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Memorandum

Date: July 15, 2002

To: Mike Ribordy, USEPA
Peter Barrett, CH2M Hill
Sandra Bron, IEPA
Michael Henry, IDNR
Kevin de la Bruere, USF&WS

From: Bob Veenstra, URS Corporation

Subject: **Transmittal of Final, Approved Sauget Area 2 SSP Volumes 1, 2A, 2B, & 2C**

Attached please find your copy (or copies) of the final Support Sampling Plan, Volumes 1, 2A, 2B, and 2C, for the Sauget Area 2 RI/FS work. Please do not hesitate to call me at (314) 754-1036 if I can be of further assistance.

cc: Steve Smith, Sauget Area 2 Sites Group Project Manager
Bruce Yare, Solutia
John Regan, Herst & Associates
Dick Burke, Eagle Marine

RI/FS Support Sampling Plan

Sauget Area 2 Sites

Sauget, Illinois

Volume 1

Support Sampling Plan

April 15, 2002

Submitted To:

U.S. Environmental Protection Agency

Submitted By:

Sauget Area 2 Sites Group

Volume 1

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Waste, Soil, Storm Water, Groundwater and Air Sampling Project Plans

Volume 2A Field Sampling Plan
Volume 2B Quality Assurance Project Plan
Volume 2C Health and Safety Plan

Volume 3

Surface Water, Sediment and Aquatic Biota Sampling Project Plans

Volume 3A Field Sampling Plan
Volume 3B Quality Assurance Project Plan
Volume 3C Health and Safety Plan

Volume 4

Terrestrial Biota Sampling Project Plans

Volume 4A Field Sampling Plan
Volume 4B Quality Assurance Project Plan
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Volume 5

Analytical Laboratory Quality Assurance Plans and Standard Operating Procedures

Volume 5A Lancaster Laboratories, Lancaster, Pennsylvania
Volume 5B STL Savannah Laboratories, Savannah, Georgia
Volume 5C Triangle Laboratories, Durham, North Carolina

Volume 6

Data Validation Plan

Section 1

1.0 Introduction

On November 20, 2000, the Sauget Area 2 Sites Group (SA2SG) Potentially Responsible Parties (PRPs) signed an Administrative Order on Consent (AOC), Docket Number V-W-01-C-622, to perform a Remedial Investigation/Feasibility Study (RI/FS) at Sauget Area 2 Sites O, P, Q, R and S. USEPA Region 5 signed the AOC on November 24, 2000. This Support Sampling Plan (SSP) is submitted to partially fulfill the requirements of Section V.2, Work to be Performed, of the AOC.

The Sauget Area 2 Sites Group (SA2SG) is committed to performing the work required by the November 24, 2000 AOC in a responsive, responsible and cost-effective manner that is consistent with the National Contingency Plan (NCP). This Support Sampling Plan sets forth the steps that the SA2SG plans to undertake in performing the work required by the AOC Scope of Work (SOW). Specifically, it presents:

- A comprehensive investigation of waste in the disposal areas; the extent of migration of site-related constituents via the soil, groundwater, surface water, sediment and air pathways and determination of constituent concentrations in aquatic and terrestrial biota. These investigations are described in the following plans:
  - Waste, Soil and Stormwater Sampling Plan (Section 6.0)
  - Ground Water Sampling Plan (Section 7.0)
  - Surface Water, Sediment and Biota Sampling Plan (Section 8.0)
  - Air Sampling Plan (Section 9.0)
- A comprehensive evaluation of the human health risks associated with the migration of constituents via the soil, groundwater, surface water, sediment and air pathways. This evaluation is presented in the Human Health Risk Assessment Work Plan (Section 11.0).
- A comprehensive evaluation of the ecological risks associated with the migration of constituents via the soil, groundwater, surface water and sediment pathways. This evaluation is presented in the Ecological Risk Assessment Work Plan (Section 12.0); and
- An RI/FS Work Plan (Section 13.0)

These are complicated site investigations for at least three reasons: 1) the size of the study area, 2) the number (5) and age (1950s to 1980s) of the disposal areas and 3) the varied nature of the constituents likely to the present. In addition, these sites are on or adjacent to the Mississippi River. Disposal area contents, all five environmental media (soil, groundwater,

surface water, sediments and air), the aquatic ecosystem and the terrestrial ecosystem are being investigated in Sauget Area 2. Analytical parameters include Volatile Organic Compounds (VOCs), Semivolatile Organic Compounds (SVOCs), Metals, Pesticides, Herbicides, PCBs and Dioxin.

The Human Health Risk Assessment will evaluate exposure of indoor-industrial workers, outdoor-industrial workers, construction/utility workers, trespassing teenagers and recreational fishers to constituents in soil, groundwater, surface water, sediments, fish tissue, and air as appropriate for each receptor. The ERA will evaluate the potential for ecological effects to be expressed as a result of the exposure of representative organisms to constituents of concern in the aquatic and terrestrial environments. Benthic invertebrates, fish, great blue herons and ospreys will serve as the representative organisms to be used in the determination of ecological impairments to the aquatic community. Plants, short-tailed shrews, prairie voles, and the red fox will serve as the endpoint organisms for the evaluation of the terrestrial community.

The RI/FS will compile and interpret all of the data collected as part of the SSP, summarize the results of the Human Health and Ecological Risk Assessments and evaluate potential remedial measures.

Section 1.1 gives the requirements of the AOC, Section 1.2 describes the Conceptual Model for the Sauget Area 2 Sites, Section 1.3 lists the Support Sampling Plan Objectives and Section 1.4 explains the Support Sampling Plan Organization.

1.1 Administrative Order on Consent

The AOC requires preparation of a streamlined Remedial Investigation and Feasibility Study for Sauget Area 2 Sites O, P, Q, R and S. Specifically, the RI will evaluate the nature and extent of contamination resulting from the disposal/deposition of contaminants in Sauget Area 2 (Sites O, P, Q, R and S) and also assess the risk from this contamination on human health and the environment. The FS Report will evaluate alternatives for addressing the impact to human health and/or the environment from the contamination at Sauget Area 2. The RI and FS Reports will be conducted, at a minimum, consistent with the "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (U.S. EPA, Office of

Emergency and Remedial Response, October, 1988) and any other guidances that U.S. EPA uses in conducting a RI/FS, as well as any additional requirements in the administrative order.

The tasks to be completed as part of this RI/FS are:

Task 1	Support Sampling Plan
Task 2	Field Sampling Plan/Quality Assurance Project Plan
Task 3	Health and Safety Plan
Task 4	Remedial Investigation
Task 5	RI/FS Report

Each of these tasks is described below.

1.1.1 RI/FS Support Sampling Plan

The RI/FS Support Sampling Plan will address the following as set forth in the Scope of Work crafted by USEPA and attached to the AOC as Attachment B.

"The objective of this RI/FS support sampling is to further determine the extent of contamination at the Site beyond that already identified by previous site investigations. The plan shall contain a description of equipment specifications, required analyses, sample types, and sample locations and frequency. The plan shall address specific hydrologic, hydrogeologic, and air transport characterization methods including, but not limited to, geologic mapping, geophysics, field screening, drilling and well installation, flow determination, and soil/water/sediment/waste sampling to determine extent of contamination." (Pg. 2, AOC, Attachment B hereinafter referred to as "SOW")

"Respondents shall identify the data requirements of specific remedial technologies that may be necessary to evaluate remedial activities in the RI/FS and the Respondents shall provide a schedule stating when events will take place and when deliverables will be submitted." (Pg. 2, SOW)

"The RI/FS Support Sampling Plan shall include the following information:"

"**Site Background** - A brief summary of the Site location, general Site physiography, hydrology and geology shall be included. A summary description of the data already available shall be included which will highlight the areas of known contamination and the levels detected. Tables shall be included to display the minimum and maximum levels of detected contaminants across the Site." (Pg. 2, SOW)

"**Data Gap Description** - Respondents shall make an analysis of the currently available data to determine the areas of the Site which require additional data in order to define the extent of contamination for purposes of implementing a remedial action. A description of the number, types, and locations of additional samples to be collected shall be included in this section of the sampling plan." (Pg. 2-3, SOW)

"**Waste Characterization** - Respondents shall include a program for characterizing the waste materials at the Site. This shall include an analysis of current information/data on past disposal practices at the Site. For buried wastes, test pits/trenches and deep soil borings shall be proposed in the plan to determine waste depths and volume and to determine the extent of cover over fill areas. Soil gas surveys shall also be proposed for the areas on and around fill areas of the site. Geophysical characterization methods, such as ground penetrating radar or magnetometry, to further delineate potential "area of elevated concentration" drum removal areas shall also be included." (Pg. 3, SOW)

"**Hydrogeologic Investigation** - The plan shall include the degree of hazard, the mobility of pollutants, discharges/recharge areas, regional and local flow direction and quality, and local uses of groundwater. The plan shall also develop a strategy for determining horizontal and vertical distribution of contaminants and may include other hydraulic tests such as slug tests, and grain size analysis to assist in determining future potential remediation options. Upgradient samples shall be included in the plan." (Pg. 3, SOW)

"**Soils and Sediments Investigation** - Respondents shall include a program to determine the extent of contamination of surface and subsurface soils at the Site. The plan shall also determine the extent, including depth, of contamination of sediments in the Mississippi River. Samples of any leachate from the areas described as fill shall also be collected." (Pg. 3, AOC, AH:B)

"**Surface Water Investigation** - Respondents shall include [a program to determine the areas of surface water contamination in the Mississippi River]..." (Pg. 4, SOW)

"**Air Investigation** - Respondents shall include a program to determine the extent of atmospheric contamination from the various source areas at the Site. The program shall address the tendency of the substances identified through the waste characterization (i.e., PCBs) to enter the atmosphere, local wind patterns, and the degree of hazard." (Pg. 4, SOW)

"**Ecological Assessment** - Respondents shall include a plan for collecting data for the purpose of assessing the impact, if any, to aquatic and terrestrial ecosystems within and adjacent to Sauget Area 2, including within the Mississippi River, as a result of the disposal, release and migration of contaminants. The plan shall include a description of the ecosystems affected, an evaluation of toxicity, an assessment of endpoint organisms, and the exposure pathways. The plan shall also include a description of any toxicity testing or trapping to be included as part of the assessment. The ecological assessment shall be conducted in accordance with U.S. EPA guidance, including Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (June 5, 1997; EPA 540-R-97-006)." (Pg. 4, SOW)

"**Pilot Tests** - Respondents shall include a program for any pilot test(s) necessary to determine the implementability and effectiveness of technologies where sufficient information is not otherwise available." (Pg. 4, SOW)

1.1.2 Field Sampling Plan/Quality Assurance Project Plan

"Respondents shall include a description of the depths of sampling, parameters to be analyzed, equipment to be used, decontamination procedures to be followed, sample quality assurance, data quality objectives and sample management procedures to be utilized in the field. All sampling and analyses performed shall conform to U.S. EPA direction, approval, and guidance regarding sampling, quality assurance/quality control ("QA/QC"), data validation, and chain of custody procedures. Respondents shall ensure that the laboratory used to perform the analyses participates in a QA/QC program that complies with U.S. EPA guidance." (Pg. 4, SOW)

1.1.3 Health and Safety Plan

"Respondents shall prepare a Site safety plan which is designed to protect on-site personnel, area residents and nearby workers from physical, chemical and all other hazards posed by this sampling event. The safety plan shall develop the performance levels and criteria necessary to address the following areas:

- General requirements
- Personnel
- Levels of protection
- Safe work practices and safe guards
- Medical surveillance
- Personal and environmental air monitoring
- Personal hygiene
- Decontamination - personal and equipment
- Site work zones
- Contaminant control
- Contingency and emergency planning (including response to fires/explosions)
- Logs, reports and record keeping

The safety plan shall, at a minimum, follow U.S. EPA guidance document Standard Operating Safety Guides (Publication 9285.1-03, PB92-963414, June 1992), and all OSHA requirements as outlined in 29 CFR 1910." (Pg. 5, SOW)

1.1.4 Remedial Investigation

"Respondents shall conduct the Remedial Investigation according to the U.S. EPA approved Sampling Plan and schedule. Respondents shall coordinate activities with U.S. EPA's Remedial Project Manager (RPM). Respondents shall provide the RPM with all laboratory data." (Pg. 6, SOW)

1.1.5 Remedial Investigation/Feasibility Study Report

"...Respondents shall submit to U.S. EPA for approval a draft RI/FS report addressing all of Sauget Area 2. The RI/FS shall be consistent with the AOC and the SOW. The RI/FS shall be completed in accordance with the following [outline]" (Pg. 6, SOW)

Executive Summary

"The Executive Summary shall provide a general overview of the contents of the RI/FS. It shall contain a brief discussion of the Site and the current and/or potential threat posed by conditions at the Site." (Pg. 8, SOW)

Remedial Investigation

"The Remedial Investigation shall summarize available data on the physical, demographic, and other characteristics of the Site and the surrounding areas. Specific topics that shall be addressed in the site characterization are detailed below. The site characterization shall concentrate on those characteristics necessary to evaluate and select an appropriate remedy." (Pg. 8, SOW)

- Site Description and Background

  "The site description includes current and historical information. The following types of information shall be included, where available and as appropriate, to the site-specific conditions and the scope of the remedial action:

  - Site Location and Physical Setting
  - Present and Past Facility Operations and Disposal Practices
  - Geology/Hydrology/Hydrogeology
  - Current and past groundwater usage in the site area
  - Surrounding Land Use and Populations
  - Sensitive Ecosystems
  - Meteorology/Climatology" (Pg. 8, SOW)

- Previous Removal/Remedial Actions

  "The site characterization section shall also describe any previous removal and remedial actions at the Site. Previous information, if relevant, shall be organized as follows for each removal/remedial action:

- Scope and Objectives...
- [Duration]
- Nature and Extent of... [Constituents] Treated or Controlled...
- Monitoring...
- [Removal and/or Treatment Technologies]...
- [Treatment Levels]... (Pg. 9, SOW)

- Analytical Data

"This section shall [present] the available data, including, but not limited to soil, groundwater, surface water, sediments, and air. This section should discuss any historical data gaps that were identified, and the measures taken to develop all necessary additional data." (Pg. 9, SOW)

- Source, Nature and Extent of Contamination

"This section shall summarize the available site characterization data for Sauget Area 2, including the locations of the hazardous substances, pollutants, or contaminants; the quantity, volume, size or magnitude of the contamination; and the physical and chemical attributes of the hazardous pollutants or contaminants." (Pg. 9, SOW)

- Groundwater Fate and Transport

"- Constituent Characteristics
- Groundwater Fate and Transport Processes
- Groundwater Constituent Migration Trends
- Groundwater Modeling" (Pg. 8, SOW)

Risk Assessment

- Human Health Risk Assessment

"The risk assessment shall focus on actual and potential risks to persons coming into contact with on-site contaminants as well as risks to the surrounding residential and industrial worker populations from exposure to contaminated soils, sediments, surface water, air, and ingestion of contaminated organisms in surrounding impacted ecosystems.

Reasonable maximum estimates of exposure shall be defined for both current land use conditions and reasonable future land use conditions. It shall use data from the Site to identify the chemicals of concern, provide an estimate of how and to what extent human receptors might be exposed to these chemicals, and provide an assessment of the health effects associated with these chemicals. The evaluation shall project the potential risk of health problems occurring if no cleanup action is taken at the Site and establish target action levels for COCs (carcinogenic and non-carcinogenic). The risk evaluation shall be conducted in accordance with U.S. EPA guidance including, at a minimum: Risk Assessment Guidance for Superfund (RAGS) (EPA/540/1-89/002, December 1989) and RAGS Part D (EPA 540/R/97/033, January 1998). The risk assessment shall also include the following elements:

- Hazard Identification (Sources)

  The Respondents shall review available information on the hazardous substances present at the Site and identify the major contaminants of concern.

- Dose-Response Assessment

  Contaminants of concern should be selected based on their intrinsic toxicological properties.

- Conceptual Exposure/Pathway Analysis

- Characterization of Site and Potential Receptors

- Exposure Assessment

  Respondents shall develop reasonable maximum estimates of exposure for both current land use conditions and potential land use conditions at the Site.

- Risk Characterization.

- Identification of Limitations/Uncertainties" (Pg. 9-10, SOW)

- Ecological Risk Assessment

"The ecological risk assessment shall be conducted in accordance with U.S. EPA guidance including, at a minimum: Ecological Risk Assessment Guidance for Superfund, Process for

Designing and Conducting Ecological Risk Assessments, (EPA/540/R/97/006, June 1997). [It] shall describe the data collection activities conducted as part of Support Sampling Plan as well as the following information:

- Hazard Identification (Sources)

  The Respondents shall review available information on the hazardous substances present at and adjacent to the Site and identify the major contaminants of concern.

- Dose-Response Assessment

  Contaminants of concern should be selected based on their intrinsic toxicological properties.

- [Prepare] Conceptual Exposure/Pathway Analysis

- Characterization of Site and Potential Receptors

- [Select Chemicals, Indicator Species, and Endpoints

  In preparing the assessment, the Respondents shall select representative chemicals, indicator species (species that are especially sensitive to environmental contaminants), and end points on which to concentrate.]

- Exposure Assessment

  [The exposure assessment will identify the magnitude of actual exposures, the frequency and duration of these exposures, and the routes by which receptors are exposed. The exposure assessment shall include an evaluation of the likelihood of such exposures occurring and shall provide the basis for the development of acceptable exposure levels.]

- [Toxicity Assessment/Ecological Effects Assessment

  The toxicity and ecological effects assessment will address the types of adverse environmental effects associated with chemical exposures, the relationships between magnitude of exposures and adverse effects, and the related uncertainties for contaminant toxicity (e.g., weight of evidence for a chemical's carcinogenicity).]

- Risk Characterization

  [During risk characterization, chemical-specific toxicity information, combined with quantitative and qualitative information from the exposure assessment, shall be compared to measured levels of contaminant exposure levels and the levels predicted through environmental fate and transport modeling. These comparisons shall determine

whether concentrations of contaminants at or near the Site are affecting or could potentially affect the environment.]

- Identification of Limitations/Uncertainties

  [Respondents shall identify critical assumptions (e.g., background concentrations and conditions) and uncertainties in the report.]" (Pg. 10, SOW)

Feasibility Study

- Identification of Remedial Action Objectives

"The [Feasibility Study] shall develop remedial and, where appropriate, removal action objectives, taking into consideration the following factors:

- Prevention or abatement of actual or potential exposure to nearby human populations, (including workers), animals, or the food chain from hazardous substances, pollutants, or contaminants;
- Prevention or abatement of actual or potential contamination of drinking water supplies and ecosystems;
- Stabilization or elimination of hazardous substances in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release;
- Treatment or elimination of hazardous substances, pollutants, or contaminants in soils or sediments that may migrate;
- Elimination of threat of fire or explosion;
- Acceptable chemical-specific contaminant levels, or range of levels, for all exposure routes; and
- Mitigation or abatement of other situations or factors that may pose threats to public health, welfare, or the environment" (Pg. 11-12, SOW)

- Determination of Remedial Action Scope

"The [Feasibility Study] shall define the broad scope and specific short-term and long-term objectives of the remedial action and address the protectiveness of the remedial action." (Pg. 12, SOW)

- Determination of Remedial Action Schedule

  "The general schedule for remedial action and, where appropriate, removal activities shall be developed, including both the start and completion time for the remedial action." (Pg. 12, SOW)

- Identification of and Compliance with ARARs

  "The Feasibility Study shall identify all applicable, relevant and appropriate requirements at both the federal and state levels that will apply to the remedial action. The Feasibility Study shall also describe how the ARARs will be met." (Pg. 12, SOW)

- Identification and Analysis of Remedial Action Alternatives

  "Based on the analysis of the nature and extent of contamination and on the cleanup objectives developed in the previous section, a limited number of alternatives appropriate for addressing the remedial action objectives shall be identified and assessed. Whenever practicable, the alternatives shall also consider the CERCLA preference for treatment over conventional containment or land disposal approaches.

  The use of presumptive remedy guidance, if appropriate and applicable to any of the disposal areas of the Sauget Area 2 Site, may also provide an immediate focus to the identification and analysis of alternatives. This guidance includes, but is not limited to: Implementing Presumptive Remedies (EPA 540-R-97-029, October 1997). Presumptive remedies involve the use of remedial technologies that have been consistently selected at similar sites or for similar contamination.

  A limited number of alternatives, including any identified presumptive remedies, shall be selected for detailed analysis. Each of the alternatives shall be described with enough detail so that the entire treatment process can be understood. Technologies that may apply to the media or source of contamination shall be listed in the Feasibility Study.

The preliminary list of alternatives to address the Sauget Area 2 Site shall consist of, but is not limited to, treatment technologies (i.e., thermal methods), removal and off-site treatment/disposal, removal and on-site disposal, and in-place containment for soils, sediments and wastes." (Pg. 12-13, SOW)

- Detailed Analysis of Alternatives

"Defined alternatives are evaluated against the short- and long-term aspects of three broad criteria: 1) effectiveness, 2) implementability, and 3) cost." (Pg. 13, SOW)

  - Effectiveness

    "The effectiveness of an alternative refers to its ability to meet the objective regarding the scope of the remedial action. The "Effectiveness" discussion for each alternative shall evaluate the degree to which the technology would mitigate threats to public health and the environment. Criteria to be considered include:" (Pg. 13, SOW)

    - Overall Protection of Public Health and the Environment

      "How well each alternative protects public health and the environment shall be discussed in a consistent manner. Assessments conducted under other evaluation criteria, including long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs shall be included in the discussion. Any unacceptable short-term impacts shall be identified. The discussion shall focus on how each alternative achieves adequate protection and describe how the alternative will reduce, control, or eliminate risks at the Site through the use of treatment, engineering, or institutional controls." (Pg. 13, SOW)

    - Compliance with ARARs and Other Criteria, Advisories, and Guidance

      "The detailed analysis shall summarize which requirements are applicable or relevant and appropriate to an alternative and describe how the alternative meets

those requirements. A summary table may be employed to list potential ARARs. In addition to ARARs, other Federal or State advisories, criteria, or guidance to be considered (TBC) may be identified." (Pg. 14, SOW)

- Long Term Effectiveness and Permanence

"This evaluation assesses the extent and effectiveness of the controls that may be required to manage risk posed by treatment of residuals and/or untreated wastes at the Site. The following components shall be considered for each alternative: magnitude of risk, and, adequacy and reliability of controls." (Pg. 14, SOW)

- Reduction of Toxicity, Mobility, or Volume Through Treatment

"Respondents' analysis shall address U.S. EPA's policy of preference for treatment including an evaluation based upon the following subfactors for a particular alternative:

- Treatment process(s) employed and the material(s) it will treat
- Amount of the hazardous or toxic materials to be destroyed or treated
- Degree of reduction expecfed in toxicity, mobility, or volume
- Degree to which treatment will be irreversible
- Type and quantity of residuals that will remain after treatment
- Whether the alternative will satisfy the preference for treatment" (Pg. 14, SOW)

- Short Term Effectiveness

"The short-term effectiveness criterion addresses the effects of the alternative during implementation before the remedial objectives have been met. Alternatives shall also be evaluated with respect to their effects on human health and the environment following implementation. The following factors shall be addressed as appropriate for each alternative:

- Protection of the Community
- Protection of the Workers

- Environmental Impacts
- Time Until Response Objectives are Achieved" (Pg. 14, SOW)

- Implementability

"This section is an assessment of the implementability of each alternative in terms of the technical and administrative feasibility and the availability of the goods and services necessary for each alternative's full execution. The following factors shall be considered under this criterion:" (Pg. 15, SOW)

- Technical Feasibility

"The degree of difficulty in constructing and operating the technology; the reliability of the technology, the availability of necessary services and materials; the scheduling aspects of implementing the alternatives during and after implementation; the potential impacts on the local community during construction operation; and the environmental conditions with respect to set-up and construction and operation shall be described. Potential future removal actions shall also be discussed. The ability to monitor the effectiveness of the alternatives may also be described." (Pg. 15, SOW)

- Administrative Feasibility

"The administrative feasibility factor evaluates those activities needed to coordinate with other offices and agencies. The administrative feasibility of each alternative shall be evaluated, including the need for off-site permits, adherence to applicable non-environmental laws, and concerns of other regulatory agencies. Factors that shall be considered include, but are not limited to, the following: statutory limits, permits and waivers." (Pg. 15, SOW)

- Availability of Services and Materials

"The RI/FS must determine if off-site treatment, storage, and disposal capacity, equipment, personnel, services and materials, and other resources necessary to

implement an alternative shall be available in time to maintain the remedial schedule." (Pg. 15, SOW)

- State and Community Acceptance

  "State and Community Acceptance will be considered by U.S. EPA before a final remedial action is decided upon. Respondents need only mention in the Feasibility Study that U.S. EPA will consider and address State and community acceptance of an alternative when making a recommendation and in the final selection of the alternative in the ROD." (Pg. 15-16, SOW)

- Cost

  "Each alternative shall be evaluated to determine its projected costs. The evaluation should compare each alternative's capital and operation and maintenance costs. The present worth of alternatives should be calculated." (Pg. 16, SOW)

  - Direct Capital Costs

    "Costs for construction, materials, land, transportation, analysis of samples, treatment shall be presented." (Pg. 16, SOW)

  - Indirect Capital Costs (Pg. 16, SOW)

    "Cost for design, legal fees, permits shall be presented." (Pg. 16, SOW)

  - Long Term Operation and Maintenance Costs

    "Costs for maintenance and long-term monitoring shall be presented." (Pg. 16, SOW)

- Comparative Analysis of Remedial Action Alternatives

"Once remedial action alternatives have been described and individually assessed against the evaluation criteria described above, a comparative analysis shall be conducted to evaluate the relative performance of each alternative in relation to each of the criteria. The purpose of the analysis shall be to identify advantages and disadvantages of each alternative relative to one another so that key tradeoffs that would affect the remedy selection can be identified." (Pg. 16, SOW)

1.2 Conceptual Model for Sauget Area 2 Sites

Detailed discussions of the Conceptual Site Model (CSM) developed for the purposes of the Human Health Risk Assessment are presented in Section 11.2 and Figure 11-1. A detailed discussion of the CSM for the Ecological Risk Assessment (ERA) is presented in Section 12.5, for both aquatic and terrestrial pathways. This CSM is also presently graphically as Figures 12-1 through 12-3. The CSM for the Area 2 Sites will be further developed and refined, incorporating the information generated by this investigation program, in the RI/FS Report.

1.2.1 Constituent Migration to the Mississippi River

Two of the five disposal sites in Sauget Area 2 are located on the east bank of the Mississippi River (Sites Q and R). The other three disposal sites (O, P and S) are located 1500 to 2000 feet east of the riverbank. Solid and liquid industrial and municipal wastes were disposed at these facilities from the 1950s to the 1980s. The potential exists for constituent migration to the groundwater system from these disposal sites. The aquifer beneath Sauget Area 2 consists of three hydrogeologic units: 1) the Shallow Hydrogeologic Unit with fine-grained, silty sands, 2) the Middle Hydrogeologic Unit with clean, medium to coarse sand and 3) the Deep Hydrogeologic Unit with clean, medium to coarse sand and gravel. Leachate migrating from the waste disposal areas could enter these hydrogeologic units and then discharge to the river via the groundwater pathway. This is potentially the primary migration pathway for constituents from the disposal sites.

Another potential pathway for constituent migration to the Mississippi River is discharge via stormwater runoff. This pathway is not likely to be a major migration pathway at the sites with covers, i.e. Site O, Site P, the northern portion of Site Q, Site R and Site S. In addition, Sites O,

P, and S are located on the dry side of the floodwall and levee. Site O is covered with approximately two feet of clean, low permeability soil. Site P is partially covered by parking lots associated with entertainment establishments while the remainder of the area is vegetated. The northern portion of Site Q is used as a bulk storage terminal and is covered with cinders or gravel. Site R is covered with a clay cap two to eight feet thick. The northern portion of Site S is vegetated and the southern portion is covered with gravel. As reported by USEPA, past floods have inundated Site Q exposing drums and contaminated soils.

1.2.2 Constituent Migration to Human Receptors

Potential constituent migration pathways to human receptors are discussed in the Human Health Risk Assessment Site Conceptual Model (Section 11.0).

1.2.3 Constituent Migration to Ecological Receptors

Potential constituent migration pathways to ecological receptors are discussed in the Ecological Risk Assessment Site Conceptual Model (Section 12.0).

1.3 Support Sampling Plan Objectives

To expedite work plan approvals, the Sauget Area 2 Support Sampling Plan is patterned after the Sauget Area 1 Support Sampling Plan approved by USEPA Region 5 on September 9, 1999. The Sauget Area 2 SSP consists of four sampling plans: 1) Waste, Soil and Stormwater Sampling Plan, 2) Groundwater Sampling Plan, 3) Surface Water, Sediment and Ecological Sampling Plan and 4) Air Sampling Plan. Objectives for each sampling plan are outlined below:

- Waste, Soil and Stormwater Sampling Plan
  - Determine the areal extent of each disposal area
  - Identify areas of buried drums or tanks
  - Characterize wastes present at each disposal site
  - Characterize leachate present at each disposal site
  - Characterize surface soil at each disposal site
  - Characterize stormwater runoff at Sites R and Q
  - Characterize background soil

- Provide information for the Human Health Risk Assessment
- Provide information for the Ecological Risk Assessment

- Groundwater Sampling Plan
  - Characterize groundwater beneath and downgradient of Site O
  - Characterize groundwater beneath and downgradient of Site P
  - Characterize groundwater beneath and downgradient of Site Q
  - Characterize groundwater beneath and downgradient of Site R
  - Characterize groundwater beneath and downgradient of Site S
  - Determine groundwater flow direction
  - Determine groundwater flow rate
  - Provide information for the Human Health Risk Assessment

- Surface Water, Sediment and Ecological Sampling Plan
  - Characterize surface water, sediments and fish downgradient of Site P
  - Characterize surface water, sediments and fish downgradient of Sites O, R, S and the north end of Q
  - Characterize surface water, sediments and fish downgradient of Site Q
  - Characterize surface water, sediments and fish upstream of Sauget Area 2
  - Characterize surface water, sediments and fish downstream of Sauget Area 2
  - Provide information for the Human Health Risk Assessment
  - Provide information for the Ecological Risk Assessment

- Air Sampling Plan
  - Characterize air emissions from Site P
  - Characterize air emissions from Sites O, R and S
  - Characterize air emissions from Site Q
  - Provide information for the Human Health Risk Assessment

In addition to using the Sauget Area 1 Support Sampling Plan as a basis for the Sauget Area 2 Sites Sampling Plan Outline and follow-on work plans, the Sauget Area 1 Field Sampling Plans, Quality Assurance Project Plans and Health and Safety Plans will be used as a basis for preparing the corresponding Sauget Area 2 plans.

