synthetic Turf?

**There are many reasons why synthetic turf has become so popular.**

A heightened sense of environmental awareness prompts interest in its ability to conserve billions of gallons of water each year. Increased user requirements and intense competition have given rise to a new generation of synthetic turf systems that replicate the look and playability of natural, lush grass.

Athletes enjoy significantly more playing time without the need for resource-intensive maintenance. Homeowners, businesses, parks, municipalities and government entities use synthetic grass as an attractive landscape solution that saves time, money and water.

*The Synthetic Turf Council (STC) created this guide to showcase the numerous uses and benefits of synthetic turf. It features information about athletic fields and the growing landscape and recreation category, which includes parks, playgrounds, homes, businesses, golf courses and more.*

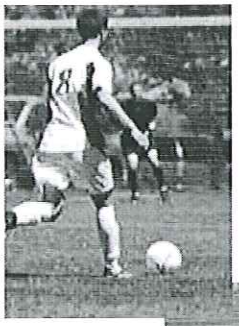
If you would like to learn more, we invite you to visit www.syntheticturfcouncil.org. Thanks for your interest in synthetic turf!

# Athletic Fields

**Popular, versatile solution**

At the beginning of 2011, more than 6,000 synthetic turf fields were being used in North America by a growing number of high school and collegiate athletes playing and practicing football, soccer, hockey, baseball, rugby, lacrosse and many other sports.

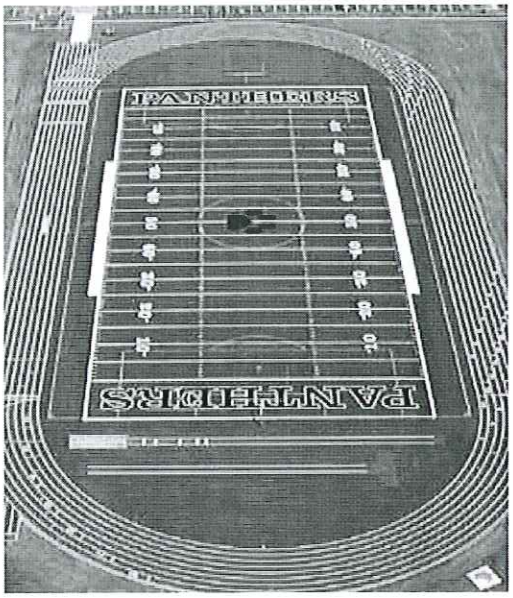
*About half of all NFL teams currently play their games on synthetic turf and, since 2003, over 70 FIFA U-17 and U-20 World Cup matches have been played on synthetic turf soccer fields.*



## Significant environmental benefits

Depending on the region of the country, one full-size synthetic turf sports field saves 500,000 to 1,000,000 gallons of water each year. During 2010, between 3 billion and 6 billion gallons of water were conserved through its use. According to the EPA, the average American family of four uses 400 gallons of water a day.[1] Therefore, a savings of 3 billion to 6 billion gallons of water equates to the annual water usage of over 20,000 to 40,000 average American families of four.

*For a multi-use field in Texas, where there is little rain, the water savings is much greater. School officials with the El Paso Independent School District stated that their 10 new synthetic turf sports fields will save more than 80 million gallons of water every year, or 8 million gallons of water per field.*




**The estimated amount of synthetic turf currently installed has eliminated the need for nearly a billion pounds of harmful pesticides and fertilizers, which has significant health and environmental implications.**

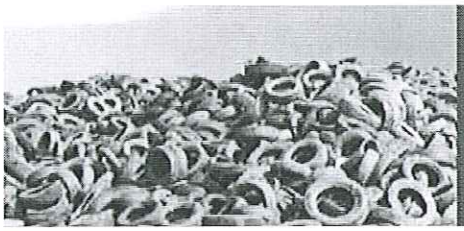
## Example:

In a July 7, 2007, article entitled "Grass Warfare," the Wall Street Journal states, "The pesticides used in lawn-care products found on shelves nationwide are considered legal by government standards. But broader research on health risks from such chemicals has prompted general warnings. The EPA, which regulates pesticide use, notes on its own website that kids are at greater peril from pesticides because their internal organs and immune systems are developing." [2]

According to the North Carolina Department of Environment and Natural Resources polluted storm water run-off is the No. 1 cause of water pollution in their state, with common examples including over-fertilizing lawns and excessive pesticide use.[3]

The EPA has identified run-off of toxic pesticides and fertilizers as a principal cause of water pollution. According to that federal agency, approximately 375,000 acres of lakes, 1,900 miles of rivers and streams and 550 square miles of estuaries in Florida are known to be impaired by nutrient pollution, a primary source of which is excess fertilizer.[4]

[1] WaterSense, an EPA publication, www.epa.gov/watersense/pubs/indoor.html
[2] Gwendolyn Bounds, "Grass Warfare" (Wall Street Journal, July 7, 2007)
[3] Stormwater FAQs (North Carolina Department of Environment and Natural Resources website)
[4] Public Q&A Index – Florida (EPA website)



**Most of the 6,000-plus synthetic turf sports fields in use today use crumb rubber infill recycled from used tires, keeping more than 105 million tires out of landfills.**

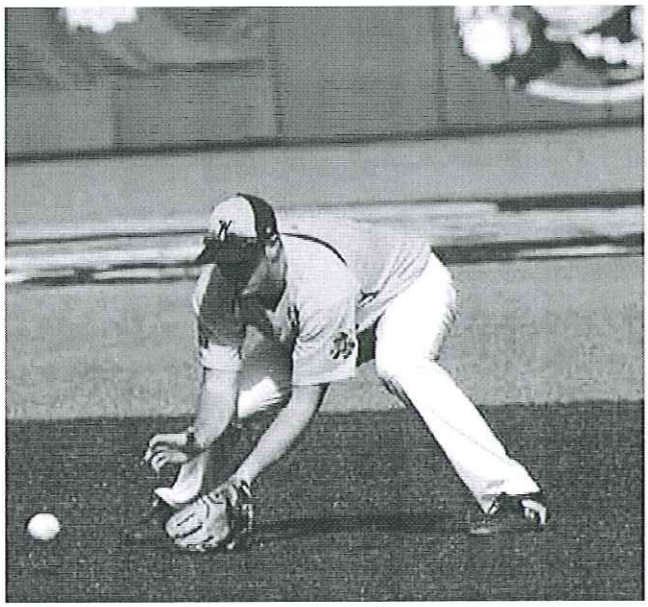
**Synthetic turf helps reduce noxious emissions.**

According to the EPA, "lawn mowers emit high levels of carbon monoxide, a poisonous gas, as well as hydrocarbons and nitrogen oxides that contribute to the formation of ground level ozone, a noxious pollutant that impairs lung function, inhibits plant growth and is a key ingredient of smog."[5] The EPA also reports that a push mower emits as much pollution in one hour as 11 cars and a riding mower emits as much as 34 cars.[6]

In 2010, a BASF Corporation Eco-Efficiency Analysis, which compared synthetic turf athletic fields with professionally installed and maintained grass alternatives, concluded that synthetic turf can lower consumption of energy and raw materials and generation of solid waste depending on field usage. BASF also found that the average life-cycle costs over 20 years of a natural grass field are 15 percent higher than the synthetic turf alternatives.

A synthetic turf company and STC member has forged a recycling partnership with Yellowstone National Park to divert nearly 300 million plastic bottles from landfills each year. The plastic bottles will be recycled into select synthetic turf products and backing for carpet.

Using synthetic turf can help environmentally conscious builders and specifiers with LEED® (Leadership in Energy and Environmental Design) project certification from the U.S. Green Building Council in the areas of Water Efficient Landscaping, Recycled Content, Rapidly Renewable Material and Innovation in Design.



*"With synthetic turf, we use a lot less water. It used to be 3 million gallons of water each year with regular grass and now we probably use a tenth of that amount."*

— Bob Sube, Director of Facilities and Construction, Fillmore Unified School District, California

[5] Your Yard and Clean Air. EPA Office of Mobile Sources. (Fact Sheet OMS-19. May 1998)
[6] Small Engine Rule to Bring Big Emissions Cuts. (EPA News Release. April 17, 2007)

## Increased playing time and safety

Synthetic turf can be utilized around 3,000 hours per year with no "rest" required, more than three times that of natural grass. This creates increased practice and play time as well as the valuable flexibility to use your field for other events. The opportunity to be active and participate in sports is critical for the fitness, mental health, self-esteem and leadership development of youth.

It is a smart solution for playing fields that have become unsafe from overuse or severe climatic conditions. A grass field simply cannot remain lush and resilient if it is used more than three to four days a week, in the rain, or during months when grass doesn't grow. Rain-outs are eliminated since highly permeable synthetic turf quickly drains excess water off the field.

**Made with resilient materials for safety, synthetic turf sports fields provide a uniform and consistent playing surface.**

Traction, rotation and slip resistance, surface abrasion and stability meet the rigorous requirements of the most respected sports leagues and federations. Some of the published studies of the comparative safety of synthetic turf include:

- A 2004 NCAA study among schools nationwide comparing injury rates between natural and synthetic turf; the injury rate during practice was 4.4% on natural turf, and 3.5% on synthetic turf.

- An analysis by FIFA's Medical Assessment and Research Centre of the incidence and severity of injuries sustained on grass and synthetic turf during two FIFA U-17 World Championships. According to FIFA, "The research showed that there was very little difference in the incidence, nature and causes of injuries observed during games played on artificial turf compared with those played on grass."[7]

- Three 2010 long-term studies published by researchers from Norway and Sweden comparing acute injuries on synthetic turf and grass. The studies examined the type, location and severity of injuries sustained by hundreds of players during thousands of hours of matches and training over a four-to-five-year period. Many types of acute injuries to men and women soccer players, particularly knee injury, ankle sprain, muscle strains, concussions, MCL tears and fractures were evaluated. The researchers concluded that the injury risk of playing on artificial turf is no greater than playing on natural grass.[8]

*These studies and many more, including the FIFA comparative results of its exhaustive research, are posted on the Synthetic Turf Council's website under Research & Latest Thinking.*

[7] "Very Positive Medical Research on Artificial Turf" (Turf Roots Magazine 01, pp. 8-10, FIFA)

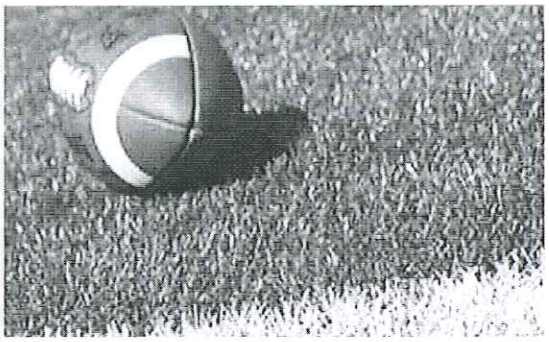
[8] Bjorneboe J, Bahr R, Andersen TE (2010) Risk of injury on third generation artificial turf in Norwegian professional football. British Journal of Sports Medicine 44: 794-798.

Ekstrand J, Hagglund M, Fuller CW (2010) Comparison of injuries sustained on artificial turf and grass by male and female elite football players. Scandinavian Journal of Medicine and Science in Sports. DOI: 10.1111/j.1600-0838.2010.01118.x

Soligard T, Bahr R, Andersen TE (2010) Injury risk on artificial turf and grass in youth tournament football. Scandinavian Journal of Medicine and Science in Sports. DOI: 10.1111/j.1600-0838.2010.01174.x

## Cost-effectiveness

According to Cory Jenner, a landscape architecture professional in Syracuse, N.Y., the cost of installing and maintaining a synthetic turf sports field over a 20-year period (including one replacement field) is over three times less expensive per event than the cost of a grass field over the same period of time. This is because many more events can be held on a synthetic turf sports field. This cost-per-event advantage is validated by other authorities and field owners.



Because synthetic turf can withstand so much wear and tear, many schools rent their fields to local sports teams and organizations to bring in extra funding. At Cincinnati's Turpin High School, the field is rented 80 percent of the evenings between January and October — raising $40,000/year for the last two years from rental fees.

*"The synthetic field completely revolutionized our sports program. We now have a multi-dimensional facility with activities scheduled year-round, nearly around the clock. Along with football, Newman Field now hosts an incredible range of activities — intramural sports, lacrosse sports, lacrosse playoffs, soccer leagues, local high school events, such as sports camps, cheerleading competitions and much more."*

— Rob Coleman, Athletic Director, Whittier College, California

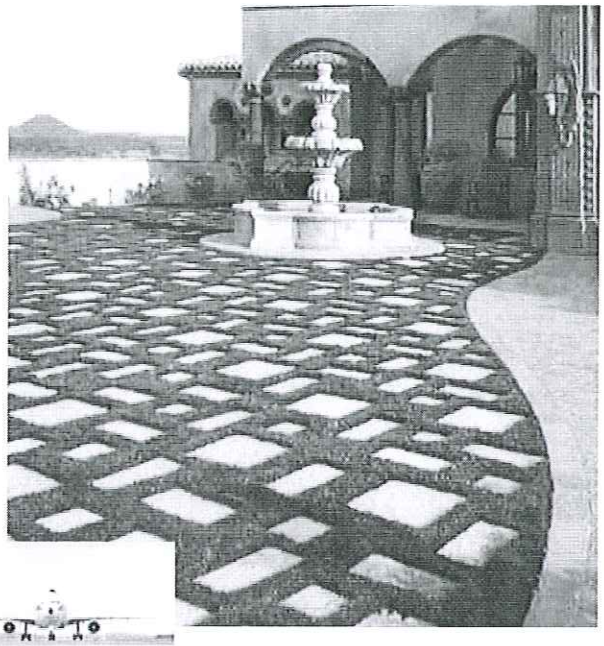
# Landscape and Recreation

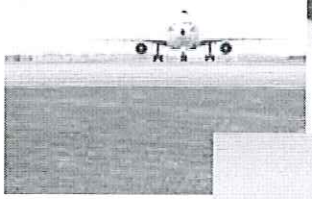
### Various applications

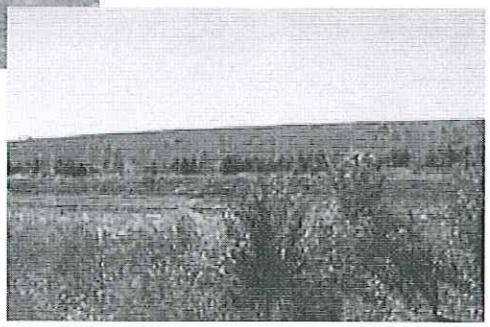
Beautifully landscaped synthetic turf can often be installed in places where grass can't grow or be effectively maintained.

### Applications include:

- Airport grounds
- Businesses/commercial developments
- Golf courses
- Highway medians
- Homes/residential communities
- Municipalities
- Parklands
- Pet parks
- Playgrounds
- Rooftops
- Tennis courts
- Closed landfills







Closed Landfill

## Eco-friendly solution

From Disneyland and the Wynn Hotel to the Twentynine Palms Marine Corps Base and your neighbor's yard, thousands of homes, businesses, golf courses and public spaces have turned to synthetic grass to provide a lush, attractive landscape solution that requires minimal resources and maintenance.

Water conservation is a necessity. In March 2011, Wharton published a report about the growing scarcity of water. It references a prediction by the 2030 Water Resources Group that by 2030 global water requirements will be "a full 40 percent above the current accessible, reliable supply." Further, less than 3 percent of all available water is fresh and drinkable. Underground aquifers hold almost all the potable water available in liquid form, and their rate of depletion more than doubled between 1960 and 2000.[9] Yet, the EPA states that nationwide landscape irrigation is estimated to account for almost one-third of all residential water use, totaling more than 7 billion gallons per day.[10]

Synthetic turf promotes greater utilization of land, as you can do more with the same space surfaced with synthetic turf than with natural grass. Rooftops once deemed unusable for high-rises and residential buildings can now feature inviting green areas. Hotels that had to restrict the use of the lawns for parties and events can now schedule as many functions as they can book.

The Southern Nevada Water Authority estimates that every square foot of natural grass replaced saves 55 gallons of water per year.[11] If an average lawn is 1,800 square feet, then Las Vegas homeowners with synthetic turf could save 99,000 gallons of water each year or about $400 annually. In Atlanta, homeowners could save $715 a year, not including much higher sewer charges.

In its report, "Municipal Solid Waste in the United States, 2009 Facts and Figures," the EPA estimates that 33.2 million tons of yard trimmings were generated in 2009, the third largest component of Municipal Solid Waste in landfills.[12] As yard trimmings decompose, they generate methane gas, an explosive greenhouse gas and acidic leachate.[13]

A June 2008 National Public Radio report called "Water-Thirsty Golf Courses Need to Go Green" reported "Audubon International estimates that the average American golf course uses 312,000 gallons of water per day. In a place like Palm Springs, where 57 golf courses challenge the desert, each course eats up a million gallons a day. That is, each course each day in Palm Springs consumes as much water as an American family of four uses in four years."[14]

Impermeable synthetic turf is being used as an economical and environmentally effective solution for the closure of landfills, mine spoils and hazardous sites. Among the many reasons: it provides a perennially green landscape cover; dramatically reduces construction and long-term maintenance costs; improves stability; prevents erosion; controls gas and odor; and reduces leachate.

*"The inclusion of synthetic grass in our landscape has proven to be a smart choice for the resort and Mother Earth. Since the conversion, we are able to accommodate increased capacity and utilize a greater percentage of grassy areas, while providing an enhanced event experience, without damaging the grass. This year, there will be 8 million gallons of water conserved and our new synthetic lawn allows us to eliminate the use of fertilizers, pesticides and herbicides on ground in close proximity to the beach."*

— Rodrigo A. Carrillo, Project Manager, Fontainebleau Hotel, Miami Beach, Fla.

[9] "Valuing Water: How Can Businesses Manage the Coming Scarcity?" (Wharton School of the University of Pennsylvania, March 2011)
[10] Outdoor Water Use in the United States, (EPA 832-F-06-005, August 2006)
[11] Water Smart Landscapes Rebate (Southern Nevada Water Authority website)
[12] Municipal Solid Waste in the United States, 2009 Facts and Figures, (EPA Office of Solid Waste, EPA530-R-10-012, December 2010)
[13] Frequent Questions about Yard Trimmings, (EPA website, December 2010)
[14] Frank Defendi, "Water-Thirsty Golf Courses Need to Go Green," (National Public Radio, June 11, 2008)

## Saves money

A growing number of tax credits and rebates are available since synthetic turf conserves water. For example, the Central Basin Municipal Water District in California reports that Golden State Water Company customers replacing their irrigated areas with synthetic turf can save $1 per square foot, up to a $1,000 rebate.

*Many public spaces, from government grounds and highway medians to airport entrances, are turning to synthetic grass for appealing, water-saving landscape solutions that reduce operating and maintenance expenditures.*

Rooftop Garden

## Promotes accessibility

Play areas are among the public spaces covered by the Americans with Disabilities Act. The 2010 Standards for Accessible Design (Sections 240, 1008) addresses play areas designed, constructed and altered for children ages 2 and over in a variety of settings, including parks, schools, childcare facilities, shopping centers and public gathering areas. According to the standards, "the surfaces that are universally accessible and go beyond ADA to be actually usable for children with disabilities include artificial grass with rubber underneath. The benefit of these surfaces besides the accessibility is the maintenance. You do not need to do daily maintenance to ensure that safety is maintained."[15]

Making recreation for the disabled as inclusive as possible is a growing priority. "Inclusive recreation is one of the fastest growing needs in more and more parks and recreation agencies across the United States," said Elizabeth Kessler, 2009-2010 National Recreation and Park Association president, during the 11th annual National Institute on Recreation Inclusion conference in November 2010.

Synthetic turf creates more recreation opportunities for people with disabilities and physical challenges. Wheelchairs roll easily and crutches won't sink into park and landscape surfaces, like those used by the Miracle League nationwide to help youth with physical disabilities play baseball.

Many retirement communities use extensive amounts of synthetic turf for landscaping to assist residents with mobility challenges. People using wheelchairs, canes or walkers can easily move across the turf. Because they are easy to maintain, synthetic turf surfaces also offer seniors the beauty of a decorative lawn without the expense, labor and time of weekly yard work during much of the year.

*"Our new artificial lawn helps keep the dogs and the facility clean and the yard will be better for people in wheelchairs to use when practicing with their dogs. We are so thankful to have this big improvement."*

— Mo Maurer, founder and owner of Hawaii Canines for Independence

[15] Fact Sheet: Adoption of the 2010 Standards for Accessible Design (ADA website)

## Promotes safety and security

Local communities need accessible, versatile play surfaces for its youth and people of all ages. Parks and playgrounds that use synthetic turf allow kids to be active year-round on safe and resilient sports surfaces.

With synthetic turf, kids and parents don't have to worry about mildew and bacteria from wet mulch, allergies associated with natural grasses or other potential health irritants.

Owners of second homes that landscape with synthetic turf don't need a lawn maintenance crew that may be tempted by a vacant home.

*"In 2009 the City of Lakeland opened Common Ground, our first inclusive playground featuring unique play experiences for children of varying physical and cognitive abilities. We utilized synthetic turf to cover over 25,000 square feet of play zones to connect our barrier free play elements. The surface creates the natural looking green environment so critical to our design, provides barrier free safety fall zones that protect our children, drains almost instantly even after a tropical torrential rain and it remains cooler than other safety surface options. Maximizing our children's outdoor play time, Common Ground is a community dream come true."*

— Pam Page, Assistant Director of Parks & Recreation, City of Lakeland Parks & Recreation Department, Lakeland, Fla.

Common Ground Park, Lakeland, Florida

## Community and lifestyle enhancement

By making continuous and safe play possible, synthetic turf promotes a healthy lifestyle, which enhances community well-being. It also helps increase childhood fitness, an important objective of the "Let's Move!" program championed by First Lady Michelle Obama, and the NFL's "Play 60" campaign.

Synthetic grass creates low-maintenance, pet-friendly lawns that keep man's best friend safe and healthy while controlling odors.

Homeowners remove the headaches of ongoing lawn care, adding more leisure time back into their already busy lives.

*Synthetic turf can come in many colors, like the orange, blue and yellow grass at the Sunflower Preschool Playground at Barnett Family Park in Lakeland, Florida.*

Pixie Hollow Fairy Garden, 2011 Epcot International Flower and Garden Festival, Disney World, Orlando, Florida

Ready to get started with synthetic turf?
Visit our Online Buyers Guide and Member Directory at www.syntheticturfcouncil.org.

www.syntheticturfcouncil.org

Audubon
3/2002



# GOING THE EXTRA YARD

introduction by ***jennifer bogo***

Barbecues and picnics, freeze tag and laughter. The yard is a place where neighbors gather, kids play, and pets frolic. It's where you go to read on a warm afternoon, or catch fireflies in the cool of the evening. The first piece of nature as you walk out your door. Or is it?

