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

SEP 20 2007

REPLY TO THE ATTENTION OF:

(AR-18J)

Tony Sullins, Field Supervisor
Twin Cities Minnesota Field Office
United States Fish and Wildlife Service
4101 E. 80th Street
Bloomington, Minnesota 55425-1665

Dear Mr. Sullins:

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 (EPA) has reviewed the biological information and analysis related to a Prevention of Significant Deterioration (PSD) permit for Flint Hills Resources, Pine Bend Refinery (FHR) to determine what impact there may be to any threatened or endangered species in the area around the proposed facility. The purpose of this letter is to seek concurrence from the United States Fish and Wildlife Service (USFWS) on our determination that the proposed project is not likely to adversely affect any federally listed species in relation to the proposed air quality permit for this facility.

The parties utilized the informal consultation process as specified in the "Endangered Species Act (ESA) Consultation Handbook, procedures for conducting consultation and conference activities under Section 7 of the ESA, (March 1998 final)", by the USFWS and National Marine Fisheries Service. EPA prepared this biological assessment following the guidance provided in the ESA consultation handbook, as well as the recommended content suggested in the ESA regulations found in 50 CFR Part 402.12(f). As part of developing the biological assessment, the designated representative for EPA prepared a Recommended Scope of Analysis (RSA) for FHR, dated March 27, 2007, describing the general topics of need, species of concern, effects analysis, and literature search, needed in the biological assessment (Enclosure 1). FHR then prepared the April 19, 2007, documents entitled, "Endangered Species Impacts Assessment, Flint Hills Resources, LP – Pine Bend Refinery, In Support of EPA Review of #3 Coker Drum Replacement Project" and an Addendum dated July 2007 (Enclosure 2).

Project Description

FHR is proposing a coker drum replacement project to replace the end-of-life coke drums in their #3 coker unit. The new drums will lead to a small increase in the #3 coker charge rate and associated downstream utilization increases. Other miscellaneous minor physical

changes will be made within the existing coker process units inside the refinery fence line. None of these changes involve the installation of new process units.

Current facility emissions and project emissions are summarized below:

	CO	NO_x	PM	PM_{10}	SO_2	VOC
Actual emissions in 2005 (tons/year)	847	2131	478	312	1046	337
Project emissions (tons/year)	22	76	7	3	20	13

The project also has the potential to emit small amounts of the following hazardous air pollutants: benzene, ethyl benzene, naphthalene, hexane, toluene, xylenes, polycyclic organic matter, and biphenyl.

Action Area

The Pine Bend Refinery is in the city of Pine Bend in Dakota County, Minnesota. EPA considered the area within a 3 kilometer radius of the facility as the action area. EPA would anticipate that the majority of pollutants in the stack emissions would deposit from ambient air within this distance.

List of Species

There were two species listed in the RSA to be considered in this consultation, the Bald eagle (*Haliaeetus leucocephalus*) and the Higgens-eye pearly mussel (*Lampsilis higginsi*). The Bald Eagle was removed from the endangered species list on August 8, 2007 and therefore, FHR did not consider it in its analysis. A quantitative evaluation of potential project impacts was conducted on the Higgens-eye pearly mussel.

Summary of Analysis

FHR performed modeling for emissions associated with the planned project. As recommended by EPA, FHR followed the procedures outlined in Chapter 3 of the EPA, Office of Solid Waste, November 1999, draft document "Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities", (SLERA protocol) to estimate the soil, water and sediment concentrations of the chemicals of interest (COI) associated with this project. The AERMOD model was used to conduct air dispersion and deposition modeling rather than ISCST3. As suggested in the SLERA protocol, AERMOD replaced ISCST3 as EPA's required air dispersion model on December 9, 2006. Chemicals were modeled in the vapor phase, particle phase and/or particle-bound phase depending on their physical and chemical characteristics. Annual air concentrations and deposition rates were estimated with AERMOD. The modeled air concentrations and deposition rates were then used to estimate media specific

concentrations. The approach used to derive media specific COI concentrations was generally conservative. For each COI, the modeled or estimated media-specific concentration (soil, sediment, water) was compared to the most conservative and applicable toxicity reference value (TRV) developed for that media. A more detailed explanation of the modeling performed by FHR is found in Enclosure 2.

ESA Effects Analysis

Criteria Pollutants

Ozone: The project will result in a very small increase in volatile organic compound (VOC) emissions of 13 tons per year. At the current time, EPA is unaware of any reliable means to assess ozone changes through "point source" modeling. Although point source screening models have been developed, they have not been consistently applied with success for source changes of this small magnitude. Such screening models were developed for much larger VOC and NO_x sources and/or emissions changes. Urban scale photochemical ozone models, such as the Urban Airshed Model, could be employed to assess the ambient impact of emission increases as well as emission decreases resulting from the implementation of emissions control programs. Past experience, however, with such models indicates that a VOC change of 13 tons per year would not produce a predicted change in ozone concentrations. The Urban Airshed Model, for example, has been shown to be relatively insensitive to changes in VOC emissions. Past modeling results considering VOC emissions changes on the order of hundreds to several thousand tons per year of VOC major urban areas have shown only modest decreases in predicted peak ozone concentrations. Therefore, it is concluded that such models would likely show a zero ozone change for a VOC increase of 13 tons per year. Based on this information, EPA concludes the project will have no measurable effect, if not, no effect, on the endangered species with respect to ozone. At a minimum, the project is not likely to adversely effect the endangered species as no measurable change in ozone will result from the project.

SO_2: The project will result in an increase in SO_2 of 20 tons per year. The effect of gaseous emissions, other than NO_x, is outside the scope of this Section 7 consultation.

NO_x : The project is estimated to result in a 76 tons per year increase in NO_x emissions. Nitrogen deposition would be a concern mostly for plant species that may occur in the vicinity of this facility. However, no endangered or threatened plant species occur within the action area so nitrogen deposition modeling was not performed.

PM/PM_{10}: The project will result in an increase in PM emissions of 7 tons per year, of which 3 tons per year consist of PM_{10}. The portion of PM/PM_{10} emissions of concern for the potentially affected species would be a hazardous air pollutant (HAP) component.

CO: The project is estimated to result in an increase of 22 tons per year of CO. The effect of gaseous emissions, other than NO_x, is outside the scope of this Section 7 consultation.

Hazardous Air Pollutants (HAPs)

A concentration-toxicity screen was used as an initial evaluation of the potential to cause adverse health effects in ecological receptors to identify the subset of HAPs that are quantitatively evaluated in the screening analysis.

The emphasis of the ESA screening analysis was on the potential for long-term adverse effects to the habitats of interest, constituent transfer through food webs, and chronic health effect in the species of interest. The COI were identified as benzene, biphenyl, ethylbenzene, hexane, napththalene, polycyclic organic matter (POM), toluene and xylenes. Due to the lack of media-specific toxicity benchmarks for POM compounds as a group, total polycyclic aromatic hydrocarbons (PAHs) as a group was selected as a surrogate to represent all POM compounds because PAHs are a major part of POM and toxicity benchmarks are available.

The pathways evaluated in the SLERA for ecological impacts were exposure to soil, surface water and sediments. Annual air concentrations and deposition rates were estimated with AERMOD and then used to estimate media-specific concentrations. For each COI, the modeled media-specific concentration (soil, sediment, water) was compared to the most conservative and applicable TRVs developed for that media. If the COI's estimated environmental concentration was less than the TRV, expressed as the ecological screening quotient (ESQ) (EEC/TRV < 1.0), the specific chemical is not likely to cause an adverse impact on ecological receptors at the modeled concentration. If the modeled concentration is above the toxicity benchmark, additional analysis is warranted.

The modeling performed for soil, surface water and sediment exposure pathways, all chemical specific ESQs and hazard indices were below 1.0 indicating that, even when using conservative models, adverse impacts to ecological receptors including threatened and endangered species associated with emissions of the COIs are not likely to occur.

Background concentrations of COIs in air, soil and surface water for which data were available show that modeled or estimated concentrations are a small percent of background concentrations. The modeled/estimated concentrations do not add significantly to background conditions, indicating that the project is not likely to increase the risk for adverse effects to ecological receptors over existing background.

ESA Determination

A screening-level ecological risk analysis was conducted to assess the potential impacts from the potential to emit fugitive air emissions that could be emitted from the #3 coker drum replacement project. The conservative risk analysis results indicate that the project is unlikely to result in adverse impacts to ecological receptors including federally-listed threatened and endangered species. The proposed project has no land-disturbing impacts within habitat or immediately adjacent to known locations of listed species, does not result in an increased discharge to streams or other waterways, has low emissions of COIs and small estimated media concentrations that are below screening levels thresholds of concern.

Considering this analysis in its entirety, EPA concludes that the proposed construction and operation of this facility may affect, but is not likely to adversely affect, any of the threatened and endangered species. EPA respectfully requests USFWS concurrence on this determination.

Sincerely yours,

Pamela Blakley

Pamela Blakley, Chief
Air Permits Section

Enclosures

standard bccs: official file copy w/attachment(s)
originator=s file copy w/attachment(s)
originating organization reading file w/attachment(s)

other bccs:

ARD:APB:APS: :01/25/05
DISKETTE/FILE: Jdarrow/epawork/flint hills.bio-assess

Enclosure 1

Recommended Scope of Analysis for Flint Hills Resources, Pine Bend Refinery, Pine Bend, Minnesota
Endangered Species Act Consultations
March 27, 2007

Purpose of analysis:

The analysis is intended to determine whether the proposed project at Flint Hills Resources, Pine Bend Refinery (FHR), is likely to directly or indirectly adversely affect federally listed species. This recommended scope of analysis or roadmap recommends using USEPA's ecological risk assessment process to inform the decision points in section 7 of the Endangered Species Act. Portions of the USEPA's draft Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (EPA 530-D-99-001A) provides useful guidance for this analysis. Although this guidance was designed specifically to assess the impact of hazardous waste combustion facilities, it offers general approaches for assessing the fate of chemicals released to the air that can be applied to all types of industrial facilities.

Overall, the evaluation should focus on emissions from the facility. To complete this analysis we need an understanding of the background concentrations and deposition patterns. The anticipated emissions from permitted but not yet operational facilities should be included in background. The anticipated concentration in air or deposition at sites supporting listed species should be compared against NOEL (No observed effects level) benchmarks thought to be protective of the appropriate group (e.g., plants). The evaluation should look at the incremental addition in the context of background concentrations.

Benchmarks:

For these analyses, commonly accepted NOEL (no observed effects levels) benchmarks should be used. Where more than one benchmark can be found, the most conservative value should be used, unless an explanation is given to justify a less conservative benchmark. When there is no commonly accepted benchmark, there should be a search of the scientific literature for relevant toxicity information to provide a basis for risk assessment for the species of concern.

Modeling protocol:

Modeling should follow the general guidance provided in Chapter 3 of USEPA's SLERA protocol for assessing chemical fate and transport. The modeling should show air concentrations and deposition rates for all pollutants (where appropriate). The air emissions resulting from the project should be modeled at the facility level, not on a unit basis. Total impacts should be evaluated looking at the combined effects of the vapor phase, particle phase and particle-bound phase of pollutants. ISCST3 is an acceptable model for this analysis. For chemicals amenable to deposition, models in the SLERA guidance should be used to estimate concentrations in soil, surface water, and sediment in conjunction with relevant fate and transport parameters.

Background Levels:

Site specific background concentrations in air, soil, water and sediment should be considered in the effects analysis.

Suite of pollutants to consider:

The assessment should cover all air pollutants emitted from the facility including ozone, sulfur compounds, oxides of nitrogen, carbon monoxide, particulates, and hazardous air pollutants. USEPA will provide the analysis for ozone for this project.

Types of impact to consider:

1) Long term, depending upon pollutant. Compare the worst year of concentrations in air or deposition on soil (over the last 5 years) with appropriate bench marks for chronic effects.
2) Direct effects to listed plants and animals from exposure to the vapor phase, particle phase and particle-bound phase of pollutants.
3) The indirect effects to animals from ingestion of plants, fish, and invertebrates that have accumulated these pollutants.

Listed Species:

The Bald Eagle (Haliaeetus leucocephalus), which is listed at threatened under the Endangered Species Act nests within 3 kilometers (km) of this facility. In addition, the Mississippi River occurs within 3 km of the facililty. Higgins eye (Lampsilis higginsii), and endangered freshwater mussel, occurs in the river just downstream near Hastings, Minnesota. Both of the aforementioned species should be considered relative to this action.

Enclosure 2

July 17, 2007

Ms. Jennifer Darrow
US EPA Region 5
77 West Jackson Boulevard
Mail Code: AR-18J
Chicago, IL 60604-3507

**RE: Flint Hills Resources, LP– Pine Bend Refinery
Revised Endangered Species Impacts Assessment for the #3 Coker Drum Replacement Project**

Dear Ms. Darrow:

Please find the revised report on compact disk including modeling information providing the endangered species impacts assessment for the #3 Coker Drum Replacement Project in accordance with the conference call between FHR, yourself and Mr. Phil Delphey on June 12, 2007.

As described in the April 19, 2007 submittal and confirmed in the revised report, the #3 Coker Drum Replacement Project will not result in adverse impacts to Federal- or State-listed species for numerous reasons. The project has no ground-disturbing impacts within habitat or known locations of listed species, has no discharge to streams or other waterways, has small emissions of COI and small estimated media concentrations that are below screening level thresholds of concern.

If you have any questions about this submittal, please contact me directly at 651-437-0541.

