UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

APR 19 2011

REPLY TO THE ATTENTION OF:

Louise Clemency, Field Supervisor
United States Fish and Wildlife Service
Chicago Illinois Field Office
1250 South Grove, Suite 103
Barrington, Illinois 60010

Dear Ms. Clemency:

Pursuant to Section 7 of the Endangered Species Act, (87 Stat. 884, as amended; 16 U.S. C. 1531 et seq.), the U. S. Environmental Protection Agency has reviewed the biological information and analysis related to a Prevention of Significant Deterioration permit for the proposed Universal Cement, LLC Portland cement production facility to determine what impact there may be to any threatened or endangered species in the area around the facility. The purpose of this letter is to seek concurrence from the U. S. Fish and Wildlife Service on our determination that the proposed project may affect, but is not likely to adversely affect any federally listed species in relation to the proposed air quality permit for this facility.

Universal Cement, LLC is proposing to build a new Portland cement production facility in Chicago, Illinois. Cambridge Environmental, Inc. provided an analysis of the impacts from the proposed expansion dated February 11, 2011. Based on the information submitted, the EPA finds that the proposed project may affect, but is not likely to adversely affect an endangered or threatened species. If you have any questions with respect to this letter, please contact Rachel Rineheart, of my staff, at (312) 886-7017.

Sincerely,

Pamela Blakley

Pamela Blakley
Chief
Air Permits Section

Enclosure

cc: Laurel Kroack, IEPA

Universal Cement Facility
Enhanced Soils and Vegetation Analysis
and
Ecological Screening Assessment

Submitted to:
Universal Cement, LLC

Submitted by:
Stephen G. Zemba, Ph.D. and Michael R. Ames, Sc.D.

Cambridge Environmental Inc

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February 11, 2011

Summary

Universal Cement, LLC (Universal Cement) proposes to build a new Portland cement production facility, to be located on the south side of Chicago, Illinois, near the intersection of South Torrence Avenue and 117th Street. The Universal Cement facility will consist of an in-line raw mill and preheater/precalciner Portland cement kiln, a clinker cooler and associated clinker handling and storage equipment, a coal mill and associated coal handling and storage equipment, a finish mill and associated cement handling and storage equipment, and raw material handling and storage equipment.

The three largest sources of pollutant emissions are expected to be the cement kiln stack, the clinker cooler, and the finishing mill. Potential emissions include nitrogen oxides (NO_x), sulfur dioxide (SO_2), particulate matter (PM), and Hazardous Air Pollutants (HAPs) such as cadmium, chromium, mercury, benzene, formaldehyde, hydrogen chloride, and hydrogen fluoride (HF).

This Enhanced Soils and Vegetation Analysis (ESVA) and Ecological Screening Assessment (ESA) examines potential project impacts to soils and vegetation. An area of particular concern is the naturalized portion of Lake Calumet, and in particular Indian Ridge Marsh, an area immediately to the west of the proposed Universal Cement facility, that is undergoing active environmental restoration, and serves as a valued ecological oasis and home to many threatened and endangered migratory birds.

The ESVA/ESA is in part motivated by the Section 7 requirement of the Federal Endangered Species Act that requires federal agencies (in this case the U.S. Environmental Protection Agency) to consult with the U.S. Fish and Wildlife Service to determine whether the proposed action of approving a Clean Air Act permit might affect relevant threatened and endangered wildlife species. In a larger sense, however, the analyses serve as a screening-level assessment to gauge potential threats to the environment associated with air pollutant emissions from the proposed Universal Cement facility.

There are three general mechanisms by which Universal Cement facility emissions could, if sufficiently large, adversely affect local soils and vegetation: direct phytotoxicity, deposition, and accumulation. Direct phytotoxicity (plant injury) from NO_x, SO_2, H_2SO_4, NH_3, HCl, and HF is not expected based on the projected concentrations in air. Similarly, the modeled level of deposition of particulate matter is likewise not expected to harm vegetation. Deposition of nitrogen is not predicted to occur at levels believed to cause nutrient loading and ecosystem changes. Finally, some HAPs have the potential to deposit into local soils, surface water, and sediment, and potentially accumulate in concentration, but HAPs from facility emissions are not expected to lead to levels sufficient to be toxic to flora and fauna. Hence, no adverse effects on the local environment are expected due to facility emissions.

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Introduction

Background

Universal Cement proposes to build a new Portland cement production plant to be located on the south side of Chicago, Illinois (Chicago Plant), near the intersection of South Torrence Avenue and 117th Street. The heart of the cement production involves the heating of limestone and other materials to high temperatures to cause calcining reactions. This process occurs in a slowly rotating kiln in which the combined materials are heating through the combustion of fuels, which for the Chicago Plant will include principally coal and petroleum coke, and to a lesser extent tires and natural gas. The Chicago Plant will consist of an in-line raw mill and preheater/precalciner Portland cement kiln, a clinker cooler and associated clinker handling and storage equipment, a coal mill and associated coal handling and storage equipment, a finish mill and associated cement handling and storage equipment, and raw material handling and storage equipment.

The Universal Cement facility will be located in a once heavily industrialized area of south Chicago. Figure 1 provides a view of the area, which includes wetlands and the 724 acre Lake Calumet immediately to the west. Former industrial use has left a legacy of soil and surface water contamination, but even so, the area remains a valuable ecological resource, which is expected to improve in quality through natural and active remediation and restoration processes.

Overview of Soil and Vegetation Analysis

The major anticipated sources of pollutant emissions from the proposed Universal Cement facility are the stacks of the cement kiln, clinker cooler, and finish mill. The cement kiln stack, as part of a combustion system, will release the greatest number and highest rates of pollutants. The clinker cooler and finish mill will release pollutants associated with the cement clinker product, specifically its trace levels of metallic compounds.

Compounds of potential concern (COPCs) potentially emitted from the cement kiln stack include Criteria Pollutants, which are the pollutants subject to the Clean Air Act's National Ambient Air Quality Standard (NAAQS) regulations and those generally emitted in the greatest quantities by industrial facilities such as the Universal Cement Plant, and some Hazardous Air Pollutants (HAPs, as designated by the Clean Air Act). The HAPs include chemicals such as cadmium, chromium, mercury, benzene, formaldehyde, hydrogen chloride, and hydrogen fluoride.

There are three general mechanisms by which Universal Cement Plant emissions could, if sufficiently large, adversely affect local soils and vegetation:

- *Direct phytotoxicity*: Several COPCs are known to be toxic to plants if present in high enough concentrations in air. Based on the phytotoxicity literature, the principal COPCs that might be toxic due to their presence in air are SO_2, NO_x, and HF;

- *Deposition*: Excessive PM depositing on leaf surfaces can reduce photosynthesis levels. Additionally, nitrogen deposition can lead to increased levels of nutrient loading; and

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- *Accumulation*: Some HAPs to be emitted by the Universal Cement facility have the potential to deposit into local soils and accumulate in concentration. At sufficient levels, these HAPs can be toxic to flora and fauna.

Report Outline

The soils and vegetation analysis begins by reviewing the environmental setting of the proposed Universal Cement facility. Potential pollutant emissions and their potential to cause direct phytotoxicity and vegetation injury through particulate deposition are then discussed. In the most extensive section of the report, indirect effects of deposited facility emissions are evaluated using two different estimation methods and potential acidification and nitrogen loading impacts. Finally, emissions and potential impacts of HAPs are evaluated.

Environmental Setting

The proposed location of the Universal Cement facility is within the midst of a once heavily industrialized area of urbanized south Chicago (Figure 1). Historic development of the area during the industrial revolution significantly affected and modified water resources and included rerouting of the Calumet River and the reshaping of Lake Calumet to support shipping and transport of goods and resources. Prior to industrialization and urban development, the area in the vicinity of the Calumet River was a vast stretch of wetland. The Calumet River was widened and deepened by burgeoning industry throughout the late 19th and early 20th centuries, creating a shipping channel and decreasing the size of Lake Calumet, where 300 acres of dry land were created from dredging spoils (Sparks, 2000). Companies also dumped wastes and created landfills, introducing various contaminants in soil and surface water, much of which remains today. Paralleling the decline of American manufacturing, much of the industry of the Lake Calumet region is gone, leaving behind in some cases a legacy of substantial contamination and environmental degradation (Figure 2 and Figure 3). At the same time, however, the Lake Calumet region has evolved to become a valued ecological resource, and efforts are underway to protect, restore, and enhance habitats. Consequently, although the soil and vegetation analysis examines the entire area that could potentially be affected by emissions from the proposed Universal Cement facility, particular attention is focused on the Lake Calumet region.

Land Use and Soil Characteristics

In addition to the significant modifications by industrial facilities, Lake Calumet and associated wetlands have been enveloped by the growth of the urban Chicago region. Once part of a vast prairie, only limited amounts of land in the Calumet area have escaped development. The locations of surface water features, municipal parks, and forested areas (preserves) are shown in Figure 4.

Figure 5 illustrates the major soil types (associations) found in the Calumet area, and Figure 6 depicts the parent materials responsible for their formation. Approximate percentages of soil types reflected in these Figures are provided in Table 1. Parent materials of most soils reflect remnants of the Wisconsinan glacial period (the most recent event that affected the geographical features of much of North America, which ended about 10,000 years ago). The parent materials for the majority of soils in the immediate Lake Calumet area are Lacustrine silts, loamy and silty clay loam glacial sediments, and sandy outwash. Soils in the Calumet Assessment Area are

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classified predominantly as Alfisols and Mollisols, differentiated by the amount of organic matter accumulated in the upper soil horizon. In the immediate area of Lake Calumet (near the proposed Universal Cement facility), Mollisols, developed under natural prairie or marsh vegetation, dominate. These soils are rich in organic matter and have a darker soil color (black to dark brown).

Table 1. Soil types in the vicinity of the proposed Universal Cement facility

Soil Association	Percent Area Covered	Parent Material Description
Sparta-Dickinson-Onarga	42.5%	Thick, sandy Wisconsinan outwash and Aeolian materials
Oakville-Lamont-Alvin	20.5%	
Martinton-Milford	16.9%	Loamy, silty, and clayey Wisconsinan lacustrine sediments
Plano-Proctor-Worthen	8.9%	Moderately thick to thin loess or silty material (24-60+ inches) on medium-textured, Wisconsinan outwash
Morley-Blount-Beecher	5.4%	Thin loess (<20 inches) on silty clay loam, Wisconsinan till, or lacustrine sediments
Varna-Elliott-Ashkum	1.5%	
Channahon-Dodgeville-Ashdale	2.8%	Thin to thick loess or loamy materials with or without residuum on limestone
Surface Water	1.5%	—

Appendix A provides information about the soil associations, as obtained from the Soils of Illinois publication.[1] Three soil associations account for roughly 80% of the area covered in Figure 5, and also represent the soil types found in the Lake Calumet area in the immediate region of the proposed Universal Cement facility:

- The Sparta-Dickinson-Onarga association soils are found in areas of central and northern Illinois where very sandy materials have been deposited either by wind or water, associated with rivers or streams, or with glacial outwash plains that had a very high concentration of glacial meltwaters. The soils are dark colored, having developed primarily under prairies. The native vegetation of the poorly drained and very poorly drained soils was probably marsh grasses and some water-tolerant trees. These soils typically have moderate to low available-water holding capacity and rapid permeability. Surface runoff is typically slow or very slow. Soils in this association are droughty during the late summer when rainfall is normal or below normal. These soils are poor filters for sewage disposal systems because their subsoils have a relatively low amount of clay. Their moderately rapid or rapid permeability can easily lead to contamination of

[1] Fehrenbacher, J.B., J.D. Alexander, I.J. Jansen, R.G. Darmody, R.A. Pope, M.A. Flock, E.E. Voss, J.W. Scott, W.F. Andrews, and L.J. Bushue. 1984. *Soils of Illinois*. University of Illinois at Urbana-Champaign, Agricultural Experiment Station and the Soil Conservation Service, U.S. Department of Agriculture, Bulletin 778.

water supplies. Another result of their low clay content is that they do not hold plant nutrients well.

- The Oakville-Lamont-Alvin soil association occurs in many Illinois counties, and is often the forested counterpart of the Sparta-Dickinson-Onarga association. Similarly, the soils of this association are located in areas where materials high in sand have been deposited either by wind or water from rivers or streams, or glacial outwash, having been formed in sandy glacial outwash, sandy alluvium, or sandy aeolian material. These light-colored soils were generally formed under deciduous forests or a combination of prairie grass and widely scattered deciduous trees. These soils typically have a moderate to low available-water holding capacity with rapid permeability in the subsoil or substratum. Surface runoff ranges from very slow to medium. Erosivity and droughtiness are characteristic of these soils. Wind erosion is frequently a problem in the spring if the soil surface is unprotected, and in some areas there is also some erosion by runoff. These soils are typically poor filters for sewage disposal systems, and if used for that purpose, may contaminate groundwater because of the low clay content in their subsoils and consequent rapid permeability. Another consequence of the rapid permeability is a limited ability to hold plant nutrients. These soils will generally support tree growth.

- The Martinton-Milford soil association occurs mainly in east central and northeastern Illinois. Most areas are located in old glacial lakebeds formed by glacial moraines or other obstructions to natural drainage such as valley fills. Eastern Cook County hosts some of the largest areas of these lacustrine soils (along with Douglas, Iroquois, and northern Henry counties). The majority of these soils formed in lacustrine sediments of silt loam, silty clay loam, silty clay, or clay texture. A thin loess cover is present in some areas. The substratum layers are generally lower in clay and higher in sand and silt than the subsoils. All of these soils formed under grass and are dark colored. Most of the soils in this association are level, and the larger lake plains often appear as wide, flat expanses. With respect to agriculture, the major issues that characterize these soils are drainage and maintenance of fertility. As a consequence of poor drainage, these soils are often traversed by deep ditches.

The general characteristics of soils in the Lake Calumet area have two relevant implications with respect to air pollutants released from the proposed Universal Cement facility. Pollutants deposited by atmospheric deposition could linger due to slow drainage (consistent with the presence of wetlands and marshes in the area). However, deposited contaminants will also be likely to eventually flush out of the soils due to their generally sandy nature and low clay content, which will limit adherence and binding.

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Figure 1 Aerial Image (Orthophotograph) of Lake Calumet Study Area. Location of Proposed Universal Cement Plant highlighted in violet.

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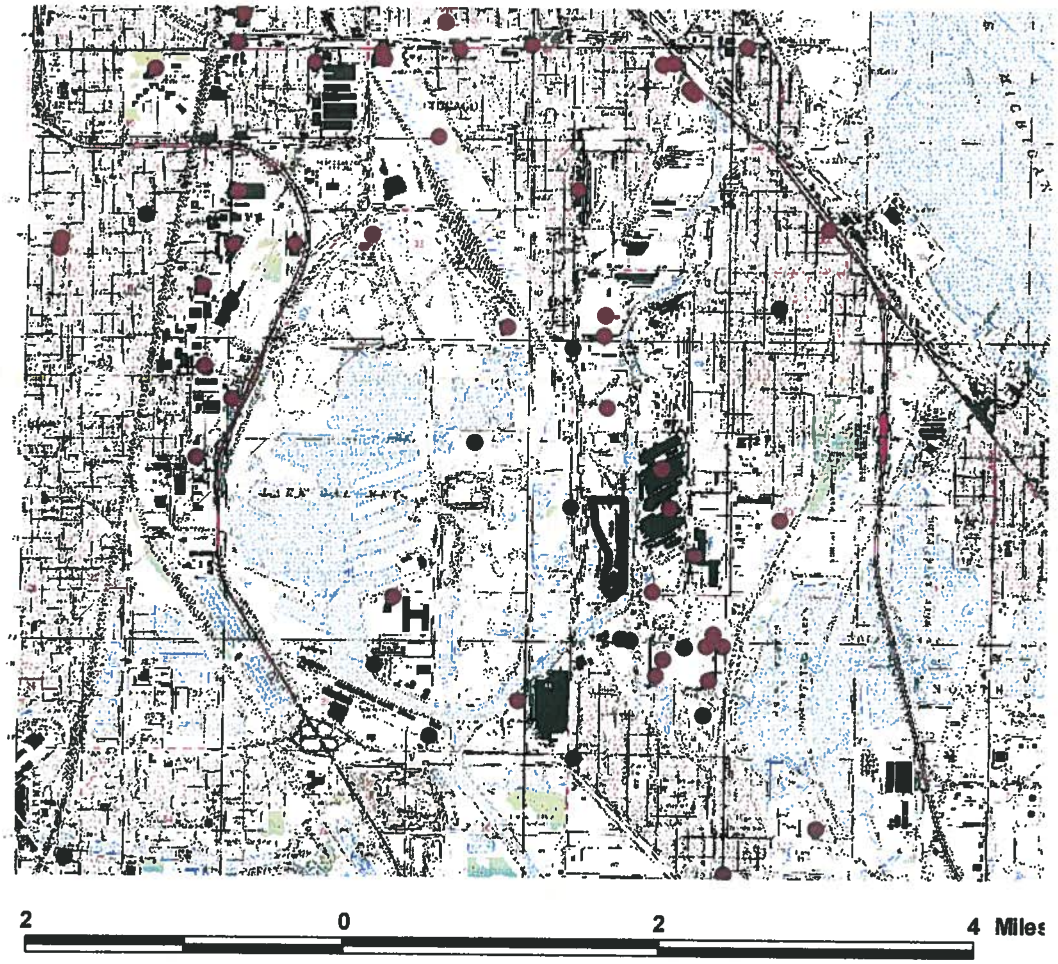

Figure 2 Sites Registered with the Illinois Site Remediation Program (red symbols). Location of Proposed Universal Cement Plant highlighted in violet.

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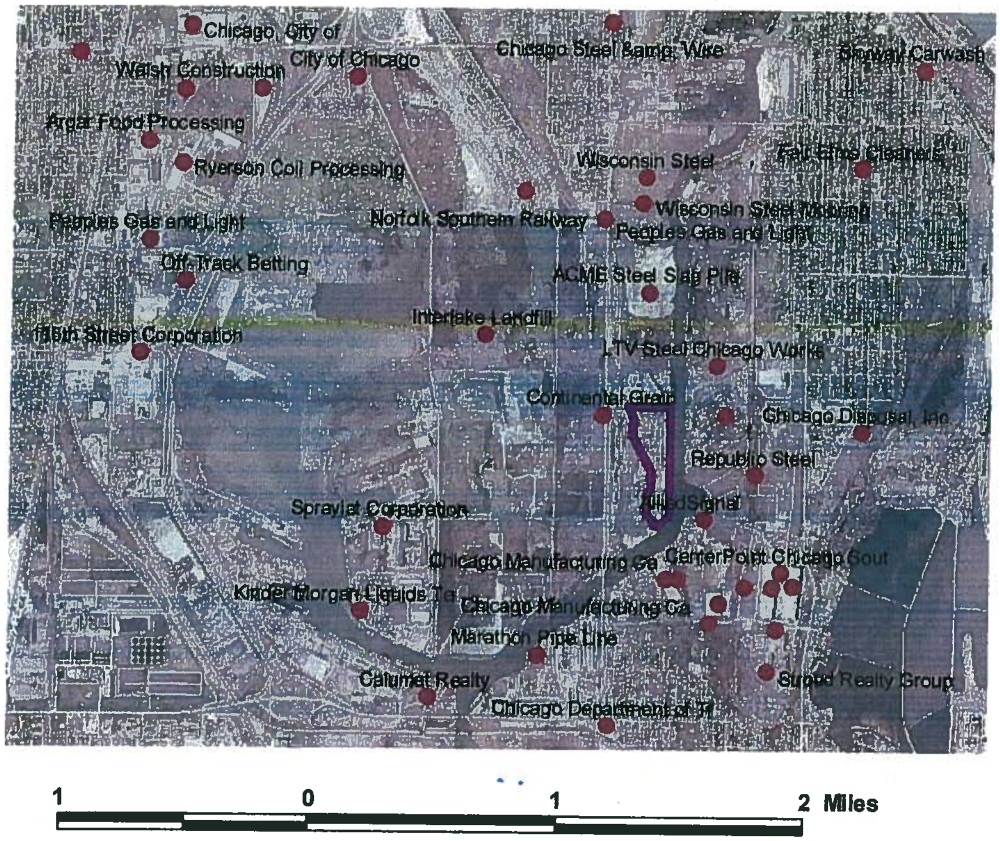

Figure 3 Sites Registered with the Illinois Site Remediation Program (labeled red symbols). Names of some sites omitted due to crowding. Location of Proposed Universal Cement Plant highlighted in violet.

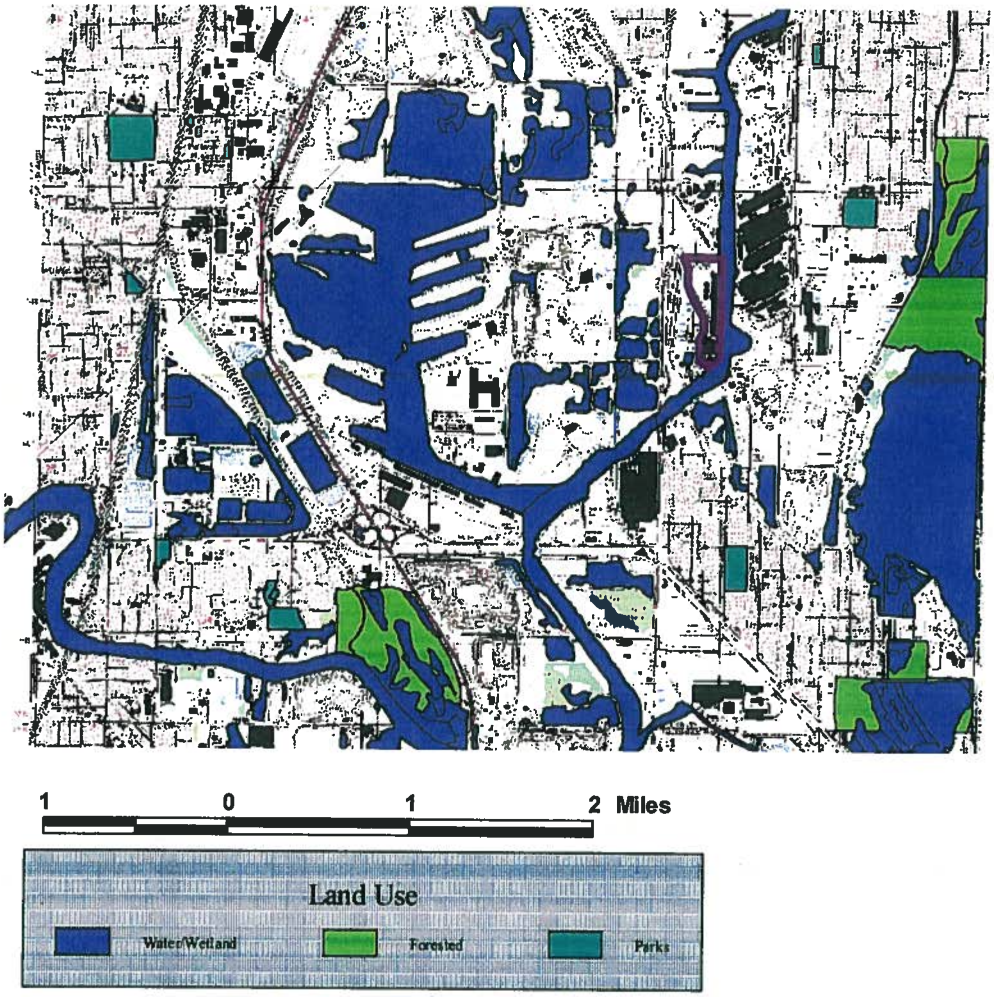

Figure 4 Surface water and designated parks and forested areas near the proposed Universal Cement facility.