Yards have long been considered places where wilderness is not so much cultivated as tamed. Places of gadgets and gizmos--sprinklers, sprayers, seeders, shears. With Japanese beetles to be fought and dandelions to stifle, products like Weed-a-Bomb and the Flame Gun soon filled out the arsenal. Pre-made lawns could be bought and unfurled like sheets on a bed of suburbia, and mowed without even having to set foot on the ground.

Advertisements whetted Americans' appetites for golf-course-like greens. Scotts Weedfree Seed and Turf Builder in 1944 promised a "carpet of sparkling green turf [that] will be the pride of the family and the envy of the neighborhood." In 1959 the Porter-Cable Machine Company encouraged buyers to hop on its Yard Master mower and "watch the crowds gather." To many, lawns represented status that could be sowed. Today they cover more U.S. land--25 million acres--than any single crop.

"They have proven to be a very expensive ecologic and economic symbol," points out Bret Rappaport, the director of Wild Ones, a nonprofit organization that encourages landscaping with native plants as an alternative to the vast swaths of monoculture widespread today. "An exotic landscape requires life support," he says. "One has to alter the environment for it to survive. And life support isn't cheap--it requires pesticides, fertilizers, and water." In fact, a typical U.S. lawn, one-third of an acre in size, receives as much as 10 pounds of pesticides, 20 pounds of fertilizer, and 170,000 gallons of water annually. What's more, in a year a homeowner could spend the equivalent of a 40-hour workweek simply mowing that lawn (producing pollution equal to that created by driving a car 14,000 miles) and hundreds of dollars caring for it.

Natural landscaping, on the other hand, harmonizes a yard's plant life with the greater ecological community--the species already adapted to the local climate--while eliminating the need for costly maintenance. Whereas nitrogen and phosphorous fertilizers, along with chemical herbicides and pesticides, easily run off conventional lawns and into water sources, the varying root lengths of native plants actually reduce this "non-point-source pollution" by anchoring soil and absorbing water. Natives also attract a variety of local wildlife and provide respite for millions of migrating birds that, in turn, disperse seeds, pollinate plants, and keep insect populations

### What You Can Do

If you'd like a copy of the "Audubon Guide for a Healthy Yard and Beyond," or if you have a natural landscaping story to share, send an e-mail to Audubon At Home.

For information about landscaping with natives, contact Wild Ones, which was started in 1980 and now educates its 3,000 members through 40 local chapters, a handbook, and a national publication. Call Wild Ones at 877-394-9453.

that, in turn, disperse seeds, pollinate plants, and keep insect populations in check.

"Anybody can do this in their own backyard," says Diana Balmori, coauthor of *Redesigning the American Lawn: A Search for Environmental Harmony*. "It's not rocket science." Start by reducing the amount of lawn itself, she suggests, and replace it with a more diverse plant community. Then layer what you plant, since different heights provide shelter for different insects and birds. Whenever possible, use grasses and plants that are native to your area--and thus adept at growing in boggy, steep, or exposed spots. This vegetation should need no more water than rain and snow provide.

You can feed grassy areas by mixing the seeds with clover, which as it's cut becomes a natural source of nitrogen, or by applying organic fertilizers such as lawn clippings and compost. "All of these things are common sense, and they can be found in the same nursery that's pushing monoculture," Balmori says.

"People want to make a difference at home, in the communities where they live," says Noel Gerson, vice-president of Audubon At Home, a national program that was recently launched to support this transformation. "And they want the information to do that." Like the people profiled here, residents of Tampa, San Antonio, and Seattle don't have to look far to find hands anxious to help them on the path to a healthier yard. Audubon chapters in these cities spread the message of natural landscaping through programs that teach the nuts and bolts of conserving water, cutting down on chemical use, and providing wildlife habitat. While more examples exist, these three prove that conservation can be easy wherever you live, and it can be accomplished one yard at a time.

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tampa, florida, by ***jeff klinkenberg***

## WASTING NO WATER

### *What You Can Do*

Floridian Charner Reese (left) uses native species such as Chickasaw plum and muhly grass (below) in place of a water-thirsty grass lawn. Native plants are less energy-intensive while imparting a regional look.

If you're wondering where to buy native plants in the Tampa area, the local

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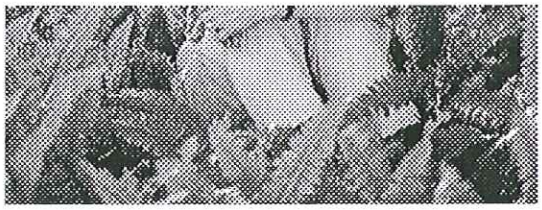

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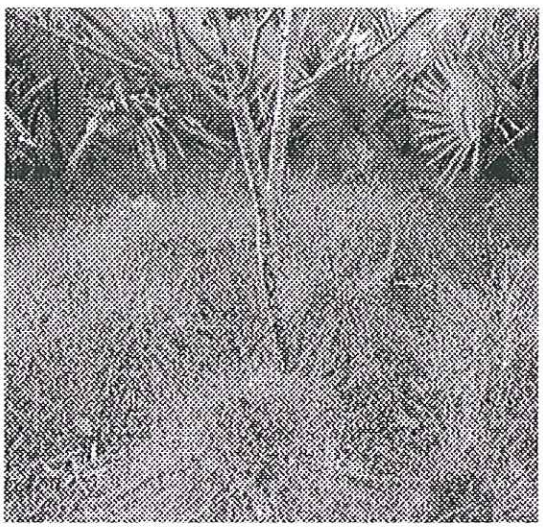
Audubon chapter serves as a clearinghouse of materials for breaking the St. Augustine grass habit. Call Tampa Audubon at 813-983-0258, or e-mail tampa.audubon@verizon.net.

**1.** "Let's go get rid of some grass," says Charner Reese, grabbing a hoe and marching toward a lawn that should be wilting with fright. Her sacrilege is taking place in a Florida suburb where most folks worship--and water--their lawns. Reese, an environmental planner, and her husband, Tom, an environmental lawyer, are different from their neighbors. During the past decade they have removed their greedy lawn inch by inch and replaced it with native vegetation that's far less thirsty and much kinder to wildlife.

Pines, palmettos, cypresses, Chickasaw plums, and cabbage palms are slowly taking over their Tampa yard. Under the trees is a riot of wildflower pinks, reds, and yellows.

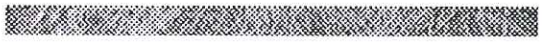
A green tree frog watches near the American beauty berry; a mockingbird sings from the red cedar. Yes, those are flamingos perched beneath the magnolia. They're plastic, of course. The Reeses may dislike traditional landscapes, but they are Floridians, after all.

And like most Floridians, they know how to push a lawn mower. They are simply loath to do it. "My vision for my yard is not to have any lawn at all," says Charner, who moved to Florida as a child and received a master's degree in botany from the University of Florida in 1979. It's not unfair to call her an earth mother, with her skin brown from the sun and her arms and back strong from toting bags of wood chips. She flinches when she hears her neighbors' leaf blowers.



"When my lawn turns brown I do nothing," she says. "When it rains again it usually turns green. But if it doesn't, I just get rid of it and plant a native." She swings her hoe again and executes a small patch of St. Augustine, the found-in-every-yard grass species known for its appetite for water and pesticides.

Years ago the Reeses would have been declared



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un-American. In fact, Tom Reese once defended a homeowner who defied a landscape ordinance in coastal Florida by refusing to have a real lawn. Tom managed to keep the man from becoming a scofflaw, and the ordinance became extinct. But the dark ages haven't entirely disappeared. In the drought-plagued Tampa region, the average citizen uses 132 gallons of water a day--about half of it in the yard. The Southwest Florida Water Management District now encourages area residents to replace grass with native vegetation, and Tampa's Audubon chapter conducts "healthy habitat" monthly seminars to help homeowners learn how.

"It's like fighting the American Dream," says Ged Caddick, president of Tampa Audubon, who points out that many local communities are still deed-restricted, which means residents are required to maintain that perfect field of green. "But examples like the Reeses," he says, "show that a yard that doesn't require a lot of water or chemicals can look nice, that it can be aesthetically pleasing and easy to maintain."

"It was pretty easy," Charner Reese agrees. First she and Tom made a diagram of their yard. Then they decided what they wanted to plant and headed for a nursery that sells only Florida natives. Although over the years the Reeses have spent about $400 on nearly three dozen plant species, they're sure they have more than paid for their new landscaping with a lower water bill.

"We don't even have a sprinkler," Charner says. She waters only by hand and only after she has put a new plant into the ground. Once a native is established, she says, it usually does fine. Even her grass thrives. Of course, her new variety, muhly grass, is a native. "I found a baby black snake under a patch of it," says Charner, who values snakes so much she even tossed a rubber serpent in a hedge for good luck.

Alas, the workman who arrived to fix an awning must have been startled. He chopped off the rubber snake's head. After the Reeses teach their city to value native landscaping, perhaps they can mount a public relations campaign on behalf of snakes.

Jeff Klinkenberg *is the author of two essay collections on Florida history and culture.*

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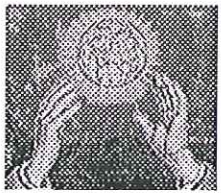
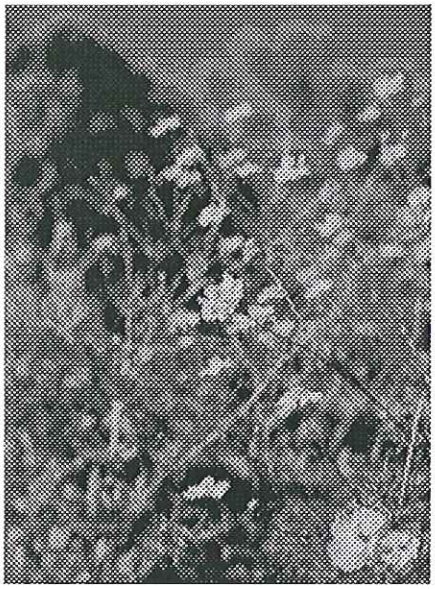
san antonio, texas, by ***kelly bender***

## CUTTING OUT CHEMICALS



rocks. In the spring, purple martins swoop and swirl in feeding frenzies. "Dragonflies are everywhere," Marjie says, "and they're so good about eating the mosquitoes."



© Brent Humphreys

Marjie is convinced that none of this would be possible if she and her husband used harsh chemical pesticides. "Hummingbirds need the little mites they find in flowers," she says, "and songbirds have to have insect protein when they feed their nestlings in the summer." All native insects, from the lovely butterflies to the lowly aphids, are subject to natural predators, but Marjie has yet to experience a plague of any particular species. And as for a safer fertilizer? "A little fish emulsion goes a long way," she says, her hazel eyes twinkling.

The Christophers' yard is a place of harmony, where humans work with nature instead of against it. Now neighbors who once scoffed ask for their advice, which Marjie, a member of the Bexar Audubon Society and a

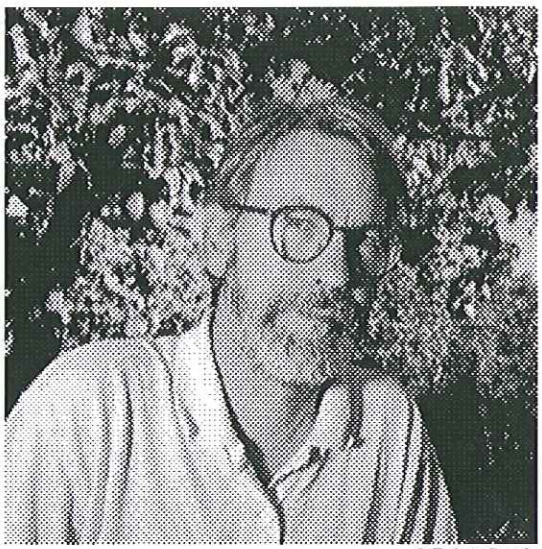
volunteer with the Texas Master Naturalists, is eager to give. "She knows her plants well and has learned quite a bit about environmentally friendly pest control," affirms Patty Leslie Pasztor of Bexar Audubon, who plans to include a stop at the Christopher yard in a spring "wildscaping" workshop the chapter is staging. "Marjie is really willing to share her garden and knowledge with others."

That becomes obvious with one look at her landscaping, which spills out onto the utility easement adjacent to the backyard. The area has become a place where neighborhood adults gather to talk and trade plant cuttings and seeds, and where neighborhood children play among the shrubs, grasses, and flowers. Though her own roots are planted firmly in the Texas soil, Marjie looks across her homemade Eden and sighs, "It's like being a million miles away."

Kelly Bender, *a wildlife biologist, recently coauthored a book on gardening for wildlife.*

Audubon
3/2002

# WOOING THE WILDLIFE



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## What You Can Do

Don Norman (left) has watched many a contented waxwing feast on the native serviceberry along the back of his garden. The Bosc pear tree (below), which Norman planted for his own snacking, is a variety adapted to the local climate, so besides being pest-resistant, it rarely loses fruit to a late cold snap.

Just ask Seattle Audubon if you'd like a copy of a booklet full of other regional tips, or if you'd like a Gardening for Life workshop brought to your Seattle neighborhood. Call 206-523-8243, extension 14, or e-mail laurenb@seattleaudubon.org

***3.*** It's easy to miss Don Norman's driveway, on a quiet street in northern Seattle. It seems to disappear into a lush landscape of cedar, vine maple, and snowberry. Follow it past a tall stand of Pacific wax myrtle, the leafy branches swaying with the movement of seed-gobbling warblers, and you'll come to an opening in the trees, where Norman's modest house sits next to a manmade pond ringed by ferns. Nearby, a downy woodpecker drums against a Douglas fir snag that is riddled with ragged holes--the nesting sites of northern flickers and chickadees.

Standing quietly in the clearing, Norman slips binoculars over an unruly thatch of brown hair. He is watching a golden-crowned sparrow peck at leaf litter. As a wildlife toxicologist who bands and studies migratory birds, he has seen this individual before. "This bird is trap-happy," he says. "I've caught and examined it several times in the past week, and it's definitely gaining weight for winter."

Other bird sightings on his half-acre lot practically leap off the pages of his carefully kept notebook: a ruby-crowned kinglet that spent the winter, three fox sparrows that made their debut this year. Then there was the Costa's hummingbird--the second ever sighted in Washington--that found the yellow blooms on Norman's broccoli so appealing that it stayed for two weeks, attracting a steady stream of local birders. More than 70 species of birds have landed in his yard since he began his tally in 1980.

Norman, a member of the Seattle Audubon Society's conservation committee, opens up his yard to other visitors, too--anyone who is interested in the chapter's Gardening for Life program and wants to see the concept in action. "Don accepts that it takes time to transform a yard into real habitat," says Lauren Braden, program director. "It's easy to get overwhelmed by the idea, but there are very simple things that will make a yard more friendly and healthy to wildlife."

"The part of Gardening for Life that really hit home with me was the idea of leaving things alone--not cleaning up in fall, not trying to have a perfect

of leaving things alone—not cleaning up in fall, not trying to have a perfect yard," says Norman. He leaves piles of brush and garden clippings for Bewick's wrens to pick over in winter, as well as a swath of uncut grass where towhees can forage undisturbed. The seeds of overwintering mustards are so enthusiastically devoured by finches and siskins that he now plants extra mustard.

Norman didn't always visualize his yard as one seamless wildlife habitat. When he moved in, two decades ago, he was faced by an overgrown tangle of Himalayan blackberry and holly. He

planned a landscape of varied uses: an organic vegetable garden with fruit trees and vines, and a wildlife garden of native trees and shrubs. But as he [illegible] its way [illegible] the [illegible]erty, removing invasives and [illegible] discovers a rich intermingling of the two gardens.

[illegible] herb sect[illegible] is sunny and open, and many birds, like [illegible] find it irresistible. Flocks of bushtits, working [illegible] fennel plant for insects, make room for an Anna's [illegible] as it [illegible] briefly on its way to the porch feeder. A border [illegible] provides shelter and early fruit for robins and waxwings, which make forays into the garden for insects. Along the garden's perimeter, Norman is planting more native shrubs, such as snowberry and red-flowering currant, to extend the wildlife space. In a recently cleared spot, he extends the food garden by adding raspberry canes.

And if a few of Norman's berries make a meal for a flicker? Given the rewards of habitat gardening, he is more than willing to share.

Claire Hagen Dole *was the publisher of* Butterfly Gardeners' Quarterly *for seven years.*

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# Photos of Synthetic Turf Uses

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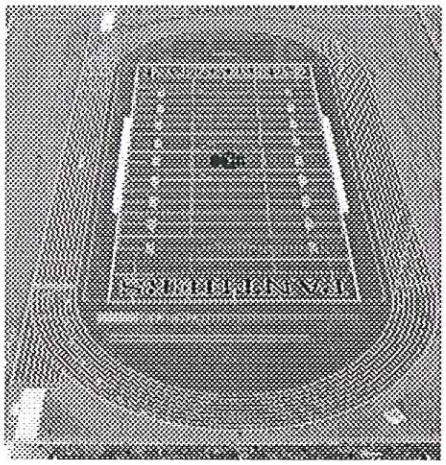
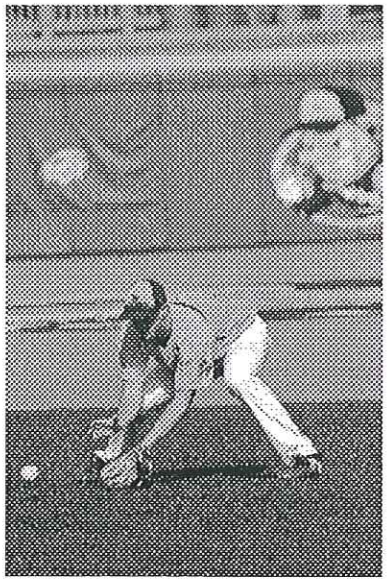
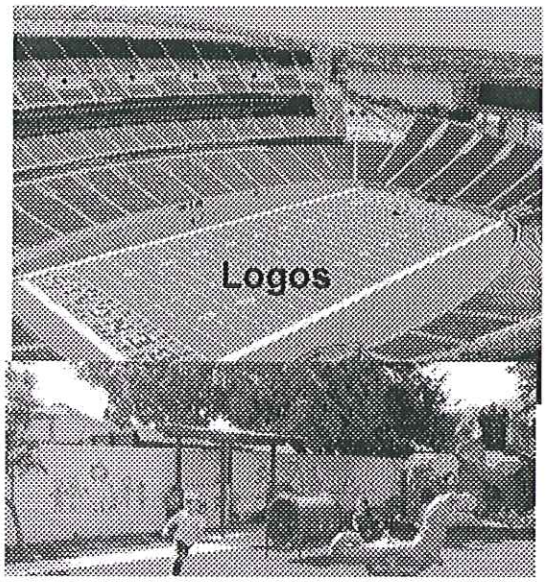
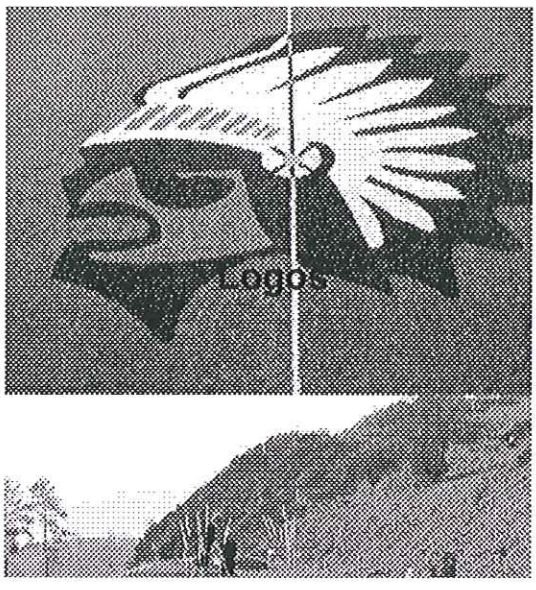


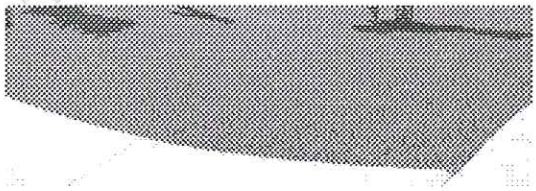
**Sports Fields**



**Sports Fields**





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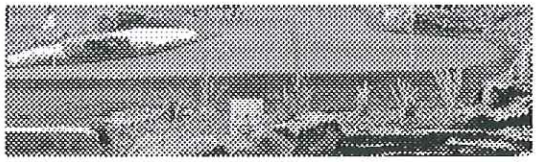
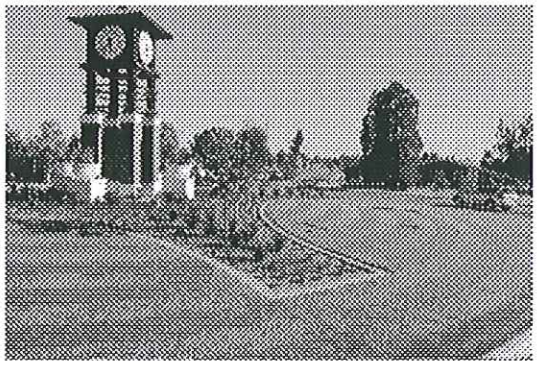


Golf

Landscape



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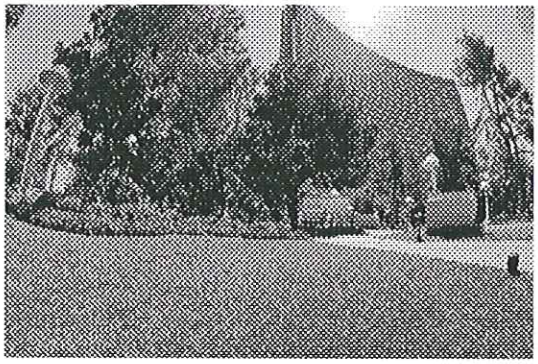

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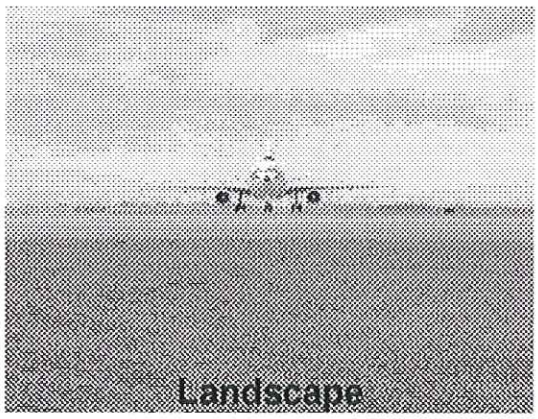
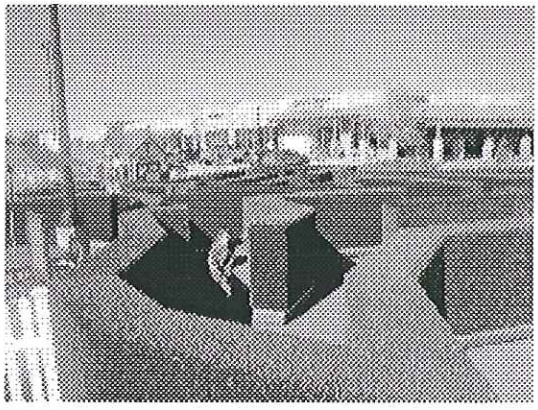


Landscape

Pet Turf



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Performing your original search, ***artificial or synthetic turf***, in PubMed Central will retrieve ***124273*** records.