Sincerely,

Nathan H. Kowalsky
Air Permitting Engineer
Flint Hills Resources

Encl.

cc: Mr. Phil Delphey, USFWS

Endangered Species Impacts Assessment

Addendum 01 to April 19, 2007 Submittal

Flint Hills Resources, LP – Pine Bend Refinery

In Support of USEPA Review of the #3 Coker Drum Replacement Project

July 2007

Endangered Species Impacts Assessment

Addendum 01 to the April 19, 2007 Submittal

Flint Hills Resources, LP – Pine Bend Refinery

In Support of USEPA Review of the #3 Coker Drum Replacement Project

July 2007

Table of Contents

Executive Summary

On April 19, 2007 Flint Hills Resources, LP (FHR) submitted a qualitative assessment of potential impacts on federally listed threatened and endangered species from the #3 Coker Drum Replacement Project (project) to the U.S. Environmental Protection Agency (USEPA). That analysis focused on the Bald Eagle (*Haliaeetus leucocephalus*) and the Higgins-eye pearly mussel (*Lampsilis higginsi*) per USEPA guidance. On June 12, 2007 the USEPA and the U. S. Fish & Wildlife Service (USFWS) requested via conference call additional quantitative information on the potential ecological risk associated with fugitive emissions from the project. During the discussions with USEPA and USFWS staff, FHR emphasized the following:

- Only a small number of chemicals are potentially emitted from the project and they are fugitive emissions: benzene, biphenyl, ethylbenzene, hexane, naphthalene, polycyclic organic matter (POM), toluene, and xylenes.
- Mercury air emissions are not expected to be associated with the project.
- Mercury contamination of fish is a priority issue for state and federal agencies. The fish consumption pathway is of most importance for the Bald Eagle.
- Because mercury air emissions are not associated with the project, FHR recommended that a food chain assessment for the Bald Eagle is not needed.

The USEPA and USFWS staff subsequently agreed that a food chain analysis for the Bald Eagle was not needed and the food chain analysis should focus on the Higgins-eye pearly mussel. Following USEPA guidance for ecological risk analysis, a quantitative evaluation of potential project impacts was conducted and the results are provided in this Addendum.

The primary objective of the quantitative screening level ecological risk assessment (SLERA) conducted by FHR is to provide the USEPA and USFWS with information regarding the potential for the project's air emissions to adversely effect ecological receptors, and specifically the Higgins-eye pearly mussel (*Lampsilis higginsi*). Additionally the SLERA provides information on background concentrations in air, soil, surface water, and sediments where such information was available.

Major components of the SLERA include the following:

- Chemicals of Interest (COI) are as follows: benzene, biphenyl, ethylbenzene, hexane, naphthalene, polycyclic organic matter (POM), toluene, and xylenes. Due to the lack of media-specific toxicity benchmarks for POM compounds as a group, total polycyclic aromatic hydrocarbons (PAHs) as a group was selected as a surrogate to represent all POM compounds because PAHs are a major part of POM and toxicity benchmarks are available.

- The pathways evaluated in the SLERA for ecological impacts were exposure to soil, surface water and sediments.

- AERMOD was used to conduct air dispersion and deposition modeling. Chemicals were modeled in the vapor phase, particle phase and/or particle-bound phase depending on their physical and chemical characteristics. Annual air concentrations and deposition rates were estimated with AERMOD.

- The modeled air concentrations and deposition rates were then used to estimate media specific concentrations. The approach used to derive media specific COI concentrations was generally conservative.

- For each COI, the modeled or estimated media-specific concentration (soil, sediment, water) was compared to the most conservative and applicable toxicity reference value (TRVs) developed for that media. TRVs are generally used as a simple and conservative method for identifying a potential for harm and the need for more detailed evaluation. If a COI's estimated environmental concentration (EEC) does not exceed the TRV ($EEC \div TRV \leq 1.0$, which is expressed as the Ecological Screening Quotient, ESQ), the specific chemical is not likely to cause an adverse impact on ecological receptors at the estimated or modeled concentration. If the estimated concentration is above the toxicity benchmark additional analysis is warranted. It must be noted that an ESQ greater than 1 does not necessarily indicate an adverse ecological impact.

- For a specific ecological receptor that might be exposed to multiple chemicals, this analysis assumes additivity. For each media, the individual ESQs were added to derive a Hazard Index (HI). Typically, only the chemicals affecting the same species or having the same toxic effects are added together. This summing of ESQs without regard for receptor type or toxic effect is conservative and likely overestimates the potential ecological effects from multiple chemicals.

Results

Soil Exposure Pathway - All chemical specific ESQs (highest ESQ: toluene = 0.27) as well as the HI (HI = 0.58) in soil were below 1.0 indicating that, even when using conservative models, adverse impacts to ecological receptors including threatened and endangered species (e.g., Higgins-eye pearly mussel) associated with emissions of the COIs are not likely to occur.

Surface Water Exposure Pathway - All chemical specific ESQs (highest ESQ: Hexane = 0.00022) as well as the HI (HI = 0.00036) in surface water were below 1.0 indicating that, even when using conservative models, adverse impacts to ecological receptors including threatened and endangered species (e.g., Higgins-eye pearly mussel) associated with emissions of the COIs are not likely to occur.

Sediment Exposure Pathway - All chemical specific ESQs (highest ESQ: Xylene = 1.02E-09) as well as the HI (HI = 2.57E-09) in sediments were below 1.0 indicating that, even when using conservative models, adverse impacts to ecological receptors including threatened and endangered species (e.g., Higgins-eye pearly mussel) associated with emissions of the COIs are not likely to occur.

Comparison to Background Conditions – Background concentrations for the COIs were not available for surface soils. Background concentrations of COIs in air, soil, and surface water for which data were available show that modeled or estimated concentrations are a small percent of background concentrations. The modeled/estimated concentrations do not add significantly to background conditions, indicating that the project is not likely to increase the risk for adverse effects to ecological receptors over existing background.

Conclusion

Media concentrations for the VOC fraction of the fugitive emissions are likely overestimated by orders of magnitude resulting in an over-estimation of potential risk. Taking this conservatism into account, when considering all significant potential pathways—soil exposure, surface water exposure, and sediment exposure—for assessing the potential for ecological effects, potential to emit fugitive emissions from the #3 Coker Drum Replacement Project are not likely to pose a risk to ecological receptors including threatened and endangered species.

1.0 Introduction

On April 19, 2007 Flint Hills Resources, LP (FHR) submitted a qualitative assessment of potential impacts on federally listed threatened and endangered species from the #3 Coker Drum Replacement Project (project) to the U.S. Environmental Protection Agency (USEPA). That analysis focused on the Bald Eagle (*Haliaeetus leucocephalus*) and the Higgins-eye pearly mussel (*Lampsilis higginsi*) per USEPA guidance contained in the "Roadmap" document for the project. On June 12, 2007 the USEPA and the U. S. Fish & Wildlife Service (USFWS) requested additional quantitative information via conference call on the potential ecological risk associated with fugitive emissions from the project. During the discussions with USEPA and USFWS staff, FHR emphasized the following:

- Only a small number of chemicals are potentially emitted from the project and they are fugitive emissions: benzene, biphenyl, ethylbenzene, hexane, naphthalene, polycyclic organic matter (POM), toluene, and xylenes.
- Mercury air emissions are not expected to be associated with the project.
- Mercury contamination of fish is a priority issue for state and federal agencies. The fish consumption pathway is of most importance for the Bald Eagle.
- Because mercury air emissions are not associated with the project, FHR recommended that a food chain assessment for the Bald Eagle is not needed.

The USEPA and USFWS staff subsequently agreed that a food chain analysis for the Bald Eagle was not needed and the quantitative analysis should focus on the Higgins-eye pearly mussel. Following USEPA guidance for ecological risk analysis, a quantitative evaluation of potential project impacts was conducted and the results are provided in this Addendum.

The primary objective of the quantitative screening level ecological risk assessment (SLERA) conducted by FHR is to provide the USEPA and USFWS with information regarding the emissions potential for generating adverse effects to ecological receptors and specifically the Higgins-eye pearly mussel (*Lampsilis higginsi*). Additionally the SLERA provides information on background concentrations in air, soil, surface water, and sediments where such information was available.

Chemicals potentially emitted may be deposited on soil and surface water, where they may transfer to sediments. Once deposited, they may come into contact with ecological receptors. The pathways evaluated in the SLERA for ecological impacts were exposure to soil, surface water and sediments.

In the SLERA, the potential for environmental effects associated with chemicals in surface soils, surface water, and sediments is estimated by modeling chemical-specific concentrations in these media and comparing those concentrations to available toxicity reference values (TRVs) developed for these media. The procedures used in the SLERA were generally based on methodologies defined in various USEPA Guidelines for Ecological Risk Assessments.

The TRVs used in the SLERA are media specific and used to screen ecological effects to receptors inhabiting soil, surface water, and sediment. The approach used to develop the media specific TRVs was to base the criteria on those species, among those tested, that are more sensitive to the COI. Using this approach, the criteria are thought to be protective of all species. TRVs are generally used as a simple and conservative method for identifying a potential for harm and the need for more detailed evaluation.

To derive an estimate of a chemical's concentration in various media at specific receptor locations air dispersion and deposition modeling was conducted, using AERMOD, EPA's preferred air dispersion model. Chemicals were modeled in the vapor phase, particle phase and/or particle-bound phase depending on their physical and chemical characteristics. The modeled air concentrations and deposition rates were then used to estimate media specific concentrations.

2.0 Overview of the SLERA Approach

This SLERA is a multi-pathway screening ecological risk assessment based on reasonable, protective assumptions about the potential for ecological receptors to be exposed to, and to be adversely affected by, fugitive emissions from the # 3 Coker Drum Replacement Project. The SLERA process is a prescriptive analysis intended to be performed using (1) measurement receptors representing food web-specific class/guilds and communities, and (2) readily available exposure and ecological effects information.

This initial screening analysis is focused on the potential ecological impacts of chemicals emitted to air as fugitive emissions from the # 3 Coker Drum Replacement Project and their subsequent deposition to soil, surface water, and sediments. The potential fugitive emissions are from expected normal and typical operations and this is reflected in the potential to emit estimates. In addition, it is assumed that the meteorology data and other climate related data, including precipitation data, used in the dispersion and deposition modeling are representative of current typical conditions and also of potential future conditions. Metrological data from 1986 through 1999 were used in the dispersion and deposition modeling.

In general terms, the potential for adverse impacts to ecological receptors risk is a comparison of the toxicity of a chemical with the exposure to that chemical. Risk is dependent on toxicity and exposure and to alter either, alters the risk. The toxicity of a chemical is established by the TRV. The potential exposure of ecological receptors to the potential to emit air emissions from the # 3 Coker Drum Replacement Project is based on the chemical specific concentrations in each affected media (soil, surface water, sediment). The estimated chemical-specific concentration in each media is compared to the media specific TRV to derive an Ecological Screening Quotient (ESQ).

3.0 Chemicals of Interest

Chemicals of interest (COIs) were identified in the April 19, 2007 Endangered Species Impacts Assessment (Barr, 2007 –Table 3) These chemicals are benzene, biphenyl, ethylbenzene, hexane, naphthalene, polycyclic organic matter (POM), toluene, and xylenes. Due to the lack of media-specific toxicity benchmarks for POM compounds as a group, total polycyclic aromatic hydrocarbons (PAHs) as a group was selected as a surrogate because PAHs are a major part of POM and toxicity benchmarks are available.

The potential to emit estimates of HAPs from the new process components associated with this project at the #3 Coker unit is described in the April 19, 2007 Endangered Species Impacts Assessment Report (Barr, 2007). The emissions listed in that document are provided in Table 3-1. The listed emission rates are based on the application of very conservative emission factors

Table 3-1. Emission estimates for the Chemicals of Interest from the #3 Coker Drum Replacement Project at the Flint Hills Resources, LP, Pine Bend Refinery, Minnesota.

Chemical Of Interest (COI)	Emissions (tons/yr)
Benzene	0.016
Ethylbenzene	0.096
Naphthalene	0.037
Hexane	0.220
Toluene	0.305
Xylenes	0.582
Polycyclic Organic Matter	0.084
Biphenyl	0.004
Total	1.344

4.0 Estimating Media Concentrations

4.1 Air Concentrations and Deposition Rates

The air dispersion and deposition modeling conducted for this SLERA used the current version of AERMOD (07026). Specifics on the modeling include the following:

- The elevated terrain and urban model settings were selected with a population estimate of 500,000.
- The fugitive emissions associated with the project were originally listed in Table 3 of the April 19, 2007 Endangered Species Impacts Assessment Report previously submitted to USEPA. These fugitive emissions were modeled from a single volume source. Table 4-1 lists the model input parameters and emissions for the ecological risk analysis.
- The fugitive emissions were modeled for five individual years using Minneapolis, MN AERMET data for 1986 through 1990. The meteorological data were obtained from the Minnesota Pollution Control Agency (MPCA) website.
- The receptor grid used for this risk analysis was the same receptor grid used by FHR for the SO_2 State Implementation Plan (SIP) modeling submitted in February 2006 because it provided a high number of receptor locations along the Refinery's property boundary and extended beyond the Mississippi River (i.e., the water body of concern in this analysis). Figure 4-1 shows the coverage of the entire SIP receptor grid.

Table 4-1. Modeling parameters and emissions for the screening-level ecological risk analysis conducted for the #3 Coker Drum Replacement Project proposed for the Flint Hills Resources, LP, Pine Bend Refinery in Minnesota.