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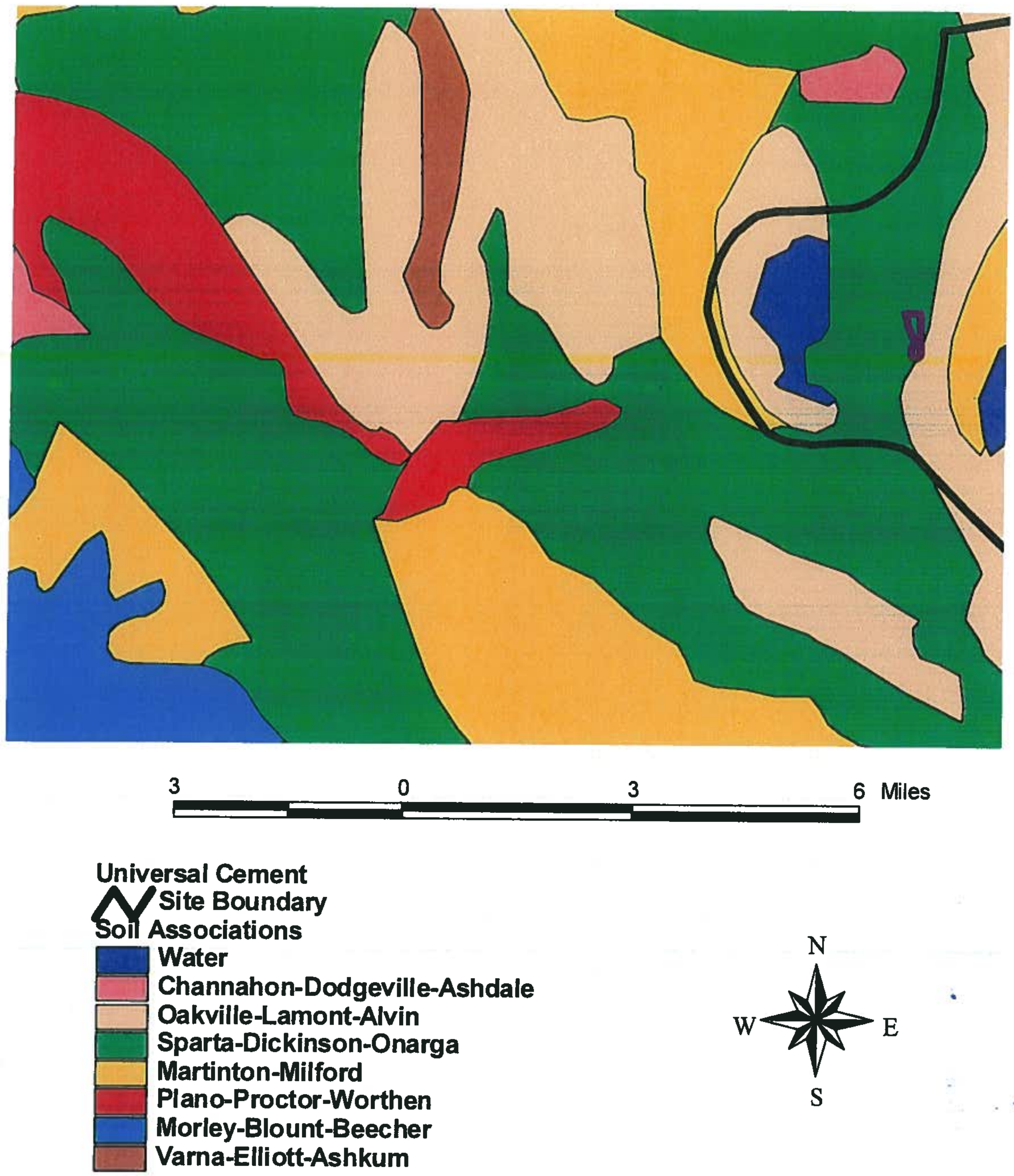

Figure 5 Soil associations in the vicinity of the proposed Universal Cement facility (location outlined in purple). Thick dark line delineates the Little Calumet River watershed.

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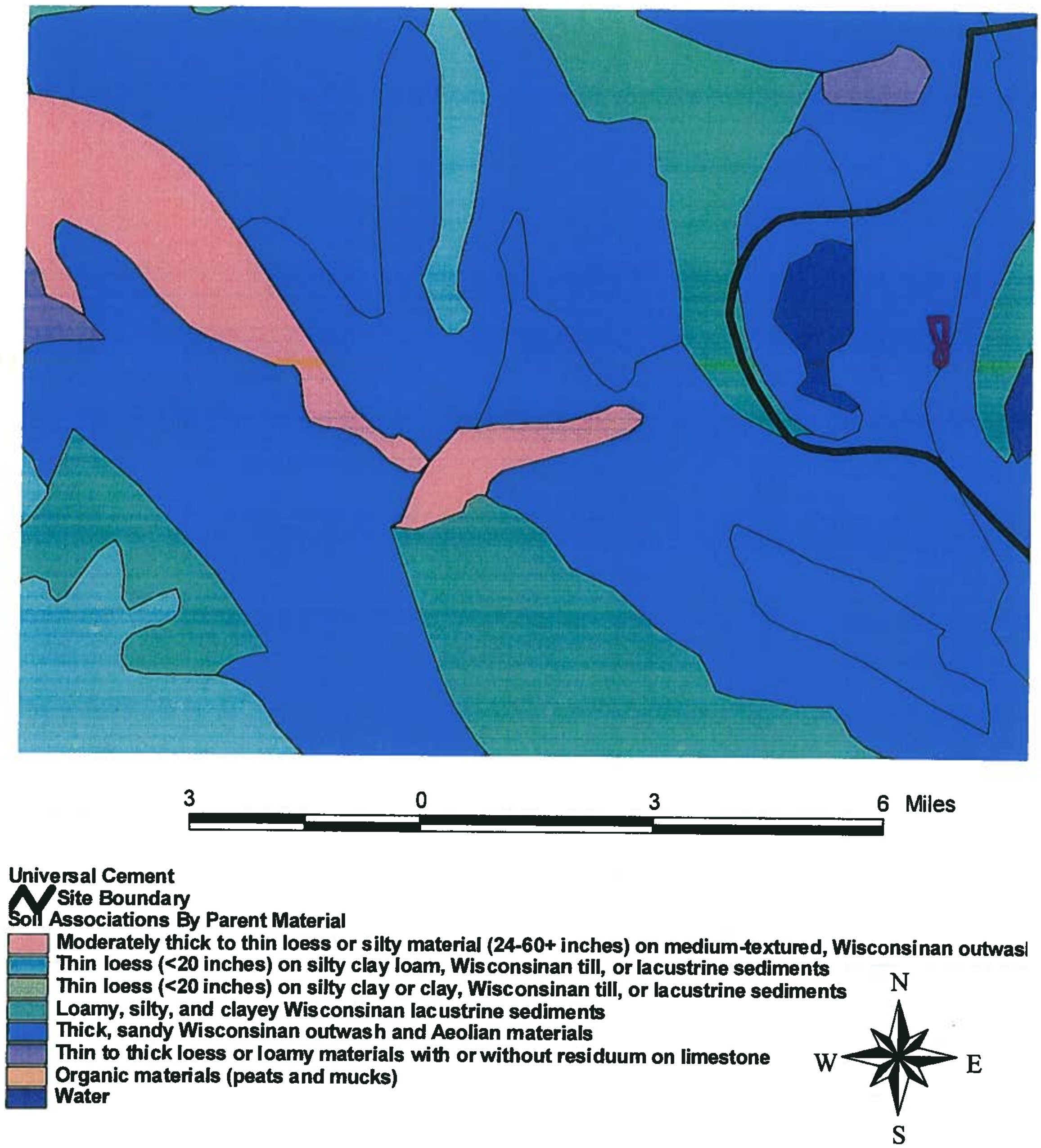

Figure 6 Parent materials of soils in the vicinity of the proposed Universal Cement facility (location outlined in purple). Thick dark line delineates the Little Calumet River watershed.

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Species of Concern

Species of potential concern include threatened and endangered wildlife species that have been designated by both federal and state authorities for Cook County and the Lake Calumet area, respectively.

Federally-listed Threatened and Endangered Species

Seven federally-listed threatened and endangered species are listed in the roadmap scope-of-analysis provided by U.S. EPA Region 5 as possibly living near the proposed Universal Cement facility:

1. Indiana Bat[2] (*Myotis sodalist*)

   The Indiana Bat is a small, dark-brown bat weighing approximately one-quarter of an ounce. The bats can be found in caves and mines, and forage in small stream corridors with well developed riparian woods and upland forests. The Indiana Bat hibernates during winter in caves or, occasionally, in abandoned mines. After hibernation, Indiana bats migrate to their summer habitat in wooded areas where they usually roost under loose tree bark on dead or dying trees. Indiana Bats forage in or along the edges of forested areas and eat a variety of flying insects found along rivers or lakes and in uplands.

   Indiana bats occupy distinct home ranges, particularly in the summer. However, relatively few studies have determined the home ranges of Indiana bats, and these studies based their calculations on a small number of individuals. Studies of home ranges identified home ranges as small as 28 ha (69 acres) to as large as 1,584 ha (3,825 acres).

2. Piping plover[3] (*Charadrius melodus*)

   The piping plover is a small migratory shorebird that nests in the Great Plains states, on the shores of Lakes Michigan and Superior, and along the Atlantic coast. All populations winter along the southern Atlantic and Gulf coasts in the U.S. The piping plover, named for its melodic call, is approximately 17 cm (6.7 in) in length, weighs 40-65 g (1.4-2.3 oz), and has a wing span measuring about 38 cm (15 in). Light sand-colored upper plumage and white undersides blend in well with the piping plover's principal beach habitats. Piping plovers spend approximately 3-4 months a year on breeding grounds. In the Great Lakes region, birds begin arriving on breeding grounds in late April, and most

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[2] Sources: http://www.fws.gov/midwest/endangered/mammals/inba/index.html; http://www.fws.gov/midwest/Endangered/section7/s7process/mammals/inba/inbaMIlifehist.html; and http://www.fws.gov/midwest/endangered/mammals/inba/inbafctsht.html.

[3] Sources: http://www.fws.gov/midwest/endangered/pipingplover/index.html; http://ecos.fws.gov/docs/recovery_plan/030916a.pdf; and http://www.fws.gov/southdakotafieldoffice/images/PLOVER.JPG.

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nests are initiated by mid to late May. Breeding adults depart nesting grounds in the Great Lakes as early as mid-July, but the majority departs by mid-August.

The piping plover prefers wide, open, sandy beaches with very little grass or other vegetation. Threats to populations and habitat are similar on the breeding and wintering ranges. Habitat destruction and degradation are pervasive and have reduced physically suitable habitat. Human disturbance and predators further reduce breeding and wintering habitat quality and affect survival. Contaminants, as well as genetic and geographic consequences of small population size, pose additional threats to piping plover survival and reproduction.

Piping plovers feed primarily on exposed beach substrates by pecking for invertebrates one centimeter (0.4 in) or less below the surface. Diet generally consists of invertebrates, including insects, marine worms, crustaceans, and mollusks.

3. Hine's emerald dragonfly[4] (*Soonatochlora hineana*)

The Hine's emerald dragonfly has brilliant emerald-green eyes and a dark brown and metallic green body, with yellow stripes on its sides. Its body is about 2.5 inches long; its wingspan reaches about 3.3 inches. Historically, the Hine's emerald dragonfly was found in Alabama, Indiana, and Ohio and probably has been extirpated in those states. Today the dragonfly can only be found in small areas of Illinois, Michigan, Missouri, and Wisconsin. One of these areas is the intermittent wetland habitat along the Des Plaines River (in areas of groundwater discharge).

The Hine's emerald dragonfly may occur in spring-fed wetlands, wet meadows, and marshes. The life cycle of the Hine's emerald dragonfly is similar to most dragonflies in that it comprises the following stages: aquatic egg, aquatic larva, and a terrestrial/aerial adult.

The greatest threat to the Hine's emerald dragonfly is further habitat destruction. Most of the wetland habitat that this dragonfly depends on for survival has been drained and filled to make way for urban and industrial development. Contamination of wetlands by pesticides or other pollutants also poses a threat. The dragonfly depends on pristine wetland or stream areas, with good water quality, for growth and proliferation. Man-made development that decreases the amount or quality of groundwater flowing to the dragonfly's habitat threatens its survival because it depends on spring-fed shallow water to breed.

[4] Sources: http://www.fws.gov/midwest/endangered/insects/hed/pdf/chicagobrochure.pdf; Federal Register, Vol. 72, No. 171 (Wednesday, September 5, 2007); http://www.fws.gov/midwest/endangered/insects/hed/pdf/hed-color.pdf.

4. Eastern prairie fringed orchid[5] (*Platanthaera leucophaea*)

The eastern prairie fringed orchid is an 8 to 40 inch tall plant that has an upright leafy stem with a flower cluster called an inflorescence. Each plant has one single flower spike composed of 5 to 40 creamy white flowers. The eastern prairie fringed orchid is a perennial herb that grows from an underground tuber. Flowering begins from late June to early July, and lasts for 7 to 10 days. The eastern prairie fringed orchid occurs in a wide variety of habitats, from mesic prairie to wetland communities such as sedge meadows, marsh edges, and even bogs.

The eastern prairie fringed orchid was once widespread across the upper Midwest, but after it had declined in range by more than 70 percent, it was listed as threatened in 1989. Early decline was due to the loss of habitat, mainly conversion of natural habitats to cropland and pasture. Current decline is mainly due to the loss of habitat from the drainage and development of wetlands. Other reasons for the current decline include succession to woody vegetation, competition from non-native species and over-collection.

5. Leafy-prairie clover[6] (*Dalea foliosa*)

Leafy-prairie clover (*Dalea foliosa*) is found in dry prairies in Illinois, Kentucky, Tennessee, and Alabama. The largest known remaining populations of leafy-prairie clover are located in dolomite prairie communities in northeast Illinois. It is found in prairie remnants along the Des Plaines River in Illinois, in thin soils over limestone substrate. Habitat destruction and grazing effects are believed to have caused declines. It was listed as endangered in 1991.

Leafy-prairie clover requires full sun and low competition for optimum growth and reproduction. It can persist in successional plant communities following disturbance or woody succession, but will decline in advanced stages of woody succession. The natural communities supporting leafy prairie-clover must be maintained by periodic burning. Because the species is short-lived and does not spread vegetatively, population maintenance is dependent upon seed production and may be buffered from extinction-causing phenomena by a persistent seed bank.

Surviving today at only 14 sites, this clover and its habitat are threatened by land development. Leafy prairie-clover is especially vulnerable to commercial and residential development and to road construction. Other threats include off-road vehicle use and grazing by rabbits and deer. Fire suppression practices have eliminated the wildfires which once regularly cleared prairie grasslands of the encroaching woods. Now the

[5] Sources: http://www.fws.gov/midwest/endangered/img_coll/plants/easternp.jpg; http://www.fws.gov/midwest/endangered/plants/epfo.html; http://ecos.fws.gov/docs/recovery_plan/990929.pdf; http://www.fws.gov/endangered/bulletin/2003/07-12/14-15.pdf.

[6] Sources: http://www.fws.gov/midwest/endangered/img_coll/plants/leafypra.jpg; http://www.fws.gov/midwest/Chicago/lpcloverspotlight.htm; http://www.fws.gov/midwest/endangered/plants/leafypra.html; http://ecos.fws.gov/docs/recovery_plans/1996/960930c.pdf.

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expansion of shrubs and trees threatens this clover, which needs hot, sunny sites to survive.

6. Mead's milkweed[7] (*Asclepias meadii*)

   Mead's milkweed is a long-lived, tallgrass prairie herb belonging to the milkweed family (Asclepiadaceae). It has a single slender unbranched stalk, 8 to 16 inches high, without hairs but with a whitish waxy covering. The hairless leaves are opposite, broadly ovate, 2 to 3 inches long, 3/8 to 2 inches wide, also with a whitish waxy covering. A solitary umbel (an umbrella-like cluster of flowers) at the top of the stalk has 6 to 15 greenish, cream-colored flowers.

   The primary habitat of Mead's milkweed is mesic to dry mesic, upland tallgrass prairie, characterized by vegetation adapted for drought and fire. Mead's milkweed usually occurs between 800-1200 feet above sea level on middle and upper portions of slopes less than 20 percent.

   Mead's milkweed is threatened by the destruction and alteration of tallgrass prairie due to farming along with residential and commercial development. Sites known to have Mead's milkweed were destroyed by plowing and land development. Smaller habitat fragments support lower numbers of plants, and thus, fragmentation may hasten or explain the loss of genetic diversity and failure of this plant to sexually reproduce. Populations with low numbers may not attract sufficient numbers or types of pollinators. Based on historical collections, Mead's milkweed has been extirpated from Wisconsin and Indiana. Mead's milkweed has also been extirpated from Cook, Ford, Fulton, Hancock, Henderson, LaSalle, Menard, and Peoria counties in Illinois. Extant populations remain in Kansas, Missouri, Iowa, and southern Illinois.

7. Prairie bush clover[8] (*Lespedeza leptostachya*)

   Prairie bush clover is a federally threatened prairie plant found only in the tallgrass prairie region of four midwestern states (Illinois, Iowa, Minnesota, and Wisconsin). It is a member of the bean family (a legume) and a midwestern "endemic" — known only from the tallgrass prairie region of the upper Mississippi River Valley. Also known as slender-leaved bush clover, it has a clover-like leaf comprised of three leaflets about an inch long and a quarter inch wide. Flowering plants are generally between nine and eighteen inches tall with the flowers loosely arranged on an open spike. The pale pink or cream colored flowers bloom in mid-July.

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[7] Sources: http://www.fws.gov/midwest/Chicago/milkweedspotlight.htm; http://www.fws.gov/midwest/endangered/plants/pdf/meads-fnl-rp.pdf; http://www.fws.gov/midwest/endangered/img_coll/plants/meadsmi.jpg.

[8] Sources: http://www.fws.gov/midwest/endangered/img_coll/plants/pb-clover.jpg; http://www.fws.gov/midwest/endangered/plants/prairieb.html; http://files.dnr.state.mn.us/natural_resources/ets/prairie_bush_clover.pdf.

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Prairie bush clover may occur in dry to mesic prairies with gravelly soil. Plants are often localized in slightly concave, midslope areas. Prairie bush clover's rarity is probably best explained by the loss of its tallgrass prairie habitat. At the beginning of the 19th century, native prairie covered almost all of Illinois and Iowa, a third of Minnesota and six percent of Wisconsin. Prairie with moderately damp to dry soils favored by prairie bush clover was also prime cropland; today only scattered remnants of prairie can be found in the four states. Many of today's prairie bush clover populations occur in sites that escaped the plow because they were too steep or rocky.

The seven federally-listed species include a mammal, a bird, an insect, and four plants. The ecological profiles for each species are compiled from U.S. Fish and Wildlife Service literature and other sources. Representative photographs of each species are provided in Figure 7.

Of the federally-listed species, the Lake Calumet habitat is probably best suited for the Eastern prairie fringed orchid due to the high water table and wetland environments. Coincidentally, it is the only one of the seven species identified by the Illinois Department of Natural Resources in a wildlife inventory of the Calumet area (IDNR, 2000). Suitable habitat for the other species is more likely at more distant locations in Cook County. The Hine's emerald dragonfly is known to occur in specific wetland areas along the Des Plaines River, in areas of specific soil types, at distances more than 20 km to the west of Lake Calumet (and the proposed Universal Cement facility; see Figure 8). The wetland environment of the Lake Calumet area is not ideal habitat for the other plant species, which thrive in mesic and tallgrass prairies. Also, there are no open beach areas along the shores of Lake Calumet that would attract the Piping plover, nor are there abundant riparian or upland forested areas that might attract significant numbers of Indiana bats (the prairie in this portion of Illinois prior to settlement and development was largely devoid of trees). Although there are some local patches of forested land in the Calumet area (Figure 4), observed colonies of Indiana bats are not reported in Cook County in the species recovery plan. As depicted in Figure 9, most bat colonies in Illinois have been observed in the western border counties.

Illinois State-listed Threatened and Endangered Species

The sparseness of suitable habitat for the federally-listed species fails to reflect the richness, diversity, and importance of the Lake Calumet habitat. Despite its industrial heritage, the 724 acre Lake Calumet remains a valuable ecological resource embedded within an urban landscape. The broader Calumet region hosts 57 of Illinois' threatened and endangered species (Figure 10) — mostly plants and birds — with the 26 avian species representing 85% of the state's threatened and endangered birds (IDNR, 2000). One particularly valued species is the black-crowned night heron, which is found in the wetland marshes on the east side of Lake Calumet (in close proximity to the proposed Universal Cement facility). Other state endangered and threatened avian species found in the Calumet area wetlands include yellow-crowned night herons, American bitterns, little blue herons, northern harriers, king rails and yellow-headed blackbirds, least bitterns, pied-billed grebes, red-shouldered hawks, and common moorhens. The area also serves as summer habitat for migratory songbirds, waterfowl, shorebirds, rails, and long legged waders, including swallows, wrens, purple martins, yellowthroats, and red-winged blackbirds.

A project information search was conducted using the Illinois Department of Natural Resources' Ecological Compliance Assessment Tool (EcoCAT). The Illinois Natural Heritage Database indicates a number of state-protected resources to be in the vicinity of the proposed Universal Cement Facility:

- Two Illinois Natural Areas Inventory (INAI) Sites:
  - Lake Calumet;
  - Wolf Lake;

- Eight avian species:
  - Black tern (*Chlidonias niger*);
  - Black-crowned heron (*Nycticorax nycticorax*);
  - Common moorhen (*Gallinula chloropus*);
  - Least bittern (*Ixobrychus exilis*);
  - Little blue heron (*Egretta caerulea*);
  - Snowy egret (*Egretta thula*);
  - Yellow-crowned night heron (*Nyctanassa violacea*);
  - Yellow-headed blackbird (*Xanthocephalus xanthocephalus*);

- And one reptile:
  - Blanding's turtle.

The EcoCAT information confirms the study focus on aquatic habitats of Lake Calumet and Wolf Lake as valuable habitat for birds (as well as other species). All of the species identified by the EcoCAT search are also included in the larger species list for the Lake Calumet region (Figure 10). A copy of the EcoCAT search output is provided in Appendix B.

Figure 11 depicts the nine state-protected species named in the EcoCAT search. Brief descriptions of these species follow. Principal sources of information for these summaries include the publication *Endangered and Threatened Species of Illinois: Status and Distribution* (Illinois Endangered Species Protection Board, 2006) and the Illinois Natural History Survey (University of Illinois, http://www.inhs.illinois.edu).

1. Black-crowned night-heron (*Nycticorax nycticorax*)

   The black-crowned night heron is 23-28 inches long and has a 45 inch wingspan. Males are slightly larger, though coloring is similar. The body is chunky, and the neck and legs are short and thick. Coloring is distinguished by the black head/back and scarlet eyes; the underbody is white, and wings and tail gray. Nesting areas for this migratory species include herbaceous marsh vegetation, and are often found near colonies of other herons and egrets. Nests of 3-5 pale green-blue eggs are typical. The young fly at approximately six weeks, though full maturity requires 2-3 years. Proximity to foraging areas is a likely factor in selecting nesting areas. The black-crowned night heron is

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expert at catching fish, and typically resides in Illinois from April to September. Predators include raccoons, crows, hawks, vultures, skunks, weasels and foxes.

2. Black tern (*Chlidonias niger*)

The black tern is 9-10½ inches long and weighs up to 2¼ ounces. Its head and underparts are black when mature, with dark grey wings and tail feathers. It breeds in freshwater marshes and shallow ponds and lakes, nesting on floating mud mats, cattail root stocks, muskrat lodges, and floating boards and logs. It requires a large wetland area with open water, or a group of small wetlands in a larger wetland complex to flourish and reproduce. Urban development has eliminated much of its natural wetland habitat. Lake Calumet hosts one of four known populations of significant size that remain in Illinois. The breeding season extends from late spring through mid-summer, with nests of 2-5 eggs. Chicks take flight after approximately a month and proceed to establish territories shortly thereafter. Black terns primarily eat insects but also forage for small fish. The species is known to be adversely affected by heavy spraying of DDT.

3. Common moorhen (*Gallinula chloropus*)

The common moorhen is a slate-grey chicken-like bird, 12-15 inches long, weighing about 14 ounces and having a 20-23 inch wingspan. Sexes are similar in appearance, with females smaller than males. It is distinguished by a chicken-like red bill with a yellow tip and red frontal shield. It has yellow-green legs and feet. The common moorhen inhabits and requires open freshwater marshes and surface waters with emergent aquatic vegetation, especially cattails and bulrushes. It arrives in the spring and begins nesting in May, and undergoes elaborate courtship rituals. Nests have sloping runways of rushes leading to the water, and broods typically number 7-12. The common moorhen is territorial, though can form small colonies. Large, long toes allow the common moorhen to walk on floating vegetation. Its omnivorous diet includes plant material, insects, and small fish.

4. Least bittern (*Ixobrychus exilis*)

The least bittern is the smallest heron species, typically 11-14 inches long, weighing 1.5-4 ounces, with a wingspan of 16-18 inches. It has buffy wing patches, and a dark crown and back. The least bittern inhabits shallow freshwater lakes and marshes with dense, tall growths of vegetation, building nests less than 10 meters from open water. It lays eggs in late spring to early summer, and at fourteen days the young are fed away from the nest. Habitat area has been estimated at 2.5 acres. The least bittern's carnivorous diet may include small fish, salamanders, tadpoles, frogs, leeches, slugs, crayfish, dragonflies, shrews, and mice. The least bittern has been found to be sensitive to chemical contamination and eutrophication, though loss of wetland habitat appears to be the most significant factor to its declined abundance.