Environ Health Perspect. 2008 March; 116(3): A116–A122. PMCID: PMC2265067

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**Environews**
Focus

# Synthetic Turf: Health DebateTakes Root

Luz Claudio

This article has been cited by other articles in PMC.

In Little League dugouts, community parks, professional athletic organizations, and international soccer leagues, on college campuses and neighborhood playgrounds, even in residential yards, the question being asked is "grass or plastic?" The debate is over synthetic turf, used to blanket lawns, park spaces, and athletic fields where children and adults relax and play; the questions are whether synthetic turf is safe for human and environmental health, and whether its advantages outweigh those of natural grass. Despite or perhaps because of the fact that it is too early to definitively answer those questions, the debate is fierce.

New York City, which buys the largest amount of synthetic turf of any U.S. municipality, held a hearing 13 December 20007 on the use of synthetic turf in city parks. There is a clear need for open space in the city. The 28,700 acres of land constituting some 4,000 parks are distributed unevenly throughout the city. "Many districts have no green parks, not even one," said Helen Sears, a city council member representing the Jackson Heights neighborhood, during the hearing.

New York City Department of Parks & Recreation commissioner Adrian Benepe wants to address the need for parks and athletic fields by installing not only natural grass fields and lawns but also synthetic turf. "With quality recreational facilities—which means, in some cases, synthetic turf fields—we will be able to better confront this issue," he says. In New York City, he points out, at least 35 synthetic turf fields are or will be a replacement for asphalt surfaces.

Others oppose the move toward synthetic turf. "Grassroots organizations have been working hard to have pesticide use reduced or banned in places where it is unnecessary," says Tanya Murphy, a board member of Healthy Child, Healthy World, an advocacy organization. "Now we're going from the frying pan and into the fire when replacing grass with synthetic turf."

The debate leaves many on the fence. Orlando Gil, an assistant research scientist at New York University and soccer coach, is weighing both alternatives: "We want children to play outside, exercise, and play sports, but with pesticides and fertilizers in grass and chemicals in artificial turf, I don't know which to choose."

Indeed, a dearth of research on the nonoccupational human health effects of exposure to the constituents of synthetic turf hampers the ability to make that choice with any degree of confidence. On the basis of limited toxicity data, some reports have concluded the health risks are minimal. Most agree, however, that far more

research is needed before the question can be definitively answered. In the 13 December 2007 issue of *Rachel's Democracy and Health News*, William Crain of the City College of New York Psychology Department and Junfeng Zhang of the University of Medicine & Dentistry of New Jersey School of Public Health called conclusions of minimal risk "premature."

## A Turf History

During the 1950s, the Ford Foundation studied ways to incorporate physical fitness into the lives of young people, particularly in cities where outdoor play areas were scarce. Ford joined Monsanto Industries to create an artificial surface on which children could play sports. In 1964 the first artificial playing surface was marketed under the name Chemgrass.

Meanwhile, the first domed stadium was being built in Houston, Texas. The Astrodome, with its retractable translucent plastic ceiling, let in enough sunshine to maintain a natural grass field. But after the first baseball season, it was clear there was a problem. The plastic panes produced a glare that made it difficult for players to see the ball. This problem was solved by painting the panes black—but then the grass began to die from lack of sunlight. By the beginning of the second season, the Astros were playing on dead grass and painted dirt. At this time, production of Chemgrass was limited, but what little was available was installed in the Astrodome. By the end of the 1966 season, the material had been renamed AstroTurf. The green nylon carpet was a success.

The popularity of AstroTurf grew steadily during the 1970s and 1980s, with most of its use in professional sports arenas. However, a backlash began to unfold when players started to complain about the surfacing. The English Football Association banned synthetic turf in 1988, mainly because of complaints from athletes that it was harder than grass and caused more injuries. Similar concerns were growing in the United States. A poll conducted by the National Football League Players Association in 1995 showed that more than 93% of players believed playing on artificial surfaces increased their chances of injury. This sentiment was famously expressed by baseball player Dick Allen: "If a horse won't eat it, I don't want to play on it."

The movement against AstroTurf gained traction, and many ballparks were converted to natural grass during the 1990s. One example was Giants Stadium in New Jersey, which had used AstroTurf since its construction in 1976. The stadium was refitted with a system of 6,000 removable trays of natural grass. Even the new stadium in Houston, built to replace the original Astrodome, was surfaced with grass.

In this story of grass, the balance is tilting once more against the natural kind. Natural grass, under some circumstances, cannot consistently withstand the demands of sports where a lot of running is involved. Parallel to this back-and-forth controversy over which is best have come new developments in the manufacture of synthetic turf. Several companies, including the makers of the original AstroTurf, have come on the market with new playing surfaces.

FieldTurf, for example, is made of a blended polyethylene–polypropylene material woven to simulate blades of grass. The "grass" is held upright and given some cushioning by adding a layer of infill made of recycled tires, rubber particles 3 mm in diameter or smaller. This crumb rubber infill is sometimes mixed with silica sand. Many stadiums that switched to grass from AstroTurf have since switched back to FieldTurf-style synthetic turf.

Figures from the Synthetic Turf Council, a trade organization based in Atlanta, show that 10 years ago there were 7 new-generation fields installed in the United States. Today there are 3,500. Says Geoffrey Croft, president of the nonprofit New York City Parks Advocates, which promotes public funding and increased park services, "There are millions of square feet of synthetic turf already installed on fields around the country, and not one environmental impact statement has been issued."

## Human Health Questions

Given the relatively recent development of new-generation synthetic turf, there are unanswered questions regarding its potential effects on health and the environment, with the rubber infill one of the main sources of concern. The crumbs become airborne and can be breathed in and tracked into homes on clothes and athletic gear. There are also questions about dermal and ingestional exposures, and about ecosystem effects.

For athletes, the little black rubber pellets may seem little more than a nuisance. Others express more concern, especially when it comes to children's exposure to the infill. Patti Wood, executive director of the nonprofit Grassroots Environmental Education, argues, "This crumb rubber is a material that cannot be legally disposed of in landfills or ocean-dumped because of its toxicity. Why on earth should we let our children play on it?"

Recycled crumb rubber contains a number of chemicals that are known or suspected to cause health effects. The most common types of synthetic rubber used in tires are composed of ethylene–propylene and styrene–butadiene combined with vulcanizing agents, fillers, plasticizers, and antioxidants in different quantities, depending on the manufacturer. Tire rubber also contains polyaromatic hydrocarbons (PAHs), phthalates, and volatile organic compounds (VOCs).

According to the Rubber Manufacturers Association, only 8 states have no restrictions on placing tires in landfills. Most of these restrictions have to do with preventing pest problems and tire fires, which release toxicants such as arsenic, cadmium, lead, nickel, PAHs, and VOCs.

Some studies suggest that the same chemicals that can be released profusely during a tire fire may also be released slowly during deterioration of crumb rubber. For instance, researchers at the Norwegian Institute of Public Health presented a report at the 2006 meeting of the International Association for Sports Surface Sciences on turf-related chemicals in indoor stadiums. The report, *Artificial Turf Pitches: An Assessment of the Health Risks for Football Players*, showed that VOCs from rubber infill can be aerosolized into respirable form during sports play. The authors calculated health risk assuming the use of recycled rubber granulate, which releases the lowest amounts of these chemicals of any type of rubber infill.

The report concluded that, given current knowledge, the use of synthetic turf indoors does not cause any elevated health risk, even in vulnerable populations such as children. However, the report continues, "It should also be noted that little or no toxicological information is available for many of the volatile organic compounds which have been demonstrated as being present in the air in the [indoor stadiums]. . . . [Furthermore], not all organic compounds in the [stadium] air have been identified." In particular the report called for more information regarding the development of asthma and airway allergies in response to exposure to the latex in many tires.

Similarly, the California Office of Environmental Health Hazard Assessment (OEHHA), in the January 2007 report *Evaluation of Health Effects of Recycled Waste Tires in Playground and Track Products*, concluded that 49 chemicals could be released from tire crumbs. Based on an experiment simulating gastric digestion, the OEHHA calculated a cancer risk of 1.2 in 10 million assuming a one-time ingestion over a lifetime—well below the 1 in 1 million *di minimis* risk threshold. In a hand-wipe experiment, the OEHHA calculated an increased cancer risk of 2.9 in 1 million for ingestion of chrysene (a suspected human carcinogen found in tire rubber) via hand-to-mouth contact with crumb rubber infill. This estimate assumed regular playground use for the first 12 years of life and was termed by the authors to be "slightly higher" than the *di minimis* level.

In the summer of 2007, Environment and Human Health, Inc. (EHHI), a nonprofit organization headquartered in North Haven, Connecticut, commissioned a study from the Connecticut Agricultural Experiment Station to determine whether toxic compounds from crumb rubber could be released into air or water. The report *Artificial Turf* describes identifying 25 chemical species with 72–99% certainty using mass spectrometry–gas

chromatography. Among those definitively confirmed were the irritants benzothiazole and *n*-hexadecane; butylated hydroxyanisole, a carcinogen and suspected endocrine disruptor; and 4-(*t*-octyl) phenol, a corrosive that can be injurious to mucous membranes.

The Synthetic Turf Council said in a statement issued on 13 December 2007 that "Claims of toxicity [in the EHHI report] are based on extreme laboratory testing such as the use of solvents and high temperatures to generate pollutants." But the EHHI stands by its studies. *Artifical Turf* author David Brown, EHHI's director of public health toxicology, says, "It is clear the recycled rubber crumbs are not inert, nor is a high temperature or severe solvent extraction needed to release metals, volatile, or semi-volatile organic compounds." Brown asserts that the laboratory tests approximate conditions that can be found on the field, and that no solvent besides water was used.

According to Brown, the basic barrier to accurately assessing the safety of recycled tire rubber is the high variability in tire construction and the lack of chemical characterization of the crumb rubber. "Very few samples have been tested," he says. "There is no study with sufficient sample sizes to determine the potential hazard." He adds, "Since new tires contain vastly different amounts of the toxic materials, based on the intended use, it is impossible to ensure players or gardeners and others that their personal exposure is within safe limits."

Another debated health issue is that of injuries. Several studies published in a supplement to the August 2007 issue of the *British Journal of Sports Medicine* reported no differences in the incidence, severity, nature, or cause of injuries in soccer teams who played on grass versus new-generation synthetic turf. However, injuries may depend on the type of sport being played. A five-year prospective study of football injuries among high school teams published 1 October 2004 in *The American Journal of Sports Medicine* showed that there were about 10% more injuries when games were played on synthetic turf than when played on grass surfaces. Conversely, the risk of serious head and knee injuries was greater on grass fields.

Injuries lead to another concern: infection with methicillin-resistant *Staphylococcus aureus* (MRSA), which is thought to spread especially easily among athletes because of repeated skin-to-skin contact, frequency of cuts and abrasions, and sharing of locker room space and equipment. A study conducted by the Centers for Disease Control and Prevention and published in the 3 February 2005 issue of the *New England Journal of Medicine* showed that, although synthetic turf itself did not appear to harbor MRSA, the greater number of turf burns caused by the abrasive friction of this type of surface increased the probability of MRSA infection, especially among professional athletes playing on hard surfaces.

There is, however, some evidence to suggest that synthetic turf may harbor more bacteria. For example, an industry study sponsored by Sprinturf, a maker of synthetic turf, found that infill containing a sand/rubber mixture had 50,000 times higher levels of bacteria than infill made of rubber alone. To address this, the company markets synthetic turf that is "sand-free" as a safer alternative and offers sanitation for those fields already installed.

Proper maintenance of synthetic turf requires that the fields be sanitized to remove bodily fluids and animal droppings; manufacturers market sanitizing products for this purpose. According to *Synthetic Turf Sports Fields: A Construction and Maintenance Manual*, published in 2006 by the American Sports Builders Association, some synthetic turf owners disinfect their fields as often as twice a month, with more frequent cleanings for sideline areas, where contaminants concentrate.

## Different Shades of Green

Cultivated natural grass carries plenty of environmental baggage. According to "Water Management on Turfgrass," a paper on the Texas A&M University Cooperative Extension website (http://plantanswers.tamu.edu/), natural grass sports fields can require up to 1.5 million gallons of water per acre per year. The frequent mowing

ten minutes or longer to surface temperatures above 122 °F can cause skin injuries, so this is a real concern," said Joel Forman, medical director of the Pediatric Environmental Health Specialty Unit at Mount Sinai School of Medicine, speaking at a 6 December 2007 symposium on the issue.

Many physical properties of synthetic turf—including its dark pigments, low-density mass, and lack of ability to vaporize water and cool the surrounding air—make it particularly efficient at increasing its temperature when exposed to the sun. This is not only a hazard for users, but also can contribute to the "heat island effect," in which cities become hotter than surrounding areas because of heat absorbed by dark man-made surfaces such as roofs and asphalt. From many site visits to both black roofs and synthetic turf fields, Gaffin has concluded that the fields rival black roofs in their elevated surface temperatures.

Although it is often argued that one of the advantages of synthetic turf is that it does not need irrigation, some installations must be watered to control the excessive heat. Benepe stated in public hearings that water misters may have to be installed in some fields to help remedy the heat problem. According to Gaffin, synthetic turf is so efficient at absorbing sunlight, that cooling with water is only temporarily effective. "After a short while of watering, I expect the temperature should rebound and the surface become intolerably hot again," he says.

In addition to heat control, the International Hockey Federation requires that college teams saturate synthetic turf fields before each practice and game to increase traction, according to an article in the 19 October 2007 Raleigh (North Carolina) *News & Observer*. The article, which examined why local universities were watering their synthetic turf fields in the midst of severe ongoing drought in the U.S. Southeast, noted that Duke University received a business exemption to water the fields provided overall campus water consumption decreased by 30%.

The EHHI study addressed the question of whether synthetic turf fields can contribute to increased water contamination from rain or from spraying or misting. The study found that 25 different chemical species and 4 metals (zinc, selenium, lead, and cadmium) could be released into water from rubber infill. Moreover, because synthetic turf is unable to absorb or filter rain-water, chemicals filter directly into storm drains and into the municipal sewer system without the beneficial filtration that live vegetation provides. Benepe and others agree this can be an issue that New York City would need to address, as water runoff from synthetic turf fields could overwhelm storm drains, thus contributing to the estimated 27 billion gallons of raw sewage and stormwater that discharge from 460 combined sewer overflows into New York Harbor each year.

Finally, what happens to synthetic turf fields when they are no longer usable? Industry estimates that synthetic turf fields have a lifespan of 10 to 12 years, whereupon the material must be disposed of appropriately. Rick Doyle, president of the Synthetic Turf Council, says the infill could be cleaned and reused; put to another purpose, such as for rubber asphalt; incinerated; used in place of soil to separate landfill layers; or otherwise recycled. Typically, however, it is landfilled.

## Alternatives

One of the benefits of synthetic turf is that it can serve as a way to reuse old tires, a real problem given the 1 billion–plus tires that are sold every year. Doyle says the synthetic turf industry currently recycles one-twelfth of the 300 million auto tires that are withdrawn from use each year. The average soccer field can contain crumb rubber made from 27,000 tires at a density of about 4 to 15 pounds of infill per square foot.

Europe has launched an aggressive tire recovery campaign in which tires that meet quality criteria can be retreaded and reused. End-of-life tires that cannot be reused are recycled for other uses including some industrial energy-generating applications, the production of rubberized pavement, and recycling into materials for the car industry (in addition to some use in producing synthetic turf). In western Europe, recovery rates of used tires have increased from 65% in 2001 to almost 90% in 2005.

Whereas end-of-life tires add tons of waste a year for disposal in many areas, in Europe they are turning into a potentially lucrative secondary raw material. "There are increasingly numerous applications," says Serge Palard, head of the end-of-life tire recovery department at Michelin, one of the largest tire manufacturers in the world. "In some countries where we did not know what to do with end-of-life tires a few years ago, now we do not have enough to meet the demand of all the reprocessors."

In accordance with the European Union's recently implemented REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) regulations, which will require more testing of industrial chemicals, companies such as Michelin are working to reduce the use of harmful chemicals in tires in order to facilitate recycling into other products.

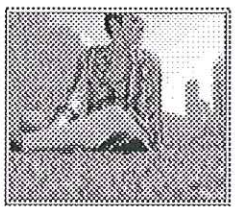
European companies are also finding innovative ways to address concerns regarding recycled tire infill in synthetic turf. In Italy, for example, there is an effort to market synthetic turf fields that feature infill made of a new thermoplastic material that is thought to be nontoxic. Mondo, a manufacturer of floor surfaces, produces Ecofill, a patented polyolefin-based granule used in synthetic turf. According to the company, this material disperses heat more efficiently; is highly shock absorbent; does not contain polyvinyl chloride, chlorine, plasticizers, heavy metals, or other harmful chemicals; and is 100% recyclable.

Another alternative is infill made from plant-derived materials. Synthetic turf manufacturer Limonta Sport produces Geo Safe Play, an infill made from coconut husks and cork. Company spokesperson Domenic Carapella says, "There are certainly alternatives to crumb rubber. There is no longer a reason to sacrifice the playing quality and more importantly the health of children [playing on synthetic turf]."

Why can't the alternative to bad grass fields simply be well-maintained grass fields, asks Croft. Certain varieties of turf grasses have been bred for resistance to stress, ability to withstand trampling and low water conditions, and other characteristics that make them appropriate for athletic field use.

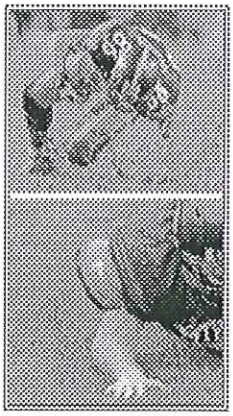
But according to Doyle, increased maintenance is not the answer. "More maintenance cannot overcome overusage of a natural grass sports field," he says. "And overusage of a natural grass sports field or usage during a rainstorm or in months of dormancy will produce an unsafe playing surface." Adds Benepe, "Even the wealthiest professional sports teams and Ivy League universities have concluded that grass fields are a losing proposition for intense-use sports such as football or soccer. . . .There is also the reality that natural turf fields used for high-intensity sports must be replaced every few years, unless you severely restrict use."

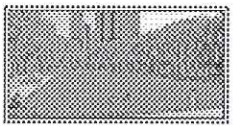
For now, New York State Assembly-members Steve Englebright, William Colton, and David Koon have proposed legislation to impose a six-month moratorium on the installation of synthetic turf until the state health and conservation departments have better studied the pros and cons of natural and synthetic grass. Said Englebright in a 5 November 2007 statement, "Before we take risks with our children's health and drinking water quality, we need to make sure that the uncertainties . . . are fully investigated."



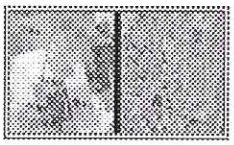
Synthetic turf field at Cadman Plaza Park, Brooklyn, New York

Weighing costs and benefits

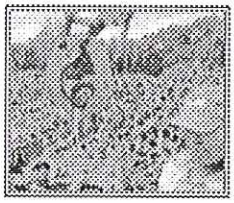




Moratorium introduced



Thermal effect



Growing demand

Articles from *Environmental Health Perspectives* are provided here courtesy of
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**PLANNING COMMISSION REPORT**
**Regular Agenda – Public Hearing Item**

PC Staff Report
8/24/11

**ITEM NO. 7 COMPREHENSIVE PLAN AMENDMENT TO CHP14; SOUTHEAST AREA PLAN (MJL)**

**CPA-10-8-10:** Consider Comprehensive Plan Amendment to Chapter 14 – Southeast Area Plan, to reference and reflect the accepted Preliminary Alignment Study for 31st Street and to update the plan to reflect changes since adoption. Authorize the chair of the Planning Commission to sign Planning Commission Resolution PCR-8-3-11 regarding the amendment to *Horizon* 2020 – Chapter 14-Southeat Area Plan (CPA-10-8-10) updating the Southeast Area Plan, if appropriate.

**STAFF RECOMMENDATION:** Staff recommends approval of the following:

1. Amendments to Chapter 14 – Specific Plans; *Southeast Area Plan* to update the reference to the adopted *Preliminary Alignment Study for Preliminary Alignment Study for 31st Street (North 1300 Road) East of 1600 Road to County Road 1057* and the Future Land Use Map to reflect the 31st Street alignment identified in this study and to generally update the plan.
2. Authorize the chair of the Planning Commission to sign Planning Commission Resolution PCR-8-3-11 regarding the amendment to *Horizon* 2020 – Chapter 14-Southeat Area Plan (CPA-10-8-10) updating the Southeast Area Plan, if appropriate.

**SUMMARY**

The *Southeast Area Plan* (SEAP) was approved in January 2008 and amended twice later that year. This amendment was initiated by the County Commission on September 29, 2010 in order to reflect the adopted *Preliminary Alignment Study for 31st Street (North 1300 Road) east of 1600 Road to County Road 1057*. This study replaces the *31st Street Corridor Study* completed in 2003. The SEAP references the *31st Street Corridor Study* and is to be amended to reference the Preliminary Alignment Study.

Once staff began looking at this plan to update based on the 31st Street alignment, staff discovered that many areas of the plan were out of date. For example references to T2025, when the Wakarusa Waste Water Reclamation Facility is to be on line, existing zoning, location of utilities, and all maps. This plan was not due for an update, based on *Horizon 2020*, until 2018 but staff thought it was appropriate to take this opportunity to update the plan at this time. All changes are identified in the plan in red with additions underlined and ~~deletions~~ struck through.

Though notice to property owners for the Planning Commission public hearing for a Comprehensive Plan Amendment (CPA) is not required, notice was sent to all property owners within the *Southeast Area Plan* planning area to notify them about the public hearing.

## COMPREHENSIVE PLAN AMENDMENT REVIEW

**A. Does the proposed amendment result from changed circumstances or unforeseen conditions not understood or addressed at the time the plan was adopted?**

This amendment is a change in information regarding the planning area of the SEAP. This study is new and offers more specific information than the previous study. Since the SEAP references the previous study, the plan should be updated to reflect the current information as the new study and identified alignment is a substantial change from the previous study.

Other changes are updates to the information to reflect changes that have occurred within the planning area since adoption.

**B. Does the proposed amendment advance a clear public purpose and is it consistent with the long-range goals and policies of the plan?**

The new study demonstrates an advance in clear public purpose by outlining a specific alignment for 31st Street through the planning area. This more specific alignment allows for more accurate planning for the area and gives property owners a clearer picture of how the City and County expects the planning area to develop in the future. The Preliminary Alignment Study references and follows recommendations outlined in the SEAP.