Coker #3 Modeling Inputs	Source Inputs	Benzene (tpy)	Ethylbenzene (tpy)	Naphthalene (tpy)	Hexane (tpy)	Toluene (tpy)	Xylenes (tpy)	Polycyclic Organic Matter (tpy)	Biphenyl (tpy)
X coordinate (m)	496541	0.016	0.096	0.037	0.22	0.305	0.582	0.084	0.004
Y coordinate (m)	4956924								
Elevation (m)	287								
Release height (m)	6.1								
Initial Lateral Dimension (m)	17.3								
Initial Vertical Dimension (m)	2.8								

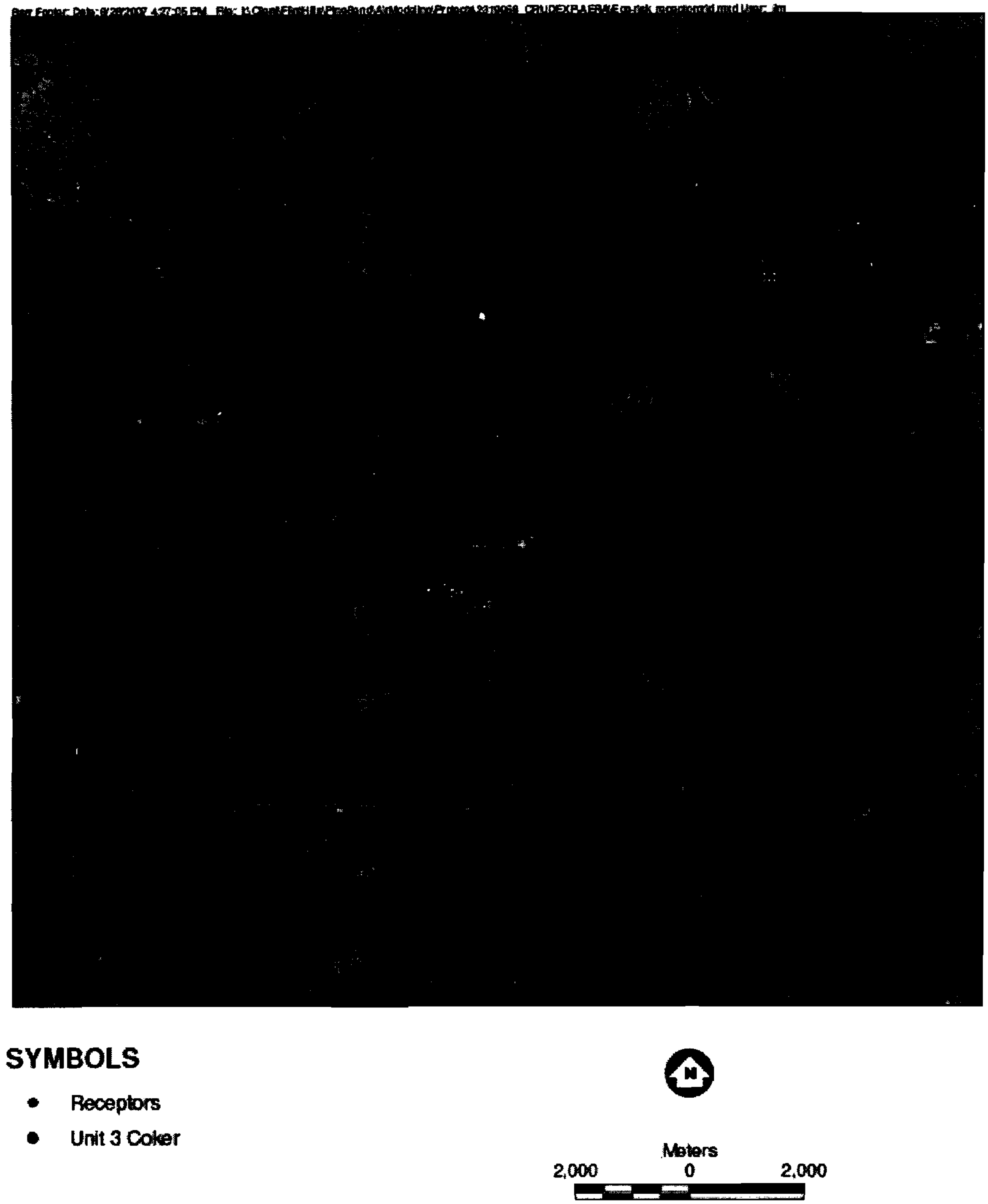

Figure 4-1. Air dispersion modeling receptor grid used in the screening-level ecological risk analysis conducted for the #3 Coker Drum Replacement Project proposed for the Flint Hills Resources, LP, Pine Bend Refinery in Minnesota.

AERMOD was used to estimate ambient air concentrations for the COI, as well as deposition to soil, water, and sediment. The potential to emit fugitive emissions associated with the #3 Coker unit are vapor leaks from piping, so the volatile emissions listed in Table 3-1 are modeled with the gas deposition AERMOD setting. Polycyclic Organic Matter (POM) is emitted from the fugitive leaks as a vapor but is expected to quickly convert to the particle-bound phase. For this reason POM is modeled using the particle deposition setting in AERMOD. The following paragraphs describe the modeling inputs used to model both particle and gas deposition in AERMOD.

Gas Deposition Modeling Inputs

The non-default setting of gas deposition was used in AERMOD to calculate the potential deposition of chemicals into the Mississippi River. This gas deposition model setting in AERMOD requires specific physicochemical information of each chemical to be modeled. Required gas deposition information in the AERMOD control options settings are 1) defining the land use categories surrounding the facility (Figure 4-2) and 2) assigning each calendar month (January, February, etc.) to a season (winter, summer, spring, fall).

The land use categories were defined using 2001 NLCD (National Land Cover Data) within a 3 kilometer radius, centered on the approximate location of the#3 Coker unit, divided into 10 degree radial segments (Table 4-2). The land use category with the largest area in each 10-degree segment was selected as the representative land use and input to AERMOD. The default seasonal values in AERMOD for each month were used in this analysis, with the exception that December was set as a winter season and not late autumn.

The source option settings required in AERMOD for gas deposition modeling is specific to each chemical being modeled. The physicochemical property parameters required for each chemical are: diffusivity in water (cm^2/s), diffusivity in air (cm^2/s), cuticular resistance (s/cm), and Henry's Law constant ($Pa\text{-}m^3/mol$). These parameters were obtained from the EPA SCRAM website (http://www.epa.gov/scram001/dispersion_prefrec.htm#rec.), AERMOD Deposition Parameterizations Document", in the AERMOD Modeling System section under the title "Model Supporting Documents", Appendices C and D.

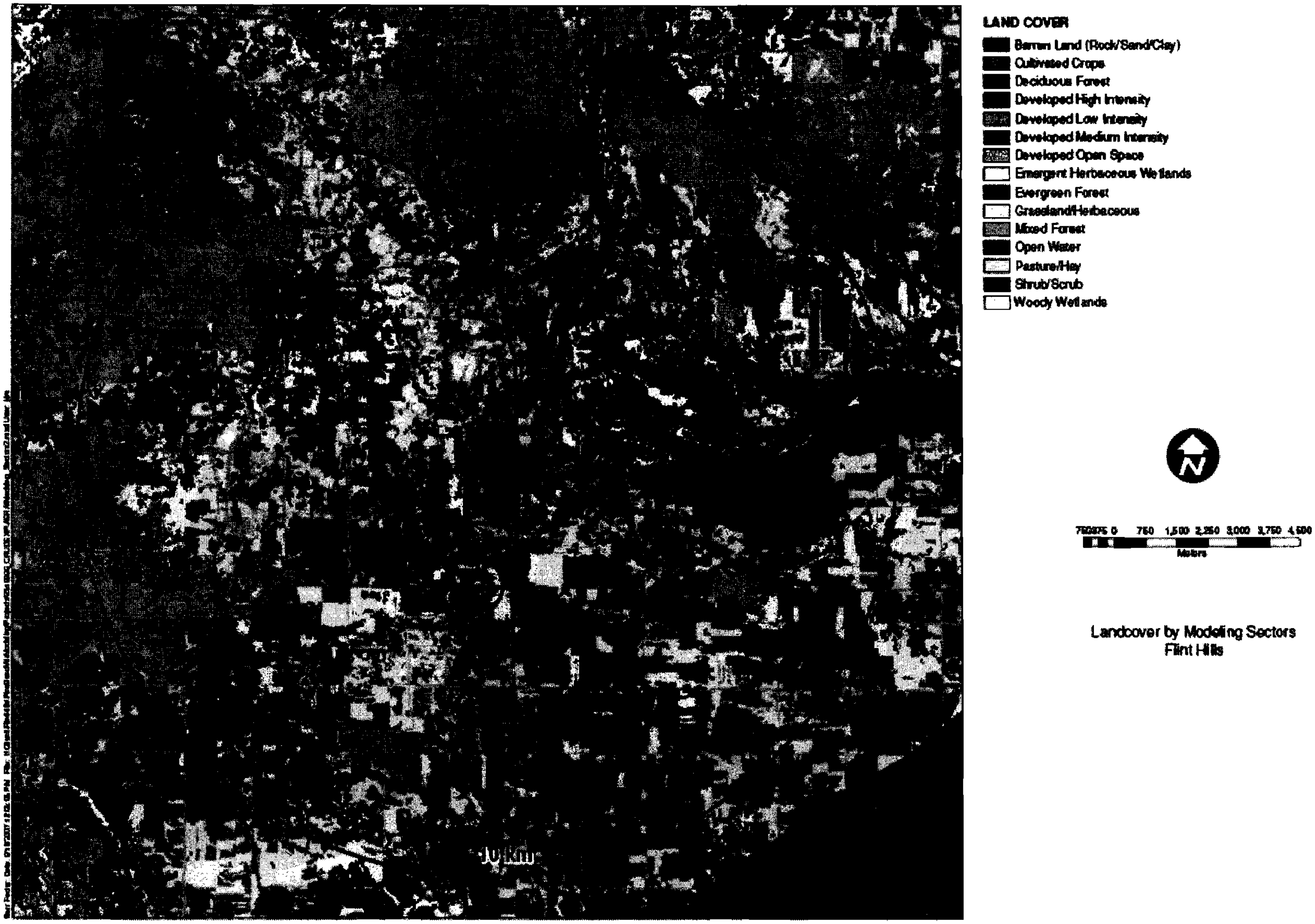

Figure 4-2. Land use within 10 kilometers of the Flint Hills Resources, LP, Pine Bend Refinery in Minnesota.

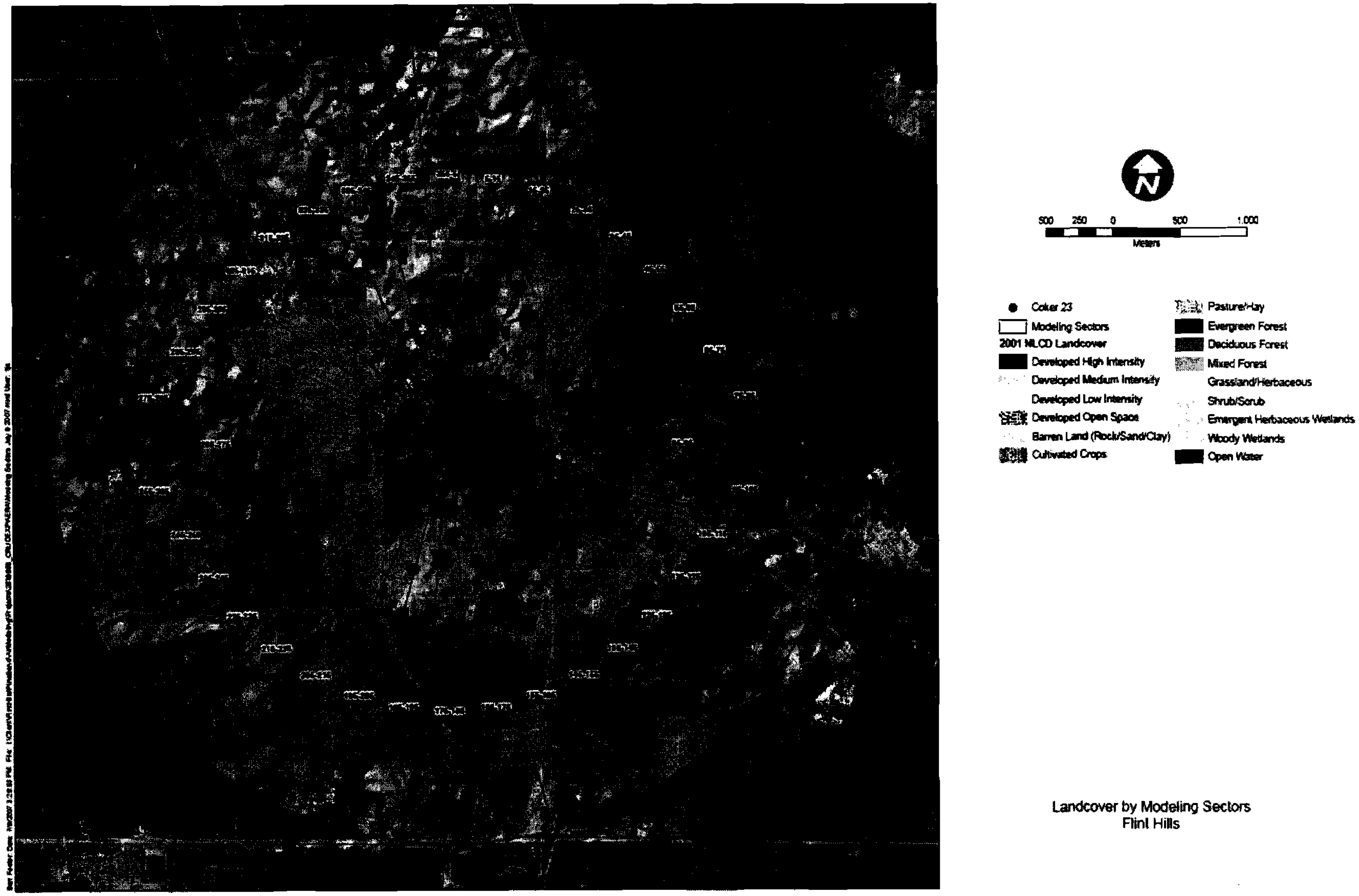

Figure 4-3. AERMOD modeling sectors established for the screening ecological risk analysis and land use designations within 3 kilometers of the Flint Hills Resources, LP, Pine Bend Refinery in Minnesota.