5. Little blue heron (*Egretta caerulea*)

The little blue heron is of medium size, 25-29 inches long, weighing up to 14 ounces, with a wingspan of 41 inches. Adults are blue-grey in color, with a deep maroon-brown neck and dark legs. Little blue herons are colonial nesters, usually among other species of herons. Breeding includes an extensive courtship ritual, and males and females cooperate in building nests, which are often located in stands of young trees such as willows and cottonwoods that form dense thickets. Broods of 3-6 are typical, and approximately three months may be required to rear young (from the point of next construction). The little blue heron feeds in shallow waters of lagoons and marshlands. Its diet includes fish, crustaceans, amphibians, insects, and reptiles, which it grabs with its pointed bill while standing in shallow water. Little blue herons are also susceptible to eggshell thinning by pesticides, but declines in numbers have mainly been attributed to habitat loss.

6. Snowy egret (*Egretta thula*)

The snowy egret has bright white plumage with a black bill, black legs, and yellow feet. Adults are 22-26 inches long, weigh 12-13 ounces, and have a wingspan of 38-45 inches. It is the only heron with "recurved" scapular plumes, and its feet turn orange coral in breeding season. Snowy egrets are highly colonial and social, and begin nesting mid-spring. Snowy egrets in Illinois nest in lowland thickets or forest in conjunction with other species of herons. Broods of 3-4 are typical, and the time from hatching to independence is about a month. Snowy egrets depart their Illinois breeding areas at the end of summer, and many return annually to the same breeding grounds. Snowy egrets forage for fish, crustaceans, amphibians, and insects in lagoons and marshes. They sometimes use their feet to rake or stir shallow water and snap up prey lured to their yellow toes.

7. Yellow-crowned night-heron (*Nyctanassa violacea*)

The stocky, uniformly gray yellow-crowned night-heron has a distinct black and white face and (often) a yellow-tinged crown. It ranges in length from 22-28 inches, weighs up to 23 ounces, and has a 40-44 inch wingspan. Its head is larger than that of the black-crowned night-heron, and it is also more stout and thicker-billed. Suitable habitat for the yellow-crowned night-heron includes swamps, forested wetlands, and forested uplands near surface waters. They construct nests in Illinois locations from late April to early May, and do not typically colonize or nest among other herons. Broods of 3-4 are typical, and the breeding period (nest to fledgling) is about two months. Few yellow-crowned night-heron are observed in Illinois beyond August. They may feed up to 1.5 miles from their nest, though a precise habitat range is not known. Habitat destruction is viewed as the most likely threat to this species. The yellow-crowned night-heron may forage both day and night on a predominantly-crustacean diet that may also include fish, eels, mussels, frogs, tadpoles, aquatic insects, snails, and small snakes.

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8. Yellow-headed blackbird (*Xanthocephalus xanthocephalus*)

The yellow-headed blackbird is a robin-sized blackbird with a yellow head and white patches on its wings. The male's yellow plumage is more extensive, as yellow is confined to the throat and chest of the smaller female. The polygamous species breeds in northeast Illinois. Preferred habitat is the emergent vegetation of palustrine wetlands, typically in cattails, bulrushes, or weeds. An estimated marsh size of at least 0.38 acres of emergent vegetation over standing water is required. Up to five females build nests in a male's territory and lay 2-6 eggs. Once hatched, the young leave the nest at 14 days, not yet able to fly. The yellow-headed blackbird forages in wetlands and surrounding savanna for seeds and insects, the latter more popular when raising/feeding young.

9. Blanding's Turtle (*Emydoidea blandingii*)

Similar to box and spotted turtles, the key distinctions of the dark-shelled Blanding's turtle include a light yellow chin and throat; a notched upper jaw; and a hinged plastron. The carapace length may be up to 24 cm, and the tail disproportionately long (compared with other turtles). Blanding's turtle typically is found in marshes, bogs, sedge meadows, and vegetated areas of lakes and ponds. Common in Illinois prior to the extensive draining of prairie bogs, it is primarily found at present in the northern portion of the state along the Illinois River. Blanding's turtle is typically found in water, but can move long distances over land. Females typically lay about 12 hard-shelled eggs in May or June, and the species may live more than 70 years. Blanding's turtle is mostly carnivorous, eating a diet of snails, insects, and crayfish.

Exposure Assessment and Conceptual Exposure Model

Lake Calumet and Wolf Lake, along with associated and nearby wetlands, provide suitable habitat for the nine state-listed threatened and endangered species – as well as many other wildlife species. All nine species are partially or wholly carnivorous, and several of the heron species consume fish, which are at higher trophic levels in the wetland ecosystem. Thus, in formulating a Conceptual Exposure Model, potential bioaccumulation of pollutants must be considered.

The Universal Cement facility is likely to introduce pollutants into the Lake Calumet and Wolf Lake ecosystems through local deposition of contaminants that are released to the air. The physical modeling of emission and deposition processes is described in subsequent sections, along with the methods used to estimate the worst-case levels of pollutants that will be added to soils, surface water, and sediments. The state-listed threatened and endangered species represent receptors that may be exposed to facility-related contaminants in these media, as well as levels of these contaminants that are taken up into their food supply (*e.g.*, by fish that eat insects that have been in contact with contaminants in water and sediment).

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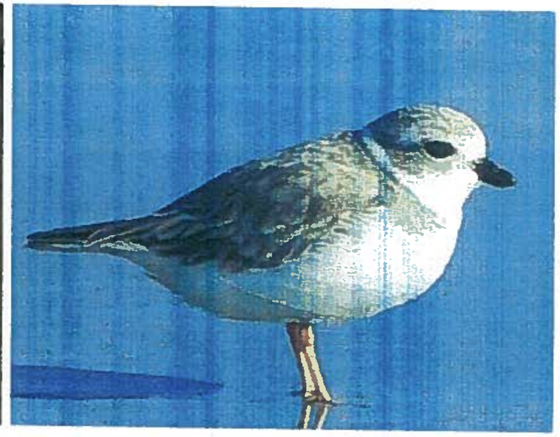
Indiana Bat
Myotis sodalist



Piping plover
Charadrius melodus

Hine's Emerald Dragonfly
Soonatochlora hineana

Eastern prairie fringed orchid
Platanthaera leucophaea

Leafy-prairie clover
Dalea foliosa

Mead's milkweed
Asclepias meadii

Prairie bush clover
Lespedeza leptostachya

Figure 7 Federally-listed Threatened and Endangered Species (photographs differ in scale)

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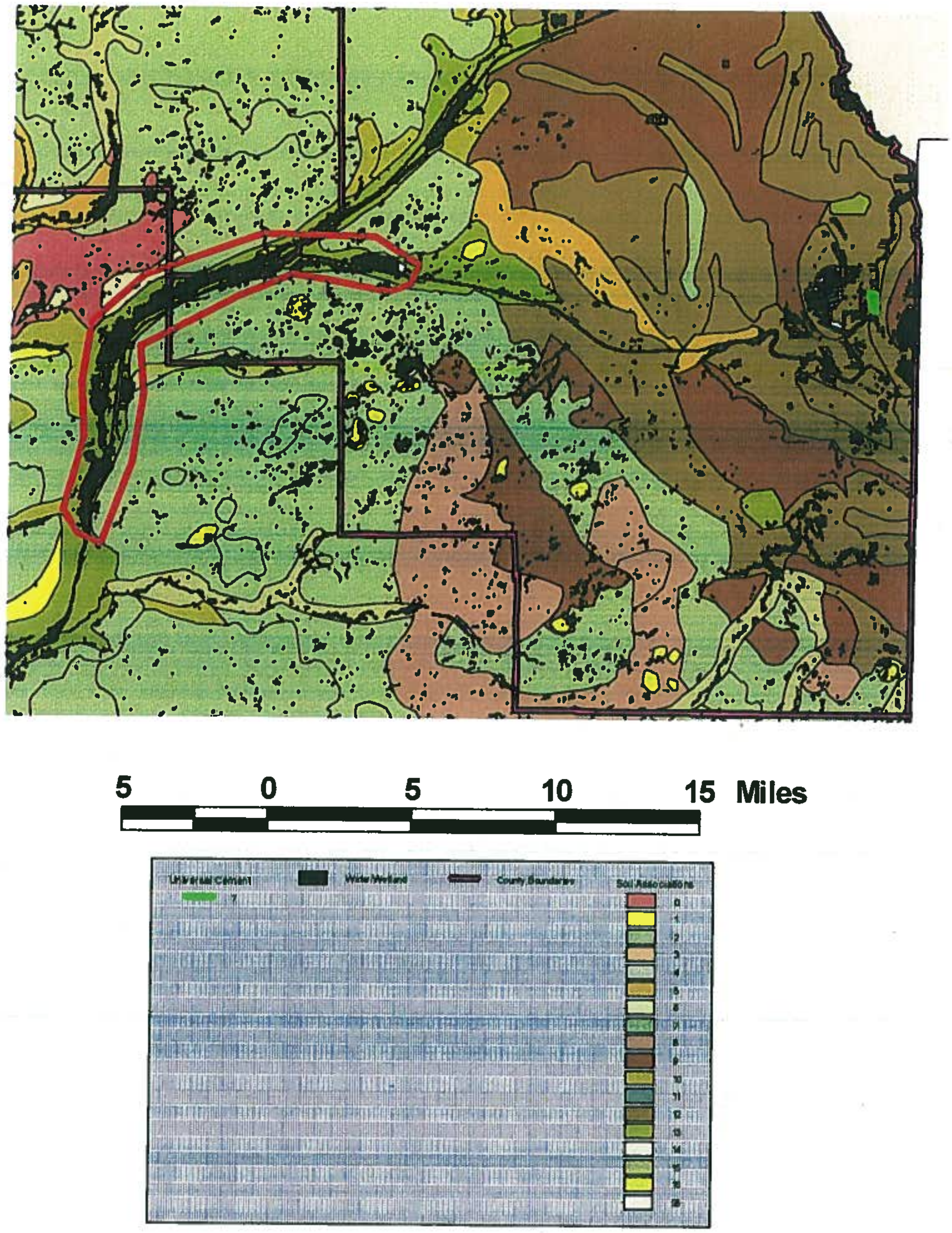

Figure 8 Known habitat locations for the Hine's emerald dragonfly, in red encircled area (per species recovery plan). Proposed Universal Cement facility (highlighted in green) is located more than 20 km to the east of the habitat area. Black areas indicate water or wetland. The Hine's emerald dragonfly habitat is found along the Des Plaines River, between moraine areas, in soil parent designation 13 (per key), described as "thin to thick loess or loamy materials with or without residuum on limestone."

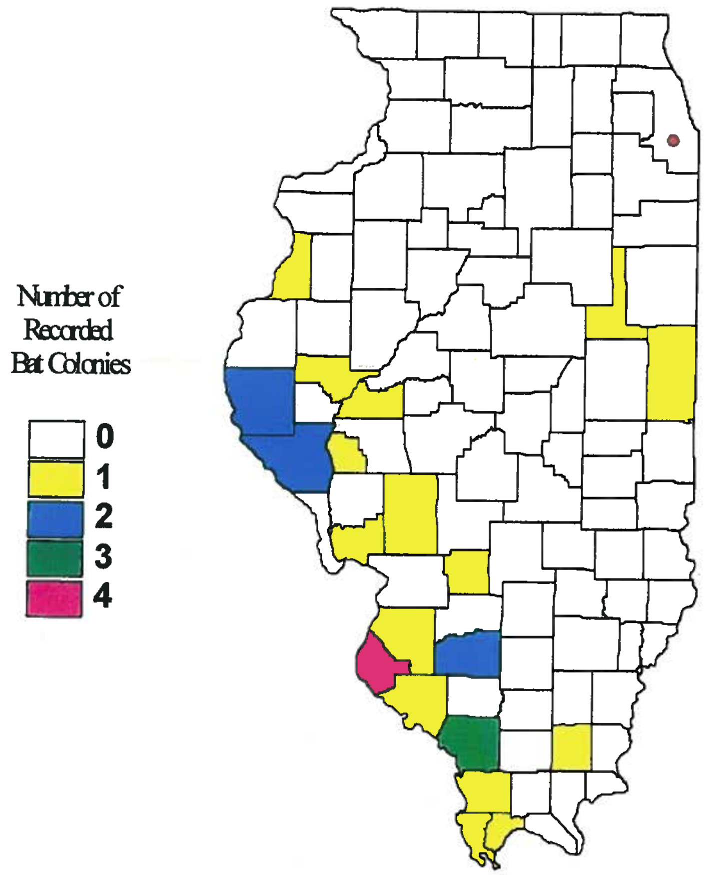

Figure 9 Number of Recorded Indiana Bat Colonies (from Species Recovery Plan)

Common name	Scientific name	Status[2,3]
Plants:		
Alkali bulrush	*Scirpus paludosus*	SE
Blazing star	*Liatris scariosa* var. *nieulandii*	ST
Bristly blackberry	*Rubus setosus*	SE
Ear-leaved foxglove	*Tomanthera auriculata*	ST
Fern pondweed	*Potamogeton robbinsii*	SE
Few-flowered spikerush	*Elocharis pauciflora*	SE
Fibrous-rooted sedge	*Carex communis*	ST
Grass pink orchid	*Calopogon tuberosus*	SE
Grass-leaved pondweed	*Potamogeton gramineus*	ST
Little green sedge	*Carex viridula*	ST
Marsh speedwell	*Veronica scutellata*	ST
Narrow-leaved sundew	*Drosera intermedia*	ST
Northern panic grass	*Panicum boreale (=Dichanthelium boreale)*	SE
Prairie white-fringed orchid	*Platanthera leucophaea*	FT, SE
Queen-of-the-prairie	*Filipendula rubra*	SE
Richardson's rush	*Juncus alpinus*	SE
Small sundrops	*Oenothera perennis*	ST
Tubercled orchid	*Platanthera flava* var. *herbiola*	SE
White lady's-slipper orchid	*Cypripedium candidum*	ST
Wood orchid	*Platanthera clavellata*	SE
Birds:		
Pied-billed Grebe	*Podilymbus podiceps*	ST
American Bittern	*Botaurus lentiginosus*	SE
Least Bittern	*Ixobrychus exilis*	ST
Snowy Egret	*Egretta thula*	SE*
Little Blue Heron	*Egretta caerulea*	SE
Black-crowned Night-Heron	*Nycticorax nycticorax*	SE
Yellow-crowned Night-Heron	*Nyctanassa violacea*	SE
Osprey	*Pandion haliaetus*	SE*
Bald Eagle	*Haliaeetus leucocephalus*	FT, ST*
Northern Harrier	*Circus cyaneus*	SE
Red-shouldered Hawk	*Buteo lineatus*	ST
Swainson's Hawk	*Buteo swainsoni*	SE*
Peregrine Falcon	*Falco peregrinus*	SE
King Rail	*Rallus elegans*	SE
Common Moorhen	*Gallinula chloropus*	ST
Sandhill Crane	*Grus canadensis*	ST
Upland Sandpiper	*Bartramia longicauda*	SE
Wilson's Phalarope	*Phalaropus tricolor*	SE
Common Tern	*Sterna hirundo*	SE*
Forster's Tern	*Sterna forsteri*	SE*
Black Tern	*Chilidonias niger*	SE
Barn Owl	*Tyto alba*	SE
Short-eared Owl	*Asio flammeus*	SE
Brown Creeper	*Certhia americana*	ST*
Henslow's Sparrow	*Ammodramus henslowii*	SE
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	SE
Reptiles:		
Blanding's turtle	*Emydoidea blandingii*	ST
Kirtland's snake	*Clonophis kirtlandii*	ST
Aquatic Biota:		
Fishes		
banded killifish	*Fundulus diaphanus*	ST
Iowa darter	*Etheostoma exile*	SE
Mussels		
slippershell mussel	*Alasmidonta viridis*	ST
purple wartyback	*Cyclonaias tuberculata*	ST
spike	*Elliptio dilatata*	ST
wavyrayed lampmussel	*Lampsilis fasciola*	SE
black sandshell	*Ligumia recta*	ST
rainbow	*Villosa iris*	SE

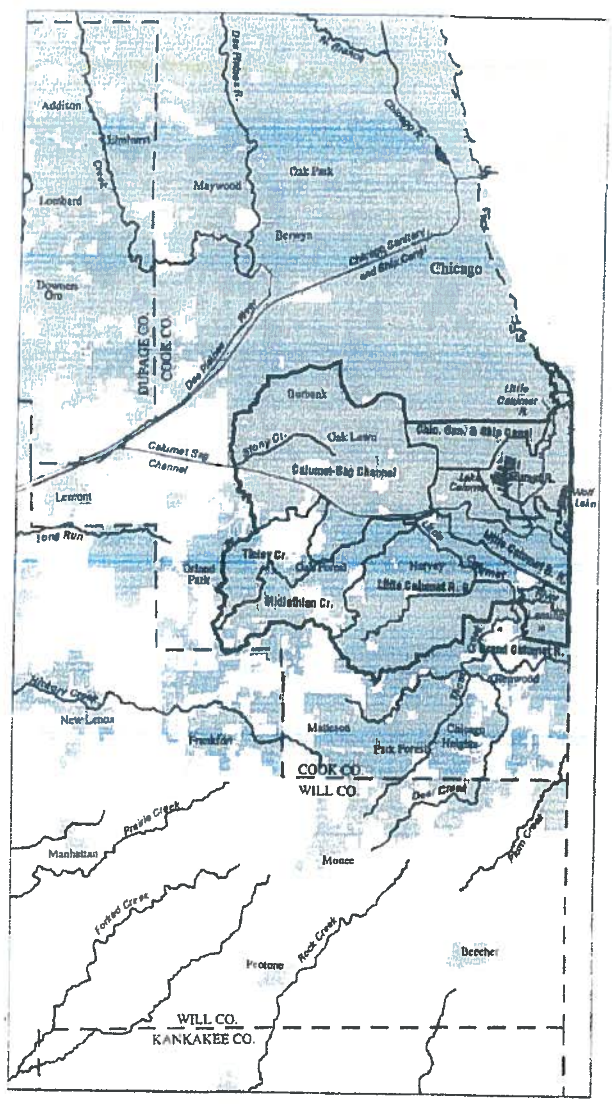

Figure 10 Illinois (state) threatened and endangered species in the Calumet Assessment Area (depicted in map at right). Taken and adapted from IDNR (2000).

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Black-crowned night heron

Black tern

Common moorhen

Least bittern

Little blue heron

Snowy egret

Yellow-crowned night heron

Yellow-headed blackbird

Cook County, IL; photo by Mike Redmer

Blanding's Turtle

Figure 11 Wildlife species protected by Illinois as threatened or endangered species in the vicinity of the proposed Universal Cement facility. Photographs from the Illinois Natural History Survey (University of Illinois, http://www.inhs.illinois.edu) and Wikipedia (www.wikipedia.org).

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Emissions and Direct Impacts

Table 2 and Table 3 list modeled emission rates of chemicals of potential concern (COPCs) relevant to *direct phytotoxicity* and *deposition* concerns. The emission estimates are based on worst-case (100% capacity) operation of the proposed Universal Cement facility.

The soil, water, sediment, and vegetation assessments consider emissions from the proposed facility's primary sources: the raw mill/kiln, the clinker cooler, and the finish mill. With the exception of mercury and polychlorinated dibenzo(p) dioxins and furans (PCDD/Fs), compound specific emission rates of Hazardous Air Pollutants (HAPs) from the raw mill/kiln were conservatively estimated using emission factors from the U.S. EPA's Compilation of Air Pollutant Emission Factors (AP-42), Portland Cement Manufacturing section, Table 11.6-9.[9] Emissions of total PCDD/Fs were conservatively estimated based on the MACT limit of 0.20 ng TEQ/dscm, and emissions of total mercury were conservatively estimated based on the MACT limit of 21 lb/million tons of clinker for new kilns. Emission rate estimates for most criteria and other non-HAP compounds were based on the emission factors described in the air quality assessment and listed in Table A-2. Emission rate estimates for ammonia (NH_3) and ammonium (NH_4^+) were based on emission factors contained in AP-42 Table 11.6-9. Because both the AP-42 emission factors (which are based on fairly old test data from kilns with higher emission levels than those found in modern kilns), and MACT-based emission limits are likely to significantly over-estimate emissions from the proposed Universal Cement facility, the potential environmental impacts predicted in this report are also likely to be significantly over-estimated.

Long-term average emission rates were calculated from the emission factors using a kiln throughput of 3,500 tons per day and an annual average operating factor of 330 days per year. The main kiln emission rates used for the soil, water, sediment, and vegetation assessments are identical to those used in the air quality assessment of the facility as given in Tables A-2 and A-16 of the Construction Permit Application submitted to the Illinois Environmental Protection Agency (the "Permit Application"). Emissions from the clinker cooler and the finish mill were estimated by assuming that the concentrations of particulate-phase, inorganic pollutants are the same in the exhaust of these sources as in the exhaust of the raw mill/kiln (particulate-phase mercury is assumed to be emitted from the finish mill but not the clinker cooler). Total mercury emissions were apportioned among vapor-phase elemental, vapor-phase mercuric chloride, and particulate-phase mercuric chloride forms based on data from a Portland cement facility in Indiana.[10] Total polychlorinated dibenzo(p)dioxin and furan emissions were apportioned among the 17 congeners which have toxic equivalent factors (TEFs) based on an extensive set of data from four Portland cement kilns assessed previously.[11]

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[9] U.S. EPA (1998). AP 42, Fifth Edition. Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Source. Chapter 11.6 Portland Cement Manufacturing. January 1995. Available at: http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s6.pdf.

[10] Cambridge Environmental (2002). Risk Assessment for the Evaluation of Kiln Stack Emissions and RCRA Fugitive Emissions from the Lone Star Alternative Fuels Facility, Greencastle, Indiana. April 2002.

[11] Cambridge Environmental (2002). Multi-pathway Risk Assessment of Stack Emissions from the SECIL Cement Kilns at Maceira and Pataias. February 2010.

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The assessment of phytotoxic effects required the estimation of emission rates for a few additional compounds. Because some of the phytotoxic effects are evaluated over short time periods (*i.e.*, 1-hour to 24 hours), short-term maximum emissions rates were required for a few of these compounds. Short-term emission rates were calculated based on emission factors in Table A-2 of the Permit Application (described above) or, if the compounds were not included in this table, based on emission factors from AP-42, using an hourly production rate of 145.83 tons of clinker per hour (3,500 tons per day / 24 hours per day). Short and long-term modeled emission rates of nitrogen oxides (NO_x) and sulfur dioxide (SO_2) were taken from the main air quality modeling analysis performed as part of the Permit Application, and include emissions of minor sources which have exhaust gases vented through the raw mill/kiln stack and finish mill vent. Short and long-term modeled emission rates of particulate matter (PM) were converted from lb/hr and ton/yr values in Table A-2 of the Permit Application. Modeled emission rates used in the phytotoxicity assessment are shown in Table 3.

In analyzing potential ecological impacts, it is important to consider the level of conservatism assumed in developing the emission estimates as well as the likely operating scenario. For example, the worst-case modeled scenario includes a combination of unrealistic assumptions that will probably never all occur in any single year over the life of the facility. Actual emission rates are likely to be considerably lower than the values listed in Table 2. Emission estimates for the Criteria Pollutants are based on permit limits, and regulated sources such as the proposed Universal Cement facility typically operate such that permit limits are not exceeded, using Continuous Emission Monitoring systems to actively manage and control environmental performance. Emission estimates of HAPs and other non-Criteria Pollutants are based on emission factors published in the U.S. EPA's AP-42 database. AP-42 emission factors are developed from measurements at existing, older cement manufacturing facilities with air pollution controls less advanced than those to be used at the Universal Cement facility, and hence are likely to overestimate actual emission rates. Additionally, the emission rates for many HAPs have been estimated using ESP-controlled emission factors due to unavailability of fabric filter-controlled emission factors. Because fabric filters are generally more effective control devices that ESPs, the emission rates for these compounds are likely over-estimated.

Modeling atmospheric dispersion and deposition

The principal atmospheric dispersion and deposition modeling of pollutants emitted from the raw mill/kiln, the clinker cooler, and the finish mill was performed with AERMOD using facility and site-specific parameters and methodologies described in Section 8.2 of the Permit Application, specifically those described in sections 8.2.1 through 8.2.6. Figure 12 shows the modeling receptor locations near the proposed Universal Cement site that are within the Indian Ridge Marsh area and the Lake Calumet watershed. Additional atmospheric modeling methods and assumptions required to extend AERMOD to calculate dry and wet deposition of the facility emissions are described below.