The general update is a clear advancement in public purpose by keeping the long-range plans up-to-date with the best information that property owners and potential property owners can use.

**C. Is the proposed amendment a result of a clear change in public policy?**

This amendment reflects an adopted study that was created through a public process involving a steering committee from the community. This study shows a specific alignment and construction costs anticipated for the 31st Street improvements where the previous study was less specific. This change to the SEAP supports the adopted study.

The general update does not change the plan policies however updates the plan to show existing conditions 2011. The plan maps have also been updated to reflect the updated FEMA Floodplain adopted in August 2010, changes in land use and the new street alignment.

## PROFESSIONAL STAFF RECOMMENDATION

Staff recommends approval of the following:

1. Amendments to Chapter 14 – Specific Plans; *Southeast Area Plan* to update the reference to the adopted *Preliminary Alignment Study for Preliminary Alignment Study for 31st Street (North 1300 Road) East of 1600 Road to County Road 1057* and the Future Land Use Map to reflect the 31st Street alignment identified in this study and to generally update the plan.
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# Southeast Area Plan

Approved by Lawrence-Douglas County Planning Commission 11/28/07
Approved by the Lawrence City Commission 1/8/08
Approved by the Douglas County Board of Commissioners 1/28/08

Revised 7/21/08; 12/1/08
Updated DATE

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# Section 1 - Introduction

## 1.1 Background & Purpose

The development of a *Southeast Area Plan* began in 1997. The primary issues at that time were: timing of development (land uses), connectivity of the major street network, the location and timing of the eastern leg of the South Lawrence Trafficway/K-10 Highway (SLT/K-10 Highway), and the timing of city sanitary sewer and water lines to the planning area. Meetings were held with the area property owners to gather their input. Planning staff created a draft land use map for the planning area on August 13, 1997, it was presented to the Planning Commission, and a plan and a summary of the process followed. The Planning Commission forwarded the *Southeast Area Plan* to the County Commission for direction on the access points shown in the plan to the SLT/K-10 Highway. The County Commission deferred the discussion because of issues due to an ongoing study of the eastern alignment of the SLT/K-10 Highway. After this deferral, the plan was not approved or adopted by any of the three Commissions.

New information regarding traffic routes and specific corridor planning along with the closing of the Farmland Industries Plant and the update of the city's wastewater master plan has created renewed interest in developing a plan for the Southeast Area. Development concerns for the area were essentially the same as they were in 1997: sanitary sewer, major roads, appropriate land uses, and the SLT/K-10 Highway alignment. While there has been some additional development in the area, the physical conditions of the planning area were substantially unchanged from the conditions that existed in the *Southeast Area Plan* drafted in 1997.

The planning process continued in 2004 with various drafts of future land use maps and text. Two future land use maps were given as options but a consensus could not be reached by the Commissions. Since then, various things have changed. The ECO$^2$ Commission has completed the first phase of their plan, development has occurred within the planning area, and the Wakarusa Water Reclamation Facility is tentatively set to be operational ~~in 2011~~ 2017-2022, south of the planning area and south of the Wakarusa River, which will provide additional sanitary sewer capacity to this area. The ECO$^2$ plan is a long-term plan for the identification, evaluation, and selection of land for the advancement of industrial/business park and open space preservation.

The recommendations contained within this plan are intended to guide the area's growth patterns as the development of the Southeast Area occurs. A plan's purpose is to provide a closer look at the specifically described area while being consistent with the overall adopted comprehensive plan for the community. The plan should fit like a puzzle piece into the larger context of the surrounding street, utility, and land use network of the entire community. Logical connections between the planning area and adjacent neighborhoods are a key factor in the development of the plan.

## 1.2 Description of Planning Area

The *Southeast Area Plan* encompasses all of Section 9, the west half of Section 10, and portions of Sections 15 and 16 in Wakarusa Township. The planning area boundaries are: E 1750 Road (Noria Road) to the east, the Wakarusa River floodplain as depicted on the 2001 FEMA maps to the south, O'Connell Road to the west, and E. 23rd Street/K-10 Highway to the north. The majority of the planning area is located within the urban growth area service area 1[1]. The properties south of N 1300 Road (E. 31st Street) are located in Service Area 4. Roughly two thirds of the planning area lie outside of the city limits of Lawrence but within the urban growth area as identified in *Horizon 2020*.

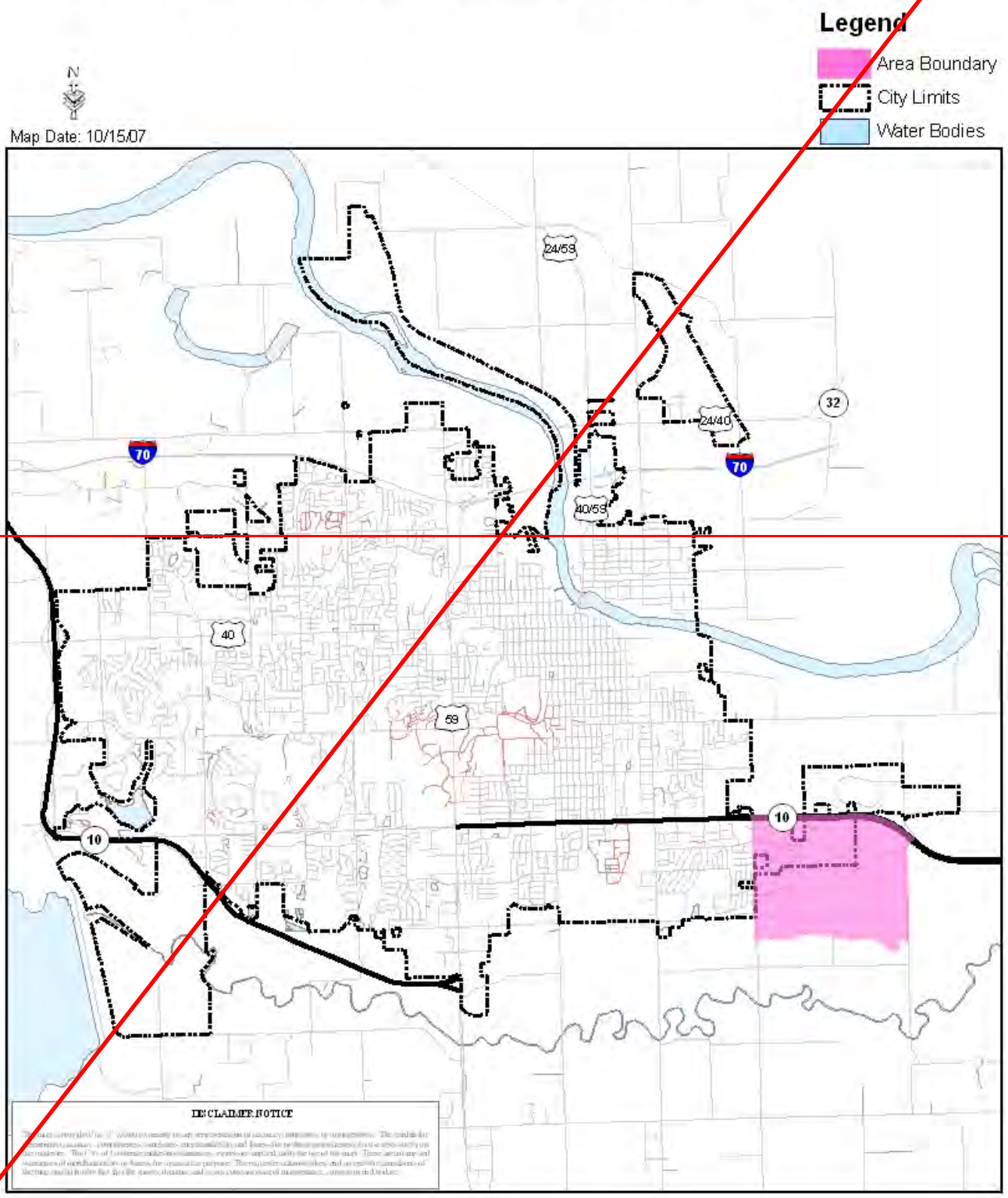
Diverse uses surround the planning area. The Prairie Park Neighborhood is located directly to the west of the planning area and has been developed within the last ten years, predominately with single-family residences. Land uses north of the planning area are comprised of large industrial properties including the vacant Farmland fertilizer plant and East Hills Business Park, all north of E. 23rd Street/K-10 Highway. South and east of the planning area is the Wakarusa River, the Wakarusa Floodplain, and agricultural uses. While the areas described are outside of the planning area boundaries, they have significant influence on the land use development patterns within the Southeast Area. Key influences are the vacant Farmland Industries property, the expansion of East Hills Business Park, and the communities' need to have sufficient wastewater capacity for future industrial uses in these areas.

The planning area contains approximately 1,300 acres with a wide range of ownership parcel sizes. Two parcels are larger than 100 acres, ~~ten~~ nine parcels are between 30 and 100 acres, and ~~fifteen~~ fourteen parcels are between 10 and 29 acres. The remaining parcels, approximately ~~315~~ 321, are less than 10 acres in size. Because of the ownership patterns, a coordinated effort on behalf of the property owners is necessary to develop benefit districts to construct the major portions of the required infrastructure. The planning area boundaries and parcel composition are illustrated in Map 1-1 and Map 1-2.

[1] Service Area 1 "This area includes lands which are proximate to the existing city limits and can be readily served by community facilities and services."

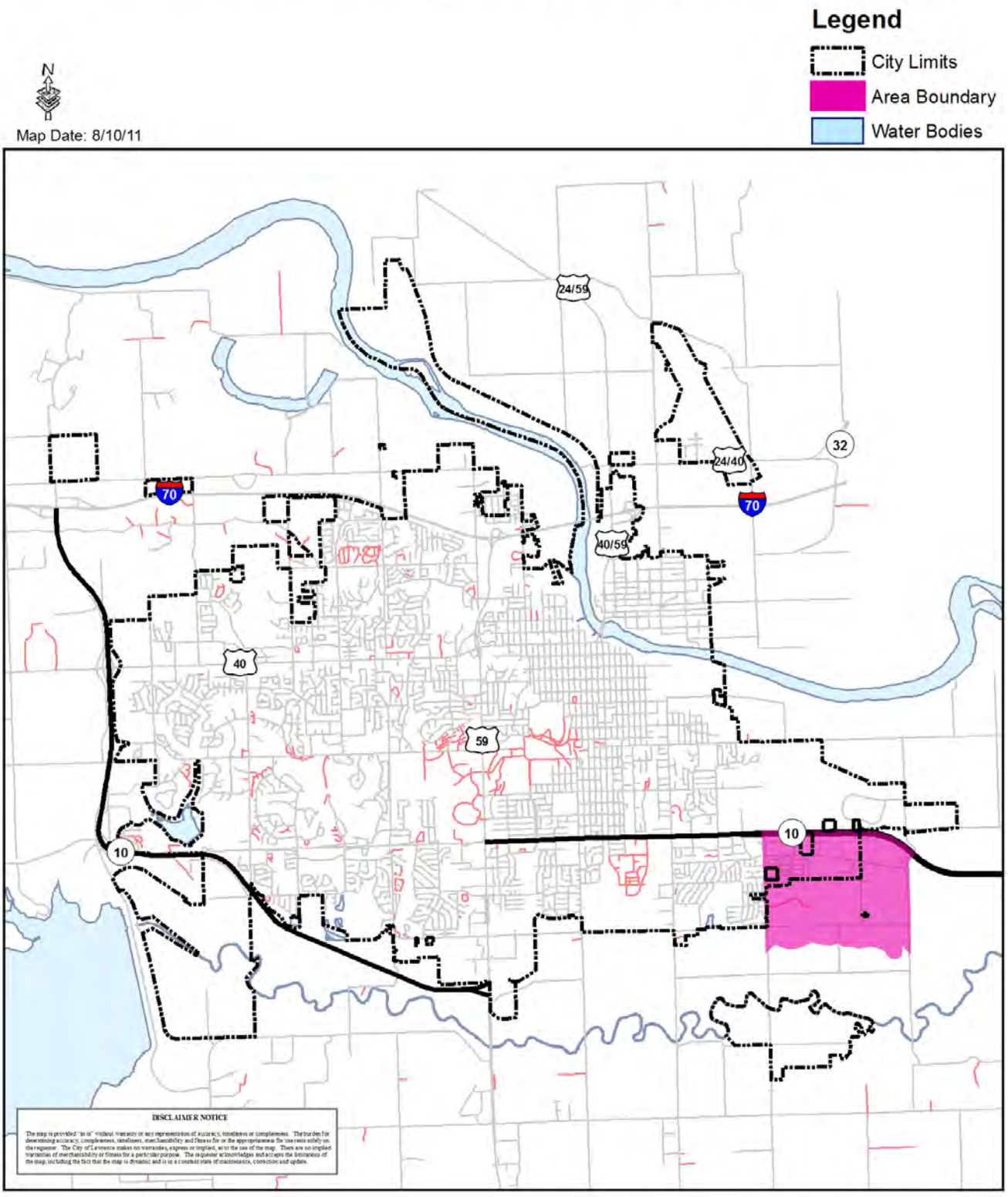
# Southeast Area Plan

## Map 1-1 Planning Area Boundary in Relation to Lawrence



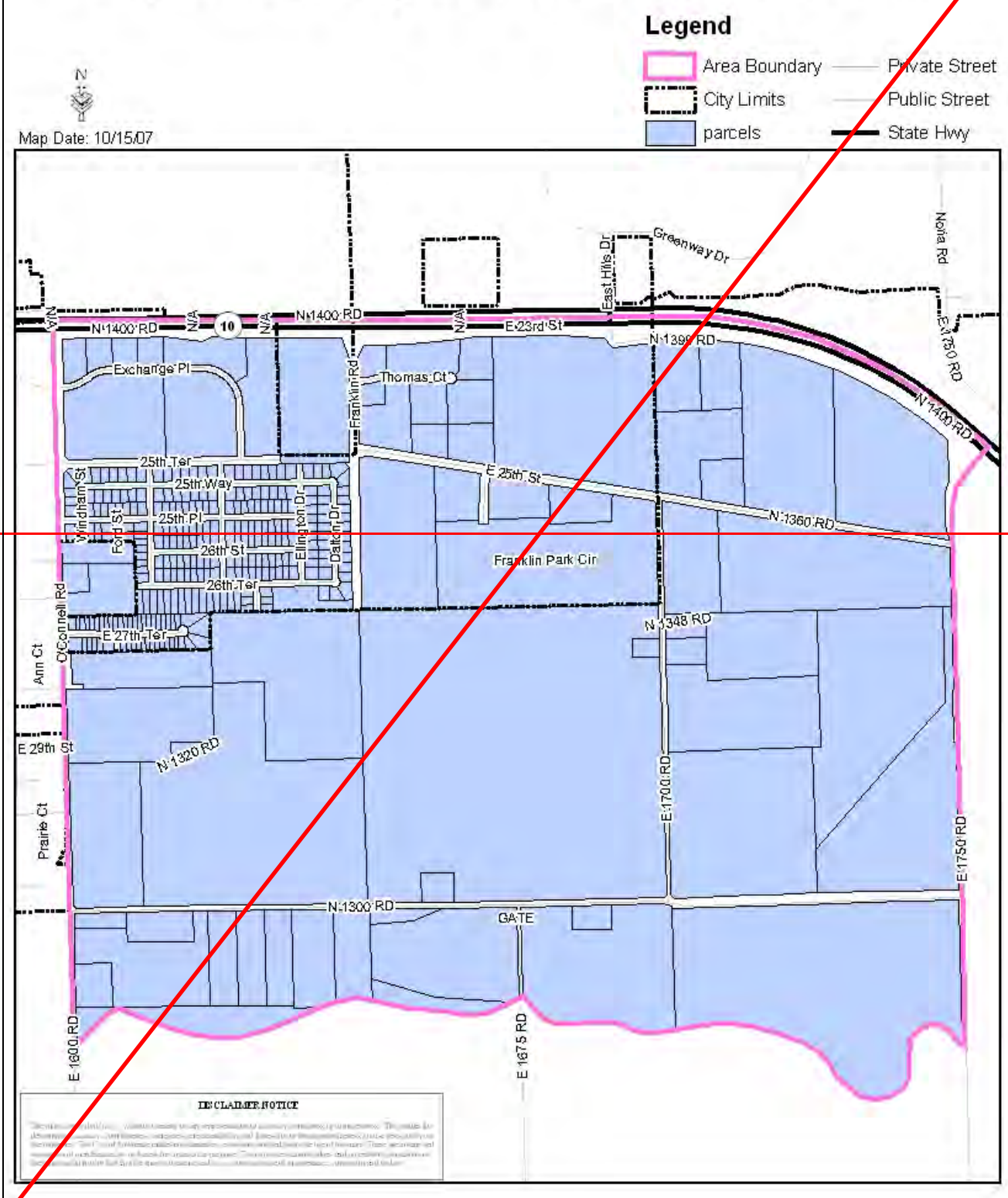
# Southeast Area Plan

## Map 1-1 Planning Area Boundary in Relation to Lawrence



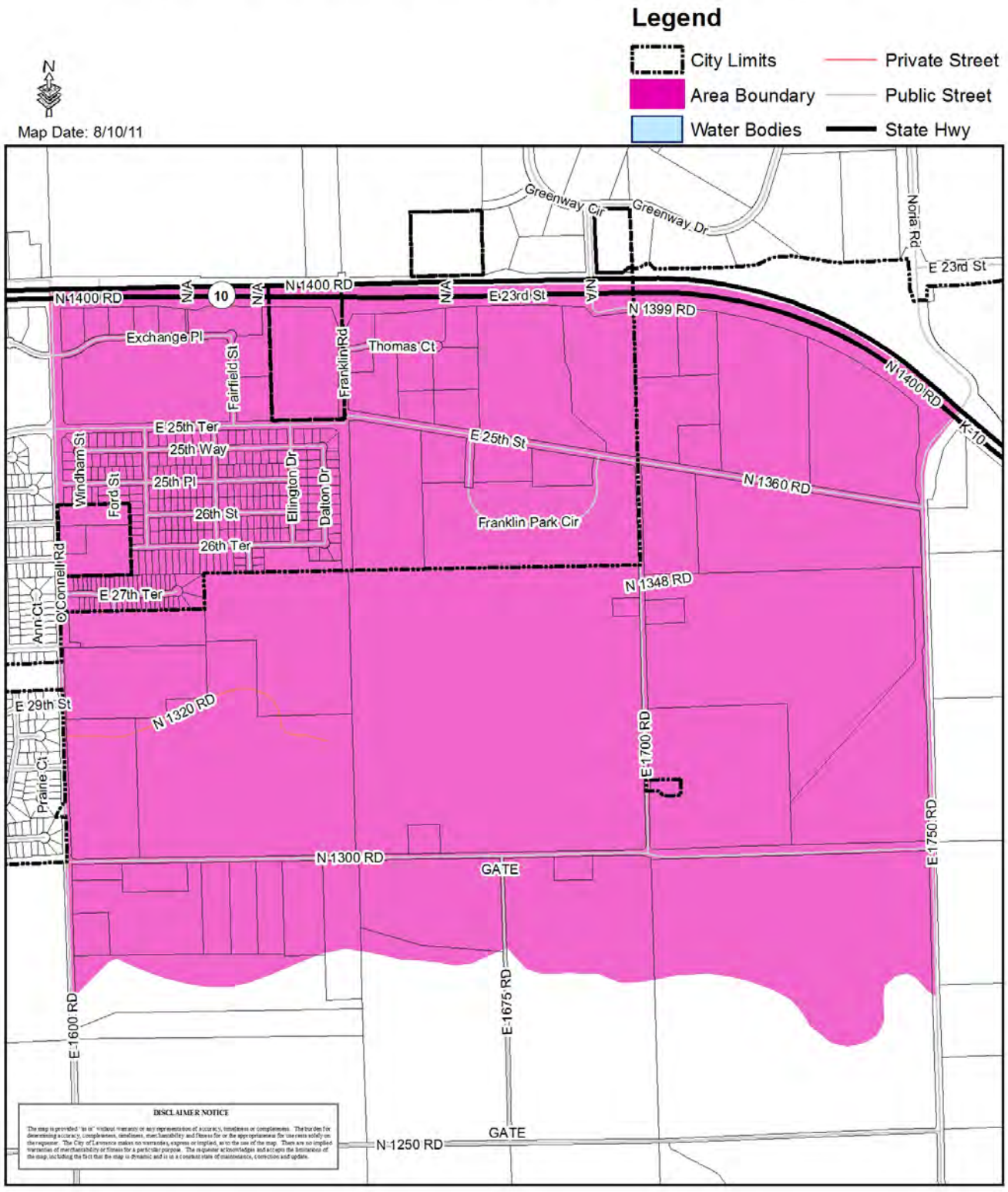
# Southeast Area Plan

## Map 1-2 Planning Area Boundary and Parcels



# Southeast Area Plan

## Map 1-2 Planning Area Boundary and Parcels



## 1.3 Policy Framework

*Horizon 2020* serves as the overall planning guide and policy document for this plan. In addition to *Horizon 2020*, guiding policy is also obtained in other adopted physical element plans. Together, these plans provide the general "umbrella" policies under which this plan is developed. Listed, these plans are:

- *Horizon 2020,* The Comprehensive Plan for Lawrence and Unincorporated Douglas County. Lawrence-Douglas County Metropolitan Planning Office. 1998 as amended.
- ~~*Transportation 2025*, Lawrence/Douglas County Long Range Transportation Plan. Lawrence/ Douglas County Metropolitan Planning Office and LSA Associates. September 2002.~~ Transportation 2030, Lawrence/Douglas county Long Range Transportation Plan. Lawrence-Douglas County Metropolitan Planning Office. April 16, 2009.
- *Lawrence-Douglas County Bicycle Plan*, Lawrence/Douglas County Metropolitan Planning Office. May 2004.
- *Lawrence Parks & Recreation Department A Comprehensive Master Plan*. Leon Younger & PROS. 2000.
- ~~*31st Street Corridor Study, Iowa Street to County Route 1057*. TransSystems Corporation. January 28, 2003.~~ Preliminary Alignment Study for 31st Street (North 1300 Road) East of 1600 Road to County Road 1057. Wilson & Company, Inc. September 29, 2010
- *City of Lawrence, Kansas Water Master Plan*. Black & Veatch. December 2003.
- *City of Lawrence, Kansas Wastewater Master Plan*. Black & Veatch. December 2003.
- *23rd Street Corridor Study*, Lawrence-Douglas County Metropolitan Planning Office. September 2002.

## Section 2 - Existing Conditions

The inventory and analysis of existing conditions in this plan are intended to serve as a resource and background for the recommendations included at the end of this plan.

### 2.1 Land Uses

There are currently a wide range of land uses within the planning area. The existing land use summary and map are based on the County Appraisers' land use code and updated by planning staff, as the source information for this portion of the plan. Agricultural uses, in the form of row crops, pasturelands, and farms are the prominent land uses. As the area urbanizes, these agricultural uses will dissolve and be reused for more intensive land use types. This category is not carried forward to the future land use map. Remaining open spaces in an urbanized environment are referred to as park or open space.