Table 4-2. Estimated land use (acres) by modeling sector within 3 kilometers of the Flint Hills Resources, LP, Pine Bend Refinery in Minnesota. (Based on USGS NLCD 2001 Landcover and Imperviousness Data)

LANDCOVER	5-15	15-25	25-35	35-45	45-55	55-65	65-75	75-85	85-95	95-105
Cultivated Crops	43.4	15.3	11.1	19.9	0.0	0.0	0.0	4.7	1.6	9.2
[redacted]	10.6	20.3	71.1	57.5	67.4	69.5	65.4	91.7	118.7	76.4
[redacted]	37.9	40.5	41.2	19.7	12.4	11.8	12.0	9.8	10.3	15.0
[redacted]	16.9	21.6	6.6	4.4	14.6	6.3	0.0	0.0	1.9	19.7
[redacted]	37.0	34.0	36.9	21.8	12.0	8.7	5.0	5.6	6.9	30.4
[redacted]	5.4	8.9	4.7	0.4	4.7	2.8	0.0	0.0	0.5	11.4
[redacted]	0.0	0.0	0.2	6.5	5.7	10.2	17.8	26.0	3.7	0.0
[redacted]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grassland/Herbaceous	6.7	7.0	2.8	6.0	2.1	1.3	0.0	2.2	9.0	1.8
[redacted]	1.8	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
[redacted]	2.3	1.9	9.6	44.2	43.4	54.0	56.5	37.5	13.0	0.0
Pasture/Hay	30.7	23.9	2.1	9.2	5.6	16.6	11.3	7.9	8.8	19.6
[redacted]	1.4	18.5	7.8	2.0	10.3	5.0	9.2	5.0	12.7	10.0
[redacted]	0.0	0.0	0.0	2.4	16.0	7.9	16.8	3.8	6.9	0.0

LANDCOVER	105-115	115-125	125-135	135-145	145-155	155-165	165-175	175-185	185-195	195-205
Cultivated Crops	27.8	58.3	53.7	28.9	59.2	27.0	85.1	48.2	78.3	70.4
[redacted]	15.7	1.7	16.8	28.4	3.6	2.6	5.6	40.5	20.9	34.8
[redacted]	26.5	32.3	20.9	19.7	22.0	46.3	13.3	11.7	9.3	2.3
[redacted]	33.1	20.2	2.5	13.7	10.1	15.8	9.6	8.7	10.2	5.7
[redacted]	61.7	46.8	13.9	14.0	30.1	61.0	30.6	15.1	19.3	24.3
[redacted]	12.0	6.5	9.7	2.7	5.4	19.0	17.5	6.1	4.7	16.0
[redacted]	3.7	1.8	8.1	2.2	1.7	0.0	1.6	5.0	0.6	4.0
[redacted]	0.0	1.6	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0
Grassland/Herbaceous	1.2	2.4	4.5	9.1	2.7	0.3	14.5	22.2	17.1	2.8
[redacted]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
[redacted]	0.0	0.0	0.0	6.8	0.0	0.0	0.0	0.0	0.1	1.3
Pasture/Hay	11.0	22.6	58.8	46.4	58.0	22.1	12.5	23.0	23.5	21.9
[redacted]	1.4	0.0	5.2	22.2	1.3	0.0	1.0	13.5	10.1	9.5
[redacted]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9

Table 4-2. Continued

LANDCOVER	205-215	215-225	225-235	235-245	245-255	255-265	265-275	275-285	285-295	295-305
Cultivated Crops	115.5	135.7	147.8	134.1	151.3	130.2	50.2	28.2	4.4	23.9
[redacted]	19.5	4.2	4.8	14.6	7.4	17.0	82.0	82.2	65.0	33.9
[redacted]	0.6	3.7	2.4	2.2	4.7	3.9	4.2	2.2	4.8	1.3
[redacted]	7.2	8.4	9.9	6.7	2.6	1.1	1.6	2.3	6.5	7.7
[redacted]	9.2	4.2	0.7	0.1	4.1	7.2	10.4	10.9	13.4	17.9
[redacted]	15.3	11.2	5.3	12.8	9.0	4.0	3.0	4.4	7.4	10.8
[redacted]	8.9	6.3	2.5	4.3	1.5	0.0	1.1	1.1	0.0	1.0
[redacted]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	8.2
Grassland/Herbaceous	0.6	3.1	1.3	1.9	0.9	5.5	13.5	14.5	28.0	31.2
[redacted]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
[redacted]	1.2	0.1	0.2	2.2	3.1	0.6	0.3	0.4	0.1	0.0
Pasture/Hay	15.4	13.6	18.3	14.3	9.5	18.8	23.1	36.1	59.9	48.0
[redacted]	0.6	0.0	0.0	0.0	0.0	5.8	4.6	11.6	4.6	10.3
[redacted]	0.0	3.3	0.7	0.8	0.0	0.0	0.0	0.0	0.0	0.0

LANDCOVER	305-315	315-325	325-335	335-345	345-355	355-5				
Cultivated Crops	32.2	22.7	17.6	0.9	1.6	22.0				
[redacted]	6.8	17.7	16.7	28.2	31.6	35.1				
[redacted]	10.6	26.7	34.9	30.1	18.0	20.7				
[redacted]	10.1	19.3	10.2	33.0	28.6	17.3				
[redacted]	25.5	34.9	38.6	44.2	20.0	16.8				
[redacted]	12.6	15.3	0.4	2.2	11.4	11.5				
[redacted]	4.4	2.9	2.9	0.5	0.5	0.6				
[redacted]	0.4	0.0	3.3	0.0	2.9	1.2				
Grassland/Herbaceous	17.4	6.9	12.0	3.7	5.8	7.6				
[redacted]	0.0	0.0	0.0	0.0	3.2	1.5				
[redacted]	0.0	0.0	0.0	0.0	0.0	0.9				
Pasture/Hay	64.5	43.9	48.8	45.1	66.8	47.0				
[redacted]	9.6	3.9	8.6	6.1	3.6	11.9				
[redacted]	0.0	0.0	0.0	0.0	0.0	0.0				

Particle Deposition Modeling Inputs

For particle deposition modeling of fugitive POM from equipment leaks at the #3 Coker unit, it is assumed that 100 percent of the particles are less than 10 microns. When greater than 10% of the particles emitted are less than 10 microns a Method 2 analysis is required in AERMOD. The particle information required in this analysis is the fraction of particle mass emitted that is less than 2.5 microns and a representative mean particle diameter in microns. For this analysis it was assumed that 100 percent of the POM particles emitted as fugitive emissions were less than 2.5 microns and the mean particle diameter was 0.5 microns.

Modeling Run and Results

For each pollutant, the average annual concentration and deposition was modeled for each individual year, and the maximum value out of the five years was used in the risk analysis. An initial gas deposition modeling run produced deposition values of 0.00000 grams per square meter (g/m^2) for every receptor because of AERMOD's output limit of 5 decimal places. This indicated the potential deposition values for the VOCS would be very small. To work around this issue the emission rates for the gas-phase pollutants were multiplied by a factor of 1000 and re-modeled. In post-processing of the AERMOD output, the revised deposition results were then divided by 1,000 before being entered into the calculations to estimate soil, sediment and water concentrations.

4.2 Soil Concentrations

Airborne chemicals may enter and accumulate in soils by deposition or by diffusion. Soil concentrations were calculated using a screening equation based on the U.S.EPA Exposure Assessment Guidance for RCRA Hazardous Waste Combustion Facilities (EPA, 1994) (Table 4-3).

For the soil exposure route, the concentration in soil is the product of the deposition and the soil accumulation period divided by the depth (1 cm) and density (1610 kg/m^3 – Gradient, 1997) of the soil where contact may occur. Estimated soil concentrations are provided in Table 4-3.

The calculated chemical concentration in soil for a specific chemical is based upon the maximum achievable soil concentration at the end of a 20-year deposition period at the point of maximum air concentration, resulting in a conservative estimate for the volatile COIs (e.g., benzene) because the volatile COIs would not be expected to accumulate over this time period. In addition, the loss of contaminant through physical, chemical, and biological processes was not taken into account in this analysis. For this analysis, all COIs were assumed to be 100% bioavailable and bioaccessible providing a conservative estimate of potential exposure (See Section 8, Uncertainty Analysis, for additional discussion).

Table 4-3. Estimated soil concentrations for the screening ecological risk analysis conducted for the #3 Coker Drum Replacement Project proposed for the Flint Hills Resources, LP, Pine Bend Refinery in Minnesota.

			C_{soil} Estimated Concentration in Soil [1]	Maximum Annual Deposition Estimated By AERMOD
Chemical Name (used in Analytical Results)	Chemical Name used in SLERA	CAS No.	Maximum Anywhere (mg/kg)	Anywhere (g/m^2)
Total PAH (surrogate for POM)	Total PAH	130498-29-2	1.12E-01	9.00E-05
Biphenyl	Biphenyl, 1,1'-	92-52-4	1.99E-04	1.60E-07
Naphthalene	Naphthalene	91-20-3	5.32E-03	4.28E-06
Hexane	Hexane, N-	110-54-3	4.84E-04	3.90E-07
Benzene	Benzene	71-43-2	1.49E-04	1.20E-07
Ethyl benzene	Ethylbenzene	100-41-4	7.83E-04	6.30E-07
Toluene	Toluene	108-88-3	2.73E-03	2.20E-06
Xylene m & p	Xylene, Mixture	1330-20-7	5.17E-03	4.16E-06

[1] Csoil = ((Dep x ty) / (BD x Zs)) x CF

Where:
C_{soil} = Maximum estimated pollutant concentration in soil (mg/kg)
Dep = Estimated maximum annual deposition (g/m^2). (see [2])
ty = time period over which deposition takes place (y = year)
BD = soil bulk density, 1,610 kg/m^3. Source: Gradient, 1997
Zs = soil mixing depth, meters (m); 0.01 m. Source: HHRAP, July 1998, Table B-1-1
CF = Conversion factor grams to milligrams; 1,000

C_{soil} uses Deposition (Dep) for the "Maximum Annual Deposition Anywhere" location. This assumes that the soil the ecological receptors come into contact with is at the location of maximum concentration.

[2] Modeling results are reported in electronic format (CD)

4.3 Surface Water Concentrations

In the screening level model, the chemical concentration estimated in the Mississippi River is a function of the COI concentration in air, direct deposition, surface area of the river (1,602,421 m^2) near the #3 Coker Drum Replacement Project and the flow (volume) of the river. Estimated surface water concentrations are provided in Table 4-4.

For deposition, a deposition velocity of 0.005 m/sec was used. This deposition velocity is conservative because for particles in the $PM_{2.5}$ range the deposition velocity would be lower than 0.001 m/sec (Sehmel, 1984; Gradient, 1996). For the volatile fraction of the COIs the deposition velocity of 0.005 represents a very conservative value because the physical properties of the volatile COIs would indicate little or no direct deposition. A 7-day low flow of 79.5 m^3/sec obtained from the U.S. Geological Survey (USGS; http://waterdata.usgs.gov/mn/nwis/rt) was used for calculating the surface water concentration. Using a low flow value is conservative because as flow increases, mixing and dilution increase and through these mechanisms, the concentration in the water column decreases. If the average flow of the Mississippi River of approximately 420 m^3/sec were used, the calculated concentration in the water column would be approximately 5 times lower than the value obtained from using the low flow value.

The contribution of run-off and erosion from the Mississippi River watershed was not included in the surface water concentration calculation. Due to the physical properties of the volatile COIs little accumulation in watershed surface soils would be expected. This issue is further discussed in the Uncertainty Analysis section (Section 8.0) of this Addendum.

Table 4-4. Estimated surface water and sediment concentrations in the Mississippi River for the screening ecological risk analysis conducted for the #3 Coker Drum Replacement Project proposed for the Flint Hills Resources, LP, Pine Bend Refinery in Minnesota.

			C_{air}	C_{water}	$C_{sediment}$
			Estimated Concentration in Air (from AERMOD)	Estimated Concentration in Surface Water [1]	Estimated Concentration in Sediments [2]
Chemical Name (used in Analytical Results)	**Chemical Name (used in SLERA)**	**CAS No.**	Maximum Near Mississippi River	Mississippi River	Mississippi River
			(mg/m^3)	(mg/L)	(mg/kg)
Total PAH	Total PAH	130498-29-2	4.71E-07	4.74E-08	3.16E-11
Biphenyl	Biphenyl, 1,1'-	92-52-4	2.25E-08	2.26E-09	1.51E-12
Naphthalene	Naphthalene	91-20-3	2.07E-07	2.09E-08	1.39E-11
Hexane	Hexane, N-	110-54-3	1.24E-06	1.24E-07	8.30E-11
Benzene	Benzene	71-43-2	8.98E-08	9.05E-09	6.03E-12
Ethyl benzene	Ethylbenzene	100-41-4	5.39E-07	5.43E-08	3.62E-11
Toluene	Toluene	108-88-3	1.71E-06	1.73E-07	1.15E-10
Xylene m & p	Xylene, Mixture	1330-20-7	3.27E-06	3.29E-07	2.19E-10

[1] $C_{water} = (C_{air} \times \mu s \times SA) / (Q \times 1000)$

Source: "Guidance for Performing Screening Level Risk Analysis at Combustion Facilities Burning Hazardous Waste", USEPA, 1994

where ...

C_{water} = COPC concentration in water body (mg/L)
C_{air} = COPC air concentration (mg/m^3) at location of water body (from AERMOD modeling)
μs = deposition velocity, meters per second (m/s). 0.005 m/s.

SA = surface area of water body; square meters (m^2). 1,602,421 m^2
(USGS Real-Time Water Data for Minnesota)
Q = 7-day low flow in river; cubic meters per second (m^3/s). 79.54 m^3/s.
(http://waterdata.usgs.gov/mn/nwis/rt)

[2] Csediment = $(C_{water} \times F) / (BD)$

Source: "Guidance for Performing Screening Level Risk Analysis at Combustion Facilities Burning Hazardous Waste", USEPA, 1994

where ...

F = Fraction of particulates settling to sediment (unitless), conservatively assumed to be 100%. Value = 1
BD = sediment bulk density (kg/m^3). 1,500 kg/m^3 Source: HHRAP, July 1998, Table B-1-1

4.4 Sediment Concentrations

The chemical concentration in sediments is a function of the rate at which chemicals are settling to sediment in the surface water, and the rate at which chemicals evaporate from the surface water. Sediment concentrations were calculated assuming that the fraction of particulates in the water column settling to sediments was 100 percent. This is a conservative assumption because the volatile COIs are not expected to be significantly associated with particulates. Rather than settle to deep sediments the volatile COIs (e.g., benzene) are expected to volatilize from the water column (see Section 8, Uncertainty Analysis).

The contribution of run-off and erosion from the Mississippi River watershed was not included in the sediment concentration calculation. Due to the physical properties of the volatile COIs little accumulation in watershed surface soils would be expected.

Estimated sediment concentrations are provided in Table 4-4.