To properly model the wet and dry deposition (*i.e.*, deposition with and without precipitation) of pollutants from the atmosphere, it is necessary to consider the physical form of the pollutants, and how they interact with moisture in the air and with the complex surfaces to which they may deposit. Each compound's emissions were divided into particulate-phase and vapor-phase emissions using the vapor fraction parameter, F_v, from EPA's Human Health Risk Assessment

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Protocol (HHRAP) chemical properties database. The particulate-phase and vapor-phase emissions were then divided into categories based on the particle and vapor deposition-related properties.

The deposition behavior of particles from the atmosphere is largely governed by the particles' size. Two different types of particle size distributions are used to assess deposition based on how the specific pollutants are found in the particles: (1) *mass-weighted* values were used for pollutants that are likely to be distributed uniformly throughout particles in the stack emissions; and (2) *surface-weighted* values were used for pollutants that are likely to condense (or form) onto the surfaces of existing particles as combustion gases cool prior to their release from the stack. In accordance with HHRAP section 3.2, all metals (except elemental mercury and the vapor-phase fraction of divalent mercury) and organic compounds with a vapor-phase fraction, F_v, of less than 0.05 are assumed to be emitted with a mass-weighted particle size distribution; the particulate bound fraction of organic compounds with a vapor-phase fraction, F_v, of 0.05 or greater are assumed to be emitted with a surface-weighted particle size distribution. To the extent that some metals such as lead and cadmium may be at least partly found on the surfaces of particles rather than throughout the particle volumes, the partitioning described above results in an over-estimate of both dry and wet deposition of these species because the normalized deposition rates are higher for mass-weighted particles than for surface-weighted particles.

Particle size distributions for emissions from the raw kiln stack are based on AP-42 Table 11.6-5 (dry process with fabric filter); particle size distributions for the clinker cooler are based on AP-42 Table 11.6-6 (controlled, gravel bed filter); and particle size distributions for the finish mill are based on AP-42 Table 11.19.2-4 (dry grinding with a fabric filter). Because (1) the particle size distributions are not well known and (2) distributions are expected to largely be dominated by small (< 10μm diameter) particles, AERMOD dry particle deposition Method 2 was applied.

The deposition behavior of vapor-phase compounds from the atmosphere is governed by a variety of factors including how the compound partitions between the vapor and aqueous-phases (*i.e.*, its Henry's Law constant), its diffusivity in both air and water, its resistance to cuticular uptake by lipids in leafy vegetation, and the surface characteristics of the area being considered (*e.g.*, whether the area is open water, forested, or urban). To model deposition of the variety of organic vapor-phase compounds emitted from the proposed facility, the compounds were divided into three categories based on their Henry's Law constants (H), as a surrogate for volatility. Organic compounds in the low H category have a Henry's Law constant less than 5×10^{-7} atmospheres-m^3/mole; the medium H compounds have a constant between 5×10^{-7} atm-m^3/mole and 2×10^{-5} atm-m^3/mole; and the high H compounds have a constant greater than 2×10^{-5} atm-m^3/mole. Each vapor-phase compound considered in the modeling was assigned deposition properties that are the median of all compounds in its Henry's Law category. In addition to the organic vapor-phase pollutants, two groups of inorganic vapor-phase compounds were considered: acid gases and vapor-phase mercuric chloride. The parameters used to model the deposition of these gases were those recommended in the support document for performing the EPA's deposition modeling.[12] The selection of land surface characteristics for the modeling is discussed in Section 8.2.2 of the Permit Application.

[12] Wesely, M.L, P.V. Doskey, and J.D. Shannon (2002). *Deposition Parameterizations for the Industrial Source Complex (ISC3) Model.* Draft ANL report ANL/ER/TR–01/003, Argonne National Laboratory, Argonne, Illinois.

Modeled impacts to air and soil have been estimated at the maximum overall impact location, the maximum location within the Indian Ridge Marsh, the maximum impact location within the Lake Calumet watershed, and as an average impact location over the Lake Calumet watershed.

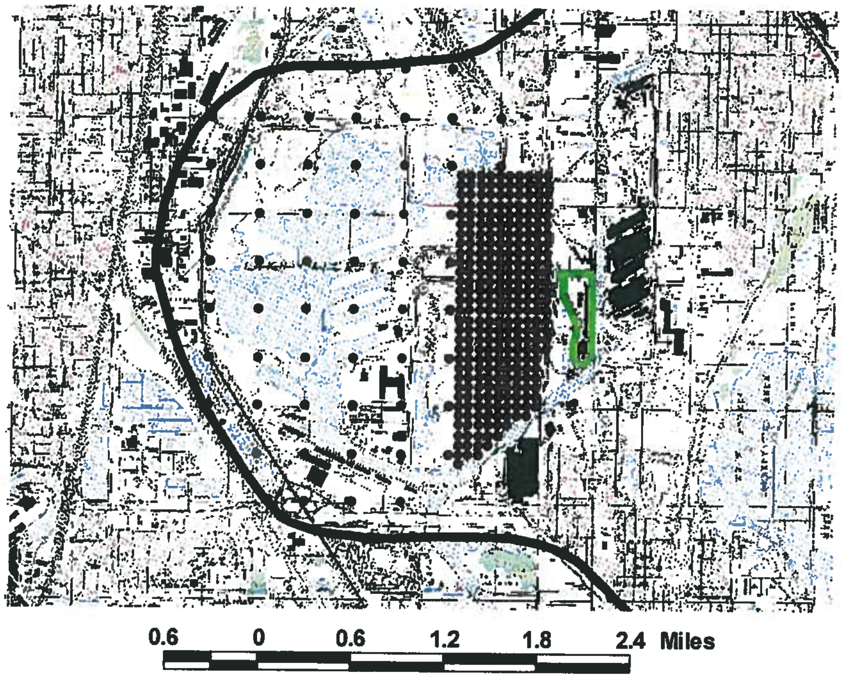

Figure 12 AERMOD receptor locations (dark burgundy symbols) in the Lake Calumet portion of the Little Calumet River watershed (thick black line indicates boundary). Average impacts are area-weighted to account for non-uniform receptor spacing. The location of the proposed Universal Cement facility is highlighted in bright green.

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Table 2. Modeled emission rates for assessment of long-term impacts to soils, vegetation, water, and sediment.

Compound	Raw Mill/Kiln			Clinker Cooler	Finish Mill
	Emission Factor[A]	Modeled emission rate[B]		Modeled emission rate[C]	
	lb/ton	tons per year	grams per second	grams per second	
Metals					
Arsenic	1.20E-05	6.93E-03	1.99E-04	6.54E-05	6.71E-05
Beryllium	6.60E-07	3.81E-04	1.10E-05	3.60E-06	3.69E-06
Cadmium	2.20E-06	1.27E-03	3.65E-05	1.20E-05	1.23E-05
Chromium (total)	1.40E-04	8.08E-02	2.33E-03	7.63E-04	7.82E-04
Chromium (hexavalent)[D]	7.00E-06	4.04E-03	1.16E-04	3.81E-05	3.91E-05
Lead	7.10E-04	4.10E-01	1.18E-02	3.87E-03	3.97E-03
Manganese[E]	8.60E-04	4.97E-01	1.43E-02	4.69E-03	4.81E-03
Selenium	2.00E-04	1.15E-01	3.32E-03	1.09E-03	1.12E-03
Mercury (total)[F]					
Elemental mercury	1.40E-04	1.09E-02	3.14E-04	—	—
Mercuric chloride (vapor)	7.75E-06	6.06E-04	1.74E-05	—	—
Mercuric chloride (particulate)	7.75E-06	6.06E-04	1.74E-05	—	5.87E-06
Acid gases					
Chlorine	2.10E-03	1.21E+00	3.49E-02	—	—
Hydrogen chloride[G]	1.60E-02	9.24E+00	2.66E-01	—	—
Hydrogen fluoride[E, H]	9.50E-04	5.47E-01	1.57E-02	—	—
Organics					
Acenaphthylene	1.20E-04	6.93E-02	1.99E-03	—	—
Benzene	1.60E-02	9.24E+00	2.66E-01	—	—
Benz(a)anthracene	4.30E-08	2.48E-05	7.14E-07	—	—
Benzo(ghi)perylene	7.80E-08	4.50E-05	1.30E-06	—	—
Benzo(a)pyrene	1.30E-07	7.51E-05	2.16E-06	—	—
Benzo(b)fluoranthene	5.60E-07	3.23E-04	9.30E-06	—	—
Benzo(k)fluoranthene	1.50E-07	8.66E-05	2.49E-06	—	—

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Table 2. Modeled emission rates for assessment of long-term impacts to soils, vegetation, water, and sediment.

Compound	Raw Mill/Kiln			Clinker Cooler	Finish Mill
	Emission Factor[A]	Modeled emission rate[B]		Modeled emission rate[C]	
	lb/ton	tons per year	grams per second	grams per second	
Biphenyl[E]	6.10E-06	3.52E-03	1.01E-04	—	—
Bis(2-ethylhexyl)phthalate[E]	9.50E-05	5.49E-02	1.58E-03	—	—
Bromomethane[E]	4.30E-05	2.48E-02	7.14E-04	—	—
Carbon disulfide[E]	1.10E-04	6.35E-02	1.83E-03	—	—
Chlorobenzene[E]	1.60E-05	9.24E-03	2.66E-04	—	—
Chloromethane[E]	3.80E-04	2.19E-01	6.31E-03	—	—
Chrysene	1.60E-07	9.24E-05	2.66E-06	—	—
Dibenz(ah)anthracene	6.30E-07	2.37E-02	6.81E-04	—	—
Di-n-butylphthalate[E]	4.10E-05	3.64E-04	1.05E-05	—	—
Ethylbenzene[E]	1.90E-05	1.10E-02	3.16E-04	—	—
Fluoranthene	8.80E-06	5.08E-03	1.46E-04	—	—
Fluorene	1.90E-05	1.10E-02	3.16E-04	—	—
Formaldehyde	4.60E-04	2.66E-01	7.64E-03	—	—
Indeno(1,2,3-cd)pyrene	8.70E-08	5.02E-05	1.45E-06	—	—
Methyl ethyl ketone[E]	3.00E-05	1.73E-02	4.98E-04	—	—
Methylene chloride[E]	4.80E-04	2.77E-01	7.97E-03	—	—
Methylnaphthalene, 2-[E]	4.20E-06	2.43E-03	6.98E-05	—	—
Naphthalene	1.70E-03	9.82E-01	2.82E-02	—	—
Phenanthrene	3.90E-04	2.25E-01	6.48E-03	—	—
Phenol[E]	1.10E-04	6.35E-02	1.83E-03	—	—
Pyrene	4.40E-06	2.54E-03	7.31E-05	—	—
Styrene[E]	1.50E-06	8.66E-04	2.49E-05	—	—
Toluene[E]	1.90E-04	1.10E-01	3.16E-03	—	—
Xylene, m-, o-, p-[E, I]	4.33E-05	2.50E-02	7.20E-04	—	—

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Table 2. Modeled emission rates for assessment of long-term impacts to soils, vegetation, water, and sediment.

Compound	Raw Mill/Kiln			Clinker Cooler	Finish Mill
	Emission Factor[A]	Modeled emission rate[B]		Modeled emission rate[C]	
	lb/ton	tons per year	grams per second	grams per second	
Polychlorinated dibenzo(p)dioxins and furans[J]					
2,3,7,8-TCDD	9.83E-11	5.68E-08	1.63E-09	—	—
1,2,3,7,8-PCDD	1.19E-10	6.89E-08	1.98E-09	—	—
1,2,3,4,7,8-HxCDD	1.39E-10	8.06E-08	2.32E-09	—	—
1,2,3,6,7,8-HxCDD	1.54E-10	8.90E-08	2.56E-09	—	—
1,2,3,7,8,9-HxCDD	1.79E-10	1.04E-07	2.98E-09	—	—
1,2,3,4,6,7,8-HpCDD	3.13E-09	1.81E-06	5.21E-08	—	—
OCDD	1.16E-08	6.67E-06	1.92E-07	—	—
2,3,7,8-TCDF	7.68E-10	4.44E-07	1.28E-08	—	—
1,2,3,7,8-PCDF	2.60E-10	1.50E-07	4.32E-09	—	—
2,3,4,7,8-PCDF	3.79E-10	2.19E-07	6.29E-09	—	—
1,2,3,4,7,8-HxCDF	3.40E-10	1.96E-07	5.65E-09	—	—
1,2,3,6,7,8-HxCDF	1.94E-10	1.12E-07	3.22E-09	—	—
1,2,3,7,8,9-HxCDF	2.68E-10	1.55E-07	4.46E-09	—	—
2,3,4,6,7,8-HxCDF	3.78E-10	2.18E-07	6.28E-09	—	—
1,2,3,4,6,7,8-HpCDF	9.36E-10	5.40E-07	1.55E-08	—	—
1,2,3,4,7,8,9-HpCDF	5.96E-10	3.44E-07	9.89E-09	—	—
OCDF	1.07E-09	6.17E-07	1.77E-08	—	—

A. Emission Factor Source: AP-42 Table 11.6-9, Summary of Noncriteria Pollutant Emission Factors for Portland Cement Kilns, except as noted for specific compounds.
B. Emission rates based on kiln throughput of 145.83 tons per hour; annual rates assume this throughput occurs 24-hours per day, 330 days per year.
C. Emission rates based on the exhaust concentrations being identical among the three sources, and using the following modeled flow rates (standard gas conditions): Raw Mill/Kiln, 124.12m^3/s; Clinker Cooler, 40.71m^3/s; Finish Mill, 41.75m^3/s.
D. Hexavalent chromium fraction of total chromium assumed to be 5% based on data from a Portland cement facility in Indiana, where the hexavalent fraction was found to be less than 3.6% of the total chromium emitted.
E. ESP-controlled emission factor used due to unavailability of fabric filter-controlled emission factor.
F. Total mercury emissions are based on the MACT limit of 21 lb per million tons of clinker. Mercury speciation assumed to be 90% elemental, 5% mercuric chloride (vapor), and 5% mercuric chloride (particulate), based on data from a Portland cement facility in Indiana.
G. HCl is the HAP expected to be emitted at the highest rate; its emission factor and emission rate are at low enough levels to make the Universal Cement facility a minor source of HAP emissions.
H. Fluoride emission factor from AP-42 Table 11.6-9 converted to hydrogen fluoride factor assuming all fluorides are hydrogen fluoride.
I. Xylene isomers assumed to be emitted at equal rates.
J. Total polychlorinated dibenzo(p)dioxins and furan emissions are based on the MACT limit 0.20 ng TEQ/dscm. Polychlorinated dibenzo(p)dioxin and furan emissions apportioned among TEQ congeners based on recent extensive stack test data from four Portland cement kilns with advanced emission controls.

Table 3. Modeled emission rates for assessment of phytotoxicity and particulate matter deposition.

Compound	Averaging period	Raw Mill/Kiln		Clinker Cooler		Finish Mill		
		Emission Factor	Emission rate	Emission Factor[A]	Emission rate	Emission Factor[A]		Emission rate
		lb/ton	grams per second	lb/ton	grams per second	gr/dscf	lb/ MMBtu	grams per second
Emission rates for phytoxicity and plant surface deposition assessments								
Nitrogen Oxides (NO_x)[B]	24-hr, Annual	—	29.0	— —	— —	—		0.076
Sulfur Dioxide (SO_2)[B]	3-hr, Annual	—	7.35	— —	— —	—		0.0050
Sulfuric Acid Mist (H_2SO_4)	Annual	0.01	0.184	—	—	—		—
Ammonia (NH_3)	24-hr	0.01	0.18	—	—	—		—
	Annual		0.17	—	—			—
Hydrogen Chloride (HCl)	Annual	0.016	0.266	—	—	—		—
Hydrogen Fluoride (HF)	1-hr, 24-hr	0.00095	0.0165	—	—	—		—
	Annual		0.0157	—	—			—
Particulate matter (PM)	Annual	0.14[C]	2.41	0.01	0.17	0.0008	0.01	0.085

A. Emission factors for NO_x, SO_2, and PM from the Clinker Cooler and Finish Mill are given for informational purposes only, the g/s emission rates were calculated from lb/hr and ton/yr rates in Table A-2 of the Permit Application.

B. Emission rates for NO_x and SO_2 are taken from the Permit Application for Universal Cement. The values shown may include emissions from minor sources not considered in the rest of the ESVA/ESA but which are ducted through the stacks and vents for the raw mill/kiln and finish mill. Identical emission rates were used in these for short and long-term impact analyses.

C. The emission factor for PM from the Raw Mill/Kiln includes both filterable and condensable emissions, and emissions from both the baghouse and the CFBA system as given in Table A-2 of the Permit Application. The NSPS/NESHAP PM emission limit of 0.01 lb/ton for this source covers only filterable PM.

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General air modeling results

Table 4 contains the maximum modeled air concentrations of the HAPs considered in this analysis along with modeled and/or measured background concentrations for each compound. U.S. EPA Region 5 has established Ecological Screening Levels (ESLs) for some of the organic HAPs considered in this analysis, and these are shown with the modeled incremental air concentrations in Table 5; the increments are all far below the ESLs. Concentrations of the other HAPs are provided in Table 4 for context and comparison with background levels, and with limited exceptions are not compared with ecological benchmark values (due largely to a lack of established values). Because the atmospheric dispersion modeling is the first step employed in assessing the impacts of the plant's emissions, predicted concentrations in air contain the lowest degree of uncertainty (compared against the soil, water, sediment, or deposition estimates which rely on the dispersion models and further modeling). Additionally, when compared to measured contaminant levels in soils or sediments, the measured air concentrations are less affected by historical impacts in the area surrounding the site, and by the tendency for sampling of soils and sediments to be conducted in areas which are known to be contaminated, and therefore are not background data. Thus, the comparison of modeled air quality impacts from the proposed facility against measured and modeled background air quality data provides a simple means of assessing the magnitude of the facility's likely impacts relative to current impacts from other sources.

The background concentrations labeled as NATA values are from the U.S. EPA's most recent National-Scale Air Toxics Assessment (NATA) which produced modeled concentrations of HAPs for each U.S. Census Tract based on emissions estimates for the year 2002. The data shown are for tract 510400 which contains the proposed facility.[13] Other background data included in Table 4 are from a variety of air quality monitoring programs which were conducted at locations near the site of the proposed facility.

Although all of the modeled organic impacts are well below background levels, some of the maximum modeled metals impacts shown in Table 4 are above modeled or measured background concentrations. However, several points are worth noting in comparing these values. First, the modeled maxima occur at the proposed facility's fenceline, and the modeled impacts decrease significantly as one moves away from the property (both effects due in part to the relatively short emission height for the clinker cooler and finish mill). Second, most of the lowest of the listed background concentrations are NATA modeled values which are often below measured concentrations because the NATA modeling does not always include relevant area, background, or local sources. Thus, the air quality impacts at receptor locations of significant ecological interest are all expected to be fairly small relative to current levels. Third, as discussed above, the modeled HAPs emission rates used in the ESA are likely to be significantly higher than the emission rates that will occur from the actual Universal Cement facility. Finally, for many COPCs and biological receptors, direct airborne doses through inhalation are a minor source of exposure, so the more relevant environmental media to consider are soil and water, as discussed below.

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[13] NATA data for Illinois, Cook County, U.S. Census Tract 510400 from the U.S. EPA's 2002 National-Scale Air Toxics Assessment (NATA). Accessed at http://www.epa.gov/ttn/atw/nata2002/tables.html.

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Direct Phytotoxicity

Several pollutants to be released from the proposed Universal Cement facility can be directly toxic to vegetation if their concentrations in air exceed certain thresholds. Historically, the gases NO_x, SO_2, and HF have been studied most extensively as potential threats to vegetation, though NH_3, H_2SO_4, and HCl have also been researched.[14] The expected worst-case impacts of these pollutants due to facility emissions are compared to representative benchmark concentrations in Table 6. Expected incremental concentrations due to Universal Cement's emissions are all more than ten-fold smaller than the benchmark levels, with only the NO_x impacts being within 100-fold of the benchmarks. Note that the annual-average benchmark levels for NO_x and SO_2 are significantly lower than their comparable National Ambient Air Quality Standards (NAAQS); for NO_x, the benchmark concentration of 30 $\mu g/m^3$ is more than three-fold smaller than the NAAQS of 100 $\mu g/m^3$, and for SO_2, the benchmark concentration of 20 $\mu g/m^3$ is four-fold smaller than the NAAQS of 80 $\mu g/m^3$.

Particulate Deposition

Particulate matter is not toxic to vegetation *per se*, though its deposition to plant surfaces can interfere with photosynthesis. Reduced levels of photosynthesis have been observed at elevated particulate matter loadings. A steady-state level of dust on plant surfaces can be estimated with the following model (as simplified from EPA)[15] as shown in Equation 1.

Equation 1
$$S_{plant} = \frac{D_{dry} + f_{wet} D_{wet}}{k_p}$$

where the terms are:

S_{plant}	Steady-state loading on the plant surface (g/m^2);
D_{dry}	Rate of dry deposition (g/m^2-yr);
D_{wet}	Rate of wet deposition (g/m^2-yr);
f_{wet}	Fraction of wet deposition that remains on the plant surface; and
k_p	Plant surface loss coefficient (1/yr).

EPA recommends values of 0.6 for f_{wet} and 18 yr^{-1} for k_p, respectively.[15] Based on the particulate matter emission rates in Table 3, and AERMOD predicted dry and wet particle deposition rates for every receptor, Equation 1 predicts a maximum potential steady-state particle loading on plant surfaces of 0.0033 g/m^2. This worst-case level, predicted using maximum model predictions at any location surrounding the proposed Universal Cement location, is well below the range of 1-10 g/m^2 at which reduced levels of photosynthesis have been observed in some plant species.[16]

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[14] NO_x, SO_2, and HF have been studied most extensively because adverse effects on vegetation were observed in some instances at concentrations occurring in the atmosphere. Concentrations of NH_3, H_2SO_4, and HCl do not typically reach levels in air that are known to damage plants.
[15] U.S. EPA (2005). *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities*. EPA 530-R-05-006.
[16] Glenn, D. and Puterka, G. (2005). Particle Films: A New Technology for Agriculture. *Horticultural Reviews* **31**:1–44.

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Table 4. Maximum modeled ambient air impacts due to Universal Cement emissions, and EPA modeled and measured nearby background ambient air concentrations.

Compound	Modeled impacts (µg/m³)				Background concentrations (µg/m³)						
	Overall Maximum	Indian Ridge Marsh Maximum	Lake Calumet Watershed Maximum	Lake Calumet Watershed Average	NATA[A]	AirData TSP[B]	AirData PM_{10}[C]	IEPA[D]	O'Hare[E]	Southeast Chicago[F] Calumet	Southeast Chicago[F] Comm-unity
Metals											
Arsenic	3.26E-04	3.41E-05	3.41E-05	5.10E-06	7.71E-04		8.23E-04		1.00E-03	1.50E-03	1.80E-03
Beryllium	1.79E-05	1.87E-06	1.87E-06	8.47E-09	5.53E-05				4.60E-04		
Cadmium	5.98E-05	6.25E-06	6.25E-06	2.82E-08	2.37E-03	1.27E-03	1.63E-04		2.60E-03	1.00E-04	5.00E-04
Chromium (total)	3.81E-03	3.98E-04	3.98E-04	1.80E-06	9.32E-04	6.37E-03	2.76E-03		9.20E-03	1.90E-01	8.30E-03
Chromium (hexavalent)	1.90E-04	1.99E-05	1.99E-05	8.99E-08				1.00E-05			
Lead	1.93E-02	2.02E-03	2.02E-03	9.12E-06	8.20E-03	1.23E-02	4.59E-03		3.15E-02	3.82E-02	7.59E-02
Manganese	2.34E-02	2.44E-03	2.44E-03	1.10E-05	9.55E-03	2.83E-02	6.91E-03		1.40E-01	1.29E-01	2.35E-01
Selenium	5.44E-03	5.68E-04	5.68E-04	2.57E-06	1.41E-04		8.60E-04			1.80E-03	2.50E-03
Mercury (total)	1.86E-05	5.34E-06	5.34E-06	6.59E-08	5.19E-04			1.42E-03			
Acid gases											
Chlorine	4.37E-04	4.13E-04	4.37E-04	5.93E-06	1.44E-03						
Hydrogen chloride	3.33E-03	3.15E-03	3.33E-03	4.52E-05	1.35E-01						
Fluoride	1.97E-04	1.86E-04	1.97E-04	2.68E-06	7.01E-02						
Organics											
Acenaphthylene	2.50E-05	2.37E-05	2.50E-05	3.43E-07						3.95E-03	4.80E-03
Benzene	3.34E-03	3.15E-03	3.34E-03	4.58E-05	1.42E+00			2.49E+00	2.20E+00	1.81E+00	2.18E+00
Benz(a)anthracene	8.97E-09	8.47E-09	8.97E-09	1.23E-10						2.68E-04	9.72E-04
Benzo(ghi)perylene	1.63E-08	1.54E-08	1.63E-08	2.23E-10						4.92E-04	6.88E-04
Benzo(a)pyrene	2.71E-08	2.56E-08	2.71E-08	3.71E-10						4.68E-04	9.07E-04
Benzo(b)fluoranthene	1.17E-07	1.10E-07	1.17E-07	1.60E-09						2.76E-04	7.60E-04
Benzo(k)fluoranthene	3.13E-08	2.96E-08	3.13E-08	4.28E-10						2.76E-04	7.60E-04
Biphenyl	1.27E-06	1.20E-06	1.27E-06	1.74E-08	3.42E-04					1.04E-02	1.02E-02
Bis(2-ethylhexyl)phthalate	1.98E-05	1.87E-05	1.98E-05	2.71E-07	5.69E-03						
Bromomethane	8.98E-06	8.48E-06	8.98E-06	1.23E-07	1.27E-01						
Carbon disulfide	2.30E-05	2.17E-05	2.30E-05	3.15E-07	5.64E-03						
Chlorobenzene	3.34E-06	3.15E-06	3.34E-06	4.58E-08	3.06E-02					1.08E-01	1.03E+00
Chloromethane	7.94E-05	7.49E-05	7.94E-05	1.09E-06	1.20E+00						
Chrysene	3.34E-08	3.15E-08	3.34E-08	4.57E-10						5.84E-04	1.42E-03
Dibenz(ah)anthracene	8.55E-06	8.08E-06	8.55E-06	1.17E-07						1.12E-04	1.69E-04

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Table 4. Maximum modeled ambient air impacts due to Universal Cement emissions, and EPA modeled and measured nearby background ambient air concentrations.