The second largest land use category is the public/institutional use which is a mix of public and privately owned uses. The publicly owned uses ~~is~~ are the Douglas County Jail located at the southeast corner of Franklin Road and E. 25th Street and the sanitary sewer pump station located on the edge of the future park northeast of the intersection of N 1300 Road (E. 31st Street) and E 1700 Road (Kitsmiller Road). The two private institutional uses include the O'Connell Youth Ranch and Teen Challenge facility located at the northeast corner of O'Connell Road and N 1300 Road (E. 31st Street). This does not include the identified future park located at the northeast corner of N 1300 Road (E. 31st Street) and E 1700 Road (Kitsmiller Road).

Within the planning area, there has been some residential home development. There is an area platted and developed with duplex type uses located along E. 27th Terrace. There is also a large portion of the area south of N 1300 Road (E. 31st Street) that is developed with large lot, single-family uses.

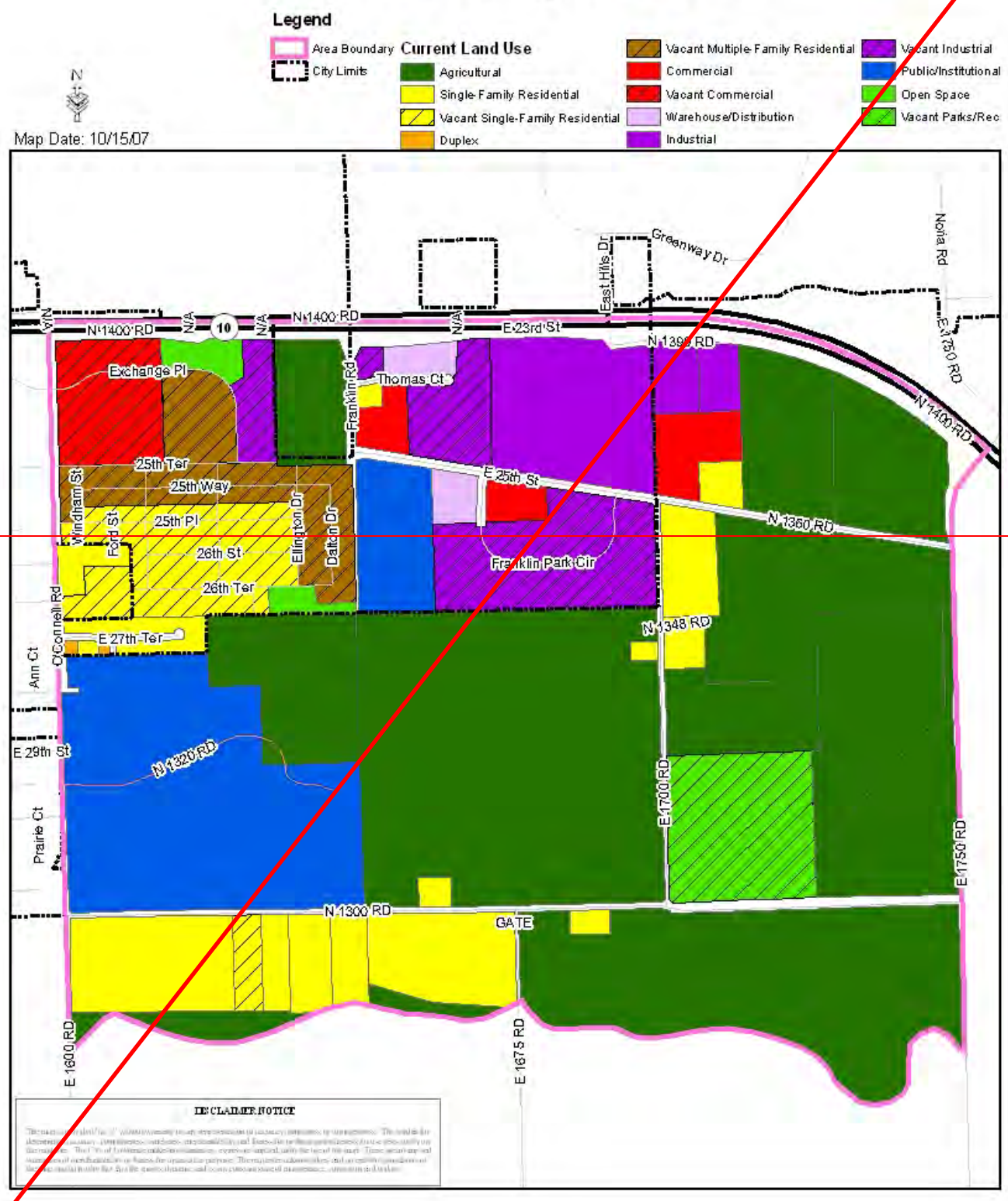
The remaining land is designated a variety of uses ranging from open space to industrial. A variety of uses are categorized as "vacant" uses. Many of these areas are within the city and are already platted and/or zoned for a specific use. The existing land uses are shown on Map 2-1.

Table 2-1 Existing Land Use Summary (August 2011)

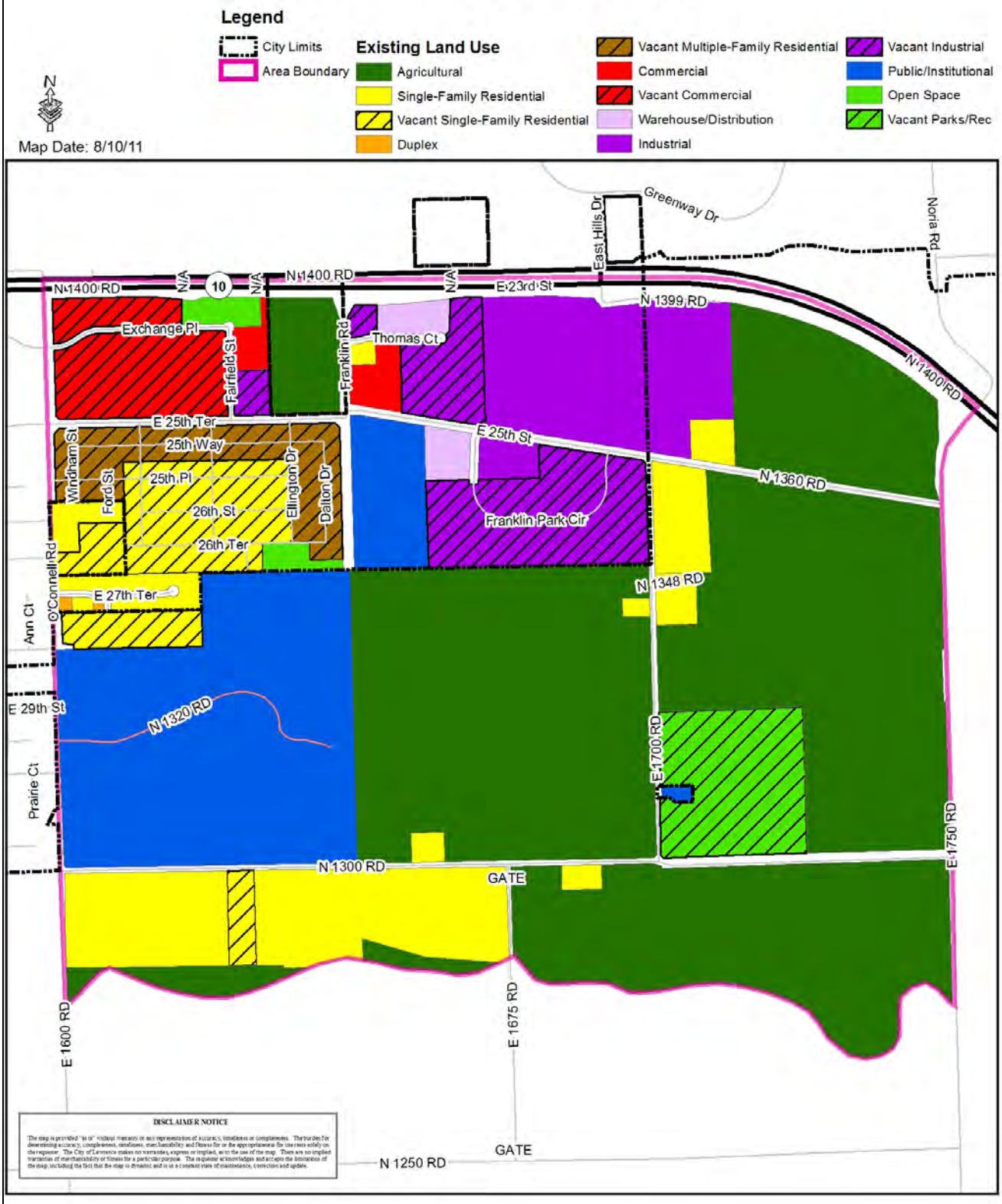
| Land Use | Acres |
|---|---|
| Agricultural | ~~502.57~~ 489.27 |
| Single-Family Residential | ~~126.67~~ 105.56 |
| Vacant Single-Family Residential | ~~47.52~~ 52.69 |
| Duplex | 0.65 |
| Vacant Multiple-Family Residential | ~~43.46~~ 32.15 |
| Commercial | ~~20.38~~ 8.55 |
| Vacant Commercial | ~~24.01~~ 33.65 |
| Warehouse/Distribution | ~~8.40~~ 8.47 |
| Industrial | ~~52.77~~ 68.08 |
| Vacant Industrial | ~~65.12~~ 59.74 |
| Public/Institutional | ~~135.70~~ 160.33 |
| Open Space | ~~8.29~~ 6.99 |
| Vacant Parks/Rec | ~~38.97~~ 38.07 |
| TOTAL | ~~1,074.49~~ 1064.19 |

# Southeast Area Plan

## Map 2-1 Existing Land Use



# Southeast Area Plan
## Map 2-1 Existing Land Use



## 2.2 Zoning Patterns

The planning area encompasses approximately 1,154 acres. The majority~~, approximately 852 acres,~~ is within the unincorporated portions of Douglas County and is mainly zoned A (Agricultural). Additional county zoning districts within the planning area occur predominately along E. 23rd Street/K-10 Highway and include: ~~B-1 (Neighborhood Business District),~~ I-1 (Limited Industrial) District~~)~~, ~~and~~ I-2 (Light Industrial) District~~)~~, and I-3 (Heavy Industrial) District. The county zoning districts shown on Map 2-2 are described in Table 2-~~3~~2.

There are a number of city zoning districts within the planning area. Planned Residential Development (PRD-Prairie View) zoning is located along E. 27th Terrace, on the east side of O'Connell Road. This area is developed with low-density residential structures in the form of duplexes and is reflected on the Existing Land Use Map as low-density residential. There is also a platted subdivision east of O'Connell Road, abutting the Prairie View PRD to the north, called Fairfield Farms East Addition No. 1. This subdivision is a mix of single-dwelling and multi-dwelling ~~duplex~~ zoning. ~~Additionally, there is a parcel zoned for high-density residential development at the northwest intersection of E. 25th Terrace and Exchange Place.~~

Planned Industrial Development (PID-LRM Industries, PID-Franklin Park and PID-Mt. Blue) zoning is located along E. 23rd Street/K-10 Highway, E. 25th Street and N 1360 Road. Approximately 58 acres of these planned industrial developments remain undeveloped. Some of the industrial uses developed in the area include a concrete and asphalt plant, the Douglas County Jail, a self-storage business, and a towing company. These uses are representative of the area shown as existing industrial land use within the planning area, the exception being the public institutional use of the jail. The city zoning districts shown on Map 2-2 are described in Table 2-3.

Table 2-2 County Zoning Classifications

| County Zoning | District Name | Comprehensive Plan Designation |
|---|---|---|
| A | Agricultural | Agriculture |
| B-1 | Neighborhood Business District | Neighborhood Commercial |
| I-1 | Limited Industrial District | Office Research |
| I-2 | Light Industrial District | Warehouse and Distribution |
| I-3 | Heavy Industrial District | Industrial |
| I-4 | Heavy Industrial District | Industrial |
| VC | Valley Channel District | N/A |

Table 2-~~2~~ 3 City Zoning Classifications

| City Zoning | District Name | Comprehensive Plan Designation |
|---|---|---|
| RS7 | Single-Dwelling Residential (7,000 sq. feet per dwelling unit) | Low-Density Residential |

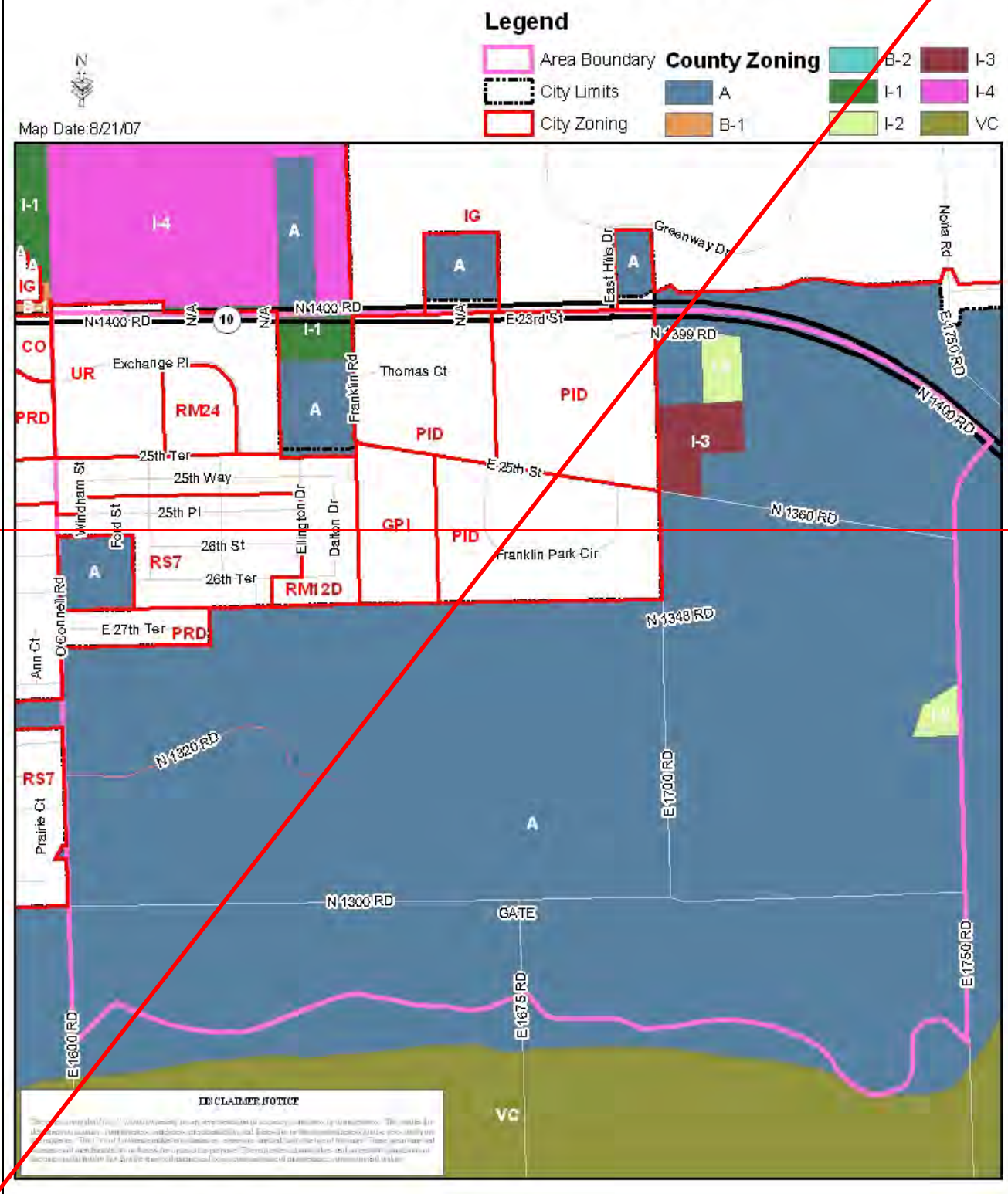
| | | |
|---|---|---|
| RM12D | Multi-Dwelling Residential Duplex (12 dwelling units per acre) | Medium-Density Residential |
| ~~RM24~~ | ~~Multi-Dwelling Residential (24 dwelling units per acre)~~ | ~~High-Density Residential~~ |
| PRD | Planned Residential District | N/A |
| CO | Office Commercial | Office or Office/Research |
| CC200 | Community Commercial District (200,000 gross square feet of commercial) | Community Commercial Center |
| PID | Planned Industrial District | N/A |
| IL | Limited Industrial District | Warehouse and Distribution or Industrial |
| IG | General Industrial | Warehouse and Distribution or Industrial |
| GPI | General Public and Institutional | N/A |
| ~~UR~~ | ~~Urban Reserve~~ | ~~N/A~~ |

~~Table 2-3 County Zoning Classifications~~

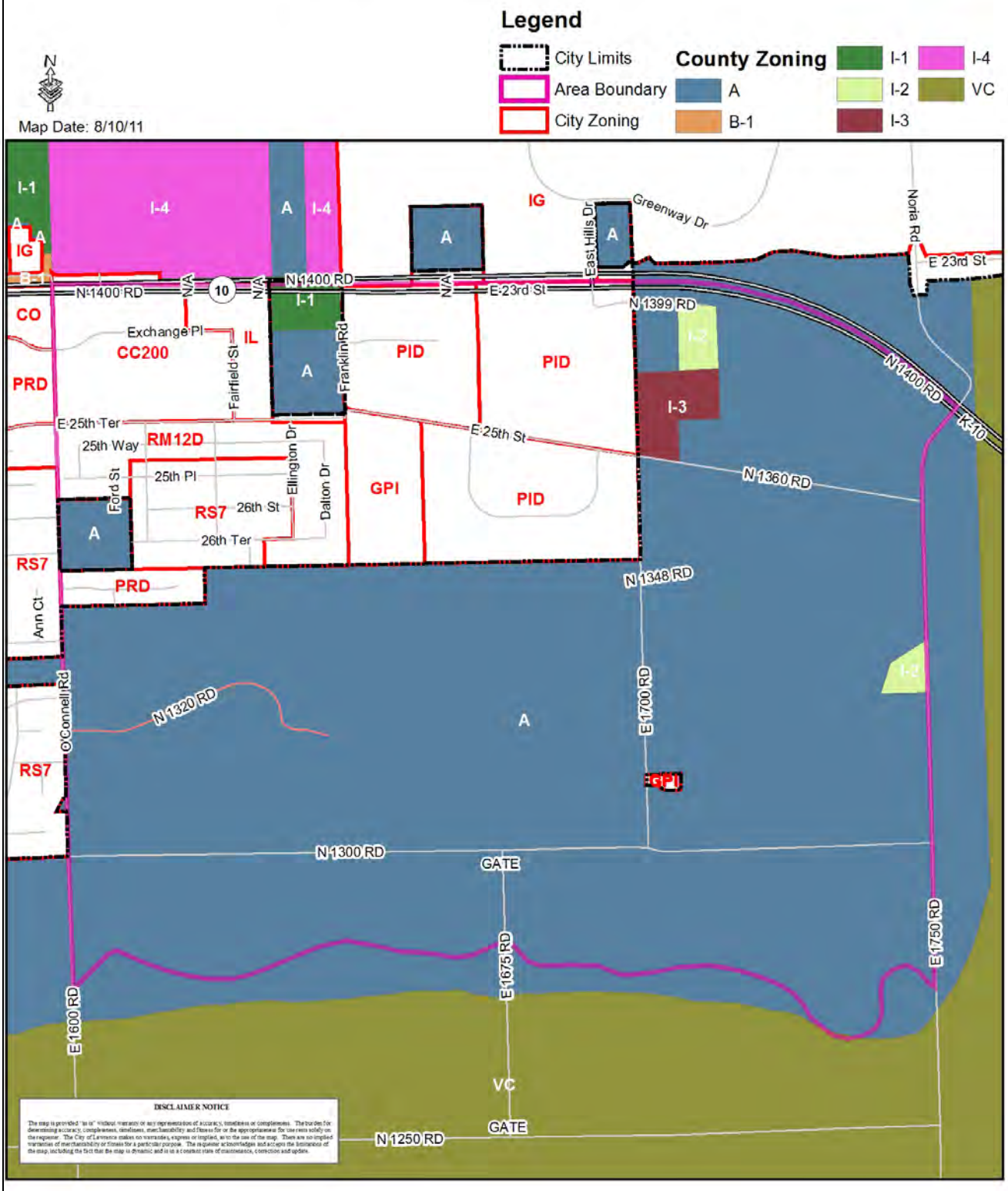
| ~~County Zoning~~ | ~~District Name~~ | ~~Comprehensive Plan Designation~~ |
|---|---|---|
| ~~A~~ | ~~Agricultural~~ | ~~Agriculture~~ |
| ~~B-1~~ | ~~Neighborhood Business District~~ | ~~Neighborhood Commercial~~ |
| ~~I-1~~ | ~~Limited Industrial District~~ | ~~Office Research~~ |
| ~~I-2~~ | ~~Light Industrial District~~ | ~~Warehouse and Distribution~~ |
| ~~I-3~~ | ~~Heavy Industrial District~~ | ~~Industrial~~ |
| ~~I-4~~ | ~~Heavy Industrial District~~ | ~~Industrial~~ |
| ~~VC~~ | ~~Valley Channel District~~ | ~~N/A~~ |

# Southeast Area Plan

## Map 2-2 Existing Zoning



# Southeast Area Plan
## Map 2-2 Existing Zoning



## 2.3 Infrastructure

### *2.31 Water and Wastewater Infrastructure*

A summary of the existing water and wastewater utilities are shown on Map 2-3. Municipal water and wastewater is provided to those properties that are within the current city limits. ~~Lawrence's sanitary sewer and water lines have not been extended beyond the city limits.~~ Properties that are within the planning area, but outside the city limits, are served by non-municipal water and septic systems.