1.4 Support Sampling Plan Organization

The Support Sampling Plan consists of the following volumes:

Volume 1 Support Sampling Plan
Volume 2A Waste, Soil, Stormwater, Groundwater and Air Field Sampling Plan

Volume 2B Waste, Soil, Stormwater, Groundwater and Air Quality Assurance Project Plan
Volume 2C Waste, Soil, Stormwater, Groundwater and Air Health and Safety Plan

Volume 3A Surface Water, Sediment and Aquatic Biota Field Sampling Plan
Volume 3B Surface Water, Sediment and Aquatic Biota Quality Assurance Project Plan
Volume 3C Ecological Sampling Health and Safety Plan

Volume 4A Terrestrial Biota Field Sampling Plan
Volume 4B Terrestrial Biota Quality Assurance Project Plan
Volume 4C Ecological Sampling Health and Safety Plan

Volume 5 STL Savannah Laboratories Quality Assurance Manual and Standard Operating Procedures

Volume 6 Data Validation Plan

Specific requirements of the November 24, 2000 AOC SOW are addressed in the Support Sampling Plan as shown below:

AOC SOW Support Sampling Plan Element	**SA2SG Support Sampling Plan Section**
	1.0 Introduction
Site Background	2.0 Sites Description and Background
Data Gap Description	5.0 Data Gap Description
Waste Characterization	6.0 Waste, Soil and Stormwater Sampling Plan
Hydrogeologic Investigation	7.0 Groundwater Sampling Plan
Soil and Sediment Investigation	8.0 Surface Water, Sediment and Ecological Sampling Plan [1]
Surface Water Investigation [2]	
Air Investigation	9.0 Air Sampling Plan
Ecological Assessment [3]	
Pilot Tests	10.0 Treatability Testing Plan
Field Sampling Plan	Field Sampling Plans
	Volume 2A Waste, Soil, Stormwater, Groundwater and Air Field Sampling Plan
	Volume 3A Surface Water, Sediment and Aquatic Biota Field Sampling Plan
	Volume 4A Terrestrial Biota Field Sampling Plan

AOC SOW Support Sampling Plan Element	SA2SG Support Sampling Plan Section
Quality Assurance Plan	Quality Assurance Project Plans
	Volume 2B Waste, Soil, Stormwater, Groundwater and Air Quality Assurance Project Plan
	Volume 3B Surface Water, Sediment and Aquatic Biota Quality Assurance Project Plan
	Volume 4B Terrestrial Biota Quality Assurance Project Plan
Health and Safety Plan	Health and Safety Plans
	Volume 2C Waste, Soil, Stormwater, Groundwater and Air Sampling Health and Safety Plan
	Volume 3C Ecological Sampling Health and Safety Plan
	Volume 4C Ecological Sampling Health and Safety Plan
Laboratory Quality Assurance Plans	Laboratory Quality Assurance Plans
	Volume 5 STL Savannnah Laboratories QAM and SOPs

Notes:

1) Soil sampling is described in Section 6.0 Waste, Soil and Stormwater Sampling Plan
2) Surface water sampling is described in Section 8.0 Surface Water, Sediment and Ecological Sampling Plan
3) Ecological assessment sampling is described in Section 8.0 Surface Water, Sediment and Ecological Sampling Plan

Section 2

2.0 Sites Description and Background

The Sauget Area 2 Sites are located in the City of East St. Louis and the Villages of Sauget and Cahokia in St. Clair County, Illinois. The Sauget Area 2 study area is east of the Mississippi River and south of the MacArthur bridge railroad tracks (Figure 2-1). The study area is west of Route 3 (Mississippi Avenue) and north of Cargill Road.

Sites	Former Use	Municipality
Site O	Sewage Sludge Dewatering	Village of Sauget
Site P	Municipal and Industrial Waste Disposal	City of East St. Louis Village of Sauget
Site Q	Municipal and Industrial Waste Disposal	Village of Sauget Village of Cahokia
Site R	Industrial Waste Disposal	Village of Sauget
Site S	Chemical Reprocessing Waste Disposal	Village of Sauget

These sites are located in an area historically used for heavy industry, including chemical manufacturing, metal refining and power generation, and waste disposal. Currently the area is used for heavy industry, warehousing, bulk storage (coal, refined petroleum, lawn and garden products and grain), waste water treatment, hazardous waste treatment, waste recycling and truck terminals. Four commercial establishments are located at the north end of the study area. No residences are located within the study area. Residential areas closest to Sauget Area 2 are approximately 3,000 feet east of Site P and about 3,000 feet east of Site O. These residential areas are located, respectively, in East St. Louis and Cahokia.

2.1 Sites Location and Physical Setting

The Sauget Area 2 Sites are located in the floodplain of the Mississippi River in an area known as American Bottoms. Topographically, the area consists primarily of flat bottom land although local topographic irregularities do occur. Generally, land surface in the American Bottoms

slopes from north to south and from east to west toward the Mississippi River. Land surface elevation ranges from 400 to 410 feet above Mean Sea Level (MSL) with little topographic relief. Sauget Area 2 consists of five former disposal areas, Sites O, P, Q, R and S, adjacent, or in close proximity, to the Mississippi River. These five disposal areas were given letter designations by the Illinois Environmental Protection Agency (IEPA) in the 1980s. Two of these sites, Sites Q and R, are located on the wet side of the floodwall and levee which is operated and maintained by the US Corps of Engineers and the Metro East Sanitary District. The floodwall is designed to protect the City of East St. Louis and the Villages of Sauget and Cahokia from flooding. Sites O, P and S are located on the dry side of the floodwall and levee.

2.2 Present and Past Facility Operations and Disposal Practices

Each of the five sites in Sauget Area 2 is described below. Maximum chemical concentrations included in these site descriptions were included by USEPA in the AOC.

2.2.1 Site O

Site O, located on Mobile Avenue in Sauget, Illinois, occupies approximately 20 acres of land to the northeast of the American Bottoms Regional Wastewater Treatment Facility (ABRTF). An access road to the ABRTF runs through the middle of the site. In 1952, the Village of Sauget Waste Water Treatment Plant began operation at this location. In addition to providing treatment for the Village of Sauget, the plant treated effluent from the various Sauget industries. During its operation the treatment plant received and treated industrial and municipal wastewater. Approximately 10 million gallons per day of wastewater was treated most of which was from area industries.

Four lagoons were constructed at the wastewater treatment plant in 1965 and placed in operation in 1966/1967. Between 1966/67 and approximately 1978, these lagoons were used to dispose of clarifier sludge from the wastewater treatment plant. They were designated as Site O during a site investigation conducted by IEPA in the 1980s. The lagoons were closed in 1980 by stabilizing the sludge with lime and covering it with approximately two feet of clean low-permeability soil. Currently, the lagoons are covered with clean low-permeability soil and are vegetated.

Parties that EPA alleges discharged to the Sauget Wastewater Treatment Plant during the time period that the sludge lagoons were in operation included, at a minimum:

- Amax Zinc Corporation,
- American Zinc Company
- Cerro Copper Products Company
- Clayton Chemical Co.
- Darling Fertilizer
- Ethyl Petroleum Additives, Inc.
- Midwest Rubber Reclaiming
- Mobil Oil Corporation
- Monsanto Company
- Rogers Cartage Company
- Wiese Planning and Engineering

Parties which own and/or operate, or previously owned and/or operated, portions of Site O include:

- Village of Sauget

2.2.2 Site P

Site P, which is bounded by the Illinois Central Gulf Railroad tracks, the Terminal Railroad Association tracks and Monsanto Avenue, occupies approximately 20 acres of land located in the City of East St. Louis and the Village of Sauget. It was operated by Sauget and Company as an IEPA-permitted landfill from 1973 to approximately 1984 accepting general wastes, including diatomaceous earth filter cake, from Edwin Cooper and non-chemical wastes from Monsanto. IEPA inspections documented the presence of drums labeled "Monsanto ACL-85, Chlorine Composition," drums labeled phosphorus pentasulfide from Monsanto and Monsanto ACL filter residues and packaging. Site P is currently inactive and partially covered, however, access to the site is not restricted.

Parties which EPA alleges to have generated, disposed of, released into and/or transported wastes to Site P include:

- Edwin Cooper Petroleum Additives
- Kerr-McGee Chemical Company
- Monsanto Chemical Company

EPA alleges that parties who potentially own, previously owned and/or operated Site P include:

- Cahokia Trust Properties
- Chicago Title & Trust Company
- City of East St. Louis
- Gulf-Mobile & Ohio Railroad
- Magna Trust
- Metro East Sanitary District
- Norfolk Southern
- SI Enterprises
- Sauget and Company
- Solutia
- Southern Railway System
- Union Electric Company

2.2.3 Site Q

Site Q, a former subsurface and surface disposal area, occupies approximately 90 acres in the Villages of Sauget and Cahokia. This Site is divided by the Alton and Southern Railroad into a northern portion and a southern portion. The northern portion consists of 65 acres bordered on the north by Site R and Monsanto Avenue. The northern portion is bordered on the south by the main track of the Alton and Southern Railroad and property owned by Patgood Inc. On the east, the northern portion of the site is bordered by the Illinois Gulf Central Railroad and the US Army Corps of Engineers (USACE) flood control levee and on the west the Site is bordered by the Mississippi River.

The southern portion consists of 25 acres, north of Cargill Road and south of the Alton and Southern Railroad. The southern portion is bounded on the west by a 10-ft wide easement owned by Union Electric for transmission lines and a spur track of the Alton and Southern Railroad to the Fox Terminal. A barge terminal operated by St. Louis Grain Company is located between the Union Electric easement, the spur track and the Mississippi River. Southern Site Q is bordered on the east by the Illinois Central Gulf Railroad and the flood control levee.

Disposal started in the 1950s and continued until the 1970s. Allegedly, Sauget and Company started operation of a landfill south of the River Terminal in 1966 and terminated operations in 1973. This facility took various wastes including municipal waste, septic tank pumpings, drums, organic and inorganic wastes, solvents, pesticides and paint sludges. It also took plant trash and waste from other industrial facilities and demolition debris.

Most of Site Q is covered with highly permeable black cinders. Eagle Marine Industries and Peavy Company, a division of ConAgra, operate barge terminal facilities in the central part of the northern portion of Site Q. The southern portion of Site Q is used for reclaiming rebar from concrete. A 10-acre site on the northern portion of Site Q is currently used by Rivercity

Landscape Supply as a bulk storage terminal for lawn and garden products. Raw landscape products such as mulch, rock and soil are processed and packed on this portion of the site.

Access to some portions of the site is restricted by fencing and gates. Other parts of the site have unrestricted access.

Site Q is on the west side of the USCOE floodwall. In 1993, during the highest recorded flood in St. Louis's history, Site Q was flooded. USEPA conducted a CERCLA removal action at the northern portion of Site Q in 1995. USEPA conducted a second CERCLA removal action at the southern portion of Site Q beginning in October of 1999 and into early 2000. During this removal action, USEPA excavated over 3,200 drums and over 17,000 cubic yards of contaminated soils containing metals, PCBs, and organics. Excavated material was transported by rail to Oklahoma for disposal at SafetyKleen's Lone Elk hazardous waste landfill.

EPA alleges that the following parties potentially generated, disposed of, released into and/or transported wastes to Site Q;

- AALCO Wrecking Company, Inc.
- Abco Trash Service
- Able Sewer Service
- Ajax Hickman Hauling
- Atlas Service Company
- Banjo Iron Company
- Barry Weinmiller Steel Fabrication
- Becker Iron & Metal Corporation
- Belleville Concrete Cont. Company
- Bi-State Parks Airport
- Bi-State Transit Company
- Boyer Sanitation Service
- Browning-Ferris Industries of St. Louis
- C&E Hauling
- Cargill Inc.
- Century Electric Company
- Circle Packing Company
- Clayton Chemical Company
- Corkery Fuel Company
- Crown Cork & Seal Company, Inc.
- David Hauling
- Dennis Chemical Company, Inc.
- Disposal Service Company
- Edgemont Construction
- Edwin Cooper Inc.
- Eight & Trendy Metal Company
- Evans Brothers
- Finer Metals Company
- Fish Disposal
- Fruin-Colnon Corporation
- Gibson Hauling
- H.C. Fournie Inc.
- H.C. Fournie Plaster
- Hilltop Hauling
- Huffmeier Brothers
- Hunter Packing Company
- Illinois Department of Transportation
- Inmont Corporation
- Lefton Iron & Metal Company
- Mallinckrodt Chemical
- Midwest Sanitation
- Mississippi Valley Control
- Monsanto Company
- Myco-Gloss
- Obear Nestor
- Roy Baur

- Dore Wrecking Company
- Dotson Disposal "All" Service
- Dow Chemical
- Patgood
- Thomas Byrd
- Trash Men Inc.
- United Technologies Corporation
- U.S. Paint Corporation

EPA alleges that the following parties potentially own, previously owned and/or operated Site Q:

- Cahokia Trust Properties
- ConAgra, Inc. (leasee)
- Eagle Marine Industries Inc.
- Industrial Salvage & Disposal Company
- Peavey Company
- Phillips Pipe Line Company
- Pillsbury Company (leasee)
- Sauget & Company
- Union Electric Company
- Village of Cahokia
- Village of Sauget

2.2.4 Site R

Site R, a closed industrial-waste disposal area owned by Solutia Inc, is located between the flood control levee and the Mississippi River in Sauget, Illinois. It is approximately 24 acres in size (approximately 2, 100 by 500 feet). Its northern border is Monsanto Avenue and its southern border is Site Q. A portion of Site Q, known as the "Dog Leg", is located to the east of Site R. This site once called the "Sauget Toxic Dump" and the "Monsanto Landfill" it is now known as the "River's Edge Landfill".

Industrial Salvage and Disposal, Inc. (ISD) operated the River's Edge Landfill for Monsanto from 1957 to 1977. Hazardous and non-hazardous bulk liquid and solid chemical wastes and drummed chemical wastes from Monsanto's W.G. Krummrich plant and, to a lesser degree, its Queeny plant in St. Louis were disposed at Site R. Disposal began in the northern portion of the site and expanded southward. Wastes contained phenols, aromatic nitro compounds, aromatic amines, aromatic nitro amines, chlorinated aromatic hydrocarbons, aromatic and aliphatic carboxylic acids and condensation products of these compounds.

In 1979, Monsanto completed the installation of a clay cover on Site R to cover waste, limit infiltration through the landfill, and prevent direct contact with fill material. The cover's thickness ranges from 2 feet to approximately 8 feet. In 1985, Monsanto installed a 2,250-foot long rock revetment along the east bank of the Mississippi River adjacent to Site R. The purpose of the

stabilization project was to prevent further erosion of the riverbank and thereby minimize potential for the surficial release of waste material from the landfill. During the 1993 flood, Site R was flooded but the clay cap was not overtopped. No erosion of the river bank or cap resulted from this flood.

Access to Site R is restricted by fencing and is monitored by Solutia plant personnel.

On February 13, 1992, the State of Illinois and Monsanto signed a consent decree entered in St. Clair County Circuit Court requiring further remedial investigations and feasibility studies to be conducted by Monsanto on Site R. The results of the Remedial Investigation/Feasibility Study were submitted to Illinois EPA in 1994. Solutia made a good faith offer to the IEPA to install an engineered cap and a leachate recovery system in 1997.

Parties who allegedly own, previously owned and/or operated Site R include:

- Cahokia Trust Properties
- Monsanto Company
- Solutia Inc
- Sauget and Company

2.2.5 Site S

Site S is located southwest of Site O. It is approximately 0.92 acres in size (approximately 100 by 400 feet). Allegedly, the property is or was owned by the Village of Sauget, Clayton Chemical and/or the Resource Recovery Group. In the mid-1960s, solvent recovery began on the Clayton Chemical property, part of which included in Site S, which is now owned by the Resource Recovery Group (RRG). The waste solvents were steam-stripped resulting in still bottoms that were allegedly disposed of in a shallow, on-site excavation that is now designated Site S. Historical aerial photographs indicate that Site S was potentially a waste and / or drum disposal area. The northern portion of the site is grassed and its southern portion is covered with gravel and fenced.

2.3 Geology, Hydrology and Hydrogeology

2.3.1 Geology

American Bottoms, the floodplain area on the east side of the Mississippi River, consists of unconsolidated valley fill deposits which are composed of Recent alluvium (Cahokia Alluvium) unconformably overlying glacial material of the Henry Formation. These unconsolidated deposits are underlain by Pennsylvanian and Mississippian age limestone and dolomite with lesser amounts of sandstone and shale.

Cahokia Alluvium (Recent deposits) consists of unconsolidated, poorly sorted, fine-grained materials with some local sand and clay lenses. Shallow Cahokia Alluvium is a fine-grained silty sand that becomes coarser with depth. These deposits are about 95 feet thick at the Mississippi River thinning away to about 40 feet thick at Route 3.

The underlying Henry Formation consists of approximately 40 feet of coarse-grained glacial outwash deposits composed of medium to coarse-grained sands becoming coarser with depth. In some areas, till and/or boulder zones were found 10 to 15 feet above the base of this unit.

Previous subsurface investigations conducted at the site (Geraghty & Miller, Inc. Remedial Investigation at Sauget Site R, August 1994) have identified a fill layer which is approximately 5 to 20 feet thick overlying the Cahokia Alluvium which was observed to be approximately 50 feet thick. The Henry Formation was observed to be approximately 80 feet thick during these investigations. Cross sections showing the regional geology are provided as Figures 2-2 through 2-4 and cross sections showing site-specific geology are provided as Figure 2-5.

2.3.2 Hydrology

One major surface-water feature, the Mississippi River, is found in the study area. The study area itself is located in the floodplain of the Mississippi River in an area known as American Bottoms. Topographically, the area consists, primarily, of flat bottom land although many minor irregularities occur locally. Generally, land surface in the American Bottoms area slopes from

north to south and from east to west toward the Mississippi River. Land surface elevation ranges from 400 to 410 ft above mean sea level with little topographic relief.

2.3.3 Hydrogeology

Site-specific geologic data show that the unconsolidated deposits range from 140 feet thick near the river to about 110 feet east of the study area. At most locations, the contact between Cahokia Alluvium and the Henry Formation can not be distinguished. However, three distinct hydrogeologic units can be identified: 1) a Shallow Hydrogeologic Unit (SHU), 2) a Middle Hydrogeologic Unit (MHU) and 3) a Deep Hydrogeologic Unit (DHU). The 30 ft. thick Shallow Hydrogeologic Unit includes the Cahokia Alluvium (recent deposits) and the uppermost portion of the Henry Formation. This unit is primarily an unconsolidated, fine-grained silty sand with low to moderate permeability. The 40 ft. thick Middle Hydrogeologic Unit is formed by the upper to middle, medium to coarse sand portions of the Henry Formation. It contains a higher permeability sand than found in the overlying Shallow Hydrogeologic Unit and these sands become coarser with depth. At the bottom of the aquifer is the 40 ft. thick Deep Hydrogeologic Unit which includes the high permeability, coarse-grained deposits of the lower Henry Formation. The zone is estimated to be about 40 feet thick.

Aquifer tests performed during the 1994 Geraghty & Miller Remedial Investigation indicate that the hydraulic conductivities are approximately 4 feet per day, 330 feet per day, and 300 feet per day for the shallow, medium, and deep groundwater zones respectively. A complete presentation and discussion of the results of the aquifer test and the groundwater modeling for Sauget Area 2 Site R, which was performed by Geraghty & Miller, is provided in Appendix 3 and 4, respectively.

The study area is very flat and surface drainage is predominantly by infiltration rather than surface runoff. Depth to water beneath the study area varies based on seasonal fluctuations, proximity to the river and the elevation of the Mississippi River. In general, depth to water varies from less than 10 feet to about 20 feet deep. Groundwater flow direction is from east to west with groundwater discharging to the Mississippi River.

2.4 Current and Past Ground Water Usage in the Sauget Area 2 Area

Groundwater is not used as a drinking water source in the Village of Sauget. In fact, groundwater use is controlled by village ordinance (Appendix 2). No public water supply wells are located near the study area. The nearest water supply well listed in public records is located at the former Falcon Drive-In Theater in East St. Louis, greater than two miles to the north. No residential wells were identified at or near the study area. Potable water is supplied to area industry and residents by a public water supply system that obtains its water from a surface water intake in the Mississippi River upstream of Sauget Area 2.

2.5 Surrounding Land Use and Population

Heavy industry has located on the east bank of the Mississippi River between Cahokia to Alton, Illinois for nearly a century. Industrial activity peaked in the 1960s and industries have been closing ever since. Although heavy industry has shut down throughout the American Bottoms, the area around Sauget Area 2 is still highly industrialized. In addition to heavy industry, the area currently has warehouses, trucking companies, and other commercial facilities. Industrial facilities currently operating in or near Sauget Area 2 are listed below:

Cahokia Marine Services	Coal Bulk Storage and Transfer
Eagle Marine Industries	Barge Terminal and Fleeting
Phillips Petroleum	Petroleum Bulk Storage and Transfer
Onyx Environmental Services	Hazardous Waste Treatment
Peavey/ConAgra	Bulk Grain Storage and Transfer
Resource Recovery Group	Waste Recycling
River City Landscape and Supply	Lawn and Garden Product Storage
Slay Terminals	Coal Bulk Storage and Transfer
St. Louis Grain Company	Bulk Grain Storage and Transfer
Union Electric	Electricity Distribution

Sauget Area 2 is transected by several petroleum, petroleum product or natural gas pipelines operated by Explorer Pipeline Company, Marathon, Phillips Pipeline and ExxonMobil.

Two dismantled industrial facilities, Midwest Rubber and Darling Fertilizer, were located east of the study area.

Historically, the study area was used for waste disposal. Three closed landfills (Sauget Area 2 Sites P, Q and R) and four closed sludge lagoons (Sauget Area 2 Site O) are located in the study area. Currently the area is used for waste treatment and recycling. Two active wastewater treatment plants, the PChem Plant and the American Bottoms Regional Treatment Facility, are located in the area. Both of these treatment plants are owned by the Village of Sauget. An operating hazardous waste incinerator, Onyx Environmental Services, is also located in area. The Resource Recovery Group recycled wastes at the location where Clayton Chemical reprocessed waste solvents. Additional information about the historical activities at the Resource Recovery Group area are presented later in this section. No additional information concerning current activities at this facility are known to the PRP Group. The facility reportedly is not currently active, and USEPA is conducting an emergency response at this facility.

No residential land use is located adjacent to or in the immediate vicinity of the Sauget Area 2 Sites. Residential areas of Sauget and East St. Louis are separated from the study area by other industries or undeveloped tracts of land. Limited residential areas exist to the northeast and southeast of these industrial facilities. Industrial areas exist approximately 2,000 feet west of the study area, across the Mississippi River in the City of St. Louis, Missouri, with residential areas further to the west.

A number of active industrial facilities are located upgradient of Sauget Area 2 including:

Astaris	Phosphorous Pentasulfide Manufacturing
Big River Zinc	Zinc Refining
Cerro Copper	Copper Tube Manufacturing
Ethyl Corporation	Petroleum Additive Manufacturing
Flexsys	Rubber Chemicals Manufacturing
Oxychem	Swimming Pool Chlorine Manufacturing
Solutia	Monochlorobenzene Manufacturing
Sterling Steel Castings	Foundry

American Bottoms Regional Treatment Facility – The Village of Sauget, Illinois owns and operates the American Bottoms Regional Wastewater Treatment Facility (ABRTF). The ABRTF brought on line in 1986 provides both primary and secondary treatment for its regional service area. It also provides secondary treatment for effluent from the Physical/Chemical Wastewater

Treatment Plant (PChem Plant). The PChem Plant provides primary treatment for Village wastewater that consists primarily of industrial wastewater. ABRTF has an NPDES Permit (No. IL0065145) to discharge treated effluent via a multiport diffuser to the Mississippi River at river mile 178. American Bottoms provides primary treatment as well as secondary biological treatment enhanced by powdered activated carbon..

Darling Fertilizer - Darling manufactured chemical fertilizers from 1922 to 1967. The process involved acidulation of phosphate rock and the subsequent blending of the rock with nitrates, lime, etc. After operations ceased, the plant was dismantled.

Midwest Rubber -- Midwest Rubber began operations in 1928. The company reclaimed rubber, principally from discarded automobile tires by heating the tires in autoclaves with caustic solution or chloride solution. Scrap rubber was run through a series of grinding processes creating sand-size granules that were fed into a dynamic devulcanizer unit and heated along with pitch, aromatic disulfide and turpene additives. This process produced a soft grade of rubber that was milled, compressed into blocks and sold for reuse in less expensive rubber products such as mats and toy tires. Butyl rubber was also manufactured at the site. A release of Diptene and gasoline from an underground storage tank at the facility was reported in January 1990. The plant is now dismantled. Above-ground storage tanks were removed in 1997 and underground storage tanks were removed in 1998.

Phillips Petroleum - Phillips Pipeline Company, a subsidiary of Phillips Petroleum, operates an active terminal for bulk storage and transfer of petroleum and propane at 3300 Mississippi Avenue in the Village of Cahokia. This facility, in operation since 1931, currently has 58 above-ground petroleum storage tanks with a total capacity of 2,309,235 barrels (96,987,970 gallons). It also has two above-ground propane storage tanks. Unleaded gasoline, premium unleaded gasoline, No. 2 low-sulfur distillate, No. 2 high-sulfur distillate, overhead gasoline, 100 aviation fuel, K-1, butane, propane, oil mix, sulfur distillate and ethanol are stored in these tanks. The terminal receives product via pipeline, rail tankers and trailer trucks. Products are moved from the terminal via tank trucks and pipelines.

Resource Recovery Group - This 7.35-acre property, and the area around it, was used as a railroad repair yard, complete with roundhouse and terminal, from 1930 to 1962. In 1962,

Joseph Reidy began operating a crude oil topping plant at the site. Products derived from this operation included white gas, distillate fuel oils and residual bottoms materials. Oil tank bottoms and white gas were disposed to the ground on site. Clayton Chemicals began solvent reclamation in the mid-1960s and continued until 1978. In 1983, IEPA modified the site's permit to allow acceptance and distillation of the following spent solvents:

- Spent halogenated-solvents including Tetrachloroethylene; Trichloroethylene; 1,1,1-Trichloroethane and Methylene Chloride;
- Spent nonhalogenated-solvents including Xylene, Acetone, Ethyl Acetate, Toluene and Methyl Ethyl Ketone; and
- Spent high flash-point, nonhalogenated-solvents including Mineral Spirits, Glycol Ether and heavy Naptha.

All spent solvents were to have a minimum solvent content of 30 percent. F001, F002, F003 and F005 and other sludges and still bottoms were excluded. Clayton Chemical was sold to Emerald Environmental in December 1993 and later renamed the Resource Recovery Group.

Trade Waste Incineration - Trade Waste Incineration (TWI), now Onyx Environmental Services, began by operating a hazardous waste incinerator on the Clayton Chemical property in 1980. Operations were relocated to their current site in 1983 after the property was purchased from the Illinois Central Gulf Railroad. In or about 1982, TWI connected its scrubber drain to the Village sewer system so that blowdown could be treated at the POTW. Scrubber sludge was drawn off and added to the waste ash removed from the incinerator.

2.6 Sensitive Ecosystems

The Sauget Area 2 Sites are within the wintering habitat range of the Bald Eagle, which has Federal "Endangered Species" protection. Bald eagles were observed at Sites Q and R by USEPA and Illinois EPA personnel in 1999. In addition, the site is within the range of the Federal "Threatened Status" decurrent false aster (Boltonia Decurrens). A discussion of

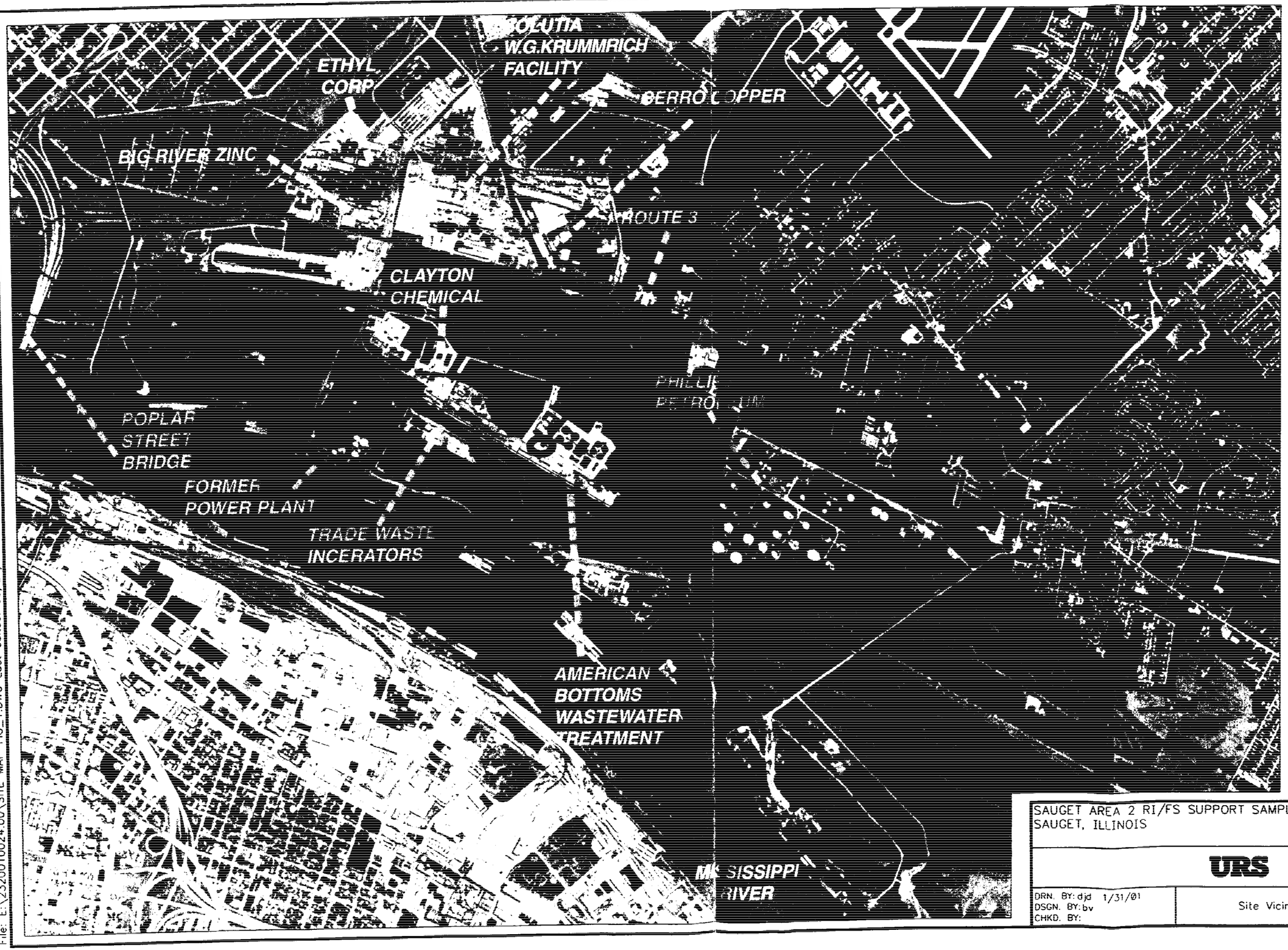
threatened and endangered species, both Federal and State (Missouri and Illinois) is presented in Section 12.4.2.