5.0 Toxicity Reference Values

The TRVs used in the SLERA are media specific and used to screen ecological effects to receptors inhabiting soil, surface water, and sediment. The approach used to develop the media specific TRVs was to base the criteria on those species, among those tested, that are more sensitive to the COI. Using this approach, the criteria are thought to be protective of all species (EPA, 2003). The TRV represents a receptor-class specific estimate of a no-observed adverse effect level (NOAEL) (dose) for the respective contaminant. (EPA, 2003). TRVs are generally used as a simple and conservative method for identifying a potential for harm and the need for more detailed evaluation. TRVs are expressed on a concentration basis, such as milligrams of a chemical per kilogram of soil. When more than one TRV was available for a specific chemical, the lowest relevant TRV was selected for use in calculating an Environmental Screening Quotient or ESQ.

5.1 Soil

The TRVs for soils were preferentially based on the most bioavailable form of COI. Soil consists of organic, mineral and living matrices in variable proportions. Each of these three soil constituents, and their specific combinations within soils, affects the soil properties and the bioavailability, bioaccessibility, and toxicity to the receptor. When more than one TRV was available for a specific chemical for the sources listed below, the lowest relevant TRV was selected to calculate the ESQ.

The TRV values for soil were obtained from the following sources (values are listed in Appendix A):

- Screening Level Concentration For Analytes in Phase 1 & 2 Soils
- Dutch Intervention Soil Screening Benchmark
- Dutch Target Soil Screening Benchmark
- EPA R6 Earthworms Surface Soil Screening Benchmark
- EPA R6 Plants Surface Soil Screening Benchmark
- Eco-SSL Avian Soil Screening Benchmark
- Eco-SSL Inverts Soil Screening Benchmark
- Eco-SSL Mammalian Soil Screening Benchmark
- Eco-SSL Plants Soil Screening Benchmark
- ORNL Invertebrates Soil Screening Benchmark

- ORNL Microbes Soil Screening Benchmark
- ORNL Plants Screening Benchmark
- SO EPA R4 Soil Screening Benchmark
- SO EPA R5 ESL Soil Screening Benchmark

5.2 Surface Water

The TRVs for surface water were preferentially based on the most bioavailable form of the COI. When more than one TRV was available for a specific chemical for the sources listed below, the lowest relevant TRV was selected for use in calculating an Environmental Screening Quotient or ESQ). The TRV values for surface waters were obtained from the following sources (specific values listed in Appendix A):

- EPA Freshwater Toxicity Reference Values
- EPA GLI Wildlife Screening Criteria
- Canadian WQG Surface Water Screening Benchmark
- EC20 Daphnids Surface Water Screening Benchmark
- EC20 Fish Surface Water Screening Benchmark
- EC20 Sensitive Species Surface Water Screening Benchmark
- EC25 Bass Population Surface Water Screening Benchmark
- EPA R4 Acute Surface Water Screening Benchmark
- EPA R4 Chronic Surface Water Screening Benchmark
- LCV Aquatic Plants Surface Water Screening Benchmark
- LCV Daphnids Surface Water Screening Benchmark
- LCV Fish Surface Water Screening Benchmark
- LCV Non-Daphnid Inverts Surface Water Screening Benchmark
- NAWQC Acute Surface Water Screening Benchmark
- NAWQC Chronic Surface Water Screening Benchmark
- OSWER Ambient Water Quality Criteria

- OSWER Tier II Secondary Surface Water Screening Benchmark
- SW EPA R5 ESL Surface Water Screening Benchmark
- SW EPA R6 FW Surface Water Screening Benchmark
- SW EPA R6 Mar Surface Water Screening Benchmark
- Tier II SAV Surface Water Screening Benchmark
- Tier II SCV Surface Water Screening Benchmark

5.3 Sediments

The TRVs for sediments were preferentially based on the most bioavailable form of the COI. When more than one TRV was available for a specific chemical for the sources listed below, the lowest relevant TRV was selected for use in calculating an Environmental Screening Quotient or ESQ. The TRV values for surface waters were obtained from the following sources (specific values listed in Appendix A):

- Canadian ISQG Sediment Screening Benchmark
- Canadian PEL Sediment Screening Benchmark
- ARCS NEC Sediment Screening Benchmark
- ARCS PEC Sediment Screening Benchmark
- ARCS TEC Sediment Screening Benchmark
- Consensus PEC Sediment Screening Benchmark
- Consensus TEC Sediment Screening Benchmark
- FDEP PEL Sediment Screening Benchmark
- FDEP TEL Sediment Screening Benchmark
- NOAA ERL Sediment Screening Benchmark
- NOAA ERM Sediment Screening Benchmark
- ORNL Lowest Chronic Value Fish EqP Sediment Screening Benchmark
- ORNL Lowest Chronic Value Nondaphnid Inverts EqP Sediment Screening Benchmark
- ORNL Lowest Chronic Value Daphnids Equilibrium Partitioning EqP Benchmark
- ORNL Secondary Chronic Value Sediment Screening Benchmark

- OSWER Ecotox Thresholds Sediment Screening Benchmark
- Ontario Low Sediment Screening Benchmark
- Ontario Severe Sediment Screening Benchmark
- SD EPA R4 Sediment Screening Benchmark
- SD EPA R5 ESL Sediment Screening Benchmark
- SD EPA R6 FW Sediment Screening Benchmark
- SD EPA R6 Mar Sediment Screening Benchmark
- Washington MAEL Sediment Screening Benchmark
- Washington NEL Sediment Screening Benchmark

5.4 Application of TRVs

The TRVs used in the SLERA represent concentrations of chemicals in various environmental media (soil, sediment, water) that are presumed to be non-hazardous to biota. For each chemical evaluated in this SLERA, the lowest applicable TRV for the specific media was selected for comparison to chemical specific concentrations in that medium. While values greater than these toxicity screening values does not indicate any particular level or type of risk, concentrations below these toxicity screening values should not result in significant ecological effects.

6.0 Estimating Potential Impacts to Ecological Receptors

6.1 Ecological Screening Quotients

For ecological risk estimation, an Ecological Screening Quotient (ESQ) is calculated. In this calculation, TRVs are set as the denominator for calculating chemical specific ESQs to characterize risk. The ESQ method is the most common method of risk characterization used in screening-level ecological risk assessments. The ecological screening quotient method is relatively easy to implement, generally accepted, and can be applied to any data set. It must be noted that the ESQ does not explicitly consider uncertainty (e.g., extrapolation from tested species to the species of concern). Some uncertainties, however, can be incorporated in single point estimates to provide a statement of likelihood that the effects point estimate exceeds the exposure point estimate.

For this SLERA, the screening level risk evaluation consisted of comparing the maximum concentration of a COI in soil, surface water and/or sediment to the lowest applicable TRV for the specific media. As discussed in Section 5.0, the TRVs are associated with known thresholds below which adverse ecological effects are highly unlikely. An ESQ can be expressed by the following equation:

$$ESQ = EEC/TRV$$

Where:

ESQ	=	ecological screening (hazard) quotient (unitless)
EEC	=	estimated environmental concentration (mg/kg or mg/L)
TRV	=	toxicity reference value (mg/kg or mg/L)

The ESQ is not a statistical measure of the probability that an adverse effect will occur; it only indicates that the exposure level is below or above the specific chemical toxicity threshold. An ESQ less than 1.0 indicates that the specific chemical is not likely to cause adverse ecological effects. However, an ESQ greater than 1.0 does not necessarily imply unacceptable ecological effects or that adverse impacts are expected.

For ecological receptors that may be exposed to multiple chemicals, the ESQs are summed to derive a hazard index (HI). This can be expressed by the following equation:

$$\text{Total ESQ} = EEC_1/TRV1 + EEC_2/TRV2 + EEC_i/TRV_i$$

Where:

Total ESQ	=	a sum of individual ESQs for that media (unitless)
TRV_i	=	toxicity reference value for the i^{th} chemical (mg/kg or mg/L)
EEC_i	=	estimated environmental concentration for the i^{th} chemical (mg/kg or mg/L)

In this analysis a total ESQ is derived by summing the ESQ for each media (soil, water, sediments) regardless of chemical, toxic endpoint, species affected, or type of effect (acute, subchronic, chronic). This results in a conservative estimate of effects.

All chemical specific ESQ for all exposure pathways (soil, surface water, and sediments) were below 1.0, indicating that even when using simple conservative models, adverse impacts to ecological receptors, including the Higgins-eye pearly mussel (*Lampsilis higginsi*), associated with potential to emit fugitive emissions from the #3 Coker Project are not expected. When assuming additivity for potential effects, and combining all exposure pathways the HI, was also below 1.0 indicating that exposure to all of the COIs combined is not expected to result in adverse effects to ecological receptors, including the Higgins-eye pearly mussel (*Lampsilis higginsi*). Detailed results are presented in Appendix A.

Table 6-1. Estimated soil Ecological Screening Quotients (ESQs) for chemicals of interest for the #3 Coker Drum Replacement Project proposed for the Flint Hills Resources, LP, Pine Bend Refinery in Minnesota.

Chemical	Lowest Available Toxicity Reference Value [1] (mg/kg)	Estimated Soil Concentration (mg/kg)	HQ (Unitless)
Benzene	0.01	1.49E-04	1.49E-02
Total PAH (POM Surrogate)	1	1.12E-01	1.12E-01
Biphenyl	60	1.99E-04	3.31E-06
Ethyl benzene	0.03	7.83E-04	2.61E-02
Hexane	--	4.84E-04	
Naphthalene	0.0994	5.32E-03	5.35E-02
Toluene	0.01	2.73E-03	2.73E-01
Xylene	0.05	5.17E-03	1.03E-01
Total HI			**5.83E-01**

[1] Toxicity reference values obtained from the Oak Ridge National Laboratory – Risk Assessment Information System, June 2007. The lowest value of available TRVs used in this analysis.

-- indicates no toxicity value available from ORNL-AIS as of July 2007.

Table 6-2. Estimated Surface Water Ecological Screening Quotients (ESQs) for chemicals of interest for the #3 Coker Drum Replacement Project proposed for the Flint Hills Resources, LP, Pine Bend Refinery in Minnesota.

Chemical	Lowest Available Toxicity Reference Value [1] (mg/kg)	Surface Water Concentration (mg/L)	HQ (Unitless)
Benzene	0.02	9.05E-09	4.52E-07
Total PAH (POM Surrogate)	--	4.73E-08	
Biphenyl	0.014	2.26E-09	1.62E-07
Ethyl benzene	0.0073	5.43E-08	7.44E-06
Hexane	0.00058	1.24E-07	2.15E-04
Naphthalene	0.0011	2.09E-08	1.90E-05
Toluene	0.002	1.73E-07	8.63E-05
Xylene	0.01	3.29E-07	3.29E-05
Total HI			**3.61E-04**

[1] Toxicity reference values obtained from the Oak Ridge National Laboratory – Risk Assessment Information System, June 2007. The lowest value of available TRVs used in this analysis.

Table 6-3. Estimated Sediment Ecological Screening Quotients (ESQs) for chemicals of interest for the #3 Coker Drum Replacement Project proposed for the Flint Hills Resources, LP, Pine Bend Refinery in Minnesota.

Chemical	Lowest Available Toxicity Reference Value [1] (mg/kg)	Sediment Concentration wet weight (mg/kg)	Sediment Concentration dry weight (mg/kg)	HQ (Unitless)
Benzene	0.05	6.03E-12	1.21E-11	2.41E-10
Total PAH (POM Surrogate)	1.61	3.16E-11	6.31E-11	3.92E-11
Biphenyl	--	1.51E-12	3.02E-12	--
Ethyl benzene	0.175	3.62E-11	7.24E-11	4.14E-10
Hexane	--	8.30E-11	1.66E-10	--
Naphthalene	0.03	1.39E-11	2.79E-11	9.29E-10
Toluene	0.67	1.15E-10	2.30E-10	3.43E-10
Xylene	0.43	2.19E-10	4.39E-10	1.02E-09
Total HI				**2.99E-09**

[1] Toxicity reference values obtained from the Oak Ridge National Laboratory – Risk Assessment Information System, June 2007. The lowest value of available TRVs used in this analysis.

6.2 Potential Impact on the Higgins-eye Pearly Mussel

The Higgins-eye pearly mussel (*Lampsilis higginsi*) occurs in the Mississippi River north of Lock and Dam 19 at Keokuk, Iowa and between Illinois and Iowa. Essential habitat areas identified by the USFWS include the Mississippi River at Lansing, Iowa, near Harper's Ferry Iowa, Prairie du Chien, Wisconsin, near Guttenberg, Iowa, Cordova, Illinois, and Moline, Illinois. They favor "stable" sand and gravel that is not "fine" such as silt or "coarse" such as "cobble". They avoid sand that is "unstable" or "shifting", "packed clay," "flocculent silt," "organic material," and "concrete". They have been noticed to live where there are few plants in river, but have been observed where plants are on the shore. Not much is known about the impacts of organic compounds on the mussels. Water quality parameters identified to potentially effect *L. higginsii* include un-ionized ammonia, select metals, and possibly some organic compounds (USFWS, 2004).

Because many inorganic and organic contaminants that enter aquatic systems associate with fine sediments (i.e. silts and clays), the greatest likelihood for adverse effects for these contaminants should be depositional areas with fine sediments. The existing data for *L. higginsii*, however, suggests that the species is not generally found in areas with a relatively significant amount of sediment deposition. Thus *L. higginsii* are generally not located in areas where concentrations of organic compounds are likely to reach toxic levels (USFWS, 2004).

In contrast to the results of toxicity tests with metal pollutants, *L. higginsii* was found to generally be less sensitive to organic pollutants than were standard toxicity organisms such as *D. magna, Ceriodaphnia dubia*, the fathead minnow, and bluegill sunfish. The reasons for the apparent tolerance of these mussels to pesticides, herbicides and effluents, all having different chemical structures, characteristics and mechanisms is unknown. There may be protective physiological adaptations or short-term behavioral responses that allow mussels to survive longer (Keller, 1993).

The combined modeled COI concentrations in sediments was well below the acceptable hazard index of 1 (HI = 4.52E-09) indicating that adverse effects to the Higgins-eye pearly mussel are not expected from potential to emit fugitive air emissions from the #3 Coker Drum Replacement Project.

6.3 Comparing Modeled Concentrations from the Project to Background Concentrations

The following databases were searched for background concentrations of the COI in air, soil, surface water, and sediments:

- USGS Upper Midwest Environmental Sciences Center

  Sediment-Contaminant Database for the Upper Mississippi River System and Selected Tributaries (version 2).