Compound	Modeled impacts (µg/m³)				Background concentrations (µg/m³)						
	Overall Maximum	Indian Ridge Marsh Maximum	Lake Calumet Watershed Maximum	Lake Calumet Watershed Average	NATA[A]	AirData TSP[B]	AirData PM_{10}[C]	IEPA[D]	O'Hare[E]	Southeast Chicago[F] Calumet	Southeast Chicago[F] Comm-unity
Di-n-butylphthalate	1.31E-07	1.24E-07	1.31E-07	1.80E-09	1.46E-04						
Ethylbenzene	3.97E-06	3.75E-06	3.97E-06	5.43E-08	4.36E-01					9.34E-01	7.77E-01
Fluoranthene	1.84E-06	1.73E-06	1.84E-06	2.51E-08				7.40E-03		3.78E-03	7.44E-03
Fluorene	3.97E-06	3.75E-06	3.97E-06	5.43E-08				1.25E-02		7.10E-03	9.82E-03
Formaldehyde	9.61E-05	9.06E-05	9.61E-05	1.31E-06	2.26E+00			6.00E-01	2.33E+00		
Indeno(1,2,3-cd)pyrene	1.81E-08	1.71E-08	1.81E-08	2.48E-10						4.00E-04	4.87E-04
Methyl ethyl ketone	6.26E-06	5.91E-06	6.26E-06	8.58E-08							
Methylene chloride	1.00E-04	9.46E-05	1.00E-04	1.37E-06	3.70E-01			4.5E-01	1.63E+00	6.25E-01	1.09E+00
Methylnaphthalene, 2-	8.77E-07	8.28E-07	8.77E-07	1.20E-08							
Naphthalene	3.55E-04	3.35E-04	3.55E-04	4.86E-06	1.20E-01			8.01E-02		1.79E-01	3.28E-01
Phenanthrene	8.14E-05	7.69E-05	8.14E-05	1.12E-06				3.52E-02		1.17E-02	1.73E-02
Phenol	2.30E-05	2.17E-05	2.30E-05	3.14E-07	1.30E-02						
Pyrene	9.18E-07	8.67E-07	9.18E-07	1.26E-08				3.19E-03		2.37E-03	4.29E-03
Styrene	3.13E-07	2.96E-07	3.13E-07	4.29E-09	4.78E-02					2.69E-01	2.66E-01
Toluene	3.97E-05	3.75E-05	3.97E-05	5.43E-07	3.36E+00			1.66E+00	3.66E+00	4.86E+00	3.53E+00
Xylene (total)	2.71E-05	2.56E-05	2.71E-05	3.72E-07	2.03E+00				2.30E+00	3.82E+00	3.20E+00

A. NATA data are for Illinois, Cook County, U.S. Census Tract 510400 from the U.S. EPA's 2002 National-Scale Air Toxics Assessment (NATA). Accessed at http://www.epa.gov/ttn/atw/nata2002/tables.html.
B. AirData TSP data are 2006-2008 average concentrations from U.S. EPA's AirData system, site number 170310022, at 3535 E. 114TH St.
C. AirData PM_{10} data are 2006-2008 average concentrations from U.S. EPA's AirData system, site number 170314201 at the Northbrook Water Plant, Dundee Rd.
D. IEPA data are from "Illinois Annual Air Quality Report 2008." Northbrook Water Plant, Dundee Rd.
E. O'Hare data are from the "Chicago O'Hare Airport Air Toxic Monitoring Program June – December, 2000". Illinois Environmental Protection Agency Bureau of Air May 2002. Data shown are from the Chicago Washington H.S. site. Dioxin data are totals of listed dioxins and furans.
F. Southeast Chicago data are from "Comparison of Measured Concentrations, TRI Emissions, and Modeled Cumulative Outdoor Concentrations of Hazardous Air Pollutants in Southeast Chicago" U.S. EPA, Region 5, Chicago IL.

Table continued below.

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Table 4. Maximum modeled ambient air impacts due to Universal Cement emissions, EPA modeled and measured nearby background ambient air concentrations.

Compound	Maximum Modeled impacts (μg/m³)				Background concentration (μg/m³)		
	Overall Maximum	Indian Ridge Marsh Maximum	Lake Calumet Watershed Maximum	Lake Calumet Watershed Average	EPA Rural survey[G]		O'Hare[E]
					Dixon Springs	Monmouth	
Polychlorinated dibenzo(p)dioxins and furans							
2,3,7,8-TCDD	2.05E-11	1.94E-11	2.05E-11	2.81E-13	1.50E-09	6.00E-10	2.389E-06
1,2,3,7,8-PCDD	2.49E-11	2.35E-11	2.49E-11	3.40E-13	8.00E-09	4.10E-09	
1,2,3,4,7,8-HxCDD	2.91E-11	2.75E-11	2.91E-11	3.98E-13	8.20E-09	6.10E-09	
1,2,3,6,7,8-HxCDD	3.21E-11	3.04E-11	3.21E-11	4.40E-13	1.53E-08	1.28E-08	
1,2,3,7,8,9-HxCDD	3.74E-11	3.53E-11	3.74E-11	5.11E-13	1.38E-08	1.22E-08	
1,2,3,4,6,7,8-HpCDD	6.54E-10	6.18E-10	6.54E-10	8.94E-12	1.99E-07	1.74E-07	
OCDD	2.41E-09	2.28E-09	2.41E-09	3.30E-11	8.51E-07	5.78E-07	
2,3,7,8-TCDF	1.60E-10	1.51E-10	1.60E-10	2.19E-12	2.50E-09	2.40E-09	1.046E-06
1,2,3,7,8-PCDF	5.42E-11	5.12E-11	5.42E-11	7.42E-13	2.10E-09	2.40E-09	
2,3,4,7,8-PCDF	7.90E-11	7.46E-11	7.90E-11	1.08E-12	3.90E-09	4.00E-09	
1,2,3,4,7,8-HxCDF	7.09E-11	6.70E-11	7.09E-11	9.70E-13	4.30E-09	4.90E-09	
1,2,3,6,7,8-HxCDF	4.04E-11	3.82E-11	4.04E-11	5.53E-13	4.50E-09	4.40E-09	
1,2,3,7,8,9-HxCDF	5.59E-11	5.28E-11	5.59E-11	7.65E-13	5.00E-10	1.50E-09	
2,3,4,6,7,8-HxCDF	7.89E-11	7.45E-11	7.89E-11	1.08E-12	5.50E-09	5.50E-09	
1,2,3,4,6,7,8-HpCDF	1.95E-10	1.84E-10	1.95E-10	2.67E-12	2.41E-08	2.42E-08	
1,2,3,4,7,8,9-HpCDF	1.24E-10	1.17E-10	1.24E-10	1.70E-12	2.50E-09	3.00E-09	
OCDF	2.23E-10	2.11E-10	2.23E-10	3.05E-12	2.81E-08	2.35E-08	
TEQ (WHO, 1998 TEFs)	1.48E-10	1.40E-10	1.48E-10	2.03E-12	1.94E-8	1.39E-8	—

E. O'hare data are from the "Chicago O'Hare Airport Air Toxic Monitoring Program June – December, 2000". Illinois Environmental Protection Agency Bureau of Air May 2002. Data shown are from the Chicago Washington H.S. site. Dioxin data are totals of listed dioxins and furans.

G. EPA Rural survey data are from the Pilot Survey of Levels of Polychlorinated dibenzo-p-dioxins, Polychlorinated dibenzofurans, Polychlorinated biphenyls, and Mercury in Rural Soils of the United States. U.S. Environmental Protection Agency, Washington, DC 20460. Report # EPA/600/R-05/048F.

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Table 5. Maximum modeled ambient air impacts due to Universal Cement emissions and ecological screening levels.

Pollutant	Modeled Incremental Concentration due to Universal Cement Facility Emissions (µg/m^3)				Ecological Screening Level (µg/m^3)^A
	Worst-Case Point	Maximum over Indian Ridge Marsh	Maximum over Lake Calumet Watershed	Average over Lake Calumet Watershed	
Benzene	3.34E-03	3.15E-03	3.34E-03	4.58E-05	9.76E+03
Bromomethane	8.98E-06	8.48E-06	8.98E-06	1.23E-07	2.65E+04
Carbon Disulfide	2.30E-05	2.17E-05	2.30E-05	3.15E-07	3.67E+03
Chlorobenzene	3.34E-06	3.15E-06	3.34E-06	4.58E-08	1.20E+05
Chloromethane	7.94E-05	7.49E-05	7.93E-05	1.09E-06	2.63E+03
Ethylbenzene	3.97E-06	3.75E-06	3.97E-06	5.43E-08	3.04E+05
Methyl Ethyl Ketone	6.26E-06	5.91E-06	6.26E-06	8.58E-08	6.42E+05
Methylene Chloride	1.00E-04	9.46E-05	1.00E-04	1.37E-06	4.78E+06
Naphthalene	3.55E-04	3.35E-04	3.55E-04	4.86E-06	8.01E+04
Pphenol	2.30E-05	2.17E-05	2.30E-05	3.14E-07	4.31E+03
Styrene	3.13E-07	2.96E-07	3.13E-07	4.29E-09	9.46E+02
Toluene	3.97E-05	3.75E-05	3.97E-05	5.43E-07	1.04E+06
Xylene, total	2.71E-05	2.56E-05	2.71E-05	3.72E-07	1.35E+05

A. Ecological screening levels are from U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003. Available at: http://www.epa.gov/reg5rcra/ca/ESL.pdf. Accessed October 19, 2010.

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Table 6. Maximum modeled air impacts and maximum impacts over the Indian Ridge Marsh due to emissions from Universal Cement, and guideline benchmark concentrations to protect against phytotoxicity.

Pollutant	Averaging Time	Modeled Incremental Concentration due to Universal Cement Facility Emissions ($\mu g/m^3$)				Guideline Benchmark Concentration ($\mu g/m^3$)
		Worst-Case Point	Maximum over Indian Ridge Marsh	Maximum over Lake Calumet Watershed	Average over Lake Calumet Watershed	
Nitrogen Oxides (NO_x)[A]	24-hr	5.91	5.23	5.39	2.79	75[B]
	Annual	0.48	0.44	0.48	0.18	30[B]
Sulfur Dioxide (SO_2)[A]	3-hr	3.41	3.32	3.32	2.07	1300[C]
	Annual	0.12	0.11	0.12	0.044	20[B, D]
Sulfuric Acid Mist (H_2SO_4)	Annual	0.0021	0.0020	0.0021	0.00082	1[B, E]
Ammonia (NH_3)	24-hr	0.036	0.032	0.033	0.017	270[B]
	Annual	0.0021	0.0020	0.0021	0.00075	8[B]
Hydrogen Chloride (HCl)	Annual	0.0033	0.0031	0.0033	0.0013	39[F, G]
Hydrogen Fluoride (HF)	1-hr	0.025	0.018	0.025	0.013	4.3[H]
	24-hr	0.0035	0.0031	0.0032	0.0017	0.86[H]
	Annual	0.00020	0.00019	0.00020	0.000077	0.22[H, I]

A. Modeled emission rates for NO_x and SO_2 were taken from the Permit Application for Universal Cement. The modeled emissions may include emissions from minor sources not considered in the rest of the ESVA/ESA but which are ducted through the stacks and vents for the raw mill/kiln and finish mill. Identical emission rates were used in these for short and long-term impact analyses.

B. Source: *Air Quality Guidelines for Europe*, World Health Organization, Regional Office for Europe, Copenhagen, WHO Regional Publications, European Series, No. 91, Second Edition, 2000.

C. National Ambient Air Quality Standard. Secondary standard of 0.50 ppm (to be exceeded no more than once per year) to protect vegetation. Impacts shown are maximum, second highest 3-hour modeled concentrations.

D. The 20 $\mu g/m^3$ benchmark is recommended to protect forest habitat and natural vegetation. A lower guideline of 10 $\mu g/m^3$ is recommended to protect lichens.

E. Benchmark concentration based on particulate sulfate as a surrogate for acidity.

F. Source: Ontario Air Standards for Hydrogen Chloride, Standards Development Branch, Ontario Ministry of the Environment, March 2001.

G. Benchmark concentration of 60 $\mu g/m^3$ for a 30-day exposure period adjusted to 39 $\mu g/m^3$ for an annual period based on power-law scaling factor of 0.654 (U.S. EPA, *Workbook of Atmospheric Dispersion Estimates*, 1970, AP-26, p. 38).

H. Source: Rationale for the Development of Ontario Air Standards for Hydrogen Fluoride, Standards Development Branch, Ontario Ministry of the Environment, June 2004.

I. Benchmark concentration of 0.34 $\mu g/m^3$ for a 30-day exposure period adjusted to 0.22 $\mu g/m^3$ for an annual period based on power-law scaling factor of 0.654 (U.S. EPA, *Workbook of Atmospheric Dispersion Estimates*, 1970, AP-26, p. 38).

Deposition of Nitrogen Species

Potentially significant increases in nitrogen loading to soils might place native vegetation at a competitive disadvantage to invasive species. Reactive and depositable nitrogen species that will be emitted from the proposed Universal Cement facility in significant amounts include the oxidized species NO and NO_2, collectively identified as NO_x, and reduced species NH_3 and NH_4. The rates at which nitrogen species are removed from the atmosphere depend upon on many factors, including their form (they react with other chemicals and transform into other species) and atmospheric conditions. For example, studies have determined that much NO_2, a relatively insoluble gas, is removed principally in the form of nitrate, which first requires that NO_2 further oxidize in the atmosphere to ionic NO_3, then deposit to the ground or be scavenged (removed) by precipitation. These steps require sufficient time and appropriate conditions, and hence it is possible, perhaps even likely, that very little NO_x emitted by Universal Cement will deposit near the proposed facility.

A special set of atmospheric dispersion and deposition modeling runs were used to estimate long-term nitrogen deposition fluxes to the areas surrounding the site of the proposed facility. Two forms of nitrogen emissions were modeled (1) direct ammonia and ammonium emissions, and (2) oxidized nitrogen emissions (NO and NO_2, or NO_x), the deposition of which were modeled by considering how NO_x is converted to nitrate (NO_3^-) which is then neutralized and deposited as a fine particulate-phase species. Deposition of direct ammonia and ammonium emissions was modeled using emission rates described above, diffusion and Henry's Law parameters from the PHYSPROP Database[17], and a cuticular resistance term for other similar inorganic gases in Wesely, *et al.* [12] The production of particulate-phase nitrate from gas-phase NO_x emissions was modeled by assuming that NO_x converts to nitrate at a rate of 6% per hour.[18] To model this conversion, two sets of AERMOD programs were run, one with a 6% per hour exponential decay of the emitted NO_x, and one without the exponential decay factor. The production of particulate-phase nitrate from emitted NO_x has been estimated by subtracting the concentration results of the model runs with the decay from the results of the model without the decay. To calculate the deposition of the particulate-phase nitrate in the AERMOD runs, it was assumed that these secondary particles have an effective aerodynamic diameter of one micron. The results of this modeling are shown in Table 7, where the impacts of potential emissions from Universal Cement are compared against benchmarks described below.

The World Health Organization has reviewed the literature regarding critical nitrogen loadings that may have ecological consequences (WHO, 2000). Sensitive ecosystems have critical loads of 5–10 kg N/ha per year, and for natural and semi-natural ecosystems similar to those found in the limited undeveloped portions of the greater Chicago area, threshold critical loads range from

[17] The PHYSPROP Database is maintained by the Syracuse Research Corporation, Syracuse, NY. Available at: http://esc.syrres.com/interkow/physdemo.htm), accessed October 2010.

[18] This conversion is conservatively estimated from information in the 1990 U.S. National Acid Precipitation Assessment Program (NAPAP) report, *Acidic Deposition: State of Science and Technology, Volume I: Emissions, Atmospheric Processes, and Deposition*, which notes an average conversion rate of nitrogen oxides to nitric acid of 8% per hour during the daytime, and 4% averaged over the whole day.

15–20 kg N/ha per year. Of the ecosystem categories considered by WHO (2001), the closest in nature to the Lake Calumet habitat are the mesotrophic fens and calcareous grasslands, for which the critical loads are judged to be 20–35 kg N/ha per year and 15–35 kg N/ha per year, respectively. The estimated nitrogen deposition rates due to emissions from the proposed Universal Cement facility are below 0.05 kg N/ha-yr, well below both the thresholds for relevant (15–20 kg N/ha-yr) and sensitive (5–10 kg N/ha-yr) habitats.

Table 7. Maximum nitrogen deposition impacts, maximum impacts over the Indian Ridge Marsh, maximum and average impacts in the Lake Calumet watershed due to emissions from Universal Cement, and WHO guideline benchmark deposition rates.

Pollutant	Modeled Incremental Concentration due to Universal Cement Facility Emissions (kg N/ha-yr)				Guideline Benchmark Deposition Rate (kg N/ha-yr)[A]
	Worst-Case Point	Maximum over Indian Ridge Marsh	Maximum over Lake Calumet Watershed	Average over Lake Calumet Watershed	
Nitrates (NO_3^+)	0.016	0.009	0.011	0.007	–
Ammonia/Ammonium (NH_3/NH_4^-)	0.024	0.022	0.024	0.008	–
Total nitrogen deposition	0.042	0.031	0.035	0.015	15-20 for typical areas 5-10 for sensitive areas

A. *Air Quality Guidelines for Europe*, World Health Organization, Regional Office for Europe, Copenhagen, WHO Regional Publications, European Series, No. 91, Second Edition, 2000. Values generally based on threshold levels for plant growth effects.

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Evaluation of Hazardous Air Pollutants

Modeling incremental soil concentrations

The modeled, incremental concentrations of compounds in nearby soils due to emissions from the proposed plant are dependent on each compound's deposition rate from the atmosphere, the rate at which the compound is lost from or degraded in the soil, and the length of time over which these processes have occurred. Some of the compounds included in the atmospheric dispersion and deposition modeling were not included in the incremental soil concentration modeling because they are volatile and do not accumulate in soils. The criterion for excluding compounds from the soils analysis is a vapor pressure of 0.1 mm of Hg or greater based on the U.S. EPA's former definition of a volatile organic compound (VOC).[19] Equation 2 was used to calculate soil concentrations of compounds emitted from the plant.

Equation 2
$$Cs_{tD} = \frac{D_s \cdot [1 - \exp(-ks \cdot tD)]}{ks}$$

where the terms are:

Cs_{tD}	Soil concentration at time tD (mg/kg);
D_s	Deposition term (mg/kg soil/yr);
ks	Compound soil loss constant due to all processes (yr^{-1}); and
tD	Time period over which deposition occurs (time period of combustion, yr).

Default values for T_1=0, and tD=100 years are taken from HHRAP Appendix Table B-1-1. The deposition term, D_s, is calculated using Equation 3 from the compound atmospheric concentrations and deposition rates determined by the AERMOD modeling described above. The AERMOD values for unitized wet and dry deposition of particles and vapors are combined with the compound's emission rates and converted into a soil concentration deposition term D_s by including the soil mixing depth and density in the denominator as shown in Equation 3.

[19] The EPA's current definition of an atmospheric VOC is based on photochemical reactivity rather than volatility due to the role of VOCs in the photochemical formation of tropospheric ozone.

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Equation 3
$$D_s = \left[\frac{100 \cdot Q}{Z_s \cdot BD}\right] \cdot \left[F_v \cdot (Dydv + Dywv) + (1 - F_v)(Dydp + Dywp)\right]$$

where the terms are:

D_s	Deposition term (mg/kg soil-yr);
100	Units conversion factor (mg-m^2/kg-cm^2);
Q	Compound emission rate (g/s);
Z_s	Soil mixing zone depth (cm);
BD	Soil bulk density (g soil/cm^3 soil);
F_v	Fraction of compound air concentration in vapor-phase;
$Dydv$	Unitized yearly average dry deposition from vapor-phase (s/m^2-yr);
$Dywv$	Unitized yearly average wet deposition from vapor-phase (s/m^2-yr);
$Dydp$	Unitized yearly average dry deposition from particle-phase (s/m^2-yr); and
$Dywp$	Unitized yearly average wet deposition from particle-phase (s/m^2-yr).

The calculation of compound emission rates, Q, was described above. A soil mixing zone depth of 2 cm was used as the default for untilled soils. The soil bulk density, BD, is 1.5 g/cm^3. The fraction of each compound's concentration in air in the vapor-phase, F_v, is a compound-specific parameter.

The loss rate for compounds from soils, *ks*, is the sum of terms as shown in Equation 4.

Equation 4
$$ks = ksg + kse + ksr + ksl + ksv$$

where the terms are:

ks	Compound soil loss constant due to all processes (yr^{-1});
ksg	Compound loss constant due to biotic and abiotic degradation (yr^{-1});
kse	Compound loss constant due to soil erosion (yr^{-1});
ksr	Compound loss constant due to surface runoff (yr^{-1});
ksl	Compound loss constant due to leaching (yr^{-1}); and
ksv	Compound loss constant due to volatilization (yr^{-1}).

Based on HHRAP Appendix Table B-1-2, *kse* is taken as zero; *ksg* values are compound-specific and are taken from the HHRAP database. Losses of compounds due to surface runoff, *ksr*, and leaching, *ksl*, are dependent on the compound's soil-water partitioning coefficient and the amount of water available for these processes as given in Equation 5 and Equation 6.

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Equation 5 $$ksr = \frac{RO}{\theta_{sw} \cdot Z_s} \cdot \left(\frac{1}{1 + \left(Kd_s \cdot BD / \theta_{sw} \right)} \right)$$

Equation 6 $$ksl = \frac{P + I - RO - E_v}{\theta_{sw} \cdot Z_s \cdot \left[1 + \left(Kd_s \cdot BD / \theta_{sw} \right) \right]}$$

where the terms are:

ksr	Compound loss constant due to surface runoff (yr^{-1});
ksl	Compound loss constant due to leaching (yr^{-1});
RO	Average annual surface runoff from pervious areas (cm/yr);
P	Average annual precipitation (cm/yr);
I	Average annual irrigation (cm/yr);
E_v	Average annual evapotranspiration (cm/yr);
θ_{sw}	Soil volumetric water content (ml water/cm^3 soil);
Z_s	Soil mixing zone depth (cm);
Kd_s	Soil-water partition coefficient (ml water/g soil); and
BD	Soil bulk density (g soil/cm^3 soil).

Based on HHRAP Appendix Tables B-1-4 and B-1-5, and data from Geraghty *et al.* (1973)[20], region-specific values used are RO = 18 cm/yr, P = 84 cm/yr, and E_v = 66 cm/yr. No irrigation is assumed to occur in the area. The selection of these values for *RO*, *P*, *E*, and *I* yields the conservative result of compound loss due to leaching being zero for all compounds. Default values are used for BD = 1.50 g/cm^3 and θ_{sw} = 0.2 ml/cm^3; and compound-specific values are used for Kd_s.