2.7 Meteorology and Climatology

Climate at the site is continental with hot humid summers and mild winters. Periods of extreme cold are short. Average annual rainfall from 1903 to 1983 was 35.4 inches and from 1963 to 1988 it was 39.5 inches. Average annual temperature is 56°F with the highest average monthly temperature in July (79°F) and the lowest average temperature in January (32°F).

Figure 2-1

Site Location Map

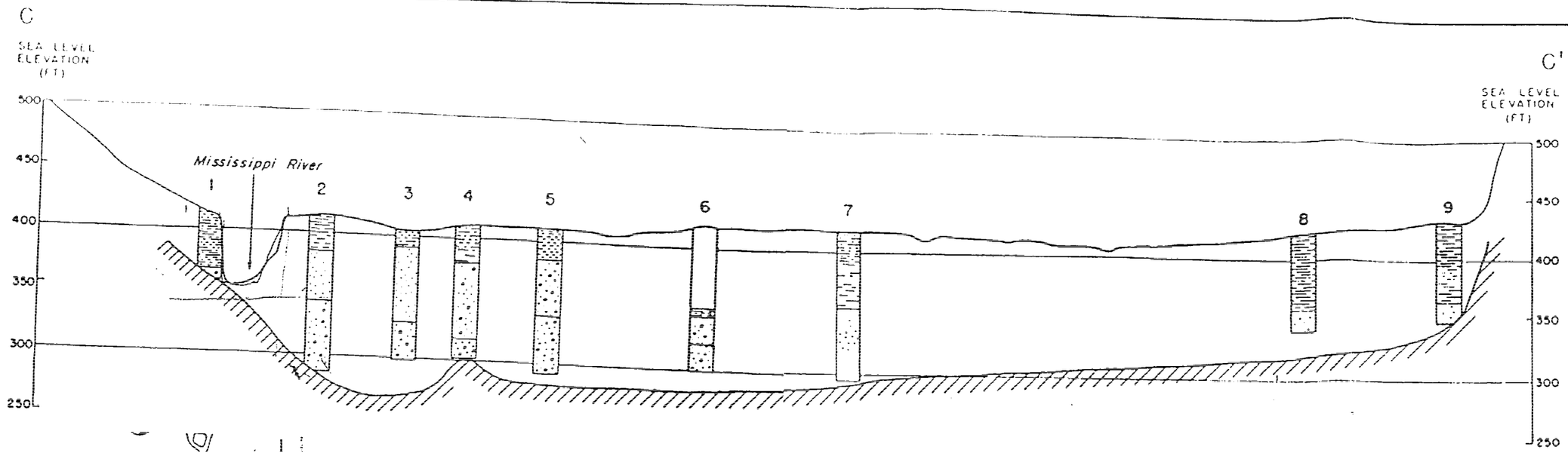


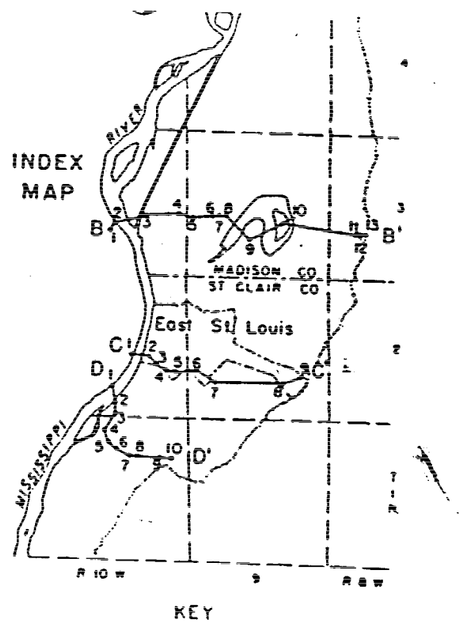
SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN SAUGET, ILLINOIS	PROJECT NO. 2320010024.02
URS	
DRN. BY: djd 1/31/01 DSGN. BY: bv CHKD. BY:	Site Vicinity Map
	FIG. NO. 1

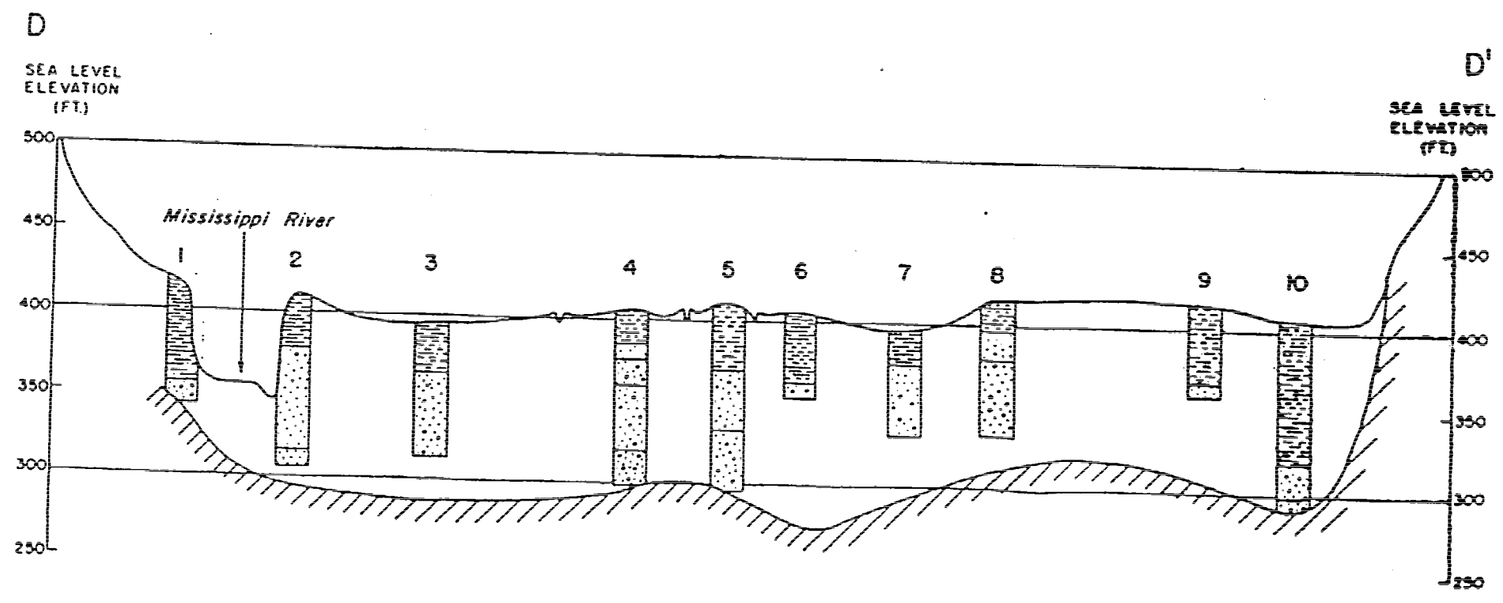
File: E:\2320010024.00\SITE MAP FIG_1.DWG Last edited: 05/29/01 @ 08:11 a.m. WC-ST.LOUIS, MO

Figure 2-2

Cross Sections of the Valley Fill in the East St. Louis Area, Illinois







HORIZONTAL SCALE
0 1 1 MILE

REFERENCE: TAKEN FROM THE GROUNDWATER GEOLOGY OF THE EAST ST. LOUIS AREA, ILLINOIS REPORT PREPARED BY ILLINOIS STATE GEOLOGICAL SURVEY.

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN SAUGET, ILLINOIS	PROJECT NO. 2320010024.02
URS	
DRN. BY:djd 5/4/01 DSGN. BY:ss CHKD. BY:	Cross Sections of the Valley Fill in the East St. Louis Area, Illinois
	FIG. NO. 2-2

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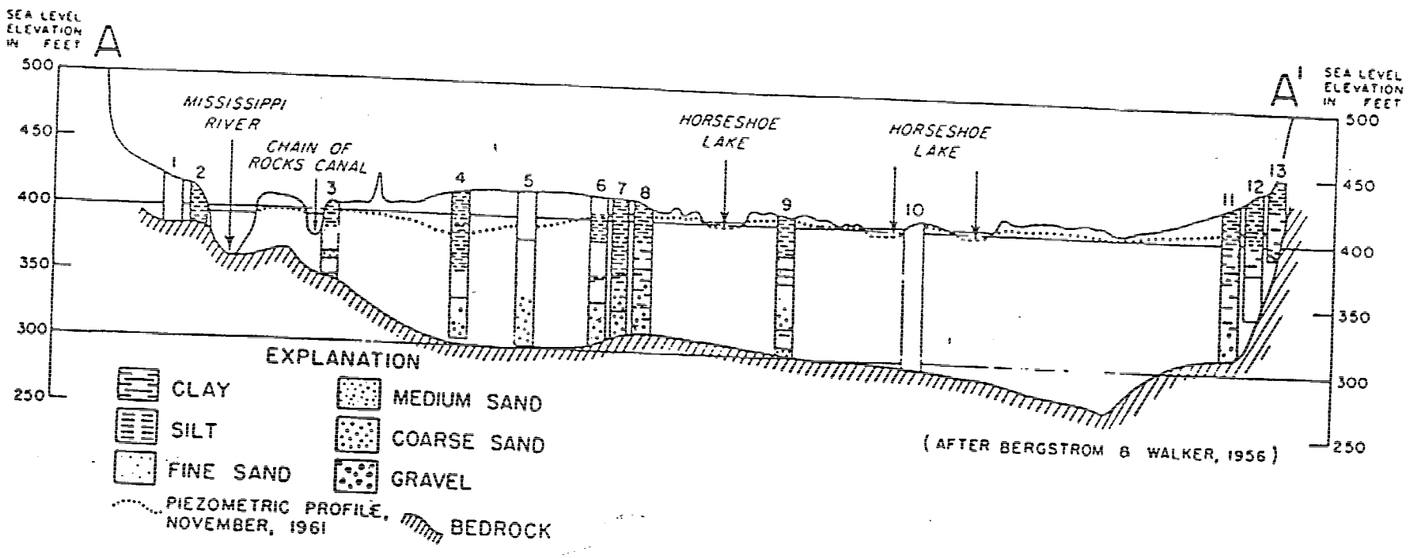
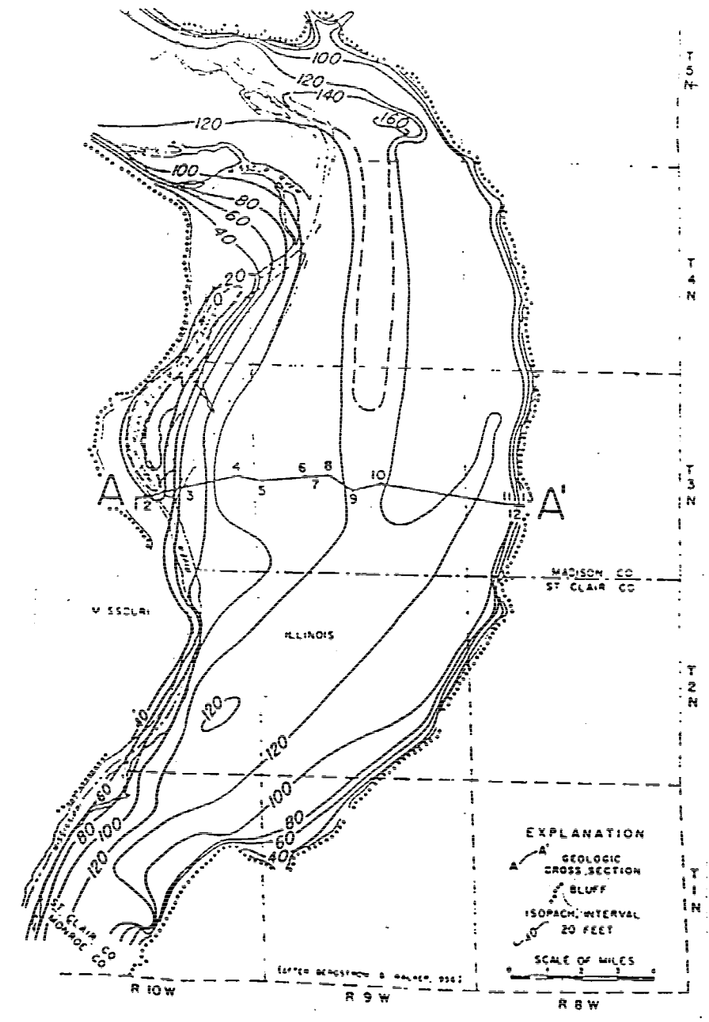
Figure 2-3

Geologic Cross Section and

Piezometric Profile of the Valley Fill





REFERENCE: TAKEN FROM A PAPER BY JOSEPH D. RITCHEY AND RICHARD J. SCHICHT ENTITLED GROUND-WATER MANAGEMENT IN THE AMERICAN BOTTOMS, ILLINOIS

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN SAUGET, ILLINOIS	PROJECT NO. 232001 0024.02
URS	
DRN. BY:djd 5/4/01 DSGN. BY:ss CHKD. BY:	Geologic Cross Section and Piezometric Profile of the Valley Fill
	FIG. NO. 2-3

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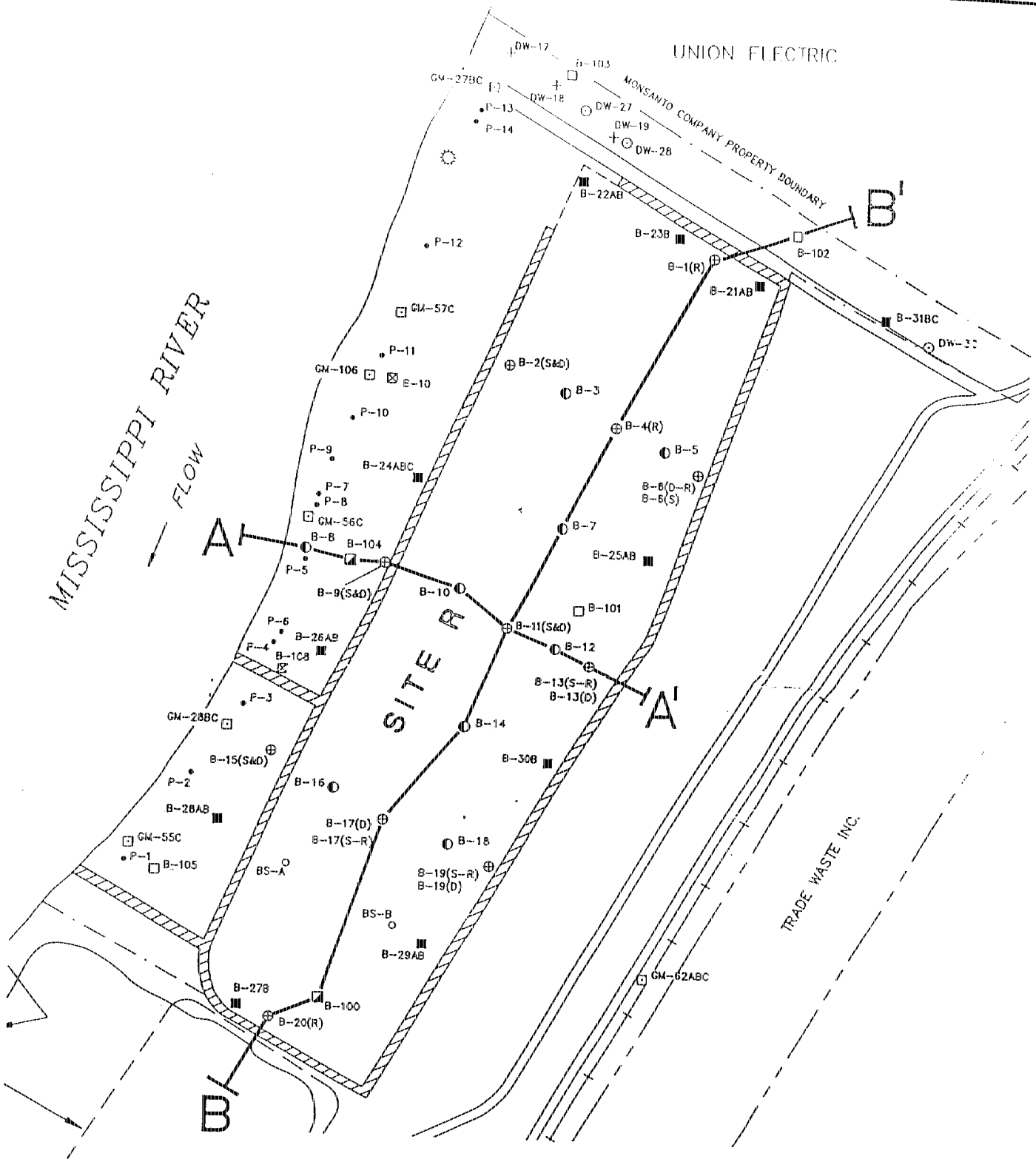
Figure 2-4

Wells, Borings, and Sampling Locations from Pre-RI/FS Investigations and Lines of Cross Section, Sauget Site R



0 250'

SCALE FEET

REFERENCE: TAKEN FROM THE REMEDIAL INVESTIGATION AT SITE R REPORT PREPARED BY GERAGHTY & MILLER

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN SAUGET, ILLINOIS		PROJECT NO. 2320010024.02
URS		
DRN. BY:djd 5/4/01 DSGN. BY:ss CHKD. BY:	Wells, Borings, and Sampling Locations from Pre-RI/FS Investigations and Lines of Cross Section, Sauget Site R	FIG. NO. 2-4

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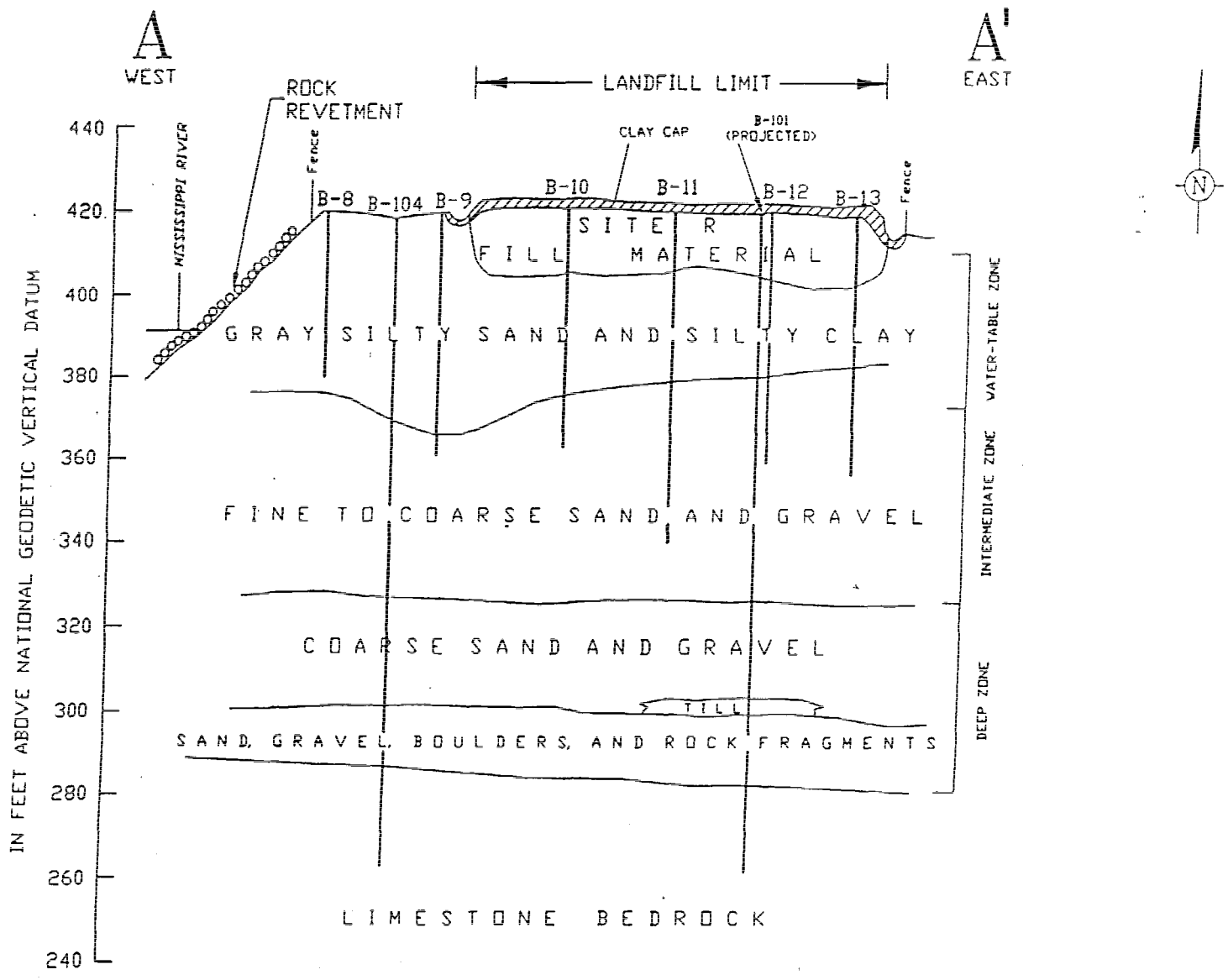
Figure 2-5

Cross Section A-A', Sauget Site R

Monsanto Company, Sauget, Illinois



0 200'

SCALE FEET

REFERENCE: TAKEN FROM THE REMEDIAL INVESTIGATION AT SITE R REPORT PREPARED BY GERAGHTY & MILLER

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN
SAUGET, ILLINOIS

PROJECT NO. 2320010024.02

URS

DRN. BY: djd 5/4/01
DSGN. BY: ss
CHKD. BY:

Cross Section A–A', Sauget Site R, Monsanto Company, Sauget, Illinois

FIG. NO. 2–5

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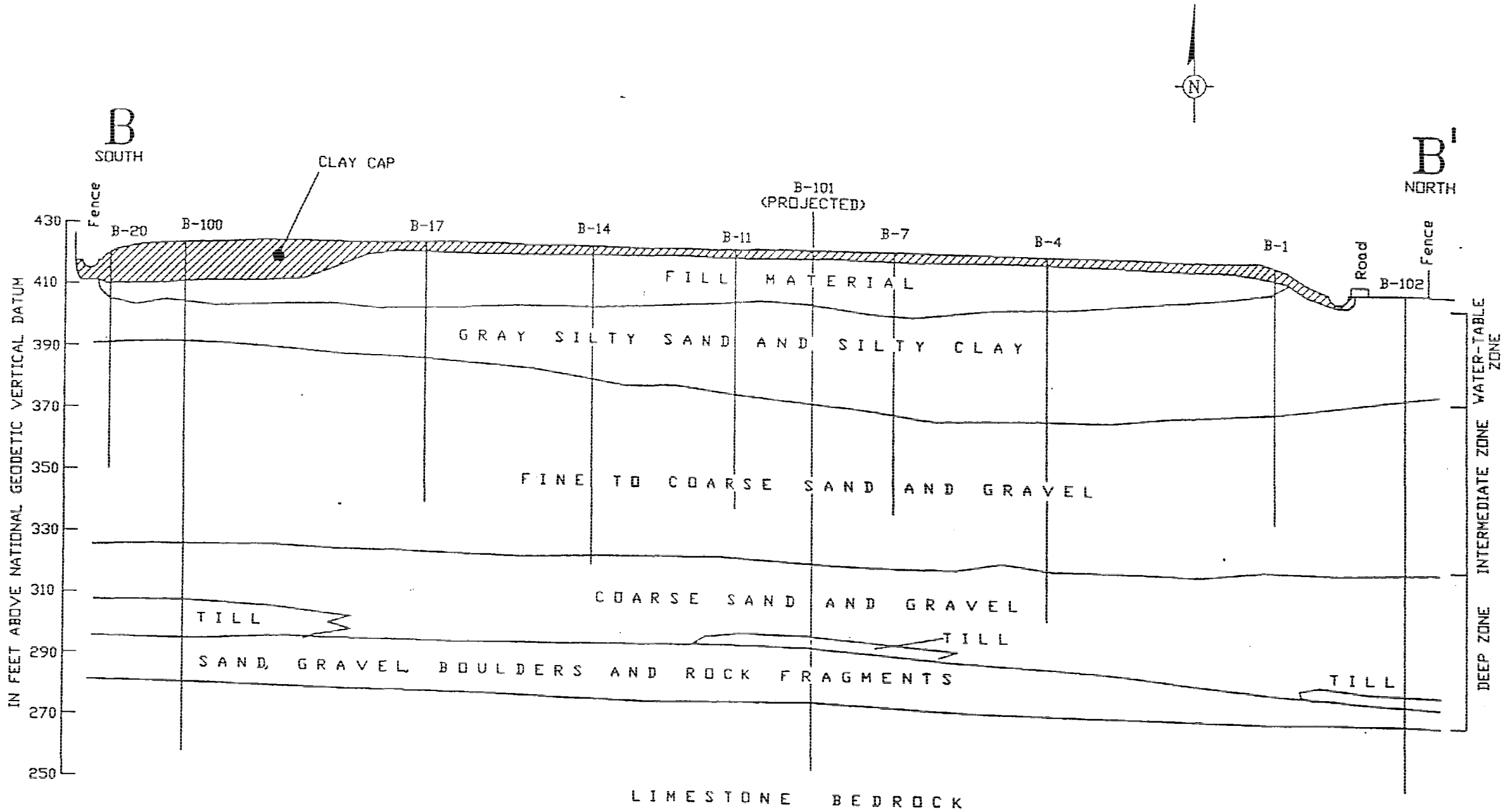
Figure 2-6

Cross Section B-B', Sauget Site R

Monsanto Company, Sauget, Illinois



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SCALE FEET

REFERENCE: TAKEN FROM THE REMEDIAL INVESTIGATION AT SITE R REPORT PREPARED BY GERAGHTY & MILLER

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN SAUGET, ILLINOIS		PROJECT NO. 2320010024.02
URS		
DRN. BY:djd 5/4/01 DSGN. BY:ss CHKD. BY:	Cross Section B–B', Sauget Site R, Monsanto Company, Sauget, Illinois	FIG. NO. 2–6

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Section 3

3.0 Previous Site Investigations

In 1998, Ecology and Environment (E&E) prepared the report "Sauget Area 2 Data Tables/Maps" for USEPA Region 5. This report summarized existing data for each site along with other information compiled by E&E during its file searches of various agencies and organizations. It contains data from investigations conducted by Clayton Environmental Consultants, Dynamac, E&E, IEPA, Geraghty and Miller, Reidel Industrial Waste Management, Russell and Axon and USEPA. Data for Sites O, P, Q, R and S are summarized in Sections 3.1, 3.2, 3.3, 3.4 and 3.5.

As part of its 1998 report, E&E prepared isoconcentration maps showing Total VOC concentration in shallow wells, Total VOC concentration in intermediate/deep wells, Total base/neutral acid (BNA) concentration in shallow wells and Total BNA concentration in intermediate/deep wells. These maps are included in the SSP as Figures 3-1, 3-2, 3-3 and 3-4, respectively.

Based on the information contained in the E&E Report, a summary table showing relevant information for each sampling event has been developed for each site. These are presented as Tables 3-1 through 3-5 for Sites O, P, Q, R and S, respectively. Additionally, maps indicating the locations of various sampling points for these previous investigations are presented as Figures 3-5 through 3-10, with Figure 3-5 providing an overall depiction of all sampling locations within Area 2. Figures 3-6 through 3-10 present locations of previous investigations at Sites O, P, Q, R, and S, respectively. There was insufficient information in the E&E Report to accurately place all sampling points on the map, therefore, not all of the investigative locations presented in Tables 3-1 through 3-5 appear on Figures 3-6 through 3-10.

3.1 Site O

The 1998 E&E report included the following information on Site O:

- Site Narrative
- Site Description
- Soil Samples
  - PCBs and Dioxin (IEPA, February 1983)
  - Benzene, Phenol and PCBs (Clayton Environmental, July 1984)

- SVOCs and PCBs (Russell and Axon, July 1984)
- VOCs, SVOCs, Pesticides and PCBs (Geraghty & Miller, August 1984)
- VOCs, SVOCs, Metals, Pesticides, PCBs (E&E, February 1987)

- Groundwater Samples

  - VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, September 1984)
  - VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, November 1984)
  - VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, February 1985)
  - VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, May1985)
  - VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, November 1985)
  - VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, February 1986)
  - VOCs, SVOCs, Metals (Geraghty & Miller, December 1986)
  - VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, March 1987)
  - VOCs, SVOCs, Metals (Geraghty & Miller, May 1987)
  - VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, July 1987)
  - VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, November 1987)

Maximum, minimum, average and 95% UCL concentrations for Site O soil and groundwater data are given in Tables 3-6 and 3-7, respectively. These summary statistics are based on the information included in the 1998 Ecology and Environment Report "Sauget Area 2 Data Tables/Maps".