    Sediment-Contaminant Database for PAHs
    http://www.umesc.usgs.gov.data/library_/sediment_contaminants/datasets/all.html.

    Pine Bend Head (River mile 824). 1/1/92.

- National Water Information System: Web Interface (Minnesota)
  http://waterdata.usgs.gov/mn/nwis/si
  USGS 05331570 MISSISSIPPI RIVER AT NININGER, MN

- National Water Information System: Web Interface (Minnesota)
  http://waterdata.usgs.gov/mn/nwis/si
  Selected "USGS 05331580 MISSISSIPPI RIVER BELOW L&D #2 AT HASTINGS, MN"

- MPCA Environmental Air Data Access Ambient Stations Search
  http://www.pca.state.mn.us/data/edaAir/ambientSearch.cfm
  MPCA Site 420 Near FHR
  2005-2006 Average (2006 has only partial data).

Background concentrations for the COIs are presented in Table 6-4. Background concentrations were not available for surface soils. Background concentrations of COIs in air and surface water for which data were available show that modeled concentrations do not add significantly to background conditions, indicating that the #3 Coker Drum Replacement Project does not increase the risk for adverse effects to ecological receptors over those potential risks represented by existing background concentrations.

Table 6-4. Comparison of available background concentrations to modeled concentrations for chemicals of interest from the #3 Coker Drum Replacement Project proposed for the Flint Hills Resources, LP, Pine Bend Refinery in Minnesota

Surface Water [1]	**Measured Value (μg/L)**	**Modeled value (μg/L)**
Toluene	< 0.1	1.73E-04
Benzene	0.02	9.05E-06
Ethylbenzene	<0.1	5.43E-05
m-Xylene	<0.1	3.29E-04
Naphthalene	<0.5	2.09E-05
Average of PAHs	<0.5	4.73E-05
Air [2]	**(μg/m³)**	**(μg/m³)**
Benzene	6.27E-04	8.98E-08
Ethylbenzene	1.66E-01	5.39E-07
M/P Xylene	5.03E-04	3.27E-06
n-Hexane	7.75E-04	1.24E-06
Toluene	1.08E-03	1.71E-06
POM	Not monitored	
Biphenyl	Not monitored	
Naphthalene	Not monitored	
Sediments [3]	**(μg/g)**	**(μg/g)**
Benzene	No Data Recorded	
Toluene	No Data Recorded	
Naphthalene	No Data Recorded	
Hexane	No Data Recorded	
Xylene	No Data Recorded	
Ethylbenzene	No Data Recorded	
Biphenyl	No Data Recorded	
Naphthalene	0.036	1.39E-11
Average of PAHs	0.06	3.16E-11
Soil [4]		
No background soil concentrations found for the chemicals of interest.		

[1] Background surface water concentrations obtained from the USGS, Hastings and Nininger monitoring stations on the Mississippi River.

[2] Background air concentrations obtained from the Minnesota Pollution Control Agency, Environmental Air Data Access Ambient Stations Search, http://www.pca.state.mn.us/data/edaAir/ambientSearch.cfm

[3] Background sediment concentrations obtained from the USGS Upper Midwest Environmental Science Center and from the USGS for the Nininger monitoring site on the Mississippi River.

[4] Background soil concentrations not found; electronic searches conducted of the following information sources: Minnesota Pollution Control Agency, Minnesota Board of Water and Soil Resources, Minnesota Association of Soil and Water Conservation Districts, Minnesota Dept. of Agriculture, Minnesota Department of Natural Resources, University of Minnesota – Department of Soil, Water, and Climate.

7.0 Conclusions

A screening-level ecological risk analysis was conducted to assess the potential impacts from the potential to emit fugitive air emissions that could be emitted from the #3 Coker Drum Replacement Project. The conservative risk analysis results indicate that the project is unlikely to result in adverse impacts to ecological receptors including Federal- or State-listed threatened and endangered species. It is unlikely for the proposed project to have adverse impacts because the project has no land-disturbing impacts within habitat or immediately adjacent to known locations of listed species, does not result in an increased discharge to streams or other waterways, and has small emissions of COI and small estimated media concentrations that are below screening level thresholds of concern.

In summary, the estimated small media concentrations of the COI are not expected to cause significant adverse effects to the ecological receptors in areas adjacent to the Pine Bend Refinery, including the Higgins pearly-eyed mussel.

8.0 Uncertainty Analysis

While the total ESQ provides useful information regarding potential risk resulting from exposure of a measurement receptor to multiple COIs at a specific location, potential limitations and uncertainties associated with the calculation of the total ESQ should be considered before its use. Specifically, the resulting total ESQ is determined by summing COI-specific ESQs that were calculated utilizing TRVs based on different effects (e.g. growth, reproduction), toxicity endpoints (e.g., NOAEL, LOAEL), exposure durations (e.g., chronic, acute), and different species (e.g., bluegill, trout) (EPA, 1999). This summing of ESQs for all chemicals likely overestimates potential additive effects. In general, calculated ESQ values less than one suggest that no ecological impact would be associated with the presence of the COIs. Because of the generally conservative nature of the TRVs, ESQ values between 1 and 10 suggest minimal impacts to ecological receptors. However, in relation to other stresses within the environment, this level of risk is not considered to have a significant effect on any single ecological measurement receptor, or to indicate the potential for significant ecological effects due to the presence of the COIs.

The contribution of runoff and erosion were not considered in the calculation of COI concentrations in surface water and sediments. This omission is not expected to greatly underestimate risk for the volatile fraction of the fugitive emissions because these compounds do not deposit to an appreciable degree nor do they accumulate over time in soil, surface water and sediment because of volatilization from these media. However, even when assuming that the contribution of runoff and erosion would increase the concentrations in soil, surface water, and sediments twofold, the HIs in these media would still be less than one indicating that adverse impacts to ecological receptors are not expected.

The volatile fraction of the fugitive emissions was assumed to be deposited onto soil, surface water and sediments where they would accumulate over time. This is a conservative assumption resulting in an over prediction of media concentrations and associated risk. The following paragraphs provide a brief description of fate and transport in the media evaluated of the pertinent COIs (Source HSDB). http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

Benzene - Vapor-phase benzene will be degraded in the atmosphere by reaction with photochemically produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 13 days. Vapor-phase benzene is also degraded by ozone and nitrate radicals found in the atmosphere but at such low rates as to not be important. Since benzene is very water soluble, it may be removed from the atmosphere by rain. If released to soil, benzene is expected to have high mobility based upon a K_{oc} of

85. Volatilization from moist soil surfaces is expected to be an important fate process based upon a Henry's Law constant of 5.6×10^{-3} atm m^3/mole. Benzene may volatilize from dry soil surfaces based upon its vapor pressure. If released into water, benzene is not expected to adsorb to sediment and suspended solids in water based upon the K_{oc}. Volatilization from water surfaces is expected to be an important fate process based upon this compound's Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 1 hr and 3.5 days, respectively.

Toluene - If released to soil, toluene is expected to have high to moderate mobility based upon K_{oc} values in the range of 37-178. Volatilization from moist soil surfaces is expected to be an important fate process based upon a Henry's Law constant of 6.4×10^{-3} atm m^3/mole. Toluene may volatilize from dry soil surfaces based upon its vapor pressure. Biodegradation is expected to occur rapidly in soil surfaces, with half-lives in the range of several hours to 71 days. If released into water, toluene is not expected to adsorb to suspended solids and sediment based upon a K_{oc} of 166 measured in lake sediment. Biodegradation is expected to occur rapidly in water, with reported half-lives of 4 and 56 days in aerobic and anaerobic water, respectively. Volatilization from water surfaces is expected to be an important fate process based upon this compound's Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 1 hour and 4 days, respectively.

Xylenes - Xylene is expected to have moderate to high mobility in soils based upon experimental K_{oc} values obtained with a variety of soils at differing pH values and organic carbon content. Volatilization from moist soil surfaces is expected based on an experimental Henry's Law constant of 7.0×10^{-3} atm m^3/mole. Biodegradation is an important environmental fate process for xylene. In general, it has been found that xylene is biodegraded in soil and groundwater samples under aerobic conditions and may be degraded under anaerobic denitrifying conditions. In water, xylene is expected to adsorb somewhat to sediment or particulate matter based on its measured K_{oc} values. This compound is expected to volatilize from water surfaces given its experimental Henry's Law constant. Estimated half-lives for a model river and model lake are 3 and 99 hours, respectively.

Hexane - Vapor-phase n-hexane will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 3 days. If released to soil, n-hexane is expected to have high mobility based upon an estimated K_{oc} of 150. Volatilization from moist soil surfaces is expected to be an important fate process based upon an estimated Henry's Law constant of 1.83 atm m^3/mole. n-Hexane may volatilize from dry soil surfaces based upon its vapor pressure. Screening studies suggest that n-hexane will undergo biodegradation in soil and water surfaces, but volatilization is expected to be the predominant fate process in the environment. If released into water, n-hexane is not expected to adsorb to suspended solids and sediment based upon the estimated K_{oc}. Volatilization from water surfaces is expected to be an important fate process based upon this compound's estimated Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 1 hour and 3 days, respectively.

Ethylbenzene - If released to soil, ethylbenzene is expected to have moderate mobility based upon an estimated K_{oc} of 520. Volatilization from moist soil surfaces is expected to be an important fate process based upon a Henry's Law constant of 7.88×10^{-3} atm m^3/mole. Ethylbenzene may volatilize from dry soil surfaces based upon its vapor pressure. Biodegradation in soil takes place via nitrate-reducing processes. If released into water, ethylbenzene may adsorb to suspended solids and sediment in water based upon the estimated K_{oc}. Biodegradation in a gasoline contaminated aquifer ranged from 10-16 days under aerobic conditions. Ethylbenzene was degraded in 8 days in groundwater and 10 days in seawater as a component of gas oil. Volatilization from water surfaces is expected to be an important fate process based upon this compound's Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 1.1 and 99 hrs, respectively.

Naphthalene - If released to air, a vapor pressure of 0.085 mm Hg at 25 deg C indicates naphthalene will exist primarily as a vapor in the ambient atmosphere. Vapor-phase naphthalene will be degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals and nitrate radicals; the half-life for these reactions in air is estimated to be 18 and 60 hours, respectively. Naphthalene also absorbs light in the environmental UV spectrum and is subject to direct photolysis. If released to soil, naphthalene is expected to have moderate to low mobility based on K_{oc} values of 440-1300, measured in soil and sediment. Volatilization from moist soil surfaces is expected to be an important fate process based upon a Henry's Law constant of 4.4×10^{-4} atm m^3/mole. Biodegradation is expected to be an important fate process based upon soil degradation half-lives of 2-18 days. If released into water, naphthalene is expected to adsorb to suspended solids and sediment based upon the K_{oc} data. Naphthalene has been shown to biodegrade in water with half-lives ranging from about 0.8 to 43 days. Photolysis in sunlit surface waters may be an important fate process based upon an aqueous photolysis half-life of 71 hours. Volatilization from water surfaces is expected to be an important fate process based upon this compound's Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 3 hours and 5 days, respectively.

Biphenyl - Volatilization from moist soil surfaces is expected to be an important fate process based upon a Henry's Law constant of 3.08×10^{-4} atm m^3/mole. If released into water, biphenyl is expected to adsorb to suspended solids and sediment based upon the measured K_{oc}. Biodegradation may be an important environmental fate process under aerobic conditions, as indicated by a reported half-life of 2-3 days in a river die-away test. Acclimation may increase biodegradation rates. Biphenyl may be resistant to biodegradation under anaerobic conditions. Volatilization from water surfaces is expected to be an important fate process based upon this compound's Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 4 hrs and 6 days, respectively. However, volatilization from water surfaces is expected to be attenuated by adsorption to suspended solids and sediment in the water column. The estimated volatilization half-life from a model pond is 41 days if adsorption is considered.

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Appendix A

Toxicity Reference Values Evaluated for Potential Use in the Screening-Level Ecological Risk Analysis Conducted for the #3 Coker Drum Replacement Project Proposed for the Flint Hills Resources, LP, Pine Bend Refinery in Minnesota

Table A-1. Soil

Table A-2. Sediment

Table A-3. Surface Water

Acronyms for Tables A-1, A-2, and A-3

Table A-1. Soil Toxicity Reference Values (TRVs) available from the Oak Ridge National Laboratory – Risk Assessment Information System (ORNL-RAIS) (June 2007)

Chemical	Dutch Intervention Soil Screening Benchmark (mg/kg)	Dutch Target Soil Screening Benchmark (mg/kg)	EPA R6 Earthworms Surface Soil Screening Benchmark (mg/kg)	EPA R6 Plants Surface Soil Screening Benchmark (mg/kg)	Eco-SSL Avian Soil Screening Benchmark (mg/kg)	Eco-SSL Inverts Soil Screening Benchmark (mg/kg)	Eco-SSL Mammalian Soil Screening Benchmark (mg/kg)	Eco-SSL Plants Soil Screening Benchmark (mg/kg)	ORNL Invertebrates Soil Screening Benchmark (mg/kg)
Benzene	25	0.01							
Total PAH (POM Surrogate)	40	1							
Biphenyl				60					
Ethylbenzene		0.03							
Hexane									
Naphthalene									
Toluene	130	0.01		200					
Xylene		0.1							

Chemical	ORNL Microbes Soil Screening Benchmark (mg/kg)	ORNL Plants Screening Benchmark (mg/kg)	SO EPA R4 Soil Screening Benchmark (mg/kg)	SO EPA R5 ESL Soil Screening Benchmark (mg/kg)	High Value	Low Value	Soil Concentration (mg/kg)	Hazard Quotient (unitless)
Benzene			0.05	0.255	25	0.01	1.49E-04	1.49E-02
Total PAH (POM Surrogate)			1		40	1	1.12E-01	1.12E-01
Biphenyl		60			60	60	1.99E-04	3.31E-06
Ethylbenzene			0.05	5.16	5.16	0.03	7.83E-04	2.61E-02
Hexane							4.84E-04	
Naphthalene			0.1	0.0994	0.1	0.0994	5.32E-03	5.35E-02
Toluene		200	0.05	5.45	200	0.01	2.73E-03	2.73E-01
Xylene			0.05	10	10	0.05	5.17E-03	1.03E-01
								HI = 0.583