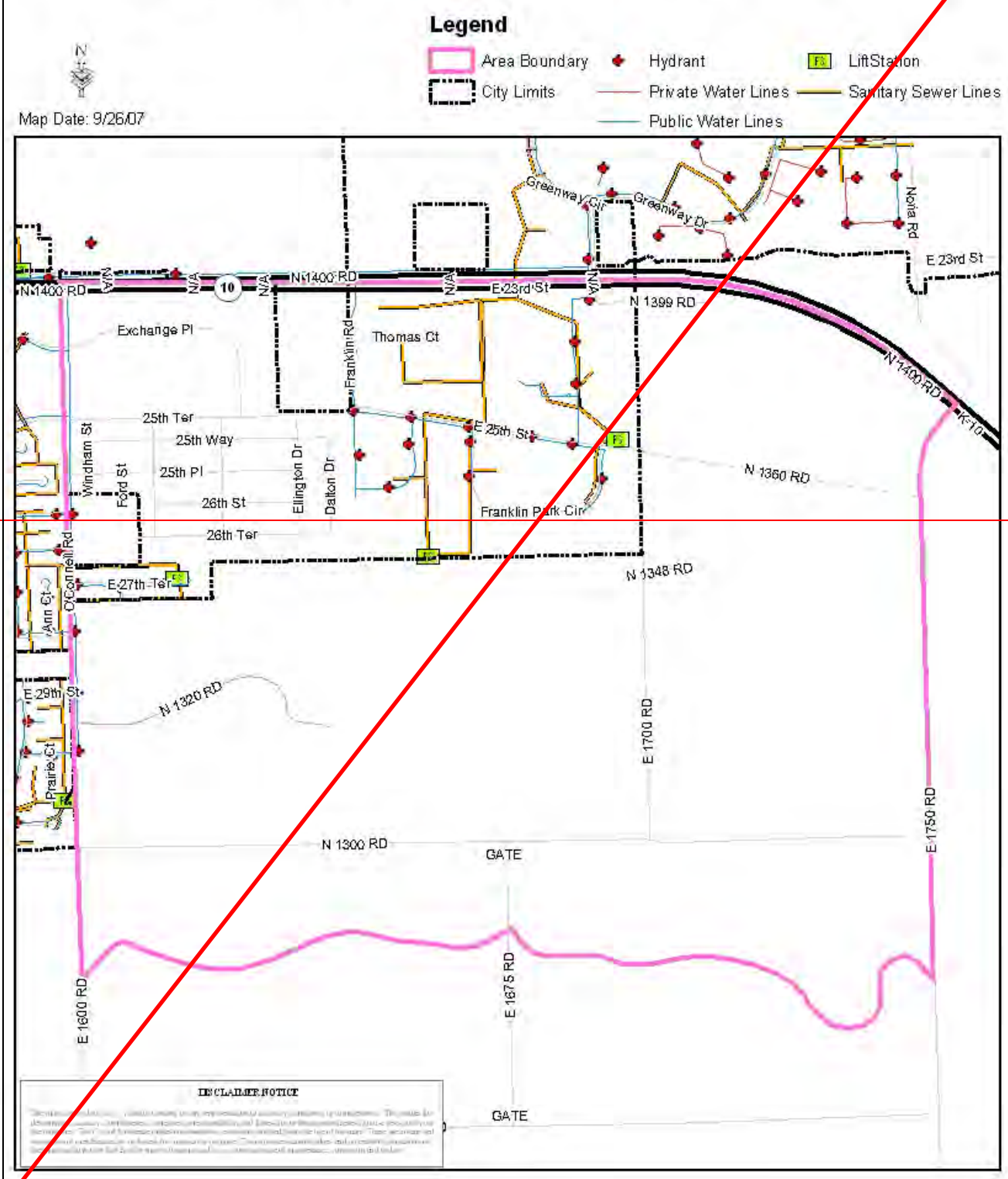
~~The county is currently engineering a sanitary sewer pump station, force main, and interceptor line within the planning area.~~ In 2008 a pump station was completed within the planning area located ~~The pump station will be located~~ on the city's future park property on the northeast corner of E 1700 Road (Kitsmiller Road) and N 1300 Road (E. 31st Street) ~~and this project is tentatively set to be completed in the summer of 2008~~. The lines from the pump station extend service into the area northwest of the pump station location. Sanitary sewer service to areas generally north and east of the pump station location will require additional interceptor lines to be constructed. This pump station allows for city sanitary sewer service for future development within the planning area.

### *2.32 Stormwater Infrastructure*

A summary of the existing stormwater utilities, channels, and natural streams are shown on Map 2-4. There is a small amount of stormwater collected by an enclosed stormwater pipe system within the planning area. The majority of the stormwater is handled by open channels and streams. The stormwater drains to the southeast, out of the planning area by way of the tributaries, to the Wakarusa River.

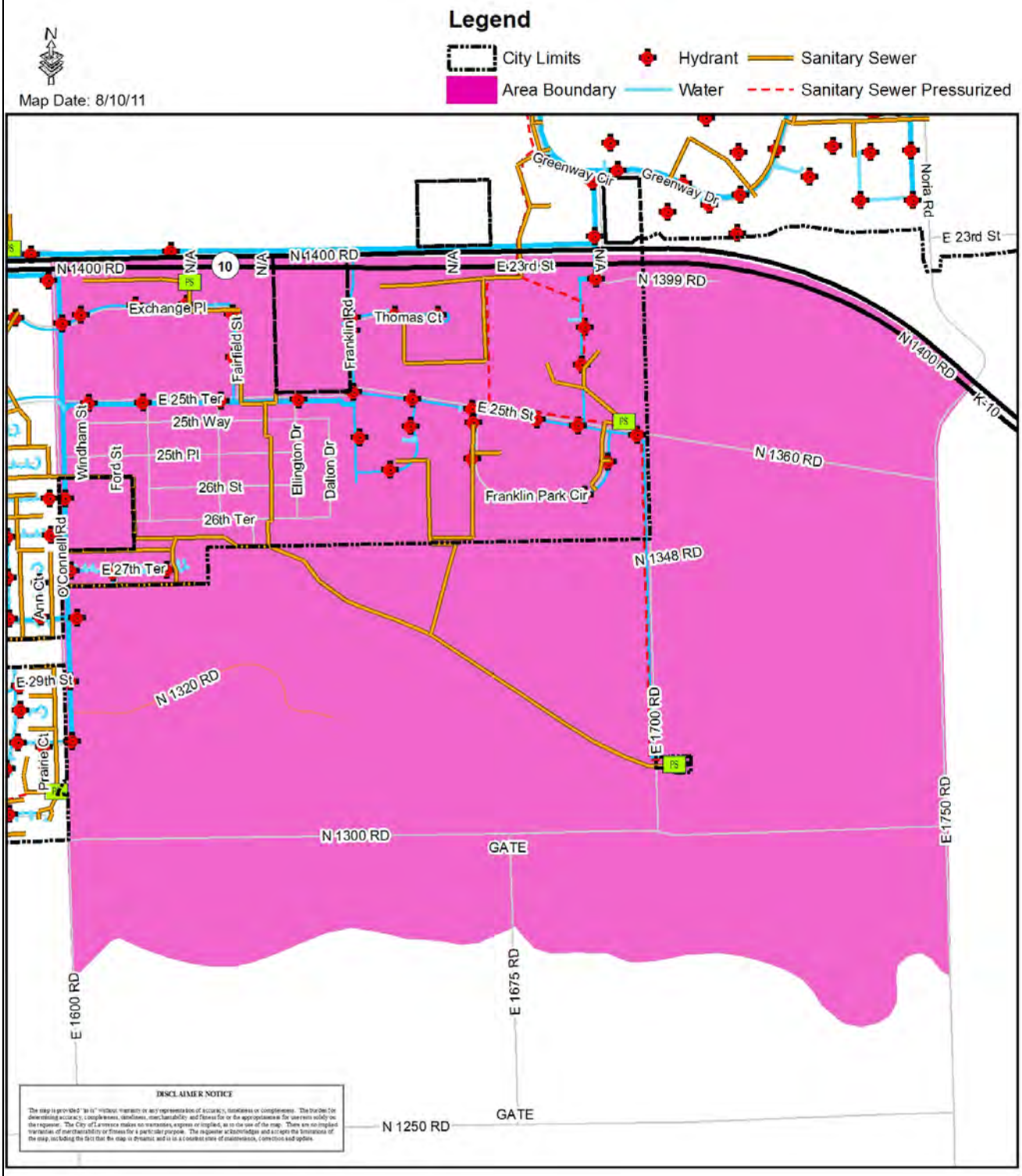
# Southeast Area Plan

## Map 2-3 Existing Water and Sanitary Sewer Lines



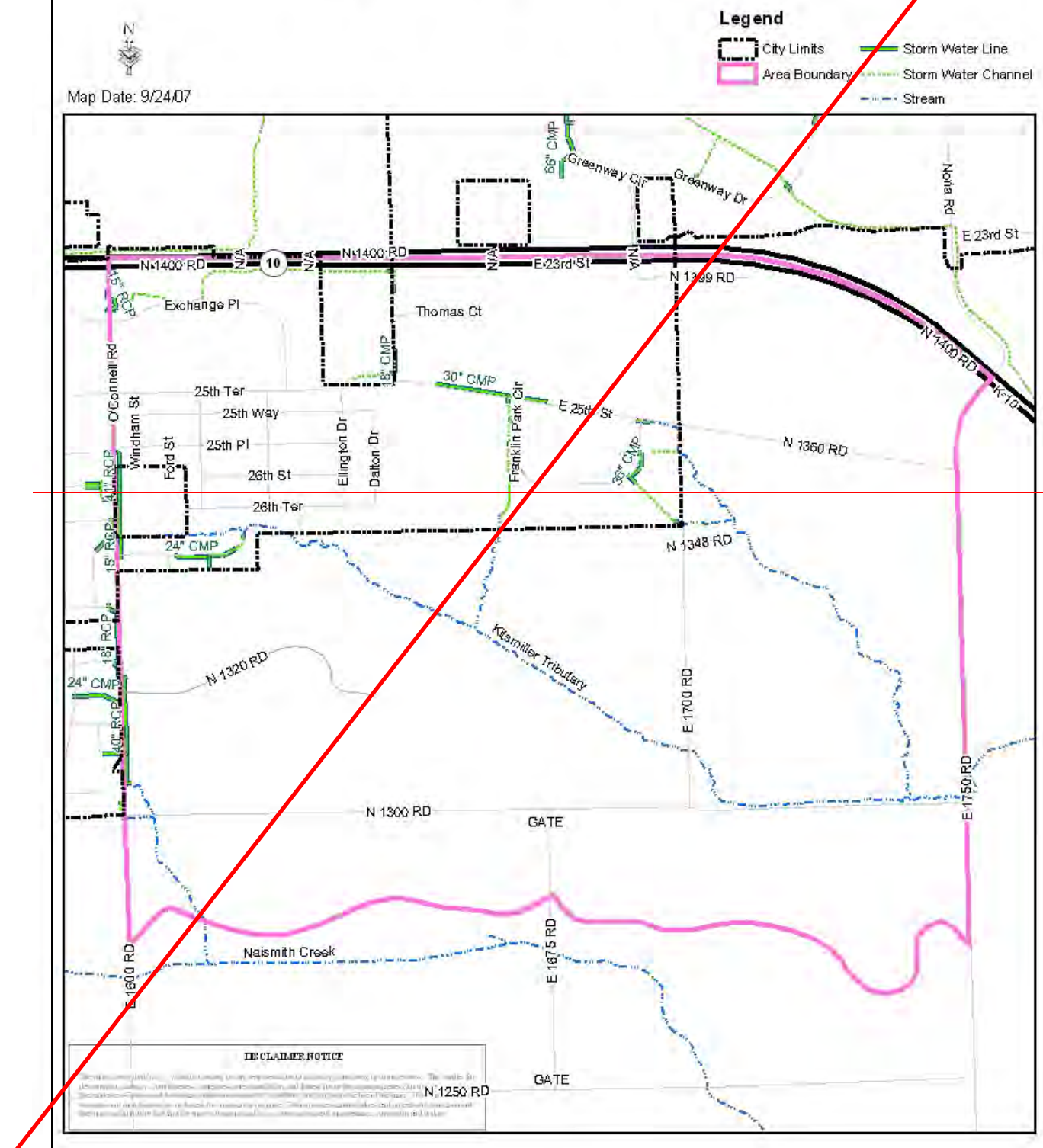
# Southeast Area Plan

## Map 2-3 Existing Water and Sanitary Sewer Facilities

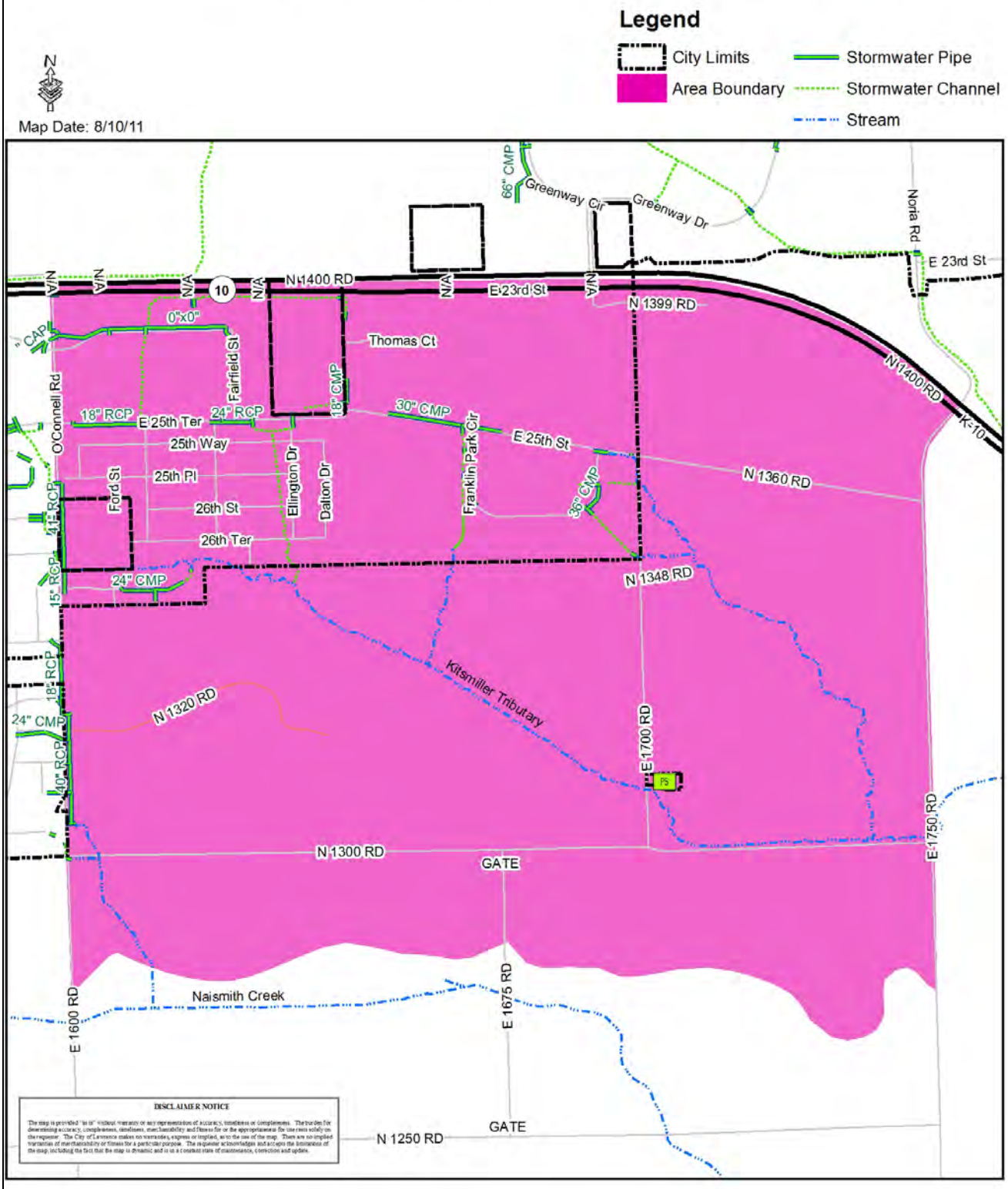


# Southeast Area Plan

## Map 2-4 Existing Stormwater Facilities



# Southeast Area Plan
## Map 2-4 Existing Stormwater Facilities



*2.33 Transportation*

2.331 Streets

*Transportation ~~2025~~ 2030* (~~T2025~~T2030) is the comprehensive, long-range transportation plan for the metropolitan area. ~~T2025~~ T2030 designates streets according to their functional classification or their primary purpose. These functional classifications are shown on Map 2-5. The classification system can be described as a hierarchy from the lowest order, (local streets) that serve to provide direct access to adjacent property, to (collector streets) that carry traffic from local streets, to major thoroughfares (arterial streets) that carry traffic across the entire city. Freeways and expressways are the highest order of streets and are designed with limited access to provide the highest degree of mobility to serve large traffic volumes with long trip lengths.

~~T2025~~ T2030 identifies gateways into the city and truck routes. E. 23rd Street/K-10 Highway is classified as a major gateway into Lawrence and a truck route into and out of Lawrence.

2.332 Transit

Lawrence has a public transportation system (The T) which operates throughout the city. This system allows people to travel to other areas of the city without relying on a personal automobile. The city transit system has one route that travels through the planning area. Route 5 (~~23rd/Clinton Crosstown-Wakarusa/South Iowa/K-10~~ 31st & Iowa to East Hills Business Park) travels along E. 23rd Street/K-10 Highway to the East Hills Business Park, northeast of the planning area. There are currently no bus shelters within the planning area.

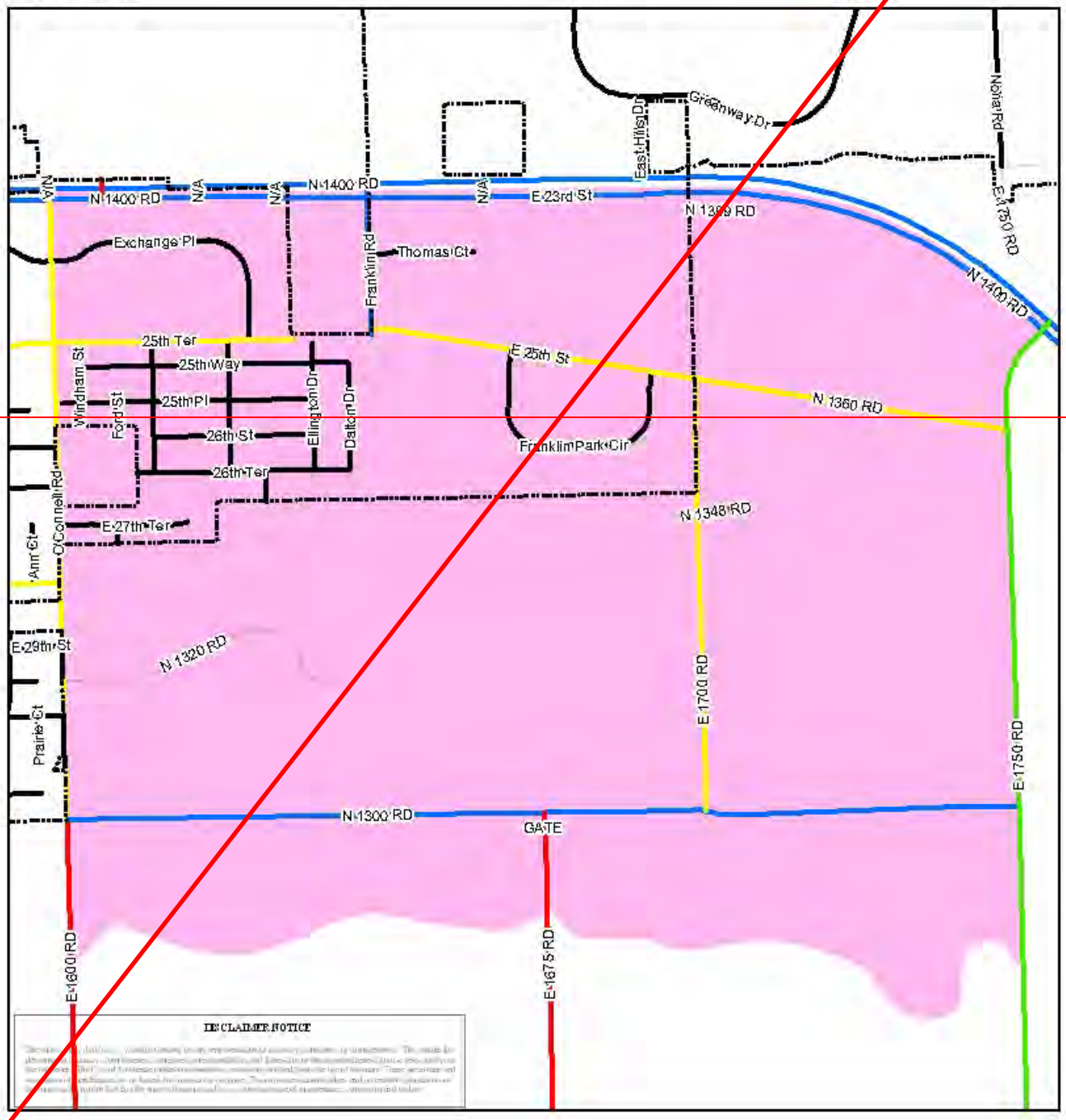
2.333 Bicycle Facilities

Lawrence and Douglas County have a joint bicycle plan for the community, the *Lawrence-Douglas County Bicycle Plan*. This plan identifies existing and future bicycle routes, lanes, and ~~recreational~~ shared use paths. A bicycle route is a network of streets to enable direct, convenient and safe access for bicyclists. A bicycle lane is a separate space designated with striping, signage or pavement markings for exclusive use by bicycles within a street. A ~~recreational~~ shared use path ~~(rec. path)~~ is a separate path adjacent to and independent of the street and is intended solely for non-motorized travel.