The calculation of the compound loss constant due to volatilization, *ksv*, is the product of the gas equilibrium coefficient, *Ke*, and the gas-phase mass transfer coefficient, K_t as shown in Equation 7.

Equation 7 $$ksv = Ke \cdot K_t$$

The equilibrium coefficient, *Ke*, is given by Equation 8.

Equation 8 $$Ke = \frac{3.1536 \times 10^7 \cdot H}{Z_s \cdot K_{ds} \cdot R \cdot T_a \cdot BD}$$

[20] Geraghty, J.J., Miller, D.W., Van Der Leeden, F., and Trose, F.L., (1973). Water Atlas of the United States. Water Information Center, Port Washington, NY.

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where the terms are:

Ke	Compound gas equilibrium coefficient (s/yr-cm);
3.1536×10^{7}	Units conversion (s/yr);
H	Henry's Law constant (atm-m^3/mol);
Z_s	Soil mixing zone depth (cm);
K_{ds}	Soil-water partition coefficient (ml/g);
R	Ideal gas constant (atm-m^3/mol-K);
T_a	Average ambient air temperature (K); and
BD	Soil bulk density (g soil/cm^3 soil).

The gas-phase mass transfer coefficient, K_t, is given by Equation 9.

Equation 9

$$K_t = \frac{D_a}{Z_s}\left(1-\left(\frac{BD}{\rho_s}\right)-\theta_{sw}\right)$$

where the terms are:

K_t	Gas-phase mass transfer coefficient (cm/s);
D_a	Diffusion coefficient in air (cm^2/s);
Z_s	Soil mixing zone depth (cm);
BD	Soil bulk density (g soil/cm^3 soil);
ρ_s	Density of soil solids (g/cm^3); and
θ_{sw}	Volumetric soil water content (unitless).

HHRAP default values were used for $Z_s = 1$ cm, $T_a = 298$ °K, $BD = 1.50$ g/cm^3, $\theta_{sw} = 0.2$ ml/cm^3, and $\rho_s = 2.7$ g/cm^3. The ideal gas constant, R, is 8.205×10^{-5} atm-m^3/mol-K. Compound-specific values were used for H, Kd_s and D_a.

Locations of the modeled maximum incremental soil impacts, which to some extent differ among COPCs based on the influence of chemical-specific properties, are shown in Figure 13. Table 8 contains the maximum modeled soil concentrations of the HAPs considered in this analysis along with measured background concentrations for each compound, and applicable ecological benchmark levels. The maximum soil impacts due to HAPs emissions from the proposed Universal Cement facility are well below both measured background levels and ecological screening levels, and the impacts over areas of particular concern such as the Lake Calumet watershed are even smaller. Thus it is expected that potential emissions from the proposed facility will not have any effect on the nearby soils or ecosystems.

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Table 8. Maximum modeled soil impacts due to Universal Cement emissions, nearby measured soil concentrations, and ecological soil screening levels.

Compound	Modeled impacts (mg/kg)				Measured concentrations (mg/kg)				Ecological Screening Level [D] (mg/kg)
	Overall Maximum	Indian Ridge Marsh Maximum	Lake Calumet Watershed Maximum	Lake Calumet Watershed Average	ECO-SSL Illinois Background [A]	Chicago [B]	Metropolitan Areas [B]	Lake Calumet Cluster Site [C]	
Metals									
Arsenic	5.90E-03	8.29E-04	8.29E-04	1.29E-04	7.1		13	7.8	18 (p)
Beryllium	4.64E-03	6.53E-04	6.53E-04	1.01E-04	0.7		0.59		21 (m)
Cadmium	2.79E-03	3.92E-04	3.92E-04	6.08E-05			0.6		0.36 (m)
Chromium (total)	4.52E-02	6.35E-03	6.35E-03	9.86E-04	48.4		16.2	245	26 (a)
Chromium (hexavalent)	2.26E-03	3.18E-04	3.18E-04	4.93E-05					81 (m)
Lead	5.20E+00	7.31E-01	7.31E-01	1.13E-01	38.6		36	185.9	11 (a)
Manganese	9.45E-01	1.33E-01	1.33E-01	2.06E-02	646.1		636		
Selenium	1.73E-02	2.43E-03	2.43E-03	3.78E-04	0.5		0.48		0.0276 (R)
Mercury (total)	2.24E-03	3.66E-04	3.66E-04	9.23E-05	0.11		0.06	0.36	0.1 (R)
Non-volatile Organics									
Acenaphthylene	5.75E-06	5.21E-06	5.75E-06	1.92E-06		0.03	0.07		682 (R)
Benz(a)anthracene	1.46E-07	1.41E-07	1.46E-07	5.39E-08				1.02	5.21 (R)
Benzo(ghi)perylene	3.37E-07	3.10E-07	3.14E-07	1.17E-07		0.68	1.7		119 (R)
Benzo(a)pyrene	3.73E-07	3.65E-07	3.73E-07	1.38E-07		1.3	2.1	1.04	1.52 (R)
Benzo(b)fluoranthene	6.82E-07	6.25E-07	6.82E-07	2.31E-07		1.5	2.1		59.8 (R)

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Table 8. Maximum modeled soil impacts due to Universal Cement emissions, nearby measured soil concentrations, and ecological soil screening levels.

Compound	Modeled impacts (mg/kg)				Measured concentrations (mg/kg)				Ecological Screening Level [D] (mg/kg)
	Overall Maximum	Indian Ridge Marsh Maximum	Lake Calumet Watershed Maximum	Lake Calumet Watershed Average	ECO-SSL Illinois Background [A]	Chicago [B]	Metropol-itan Areas [B]	Lake Calumet Cluster Site [C]	
Benzo(k)fluoranthene	1.74E-06	1.70E-06	1.74E-06	6.44E-07		0.99	1.7		148 (R)
Bis(2-ethylhexyl)phthalate	1.35E-05	1.33E-05	1.35E-05	5.01E-06					0.925 (R)
Chrysene	4.74E-07	4.53E-07	4.74E-07	1.69E-07		1.2	2.7		4.73 (R)
Dibenz(ah)anthracene	2.44E-04	2.34E-04	2.37E-04	8.83E-05		0.2	0.42	0.34	18.4 (R)
Di–n-butyl Phthalate	7.32E-08	4.99E-08	5.47E-08	1.94E-08					0.15 (R)
Fluoranthene	1.97E-05	1.35E-05	1.47E-05	5.23E-06		2.7	4.1		122 (R)
Fluorene	2.09E-06	1.89E-06	2.09E-06	6.98E-07		0.1	0.18		122 (R)
Indeno(1,2,3-cd)pyrene	4.45E-07	4.10E-07	4.17E-07	1.56E-07		0.86	1.6		109 (R)
Methylnaphthalene, 2-	2.54E-08	2.30E-08	2.54E-08	8.48E-09			0.1		3.24 (R)
Naphthalene	7.70E-05	6.98E-05	7.70E-05	2.57E-05		0.04	0.2	0.89	0.099 (R)
Phenanthrene	1.44E-04	1.30E-04	1.44E-04	4.81E-05		1.3	2.5		45.7 (R)
Pyrene	4.31E-05	2.93E-05	3.21E-05	1.14E-05		1.9	3		78.5 (R)

A: ECO-SSL data are from the U.S. EPA's database as derived from Illinois-specific data. Available at: http://www.epa.gov/ecotox/ecossl/pdf/ecossl_attachment_4-1_all_ref_data_compiled.xls.
B: Illinois TACO data are from "Tiered Approach to Corrective Action Objectives", Section 742. APPENDIX A, TABLE G Concentrations of Inorganic Chemicals in Background Soils. Illinois Pollution Control Board. Available at:http://www.ipcb.state.il.us/documents/dsweb/Get/Document-38408/.
C: Lake Calumet Cluster Site data are from the "Proposed Plan for Cleanup at the Lake Calumet Cluster Site, Chicago Illinois" Available at: http://www.csu.edu/cerc/documents/LakeCalumetClusterSiteProposedCleanupPlan.pdf.
D: SSLs are the minimum of EPA ECO-SSLs if they exist, or the EPA Region 5 ESLs if no ECO-SSL exists; (a) indicates ECO-SSL avian; (m) ECO-SSL mammal; (p) ECO-SSL plant, (R), Region 5 ESL. Available at http://rais.ornl.gov/tools/eco_search.php.

Table is continued on next page.

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Table 8. Maximum modeled soil impacts due to Universal Cement emissions, nearby measured soil concentrations, and ecological soil screening levels.

Compound	Maximum modeled impact (mg/kg)				Background concentration (mg/kg) EPA Rural survey[E]		Ecological Screening Level[D] (mg/kg)
	Overall Maximum	Indian Ridge Marsh Maximum	Lake Calumet Watershed Maximum	Lake Calumet Watershed Average	Dixon Springs	Monmouth	
Polychlorinated dibenzo(p)dioxins and furans							
2,3,7,8-TCDD	2.55E-09	2.46E-09	2.55E-09	9.20E-10	3.00E-07	2.00E-07	1.99E-07 (R)
1,2,3,7,8-PCDD	5.52E-09	5.42E-09	5.52E-09	2.05E-09	9.00E-07	8.00E-07	
1,2,3,4,7,8-HxCDD	7.72E-09	7.19E-09	7.32E-09	2.74E-09	2.10E-06	5.00E-07	
1,2,3,6,7,8-HxCDD	8.41E-09	7.85E-09	7.99E-09	2.99E-09	5.00E-06	1.60E-06	
1,2,3,7,8,9-HxCDD	9.91E-09	9.19E-09	9.35E-09	3.50E-09	5.10E-06	5.20E-06	
1,2,3,4,6,7,8-HpCDD	1.77E-07	1.63E-07	1.66E-07	6.22E-08	2.14E-04	3.75E-05	
OCDD	6.56E-07	6.04E-07	6.14E-07	2.30E-07	9.12E-03	3.08E-04	
2,3,7,8-TCDF	2.43E-08	2.29E-08	2.43E-08	8.79E-09	2.00E-07	0.00E+00	3.86E-05 (R)
1,2,3,7,8-PCDF	1.14E-08	1.11E-08	1.14E-08	4.21E-09	1.00E-07	1.00E-07	
2,3,4,7,8-PCDF	1.68E-08	1.65E-08	1.68E-08	6.24E-09	2.00E-07	2.00E-07	
1,2,3,4,7,8-HxCDF	1.83E-08	1.72E-08	1.75E-08	6.56E-09	1.10E-06	6.00E-07	
1,2,3,6,7,8-HxCDF	9.76E-09	9.21E-09	9.36E-09	3.47E-09	7.00E-07	3.00E-07	
1,2,3,7,8,9-HxCDF	1.30E-08	1.25E-08	1.27E-08	4.72E-09	0.00E+00	0.00E+00	
2,3,4,6,7,8-HxCDF	1.90E-08	1.79E-08	1.82E-08	6.76E-09	7.00E-07	5.00E-07	
1,2,3,4,6,7,8-HpCDF	5.26E-08	4.86E-08	4.94E-08	1.85E-08	3.55E-05	9.40E-06	
1,2,3,4,7,8,9-HpCDF	2.99E-08	2.83E-08	2.88E-08	1.07E-08	1.40E-06	4.00E-07	
OCDF	6.07E-08	5.59E-08	5.68E-08	2.13E-08	1.08E-04	3.01E-05	
TEQ (WHO, 1998 TEFs)	3.02E-08	2.95E-08	3.02E-08	1.12E-08	6.23E-06	2.48E-06	

D: SSLs are the minimum of EPA ECO-SSLs if they exist, or the EPA Region 5 ESLs if no ECO-SSL exists; (a) indicates ECO-SSL avian; (m) ECO-SSL mammal; (p) ECO-SSL plant, (R), Region 5 ESL. Available at http://rais.ornl.gov/tools/eco_search.php.

E: EPA Rural survey data are from the Pilot Survey of Levels of Polychlorinated dibenzo-p-dioxins, Polychlorinated dibenzofurans, Polychlorinated biphenyls, and Mercury in Rural Soils of the United States. U.S. EPA, Washington, DC 20460. Report # EPA/600/R-05/048F.

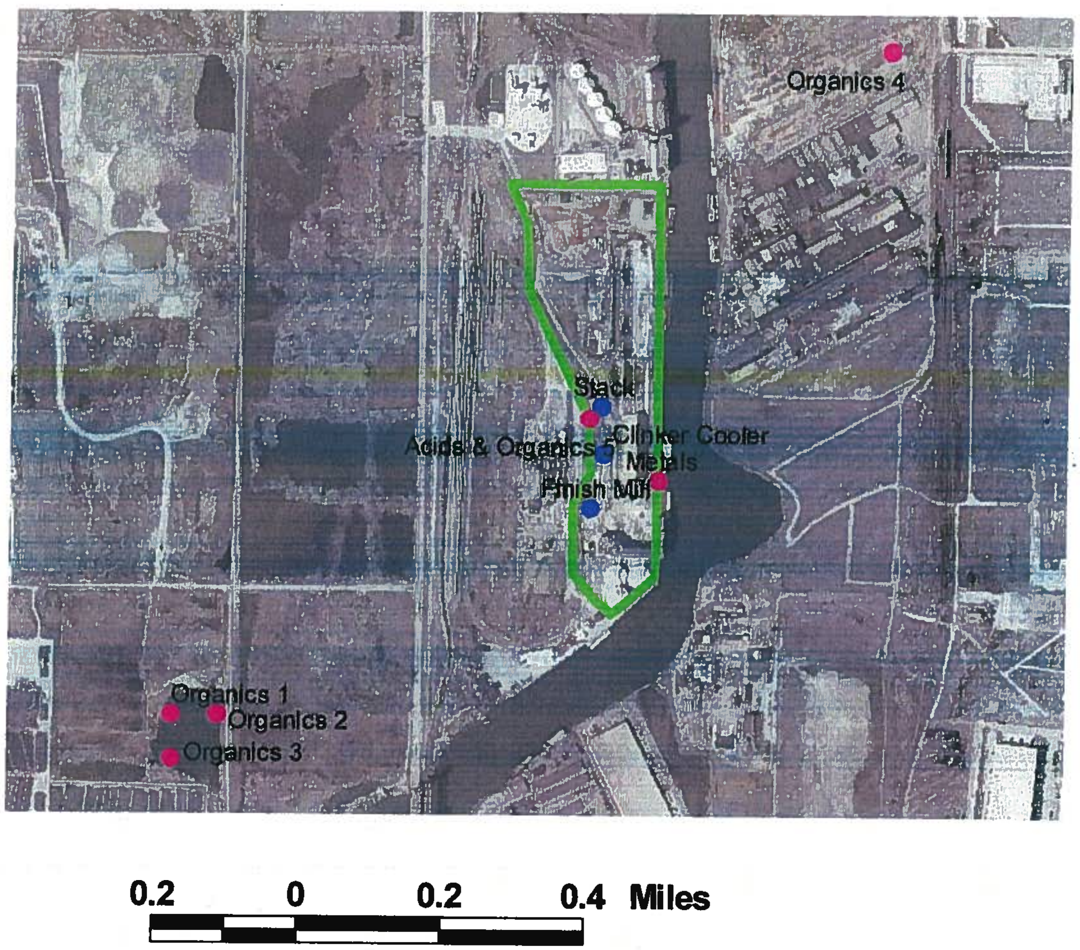

Figure 13 Locations of maximum predicted incremental concentrations in soil. Blue dots indicate the orientation of the main kiln stack, clinker cooler, and finish mill sources within the proposed Universal Cement facility boundary (green outline). Labeled pink dots indicate the maximum soil impacts, with the chemicals in the labeled groups per the following table.

Metals	Organics 1	Organics 2	Organics 3	Organics 4	Acids and Organics 5
Arsenic Beryllium Cadmium Chromium (total) Chromium (hexavalent) Lead Manganese Selenium Mercuric chloride Methyl mercury Total mercury	Acenaphthylene Benzo(b)fluoranthene Biphenyl Fluorene 2-Methylnaphthalene Naphthalene Phenanthrene 2,3,7,8-TCDF	Benz(a)anthracene Chrysene 2,3,7,8-TCDD	Benzo(a)pyrene Benzo(k)fluoranthene bis(2-Ethylhexyl)phthalate 1,2,3,7,8-PCDD 1,2,3,7,8-PCDF 2,3,4,7,8-PCDF PCDD/PCDF TEQ	Benzo(ghi)perylene Bromomethane Dibenz(ah)anthracene Indeno(1,2,3-cd)pyrene 1,2,3,4,7,8-HxCDD 1,2,3,6,7,8-HxCDD 1,2,3,7,8,9-HxCDD 1,2,3,4,6,7,8-HpCDD OCDD 1,2,3,4,7,8-HxCDF 1,2,3,6,7,8-HxCDF 1,2,3,7,8,9-HxCDF 2,3,4,6,7,8-HxCDF 1,2,3,4,6,7,8-HpCDF 1,2,3,4,7,8,9-HpCDF OCDF	Chlorine Hydrogen chloride Fluoride Di-n-butylphthalate Fluoranthene Pyrene

Modeling incremental water body concentrations

Incremental concentrations of compounds in Lake Calumet that are due to emissions from the proposed facility were calculated based on a simple, conservative screening model and, for volatile organic compounds (those with a vapor pressure of 0.1 mm of Hg or greater), a simple bounding calculation based on each compound's Henry's Law constant. The screening model for non-volatile compounds estimates the concentrations as the average deposition flux of each compound over the Lake Calumet watershed divided by the average precipitation flux over the watershed as shown in Equation 10.[21]

Equation 10
$$C_{wtot} = 10 \cdot \frac{Q \cdot [F_v \cdot (Dydv + Dywv) + (1 - F_v)(Dydp + Dywp)]}{P}$$

where the terms are:

C_{wtot}	Total water body compound concentration, including water column and bed sediment (mg/l water column);
Q	Compound emission rate (g/s);
F_v	Fraction of compound air concentration in vapor-phase;
Dydv	Unitized yearly average dry deposition from vapor-phase (s/m^2-yr);
Dywv	Unitized yearly average wet deposition from vapor-phase (s/m^2-yr);
Dydp	Unitized yearly average dry deposition from particle-phase (s/m^2-yr);
Dywp	Unitized yearly average wet deposition from particle-phase (s/m^2-yr);
P	Average annual precipitation (cm/yr); and
10	Units conversion factor (l/cm-m^2).

This screening model will over-estimate incremental concentrations in Lake Calumet because it does not include any loss terms for compounds that might either volatilize or be degraded either in the water itself or from other areas of the watershed, or for compounds that might become bound to soils in the watershed and not enter the lake.

The partitioning of compounds between the water column and the benthic sediments was calculated using Equation 11 through Equation 14 from the HHRAP guidance. The fraction of each compound in the total water body that is within the water column is given by Equation 11.

Equation 11
$$f_{wc} = \frac{\left(1 + Kd_{sw} \cdot TSS \cdot 1\times10^{-6}\right) \cdot {}^{d_{wc}}/_{d_z}}{\left(1 + Kd_{sw} \cdot TSS \cdot 1\times10^{-6}\right) \cdot {}^{d_{wc}}/_{d_z} + \left(\theta_{bs} + Kd_{bs} \cdot C_{BS}\right) \cdot {}^{d_{bs}}/_{d_z}}$$

The balance of each compound in the water body contained within the benthic sediment is then simply expressed as in Equation 12.

[21] The screening-level model provides worst-case estimates of COPC concentrations in water over the long-term as all of the pollutant that deposits in the watershed is assumed to enter surface water.

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Equation 12 $$f_{bs} = 1 - f_{wc}$$

where the terms are:

f_{wc}	Fraction of total water body compound concentration in the water column (unitless);
f_{bs}	Fraction of total water body compound concentration in benthic sediment (unitless);
Kd_{sw}	Suspended sediments/surface water partition coefficient (l water/kg suspended sediment);
TSS	Total suspended solids concentration (mg/l);
1×10^{-6}	Units conversion factor (kg/mg);
d_z	Total water body depth (m);
θ_{bs}	Bed sediment porosity (unitless);
Kd_{bs}	Bed sediment/sediment pore water partition coefficient (l water/kg bottom sediment);
C_{BS}	Bed sediment concentration (g/cm^3 [equivalent to kg/l]);
d_{wc}	Depth of water column (m); and
d_{bs}	Depth of upper benthic sediment layer (m).

The values for total suspended solids concentration TSS of 10 mg/l, θ_{bs} of 0.6, C_{BS} of 1 g/cm^3, and d_{bs} of 0.03 m, are default values from HHRAP Appendix Tables B-4-15 and B-4-16. The water column depth d_{wc} is the difference between the total water body depth d_z and d_{bs}. The partitioning coefficients Kd_{sw}, and Kd_{bs} are compound-specific. The modeled total water body depth d_z of Lake Calumet is 1.83 meters.[22]

The concentration of each compound in the water column (C_{wctot}) (as opposed to within the benthic sediments) is given by Equation 13.

Equation 13 $$C_{wctot} = f_{wc} \cdot C_{wtot} \cdot \frac{d_{wc} + d_{bs}}{d_{wc}}$$

where the terms are:

C_{wctot}	Total compound concentration in water column (mg/l water column);
f_{wc}	Fraction of total water body compound concentration in the water column (unitless);
C_{wtot}	Total water body compound concentration, including water column and bed sediment (mg/l water column);
d_{wc}	Depth of water column (m); and
d_{bs}	Depth of upper benthic sediment layer (m).

Finally the concentrations of compounds within the benthic sediments are given by Equation 14.

[22] NOAA Booklet Chart 14929 "Calumet and Indiana Harbors." The upper section of Lake Calumet is less than 6 feet in depth. Available at: http://ocsdata.ncd.noaa.gov/BookletChart/14929_BookletChart_HomeEd.pdf.

Equation 14

$$C_{sb} = f_{bs} \cdot C_{wtot} \cdot \left(\frac{Kd_{bs}}{\theta_{bs} + Kd_{bs} \cdot C_{BS}} \right) \cdot \left(\frac{d_{wc} + d_{bs}}{d_{bs}} \right)$$

where the terms are:

C_{sb}	Compound concentration sorbed to bed sediment (mg/kg sediment);
f_{bs}	Fraction of total water body compound concentration in benthic sediment (unitless);
C_{wtot}	Total water body compound concentration, including water column and bed sediment (mg/l water column);
Kd_{bs}	Benthic sediments/sediment pore water partition coefficient (l water/kg sediment);
θ_{bs}	Bed sediment porosity (unitless);
C_{BS}	Bed sediment concentration (g/cm^3);
d_{wc}	Depth of water column (m); and
d_{bs}	Depth of upper benthic sediment layer (m).

The distribution fractions, f_{wc} and f_{bs}, have been calculated based on equations described above. The depth of the water column, d_{wc}, the depth of the upper benthic sediment layer, d_{bs}, the bed sediment porosity, θ_{bs}, and the bed sediment concentration, C_{BS},, are HHRAP default parameters described above. The partitioning coefficients, Kd_{sw} and Kd_{bs}, are compound-specific properties from the HHRAP database.

For volatile organic compounds with a vapor pressure of 0.1 mm of Hg or greater, a simple calculation, based on each compound's Henry's Law constant, was used to place an upper bound on the compound's incremental concentration in Lake Calumet, as shown in Equation 15.

Equation 15

$$C_{wtotH} = \frac{C_{aLC} \cdot 24.45}{H \cdot 10^9}$$

where the terms are:

C_{wtotH}	Bounding total water body compound concentration based on Henry's Law constant (mg/l water column);
C_{aLC}	Modeled average air concentration over Lake Calumet watershed ($\mu g/m^3$);
H	Henry's Law constant ($atm\text{-}m^3/mol$);
24.45	Molar gas volume (l/mole); and
10^9	Units conversion factor $[(l/m^3)^2 \times (\mu g/mg)]$.

Table 9 contains the modeled water and sediment concentrations of the compounds in Lake Calumet along with applicable ecological benchmark levels from U.S. EPA, Region 5. The modeled maximum water and sediment impacts in Lake Calumet due to HAPs emissions from the proposed Universal Cement facility are all below the ecological benchmark levels. Thus it is expected that potential emissions from the proposed facility will not have any effect on the water quality of Lake Calumet or its ecosystems.

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Table 9. Modeled water and sediment impacts in Lake Calumet due to Universal Cement emissions, and ecological water and sediment screening levels.