The following discussion concerning nature and extent of contamination at Site O has been taken directly from the E&E Report.

> VOC concentrations in soil samples collected at Site O ranged from 0.001 to 889.9 mg/kg for 10 of the 12 samples collected. BNAs were detected at concentrations ranging from 0.28 to 1,916 mg/kg in 9 of the 12 samples collected. Pesticides were not detected in any of the 12 samples collected. PCB concentrations ranged from 11.4 to 1,871 mg/kg for 9 of the 12 samples collected. Metals, particularly Cu, Hg, and Zn, were elevated in a few samples collected. The greatest contaminant concentrations in subsurface soils were detected at depths between 0 to 10 feet BGS.
>
> The extent of soil contamination at Site O is fairly well defined through the 12 samples collected at various depths, both within and adjacent to the lagoons. The lagoons are unlined, and were excavated into the Henry Formation sands. The lateral boundary of the lagoons is well-defined, and is readily evident in historical aerial photos.

3.2 Site P

The 1998 E&E report included the following information on Site P:

- Site Narrative
- Site Description
- Soil Samples
  - VOCs, SVOCs and Metals (E&E, February 1987)

Maximum, minimum, average and 95% UCL concentrations for Site P soil data are given in Table 3-8. These summary statistics are based on the information included in the 1998 Ecology and Environment Report "Sauget Area 2 Data Tables/Maps".

The following discussion concerning nature and extent of contamination at Site P has been taken directly from the E&E Report.

> VOCs were detected at a concentration of 1.3 mg/kg in 1 of the 4 subsurface soil samples collected at Site P. BNAs were detected at 16.4 mg/kg in 1 of the 4 samples, and pesticides and PCBs were not detected in any of the four samples collected. Metals, particularly Pb and Hg were elevated in a few of the samples collected. The organic contaminants were all detected in the sample collected from boring P-1 at the south end of the site from a depth of 0 to 10 feet BGS.
>
> The extent of contamination is not very well defined for Site P given that only 4 subsurface soil samples were collected from three boring locations across the site. Although, the contamination detected does appear to be present at low levels.

3.3 Site Q

The 1998 E&E report included the following information on Site Q:

- Site Narrative
- Site Description
- Soil Samples
  - VOCs, SVOCs, PCBs and Dioxin (E&E, July 1983)
  - SVOCs, TCLP SVOCs, TCLP Metals, PCBs (E&E, May 1994)
  - VOCs, SVOCs, Metals, Pesticides, Herbicides and PCBs (IEPA, November 1994)
  - Metals and PCBs (E&E, 1997)
  - VOCs, SVOCs, TCLP Metals and PCBs (Reidel Industrial Waste Mgmt., Date Unknown)
- Surface Water Samples
  - Phenols, Metals and Inorganics (IEPA, October 1972)
  - Phenols, Metals and Inorganics (IEPA, April 1973)
- Leachate Samples
  - Phenols, Metals and Inorganics (IEPA, October 1972)
  - Phenol, PCBs, 2,3-D, Metals and Inorganics (IEPA, September/October 1981)
- Groundwater Samples
  - Phenols, Metals and Inorganics (IEPA, January 1973)
  - VOCs, SVOCs, Metals, Pesticides and PCBs (E&E, March 1987)
  - VOCs, SVOCs, Metals, Pesticides and PCBs (E&E, July 1987)

Maximum, minimum, average and 95% UCL concentrations for Site Q soil and groundwater data are given in Tables 3-9 and 3-10, respectively. These summary statistics are based on the information included in the 1998 Ecology and Environment Report "Sauget Area 2 Data Tables/Maps".

The following discussion concerning nature and extent of contamination at Site Q has been taken directly from the E&E Report.

> Southern Portion of Site Q (samples X101-X111 and Q203-Q208):
>
> VOC concentrations in soils ranged from 0.008 to 0.29 mg/kg for 5 of the 11 samples analyzed for these parameters. BNA concentrations ranged from 0.38 to 1.9 mg/kg for 5 of the 11 samples collected. Pesticides were not detected in any of the 11 samples analyzed for these parameters. PCB concentrations ranged from 0.06 to 223 mg/kg for 14 of 17 samples collected.

The samples collected from the southern portion of Site Q are collected from depressional areas. These depressional areas have been identified by IEPA as apparent disposal areas and not all of the property south of the Alton & Southern Railroad has been sampled or characterized. The extent of surficial contamination in the southern portion of Site Q (south of the Alton & Southern Railroad) is fairly well defined laterally. However, there are no subsurface soils to help delineate the extent of vertical contamination.

Northern Portion of Site Q (all samples north of the Alton & Southern Railroad:
Waste samples (QDI to QD3) collected in drums adjacent to the river at Site Q revealed a BNA concentration of 534 mg/kg in one sample, and PCB concentrations ranged from 180,000 to 260,000 mg/kg for the drum samples collected.

Surface water samples (P1 and P2) collected on Site Q did not contain appreciably high concentrations of metals. These samples were not analyzed for organic parameters. Pond sediments (Q201 and Q202) collected in the center of Site Q had PCB concentrations which ranged from 1.8 to 4.6 mg/kg for the two samples.

BNA concentrations in leachate samples (from samples L-1, L-2, L101, L102, and L103) were 5 μg/L for 2 of the 5 samples collected. The leachate samples were not analyzed for VOCs, and pesticides were not detected in any of the 5 samples. PCB concentrations ranged from 0.1 to 1.0 μg/L for 4 of the 5 samples collected. Metals, particularly As, Cr, Cu, Pb, and Zn, were elevated in a few of these samples.

VOC concentrations in the subsurface soils (from borings B-1 to B-18 and Pits 1 & 2) ranged from 0.02 to 5,855 mg/kg for 28 of the 36 samples collected. BNA concentrations ranged from 3.8 to 15,190 mg/kg for 34 of the 36 samples collected. Pesticide concentrations were 0.1 and 3.3 mg/kg for 2 of the 35 samples collected. PCB concentrations ranged from 0.002 to 16,000 mg/kg for 32 of the 36 samples collected. Dioxin (2,3,7,8-TCDD) concentrations in subsurface soil samples ranged from 0.0001 to 0.0033 mg/kg in 2 of the 35 samples analyzed for this parameter.

The extent of contamination in the southern portion of Site Q (south of the Alton & Southern Railroad) is fairly well defined laterally in and around the depressional areas identified by IEPA. However, there are no subsurface soils to help delineate the extent of vertical contamination. The extent of contamination in the central portion of Site Q is poorly defined. Wastes have been identified through sampling of drum samples and leachate but surface and subsurface soil samples are lacking in this area. The extent of contamination in the northern portion of Site Q, adjacent to Site R is well defined through multiple soil borings and subsurface soil samples.

3.4 Site R

The 1998 E&E report included the following information on Site R:

- Site Narrative
- Site Description
- Soil Samples
  - VOCs, SVOCs, Pesticides and PCBs (IEPA, November 1994)
  - VOCs, SVOCs, Pesticides, PCBs and Dioxin (Dynamac, 1994)
  - VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, April/May 1992)
- Surface Water Samples
  - Phenols, PCBs and Metals (IEPA, January 1973)
  - Dioxin (IEPA, 1981)
- Sediment Samples
  - VOCs, SVOCs, Pesticides and PCBs (IEPA, October 1981)
  - VOCs, SVOCs, Pesticides and PCBs (IEPA, November 1981)
  - Metals (E&E, November 1981)
  - VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, June 1992)
- Leachate Samples
  - Dioxin (USEPA, November 1981)
  - Metals, Dioxin (E&E, November 1981)
  - Dioxin (IEPA, March 1989)
- Groundwater Samples
  - Phenols, PCBs and Metals (IEPA, December 1972)
  - Phenols, PCBs and Metals (IEPA, February 1973)
  - Phenols, PCBs and Metals (IEPA, May 1974)
  - Phenols, PCBs and Metals (IEPA, October 1975)
  - Phenols, PCBs and Metals (IEPA, February 1976)
  - Phenols, PCBs and Metals (IEPA, October 1979)
  - SVOCs (IEPA, March 1981)
  - VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, June 1984)
  - VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, September 1984)

- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, November 1984)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, June 1984)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, October 1985)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, November 1985)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, February 1986)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, December 1986)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, March 1987)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, May 1987)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, November 1987)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, May 1988)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, August 1988)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, November 1988)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, March 1989)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, May 1989)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, November 1989)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, November 1990)
- VOCs, SVOCs, Metals, Pesticides and PCBs (Geraghty & Miller, November 1991)
- VOCs, SVOCs and Metals (Geraghty & Miller, June 1992)

Maximum, minimum, average and 95% UCL concentrations for Site R groundwater data are given in Tables 3-11 through 3-13. These summary statistics are based on the information included in the 2000 Solutia report "Descriptions of Current Conditions, W.G. Krummrich Facility, Sauget, Illinois". The DOCC was used as a source document instead of the 1998 Ecology and Environment report because Solutia collected most of the data included in the latter and this data was in an electronic data base in the former.

The following discussion concerning nature and extent of contamination at Site R has been taken directly from the E&E Report.

IEPA and USEPA File Information – Pre-1992

Sample locations are situated adjacent to the river on the west side of Site R. Nine sediment samples (A, B, C, S02, S04, S06, M02, M04, and M06) were collected from 6 locations adjacent to the river to the west of Site R. VOCs were not detected in any of the three sediment samples analyzed for this parameter group. SVOC concentrations in sediments to the west of Site R ranged from 0.001 to 7.7 mg/kg for 9 of the 9 samples collected. Pesticides were not analyzed in these sediment samples. PCB concentrations in the sediments ranged from 0.00001 to 0.23 mg/kg for 6 of the 9 samples collected. Metals were not elevated in most of the samples collected.

However, cyanide was detected at concentrations ranging from 6.8 to 90 mg/kg for all three samples analyzed for this parameter.

Nine leachate samples (X101D, X103D, X104D, S01, S03, S05, M01, M03, and M05) were collected from 6 locations adjacent to the river to the west of Site R. VOCs were not analyzed in any of the leachate samples. SVOC concentrations in the leachate to the west of Site R ranged from 0.6 to 12.3 μg/L for the 3 samples analyzed for this parameter group. Pesticide concentrations ranged from 0.5 to 3.0 μg/L for the 3 samples analyzed for this parameter. PCBs were only detected in one leachate sample at a concentration of 0.08 μg/L. Samples X101D, X103D, and X104D were analyzed for dioxins/furans only.

Total dioxin/furan concentrations ranged from 0.0001 to 0.0014 ppm. Metals were slightly elevated in some samples collected. Cyanide was detected in one leachate sample at a concentration of 71 μg/L.

Surface water samples (S101D, S013D, and S104D) were collected from the Mississippi River and analyzed for dioxins/furans. The total dioxin/furan concentration ranged from 0.0001 to 0.0007 ppm in the three samples collected.

RI Report Data – Geraghty & Miller, 1994

Eight sediment samples (SS-1 through SS-8) were collected from stormwater drainage ditches surrounding the Site R landfill. VOC concentrations in sediment samples collected from the drainage ditches ranged from 0.002 to 0.035 mg/kg. Constituents detected in these sediment samples were similar to those detected in the landfill soil samples, although the detected concentrations were orders of magnitude lower. SVOC concentrations in sediments ranged from 0.045 to 3.99 mg/kg. Pesticides were only detected in one of the sediment samples at a concentration of 0.096 mg/kg. PCBs were detected at concentrations ranging from 0.08 to 1.5 mg/kg. Metals, particularly Al, Fe, Ca, and Mg were elevated in some samples.

Soil samples were collected from 16 borings (SB-1 through SB-16) within the landfill during the RI conducted by Geraghty & Miller. In addition, Dynamac completed an investigation in 1989 which included 8 borings (D-1 through D-8) around the perimeter of the landfill, 8 surface samples (C-1 through C-8) collected from the landfill cap, and 10 surface samples collected from the perimeter (P-1 through P-10). VOC concentrations in subsurface soil samples collected from the RI borings ranged from 0.15 to 4,100 mg/kg. VOC concentrations in subsurface soil samples collected by Dynamac from the RI borings ranged from 0.51 to 5,800 mg/kg. SVOC concentrations in subsurface soil samples collected from borings SB-1 through SB-16 ranged from 0.017 to 11,000 mg/kg. SVOC concentrations in subsurface soil samples collected by Dynamac ranged from 0.37 to 19,000 mg/kg. Pesticide concentrations in subsurface soil samples collected from the borings SB-1 through SB-16 ranged from 0.011 to 99 mg/kg. Pesticides were not detected in any borings conducted by Dynamac. PCB concentrations in subsurface soil samples collected from borings SB-1 through SB-16 ranged from 0.075 to 4,800 mg/kg. PCBs were only detected in three of the borings conducted by Dynamac. Some metals, including As, Cr, Pb, Ni and Hg, were slightly elevated in most samples.

Expanded Study Area RI Report Data -- Geraghty & Miller, 1994

Soil samples were collected from 3 borings (SB-17 through SB-19) drilled along the southern portion of the landfill. This area is actually part of Site Q but was investigated as part of the Site R RI by Geraghty & Miller. VOC concentrations in subsurface soil samples collected from these borings ranged from 0.002 to 1,640 mg/kg. SVOC concentrations in subsurface soil samples collected from borings SB-17 through SB-19 ranged from 0.041 to 185 mg/kg. Pesticide concentrations in subsurface soil samples collected from the borings SB-17 through SB-19 ranged from 0.016 to 0.18 mg/kg. PCB concentrations in subsurface soil samples collected from borings SB-17 through SB-19 ranged from 0.36 to 6.6 mg/kg.

3.5 Site S

The 1998 E&E report included the following information:

- Site Narrative
- Site Description
- Soil Samples
  - VOCs, SVOCs, Metals, Pesticides and PCBs (IEPA, March 1995)
- Groundwater Samples
  - VOCs, SVOCs, Metals, Pesticides and PCBs (E&E, March 1987)

The following discussion concerning nature and extent of contamination at Site S has been taken directly from the E&E Report.

> VOC concentrations in soil samples collected from Site S ranged from 0.007 to 2,181 mg/kg in all 6 of the samples collected. BNAs were detected at concentrations ranging from 0.8 to 250 mg/kg for 5 of the 6 samples. Pesticides ranged from 0.005 to 0.2 mg/kg for 5 of the 6 samples. PCBs were detected in all 6 samples at concentrations ranging from 0.04 to 195 mg/kg. Metals, particularly Cr, Cu, Pb, and Hg, were found at elevated concentrations in a few of the samples collected. At the time of sampling, surface leachate seeps were present at the southern portion of the site.
>
> The extent of contamination at Site S is poorly defined due to the limited number of sampling locations and associated analytical data. Samples were collected from locations X102 through X106 using a hand-auger, and the sample depths ranged from 0 to 5 feet BGS. High VOC, BNA, and PCB concentrations present in samples X105 and X106 indicate that the extent of contamination at Site S has not been completely defined, either laterally or vertically.

3.6 Mississippi River

3.6.1 ABRTF Aquatic Habitat Assessment

In 1990, the Advent Group of Brentwood, Tennessee completed an aquatic habitat assessment in the Mississippi River for the American Bottoms Regional Wastewater Treatment Facility (Aquatic Habitat Assessment, Mississippi River near Sauget, Illinois, March 1990). This study was performed to examine the aquatic habitat and aquatic macroinvertebrate populations in the area downstream of a proposed multiport diffuser. The Executive Summary of this report is given verbatim below.

The American Bottoms Regional Wastewater Treatment Facility (American Bottoms) is located in Sauget, Illinois. The facility receives both industrial and municipal wastes for physical and biological treatment prior to discharge of the treated effluent. The facility has a National Pollutant Discharge Elimination System (NPDES) Permit to discharge these treated effluents into the Mississippi River at Mississippi River Mile (MRM) 178.2. A multiport high-rate diffuser has been designed to provide best engineering technology for dispersion of the effluent in the Mississippi River. The purpose of this study was to examine the aquatic habitat in the Mississippi River downstream from the proposed diffuser location. This assessment was developed using information in EPA's Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses.

Physical characteristics of the water body are the primary influence in determining aquatic habitat. These physical factors include flow (depth and velocity), temperature, substrate composition, suspended solids, and structure. Examples of structure or cover include rocks, rip-rap, logs, brush, vegetation (in-stream or riparian), roots, snags, pools, shadows, barge anchoring cells, etc. Additional physical/chemical factors such as turbidity, hardness, pH and the dissolved solids concentration can also affect habitat suitability. In addition to examining chemical/physical characteristics of the area, aquatic macroinvertebrates were examined to provide baseline information on the macroinvertebrate populations present. The study area ranged from approximately 100 ft upstream from the existing outfall to 2,000 ft downstream. The study was performed during the week of January 8, 1990.

Structure was visually surveyed and recorded during the field study. The projected path of the plume from the proposed diffuser based on modeling projections and River currents is shown in Figure 3-11. A visual summary of the habitat observations is presented in Figure 3-12. The shoreline immediately upstream (50 ft) from the outfall to about 600 ft downstream consisted primarily of sand, with rip-rap located along the shore at the outfall. From 600 to 1,000 ft downstream, the shoreline was predominantly rip-rap, with some sand. An exposed "sunken" barge was located beginning about 1,300 ft and extending to about 1,500 ft downstream, laying parallel to the shore. An old pier or "wing dam" is located at about 1,500 ft downstream. This wing dam has a number of old wooden pilings ranging to about 1 to 3 ft in height. During the field study,

the wing dam was exposed (extended above the water line) for about 300 ft from shore. Upstream of the wing dam, the structure consists of five barge mooring cells. Two of the cells were upstream of the outfall. The three remaining cells were located approximately 200 ft from shore at about 0 to 300 ft downstream from the discharge. None of the potential structure identified was expected to be in the direct influence of the mixing zone.

Particle size analysis of substrate samples indicated the bottom of the river consisted primarily of fine to coarse sand, with some silt in the near-shore areas. A notable lack of benthic invertebrates was indicated. In all substrate samples examined in the field or laboratory, only a single chironomid, two oligochaetes, and a snail (Family Physidae) were observed. No additional quantitative analysis was performed on these samples. A large number of caddis fly (Tricoptera) cases were observed along the wing dam and attached to rip-rap along the shoreline both upstream and downstream from the outfall. Organisms collected from this area were subsequently identified to be Hydropsyche orris, or Hydropsyche bidens. These species are associated with large rivers and appear to be able to survive siltation better than most Hydropsyche species. Both are often collected where there is a high silt load and high concentration of suspended organic substrates. The individual larval retreats and pupal cases at times stack on top of one another. Pupal cases are constructed predominantly of secreted substances with sand grains attached. The case type and stacking characteristics were observed at the Sauget site at the wing dam. Table 3-14 summarized those organisms collected and identified during the field study.

The proposed placement of the diffuser was in an area that will not adversely effect aquatic habitat. Title 35, Subtitle C, Chapter I, Section 301.102 of the Illinois Administrative Code (IAC) stipulated the following limitations with regard to aquatic habitat in any receiving waters in which a mixing zone is allowed:

- Mixing is not allowed in waters which include a tributary stream entrance if such mixing occludes the tributary mouth or otherwise restricts the movement of aquatic life into or out of the tributary;

- Mixing is not allowed in waters adjacent to bathing, bank fishing areas, boat ramps or dockages or any other public access area; and

- Mixing is not allowed in waters containing mussel beds, endangered species habitat, fish spawning areas, areas of important aquatic life habitat, or any other natural features vital to the well being of aquatic life in such a manner that the maintenance of aquatic life in the body of water as a whole would be adversely affected.

No tributary streams entered the Mississippi River within 2,000 ft downstream from the ABRWT facility outfall. In addition, no public bathing, bank fishing areas, boat ramps or dockages occur within 2,000 ft downstream from the facility.

There were no mussel beds evident during the habitat assessment study. The substrate in the area of the project diffuser mixing plume consisted entirely of sand. This type of substrate, particularly when located in an off-shore area with no structure or cover, is not a productive biological habitat. In addition, only four benthic macroinvertebrate specimens were observed in 45 sediment samples collected, supporting evidence that the substrate was poor habitat for benthic organisms. None of the macroinvertebrates collected were threatened or endangered species.

A submerged log upstream from the present outfall, rip-rap along the shore, five barge cells, and the wing dam located about 1,500 ft downstream were found to be the only significant habitat in this area. These structures are in areas outside the proposed mixing zone.

Habitat characteristics observed during the field investigation in the area immediately upstream and downstream of the proposed diffuser are summarized in Table 3-15.

This assessment concluded that the maintenance of aquatic life in the river as a whole would not be adversely affected by the ABRTF diffuser because of:

- Depths, velocities, substrate, and lack of structure in the projected diffuser plume, and;
- Diffuser design preventing organisms from entering the area of immediate mixing.

3.6.2 ABRTF Biological Assessment

The Advent Group conducted another river study for the American Bottoms Regional Wastewater Treatment Facility in 1996 (Biological Assessment of the Mississippi River Near Sauget, Illinois, April 1996). This study was conducted for the Village of Sauget in order to meet the requirements of a 1992 Consent Decree with USEPA and IEPA. ABRTF was required to conduct a biological study in the area affected by or within the plume of the ABRTF discharge as well as the near shore and wing dam areas. As outlined in the Consent Decree, the biological study was to:

- Examine fish populations present in the study area during one sampling event between July and October in 1994 or 1995:
- Characterize the substrate on the downstream side of the wing dam and southward along the shore between a distance of 1,600 ft and 2,000 ft from the diffuser; and
- Evaluate the macroinvertebrate community within the plume of the ABRTF discharge.

This assessment of water quality and biological conditions was conducted from September 19, 1994 to September 21, 1994 in accordance with a work plan approved by USEPA and IEPA. Specific objectives of the study were to:

- Collect 72 sediment samples at 18 locations for use in examining the macroinvertebrate community and characterizing the habitat and substrate present just upstream of the diffuser and on the downstream side of the wing dam;
- Characterize aquatic habitats present south along the shore between a distance of 1,600 and 2,000 ft from the diffuser;
- Characterize and describe the fish populations present in the near shore and wing dam sections of the diffuser study area and with 2,000 ft downstream of the diffuser; and

- Collect various physical and chemical water quality measurements.

In accordance with the Consent Decree, sampling transects were established approximately 100 ft upstream of the diffuser and at 1,600; 1,700; 1,800; 1,900 and 2,000 ft downstream of the diffuser (Figure 3-13, 3-14 and 3-15). Sampling stations were located 30 ft, 150 ft and 300 ft from the left edge of water on each transect. Water velocity readings taken at 0.2, 0.6 and 0.8 of total water depth indicated velocity ranges from 0 to 2.02 ft/sec in the study area. Highest water velocities occurred at sampling stations located 300 ft offshore. Velocity values at a given sampling station did not vary much with depth. Temperature, dissolved oxygen, conductivity and pH showed little variability with water depth or distance from shore. Relatively low Secchi disk values of 8 to 13 inches reflect the high turbidity and concomitant poor light penetration into study area waters.

Based on the results of conductivity data, effluent was present in the area of the wing dam during the study. Conductivity increased by approximately 30 to 130 micromhos/cm downstream of the discharge. Except for conductivity, no differences were observed in general water quality characteristics of waters upstream and downstream of the effluent discharge.

Sediment sampling indicated that highly diverse bottom substrate is present throughout the study area ranging from fine, silty materials to rock/cobble substrates (Tables 3-15, 3-16 and 3-17). Sand was the predominant substrate. Although the bottom substrate varied considerably, from essentially 100% sand to 100% gravel at the sampling stations, substrate upstream of the wing dam, especially in near-shore areas, was predominantly sand. Based on visual observations, some sediments were "mucky" and "silty" in nature. These sediments were generally present in areas of very low water velocity where fine materials with apparently higher levels of organic carbon were accumulated. Sediments at many locations consisted primarily of sand (over 90%). Although not present in many near-shore areas, except immediately adjacent to the rip-rap bank, gravel was a primary component of the substrate at locations further offshore.

Changes in bottom topography were observed throughout the study area but the wing dam and the sunken barges were the only notable habitat. They were also the only notable cover in the study area that would attract fish. The cover present at the rocky wing dam extending above the water's surface consists of the wing dam and wooden posts along its downstream side. Rip-

rap was present in some areas of the wing dam while other bottom substrates in the area are almost entirely composed of sand. Still other areas of the wing dam possess small areas of rock and cobble substrate.

At the time of the study, an area of shallow water, approximately one foot deep, was present between the wing dam and the left edge of water. This area consisted of small riffles resulting from water running over the rocky bottom substrate. Good benthic-macroinvertebrate habitat was provided by the many crevices and areas of loose rock which created shelter as well as dwelling and feeding sites for such organisms. Water velocity in this area averaged 1.93 ft/sec while average water velocities around the wing dam ranged from 0.02 to 2.62 ft/sec.

The changes in bottom composition, presence of above water structures and the steep depth and current gradients caused by the wing dam provide the best structure and cover for fish in the entire study area. Additionally, a sunken barge present upstream, and approximately 100 ft farther from the left edge of water that the wing dam, provides additional cover.

Organisms primarily represented at the sampling stations were the aquatic life stages of various insects (midges, caddis flies, may flies, beetles, dragon flies and damsel flies), although aquatic worms (Oligochaetes), snails (Gastropods) and clams (Pelycepods) were also present. Insects dominated the macroinvertebrate fauna both upstream and downstream of the discharge with midges and caddis flies comprising the majority of the organisms at most locations. Caddis fly and may fly species, organisms considered by USEPA to be intolerant to degraded water quality, were collected from sites downstream of the effluent discharge.

More taxa and a higher abundance of macroinvertebrates were observed in this study than in 1990. However, macroinvertebrate richness and abundance were low in the near-shore area of the wing dam as well as in near-shore areas upstream of the effluent discharge. The relatively low richness and abundance of macroinvertebrates in good-quality habitats likely reflects the nature of benthic communities in big-river systems such as the Mississippi River near St. Louis. Both the abundance and richness of macroinvertebrates generally increased with increased distance from shore along transects upstream and downstream of the discharge. This likely reflects improved habitat quality with distance from the shore as increased proportions of gravel were often found in samples collected farther from shore. Similar macroinvertebrates were

observed in near-shore areas upstream and downstream of the discharge when benthic substrate composition was similar. The highest abundance and diversity of organisms were observed at stations located approximately 300 ft from shore and downstream of the effluent discharge.

In summary, macroinvertebrate data indicated that a variety of organisms were present throughout the study area. The macroinvertebrate community was generally dominated by insects although clams, snails and aquatic worms were also present. No clear patterns in species composition or numbers were evident for samples collected from upstream as compared to downstream of the discharge. However, higher richness of individuals as well as taxa were present in samples collected from sites 300 ft from shore as opposed to sites 30 ft or 150 ft from shore. This is likely due to the higher proportions of gravel composing the substrate at locations 300 ft from shore. Higher numbers of individuals and taxa were present in samples collected downstream of the outfall as opposed to upstream of the outfall. These differences are also likely due to habitat composition. The presence of the wing dam and the associated rocks and gravel and changes in bottom substrate improved the quality of benthic habitat. Organisms considered to indicate "acceptable" water quality were present in samples collected from upstream and downstream of the effluent discharge. Overall, no deleterious impacts to macroinvertebrates appeared to be occurring as a result of the effluent discharge.

Overall, with the exception of changes in bottom topography, the fish-attracting habitat upstream of the wing dam was quite limited and the bottom appears to be barren and primarily sand. However, water quality conditions in this area appear to be quite suitable for habitation by fish. A total of 12 different fish species were collected in the study area. In order of abundance they were:

Common Name	Species Name	Number of Individuals
Gizzard Shad	Dorosoma cepedianum	37
Common Carp	Cyprinus carpo	31
White Bass	Morone chrysops	19
River Carp Sucker	Carpiodes carpio	13
Freshwater Drum	Aplodinotus grunniens	6
Bigmouth Buffalo	Ictiobus cyprinellus	5
Smallmouth Buffalo	Ictiobus bubalus	3
Flathead Catfish	Pylodictus olivaris	2

Common Name	Species Name	Number of Individuals
Goldeye	Hiodon alosoides	2
Shorthead Redhorse	Moxostoma macrolepitodum	1
Bluegill	Lepomis marcrochirus	1
Skipjack Herring	Alosa chrysochloris	1
	Total	121

All of these species are typical of what might be found in the Mississippi River basin and similar big-river systems. Common carp are considered to be a "rough" fish, tolerant of compromised water quality. All of the other fish present in the study area are generally considered "facultative" in terms of water quality indicators, i.e. they do not necessarily typify impacted or high-quality waters. Exceptions to this might be: 1) the shorthead redhorse which "is probably quite sensitive to siltation and pollution" (Miller and Robinson, 1973, The Fishes of Oklahoma, University of Oklahoma Press, Stillwater, Oklahoma) and 2) the goldeye which is considered to be intolerant (USEPA, 1989, Rapid Bioassessment Protocols for Use in Streams and Rivers - Benthic Macroinvertebrates and Fish, EPA/444/4-89-001, USEPA Office of Water, Washington, DC). Overall, the species present in the study area represent a good mixture of various types of fish representative of varying water quality and habitat.

The most abundant fish present, the gizzard shad, is a planktivorous, filter-feeding fish found in large rivers and reservoirs. This fish could not be considered indicative of compromised water quality. Gizzard shad are commonly found in high-quality fisheries typical of reservoirs managed for sport fishing. Although the common carp, the second most abundant fish observed, is typically considered to be a quite "tolerant" fish this is based primarily on its tolerance to organic enrichment and associated low dissolved oxygen concentrations. Markedly depressed dissolved oxygen conditions were not observed during the study. The presence of carp and other "rough" fish, such as the river carpsucker and buffalo species, is not an indication of "impacted" condition given the variety of other fish present. For example, white bass (the third most abundant fish observed), bluegill, flathead catfish and, to a lesser extent, the freshwater drum are considered "sport fish" and are often found in waters inhabited by other "top level" carnivorous sport fish.