Table A-2. Sediment Toxicity Reference Values (TRVs) available from the Oak Ridge National Laboratory – Risk Assessment Information System (ORNL-RAIS) (June 2007)

Chemical	Canadian WQG Surface Water Screening Benchmark (mg/L)	EC20 [1] Daphnids Surface Water Screening Benchmark (mg/L)	EC20 [1] Fish Surface Water Screening Benchmark (mg/L)	EC20 [1] Sensitive Species Surface Water Screening Benchmark (mg/L)	EC25 [2] Bass Population Surface Water Screening Benchmark (mg/L)	EPA R4 [3] Acute Surface Water Screening Benchmark (mg/L)	EPA R4 [3] Chronic Surface Water Screening Benchmark (mg/L)	SW EPA R5 [4] ESL Surface Water Screening Benchmark (mg/L)	SW EPA R6 [5] FW Surface Water Screening Benchmark (mg/L)	SW EPA R6 [5] Mar Surface Water Screening Benchmark (mg/L)	LCV [6] Aquatic Plants Surface Water Screening Benchmark (mg/L)
Benzene	0.37		0.02		0.22	0.53	0.05	0.114	0.13	0.1	525
Total PAH (POM Surrogate)											
Biphenyl									0.014		
Ethylbenzene	0.09				0.398	4.53	0.453	0.014	2.18	0.5	438
Hexane			29						0.00058		
Naphthalene	0.0011	0.6	0.45		1	0.23	0.06	0.013	0.49	0.25	33
Toluene	0.002		0.02		0.2	1.75	0.17	0.253	2.9	0.95	245
Xylene			2.68					0.027	1.34	0.85	

Chemical	LCV [6] Daphnids Surface Water Screening Benchmark (mg/L)	LCV [6] Fish Surface Water Screening Benchmark (mg/L)	LCV [6] Non-Daphnid Inverts Surface Water Screening Benchmark (mg/L)	NAWQC [7] Acute Surface Water Screening Benchmark (mg/L)	NAWQC [7] Chronic Surface Water Screening Benchmark (mg/L)	OSWER [8] Ambient Water Quality Criteria (mg/L)	OSWER [8] Tier II Secondary Surface Water Screening Benchmark (mg/L)	Tier II SAV [9] Surface Water Screening Benchmark (mg/L)	Tier II SCV [10] Surface Water Screening Benchmark (mg/L)
Benzene	98						0.04	2.3	0.13
Total PAH (POM Surrogate)									
Biphenyl									0.014
Ethylbenzene	12.9	0.44						0.13	0.0073
Hexane		65.7						0.01	0.00058
Naphthalene	1.16	0.62					0.02	0.19	0.01
Toluene	25.2	1.27					0.13	0.12	0.0098
Xylene		62.3						0.23	0.01

Table A-2 (continued)

Chemical	High Value	Low Value	Dissolved Water Phase Concentration (mg/L)	Hazard Quotient (unitless)
Benzene	525	0.02	9.05E-09	4.52E-07
Total PAH (POM Surrogate)			4.73E-08	
Biphenyl	0.014	0.014	2.26E-09	1.62E-07
Ethylbenzene	438	0.0073	5.43E-08	7.44E-06
Hexane	65.7	0.00058	1.24E-07	2.15E-04
Naphthalene	33	0.0011	2.09E-08	1.90E-05
Toluene	245	0.002	1.73E-07	8.63E-05
Xylene	62.3	0.01	3.29E-07	3.29E-05
				HI= 0.000361

Table A-2 Footnotes

[1] EC20 = Observable effects concentration in 20% of test organisms
[2] EC25 = Observable effects concentration in 25% of test organisms
[3] R4 = EPA Region 4
[4] R5 = EPA Region 5
[5] R6 = EPA Region 6
[6] LCV = Lowest Acceptable Chronic Value
[7] NAWQC = National Ambient Water Quality Criteria
[8] OSWER = Office of Solid Waste and Emergency Response
[9] SAV = Secondary Acute Value
[10] SCV = Secondary Chronic Value

Table A-3. Surface Water Toxicity Reference Values (TRVs) available from the Oak Ridge National Laboratory – Risk Assessment Information System (ORNL-RAIS) (June 2007)

Chemical	Canadian ISQG Sediment Screening Benchmark (mg/kg)	Canadian PEL Sediment Screening Benchmark (mg/kg)	ARCS NEC Sediment Screening Benchmark (mg/kg)	ARCS PEC Sediment Screening Benchmark (mg/kg)	ARCS TEC Sediment Screening Benchmark (mg/kg)	Consensus PEC Sediment Screening Benchmark (mg/kg)	Consensus TEC Sediment Screening Benchmark (mg/kg)	FDEP PEL Sediment Screening Benchmark (mg/kg)	FDEP TEL Sediment Screening Benchmark (mg/kg)	NOAA ERL Sediment Screening Benchmark (mg/kg)	NOAA ERM Sediment Screening Benchmark (mg/kg)
Benzene											
Total PAH (POM Surrogate)			84.6	13.7	3.55	22.8	1.61	16.77	1.68	4.02	44.79
Biphenyl											
Ethyl benzene											
Hexane											
Naphthalene	0.0346	0.391	0.29	0.68	0.03	0.56	0.17	0.39	0.03	0.16	2.1
Toluene											
Xylene											

Chemical	ORNL Lowest Chronic Value Fish EqP Sediment Screening Benchmark (mg/kg)	ORNL Lowest Chronic Value Nondaphnid Inverts EqP Sediment Screening Benchmark (mg/kg)	ORNL Lowest Chronic Value Daphnids Equilibrium Partitioning EqP Benchmark (mg/kg)	ORNL Secondary Chronic Value EqP Sediment Screening Benchmark (mg/kg)	OSWER Ecotox Thresholds Sediment Screening Benchmark (mg/kg)	Ontario Low Sediment Screening Benchmark (mg/kg)	Ontario Severe Sediment Screening Benchmark (mg/kg)	SD EPA R4 Sediment Screening Benchmark (mg/kg)	SD EPA R5 ESL Sediment Screening Benchmark (mg/kg)	SD EPA R6 FW Sediment Screening Benchmark (mg/kg)	SD EPA R6 Mar Sediment Screening Benchmark (mg/kg)
Benzene					0.05				0.14		
Total PAH (POM Surrogate)					4	4	100	1.68		4	4.022
Biphenyl											
Ethyl benzene					3.6				0.175		
Hexane											
Naphthalene					0.48			0.33	0.17	0.176	0.16
Toluene					0.67				1.22		
Xylene									0.43		

Table A-3 (continued)

Chemical	Washington MAEL Sediment Screening Benchmark (mg/kg)	Washington NEL Sediment Screening Benchmark (mg/kg)	High Value	Low Value	Sediment Concentration (mg/kg wet wt.)	Sediment Concentration (mg/kg dry wt.) [1]	HQ (unitless)
Benzene			0.14	0.05	6.03E-12	1.21E-11	2.41E-10
Total PAH (POM Surrogate)	7.8	3.7	100	1.61	3.16E-11	6.33E-11	3.92E-11
Biphenyl					1.51E-12	3.02E-12	
Ethyl benzene			3.6	0.175	3.62E-11	7.24E-11	
Hexane					8.30E-11	1.66E-10	
Naphthalene	1.7	0.99	2.1	0.03	1.39E-11	2.79E-11	9.29E-10
Toluene			1.22	0.67	1.15E-10	2.30E-10	3.43E-10
Xylene			0.43	0.43	2.19E-10	4.39E-10	1.02E-09
							HI = 2.99 E-09

[1] Dry weight = wet weight ÷ 0.5 (assumes 50% soil moisture content - Hillel, 1971)

List of Acronyms for Appendix Tables A-1, A-2, A-3.

Acronyms

ARCS	=	U.S. EPA Assessment and Remediation of Contaminated Sediments Program
BCMOELP	=	British Columbia Ministry of Environment, Land, and Parks
CCME	=	Canadian Council of Ministers of the Environment
CEC	=	Commission of European Communities
DEC	=	Department of Environmental Conservation
EC20	=	Observable effects concentration in 20% of test organisms
EC25	=	Observable effects concentration in 25% of test organisms
Eco-SSL	=	Ecological Soil Screening Level
ECW	=	Environmental Contaminants in Wildlife
EqP	=	Equilibrium Partitioning
ERL	=	Effects Range Low
ERM	=	Effects Range Median
ESL	=	Ecological Screening Level
ET	=	Ecotox Thresholds
FDEP	=	Florida Department of Environmental Protection
FW	=	Fresh Water
ISQG	=	The Interim Sediment Quality Guidelines
LCV	=	Lowest Acceptable Chronic Value
MAEL	=	Minor Adverse Effects Level
MAR	=	Marine
NAWQC	=	National Ambient Water Quality Criteria
NEC	=	No Effect Concentrations
NEL	=	No Effects Level
NOAA	=	National Oceanic & Atmospheric Administration
ORNL	=	Oak Ridge National Laboratory
OSWER	=	Office of Solid Waste and Emergency Response
PEC	=	Probable Effect Concentrations
PEL	=	Probable Effects Level
R4	=	EPA Region 4
R5	=	EPA Region 5
R6	=	EPA Region 6
SAV	=	Secondary Acute Value

List of Acronyms (continued)

SCV	=	Secondary Chronic Value
SD	=	Sediment
SO	=	Soil
SW	=	Surface Water
TEC	=	Threshold Effect Concentrations
TEL	=	Threshold Effects Level
WQG	=	Water Quality Guidelines

FLINT HILLS
RESOURCES®
Pine Bend Refinery

P.O. Box 64596
Saint Paul, Minnesota 55164
651.437.0700

March 8, 2007

Ms. Jennifer Darrow
US EPA Region 5
77 West Jackson Boulevard
Mail Code: AR-18J
Chicago, IL 60604-3507

RE: Flint Hills Resources, LP– Pine Bend Refinery
Information to Support US EPA's Review of #3 Coker Drum Replacement Project for the Endangered Species Act

Dear Ms. Darrow:

As follow-up to our e-mail and phone communications on the week of February 26, Flint Hills Resources (FHR) is providing supporting information on the proposed #3 Coker Drum Replacement Project at the Minnesota petroleum refinery and nearby threatened and endangered species located in the area of the refinery. Specifically, you asked for the following information:

- Description of the changes associated with the project
- Total facility actual emissions as well as the emissions increase associated with the project
- Description of location and surroundings
- Impacts of the project on threatened and endangered species

Description of #3 Coker Drum Replacement Project

The Pine Bend petroleum refinery operates three delayed coking units that process heavy hydrocarbon feedstock into lighter, more valuable fractions or into petroleum coke. The feedstock to the coker undergoes partial vaporization and mild cracking as it passes through a furnace. The lighter fractions are sent to other plants for further processing, and the petroleum coke remains in a coke drum from which it is cut into fragments, crushed, and then stored and transported off-site.

The purpose of the #3 Coker Drum Replacement Project is to replace the end-of-life coke drums in the #3 coker unit (E and F drums). The new drums will lead to a small increase in the #3 coker charge rate and associated downstream utilization increases that are detailed further below. Other miscellaneous minor physical changes will be made within the existing coker process units inside the refinery fence line, as described in the air quality permit application. See Figure 1 for the approximate boundaries of the proposed project site.

The reliability of the drums is of utmost priority to the safe operation of our delayed coking unit. The planning for such a replacement requires substantial logistical work and must be accomplished during a planned refinery shutdown. The actual work on these drums is set for the fall of 2009, but to meet that shutdown schedule, construction of the project must begin soon. The likelihood of not meeting this schedule, and thus the risks associated with delaying the coke drum replacement, increases if start of construction is delayed past the spring of 2007.

Existing Facility and Project Emissions Summaries

For context, facility-wide historical actual emissions from the Pine Bend refinery are compared to the allowable emissions increase for the #3 Coker Drum Replacement Project. Refinery-wide actual emissions for calendar years 2000 and 2005 are summarized in Table 1. During this time, FHR completed a voluntary emissions reduction initiative to decrease air, water, and waste emissions and discharges from the facility by at least 50 percent over a five year period. As shown in Table 1, emissions of NOx, SO_2, and VOC pollutants have been reduced considerably in recent years.

The allowable emissions increase from the #3 Coker Drum Replacement Project is a small fraction of the facility-wide actual emissions. For NOx, SO_2, and VOC, which are the primary criteria pollutants evaluated when completing a study on threatened or endangered animal or plant species, the allowable emissions increase from the project is more than offset by the substantial reduction in actual emissions at the refinery since 2000.

Nitrogen oxides (NOx) is the only pollutant that may exceed the Prevention of Significant Deterioration (PSD) significant emission rate thresholds for this project. All other regulated pollutants are well below the significant emission rate thresholds and thus do not trigger Federal review under PSD rules. Nevertheless, the emissions increase for these pollutants are included in Table 1 for informational purposes and to demonstrate that the project emissions of all regulated criteria pollutants are *de minimis*.

Table 1. Facility-wide historical emissions and allowable emissions increase from the project.

	CO	NOx	PM	PM_{10}	SO_2	VOC
Actual Emissions for Year 2000 (tons)*	994	4026	426	319	2697	1204
Actual Emissions for Year 2005 (tons)*	847	2131	478	312	1046	337
Allowable Emissions Increase from #3 Coker Drum Replacement Project (tons per year)	22	76	7	3	20	13
Project Emissions Increase as Percentage of Facility-wide Year 2000 Emissions (%)	2%	2%	2%	<1%	<1%	1%

* Minnesota Pollution Control Agency; Environmental Data Access Point Source Search for Permit Number 03700011; http://www.pca.state.mn.us/data/edaAir/pointResults.cfm?siteID=03700011&year=2000 and http://www.pca.state.mn.us/data/edaAir/pointResults.cfm?siteID=03700011&year=2005

The primary sources of the emissions increase associated with this project are:

1) increased utilization of existing process heaters that are fired on natural gas and refinery fuel gas,

2) new process components that could emit organic compounds as fugitive emission leaks.