Compound	Water		Sediment	
	Maximum modeled impact (mg/l)	Ecological Screening Level (mg/l)[A]	Maximum modeled impact (mg/kg)	Ecological Screening Level (mg/kg)[A]
Metals				
Arsenic	3.82E-05	1.48E-01	1.85E-05	9.79E+00
Beryllium	2.23E-07	3.60E-03	2.92E-06	
Cadmium	4.63E-06	1.50E-04	5.79E-06	9.90E-01
Chromium (total)	5.02E-04	4.20E-02	1.59E-04	4.34E+01
Chromium (hexavalent)	2.51E-05		7.95E-06	
Lead	2.13E-04	1.17E-03	3.16E-03	3.58E+01
Manganese	1.95E-03		2.12E-03	
Selenium	8.70E-04	5.00E-03	7.26E-05	
Mercury (total)	1.01E-08	1.30E-06	4.23E-06	1.74E-01
Methyl mercury	2.44E-08	2.46E-06	6.11E-07	1.00E-05
Organics				
Acenaphthylene	9.34E-06	4.84E+00	3.12E-05	5.87E-03
Benzene	1.18E-08	1.14E-01	5.17E-10	1.42E-01
Benz(a)anthracene	2.30E-10	2.50E-05	4.33E-08	1.08E-01
Benzo(ghi)perylene	1.87E-10	7.64E-03	9.89E-08	1.70E-01
Benzo(a)pyrene	3.85E-10	1.40E-05	1.44E-07	1.50E-01
Benzo(b)fluoranthene	5.29E-10	9.07E-03	2.07E-07	1.04E+01
Benzo(k)fluoranthene	4.43E-10		1.68E-07	2.40E-01
Biphenyl	2.83E-11		9.65E-11	
Bis(2-ethylhexyl)phthalate	1.62E-06		1.19E-04	
Bromomethane	2.45E-11		2.16E-13	
Carbon disulfide	3.54E-11	1.50E-02	1.21E-12	2.39E-02

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Table 9. Modeled water and sediment impacts in Lake Calumet due to Universal Cement emissions, and ecological water and sediment screening levels.

Compound	Water		Sediment	
	Maximum modeled impact (mg/l)	Ecological Screening Level (mg/l)[A]	Maximum modeled impact (mg/kg)	Ecological Screening Level (mg/kg)[A]
Chlorobenzene	1.59E-11	4.70E-02	2.38E-12	2.91E-01
Chloromethane	1.81E-10		7.55E-13	
Chrysene	4.48E-10		9.19E-08	1.66E-01
Dibenz(ah)anthracene	1.02E-07		5.19E-05	3.30E-02
Di–n-butyl Phthalate	2.26E-07	9.70E-03	2.37E-07	1.11E+00
Ethylbenzene	8.95E-12	1.40E-02	1.22E-12	1.75E-01
Fluoranthene	2.00E-07	1.90E-03	6.30E-06	4.23E-01
Fluorene	1.05E-06	1.90E-02	5.37E-06	7.74E-02
Formaldehyde	5.76E-06		8.65E-09	
Indeno(1,2,3-cd)pyrene	1.92E-10	4.31E-03	1.19E-07	2.00E-01
Methyl ethyl ketone	2.26E-09	2.20E+00	3.01E-12	4.24E-02
Methylene chloride	1.60E-04	9.40E-01	1.07E-06	1.59E-01
Methylnaphthalene, 2-	5.34E-07	3.30E-01	8.83E-07	2.02E-02
Naphthalene	3.19E-04	1.30E-02	2.53E-04	1.76E-01
Phenanthrene	7.22E-06	3.60E-03	1.25E-04	2.04E-01
Phenol	1.14E-06	1.80E-01	2.27E-08	4.91E-02
Pyrene	7.35E-08	3.00E-04	3.17E-06	1.95E-01
Styrene	1.46E-12	3.20E-02	8.90E-13	2.54E-01
Toluene	1.11E-10	2.53E-01	1.04E-11	1.22E+00
Xylene, total	7.22E-11	2.70E-02	1.19E-11	4.33E-01

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Table 9. Modeled water and sediment impacts in Lake Calumet due to Universal Cement emissions, and ecological water and sediment screening levels.

Compound	Water		Sediment	
	Maximum modeled impact (mg/l)	Ecological Screening Level (mg/l)[A]	Maximum modeled impact (mg/kg)	Ecological Screening Level (mg/kg)[A]
Polychlorinated dibenzo(p)dioxins and furans				
2,3,7,8-TCDD	9.72E-14	2.78E-10	6.44E-11	1.10E-05
1,2,3,7,8-PCDD	2.42E-13		1.44E-10	
1,2,3,4,7,8-HxCDD	2.20E-13		1.89E-10	
1,2,3,6,7,8-HxCDD	2.60E-13		2.09E-10	
1,2,3,7,8,9-HxCDD	3.04E-13		2.44E-10	
1,2,3,4,6,7,8-HpCDD	4.93E-12		4.29E-09	
OCDD	1.81E-11		1.58E-08	
2,3,7,8-TCDF	2.01E-12		6.57E-10	
1,2,3,7,8-PCDF	4.44E-13		2.92E-10	
2,3,4,7,8-PCDF	8.25E-13		4.36E-10	
1,2,3,4,7,8-HxCDF	6.23E-13		4.56E-10	
1,2,3,6,7,8-HxCDF	3.29E-13		2.40E-10	
1,2,3,7,8,9-HxCDF	4.48E-13		3.27E-10	
2,3,4,6,7,8-HxCDF	6.41E-13		4.69E-10	
1,2,3,4,6,7,8-HpCDF	1.56E-12		1.28E-09	
1,2,3,4,7,8,9-HpCDF	9.01E-13		7.38E-10	
OCDF	1.68E-12		1.46E-09	
TEQ (WHO, 1998 TEFs)	1.33E-12		7.85E-10	

A. Ecological screening levels are from U.S. EPA, Region 5, RCRA Ecological Screening Levels, August 22, 2003. Available at: http://www.epa.gov/reg5rcra/ca/ESL.pdf. Accessed October 19, 2010.

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Appendix A Soil Characteristics and Properties

More detailed information on the characteristics and properties of soils in the vicinity of the proposed Universal Cement facility follows, as provided in the *Soils of Illinois* publication.[23] The information is taken directly from the *Soils of Illinois* report (a letter "A" has been added to table designations, which numerically correspond to the designations in the *Soils of Illinois* report). The soil descriptions that follow are ordered based on the prevalence of the soil parent materials in the vicinity of the proposed facility, as given in Table 1 of the ESVA/ESA report. In some cases, table numbers do not correspond directly to soil association numbers because of the same lack of correspondence in the *Soils of Illinois* source.

Sparta-Dickinson-Onarga (Soil Association 22)

Soil association 22 occurs in many counties in the central and northern parts of Illinois in areas where very sandy materials have been deposited either by wind or water. Most areas are associated with rivers or streams or glacial outwash plains that had a very high concentration of glacial meltwaters. This association has a total area of 761,000 acres or 2.1 percent of the state's land area.

The soils in this association formed in sandy glacial outwash, sandy alluvium, or aeolian sand, and are mainly sands, loamy sands, and sandy loams. These nearly level to moderately steep soils occur on terraces and uplands. They are dark colored, having developed primarily under prairie. The native vegetation of the poorly drained and very poorly drained soils was probably marsh grasses and some water-tolerant trees. These soils are often located near those of association 50, and are considered to be the dark-colored, prairie counterparts of the light-colored sandy soils of association 50.

These soils typically have moderate to low available-water holding capacity. However, a few of the soils that have thick loamy surfaces or thick loam or clay loam strata in the substratum have good available-water holding capacity. The permeability of the soils in this association is rapid or very rapid in the subsoil or substratum. The surface runoff is typically slow or very slow, although some of the strongly sloping or moderately steep areas have medium runoff. The Ade, Dickinson, Onarga, and Sparta soils are nearly level to moderately steep and formed in aeolian sand and sandy loam. These soils range from excessively drained to moderately well drained, and the depth to the water table is greater than 6 feet. Some nearly level Onarga soils are formed in sandy alluvium and flood on rare occasions. Some areas of the Onarga soils in Carroll County have a dark reddish brown clay loam subsoil. Some areas of the Dickinson soils in Ogle County have a loamy glacial till substratum. The nearly level to gently sloping Disco and Lomax soils are formed in sandy alluvium. They are similar to the Dickinson soils but have a thicker, dark-colored surface layer. The nearly level, gently sloping, somewhat poorly drained Hoopeston, Ridgeville, and Watseka soils formed in sandy alluvium or glacial outwash. The depth to a seasonal water table in these soils is 1 to 3 feet in the spring. The nearly level, poorly drained and very poorly drained Gilford, Granby, and Maumee soils formed in sandy alluvium or glacial outwash. A seasonal water table is at or near the surface of these soils during the spring, sometimes causing them to pond water.

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[23] Fehrenbacher, J.B., J.D. Alexander, I.J. Jansen, R.G. Darmody, R.A. Pope, M.A. Flock, E.E. Voss, J.W. Scott, W.F. Andrews, and L.J. Bushue. 1984. Soils of Illinois. University of Illinois at Urbana-Champaign, Agricultural Experiment Station and the Soil Conservation Service, U.S. Department of Agriculture, Bulletin 778.

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The soils in this association are droughty during the late summer when rainfall is normal or below normal. Subsurface drainage will allow earlier planting on the poorly drained and very poorly drained soils but may increase the drought hazard in late summer. In some areas, the depth of the water table is regulated by means of open ditches with gates that can be opened or closed to regulate the rate of water removal. The sloping areas of some of these soils are susceptible to erosion. In many areas, wind erosion occurs in the spring when the soil surface is unprotected. Fall plowing or tillage should be avoided on these soils; make every effort to keep a vegetative cover on them as long as possible. These soils are poor filters for sewage disposal systems because their subsoils have a relatively low amount of clay. Their moderately rapid or rapid permeability can easily lead to contamination of water supplies. Another result of their low clay content is that they do not hold plant nutrients well. For this reason, the fertility programs for these soils usually must be adjusted to the crop being grown; otherwise, nutrients will be leached down and out of reach of plant roots.

Most areas of these soils are used for cultivated crops. Some areas are irrigated, and are quite often excellent sources of irrigation water. Some of the more sloping areas are used for pasture; a few areas are used for growing Christmas trees. The soils in this association respond well to good management. Various characteristics and the productivity indexes of soils in association 22 are given in Table A.22.

Oakville-Lamont-Alvin (Soil Association 50)

Soil association 50 occurs in many counties around the state. The three major areas are in Kankakee and Mason counties and in the Green River lowland regions of Henry and Lee counties. Many small areas are found in the Wabash River valley. The soils of this association are located in areas where materials high in sand have been deposited either by wind or water from rivers or streams or glacial outwash. This association occupies about 467,700 acres or 1.3 percent of the state's land area.

These soils formed in sandy glacial outwash, sandy alluvium, or sandy aeolian material. In general, they are very sandy and occur on nearly level to very steep terraces and on uplands. These light-colored soils formed under deciduous forest, except for the moderately dark-colored Billett soils, which developed under prairie grasses and widely scattered deciduous trees. Many of the soils in association 50 are the forested counterparts of the dark-colored, sandy soils of association 22.

The soils of this association typically have a moderate to low available-water holding capacity. Two exceptions are the poorly drained Ruark and moderately well to well drained, thick A Alvin soils, which have a high available-water holding capacity. Permeability is rapid or very rapid in the subsoil or substratum of all the soils in this association, except for the Roby, which has moderate to moderately rapid permeability in the subsoil, and the Ruark soils, which have moderately slow to moderate permeability. Surface runoff ranges from very slow to medium. The poorly drained Ruark and somewhat poorly drained Roby soils form a drainage sequence with the well and moderately well drained Alvin soils.

The Alvin, Bloomfield, Chelsea, Chute, Lamont, Oakville, and Plainfield soils are nearly level to very steep and formed in aeolian sand and sandy loams. These soils range from excessively drained to well drained, and the depth to water table is greater than 6 feet. Some areas of the Alvin soils in Alexander County have a thicker surface soil than is typical (Alvin, thick A variant). The very gently sloping to moderately steep, well-drained Billett soils formed in sandy loam alluvium or glacial outwash. The

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nearly level to gently sloping, somewhat poorly drained Morocco soils are formed in sandy or sandy loam glacial outwash or alluvium. The depth to water table is 1 to 3 feet.

Erosion and droughtiness are the main problems with these soils. Wind erosion is frequently a problem in the spring when the soil surface is unprotected. In some areas there is also some erosion by runoff. These soils are drouthy for crops such as corn and soybeans in the late summer when there is a normal or less than normal amount of rainfall. The Ruark soils are the only soils in this association that need drainage. Surface and subsurface drainage will improve yields on Ruark, although there may be problems if tiles are laid in the sandy substratum.

Except for the Roby and Ruark soils, these soils are poor filters for sewage disposal systems. If the soils are used for that purpose, the groundwater may become contaminated because of the low clay content in their subsoils and consequent rapid permeability. Another result of the rapid permeability is that these soils do not hold plant nutrients well and usually require fertilization for the crop being grown. Soil treatments must sometimes be applied in smaller amounts but with more frequency than in soils with higher water- and nutrient-holding capacities.

Most areas of these soils are used for cultivated crops. Some areas have trees growing on them, and the more sloping ones are used for pasture. Some areas are irrigated; many are good sources of water from wells. The characteristics and the productivity indexes of the soil in association 50 are given in Table A.43.

Martinton-Milford (Soil Association 19)

Soil association 19 occurs mainly in east central and northeastern Illinois; there are a few areas in northwestern Illinois in the Green River lowlands, especially in northern Henry County. Most areas are located in old glacial lakebeds formed by glacial moraines or other obstructions to natural drainage such as valley fills. This association occupies about 338,600 acres or 1.0 percent of the state's land area. The largest areas of these lacustrine soils occur in Douglas, Iroquois, eastern Cook, and northern Henry counties.

With the exception of Coyne, which is in part sandy, these soils formed in lacustrine sediments of silt loam, silty clay loam, silty clay, or clay texture. A thin loess cover is present in some areas. The substratum layers are generally lower in clay and higher in sand and silt than the subsoils. However, the very fine-textured Aholt and Booker soils, which are most extensive in northern Henry County, are usually very high in clay throughout their profiles. All of these soils formed under grass and are dark colored. The light-colored, forest soil counterparts of these soils are in association 46.

Most of the soils in this association are nearly level. The larger lake plains often appear as wide, flat expanses. The sandy Coyne and the silty Joslin and Denrock soils, which contain sandy and silty outwash layers as well as heavier lacustrine horizons, occur on low ridges in the lake plain.

The major problems on all of these soils except the Coyne and Joslin are drainage and maintenance of fertility. The Coyne and Joslin soils do not require drainage improvement, and are often subject to erosion, especially on their more sloping portions. The somewhat poorly drained Martinton and the poorly drained Milford soils, which are extensive on many of the nearly flat lakebeds, can be tile drained, although tiles draw a bit slowly in these soils. Areas of these soils are often traversed by deep ditches that serve as tile outlets. The Aholt, Booker, Montgomery, and Denrock soils are too heavy textured and too impermeable in their subsoils to be tiled satisfactorily. Where suitable grades can be developed, these soils are commonly drained by shallow open ditches emptying into deeper ditches.

Improvement and maintenance of the fertility of these soils should be based upon soil tests. Fertility requirements for good crop yields are moderate, although phosphorus supplying power is generally low. Many areas of these soils are fall plowed, especially the flatter areas that tend to be wet in the spring. In general, these soils are moderately to highly productive under high management. Corn and soybeans are the main crops grown in this soil association. Various characteristics and the productivity indexes of the soils in association 19 are given in Table A.19.

Plano-Proctor-Worthen (Soil Association 11)

Soil association 11 occurs principally in the northern and central parts of Illinois but also in some of the counties near the Mississippi and Ohio rivers in southern Illinois. This association has a total area of about 1,859,300 acres or 5.2 percent of the state's land area.

These dark-colored soils occur on nearly level to sloping glacial outwash plains and alluvial terraces. A few occur on sandy loam till or drift plains. The soils in this association formed under grass in various thicknesses of loess or silty material over mainly stratified silty, loamy, or sandy sediments, and range from very poorly drained to well drained. The soils of association 41 are mainly the forested counterparts of soils in association 11.

A number of soil drainage sequences are present in soil association 11. The well and moderately well drained Barrington soils form a drainage sequence with the somewhat poorly drained Mundelein soils and the poorly drained Pella soils. The main area of these three soils is extreme northeastern Illinois. All of these soils formed in loess or silty material and calcareous stratified silty, loamy, or sandy outwash. Barrington soils, which are nearly level and gently sloping, usually occur on crests of ridges and upper parts of slopes. Mundelein soils are also nearly level and gently sloping, but are commonly found lower on slopes than the nearby Barrington soils and on broad, nearly level areas. Pella soils are nearly level or depressional and are generally downslope from the other members of this drainage sequence when they are in the same landscape. Barrington and Pella soils are moderately permeable. Mundelein soils are moderately to moderately slowly permeable.

The well and moderately well drained Proctor soils form a drainage sequence with the somewhat poorly drained Brenton soils and the poorly drained Drummer soils. These soils are common throughout association 11. They are moderately permeable, and some Proctor soils are also moderately rapidly permeable. All of these soils formed in loess or silty material and loamy outwash. Proctor soils occur on the nearly level to strongly sloping parts of the landscape. Drummer soils on the nearly level or depressional parts, and the nearly level Brenton soils are on the intermediate parts.

The well and moderately well drained Plano soils form a drainage sequence with the somewhat poorly drained Elburn soils and the Drummer soils. They are most common in central and western Illinois, or where the loess is thicker (40 to 60 inches) than in the northeastern part of association 11. These soils formed in loess and stratified loamy glacial outwash, alluvial terraces, or sandy loam glacial till. They are moderately permeable. The nearly level to strongly sloping Plano soils occur on side slopes, crests of ridges, and wide, nearly level areas with good underdrainage. Elburn soils occur on nearly level and

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gently sloping parts of the landscape that are usually lower than Plano soils. The poorly drained Drummer soils are on nearly level areas.

The well and moderately well drained Raddle soils form a drainage sequence with the somewhat poorly drained Coffeen soils. These two soils formed in silty alluvium or colluvium typically below steep loess-covered bluffs or on alluvial terraces. They are moderately permeable. Raddle soils are gently sloping or sloping and are commonly located upslope from the nearly level and gently sloping Coffeen soils.

The well and moderately well drained Worthen soils form a drainage sequence with the somewhat poorly drained Littleton soils. These soils are similar to the Raddle and Coffeen soils, but have thicker, dark-colored surfaces. These four soils are most extensive in colluvial positions immediately below the loess bluffs of the Mississippi, Illinois, and, to a lesser extent, the Wabash River valleys. Because most of the sediment is from the thick loess bluff areas, the soils are sometimes referred to as "bluff wash" soils. The Worthen and Littleton soils are moderately permeable and have a dark upper layer more than 24 inches thick. Worthen soils are gently sloping to strongly sloping, and typically occur upslope from the nearly level and gently sloping Littleton soils.

The moderately well drained Prairieville soils form a drainage sequence with the somewhat poorly drained Nachusa soils. These soils formed in loess and loamy material 1 to 3 feet thick on a partially eroded Sangamon paleosol in Illinoian till. They are most extensive in west central Lee County and east central Whiteside County. In most areas, the paleosol was only partially eroded during the melting of the Wisconsinan ice, when its terminals stood in southeastern and eastern Lee and Ogle counties. When the volume of water was decreasing during the later stages of the melting of the Wisconsinan ice, erosion of the till surface ceased, and up to 3 feet of loamy material and loess in which the upper part of these soils formed was deposited.

Brooklyn soils are poorly drained and formed in loess or silty material and loamy outwash. They are nearly level or depressional and have a clayey subsoil that is slowly permeable. Harpster soils are nearly level or slightly depressional and occur on outwash and till plains. They are moderately permeable, poorly drained, and highly calcareous throughout. The Lemond soils are similar to Harpster soils but contain more sand and less clay. Canisteo soils are also similar to Harpster soils in many respects. Even though they are calcareous, however, they do not have as severe fertility problems as Harpster soils because they are not as high in lime. Coyne soils are nearly level to sloping and formed in sandy outwash over loamy and moderately fine-textured lacustrine materials on alluvial terraces. These soils occur on terraces in the Mississippi and adjacent Rock and Green River valleys. They are well and moderately well drained. Coyne soils are rapidly permeable in the upper part and moderately permeable in the lower part. Joslin soils, which are associated with Coyne soils, are nearly level and gently sloping. The upper part of Joslin soils formed in loamy material and the lower part in clayey lacustrine sediments. Joslin soils are well drained and moderate to moderately slowly permeable. The nearly level Knight soils are in closed depressions on till plains, outwash plains, and alluvial terraces. They formed in loess and stratified loamy and sandy materials. Knight soils are poorly drained and moderately slowly permeable. Thorp soils are nearly level or depressional and occur on outwash or till plains and stream terraces. These soils formed in loess or silty material and stratified loamy outwash or sandy loam till. Thorp soils are poorly drained and slowly permeable. Troxel soils are nearly level, and occur in depressions or concave positions on loess-covered outwash and till plains. Troxel soils are

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well and moderately well drained and moderately permeable. The surface layers are over 24 inches thick.

The Waupecan soils are similar to the Plano soils in many respects in the upper part of their profile. In their lower profile, however, the Waupecan soils contain more sand and gravel than the Plano soils.

The major problems with the soils of this association are drainage on wet soils and erosion of sloping soils. Restricted permeability is a problem in a few areas. Most of the wet soils can be drained by tile; open inlets to the tile may be needed in a few places, especially in depressional areas. Erosion control practices are needed on the sloping areas. Most soils in this association are very productive and nearly all are cultivated; corn and soybeans are the principal crops. Various characteristics and the productivity indexes of the soils in association 11 are given in Table A.11.

Morley-Blount-Beecher (Soil Association 44)

Soil association 44 occurs in the upland of northeastern Illinois and occupies about 642,200 acres or approximately 1.8 percent of the state's land area. This soil association occurs principally in Vermilion, Champaign, Grundy, Kankakee, Will, Cook, DuPage, Lake, McHenry, and Kane counties. Its soils are mostly light colored, although it does include two moderately dark-colored prairie-forest transition soils. The soils developed in 0 to 20 inches of loess over silty clay loam glacial till. Both the loess and glacial till are of Wisconsinan glacial age, and the soils are leached and weathered to shallow depths, with lime at depths of less than 42 inches. Soil association 44 occurs near or with the dark-colored soils of association 14, and are considered to be their light-colored analogues.

The major soils in this association range from nearly level to steep; most of the landscape is sloping to strongly sloping. The major soils, Morley, Blount, Beecher, and Markham, developed under native deciduous forest.

The Morley and Blount soils form a toposequence on the landscape, with the Blount soils occupying the more level positions and the Morley soils the more sloping positions. The Blount soils are somewhat poorly drained, and the Morley soils are moderately well drained for the most part, although some are well drained. The permeability of both soils is slow to moderately slow.

The Beecher and Markham soils are included in this soil association because they developed from the same kind of parent materials as the Morley and Blount soils and share the same sequence of horizons in the soil profile. They differ from the Morley-Blount soils in having darker, thicker surface horizons. The Beecher soils occur on nearly level to sloping areas and are somewhat poorly drained. They are transitional between the Blount soils and the Elliott soils of association 14. The Markham soils occur on gently sloping to moderately steep slopes, and most are moderately well drained, although some areas are well drained. These soils are transitional between the Morley soils and the Varna soils of association 14. The permeability of both soils is slow to moderately slow.

The Chatsworth soils are minor in extent in this soil association. They are light colored, having developed under native deciduous forest on strongly sloping to very steep areas. Their permeability is very slow. They are moderately well drained, have relatively thin profiles, and usually have carbonates at less than 10 inches.

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The major problem in this soil association is soil erosion. Some erosion control measures, such as terracing, are sometimes difficult to apply on the sloping soils in this association because short slopes and depressions are often intermingled on the landscape. Conservation tillage is an especially useful means of erosion control. The generally slow permeability of the soils limits tiling on the soils that require drainage. On the more level areas of Beecher and Blount soils, surface drains are recommended. The relatively shallow depth to calcareous silty clay loam till limits root penetration in these soils and is largely responsible for only moderate water-holding capacities and moderate productivity. Erosion on these soils results in substantial loss of productivity. Various characteristics and the productivity indexes of the soils in association 44 are given in Table A.38.

Varna-Elliott-Ashkum (Soil Association 14)

Soil association 14 occurs in the upland of northeastern Illinois and occupies 983,100 acres or approximately 2.7 percent of the land area of Illinois. These dark-colored soils developed in a thin layer of loess over silty clay loam till of Wisconsinan age. The loess is generally less than 20 inches thick. The slopes of the major soils in this association range from nearly level to strongly sloping. The soils developed under prairie vegetation consisting mostly of grasses such as bluestem in the genus *Andropogon*.