USEPA (1989) considers the fish found in the study area to be indicative of the following types of water quality when found in the Midwest:

Type of Fish	Type of Water Quality
Common Carp	Tolerant
Goldeye	Intolerant
Bluegill	Intermediate
Bigmouth Buffalo	Intermediate
Smallmouth Buffalo	Intermediate
Shorthead Redhorse	Intermediate
Skipjack Herring	Intermediate
Gizzard Shad	Intermediate
River Carpsucker	Intermediate
Flathead Catfish	Intermediate
White Bass	Intermediate

A good mixture of fish was found in the study area in terms of their ecological niche and status. For example, the white bass and flathead catfish are piscivorous as adults and opportunistic carnivores (insects and fish) at earlier life stages. The bluegill, goldeye, skipjack and freshwater drum are opportunistic carnivores throughout their life cycles. As adults, drum tend to feed more on bottom-dwelling mollusks and insects and skipjack tend to feed more on fish. Shorthead redhorse are primarily bottom-feeding carnivores. Bigmouth buffalo are primarily filter feeders and bottom-feeding carnivores. Gizzard shad are filter-feeders eating primarily plankton and detritus filtered from the water. Carp, carpsucker and smallmouth buffalo are primarily bottom-feeding omnivores eating plants, animal flesh and detritus.

A range of condition factors was observed for fish collected in the study area. Most were at or above the value of 1.0 considered typical for fish in good health (Carlander, 1969 and 1977, Handbook of Freshwater Fishery Biology - Volumes I and II, Iowa State University, Ames, Iowa). Average condition factor values were above 1.0 for all species for which three or more individuals were collected. Of the 121 fish collected, only two had anomalies. One white bass was missing its left opercle (gill cover) and one goldeye had a head sore. Neither of these two anomalies can be related to the effluent discharge because of the highly mobile nature of fish.

No impacts were evident to the fish community present downstream of the outfall at the time of the study. A variety of fish representing a range of trophic levels and niches were observed.

The fish present were primarily indicative of "intermediate" water quality, although one species of "tolerant" as well as one species of "intolerant" fish were observed. The low number of anomalies (2 of 121 specimens) and typical condition factors observed for fish in the area downstream of the outfall also indicated a relatively healthy fish population.

The overall conclusion from this biological assessment was that no deleterious impacts to fish or macroinvertebrate communities resulted from the effluent discharge.

3.6.3 Solutia Surface Water Sampling Plan

An Administrative Order on Consent (USEPA Docket Number R8H-5-00-003) requires Solutia to complete activities necessary to identify and define the nature and extent of releases of hazardous waste and/or hazardous constituents at or from the W.G. Krummrich Facility. This May 3, 2000 AOC also requires Solutia to prepare a Description of Current Conditions Report, a Groundwater Environmental Indicators Report (EIR) and a Current Human Exposure Environmental Indicators Report. To comply with the AOC, the Groundwater EIR must be completed by January 1, 2002 and the Current Human Exposures EIR must be completed by January 1, 2004. Solutia must also propose, by June 1, 2004, final corrective measures necessary to protect human health and the environment for all current and future unacceptable risks due to releases of hazardous waste or hazardous constituents at or from the Facility.

Solutia submitted a Description of Current Conditions Report, which included a Site Sampling Plan, to USEPA on August 1, 2000. Surface Water, Groundwater and Soil Sampling Plans were included in the Site Sampling Plan. The Surface Water Sampling Plan was implemented in October 2000 and current plans call for completing the Groundwater Sampling Plan in 2001 and the Soil Sampling Plan in 2003.

Surface water, sediment and fish sampling were conducted in the Mississippi River in October 2000 to determine the impact, if any, of groundwater discharge from the W.G. Krummrich facility. Surface water and sediment samples were collected in the Mississippi River at three locations: 1) upstream of the plume discharge area, 2) the plume discharge area and 3) downstream of the plume discharge area.

Samples were analyzed to determine the concentration of VOCs, SVOCs, Pesticides, Herbicides, PCBs and Dioxin in these environmental media. In addition, benthic community structure was evaluated to provide data for sediment triad evaluation. Bioassays were conducted on surface water and sediment samples to determine the toxicity, if any, of these environmental media to sensitive organisms. Fish were sampled in the plume discharge area and upstream and downstream of this discharge to determine the impact, if any, of groundwater discharge on higher trophic level organisms. Information collected as part of the Surface Water Sampling Plan will be used in a Ecological Risk Assessment, a Human Health Risk Assessment, a Groundwater Environmental Indicators Report and a Current Human Exposure Environmental Indicators Report.

A reconnaissance survey was conducted in September 2000 to characterize river bottom substrates and identify surface water, sediment and fish sampling locations. During this reconnaissance survey, conducted in conjunction with USEPA, sediment samples were collected in the area of plume discharge along three transects running from the bank toward center of the river. Analytical results are summarized below:

	Distance from Bank, feet								
Total VOCs, ppb	**50**	**200**	**300**	**400**	**500**	**600**	**700**	**1000**	**1400**
North Transect	644	NS	854	ND	NS	NS	ND	ND	ND
Center Transect	1300	ND	NS	NS	ND	NS	NS	NS	NS
South Transect	45	NS	473	NS	NS	1	NS	NS	NS

These sediment sample analyses indicated that sampling transects located 300 ft from the riverbank would be within the area of plume discharge. Therefore, surface water samples were collected along three transects running parallel to the bank and located 50, 150 and 300 ft from the riverbank. Three sampling stations were located on each transect resulting in nine sampling stations within the plume discharge area. One sampling station was located at the center point of each transect. Another sampling station was located half way between the center station and the upstream end of each transect. A third sampling station was located half way between the center station and the downstream end of each transect.

At each sampling station, one surface water sample was collected and analyzed for VOCs, SVOCs, Pesticides, Herbicides, PCBs and Dioxin to determine the concentration of these constituents in surface water. Samples were collected just above the sediment/surface water interface. Bioassays, using Cerodaphnia and Fat Head Minnows, were performed on each surface water sample to determine surface water toxicity. In addition, one sediment sample was collected at each sampling station and analyzed for VOCs, SVOCs, Pesticides, Herbicides, PCBs and Dioxin to determine the concentration of these constituents in sediments. Bioassays, using Hyallela and Fat Head Minnows, were performed on each sediment sample to determine sediment toxicity. Benthic community structure was determined using three grab samples collected at selected locations within each sampling area. Since the dominant river bottom substrate is sand, benthic communities were expected to be limited.

Three composite samples of each target fish species were collected in each sampling area to determine the impact of groundwater discharge to surface water on bottom feeder, forager and predator fish. A food source approach was used to select fish for analysis:

Food Source	Fish	Trophic Level	Endpoint Organism
Omnivore	Channel Catfish	Bottom Feeder	Channel Catfish
Plankton	Shad (Large)	Forager	Osprey
	Shad (Small)		Heron
Omnivore	White Bass, Buffalo	Predator	Recreational Fisher

A fourth fish sample was collected in order to provide fillet data for the Human Health Risk Assessment. Fish tissue samples were analyzed for VOCs, SVOCs, Pesticides, Herbicides, PCBs and Dioxin. Three to five fish were collected for each composite. Fish stomach contents were examined and recorded to document food sources.

One local area of soft bottom sediment was observed during the September 2000 reconnaissance survey at a wing wall downstream of the site. One soft bottom sample was collected in this area and analyzed for VOCs, SVOCs, Pesticides, Herbicides, PCBs and Dioxin. Bioassays, using Hyallela and Fat Head Minnows, were performed on this sediment sample to determine sediment toxicity. Benthic community structure were determined by collecting and evaluating three grab samples at this sampling station. One surface water sample was

collected at this location and analyzed for VOCs, SVOCs, Pesticides, Herbicides, PCBs and Dioxin. This water sample was collected just above the sediment/surface water interface. Bioassays, using Cerodaphnia and Fat Head Minnows, were performed on this surface water sample to determine surface water toxicity.

To provide a basis for comparison, one soft bottom sample was collected upstream of the site and analyzed for VOCs, SVOCs, Pesticides, Herbicides, PCBs and Dioxin. Bioassays, using Hyallela and Fat Head Minnows, were performed on this sediment sample to determine sediment toxicity. Benthic community structure were determined by collecting and evaluating three grab samples at this sampling station. One surface water sample was collected at this location and analyzed for VOCs, SVOCs, Pesticides, Herbicides, PCBs and Dioxin. This water sample was collected just above the sediment/surface water interface. Bioassays, using Cerodaphnia and Fat Head Minnows, were performed on this surface water sample to determine surface water toxicity.

Surface Water Sampling Plan sample number, type and analyses are summarized below:

Number of Surface Water Samples:		13
Number of Sediment Samples:		13
Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Dioxin	Method 8290
Number of Benthic Community Structure Samples:		7
Number of Surface Water Bioassays		
Cerodaphnia		17
Fat Head Minnow		17
		34
Number of Sediment Bioassays		
Hyallela		17
Fat Head Minnow		17
		34

Number of Fish Tissue Samples	
Channel Catfish Composites (Whole Body)	5
Large Shad Composites (Whole Body)	5
Small Shad Composites (Whole Body)	5
White Bass/Buffalo (Fillets)	5
	20

Analyses:	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Dioxin	Method 8290

Surface water and sediment samples are currently being validated and fish tissue samples are being analyzed.

3.6.4 USEPA Sediment Sampling

In October and November 2000, USEPA collected sediment samples in the Mississippi River within and adjacent to area of suspected groundwater discharge from Solutia's W.G. Krummrich plant. This work was performed in conjunction with Solutia's implementation of its Surface Water Sampling Plan using the same methods and sampling personnel, methods and equipment. Maximum detected concentrations in these samples are summarized below:

		Plume Discharge Area (Distance from Shore)			
	Upstream Reference Area	50 ft	150 ft	300 ft	Downstream Reference Area
VOCs (ppb)					
Acetone	ND	ND	ND	ND	ND
Benzene	ND	45	58	ND	ND
Chlorobenzene	ND	10,000	6,700	3,100	1.6
1,2-Dicloroethane	ND	110	ND	ND	ND
Methylene Chloride	ND	ND	ND	ND	ND
Toluene	ND	12,000	ND	ND	ND
Xylene	ND	120	ND	ND	ND

	Upstream Reference Area	Plume Discharge Area (Distance from Shore) 50 ft	150 ft	300 ft	Downstream Reference Area
SVOCs (ppb)					
Aniline	ND	3,900	3,400	ND	ND
4-Chloroaniline	ND	3,300	6,400	ND	ND
1,2-Dichlorobenzene	ND	190	ND	ND	ND
1,3-Dichlorobenzene	ND	150	ND	ND	ND
1,4-Dichlorobenzene	ND	390	1,700	ND	ND
Phenol	ND	3,200	ND	ND	ND
2-Chlorophenol	ND	400	ND	ND	ND
2,4-Dichlorophenol	ND	610	ND	ND	ND
2,6-Dichlorophenol	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND
3-Methylphenol	ND	93	ND	ND	ND
bis(2-ethylhexyl)Phthalate	ND	ND	ND	ND	ND
Organochlorine Pesticides (ppb)					
Aldrin	ND	ND	ND	ND	ND
alpha-BHC	ND	ND	ND	ND	ND
beta-BHC	ND	ND	ND	ND	ND
delta-BHC	ND	44	ND	ND	ND
gamma-BHC (Lindane)	ND	ND	ND	ND	ND
Chlordane (technical)	ND	ND	ND	ND	ND
Chlorobenzilate	ND	21	ND	ND	ND
4,4-DDD	ND	14	ND	ND	ND
4,4-DDE	ND	ND	ND	ND	ND
4,4-DDT	ND	ND	ND	ND	ND
Diallate	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND
Endosulfan sulfate	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND
Endrin aldehyde	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND
Isodrin	ND	ND	ND	ND	ND
Kepone	ND	ND	ND	ND	ND

	Upstream Reference Area	Plume Discharge Area (Distance from Shore) 50 ft	150 ft	300 ft	Downstream Reference Area
Organochlorine Pesticides (ppb) (con't.)					
Methoxychlor	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND
Organophosphorus Pesticides (ppb)					
Dimethoate	ND	ND	ND	ND	ND
Disulfoton	ND	ND	ND	ND	ND
Famphur	ND	ND	ND	ND	ND
Methyl Parathion	ND	ND	ND	ND	ND
Phorate	ND	ND	ND	ND	ND
Tetraethyldithiopyrphosphate	ND	ND	ND	ND	ND
Thionazin	ND	ND	ND	ND	ND
o,o,o-Triethylphosphorothioate	ND	ND	ND	ND	ND
Herbicides (ppb)					
2,4-D	ND	790	ND	ND	ND
2,4,5-TP (Silvex)	ND	ND	ND	ND	ND
2, 4, 5-T	ND	ND	ND	ND	ND
PCBs (ppb)					
Aroclor 1016	ND	ND	120	ND	ND
Aroclor 1221	ND	ND	ND	ND	ND
Aroclor 1232	ND	ND	ND	ND	ND
Aroclor 1242	ND	ND	ND	ND	ND
Aroclor 1248	ND	84	20	ND	ND
Aroclor 1254	ND	ND	ND	ND	ND
Aroclor 1260	ND	ND	ND	ND	ND
TOC (ppm)	ND	11,000	7,400	ND	3,700

These data indicate that two VOCs (Chlorobenzene and Toluene) and three SVOCs (Aniline, 4-Chloroaniline and Phenol) occur at concentrations greater than one ppm in sediments at four sampling locations. Constituent concentrations at all sampling stations with detected concentrations are summarized below:

Constituent Concentration, (ppb)	Sampling Station							
	PDA 2-60	MR-SD 2-150	MR-SD 4-90	PDA 5R-60	MR-SD 5-75	M R-SD 5-150	M R-SD 5-315	MR-SD 7-150
Benzene	ND	55	4.2	ND	45	58	260	36
Chlorobenzene	10,000	390	100	450	1,800	6,700	3,100	1600
1,2-Dichloroethane	ND	ND	ND	110	ND	ND	ND	ND
Ethylbenzene	ND	ND	2	ND	ND	ND	ND	ND
Toluene	12,000	ND	ND	140	ND	ND	ND	ND
Xylenes	ND	ND	2.6	120	ND	ND	ND	ND

Constituent Concentration, (ppb)	Sampling Station							
	PDA 2-60	MR-SD 2-150	MR-SD 4-90	PDA 5R-60	MR-SD 5-75	M R-SD 5-150	M R-SD 5-315	MR-SD 7-150
Aniline	210	ND	ND	3,900	2,400	3,400	ND	ND
4-Chloroaniline	720	99	ND	3,300	3,000	6,400	ND	58
1,4-Dichlorobenzene	390	ND	ND	ND	300	1,700	ND	ND
Phenol	ND	ND	ND	3,200	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	400	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	610	ND	ND	ND	ND
3-Methylphenol	95	ND	ND	ND	ND	ND	ND	ND
PCBs	ND	ND	ND	ND	ND	120	38	20
Total Organic Carbon	11,000	ND	ND	390	200	7,400	ND	ND

In order to interpret this data, Total VOC, Total SVOC and Total Organic Carbon concentrations were compared to sampling station distance from the northern, upstream boundary of Site R:

Sampling Station	Total VOCs (ppb)	Total SVOCs (ppb)	Total Organic Carbon (ppm)	Distance from Riverbank (feet)	Distance from North Boundary of Site R (feet)
MR-SD-2-150	445	99	ND	150	200
PDA-5R-60	820	11,410	390	60	1100
MR-SD-4-90	8.8	ND	ND	90	1300
MR-SD-5-75	1,845	5,700	200	75	1550
MR-SD-5-150	6,758	11,500	7,400	150	1550
MR-SD-5-315	3,360	ND	ND	315	1550

Sampling Station	Total VOCs (ppb)	Total SVOCs (ppb)	Total Organic Carbon (ppm)	Distance from Riverbank (feet)	Distance from North Boundary of Site R (feet)
PDA-2-60	22,000	1,415	11,000	60	1800
MR-SD-7-150	1,636	58	ND	150	2300

Analytical data from these sampling stations appear to indicate that there are two plume discharge areas at Site R. One plume appears to be discharging from the northern half of Site R. A second plume appears to be discharging from the southern third of site R and the northern portion of Site Q. The north plume discharge area is composed primarily of SVOCs, specifically Aniline, 4-Chloroaniline and Phenol. The northern portion of the south plume-discharge area consists primarily of SVOCs, including Aniline, 4-Chloroaniline and Dichlorobenzene, although VOCs, primarily Chlorobenzene, make up a significant percentage of the constituents present. Chlorobenzene and Toluene are the dominant components of the southern portion of the south plume-discharge area.

Based on this data set, it appears that the northern plume discharge area extends more than150 ft but less than 300 ft from shore. Another observation that can be made from this data is that VOCs appear to be discharging at least 300 ft into the river at the southern plume discharge area. Total VOC concentrations are 1,845; 6758 and 3,360 ppb at distances of 75, 150 and 315 ft from shore, respectively, at sampling stations MR-SD-5-75, MR-SD-5-150 and MR-SD-5-315. Total SVOC concentrations at these sampling stations are, respectively, 5,700 ppb; 11,500 ppb and ND.

3.7 Treatability Studies

The Advent Group of Brentwood, Tennessee conducted a groundwater treatability study for Solutia in 1992 (Groundwater Treatability Study, June 1993) using groundwater from Site R as influent. This pilot-scale test of a fluidized bed, attached biological growth, groundwater treatment system was undertaken as part of an RI/FS required by an AOC with IEPA. The purpose of this test was to evaluate treatment efficiencies and obtain treatment plant design parameters. Treatability test objectives were:

- Obtain a representative blend of groundwater for use in testing;
- Develop a treatment performance profile of the fluidized bed reactor (FBR) for the parameters of concern;
- Develop operational and design parameters for a full-scale FBR treatment system should one be constructed;
- Develop sludge handling process design parameters, if necessary;
- Determine off-gas rates and characteristics;
- Determine impacts of recalcitrant materials, if any; and
- Prepare process design and preliminary cost estimate for a full-scale FBR system.

To simulate both summer and winter operating conditions, the treatment system was operated from July 27 to November 16, 1992. From July 27 to October 15, 1992, unit temperature was 20 to 30°C to simulate summer conditions. After all necessary summer operating data were collected, a chiller was used to reduce feed temperature to between 9 and 14°C to simulate winter operations. A composite feed from existing Site R wells 28B, 56C and 57C was collected for treatment. Each well contributed approximately one third of the flow to the composite. Groundwater feed was stored in an equilization tank and pumped to the treatment system with a positive displacement pump.

A treatment system consisting of five unit operations was used to treat Site R groundwater (Figure 3-16). These sequential unit operations were:

- Biodegradation of organics with a fluidized bed reactor (FBR) using activated carbon as the growth medium and operating at a fluidization flow of 30 gpm and a forward flow of 0.4 to 1.5 gpm;
- Flocculation of solids;
- Clarification of solids;
- Filtration of solids using bag and cartridge filters in series; and
- Carbon polishing using two beds in series to remove any residual organics.

Treated effluent was discharged to the American Bottoms Regional Treatment Facility. Clarification, filtration and carbon adsorption were performed to insure that there would be no impact on the American Bottoms wastewater-treatment system.

Sludge from American Bottoms was the primary source of seed for the FBR although small quantities of microorganisms from other treatment facilities were also added during the acclimation period. To increase the rate of nitrification early in the study, the microbial population was supplemented with commercially obtained nitrifiers. After a three week long acclimation period, biological activity in the system stabilized and testing of varied organic loadings at warm and cold temperature conditions was started.

A wide-range of organics was effectively removed by the FBR. At a COD loading of 250 pounds per thousand cubic feet per day, the FBR system proved operable and capable of reliable VOC and SVOC removals approaching or exceeding 99 percent:

Constituent	Average Influent	Average Effluent	Percent Removal
VOCs, ppb			
Chlorobenzene	5,700	44	99.2
Toluene	1,350	< 5	99.8
Xylene	1,117	11	99.0
SVOCs, ppb			
2-Chloroaniline	37,667	11	> 99.9
4-Chloroaniline	16,650	< 30	> 99.9
1,2-Dichlorobenzene	2,867	90	96.9
2-Nitrochlorobenzene	129,667	330	99.7
4-Nitrochlorobenzene	41,167	57	98.7
SVOCs, ppb			
Phenol	2,983	< 10	99.8
2-Chlorophenol	6,580	14	99.8
2,4-Dichlorophenol	5,583	13	99.8
Herbicides, ppb			
2,4-D	408	34	91.7
2,4,5-T	12.5	2	84.0
Soluble TOC, ppm	219	9	95.6
Soluble COD, ppm	754	23	96.9
Soluble BOD, ppm	201	2	99.0

Mass removal by air stripping was minimal with 0.00199% of the Chlorobenzene, 0.00351% of the 1,2-Dichlorobenezene and 0.00306% of the Toluene removed by this mechanism.

Using information from the pilot-scale treatability test, Advent prepared a cost estimate for a full-scale system designed to treat a flow of 1500 gpm with a sustained COD load of 14,400 pounds per day. At this flow rate and loading, twelve, 22 ft-diameter FBRs were needed to treat extracted groundwater. Each reactor would use two pumps, of approximately 115 horsepower each, to fluidize the attached growth carbon bed at a recycle ratio of 33:1. Treated effluent would be discharged to the Mississippi River after flocculation and clarification. Sludge filter cake would be disposed at an off-site industrial waste landfill.

Installed treatment system costs, in rounded 1992 dollars, are summarized below:

Groundwater Collection System	$ 400,000
Influent Preparation	47,100
Fluid Bed Reactors	10,358,000
Solids Removal	253,500
Control Room/Laboratory	487,200
Subtotal	**$11,546,000**
Site Preparation (3%)	346,000
Piping (10%)	1,155,000
Electric (12%)	1,386,000
Installed Equipment Cost	**$14,087,000**
Engineering (20%)	2,817,000
Contingency (20%)	2,817,000
Total Installed Cost	**$19,721,000**

Annual treatment system operation and maintenance costs, in rounded 1992 dollars, are summarized below:

Labor	$ 467,200
Groundwater Recovery and Pretreatment	194,000
Fluid Bed Reactors	893,000
Sludge Treatment and Disposal	94,900
Laboratory Analyses	200,000
Maintenance (5% of Subtotal Installed Cost)	572,000
Total Annual O&M Costs	**$2,421,000**

Figure 3-1

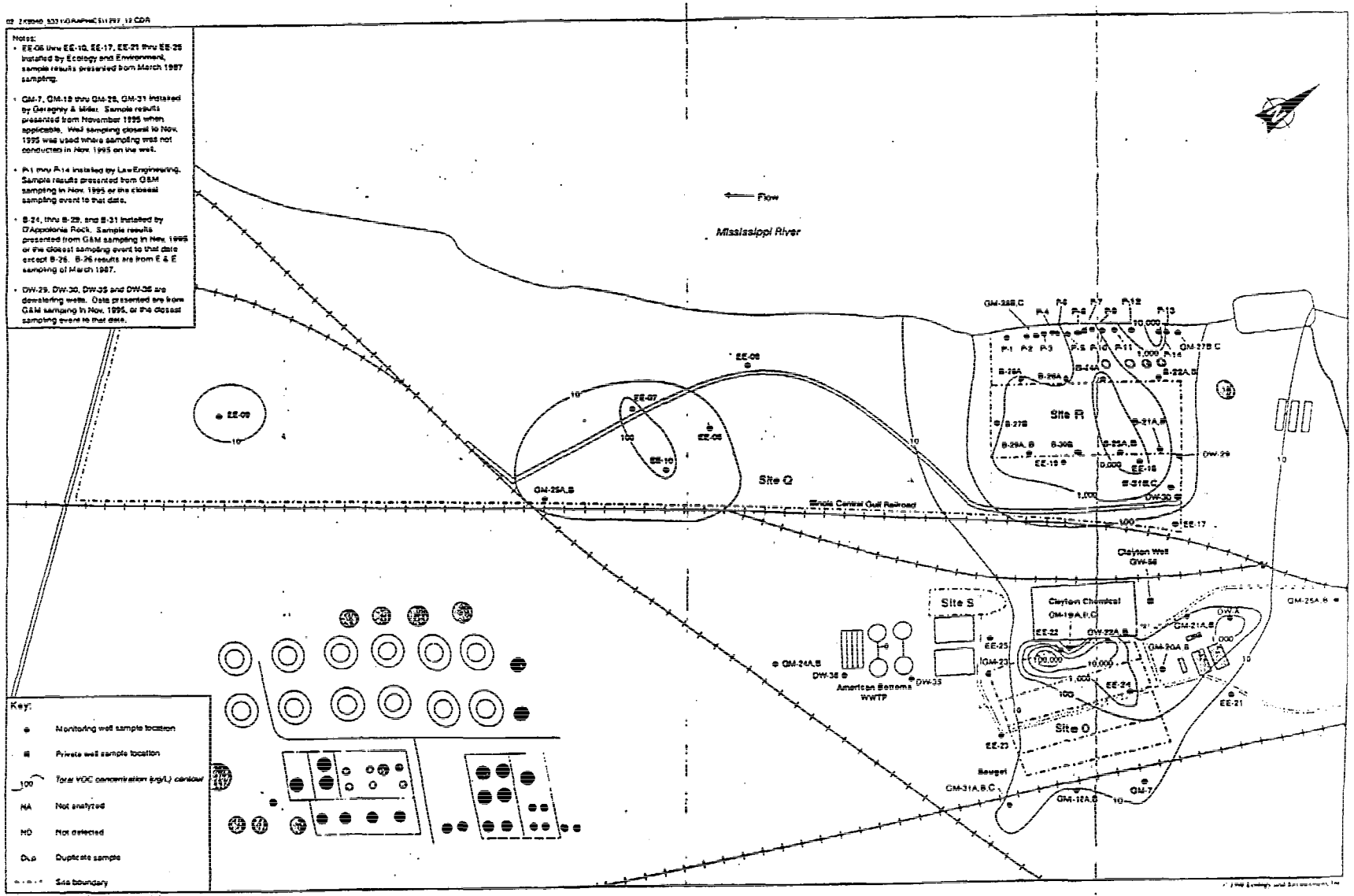
Sauget Area 2 Total VOC Concentrations

in Shallow Wells

(E&E, 1998)

Notes:

- EE-06 thru EE-10, EE-17, EE-21 thru EE-25 installed by Ecology and Environment, sample results presented from March 1997 sampling.
- GM-7, GM-18 thru GM-28, GM-31 installed by Geraghty & Miller. Sample results presented from November 1995 when applicable. Well sampling closest to Nov. 1995 was used where sampling was not conducted in Nov. 1995 on the well.
- P-1 thru P-14 installed by Law Engineering. Sample results presented from G&M sampling in Nov. 1995 or the closest sampling event to that date.
- B-24, thru B-29, and B-31 installed by D'Appolonia Rock. Sample results presented from G&M sampling in Nov. 1995 or the closest sampling event to that date except B-26. B-26 results are from E & E sampling of March 1997.
- DW-29, DW-30, DW-35 and DW-36 are dewatering wells. Data presented are from G&M sampling in Nov. 1995, or the closest sampling event to that date.



SOURCE: Ecology and Environment, Inc. 1998.

APPROXIMATE SCALE:

0 ¼ ½ Mile

AREA 2 GROUNDWATER
TOTAL VOC CONCENTRATIONS
SHALLOW WELLS

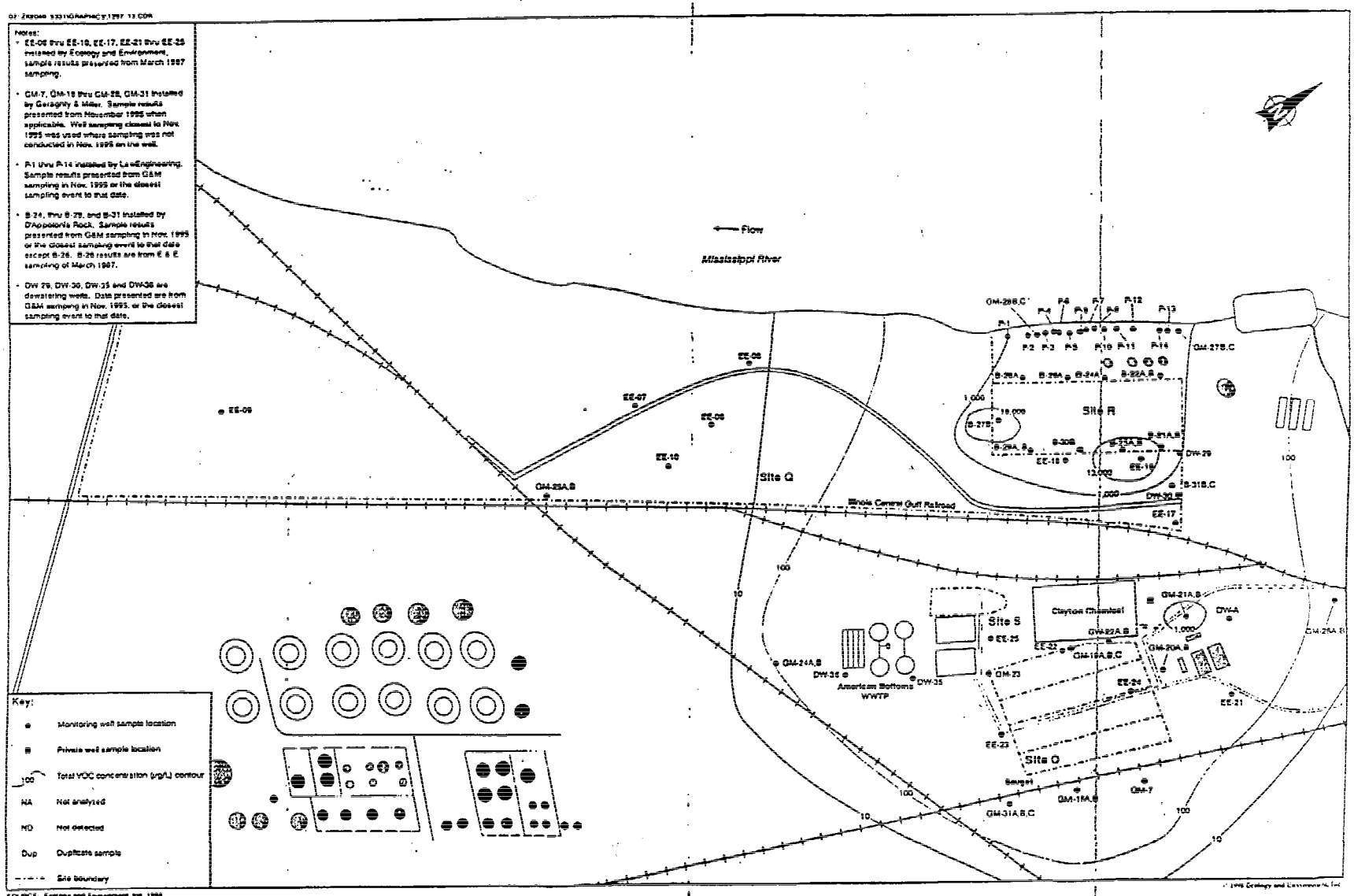
Figure 3-2

Sauget Area 2 Total VOC Concentrations in Intermediate/Deep Wells

(E&E, 1998)

Notes:

- EE-06 thru EE-10, EE-17, EE-21 thru EE-25 installed by Ecology and Environment, sample results presented from March 1997 sampling.
- GM-7, GM-18 thru GM-28, GM-31 installed by Geraghty & Miller. Sample results presented from November 1995 when applicable. Well sampling closest to Nov. 1995 was used where sampling was not conducted in Nov. 1995 on the well.
- P-1 thru P-14 installed by La eEngineering. Sample results presented from G&M sampling in Nov. 1995 or the closest sampling event to that date.
- B-24, thru B-29, and B-31 installed by D'Appolonia Rock. Sample results presented from G&M sampling in Nov. 1995 or the closest sampling event to that date except B-26. B-26 results are from E & E sampling of March 1997.
- DW-29, DW-30, DW-35 and DW-36 are dewatering wells. Data presented are from G&M sampling in Nov. 1995, or the closest sampling event to that date.