Because none of the existing process heaters will experience an increase in maximum capacity or potential to emit due to this project, hazardous air pollutant (HAP) emissions from this equipment are not considered when determining applicability of Federal permitting under 40 CFR 63, Subpart B. In addition, these heaters are subject to and comply with EPA's Maximum Achievable Control Technology (MACT) standards for existing gas-fired process heaters under 40 CFR 63 Subpart DDDDD.

The potential to emit HAP from new process components associated with this project at the #3 Coker Unit are summarized in Table 2. The estimated potential to emit in Table 2 is a very conservative quantification both in terms of the expected number of new components as well as the emissions factor applied to estimate leaks. These process components will be subject to EPA's MACT standards for equipment leaks under 40 CFR 63 Subpart CC, which require the implementation of leak detection and repair (LDAR) work practice standards.

Table 2. Potential to emit HAP from new process components associated with the project.

Pollutant	Emissions (tpy)
Benzene	0.016
Ethyl Benzene	0.096
Naphthalene	0.037
Hexane	0.220
Toluene	0.305
Xylenes	0.582
Polycyclic Organic Matter	0.084
Biphenyl	0.004
Total HAP	1.344

The potential increase in organic HAP emissions from this project is a small fraction of the overall HAP emissions from the refinery. The last reported inventory of toxic air pollutant emissions from the refinery to the MPCA was for calendar year 2002. Total annual emissions of organic toxic air pollutants from the refinery were 68.5 tons.[1] Therefore, the potential to emit organic HAP from this project of 1.34 tpy is less than 2 percent of actual refinery-wide organic toxic air pollutant emissions.

Impact of Project on Soils and Vegetation

One of the required review elements under PSD is to evaluate whether air emissions from the project could adversely affect soils and vegetation. This review was conducted as part of the initial permit application submitted to the Minnesota Pollution Control Agency and is copied below.

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[1] Minnesota Pollution Control Agency; Environmental Data Access Point Source Search for Permit Number 03700011; http://www.pca.state.mn.us/data/edaAir/pointResults.cfm?siteID=03700011&year=2002

The #3 Coker Drums Replacement Project exceeds PSD significant emission rates for only NOx. Therefore, only NOx will be further analyzed for its impact on soils and vegetation.

Reactive nitrogen compounds can have an impact on terrestrial ecosystems through ambient air exposures by entering plants, usually through the leaves, and disturbing physiological processes. Nitric oxide (NO) and nitrogen dioxide (NO_2) are considered to be the major phytotoxicants of the various NOx species. It has been shown that NO and NO_2 interact differently within the plant (EPA, 1982). The effects of NOx are therefore categorized according to NOx species.

The occurrence and magnitude of effect on vegetation depends on the concentration of the nitrogen species, exposure duration, exposure interval and various other environmental factors (i.e. temperature, precipitation, light intensity, etc.) and biological factors (i.e. development stage, pests, pathogens, etc.).

Several plant characteristics affect a specific plant reaction to NOx and generally include: genetic characteristics (i.e., species, race, cultivar); phonologic characteristics (i.e. developmental stage) and phenotypic characteristics (i.e., interaction of genetic factors and the environment). Plant species determines the dose-response relationship; in other words, the species determines the sensitivity to NOx and thereby the risk level associated with a specific exposure.

Effects of NOx on plants can be described as 1) leaf injury including accelerated aging, leaf drop, and altered plant growth and 2) metabolic and growth effects.

The relationship between leaf injury and plant yield are not well understood (EPA, 1993). The major body of available data regarding the dose-response relationship of NOx and vegetation was derived from controlled experimental studies. It is important to note that because of the generally greater sensitivity of plants to NOx under controlled environmental conditions, the observed injury at a specific exposure level might not occur under field conditions.

Foliar injury (defined as any change in the appearance and/or function of a plant that is detrimental to the plant) can serve as an indicator of NOx-induced effects. From the data presented in the literature it is clear that the dose-response effect for leaf injury is not linear. High concentrations over a short period of time may show pronounced effects (i.e., 3000 $\mu g/m^3$ for 1 hour).

Based on the data reviewed (EPA, 1982, 1983; Bedsford, 1989; Caporn, 1989; Lane, 1984), an ambient concentration of 0.1 ppm NOx (or approximately 200 $\mu g/m^3$) or less over an extended time period, should not result in foliar lesions. A NOx concentration of 76.2 $\mu g/m^3$, which includes worst case concentrations plus background, was modeled for the No. 3 Hydrogen Plant Project in 1998 and 1999. The project involved the construction and operation of a new hydrogen plant. The #3 Coker Drums Replacement Project will not add significantly to this NOx concentration. The worst case concentration increase for the expansion project is modeled at 0.542 ug/m^3. Foliar injury due to NOx emissions plus background conditions is therefore not expected to occur. Foliar injury from NOx is rarely observed at ambient concentrations in the United States (EPA, 1993).

Experimental investigations have not provided a clear demarcation between the level of exposures to NOx and adverse effects on growth, development, or reproduction of plants. However, data (EPA, 1982, 1993, Irving, 1982) indicate that ambient concentrations of 0.1 ppm NOx (or approximately 200 $\mu g/m^3$) over an extended time period should not adversely effect growth or yield. The estimated worst case concentrations plus background of the 76.2 $\mu g/m^3$ modeled for the No. 3 Hydrogen Plant Project and the 0.542 $\mu g/m^3$ increase modeled for the current project is well below the metabolic and growth effect level.

For references, see "Vegetation Impact Analysis for the #3 Hydrogen Plant," February 1998, Koch Refining Company, LP.

Information on Threatened and Endangered Species

There are no recorded occurrences of Federal- or State-listed species within the proposed #3 Coker Drum Replacement Project area, or within the FHR Pine Bend Refinery. The US Fish and Wildlife Service (USFWS) lists the following four federally-listed species potentially present in Dakota County, Minnesota:

- Bald eagle (*Haliaeetus leucocephalus*),
- Minnesota dwarf trout lily (*Erythronium propullans*),
- Prairie bush clover (*Lespedeza leptostachya*), and
- Higgins-eye pearly mussel (*Lampsilis higginsi*).

At the state level, the Minnesota Department of Natural Resources (MDNR) Natural Heritage and Non-Game Research program conducted a site survey in 2004 for environmental review of a non-PSD crude unit expansion project at the FHR Pine Bend Refinery. The 2004 MDNR survey identified eleven locations of listed species or sensitive features within the wooded area east of the Pine Bend Refinery and east of US Highway 52. The identified features include the annual herb James' Polinisia (*Polinisia jamesii*), the perennial shrub creeping juniper (*Juniperus horizontalis*), the gopher snake (*Pituophis catanifer*), and the sensitive plant communities oak forest and dry prairie. The James' Polinisia is a state-endangered species; the creeping juniper and gopher snake are state species of Special Concern. The 2004 MDNR survey also identified a bald eagle nest approximately 5000 feet east of the refinery near the banks of the Mississippi River. Figure 1 shows the locations of the 2004 MDNR survey features.

All eleven sensitive features identified by the 2004 MDNR survey are located a minimum of 1000 feet east of the FHR Pine Bend Refinery, and all but two are at least one-half mile away. Along with the horizontal distance from the refinery, most of the identified features are below the bluffs that begin east of Highway 52, so that there is vertical separation of up to 200 feet from the refinery elevation, as shown in Figure 2. Noise from the project or from the refinery itself would be inaudible over the existing traffic noise generated by trucks and cars on Highway 52.

Moreover, with regard to the Federal-listed species, it is unlikely that they are present or that the proposed action poses any potential impact to them. The Minnesota dwarf trout lily is known to be present in only two locations in the world, in Rice and Goodhue Counties south of Dakota County. The USFWS inclusion of Dakota County on the list of potential occurrences accommodates the small possibility that a third undiscovered population is present. Given the scarcity of the species and its habitat preferences, it is unlikely that the dwarf trout lily is present in the vicinity of the FHR Pine Bend Refinery. Similarly, while dry prairie habitat is present east of Highway 52, the MDNR survey did not identify prairie bush clover, and the habitat present is more shaded than the plant's preference.

Since the work on the #3 Coker Drum Replacement Project does not involve discharge to streams or to the Mississippi River, there is no potential impact to Higgins-eye pearly mussels that may be present. Finally, the bald eagle nest located by the 2004 MDNR survey is nearly one mile east of the proposed work. The USFWS generally reviews activities that have a bald eagle nest within one-quarter mile of the project, and does not consider activities beyond that distance to be potential sources of disturbance. Also, as you may be aware, the bald eagle's status is currently in the delisting process. Even with a reduction in protection status, the Bald and Golden Eagle Protection Act would still prohibit disturbance of an eagle. The definition of "disturb" has not yet been finalized; however, it generally means any injury or harassment of an eagle, including interference with breeding, feeding or sheltering behavior. The proposed activities for the #3 Coker Drum Replacement Project will not injure, harass or interfere with eagle activities.

If any of the Federal- or State-listed plant species were present, the air emissions resulting from the project are unlikely to adversely affect plant populations. As detailed above, the ambient NOx concentrations modeled for the project are well below the documented concentrations for foliar injury or disruption of metabolic and growth processes. This applies to plant species within the dry prairie and oak forest communities as well.

The #3 Coker Drum Replacement Project is unlikely to result in adverse impacts to Federal- or State-listed species, because the project has no ground-disturbing impacts within habitat or known locations of listed species, has no discharge to streams or other waterways, and will not produce NOx emissions at ambient concentrations known to cause injury or disruption of metabolic processes to plants.

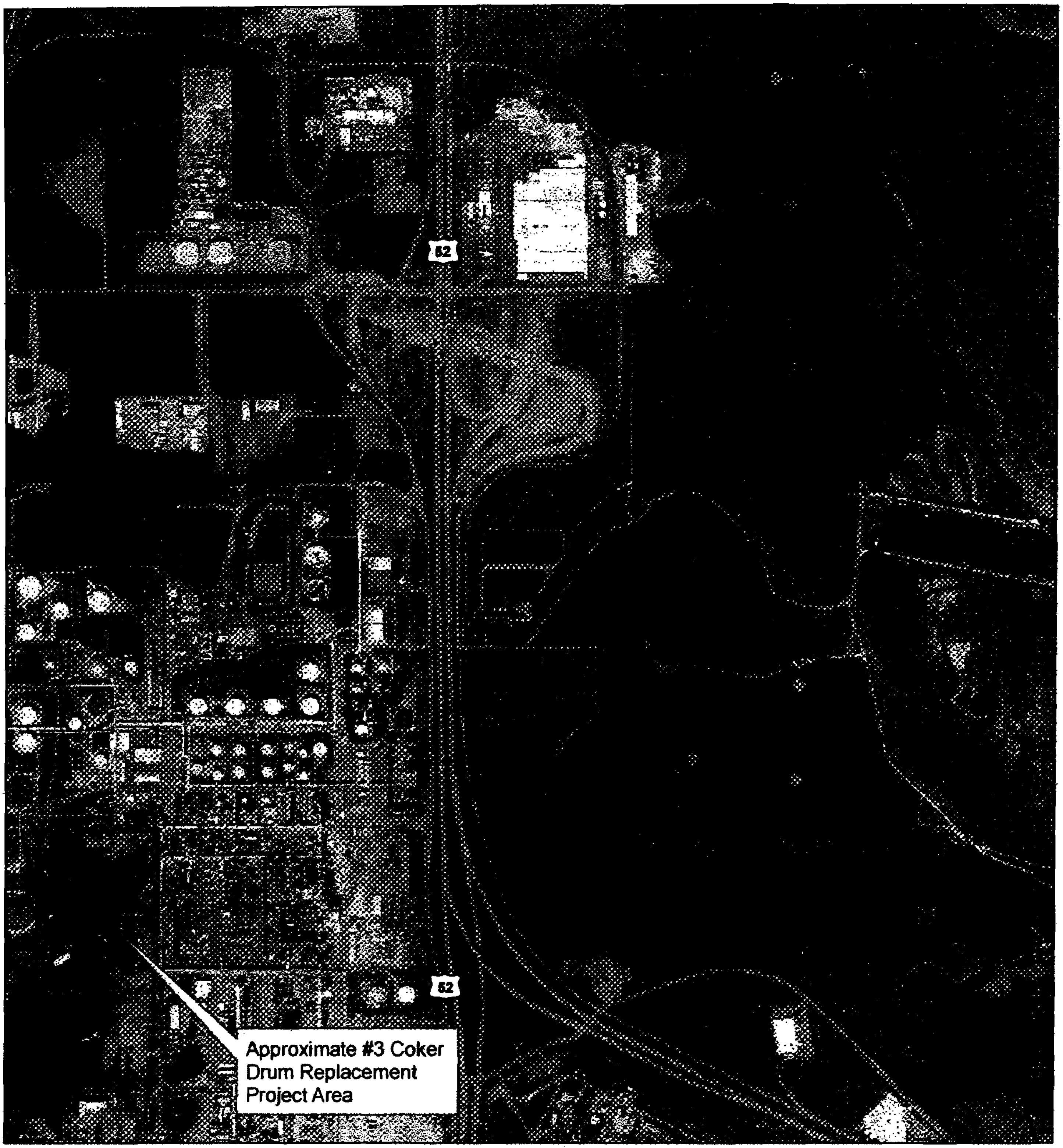
If you have any questions about this permit application, please contact me directly at 651-437-0541.

Sincerely,

Nathan H. Kowalsky
Air Project Engineer
Flint Hills Resources

Encl.

cc: Mr. Steven Pak, MPCA



Legend

- Bald Eagle Nest
- Creeping Junipoer
- Dry Prairie
- Gopher Snake
- James Polonisia
- Oak Forest

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500 0 500 1,000 1,500 2,000
Feet

Figure 1

Locations of State-Listed Species and Sensitive Features Identified by 2004 MDNR Survey

#3 Coker Drum Replacement Project
Flint Hills Resources, LP
Pine Bend, MN

Legend

- Bald Eagle Nest
- Creeping Junipoer
- Dry Prairie
- Gopher Snake
- James Polonisia
- Oak Forest

N

500 0 500 1,000 1,500 2,000

Feet

Figure 2

Topography & Locations of State-Listed Species and Sensitive Features Identified by 2004 MDNR Survey

#3 Coker Drum Replacement Project
Flint Hills Resources, LP
Pine Bend, MN