The Varna-Elliott-Ashkum soils form a catena or drainage sequence of soils on the landscape. The moderately well drained Varna soils are found predominantly on sloping areas but also occur on gently sloping and strongly sloping areas. The somewhat poorly drained Elliott soils occur on nearly level to gently sloping portions of the landscape at slightly higher elevations and are usually adjacent to the Ashkum soils. The poorly drained Ashkum soils occur in the lower, nearly level to depressional portion of the landscape. All three soils are fine textured and have moderately slow permeability.

The Peotone soil, a significant minor soil in this association, occurs as closed depressional areas that are frequently smaller than 1 acre. This dark soil is poorly to very poorly drained and has moderately slow permeability. Where possible, the depressional areas are usually drained by means of surface ditches or surface inlets into tile.

The Wesley series is another minor soil in this association. It developed in 20 to 40 inches of sandy material over silty clay loam till or silty clay loam to clay loam lacustrine materials. Wesley soils are dark colored and somewhat poorly drained.

The major problems in this soil association are moderately slow permeability, inadequate amounts of phosphorus in the surface soil, and susceptibility to erosion, especially on the sloping Varna soils and the upper range of the gently sloping Elliott soils. Despite their moderately slow permeability, Ashkum and Elliott soils can be drained effectively with tile. These soils are not deeply leached and weathered. Calcareous or limey, unweathered glacial till, which usually occurs at depths of less than 42 inches, tends to restrict root penetration of common farm crops to some extent and accounts for some of the fertility problems and the moderate levels of production on these soils. The rather shallow depth to the limey till makes erosion control especially important on these soils.

Various characteristics and the productivity indexes of the soils in association 14 are given in Table A.14.

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Channahon-Dodgeville-Ashdale (Soil Association 23)

Soil association 23 occurs primarily in two areas of northern Illinois; one is in Stephenson, Winnebago, Ogle, and Lee counties; the other in Cook, DuPage, Grundy, Kankakee, Kendall, and Will counties. A few areas of these soils occur in other counties, but most of them are too small to be shown on the General Soil Map. This association occupies about 197,100 acres or 0.6 percent of the state's land area.

The dark-colored soils of association 23 formed under grass in silty or loamy material that is underlain by limestone or clayey residuum weathered from limestone at depths ranging from less than 10 inches to as much as 60 inches. In some areas the residuum is quite thick (greater than 60 inches), but in others it is entirely absent because of erosion or glacial scouring. Most of the soils are well drained and have moderate permeability, although a few in low-lying areas are poorly drained. The amount of available water in these soils varies, depending on the texture of the upper silty or loamy material and the depth to limestone bedrock.

The soils of this association in which the limestone is generally less than 20 inches deep are used mainly for pasture. A few are essentially unused wasteland. Some level areas that have 20 to 40 inches of permeable material above limestone are cropped, but yields on these soils are usually low because of droughtiness. Areas with limestone depths greater than 40 inches have moderate water-holding capacity and are moderately productive for corn and soybeans.

Because many of the better drained soils in this association are sloping, they are subject to erosion unless proper conservation practices are used in the cropping and land use systems. Erosion is especially damaging on the thinner soils because it permanently reduces the water-holding capacity of the soil above the limestone. Various characteristics and the productivity indexes of the soils in association 23 are given in Table A.23.

Table A.11. Characteristics and Productivity Indexes of Soil Association 11 – Plano-Proctor-Worthen Soils

No. and name of soil series	Slope range (%)	Surface Soil				Subsoil						Sub-stratum texture and material	Available water to 60 inches (in)	Erodibility factor K	Productivity index	
		Avg. thickness (in)	Texture	Avg. OM in plow layer (%)	Lime group	Avg. thickness (in)	Texture	Natural drainage	Permeability	Supply of P	Supply of K				High mgmt.	Avg. mgmt.
443 Barrington	0.7	12	sil	4.0	B	20	sicl-l	Well-mod. well	Moderate	L	M	lo ow.	8.9	0.32	130	108
149 Bremon	0-3	15	sil	4.5	B	33	sicl-cl	SW. poor	Moderate	L	M	lo ow.	11.5	0.28	150	125
136 Brooklyn	0-1	17	sil	3.0	C	36	sicl-sic	Poor	Slow	L	L	lo ow. or till	10.4	0.37	105	82
347 Canisteo	0-2	18	sil-cl	5.0	A	12	cl-sl	Poor	Moderate	L	L	lo ow. or till	10.0	0.28	130	105
428 Coffeen	0-4	13	sil	3.0	B	22	sil	Sw. poor	Moderate	M	M	sil-l wash	10.3	0.32	145	118
764 Coyne	0-12	18	fsl	3.0	c	35	fsl-sicl	Well-mod. well	Rapid-mod.	L	L	s and g ow.	9.2	0.20	105	82
152 Drummer	0-2	15	sicl	6.0	A	33	sicl	Poor	Moderate	L	M	lo ow.	11.7	0.28	150	125
198 Elburn	0-5	13	sil	4.5	B	44	sicl	SW. poor	Moderate	L	M	lo ow. or till	11.8	0.28	155	128
67 Harpster	0-2	15	sicl	5.5	A	24	sicl	Poor	Moderate	L	L	lo wash	11.2	0.28	135	110
763 Joslin	0-6	14	sil	4.0	B	45	sil-sic	Well	Mod.-mod. slow	M	M	sil lac	10.6	0.32	130	108
191 Knight	0-2	32	sil	3.5	B	33	sicl	Poor	Mod. slow	L	M	lo ow.	12.4	0.32	120	98
196 Lemond	0-2	15	fsl	4.0	C	18	scl-l	Poor	Mod. rapid	L	L	san. wash	7.6	0.28	110	90
81 Littleton	0-4	26	sil	3.5	B	20	sil	SW. poor	Moderate	M	M	sil-l wash	13.0	0.32	155	128
442 Mundelein	0-5	12	sil	4.5	B	26	sicl	SW. poor	Mod.-mod. slow	L	M	lo ow.	10.1	0.28	135	115
649 Nachusa	0-3	II	sil	3.5	B	44	cl-sicl	SW. poor	Mod.-mod. slow	M	M	cI paleosol	10.2	0.32	145	120
153 Pella	0-2	13	sicl	5.5	A	25	sicl	Poor	Moderate	L	M	lo ow.	11.2	0.28	140	115
199 *Plano*	*1-12*	12	sil	4.0	B	40	sicl	Well-mod. well	Moderate	M	M	lo ow. or till	11.6	0.32	145	120
650 Prairieville	0-5	12	sil	3.5	B	42	cl-sicl	Mod. well	Mod.-mod. slow	M	M	cI paleosol	10.3	0.32	135	110
148 *Proctor*	0-15	14	sil	3.5	B	35	sicl-cl	Well-mod. well	Mod.-mod. rapid	M	H	lo ow.	11.2	0.32	140	115
430 Raddle	1-8	12	sil	3.0	B	28	sil	Well-mod. well	Moderate	M	M	sil-l wash	12.4	0.32	145	118
206 Thorp	0-1	18	sil	3.5	B	32	sicl	Poor	Slow	L	L	lo ow. or till	11.3	0.37	125	100
197 Troxel	0-2	32	sil	4.0	B	28	sicl	Well-mod. well	Moderate	L	M	lo ow. or till	11.8	0.28	140	118
369 Waupecan	0-7	12	sil	3.5	B	38	sicl-s1	Well-mod. well	Moderate	L	M	gl s-g	8.8	0.32	150	125
37 *Worthen*	1-12	20	sil	3.5	B	25	sil	Well-mod. well	Moderate	M	M	sil-l wash	13.0	0.32	145	120

Table A.14. Characteristics and Productivity Indexes of Soil Association 14 – Varna-Elliott-Ashkum Soils

No. and name of soil series	Slope range (%)	Surface Soil				Subsoil						Sub-stratum texture and material	Available water to 60 inches (in)	Erodibility factor K	Productivity index	
		Avg. thickness (in)	Texture	Avg. OM in plow layer (%)	Lime group	Avg. thickness (in)	Texture	Natural drainage	Permeability	Supply of P	Supply of K				High mgmt.	Avg. mgmt.
232 *Ashkum*	0-3	15	sicl	6.0	A	26	sicl-sic	Poor	Mod. slow	L	H	sicl till	9.6	0.28	135	110
146 *Elliott*	1-3	14	sil	4.5	B	22	sic-sicl	SW. poor	Mod. slow	L	H	sicl till	10.2	0.28	130	102
330 Peotone	0-2	16	sicl	6.0	A	32	sicl	Poor-v. poor	Mod. slow	L	M	sicl till	10.2	0.28	120	100
223 *Varna*	3-12	12	sil	3.5	B	18	sicl-sic	Mod. well-well	Mod. slow	L	M	sicl till	10.0	0.32	125	98
141 Wesley	0-5	13	fsl	3.5	C	30	l-sicl	SW. poor	Mod. rapid-mod. slow	L	M	sicl lac. or till	7.1	0.24	110	88

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Table A.19. Characteristics and Productivity Indexes of Soil Association 19 – Martinton-Milford Soils

No. and name of soil series	Slope range (%)	Surface Soil: Avg. thickness (in)	Surface Soil: Texture	Surface Soil: Avg. OM in plow layer (%)	Surface Soil: Lime group	Subsoil: Avg. thickness (in)	Subsoil: Texture	Subsoil: Natural drainage	Subsoil: Permeability	Subsoil: Supply of P	Subsoil: Supply of K	Sub-stratum texture and material	Available water to 60 inches (in)	Erodibility factor K	Productivity index: High mgmt.	Productivity index: Avg. mgmt.
670 Aholt	0-2	16	sic-c	4.0	A	35	sic-c	Poor	Very slow	L	M	sicl-c lac.	6.4	0.28	75	60
457 Booker	0-2	16	sic-c	4.0	A	30	sic-c	Poor-v. poor	Very slow	L	M	sic1-c lac.	6.3	0.28	80	65
764 Coyne	0-12	18	fsl	3.0	C	35	fsl-sicl	Well-mod. well	Rapid·mod.	L	L	s & g ow.	9.2	0.20	105	82
262 Denrock	0-2	13	sil	4.0	B	35	sic-c1	SW. poor	V. slow-mod. slow	H	M	s1-s ow.	9.2	0.37	110	88
763 Joslin	0-6	14	si1	4.0	B	45	sil-sic	Well	Mod.-mod. slow	M	M	sil lac.	10.6	0.32	130	108
189 *Martinton*	0-5	15	sil-sic1	4.5	B	30	Sid-sic	SW. poor	Mod. slow	L	M	sil-sicl lac.	10.7	0.32	135	110
69 *Milford*	0-2	16	sid	5.5	A	30	Sid-sic	Poor	Mod. slow	L	M	sicl-cl lac.	9.9	0.28	135	112
465 Montgomery	0-1	15	sic-sicl	4.0	A	23	sic	Poor	Slow-v. slow	L	M	sicl-sic lac.	10.0	0.37	115	92
141 Wesley	0-5	13	fsl	3.5	C	30	l-sicl	SW. poor	Mod. rapid-mod. slow	L	M	sicl lac. or till	7.1	0.24	110	88

Table A.22. Characteristics and Productivity Indexes of Soil Association 22 - Sparta-Dickinson·Onarga Soils

No. and name of soil series	Slope range (%)	Surface Soil: Avg. thickness (in)	Surface Soil: Texture	Surface Soil: Avg. OM in plow layer (%)	Surface Soil: Lime group	Subsoil: Avg. thickness (in)	Subsoil: Texture	Subsoil: Natural drainage	Subsoil: Permeability	Subsoil: Supply of P	Subsoil: Supply of K	Sub-stratum texture and material	Available water to 60 inches (in)	Erodibility factor K	Productivity index: High mgmt.	Productivity index: Avg. mgmt.
98 Ade	1-7	19	lfs	1.5	D	35	fs	Well	Rapid	L	L	fs ow.& aeolian	5.0	0.17	90	72
87 *Dickinson*	1·15	15	sl	3.0	c	35	fsl-ls	Well	Mod. rapid -rapid	L	L	s ow. & aeolian	5.8	0.20	105	82
742 Dickinson. loamy sub.	1-12	16	sl	3.0	c	25	s1-ls	Well	Rapid-mod.	L	L	l till	8.3	0.20	110	88
266 Disco	0-5	29	Sl	3.0	c	19	s1-ls	Well	Mod. rapid - rapid	L	L	s ow. & aeolian	6.4	0.24	105	85
201 Gilford	0-2	12	fsl	4.5	c	22	fsl-sl	Poor	Mod. rapid - rapid	L	L	Ls- ow. & aeolian	6.5	0.20	110	90
513 Granby	0-2	10	lfs	2.0	D	22	s	Poor	Rapid	L	L	s ow. & aeolian	4.8	0.17	90	75
172 Hoopeston	0-2	I8	sl	2.5	c	14	sl	sw. poor	Mod. rapid - rapid	M	L	Ls-s ow. & aeolian	6.6	0.28	105	85
265 Lomax	0-5	28	l	3.0	c	22	sl	Well	Mod. rapid	L	M	s ow. & aeolian	9.3	0.28	110	90
89 Maumee	0-1	21	lfs	4.5	D	10	S	Poor	Rapid	L	L	s ow. & aeolian	4.6	0.17	105	82
150 *Onarga*	0-10	16	fsl	3.0	c	29	l-s1	Well-mod. well	Mod.-mod. rapid	M	L	ls- s ow. &	8.6	0.20	110	88
673 Onarga red subs.	0-4	22	fsl	3.0	c	30	l-s1	Well-mod. well	Mod.-mod. rapid	M	L	ls & cl ow. & aeolian	9.4	0.20	100	80
151 Ridgeville	0-5	16	fsl	3.0	c	31	fsl-Is	sw. poor	Mod.-rapid	L	L	ls-s ow. & aeolian	8.8	0.20	120	98
88 *Sparta*	0-12	15	ls	2.0	D	19	s-fs	Well	Rapid	L	L	s ow. & aeolian	4.3	0.17	85	68
49 Watseka	0-3	10	lfs	2.0	D	22	s-fs	SW. poor	Rapid	L	L	s ow. & aeolian	4.8	0.17	95	75

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Table A.23. Characteristics and Productivity Indexes of Soil Association 23 – Channahon-Dodgeville-Ashdale Soils

No. and name of soil series	Slope range (%)	Surface Soil				Subsoil						Sub-stratum texture and material	Available water to 60 inches (in)	Erodibility factor K	Productivity index	
		Avg. thickness (in)	Texture	Avg. OM in plow layer (%)	Lime group	Avg. thickness (in)	Texture	Natural drainage	Permeability	Supply of P	Supply of K				High mgmt.	Avg. mgmt.
411 *Ashdale*	2-20	15	sil	4.0	B	35	Sicl	Well	Moderate	H	H	thin resi. on lims.	10.6	0.32	115	95
661 Atkinson	2-20	13	l	3.0	C	26	Cl	Well	Moderate	M	M	thin resi. on lims.	8.0	0.28	120	98
493 Bonfield	0-5	14	l	4.0	C	9	l-cb sl	SW. poorly	Mod.-mod. rapid	M	M	cbsl on cb	4.8	0.24	120	98
315 *Channahon*	*1-25*	8	sil	2.5	B	10	Sicl	Well-mod. well	Moderate	L	L	limestone	3.6	0.37	80	62
40 *Dodgeville*	0-30	13	sil	4.0	B	15	Sicl	Well	Mod.-mod. slow	M	M	Thick c resi. on lims.	6.9	0.32	105	85
769 Edmund	2-35	10	sil	4.0	B	6	Sic	Well	Mod. slow	L	L	thin resi. on lims.	3.4	0.37	90	72
516 Faxon	0-2	15	cl	4.0	B	19	l-fsl	Poor	Moderate	L	L	limestone	6.1	0.28	110	88
506 Hitt	1-12	12	sil	4.0	B	38	sicl-cl	Well	Moderate	M	M	thin resi. on lims.	10.1	0.32	110	90
314 Joliet	0-4	12	sid	4.5	A	7	Sicl	Poor	Moderate	L	M	limestone	3.5	0.28	90	70
494 Kankakee	0-12	9	fsl	3.5	C	18	sl-cb sl	Well-mod. well	Mod.-mod. rapid	M	L	cbsl on cb lims.	4.0	0.20	115	98
317 Millsdale	0-2	9	sicl	5.0	A	24	c-cl	Poor	Mod. slow	L	M	thin resi. on lims.	5.7	0.32	115	92
240 Plattville	1-5	14	sil	4.0	B	30	l-cl	Well-mod. well	Moderate	M	M	limestone	8.2	0.32	120	98
324 Ripon	1-12	11	sil	4.0	B	23	sicl-cl	Well	Moderate	M	M	thin resi. on lims.	7.4	0.32	110	90
503 Rockton	0-25	12		4.0	C	20	l-scl	Well	Moderate	M	M	thin resi. on lims.	6.6	0.28	105	85
316 Romeo	0-4	6	sil	4.0	B	0	limestone	Poor	Mod. above br.	L	L	limestone	1.3	0.37	30	22
508 Selma. br. sub.	0-6	15	l	5.0	C	25	l-cl	Poor	Moderate	L	M	limestone	7.4	0.28	125	105
504 Sogn	0-15	9	sil	3.0	B	0	limestone	Well	Mod. above br.	L	L	limestone	1.7	0.32	50	40

Table A.38. Characteristics and Productivity Indexes of Soil Association 44 – Morley-Blount-Beecher Soils

No. and name of soil series	Slope range (%)	Surface Soil				Subsoil						Sub-stratum texture and material	Available water to 60 inches (in)	Erodibility factor K	Productivity index	
		Avg. thickness (in)	Texture	Avg. OM in plow layer (%)	Lime group	Avg. thickness (in)	Texture	Natural drainage	Permeability	Supply of P	Supply of K				High mgmt.	Avg. mgmt.
298 *Beecher*	0-6	13	sil	3,0	C	24	sic-sicl	SW, poor	Slow-mod. slow	L	M	sicl till	10.0	0.37	115	90
23 *Blount*	0-6	11	sil	2,0	C	22	sic-sicl	SW. poor	Slow-mod. slow	L	M	sicl till	9.8	0.43	105	82
241 Chatsworth	4-50	5	sic	2.0	C	12	sic-c	Mod. well	V. slow	L	M	sic, c sicl, till or lac.	4.2	0.43	45	38
531 Markham	1-18	10	sil	2.5	C	28	sic-sicl	Mod. well-well	Slow-mod. slow	L	M	sicl till	9.8	0.37	110	88
194 *Morley*	1-35	9	sil	2.0	C	26	sic-sicl	Mod. well-well	Slow-mod. slow	L	M	sicl till	9.6	0.43	105	80

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Table A.43. Characteristics and Productivity Indexes of Soil Association 50 – Oakville-Lamont-Alvin Soils

No. and name of soil series	Slope range (%)	Surface Soil				Subsoil						Sub-stratum texture and material	Available water to 60 inches (in)	Erodibility factor K	Productivity index	
		Avg. thickness (in)	Texture	Avg. OM in plow layer (%)	Lime group	Avg. thickness (in)	Texture	Natural drainage	Permeability	Supply of P	Supply of K				High mgmt.	Avg. mgmt.
131 *Alvin*	1-30	18	fsl	1.0	D	26	l-sl	Well-mod. well	Mod.-mod. rapid	L	L	fs ow. & aeolian	8.4	0.24	105	85
131V Alvin, thick A	0-4	28	fsl	1.0	D	22	l-scl	Well-mod. well	Mod.-mod. rapid	L	L	fs ow. & Aeolian	9.0	0.24	110	90
332 Billett	0-20	8	sl	1.5	D	47	sl	Well	Mod. rapid-rapid	L	L	s ow. & aeolian	7.6	0.20	90	72
53 Bloomfield	1-20	35	fs	1.0	D	22	fs-fsl	Well	Mod. rapid-rapid	L	L	s ow. & aeolian	6.1	0.15	85	65
779 Chelsea	0-20	34	fs	1.0	D	20	fs	Well	Rapid	L	L	s ow. & aeolian	4.5	0.17	70	55
282 Chute	5-40	10	fs	1.0	D	18	fs	Well	Rapid	L	L	s ow. & aeolian	4.0	0.15	60	45
175 *Lamont*	3-25	7	fsl	1.5	D	25	fsl	Well	Mod. rapid-rapid	L	L	lfs ow. & aeolian	7.7	0.24	105	82
501 Morocco	0-2	14	fs	1.0	D	16	fs	SW. poor	Rapid	L	L	fs-s ow. & aeolian	4.3	0.17	90	72
741 *Oakville*	0-50	7	fs	1.0	D	27	fs	Well	Rapid	L	L	fs ow. & aeolian	4.3	0.15	65	55
54 Plainfield	0-30	8	s-ls	1.0	D	12	s	Well	Rapid	L	L	s ow. & aeolian	3.5	0.17	60	48
184 Roby	0-5	10	fsl	1.5	D	22	fsl	SW. poor	Mod.-mod. rapid	L	L	lfs-fsl ow. & aeolian	8.0	0.20	105	85
178 Ruark	0-2	18	fsl	1.5	D	19	cl, scl	Poor	Mod. slow-mod.	L	L	fsl ow. & aeolian	9.5	0.24	105	82

Appendix B EcoCAT Search Results

Results of a search of the Ecological Compliance Assessment Tool (EcoCAT), developed and maintained by the Illinois Department of Natural Resources, are attached. Input to EcoCAT was provided in the form of an interactively digitized outline of the proposed location of the Universal Cement facility. EcoCAT provided as output a listing of the threatened and endangered species and protected habitats that may be in the vicinity of the proposed Universal Cement project.

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EcoCAT
Ecological Compliance Assessment Tool

Applicant:	Universal Cement	*IDNR Project #:*	1106129
Contact:	Stephen Zemba	Date:	12/15/2010
Address:	11702 S Torrence Ave Chicago, IL 60617		

Project: Universal Cement
Address: 11702 S Torrence Ave, Chicago

Description: Portland cement manufacturing facility proposed in the Lake Calumet area

Natural Resource Review Results

This project was submitted for information only. It is not a consultation under Part 1075.

The Illinois Natural Heritage Database shows the following protected resources may be in the vicinity of the project location:

Lake Calumet INAI Site
Wolf Lake INAI Site
Black Tern *(Chlidonias niger)*
Black-Crowned Night Heron *(Nycticorax nycticorax)*
Black-Crowned Night Heron *(Nycticorax nycticorax)*
Blanding'S Turtle *(Emydoidea blandingii)*
Common Moorhen *(Gallinula chloropus)*
Least Bittern *(Ixobrychus exilis)*
Little Blue Heron *(Egretta caerulea)*
Snowy Egret *(Egretta thula)*
Yellow-Crowned Night Heron *(Nyctanassa violacea)*
Yellow-Headed Blackbird *(Xanthocephalus xanthocephalus)*

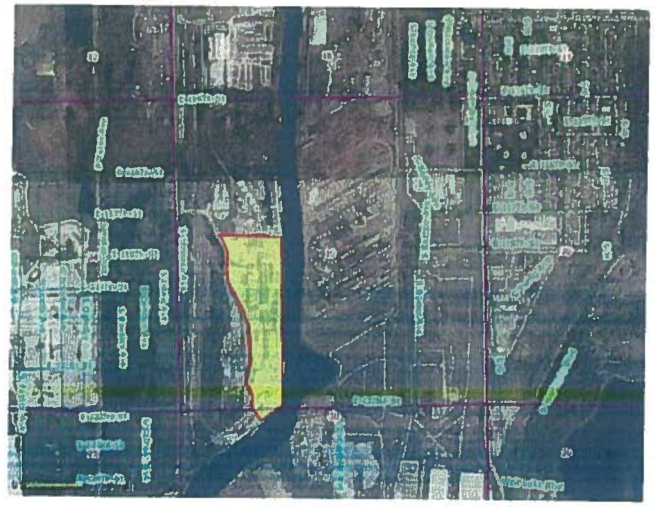
Location

The applicant is responsible for the accuracy of the location submitted for the project.

County: Cook

Township, Range, Section:

37N, 15E, 19 37N, 15E, 30



IL Department of Natural Resources Contact

Impact Assessment Section

217-785-5500

Division of Ecosystems & Environment

Disclaimer

The Illinois Natural Heritage Database cannot provide a conclusive statement on the presence, absence, or condition of natural resources in Illinois. This review reflects the information existing in the Database at the time of this inquiry, and should not be regarded as a final statement on the site being considered, nor should it be a substitute for detailed site surveys or field surveys required for environmental assessments. If additional protected resources are encountered during the project's implementation, compliance with applicable statutes and regulations is required.

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