SOURCE: Ecology and Environment, Inc. 1998

APPROXIMATE SCALE

0 ¼ ½ Mile

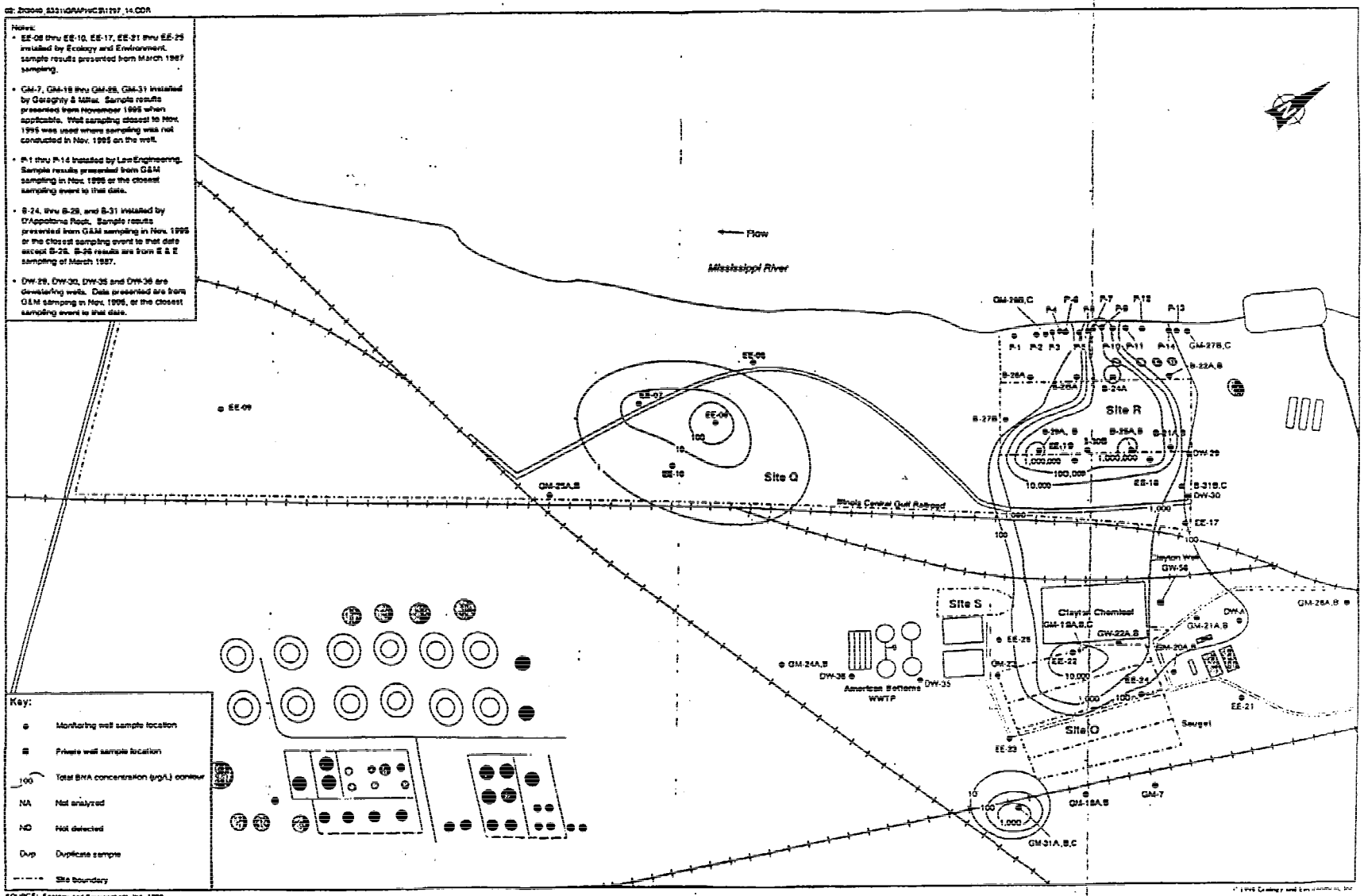
AREA 2 GROUNDWATER
TOTAL VOC CONCENTRATIONS
INTERMEDIATE/DEEP WELLS

Figure 3-3

Sauget Area 2 Total BNA Concentrations

in Shallow Wells

(E&E, 1998)



SOURCE: Ecology and Environment, Inc. 1996.

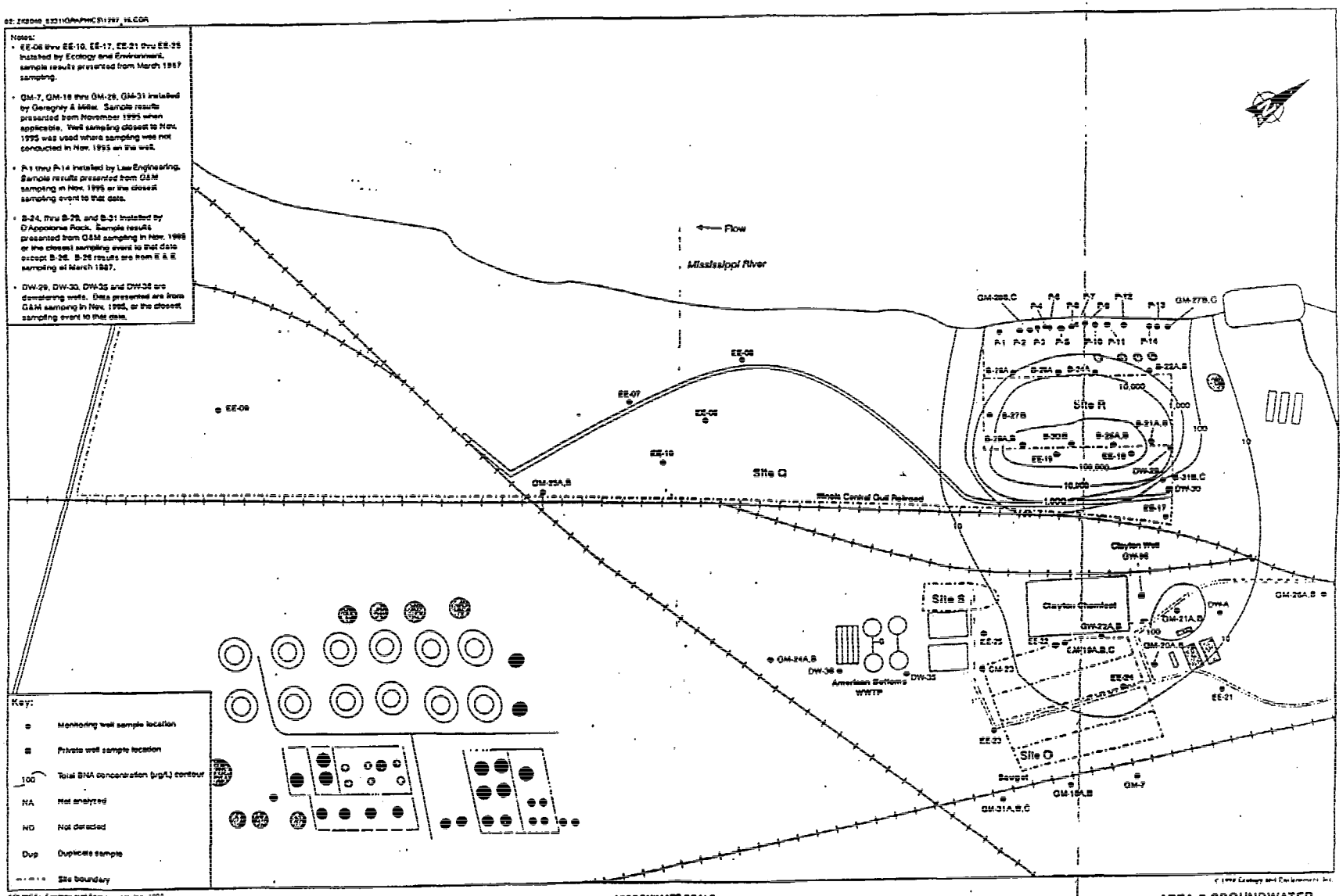
AREA 2 GROUNDWATER
TOTAL BNA CONCENTRATIONS
SHALLOW WELLS

Figure 3-4

Sauget Area 2 Total BNA Concentrations in Intermediate/Deep Wells (E&E, 1998)

Notes:

- EE-06 thru EE-10, EE-17, EE-21 thru EE-25 installed by Ecology and Environment, sample results presented from March 1997 sampling.
- GM-7, GM-18 thru GM-29, GM-31 installed by Geraghty & Miller. Sample results presented from November 1995 when applicable. Well sampling closest to Nov. 1995 was used where sampling was not conducted in Nov. 1995 on the well.
- P-1 thru P-14 installed by Law Engineering. Sample results presented from O&M sampling in Nov. 1995 or the closest sampling event to that date.
- B-24, thru B-29, and B-31 installed by D'Appolonia Rock. Sample results presented from O&M sampling in Nov. 1995 or the closest sampling event to that date except B-26. B-26 results are from E & E sampling at March 1997.
- DW-29, DW-30, DW-35 and DW-36 are domestic wells. Data presented are from O&M sampling in Nov. 1995, or the closest sampling event to that date.



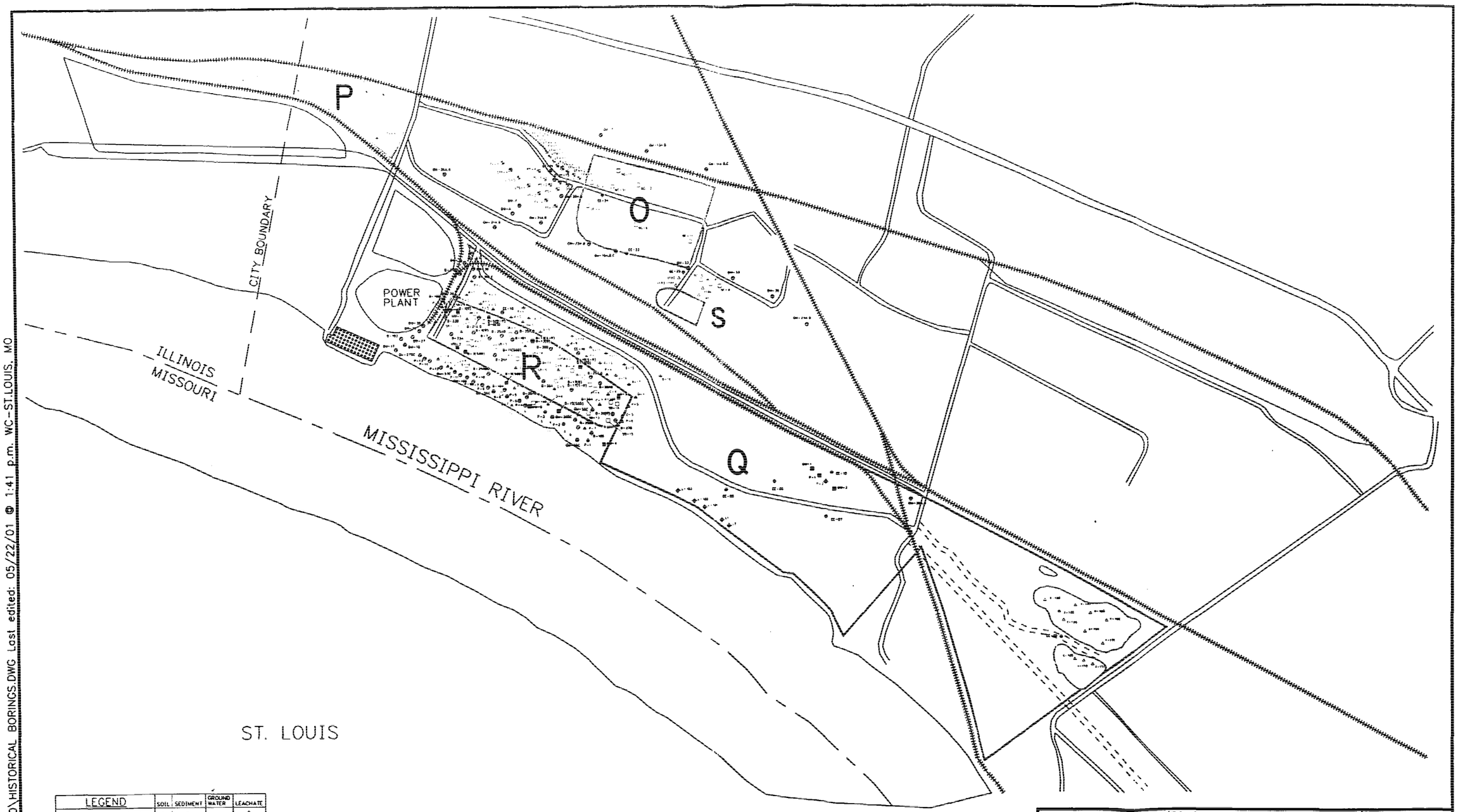
SOURCE: Ecology and Environment, Inc. 1998.

AREA 2 GROUNDWATER
TOTAL BNA CONCENTRATION
INTERMEDIATE/DEEP WELLS

Figure 3-5

Summary of Historical

Sampling Locations



LEGEND	SOIL	SEDIMENT	GROUND WATER	LEACHATE
IEPA	△	♣	▬	⌖
USEPA				★
E&E	⌖	♦	●	◇
DYNAMAC	▲			
G&M	▢		⊕	
RUSSEL & AXON	⧉			

0 1000
SCALE FEET

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN
SAUGET, ILLINOIS

PROJECT NO. 2320010024.02

URS

DRN. BY: djd 1/31/01
DSGN. BY: bv
CHKD. BY:

Summary of Historical Sampling Locations

FIG. NO. 3-5

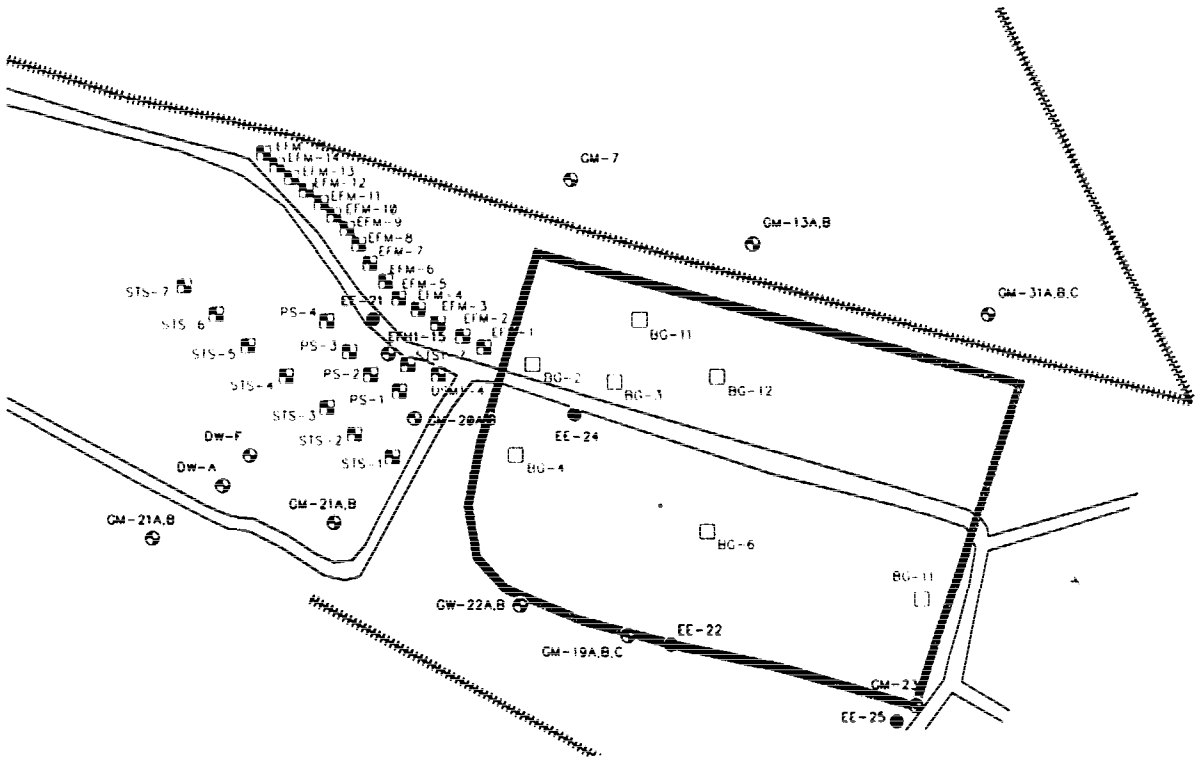
File: E:\2320010024.00\HISTORICAL BORINGS.DWG Last edited: 05/22/01 @ 1:41 p.m. WC-ST.LOUIS, MO

Figure 3-6

Summary of Historical Sampling

Locations – Site O

File: E:\2320010024.00\HISTORICAL_BORINGS.DWG Last edited: 05/22/01 @ 1:41 p.m. WC-ST.LOUIS, MO



LEGEND	SOIL	SEDIMENT	GROUND WATER	LEACHATE
IEPA	△	●	■	⊕
USEPA				★
E&E	⊕	●	●	◇
DYNAMAC	▲			
G&M	□		⊕	
RUSSEL & AXON				

0 500

SCALE FEET

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN SAUGET, ILLINOIS	PROJECT NO. 2320010024.02

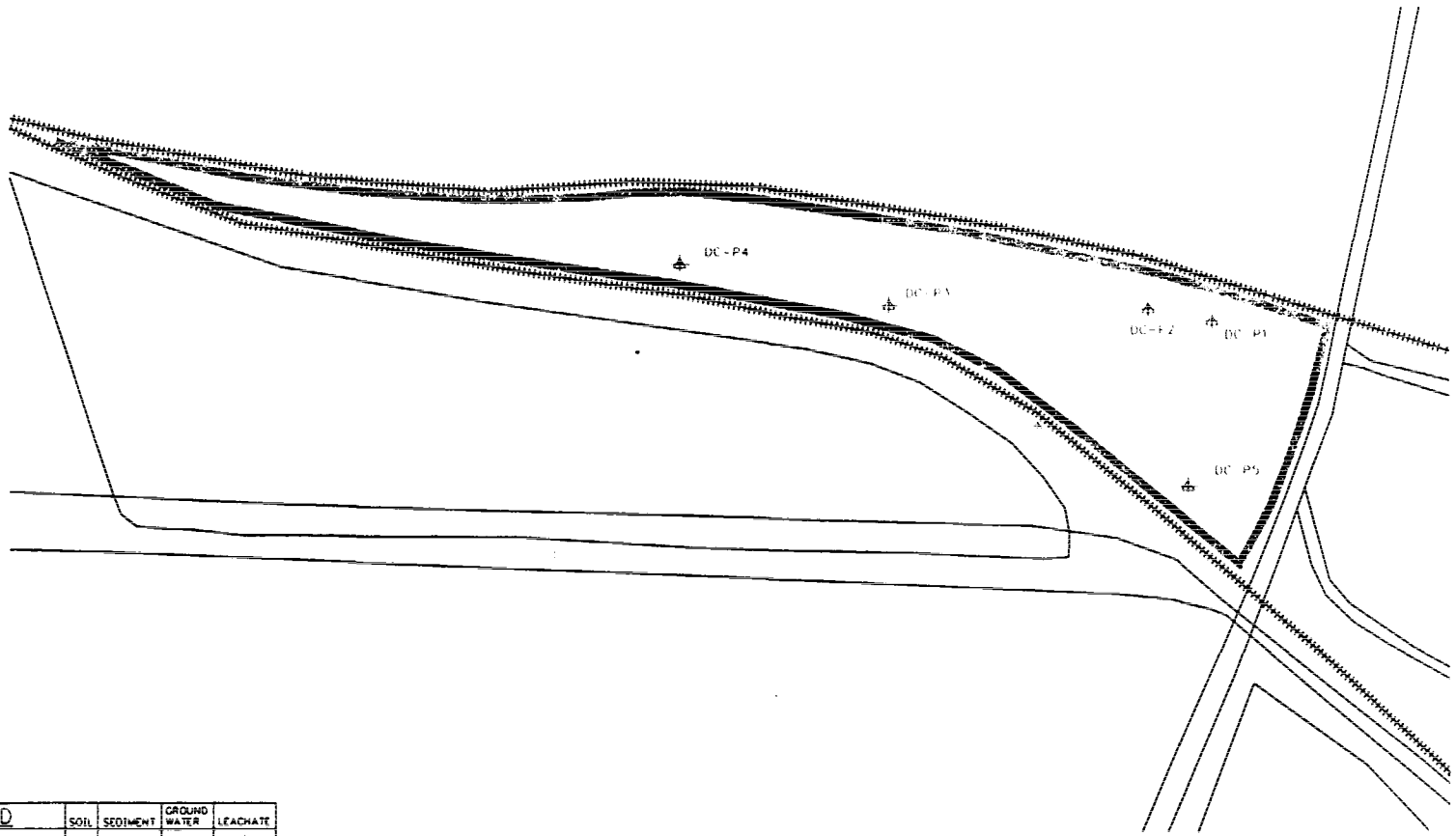
URS

DRN. BY: djd 1/31/01 DSGN. BY: bv CHKD. BY:	Summary of Historical Sampling Locations-Site O	FIG. NO. 3-6

Figure 3-7

Summary of Historical Sampling Locations -- Site P

File: E:\2320010024.00\HISTORICAL BORINGS.DWG Last edited: 05/22/01 @ 1:41 p.m. WC-ST.LOUIS, MO



LEGEND	SOIL	SEDIMENT	GROUND WATER	LEACHATE
IEPA	△	●	■	⊕
USEPA				★
E&E	⊕	♦	●	◇
DYNAMAC	▲			
G&M	□		⊖	
RUSSEL & AXON	■			

N

0 500

SCALE FEET

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN
SAUGET, ILLINOIS

PROJECT NO. 2320010024.02

URS

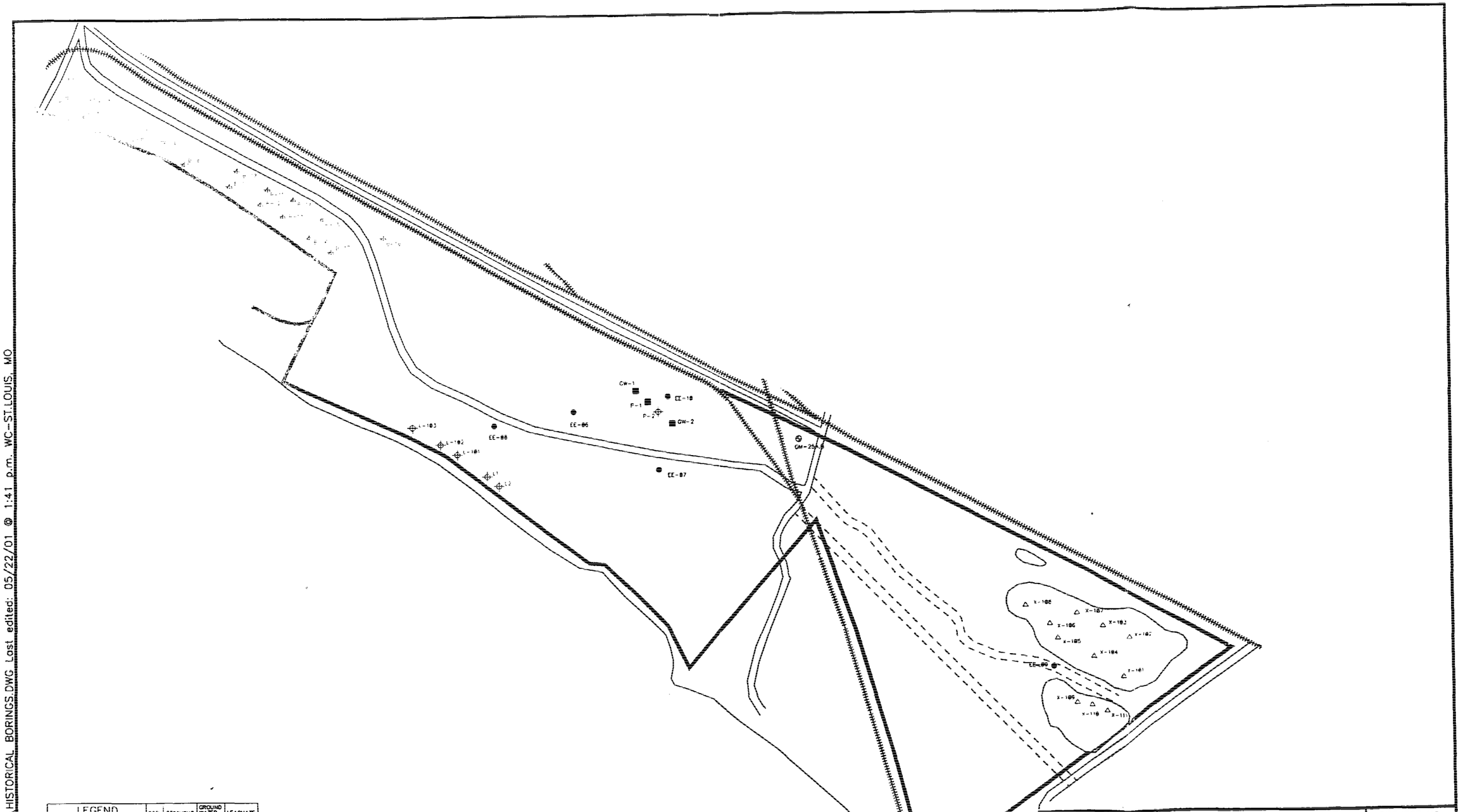
DRN. BY: djd 1/31/01
DSGN. BY: bv
CHKD. BY:

Summary of Historical Sampling Locations-Site P

FIG. NO. 3-7

Figure 3-8

Summary of Historical Sampling Locations – Site Q



LEGEND	SOIL	SEDIMENT	GROUND WATER	LEACHATE
IEPA	△	◦	▬	⌖
USEPA				★
E&E	⚓	·	●	◇
DYNAMAC	▲			
G&M	□		◎	
RUSSEL & AXON	⚓			

0 1000

SCALE FEET

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN
SAUGET, ILLINOIS

PROJECT NO. 2320010024.02

URS

DRN. BY: djd 1/31/01
DSGN. BY: bv
CHKD. BY:

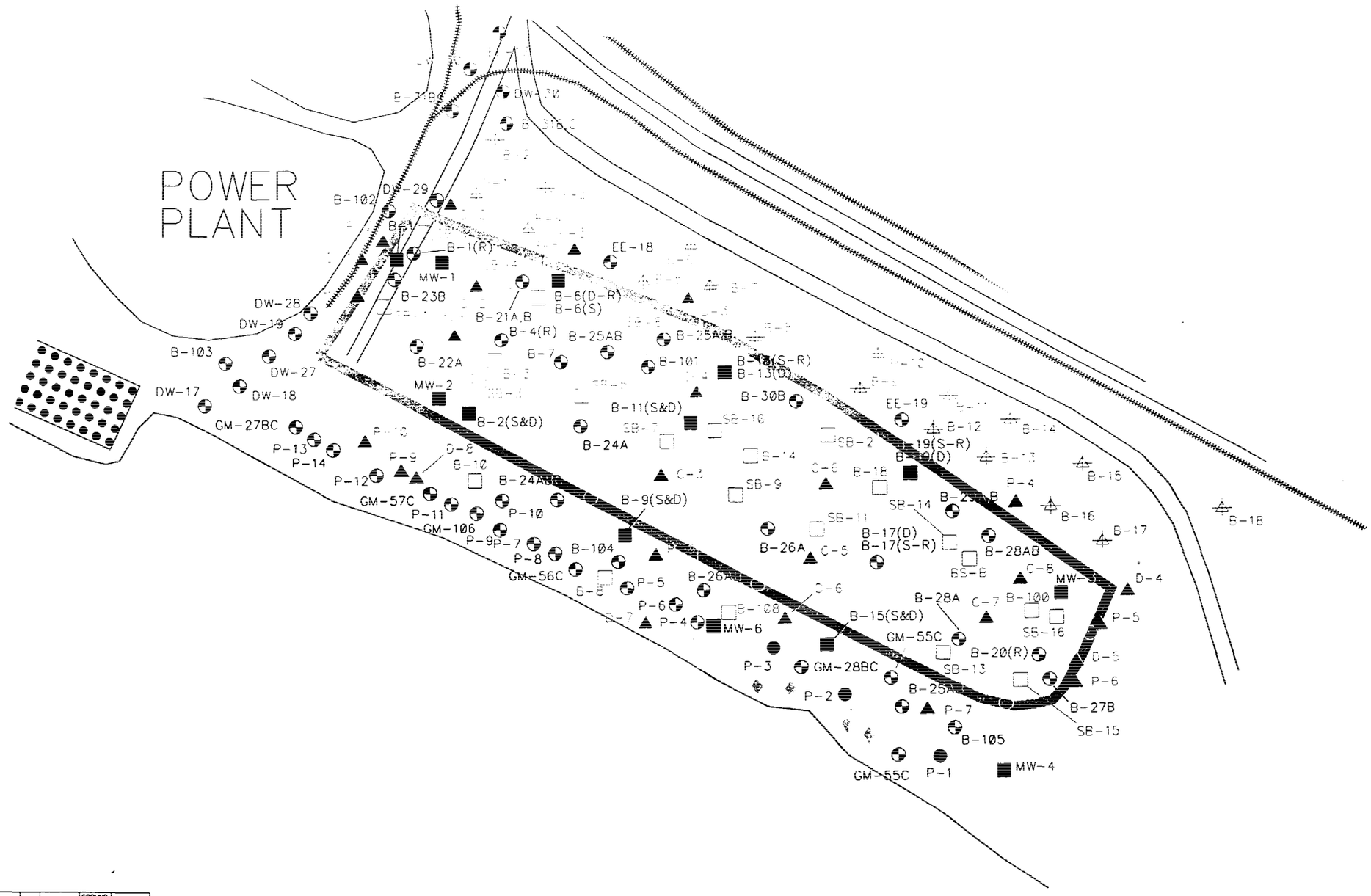
Summary of Historical Sampling Locations–Site O