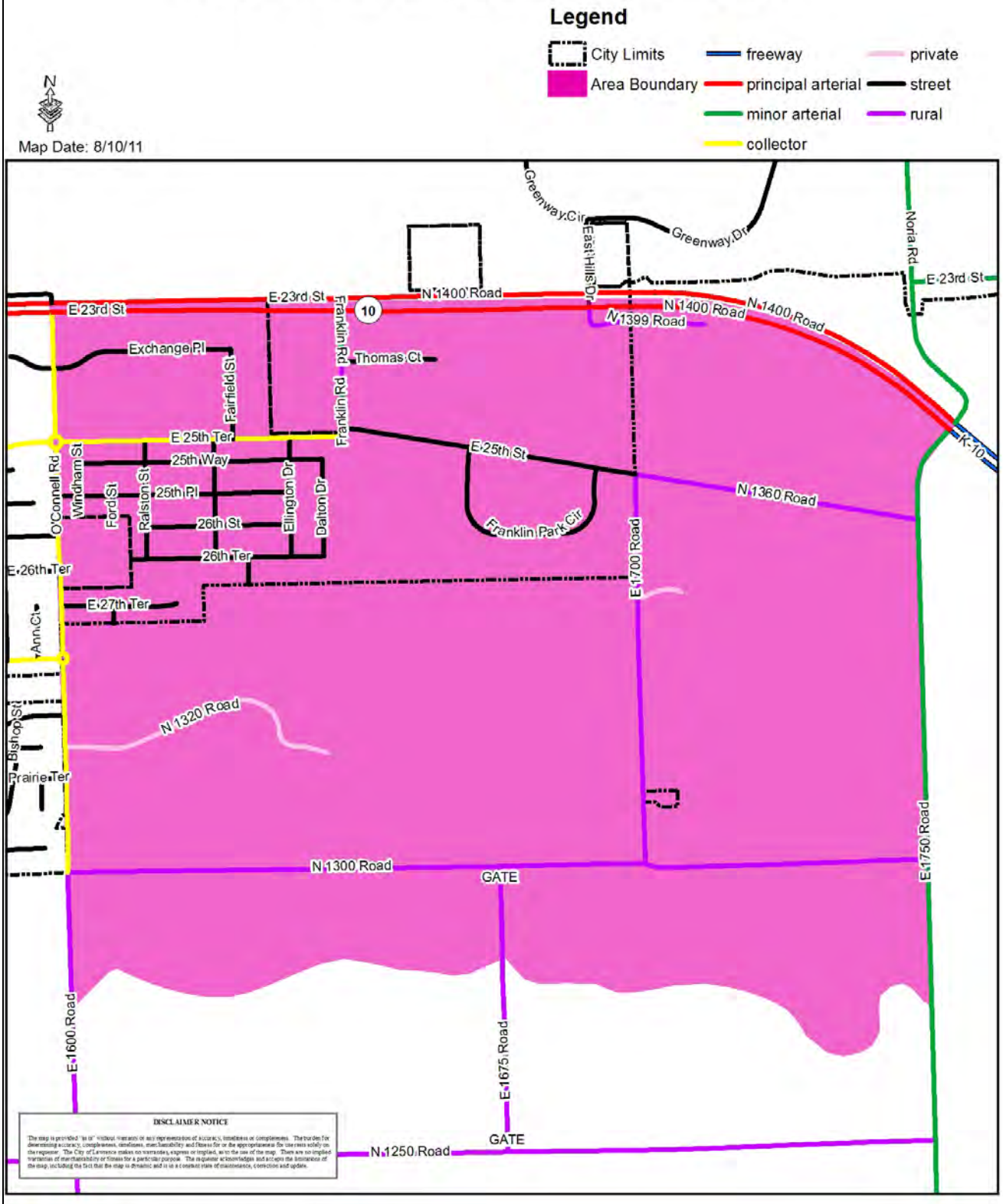
Currently, there ~~is only one~~ are two existing bicycle ~~facility~~ facilities within the planning area. O'Connell Road is identified as having an existing bike lane and E. 25th Terrace is identified as a bike route. ~~Bike lanes are identified to be located on: E. 25th Street and N 1360 Road from Franklin Road to E 1750 Road (Noria Road), E. 28th Street extended from O'Connell Road to E 1700 Road extended, and E 1700 Road from N 1300 Road (E. 31st Street) to E. 25th Street and N 1360 Road. An identified future bike route is E. 25th Terrace from O'Connell Road to Franklin Road extended. Identified future rec. paths to be constructed are: Franklin Road from E. 23rd Street/K-10 Highway to N 1300 Road (E. 31st Street), and N 1300 Road (E. 31st Street) from O'Connell Road to E. 23rd Street/K-10 Highway along the proposed SLT/K-10 Highway alignment.~~ These facilities are shown on Map 2-6.

# Southeast Area Plan

## Map 2-5 Existing Street Classifications

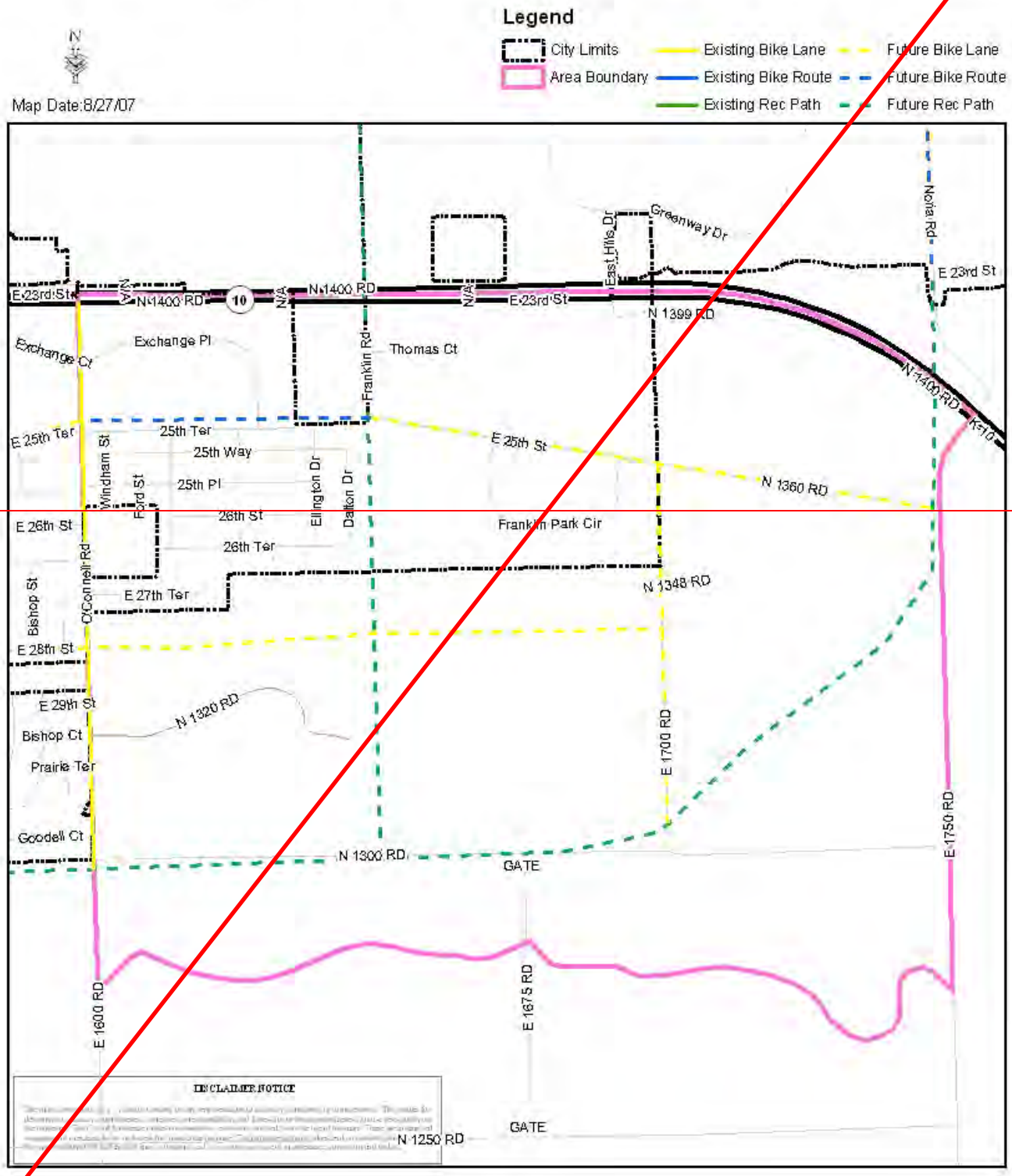


# Southeast Area Plan
## Map 2-5 Existing Street Classification



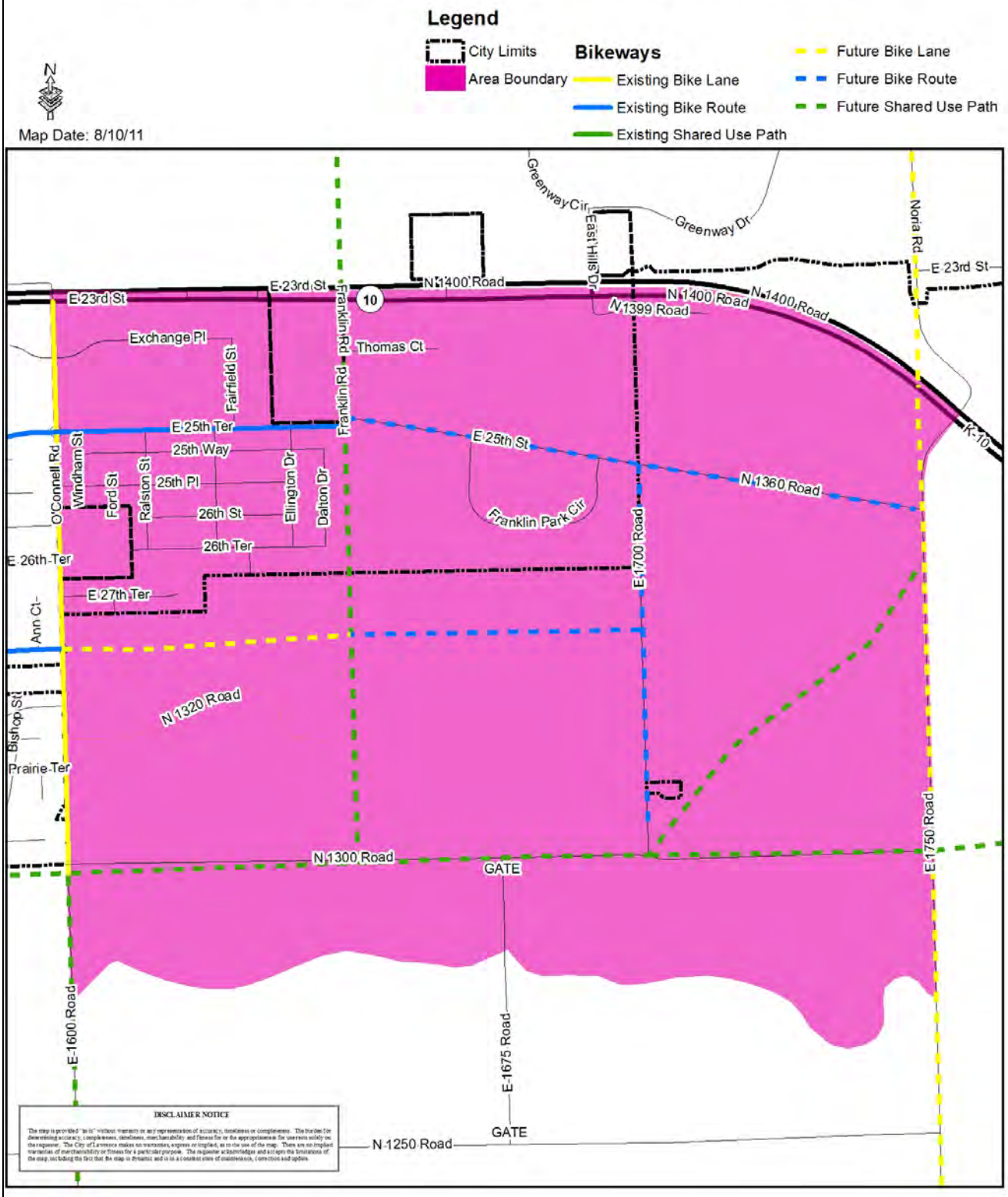
# Southeast Area Plan

## Map 2-6 Existing and Future Bicycle Facilities



# Southeast Area Plan

## Map 2-6 Existing and Future Bicycle Facilities



## 2.4 Environmental Conditions

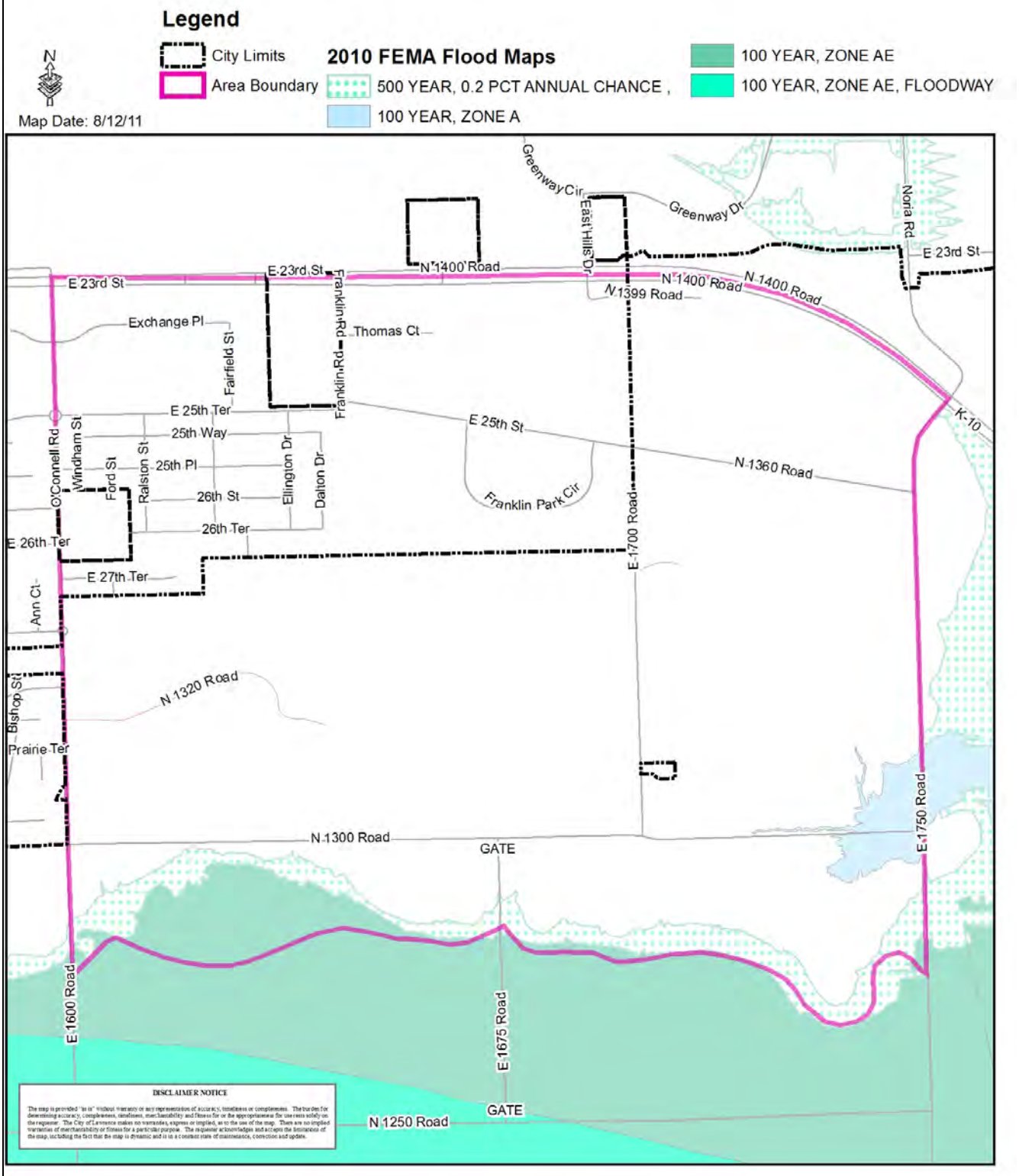
The planning area has seven drainage basins that drain to either the Kansas River or the Wakarusa River. The Farmland and the East Hills drainage basins drain to the north to the Kansas River. The O'Connell, Kitsmiller, Franklin, Noria, and the Naismith Creek drainage basins drain to the south to the Wakarusa River by way of two significant drainageways. There is ~~no~~ Federal Emergency Management Agency (FEMA) designated floodplain located within the planning area ~~however the floodplain for the Wakarusa River, as designated by FEMA, is~~ along the southern border of the planning area. The floodplain within the planning area includes 500 year, and 100 year floodplain. The 100 year floodplain means that there is a 1% chance of flooding each year and the 500 year floodplain means that there is a .2% chance of flooding each year. The floodplain is shown in Map 2-7.

The majority of slopes within the planning area are in the 0-3 percent range as identified in the Soil Survey of Douglas County, Kansas. Some areas of 3-7 percent slope can be found in the northeast and southwest corners of the planning area. A lack of steep slopes is considered to be a beneficial factor for urban development. Detailed topographic surveys will be required as individual properties are developed.

The majority of the undeveloped land within the planning area is used for either row crop or pasture land. There is a minimal amount of woodland areas within the planning area. Existing woodland is found mainly in two areas: in the northeast corner of the planning area, and in the southwest corner.

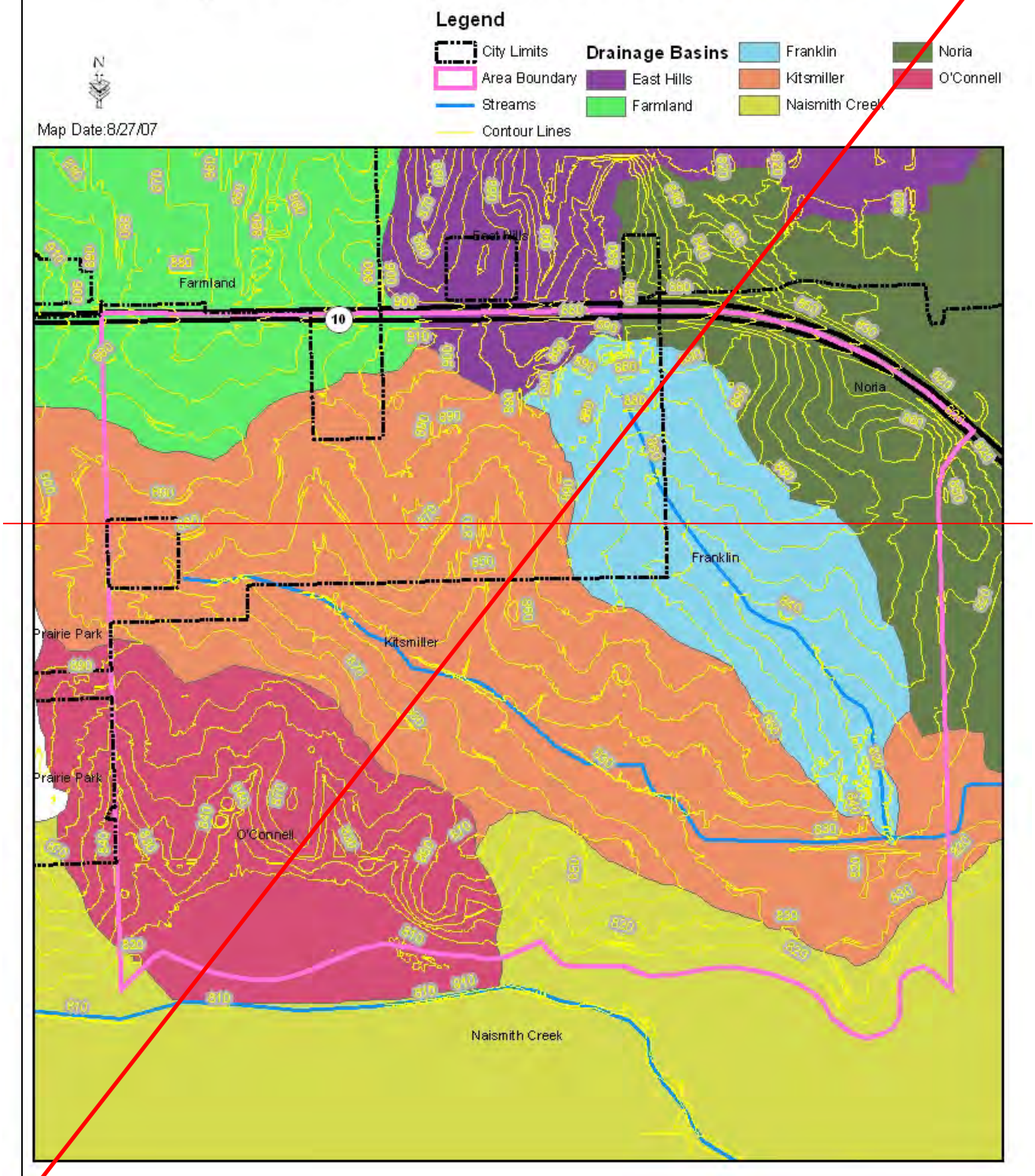
Map 2-~~6~~ 8 illustrates the existing environmental features of the planning area.

# Southeast Area Plan
## Map 2-7 Existing Floodplain

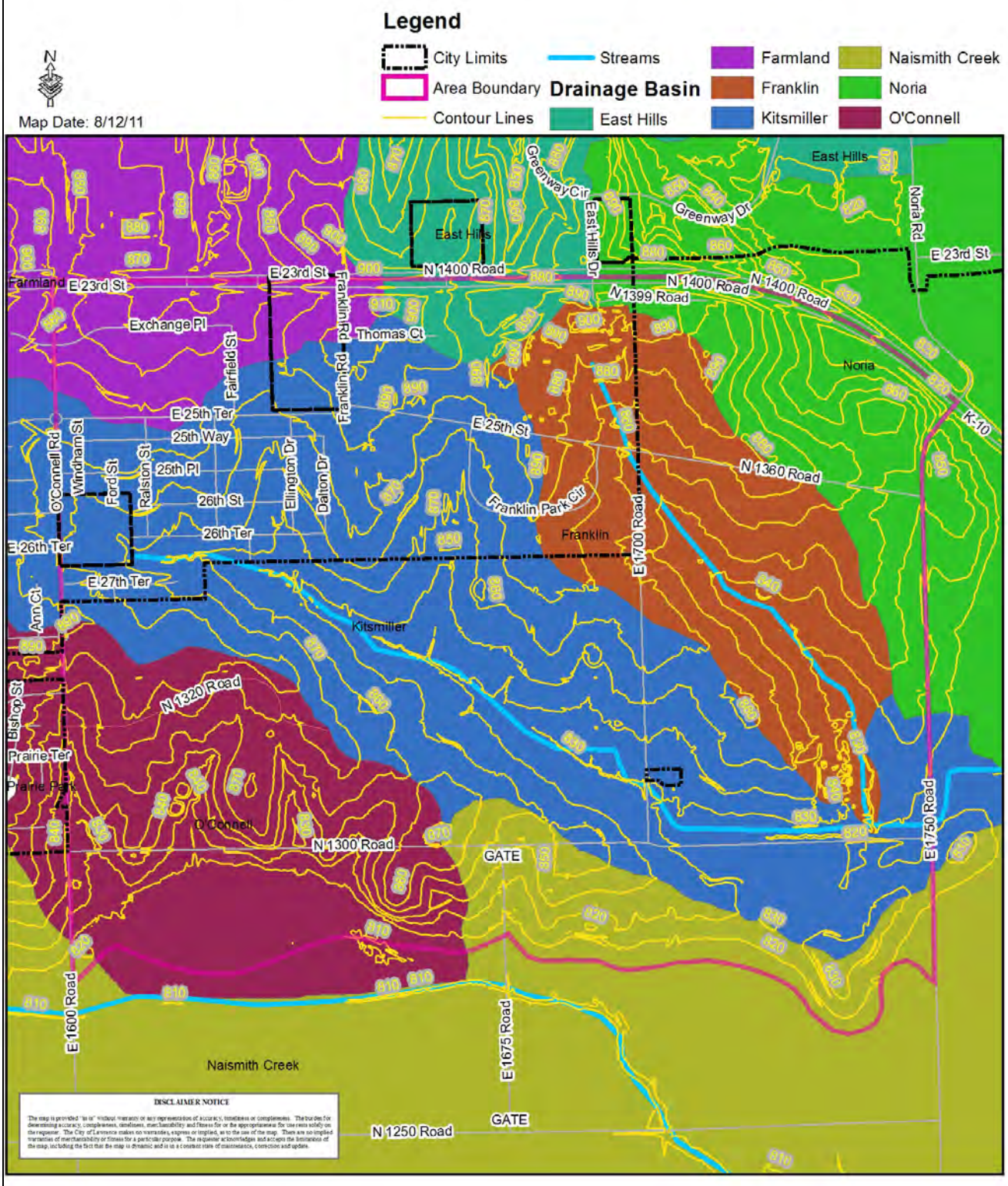


# Southeast Area Plan

## Map 2-7 Existing Environmental Features



# Southeast Area Plan
## Map 2-8 Existing Environmental Features



## 2.5 Public Services/Facilities

All urban public services, schools, fire/medical, police, developed parks, etc., are located to the west and north of the planning area.