FIG. NO. 3–8

File: E:\2320010024.00\HISTORICAL BORINGS.DWG Last edited: 05/22/01 @ 1:41 p.m. WC–ST.LOUIS, MO

Figure 3-9

Summary of Historical Sampling Locations -- Site R



LEGEND	SOIL	SEDIMENT	GROUND WATER	LEACHATE
IEPA	△		■	⌖
USEPA				★
E&E	⏚		●	◇
DYNAMAC	▲			
G&M	□		◐	
RUSSEL & AXON				

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN
SAUGET, ILLINOIS

PROJECT NO. 2320010024.02

URS

DRN. BY: djd 1/31/01
DSGN. BY: bv
CHKD. BY:

Summary of Historical Sampling Locations–Site R

FIG. NO. 3-9

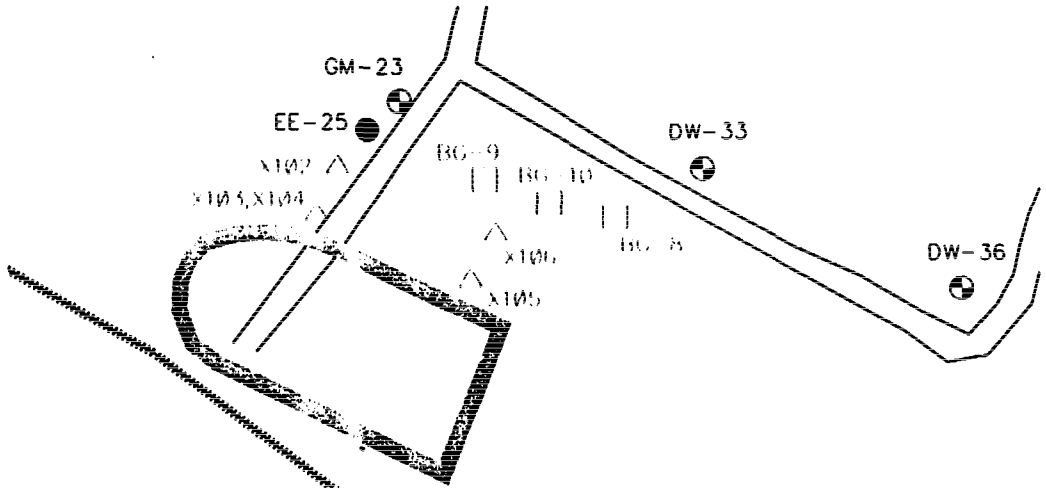
File: E:\2320010024.00\HISTORICAL BORINGS.DWG Last edited: 05/22/01 @ 1:41 p.m. WC-ST.LOUIS, MO

Figure 3-10

Summary of Historical Sampling

Locations -- Site S

File: E:\2320010024.00\HISTORICAL BORINGS.DWG Last edited: 05/22/01 @ 1:41 p.m. WC-ST.LOUIS, MO



LEGEND	SOIL	SEDIMENT	GROUND WATER	LEACHATE
IEPA	△		■	⊕
USEPA				★
E&E	⊕		●	◇
DYNAMAC	▲			
G&M	⊔		⊕	
RUSSEL & AXON	⊔			

0 200

SCALE FEET

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN
SAUGET, ILLINOIS

PROJECT NO. 2320010024.02

URS

DRN. BY: djd 1/31/01
DSGN. BY: bv
CHKD. BY:

Summary of Historical Sampling Locations-Site S

FIG. NO. 3-10

Figure 3-11

Projected ABRTF Effluent Discharge Plume Location

(Advent, 1990)

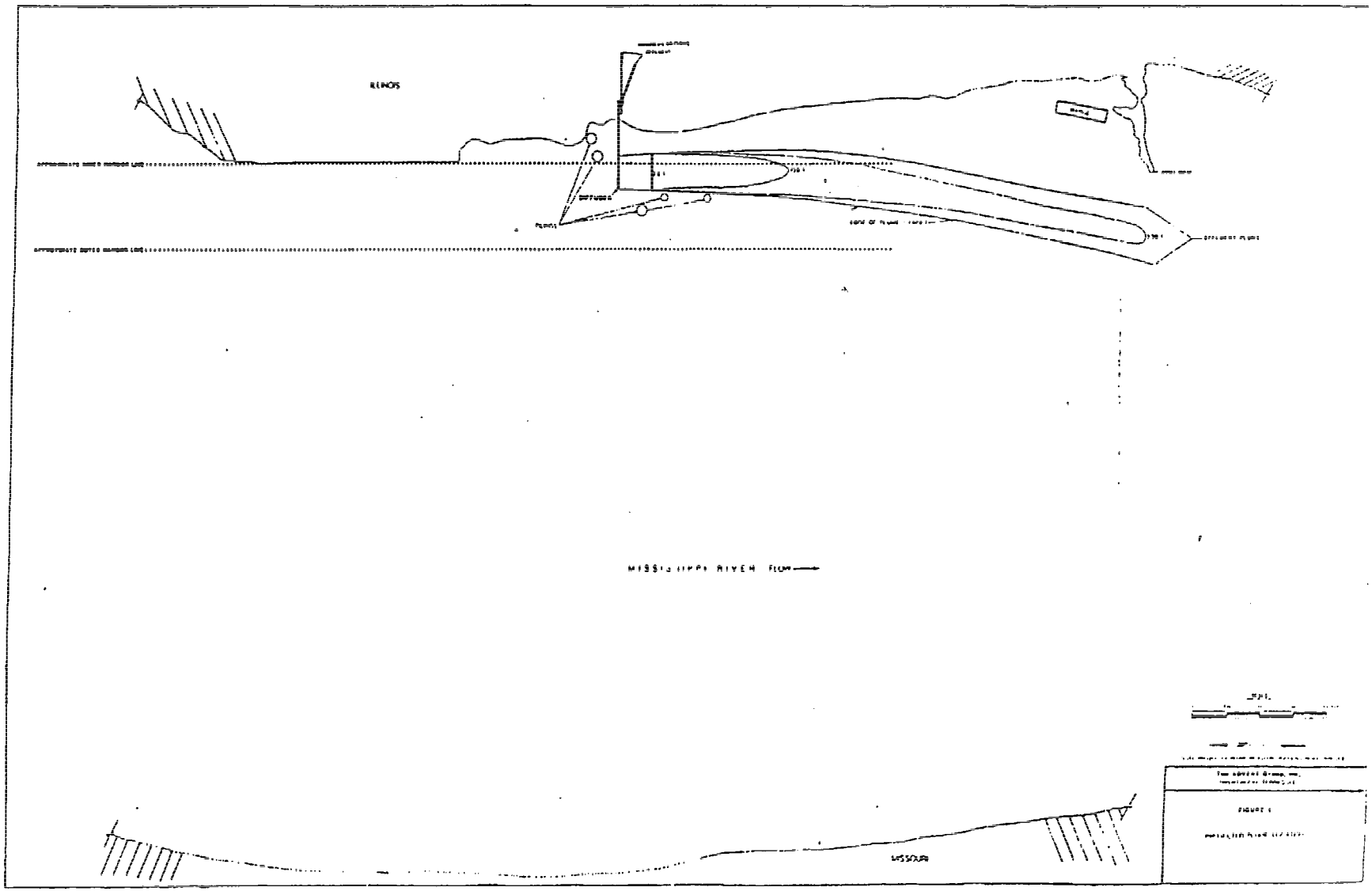

ILLINOIS
MISSISSIPPI RIVER FLOW
MISSOURI

Figure 3-12

Summary of Mississippi River Habitat Observations,

ABRTF Effluent Plume

(Advent, 1990)

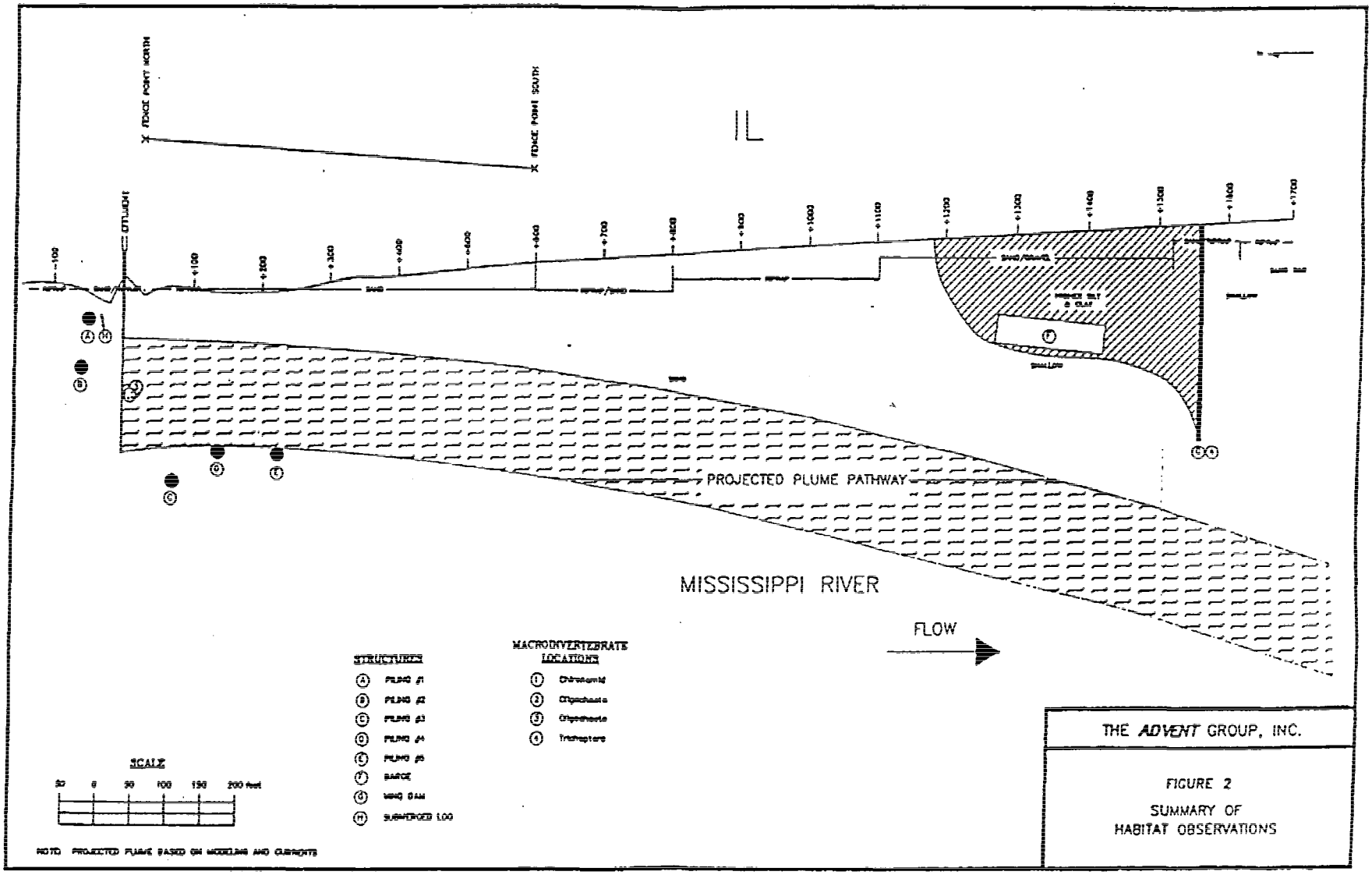

FENCE POINT NORTH
FENCE POINT SOUTH
PROJECTED PLUME PATHWAY
MISSISSIPPI RIVER
FLOW
STRUCTURES
MACROINVERTEBRATE LOCATIONS
SCALE
NOTE: PROJECTED PLUME BASED ON MODELING AND CURRENTS
THE ADVENT GROUP, INC.
FIGURE 2
SUMMARY OF HABITAT OBSERVATIONS

Figure 3-13

Schematic of Transect Sampling Locations,

ABRTF Effluent Plume

(Advent, 1990)

FIGURE 2-1. SCHEMATIC OF TRANSECT SAMPLING LOCATIONS

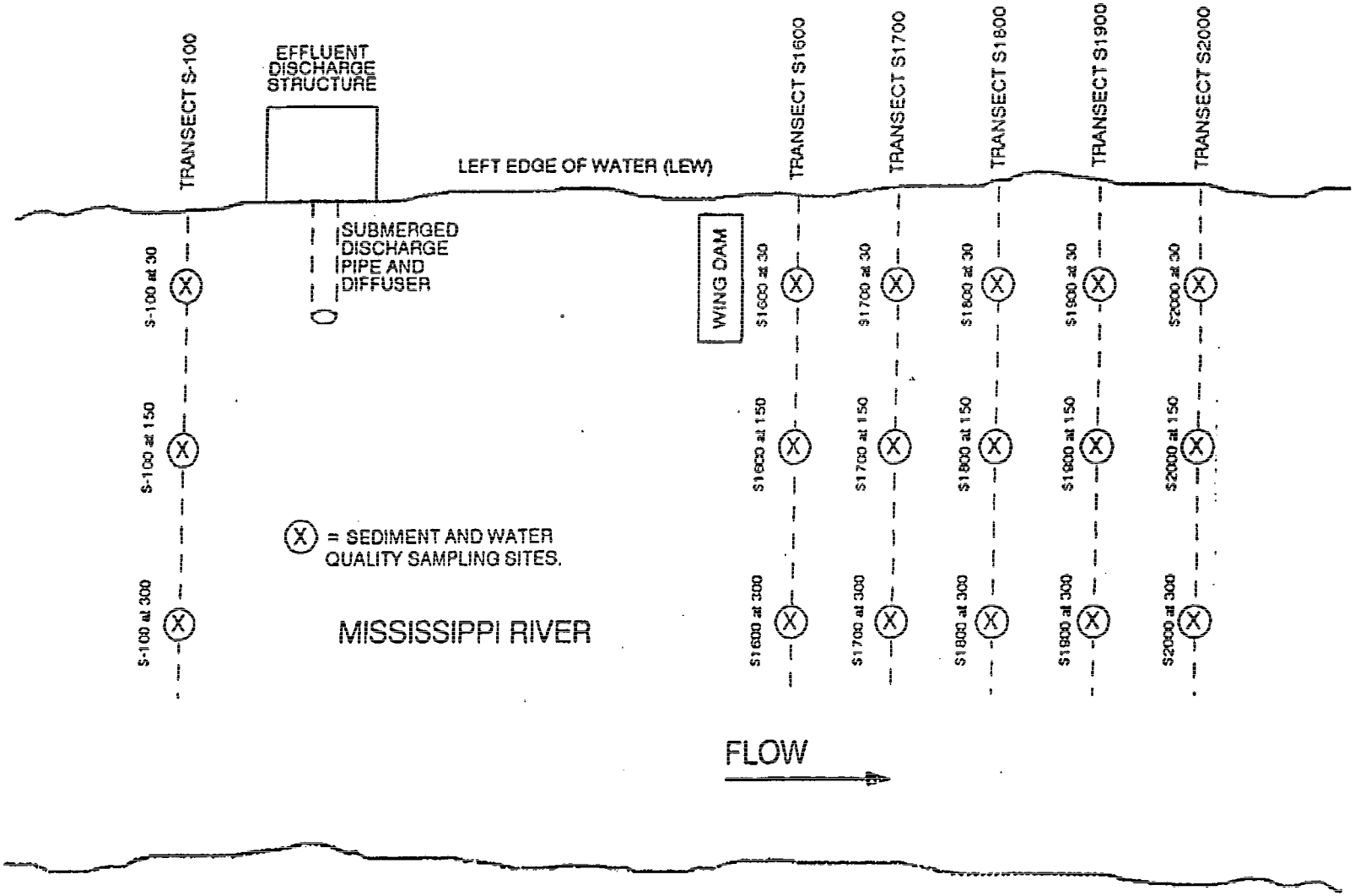


Figure 3-14

Schematic of General Study Area,

ABRTF Effluent Plume

(Advent, 1994)

FIGURE 1-2. SCHEMATIC OF GENERAL STUDY AREA

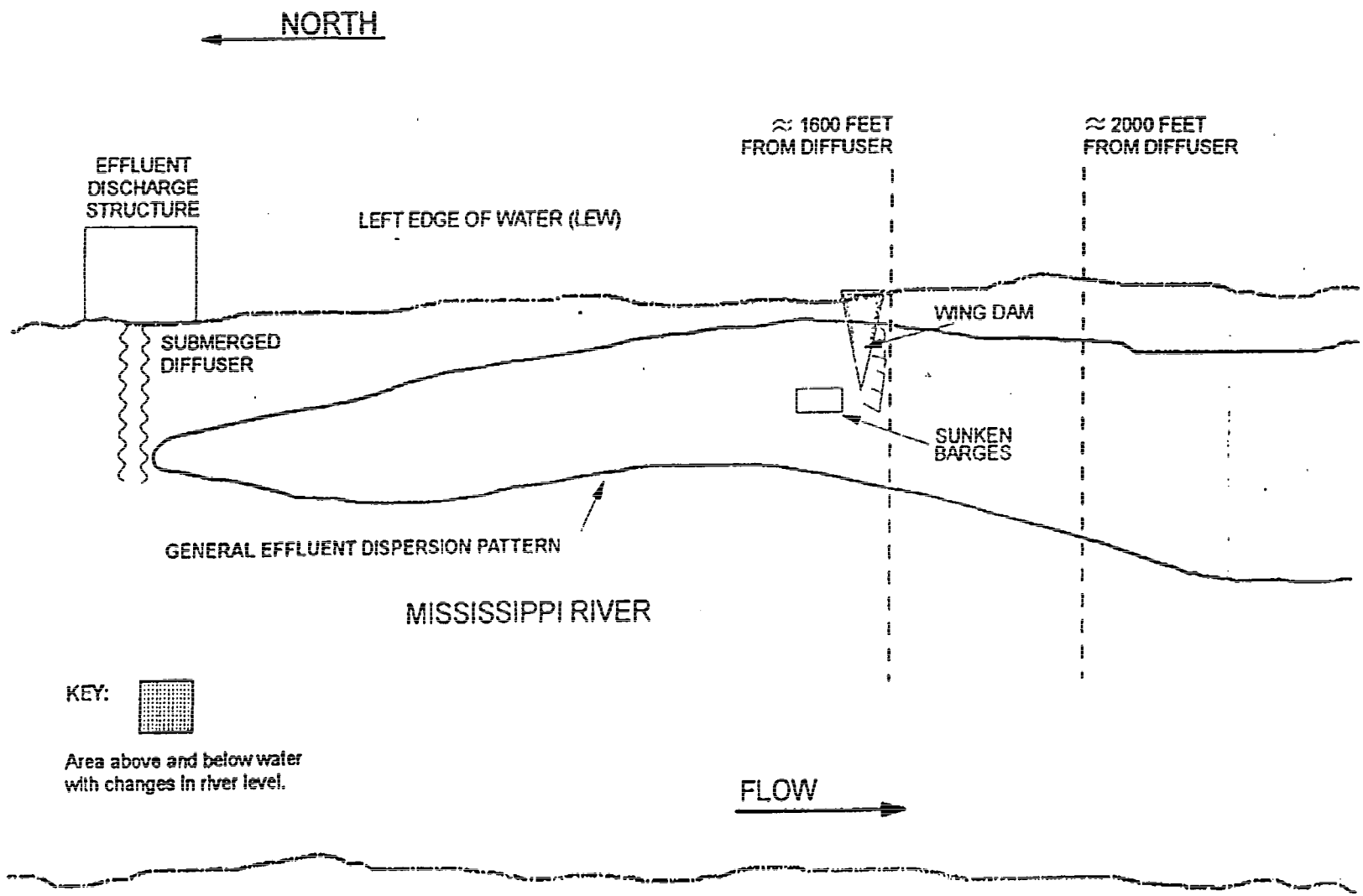


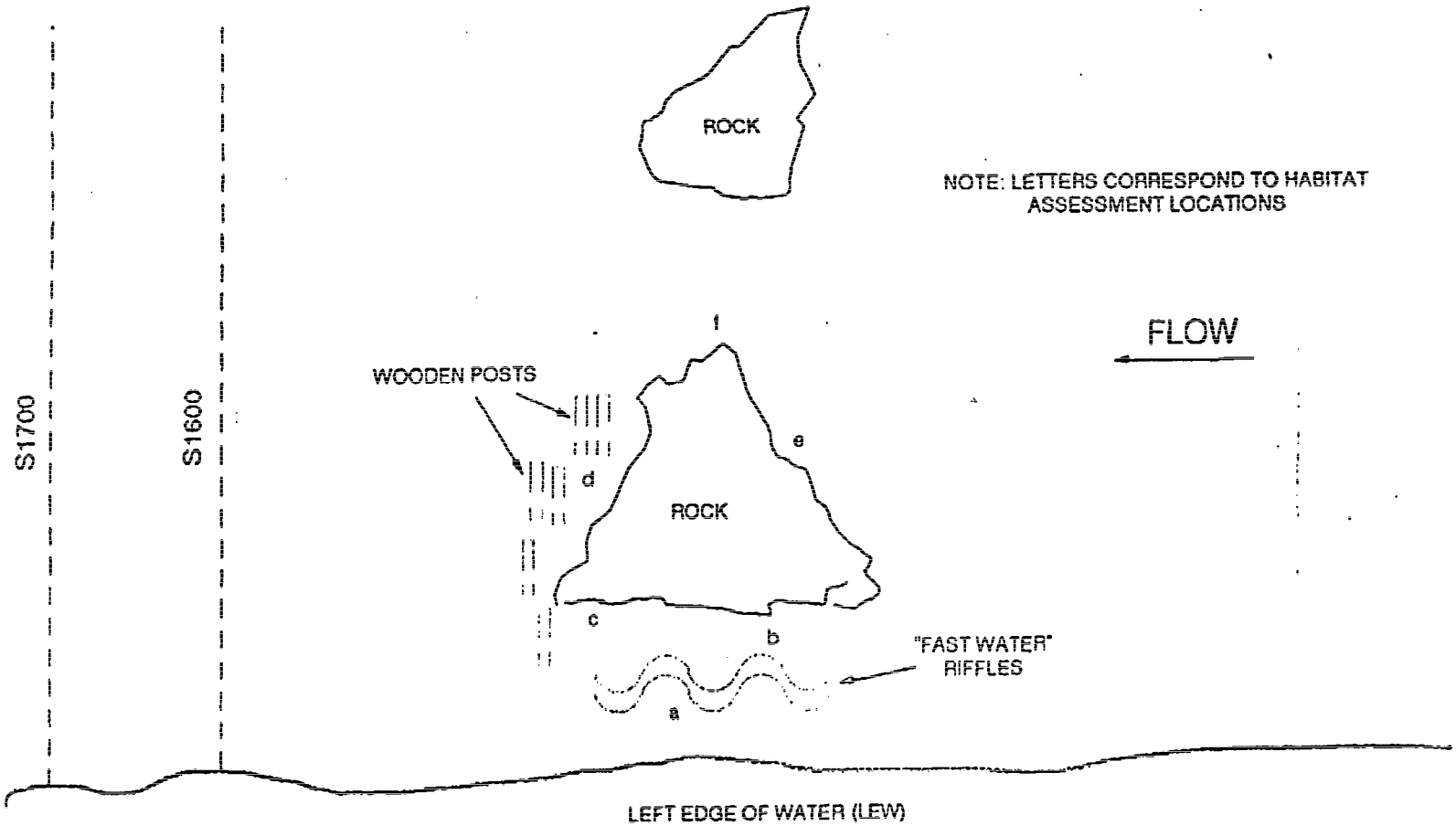
Figure 3-15

Schematic of Wing Dam Area,

ABRTF Effluent Plume

(Advent, 1994)

FIGURE 2-2. SCHEMATIC OF WING DAM AREA AS VIEWED FROM THE LEFT EDGE OF WATER



6454\TASK2\FIG2-2.DRW

OCTOBER 1994

Figure 3-16

Site R Pilot Study Groundwater Treatment System Configuration (Advent, 1993)

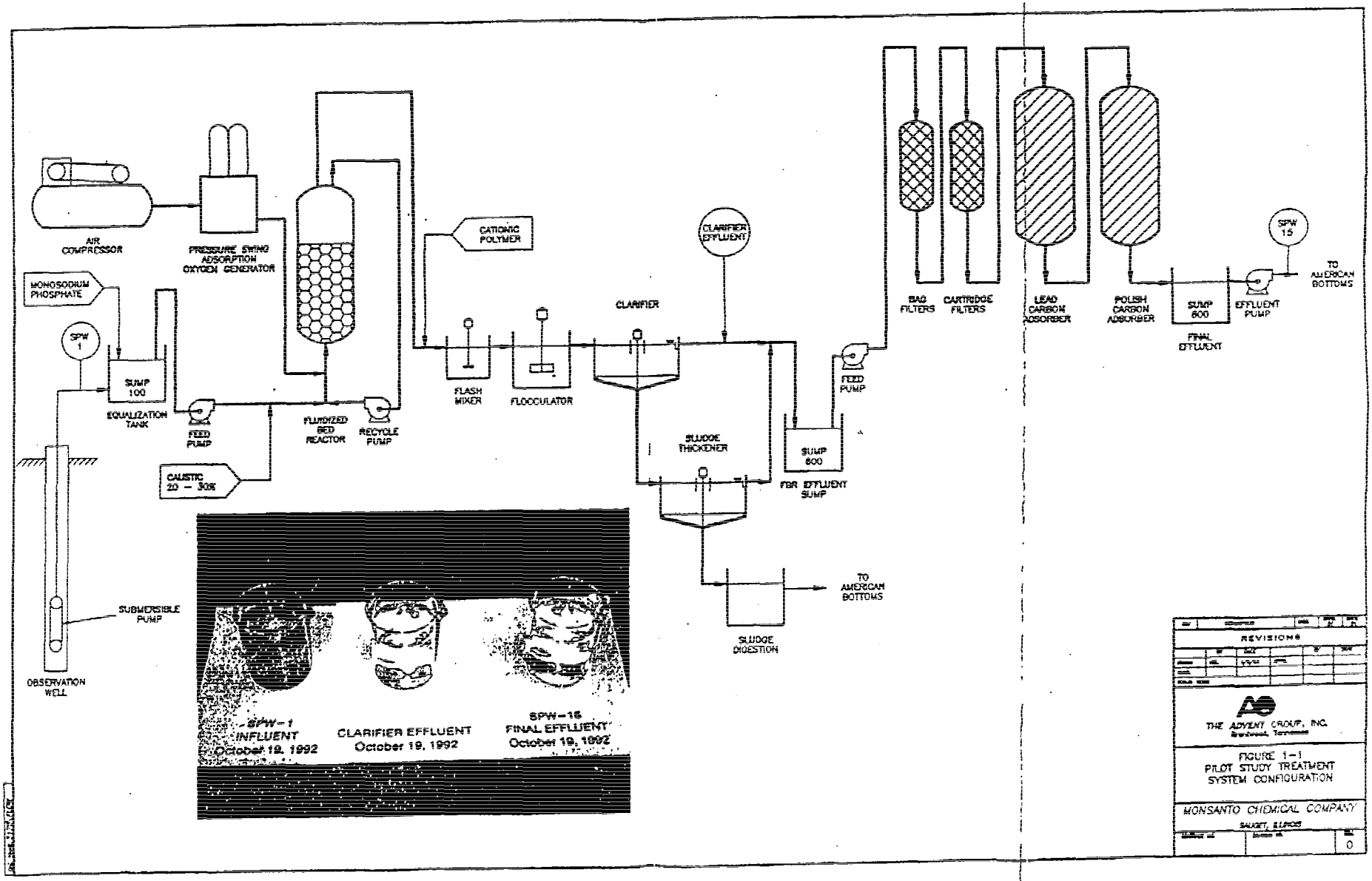

AIR COMPRESSOR
PRESSURE SWING ADSORPTION OXYGEN GENERATOR
MONOSODIUM PHOSPHATE
SPW 1
SUMP 100
EQUALIZATION TANK
FEED PUMP
CAUSTIC 20 – 30%
FLUIDIZED BED REACTOR
RECYCLE PUMP
SUBMERSIBLE PUMP
OBSERVATION WELL
CATIONIC POLYMER
FLASH MIXER
FLOCCULATOR
CLARIFIER
CLARIFIER EFFLUENT
SLUDGE THICKENER
SLUDGE DIGESTION
TO AMERICAN BOTTOMS
SUMP 600
FBR EFFLUENT SUMP
FEED PUMP
BAG FILTERS
CARTRIDGE FILTERS
LEAD CARBON ADSORBER
POLISH CARBON ADSORBER
SUMP 600
FINAL EFFLUENT
EFFLUENT PUMP
SPW 15
TO AMERICAN BOTTOMS
SPW-1 INFLUENT October 19, 1992
CLARIFIER EFFLUENT October 19, 1992
SPW-15 FINAL EFFLUENT October 19, 1992
REVISIONS
THE ADVENT GROUP, INC.
FIGURE 1-1
PILOT STUDY TREATMENT SYSTEM CONFIGURATION
MONSANTO CHEMICAL COMPANY
SAUGET, ILLINOIS
0