The entire planning area is located within the Lawrence Public School District (USD 497). The students within this area currently attend Prairie Park Elementary School, South ~~Junior High~~Middle School, and Lawrence High School. The need for a new elementary school is determined by the School Board based on residential population projections. The school district does not currently have plans to build a school within this planning area though they own property north of the future park along E 1700 Road (Kitsmiller Road). ~~There has been discussion that if the need arises for a new elementary school within the planning area, a portion of the city's future park property could be developed for a school facility.~~

Douglas County Jail

Currently, there are four public or institutional land uses within the planning area. These uses include O'Connell Youth Ranch, Teen Challenge, and Douglas County Jail, as well as the undeveloped city park property. It is anticipated that O'Connell Youth Ranch and Teen Challenge will redevelop in the future as the area urbanizes. The county jail site was developed with expansion in mind and will remain a public facility within the planning area. The undeveloped park property is likely to be developed as the planning area urbanizes. Douglas County is currently in the process of purchasing property east of the jail for the location of the county public works facility.

Fire & Medical Station No. 2

The planning area will be served partially by Fire & Medical Station Number 2, an existing facility located on Harper Street north of E. 23rd Street/K-10 Highway and partially by the Wakarusa Township Fire Department. A future Fire & Medical station location has conceptually been identified by Fire & Medical staff as being necessary, east of the current Station No. 2 location, in order to serve the larger southeast extent of the urban growth area. A more ~~in~~ in-depth study will need to be conducted to ultimately locate the facility and to address emergency response time issues as this portion of the community develops. Generalized future locations have been identified through departmental studies and a timeline for development has not been identified.

## Section 3 - Recommendations

The Southeast Area is anticipated to develop with a wide range of uses and intensities that extend from very low-density residential to industrial uses. The more intensive industrial and commercial use areas are recommended where they are in close proximity to E. 23rd Street/K-10 Highway, and arterial and collector streets. Residential uses are generally located in the southern portion of the planning area.

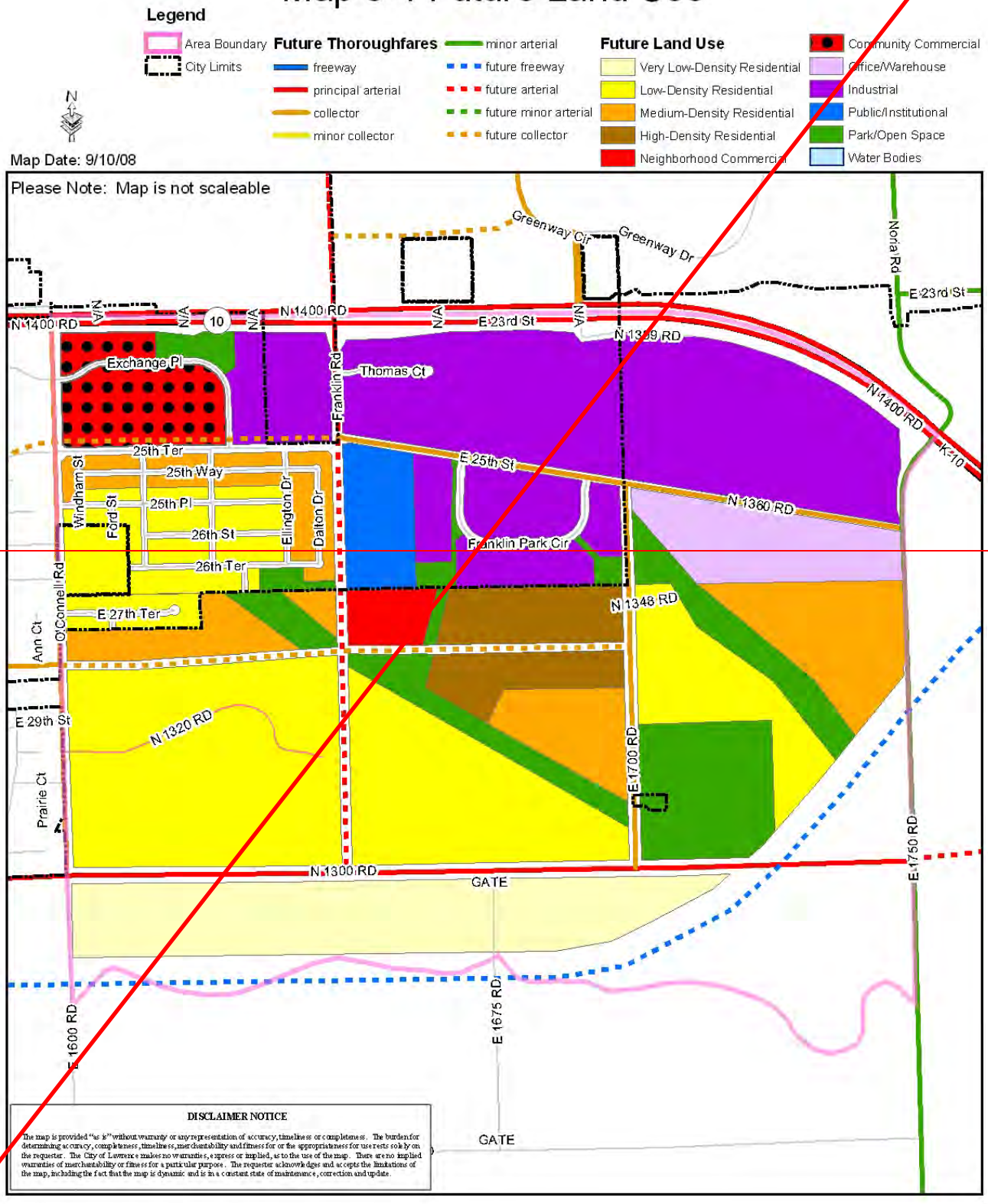
### 3.1 Land Use

This section outlines the recommended land uses for the planning area. The future land use map and land use descriptions are explained on the subsequent pages. The map is an illustration to help visually identify the different areas as they are designated. The land use descriptions are more detailed information regarding the different land use categories. These are recommended uses within the planning area. The official definitions and the permitted uses within each zoning district are outlined in the use tables that are located in the *Land Development Code* for the City of Lawrence. The map and text descriptions must be used in conjunction with one another in order to obtain the complete recommendation for each particular area.

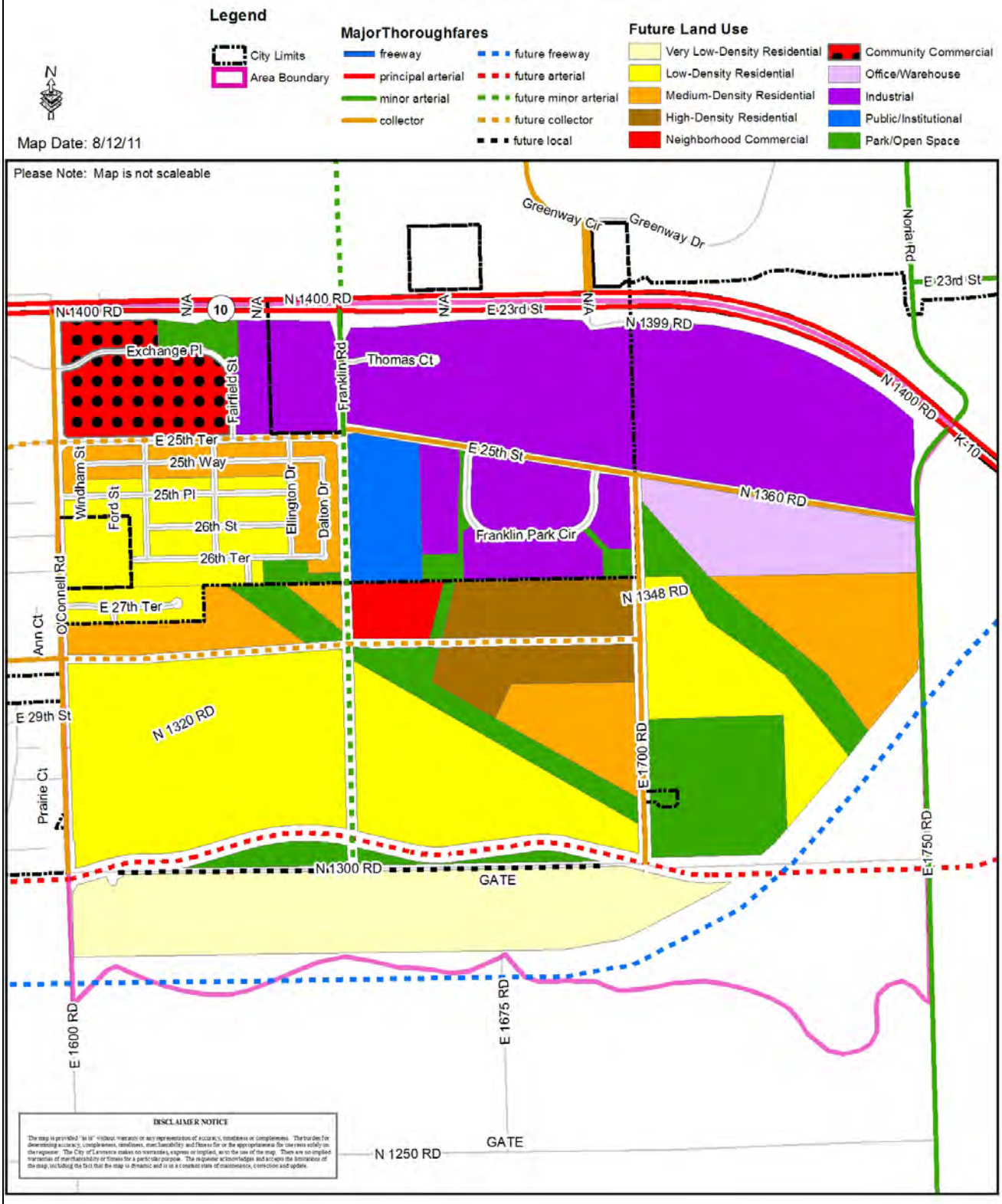
Map 3-1 provides a general concept for the location of recommended land uses in the Southeast Area. It is not intended to provide a scaleable map for determining specific land use/zoning boundaries within this area.

# Southeast Area Plan

## Map 3-1 Future Land Use



# Southeast Area Plan
## Map 3-1 Future Land Use



Very Low-Density Residential:

The intent of the very low-density residential use is to allow for large lot, single-dwelling type uses.

Density: 1 or fewer dwelling units per acre

Intensity: Very low

Applicable Area:

- Area south of N 1300 Road (E. 31st Street) between O'Connell Road and E 1750 Road (Noria Road).

Zoning Districts: RS40 (Single-Dwelling Residential), PD (Planned Development Overlay)

Primary Uses: Detached dwellings, group home, public and civic uses

Low-Density Residential:

The intent of the low-density residential use is to allow for single-dwelling, duplex, and attached dwellings but emphasis is placed on residential type uses.

Density: 6 or fewer dwelling units per acre

Intensity: Low

Applicable Areas:

- Area east of O'Connell Road, generally along the following streets: 25th Place, 26th Street, 26th Terrace, E. 27th Terrace, Ralston Street, Fairfield Street, and Ellington Drive.
- Area surrounded by O'Connell Road, E. 28th Street extended, Franklin Road extended, and N 1300 Road (E. 31st Street).
- Area east of Franklin Road extended, north of N 1300 Road (E. 31st Street), west of E 1700 Road (Kitsmiller Road), and south of the Kitsmiller tributary.
- Area east of E 1700 Road (Kitsmiller Road), north and east of the city future park property, and south of the tributary green space.

Zoning Districts: RS10 (Single-Dwelling Residential), RS7 (Single-Dwelling Residential), RS5 (Single-Dwelling Residential), RM12D (Multi-Dwelling Duplex Residential), PD (Planned Development Overlay)

Primary Uses: Detached dwellings, attached dwellings, duplex, group home, public and civic uses

Medium-Density Residential:

The intent of the medium-density residential use is to allow for a variety of types of residential options for the area.

Density: 7-15 dwelling units per acre

Intensity: Medium

Applicable Areas:

- Area east of O'Connell Road, generally along the following streets: 25th Way, Ralston Street, Windham Street, Ellington Drive, and Dalton Drive.
- Area east of O'Connell Road, north of E. 28th Street extended, and west of Franklin Road.
- Area west of E 1700 Road, north of the Kitsmiller Tributary, and just south of E. 28th Street extended.
- Area west of E 1750 Road (Noria Road), north of the future alignment of the SLT/K-10 Highway, and east of the tributary green space.

Zoning Districts: RS5 (Single-Dwelling Residential), RS3 (Single-Dwelling Residential), RM12 (Multiple-Dwelling Residential), RM12D (Multi-Dwelling Duplex Residential), RM15 (Multi-Dwelling Residential), PD (Planned Development Overlay)

Primary Uses: Detached dwellings, attached dwellings, duplex, multi-dwelling structures, group home, civic and public uses

High-Density Residential:

The intent of the high-density residential use is to allow for compact residential development.

Density: 16+ dwelling units per acre

Intensity: High

Applicable Areas:

- Area northwest of the intersection of E. 28th Street extended and E 1700 Road (Kitsmiller Road).
- Area southwest of the intersection of E. 28th Street extended, E 1700 Road (Kitsmiller Road), and east of the Kitsmiller Tributary.

Zoning Districts: RM24 (Multi-Dwelling Residential), RM32 (Multi-Dwelling Residential), PD (Planned Development Overlay)

Primary Uses: Multi-dwelling structures, group home, civic and public uses

Commercial:

The intent of the commercial use is to allow for retail and service uses. A Community Commercial Center provides goods and services to several different neighborhood areas. A Neighborhood Commercial Center provides for the sale of goods and services at the neighborhood level.

Intensity: Medium-High

Applicable Areas:

- Area southeast of the intersection of E. 23rd Street/K-10 Highway and O'Connell Road. (Community Commercial Center)
- Area northeast of the intersection of Franklin Road extended and E. 28th Street extended. (Neighborhood Commercial Center)

Zoning Districts: CC200 (Community Commercial District), CN2 (Neighborhood Commercial Center District), PD (Planned Development Overlay)

Primary Uses: Civic and public uses, medical facilities, eating and drinking establishments, general office, retail sales and services, fuel sales, car wash

Office/Warehouse:

The intent of the office/warehouse use is to allow for low-impact employment and warehouse uses that would be minimally evasive to nearby residential uses.

Intensity: Low-Medium

Applicable Area:

- Area south of N 1360 Road between E 1700 Road (Kitsmiller Road) and E 1750 Road (Noria Road).

Zoning Districts: IBP (Industrial and Business Park District), IL (Limited Industrial District), PD (Planned Development Overlay)

Primary Uses: Civic and public uses, health care offices/clinics, animal services, general office, business equipment sales, business support services, communication sales and services, building maintenance sales and services, construction sales and services, vehicle sales and services, research services, manufacturing and production limited and technology, light wholesale, storage and distribution, mini-warehouse

Industrial:

The intent of the industrial use is to allow for moderate to high-impact uses including large scale or specialized industrial uses geared toward utilizing E. 23rd Street/K-10 Highway for materials transportation.

Intensity: Medium-High

Applicable Area:

- Area northwest of the intersection of 25th Terrace and Franklin Road.
- Area east of Franklin Road, north of E 25th Street and N 1360 Road, west of E 1750 Road (Noria Road), and south of E. 23rd Street/K-10 Highway.
- Area north and south of Franklin Park Circle.

Zoning Districts: IL (Limited Industrial District), IG (General Industrial District), PD (Planned Development Overlay)

Primary Uses: Civic and public uses, animal services, general office, building maintenance services, business support services, construction sales and

service, vehicle sales and service, industrial facilities, general office, wholesale, distribution, and storage

Public/ Institutional:

The intent of the public/institutional use is to allow for public, civic, and utility uses.

Intensity: Variable

Applicable Area:

- Area southeast of the intersection of Franklin Road and E. 25th Street. (Douglas County Jail)

Zoning Districts: GPI (General Public and Institutional)

Primary Uses: Cultural center/library, school, utilities, recreational facilities, utility services

Park/ Open Space:

The intent of the park/open space use is to provide space for public recreational facilities and natural area preservation.

Intensity: Low

Applicable Areas:

- Area at the northeast intersection of E 1700 Road (Kitsmiller Road) and N 1300 Road (E. 31st Street).
- Kitsmiller Tributary and the unnamed tributary, east of E 1700 Road (Kitsmiller Road).
- Platted drainage easements.
- Area between the E. 31st Street alignment and N 1300 Road (E. 31st Street)

Zoning Districts: GPI (General Public and Institutional District), OS (Open Space), UR (Urban Reserve)

Primary Uses: crop agricultural, cultural center, schools, active recreation, passive recreation, nature preserve, entertainment and spectator sports, participant sports and recreation outdoor, private recreation

## 3.2 Policies

Policies are guiding principles that provide direction for decisions to be made regarding the planning area. These policies are in addition to the policies in *Horizon 2020* and are only applicable to the property within the Southeast Area planning area.

*3.21 Residential Land Use*

1. Residential uses shall maintain a "back-to-back" relationship to more intense uses. Buffering shall include use of green space as a primary transition tool.
2. Residential streets shall be extended to undeveloped property and shall use a grid or modified grid pattern.
3. Medium-density residential development shall take the form of small lot, detached, attached, or cluster type housing.
4. The medium-density residential use is not intended to provide for large scale apartment development.

*3.22 Commercial Land Use*

1. The Community Commercial Center shall be designed in accordance with policies and standards of *Horizon 2020.*
2. The Neighborhood Commercial Center shall be no larger than 10 acres and with no more than 15,000 gross square feet of commercial space.
3. Commercial development shall be designed to facilitate pedestrian and non-motorized access from abutting areas is recommended.

*3.23 Public Facility/Open Space Land Use*

1. Smaller parks should be located throughout the planning area.
2. If the need arises for an elementary school to be located within the planning area, the city and school district should work together to develop a joint use facility.
3. Open space areas should be provided and/or acquired along major thoroughfares and along drainage ways for development of pedestrian and bicycle trails.

*3.24 Gateway*

1. Development shall enhance the gateway along E. 23rd Street/K-10 Highway by creating an aesthetically pleasing view into the city.
2. Gateway treatments shall be a priority in development and redevelopment along E. 23rd Street/K-10 Highway and shall reflect the goals and polices stated in *Horizon 2020*.
3. Aesthetically pleasing landscaped entryways along E. 23rd Street/K-10 Highway should be required. Both public and private property owners are responsible for achieving and maintaining this aesthetically pleasing landscaping.

*3.25 Transportation Facilities and Corridors*

1. The widening of E. 31st Street (N 1300 Road) should be designed in a manner as to minimally disturb existing dwellings.
2. A frontage road should be considered along the widened E. 31st Street (N 1300 Road) to allow existing dwellings to maintain individual access drives.
3. Sufficient area, outside of the required street rights-of-way, should be required to provide screening along major thoroughfares corridors. This area shall be restricted in use to provide for: utility, berming, and landscaping needs.

4. ~~*Transportation 2030* or s~~Subsequent long-range transportation plans, once adopted, shall supersede any recommendations, actions, or policies referenced in *Transportation ~~2025~~2030*.

*3.26 General*

1. Encourage maximum efficiency, low wattage, downward directional exterior lighting. The point source shall be screened from view off-site.
2. ~~4.~~ Fencing installations along street rights-of-way and between uses shall incorporate continuous landscaping at the base and edges of the fence to integrate the fence with the site and landscaping.
3. ~~5.~~ High quality, aesthetically pleasing building materials should be used.
4. ~~6.~~ Pedestrian friendly connectivity between land uses and properties shall be incorporated.
5. ~~7.~~ Development of an implementation/capital improvement program to extend water and wastewater infrastructure to serve the area is recommended.
6. ~~8.~~ Mature trees and stands of mature trees should be preserved and protected.

## 3.3 Implementation

1. Amend *Horizon 2020* Chapter 14, Specific Plans, to include the *Southeast Area Plan* by reference. Completed February 12, 2008
2. Amend *Horizon 2020* Chapter 6, Commercial Land Use, to update the identified Neighborhood Commercial Center on the southeast corner of O'Connell Road and E. 23rd Street/K-10 Highway to be identified as a Community Commercial Center. Completed May 21, 2008
3. Amend *Horizon 2020* Chapter 6, Commercial Land Use, to identify a Neighborhood Commercial Center on the southeast corner of Franklin Road extended and E. 28th Street extended. Completed May 21, 2008
4. Amend *Horizon 2020* Chapter 6, Commercial Land Use, to remove the Neighborhood Commercial Center on the northwest corner of Franklin Road extended and N. 1300 Road (E. 31st Street). Completed May 21, 2008
5. Amend *Horizon 2020* Chapter 3, General Plan Overview, Map 3-1 Lawrence Urban Growth Area Service Areas & Future Land Use, to reflect the adopted future land use.

# Memorandum
# City of Lawrence-Douglas County
# Planning & Development Services

**TO:** **Lawrence-Douglas County Planning Commission**

**FROM:** **Michelle Leininger, AICP, Area/Neighborhood Planner**

**CC:** **Scott McCullough, Planning and Development Services Director**
**Sheila Stogsdill, Assistant Planning Director**

**Date:** **August 24, 2011**

**RE:** **Misc. 1: Initiation of a Text Amendment for Section 20-601 and Section 20-1701**

On July 12, 2011, the City Commission initiated a text amendment to the *Land Development Code* Article 6 to review standards related to setbacks and height of structures adjacent to RS zoned property. After beginning to review this text amendment, it was found that other sections, not related to development adjacent to RS zoned property need to be reviewed.

The areas of this article that specifically need to be reviewed are that the standards outlined in the residential and non-residential district tables are not consistent. The residential district table includes standards for maximum building coverage and maximum impervious cover where the non-residential table includes standards for maximum lot coverage and maximum impervious lot coverage. Within each table this may be an overlap of standards, they are not consistent between the two tables, and those non-residential standards are unclear. Additionally there is some clean up in the non-residential table that should be completed in order to make the table more concise.

Staff would like to clarify these and since it is outside of the scope of the originally initiated text amendment, staff is requesting initiation of an additional text amendment to address this issue. Staff would bring both the already initiated text amendment and the new text amendment back together at a future date.

**Action Requested**

Initiate text amendments to the *Land Development Code,* Section 20-601 to clarify the density and dimensional standards and potentially to Section 20-1701 if definitions of terms are determined to be needed.