Table 3-1

Summary of Previous Site Investigations – Site O

TABLE 3-1
SUMMARY OF PREVIOUS SITE INVESTIGATIONS
SAUGET AREA 2
SITE O
SAUGET, ILLINOIS

SAMPLING ENTITY	SAMPLE LOCATIONS	TYPE	DATE SAMPLED	SAMPLE MEDIA	ANALYSIS
Russel & Axon	WLS-3	Boring	N/A	N/A	N/A
IEPA/EEI	1 thru 5	Boring	Feb-83	Soil	PCB, Dioxins
Russel & Axon	STS-1, STS-3, STS-4 thru STS-8, TS-7, DSM-2 thru DSM-4, WLS-1, WLS-2, MH-3, All EFMs	Boring	Sep-83	Soil	Photoionization Compound Screening
Clayton Environmental Consultants	Sample No. 1 & 2	Boring	Jul-84	Soil	PCBs, Benzene, Solids %, Phenol, Oil & Grease %
Russel & Axon	#1, #2	Boring	Jul-84	Soil	Organics
Geraghty & Miller	BG-2, BG-3, BG-10, BG-12	Boring	Aug-84	Soil	BNA, VOCs, PCBs, Pesticides
Geraghty & Miller	BG-1 thru BG-12	Boring	Aug-84	Soil	Photoionization Compound Screening, PCBs
Geraghty & Miller	GM-19A,B,C, GM-20A,B GM-21 A,B, GM-22A,B GM-23 GM-24A,B GM-26A,B DW-35, DW-36, DW-A	Monitoring Well	1984-86	Ground water	VOCs, BNAs,Pesticides, PCBs, Priority Pollutant Metals, Misc. Parameters
E & E	DC-01 thru DC-10	Boring	Feb-87	Soil	VOCs, BNAs,Pesticides, PCBs, Total Metals
E & E	EE-21 thru EE-25	Monitoring Well	3/87 and 7/87	Ground water	VOCs, BNAs, Pesticides, PCBs, Total Metals

Table 3-2

Summary of Previous Site Investigations – Site P

TABLE 3-2
SUMMARY OF PREVIOUS SITE INVESTIGATIONS
SAUGET AREA 2
SITE P
SAUGET, ILLINOIS

SAMPLING ENTITY	SAMPLE LOCATIONS	TYPE	DATE SAMPLED	SAMPLE MEDIA	ANALYSIS
E & E	DC-P1, DC-P2, DC-P5	Boring	Feb-87	Soil	VOCs, BNAs, Total Metals

Table 3-3

Summary of Previous Site Investigations – Site Q

TABLE 3-3
SUMMARY OF PREVIOUS SITE INVESTIGATIONS
SAUGET AREA 2
SITE Q
SAUGET, ILLINOIS

SAMPLING ENTITY	SAMPLE LOCATIONS	TYPE	DATE SAMPLED	SAMPLE MEDIA	ANALYSIS
IEPA	P-1, L-1	N/A	Oct-72	Pond Water/Leachate	Total Metals
IEPA	P-2, P-3, GW-1, GW-2	Monitoring Well	Apr-73	Pond Water/Ground Water	Total Metals
E & E	B-1 thru B-18	Boring	Jul-83	Soil	Dioxins, Organics, PCBs
IEPA	L-1, L-2, L-101thru L-103	N/A	10/81; 9/83	Leachate	Total Metals, PCBs, Misc. Parameters
E & E	EE-6 thru EE-10, EE-18, EE-19	Monitoring Well	Mar-87	Ground Water	VOCs, BNAs, Pesticides, PCBs, Total Metals
Riedel Industrial Waste Management	Pit #1	Test Pit	Sep-89	Soil	BNAs
Riedel Industrial Waste Management	Pit #2	Test Pit	Sep-89	Soil	VOCs, RCRA Metals, EP Extraction, PCBs
E & E	QD1 thru QD3	Boring	May-94	Soil	SVOCs, Total Metals, PCBs, TCLP SVOCs
IEPA	X101-X111	Surface	Nov-94	Soil	VOCs, BNAs, Pesticides, PCBs, Total Metals
USEPA	Q201 thru Q208	N/A	1997	Soil/Sediment	Metals, PCBs

Table 3-4

Summary of Previous Site Investigations – Site R

TABLE 3-4
SUMMARY OF PREVIOUS SITE INVESTIGATIONS
SAUGET AREA 2
SITE R
SAUGET, ILLINOIS

SAMPLING ENTITY	SAMPLE LOCATIONS	TYPE	DATE SAMPLED	SAMPLE MEDIA	ANALYSIS
IEPA	MW-1 thru MW-5, Pond 221, Pond 270, RANNEY WELL, B-9S,D B-13D, B-15S, B-17S, B-19S	Monitoring Well/Pond	1972-79	Ground Water/Surface Water	Total Metals, Misc. Parameters
IEPA	Up River 1-4; Down River 1-4	River	1981	River Water	Dioxins
IEPA	B-1, B-6S, B-9S,D B-11S,D B-15D, B-17D, B-19D	Monitoring Well	Mar-81	Ground Water	Organic Compounds
IEPA	Sample A, B & C	Monitoring Well	Oct-81	Leachate	Misc. Parameters
IEPA	Sample A, B & C	N/A	Oct-81	Sediment	Misc. Parameters
E & E	S01, S03, S05	N/A	Nov-81	Leachate	Dioxins
E & E	S01, M01, D01, S03, M03, S05, M05	N/A	Nov-81	Leachate	Total Metals
E & E	S02, S03, M02, S04, M04, S06, M06	N/A	Nov-81	Sediment	Total Metals
E & E	S02, M02, S04, M04, S06, M06	N/A	Nov-81	Sediment	BNAs, Pesticides, PCBs
USEPA	CWS-1 thru CWS-5	N/A	Nov-81	Leachate	Dioxins
E & E	P-1, B-28A, P-7, B-26A, B-25A, P-11	Monitoring Well	Mar-87	Ground Water	VOCs, BNAs, Pesticides, PCBs, Total Metals
IEPA	X101D, X103D, X104D, S101D, S103D, S104D	N/A	Feb-89	Sediment/Leachate/ River Water	Dioxins
Dynamac	C-1 thru C-8, P-1 thru P-10	Surface	Mar-89	Soil	TCL VOCs
Dynamac	C-3, P-2, P-3, P-5, P-9	Surface	Mar-89	Soil	TCL SVOCs, Metals, Dioxins
Dynamac	C-1, C-3, P-2, P-3, P-5, P-9	Surface	Mar-89	Soil	Priority Pollutant Organochlorine Pesticides and PCBs
Dynamac	D-1 thru D-8	Boring	Mar-89	Soil	TCL VOCs, TCL SVOCs, Priority Pollutant Organochlorine Pesticides, PCBs, Metals, Dioxins

TABLE 3-4
SUMMARY OF PREVIOUS SITE INVESTIGATIONS
SAUGET AREA 2
SITE R
SAUGET, ILLINOIS

SAMPLING ENTITY	SAMPLE LOCATIONS	TYPE	DATE SAMPLED	SAMPLE MEDIA	ANALYSIS
N/A	GM-27B,C GM-28B,C GM-55C, GM-56C, GM-57C, GM-62A,B,C GM-106, B-24A, B-25A,B B-26A, B-27B, B-28A, B-29A,B B-30B, P-1 thru P-3, P-6 thru P-8, P-10 thru P-14	Monitoring Well	1984-91	Ground Water	VOCs
N/A	GM-27B,C GM-28B,C GM-55C, GM-56C, GM-57C, GM-62A,B,C GM-106, B-21B, B-22A,B B-24A,B,C B-25A,B B-26A,B B-27B, B-28A,B B-29A,B B-30B, B-101, P-1 thru P-14	Monitoring Well	1984-91	Ground Water	Metals, BNAs, Pesticides, PCBs, Misc. Parameters
Geraghty & Miller	SS-1 thru SS-8	N/A	1992	Sediment	TCL VOCs, TCL SVOCs, TCL Pesticides and PCBs, Target Analyte
Geraghty & Miller	SB-1 thru SB-16	Boring	1992	Soil	TCL SVOCs, Pesticides, PCBs, Target Analyte, Carbon, Chlorine, TCL VOCs
Geraghty & Miller	P-8, P-10 thru P-13, GM-62B, GM-27C, GM-55C, GM-56C, GM-57C, GM-62C, GM-106	Monitoring Well	Jun-92	Ground Water	Target Analyte
Geraghty & Miller	Shallow, Intermediate, Deep and Bedrock Zone Wells	Monitoring Well	Jun-92	Ground Water	TCL VOCs, TCL SVOCs, TCL Pesticides, PCBs, Herbicides, Target Analyte
IEPA	X112, X113	Boring	Nov-94	Soil	VOCs, BNAs, Pesticides, PCBs

Table 3-5

Summary of Previous Site Investigations – Site S

TABLE 3-5
SUMMARY OF PREVIOUS SITE INVESTIGATIONS
SAUGET AREA 2
SITE S
SAUGET, ILLINOIS

SAMPLING ENTITY	SAMPLE LOCATIONS	TYPE	DATE SAMPLED	SAMPLE MEDIA	ANALYSIS
IEPA	X101 thru X106	Surface	Mar-95	Soil	VOCs, Total Metals, BNAs, Pesticides, PCBs, Herbicides

Table 3-6

Site O Soil Data Summary

Table 3-1
Site O
95% UCL Soil Data Summary for VOC
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Sample Depth (ft)	Chloromethane	Bromoethane	Vinyl Chloride	Chloroethane	Methylene Chloride	Acetone	Carbon Disulfide	1,1-Dichloroethane	1,1-Dichloroethene	trans-1,2-Dichloroethene	Chloroform
DC-01-59	15-25						1,379 BE					
DC-02-60	20-30					35	9,103 BE			10 J	192	
DC-03-61	10-20					10 J	4,405 BE				6 J	
DC-04-62	0-10					833 BJ	7,692 B					
DC-05-63	8.5-20						8,659 BE					
DC-05-64	8.5-20					18 J	11,463 BE					
DC-08-65	na					139 B						
DC-06-66	15-25					4 J	457 B					
DC-09-72	0-10					878 BJ						
DC-09-73	15-20					519 BJ	2,593 B					
DC-010-74	5-10					731 BJ	731 BJ					
DC-010-75	10-15					341 BJ	341 BJ					
Frequency of Detection		0/12	0/12	0/12	0/12	10/12	10/12	0/12	0/12	1/12	2/12	0/12
Minimum Concentration		ND	ND	ND	ND	4 J	341 BE	ND	ND	ND	6 J	ND
Maximum Concentration		ND	ND	ND	ND	878 BJ	11,463 BE	ND	ND	10 J	192	ND
Number of Samples		12	12	12	12	12	12	12	12	12	12	12
Lognormal Statistical Distribution												
Mean of ln value						4.72499533	7.8508689			2.302585093	3.524627421	
Standard Deviation of ln value						2.02916783	1.3263588			#DIV/0!	2.450645359	
H (0.95)						4.962	3.639				6.067	
95 % UCL						1.84E+04	2.65E+04			#DIV/0!	6.05E+04	

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
No reporting limits were available for non-detect data.

Table 3-1
Site O
95% UCL Soil Data Summary for VOC
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	1,2-Dichloroethane	2-Butane (MEK)		1,1,1-Trichloroethane	Carbon Tetrachloride	Vinyl Acetate	Bromodichloromethane	1,2-Dichloropropane	trans-1,3-Dichloropropene	Trichloroethene	Dibromochloromethane	1,1,2-Trichloroethane	Benzene		cis-1,3-Dichloropropene
DC-01-59		30	B												
DC-02-60	23	25,641	BE							69			667		
DC-03-61		36	B										24		
DC-04-62		7,179	B	1,410									30,769		
DC-05-63		244	B												
DC-05-64		171	B										18	J	
DC-08-65															
DC-06-66		20	B												
DC-09-72			B												
DC-09-73		4,444	B												
DC-010-74		7,436	B										1,795		
DC-010-75		6,705	B												
Frequency of Detection	1/12	10/12		1/12	0/12	0/12	0/12	0/12	0/12	1/12	0/12	0/12	5/12		0/12
Minimum Concentration	ND	20	B	ND	ND	ND	ND	ND	ND	ND	ND	ND	18	J	ND
Maximum Concentration	23	25,641	B	1,410	ND	ND	ND	ND	ND	69	ND	ND	30,769		ND
Number of Samples	12	12		12	12	12	12	12	12	12	12	12	12		12
Lognormal Statistical Distribution															
Mean of ln value	3.135494216	6.5774151		7.251344983						4.234107			6.07964778		
Standard Deviation of ln value	#DIV/0!	2.72741691		#DIV/0!						#DIV/0!			3.11722696		
H (0.95)		6.627											7.191		
95 % UCL	#DIV/0!	6.90E+06		#DIV/0!						#DIV/0!			4.85E+07		

Table 3-1
Site O
95% UCL Soil Data Summary for VOC
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	2-Chloroethyl Vinyl Ether	Bromoform	4-Methyl-2-pentanone	2-Hexanone	Tetrachloroethene	1,1,2,2-Tetrachloroethane	Toluene	Chlorobenzene	Ethylbenzene	Styrene	Total Xylenes
DC-O1-59											
DC-O2-60			1,244 B	63		28		1,667	46		141
DC-O3-61								62	167		976
DC-O4-62			7,692				29,487	38,462	166,667 E		615,385 E
DC-O5-63								74	37 J		244
DC-O5-64								159	57 J		256
DC-O8-65											
DC-O6-66							293 J	841 J	2,439		21,951
DC-O9-72									74 J		235 J
DC-O9-73							4,339	58,974	9,103		29,487
DC-O10-74								1,250	341 J		1,114 J
DC-O10-75											
Frequency of Detection	0/12	0/12	2/12	1/12	0/12	1/12	3/12	8/12	9/12	0/12	9/12
Minimum Concentration	ND	ND	1,244 B	ND	ND	ND	293 J	62	37 J	ND	141
Maximum Concentration	ND	ND	7,692	63	ND	28	29,487	58,974	166,667 E	ND	615,385 E
Number of Samples	12	12	12	12	12	12	12	12	12	12	12
Lognormal Statistical Distribution											
Mean of ln value			8.03701169	4.14313473		3.33220451	8.11575885	7.040831628	6.186223084		7.66312691
Standard Deviation of ln value			1.288241664	#DIV/0!		#DIV/0!	2.31670392	2.619555402	2.890877361		2.89169824
H (0.95)			3.389				5.478	6.057	6.627		6.627
95 % UCL			2.65E+04	#DIV/0!		#DIV/0!	2.25E+06	4.22E+06	1.02E+07		4.50E+07

Table 3-1B
Site O
95 %UCL Soil Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Sample Depth (ft)	2,4-Dinitrophenol	4-Nitrophenol	Dibenzofuran	2,4-Dinitrotoluene	2,6-Dinitrotoluene	Diethylphthalate	4-Chlorophenyl-Phenylether	Fluorene	4-Nitroaniline	4,6-Dinitro-2-methylphenol	N-Nitrosodiphenylamine
DC-01-59	15-25											
DC-02-60	20-30											
DC-03-61	10-20											
DC-04-62	0-10											50,000 J
DC-05-63	8.5-20											
DC-05-64	8.5-20											
DC-08-65	na											
DC-06-66	15-25											
DC-09-72	0-10			1,463 J					3,049 J			10,244 J
DC-09-73	15-20											
DC-010-74	5-10											
DC-010-75	10-15											
Frequency of Detection		0/12	0/12	1/12	0/12	0/12	0/12	0/12	1/12	0/12	0/12	2/12
Minimum Concentration		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10,244 J
Maximum Concentration		ND	ND	1,463 J	ND	ND	ND	ND	3,049 J	ND	ND	50,000 J
Number of Samples		12	12	12	12	12	12	12	12	12	12	12
Lognormal Statistical Distribution												
Mean of ln value				7.288244401					8.022569			10.02711287
Standard Deviation of ln value				#DIV/0!					#DIV/0!			1.120998185
H (0.95)												3.131
95 % UCL				#DIV/0!					#DIV/0!			1.22E+05

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb)
Metal analysis are presented in mg/kg (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
No reporting limits were available for non-detect data.

Table 3-1B
Site O
95 %UCL Soil Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	4-Bromophenyl-phenylether	Hexachlorbenzene	Pentachlorophenol	Phenanthrene	Anthracene	Di-n-butyl phthalate	Fluoranthene	Pyrene	Butyl Benzyl phthalate	3,3'-Dichlorobenzidine	Benzo(a)anthracene
DC-O1-59											
DC-O2-60											
DC-O3-61			22,619		5,357						
DC-O4-62			474,359 J	217,949			43,590 J	282,051			121,795
DC-O5-63				963 J		3,780 J					
DC-O5-64											
DC-O8-65						2,785 J					
DC-O6-66											
DC-O9-72			329,268	21,951	4,146 J	7,195 J	7,317 J	62,195			25,610
DC-O9-73			6,420 J	469 J		6,049		1,605 J			
DC-O10-74											
DC-O10-75											
Frequency of Detection	0/12	0/12	4/12	4/12	2/12	4/12	2/12	3/12	0/12	0/12	2/12
Minimum Concentration	ND	ND	6,420 J	469 J	4,146 J	2,785 J	7,317 J	1,605 J	ND	ND	25,610
Maximum Concentration	ND	ND	474,359 J	217,949	5,357	7,195 J	43,590 J	282,051	ND	ND	121,795
Number of Samples	12	12	12	12	12	12	12	12	12	12	12
Lognormal Statistical Distribution											
Mean of ln value			11.1420165	8.827310131	8.458029344	8.43956808	9.790269366	10.32292			10.93041638
Standard Deviation of ln value			2.08502177	2.84996897	0.181203256	0.43409531	1.261922107	2.657647			1.102631487
H (0.95)			4.962	6.627	1.842	1.927	3.389	5.067			3.13
95 % UCL			1.37E+07	1.18E+08	5.30E+03	6.54E+03	1.44E+05	6.03E+07			2.90E+05

Table 3-1B
Site O
95 %UCL Soil Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	bis(2-ethylhexyl)phthalate	Chrysene	Di-n-octyl phthalate	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene	Benzo(g,h,i)perylene	Dibenzo(a,h)anthracene
DC-O1-59									
DC-O2-60									
DC-O3-61	1,905 BJ								
DC-O4-62		282,051		79,487 J		66,667 J		52,564 J	
DC-O5-63									
DC-O5-64	2,439 JB	1,951 J							
DC-O8-65									
DC-O6-66									
DC-O9-72		62,195		17,073 J		19,512		17,073 J	
DC-O9-73	914 J	1,605 J							
DC-O10-74									
DC-O10-75									
Frequency of Detection	3/12	3/12	0/12	2/12	0/12	2/12	0/12	2/12	0/12
Minimum Concentration	914 J	1,605 J	ND	17,073 J	ND	19,512	ND	17,073 J	ND
Maximum Concentration	2,439 J	282,051	ND	79,487 J	ND	66,667 J	ND	52,564 J	ND
Number of Samples	12	12	12	12	12	12	12	12	12
Lognormal Statistical Distribution									
Mean of ln value	7.389803752	9.63621236		10.51430116		10.49312515		10.30752015	
Standard Deviation of ln value	0.510519684	2.56806927		1.087597559		0.868808255		0.795165056	
H (0.95)	2.141	5.067		3.389		2.653		2.57	
95 % UCL	2.56E+03	2.09E+07		2.02E+05		1.05E+05		7.61E+04	

Table 3-1C
Site O
95% UCL Soil Data Summary for Metals
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Sample Depth (ft)	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead
DC-O1-59	15-25	2,023			57				5			5,230	3 *
DC-O2-60	20-30	1,923							6			5,705	6 *
DC-O3-61	10-20	3,786		4 R	131				9		8	9,548	7 *
DC-O4-62	0-10	5,885			214			31	18		205	11,859	147 *
DC-O5-63	8.5-20	3,232		3 R	106				7		7	8,902	7 *
DC-O5-64	8.5-20	3,061		3 R	101				6			8,232	9 *
DC-O8-65	na	6,215		8 R	411			2	10		33	12,658	54 *
DC-O6-66	15-25	2,148		2 R					5			4,815	4 *
DC-O9-72	0-10	4,902		6 R	165			4	13		59	11,793	18 *
DC-O9-73	15-20	3,346		3 R	125				6			7,580	5 *
DC-O10-74	5-10	5,038		7 R	158			11	22		341	11,910	71 *
DC-O10-75	10-15	2,114		3 R	45				4		15	5,648	6 *
Frequency of Detection		12/12	0/12	9/12	10/12	0/12	0/12	4/12	12/12	0/12	7/12	12/12	12/12
Minimum Concentration		1,923	ND	2 R	45	ND	ND	2	5	ND	7	4,815	3 *
Maximum Concentration		6,215	ND	8 R	411	ND	ND	31	22	ND	341	12,658	147 *
Number of Samples		12	12	12	12	12	12	12	12	12	12	12	12
Lognormal Statistical Distribution													
Mean of ln value		8.11679949		1.3657	4.83849			1.977831	2.01049975		3.63748	9.01	2.49161
Standard Deviation of ln value		0.4271669		0.4698	0.62999			1.196825	0.56131401		1.52876	0.36	1.25713
H (0.95)		2.026		2.082	2.341			3.314	2.204		3.896	1.98	3.389
95 % UCL		4,764.63		5.88	240.23			48.91	12.69		736.46	1.08E+04	96.19

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb) except metals.
Metal analysis are presented in mg/kg (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = *Spike sample recovery not within control limits*
Metal analysis are presented in mg/kg (i.e. ppm)
No reporting limits were available for non-detect data.

Table 3-1C
Site O
95% UCL Soil Data Summary for Metals
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	Tin	Vanadium	Zinc	Cyanide
DC-01-59	106 *								18 *	
DC-02-60	108 *								18 *	
DC-03-61	233 *							13	54 *	
DC-04-62	329 *	6.3	45 *					18	1,398	
DC-05-63	207 *		11 *						37 *	
DC-05-64	187 *		10 *						35 *	
DC-08-65	357 *		15 *					15	181 *	
DC-06-66	79 *								17 *	
DC-09-72	190 *	1.7	38 *					19	277	
DC-09-73	152 *	0.3							30 *	
DC-010-74	206 *	1.9	136 *					19	688 *	
DC-010-75	101 *		11 *						43 *	
Frequency of Detection	12/12	4/12	7/12	0/12	0/12	0/12	0/12	5/12	12/12	0/12
Minimum Concentration	79 *	0.3	10 *	ND	ND	ND	ND	13	17 *	ND
Maximum Concentration	357 *	6.3	136 *	ND	ND	ND	ND	19	1,398 *	ND
Number of Samples	12	12	12	12	12	12	12	12	12	12
Lognormal Statistical Distribution										
Mean of ln value	5.134798237	0.4522647	3.16618991					2.810449855	4.294225	
Standard Deviation of ln value	0.475085248	1.2533346	0.98478577					0.168114444	1.494219	
H (0.95)	2.082	3.389	2.807					1.843	3.896	
95 % UCL	256.18 #	12.41	88.64					18.50	1,294.41	

Table 3-1D
Area O
95 % UCL Soil Data Summary for Pesticides and PCBs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Sample Depth (ft)	Alpha-BHC	Beta-BHC	Delta-BHC	Lindane	Heptachlor	Aldrin	Heptachlor Epoxide	Endosulfan I	Dieldrin	4,4'-DDE	Endrin	Endosulfan II	4,4'-DDD	Endosulfan Sulfate	4,4'-DDT
DC-O1-59	15-25															
DC-O2-60	20-30															
DC-O3-61	10-20															
DC-O4-62	0-10															
DC-O5-63	8.5-20															
DC-O5-64	8.5-20															
DC-O8-65	na															
DC-O6-66	15-25															
DC-O9-72	0-10															
DC-O9-73	15-20															
DC-O10-74	5-10															
DC-O10-75	10-15															
Frequency of Detection		0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12	0/12
Minimum Concentration		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Number of Samples		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Lognormal Statistical Distribution																
Mean of ln value																
Standard Deviation of ln value																
H (0.95)																
95 % UCL																

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb) except metals.
Metal analysis are presented in mg/kg (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
Metal analysis are presented in mg/kg (i.e. ppm)
No reporting limits were available for non-detect data.

Table 3-1D
Area O
95 % UCL Soil Data Summary for Pesticides and PCBs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Methoxychlor	Endrin Ketone	Chlordane	Toxaphene	Aroclor-1016	Aroclor-1221	Aroclor-1232	Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260
DC-O1-59											
DC-O2-60											
DC-O3-61											
DC-O4-62								1,871,795			
DC-O5-63							26,829 C				5488 JC
DC-O5-64							30,366				3902 J
DC-O8-65											
DC-O6-66											
DC-O9-72								634,146			
DC-O9-73								24,691			
DC-O10-74								461,539			
DC-O10-75								11,364			
Frequency of Detection	0/12	0/12	0/12	0/12	0/12	0/12	2/12	5/12	0/12	0/12	2/12
Minimum Concentration	ND	ND	ND	ND	ND	ND	26,829 C	11364	ND	ND	3,902 J
Maximum Concentration	ND	ND	ND	ND	ND	ND	30,366	1871795	ND	ND	5,488 JC
Number of Samples	12	12	12	12	12	12	12	12	12	12	12
Lognormal Statistical Distribution											
Mean of ln value							10.25916	12.059433			8.4397818
Standard Deviation of ln value							0.087568	2.2093686			0.2411762
H (0.95)							1.775	4.962			1.883
95 % UCL							30,027.17	5.41E+07			5,463.21

Table 3-7

Site O Groundwater Data Summary

Table 3-2
Site O
95 % UCL Groundwater Data Summary for VOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Chloromethane	Bromoethane	Vinyl Chloride	Chloroethane	Methylene Chloride	Acetone	Carbon Disulfide	1,1-Dichloroethane	1,1-Dichloroethene	trans-1,2-Dichloroethene	Chloroform	Dichloroethane	2-Butanone (MEK)
DC-GW-38						7 J					*		13 J
DC-GW-38A					52,000	38,000 B					3,000 J	4,000 J	62,000
DC-GW-39					31,000	34,000			1,700	14,000	1,800		54,000 E
DC-GW-39A						6 J							11 E
DC-GW-40													
DC-GW-40A						10							
DC-GW-41													
DC-GW-41A					310	430							
DC-GW-42						5 J							5 B
DC-GW-43													
DC-GW-43A					2 J	13 B				94 J			570
DC-GW-35													
DC-GW-57													
Frequency of Detection	0/13	0/13	0/13	0/13	4/13	8/13	0/13	0/13	1/13	2/13	2/13	1/13	6/13
Minimum Concentration	ND	ND	ND	ND	2 J	5 J	ND	ND	ND	94 J	1800	ND	5 E
Maximum Concentration	ND	ND	ND	ND	52,000	38,000 B	ND	ND	1,700	14,000	3,000	4,000 J	62,000
Number of Samples	13	13	13	13	13	13	13	13	13	13	13	13	13
Lognormal Statistical Distribution													
Mean of ln value					6.90761524	4.657236			7.43838353	7.045053695	7.75095476	8.2940496	5.808258
Standard Deviation of ln value					4.7398178	3.86918			#DIV/0!	3.538021385	0.36120826	#DIV/0!	4.3192317
H (0.95)					10.792	8.636				8.064	1.958		9.747
95 % UCL					1.96E+14	2.90E+09			#DIV/0!	2.26E+09	3042.26	#DIV/0!	7.10E+11

All samples are presented in ug/l = micrograms per liter (i.e. ppb) except metals.
Metal analysis are presented in mg/l (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
No reporting limits were available for non-detect data

Table 3-2
Site O
95%UCL Groundwater Data Summary for VOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Trichloroethane	Carbon Tetrachloride	Vinyl Acetate	Bromodichloromethane	1,2-Dichloropropane	trans-1,3-Dichloropropene	Trichloroethene	Dibromochloromethane	Trichlorothene	Benzene	Dichloropropene	2-Chloroethyl Vinyl Ether	Bromoform
DC-GW-38													
DC-GW-38A													
DC-GW-39	7,800						83,000			190,000			
DC-GW-39A	5000						64,000 E			150,000 E			
DC-GW-40													
DC-GW-40A										10			
DC-GW-41										20			
DC-GW-41A										1,800			
DC-GW-42													
DC-GW-43													
DC-GW-43A													
DC-GW-35							1,000						
DC-GW-57	43 J												
Frequency of Detection	3/13	0/13	0/13	0/13	0/13	0/13	3/13	0/13	0/13	5/13	0/13	0/13	0/13
Minimum Concentration	43 J	ND	ND	ND	ND	ND	1000	ND	ND	10	ND	ND	ND
Maximum Concentration	78,000	ND	ND	ND	ND	ND	64000 E	ND	ND	190000	ND	ND	ND
Number of Samples	13	13	13	13	13	13	13	13	13	13	13	13	13
Lognormal Statistical Distribution													
Mean of ln value	7.0800908						9.766996509			7.373406			
Standard Deviation of ln value	2.8828307						2.4795846			4.701345			
H (0.95)	6.439						5.328			10.792			
95 % UCL	1.61E+07						1.71E+07			2.30E+14			

Table 3-2
Site O
95%UCL Groundwater Data Summary for VOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	4-Methyl-2-pentanone	2-Hexanone	Tetrachloroethene	1,1,2,2-Tetrachloroethane	Toluene	Chlorobenzene	Ethylbenzene	Styrene	Total Xylenes
DC-GW-38									
DC-GW-38A					15,000	150,000			1600 J
DC-GW-39	38,000		10,000		1,300	180,000 E			2,600
DC-GW-39A	28,000			12,000					
DC-GW-40					17				
DC-GW-40A					1 J	5			2 J
DC-GW-41						8			
DC-GW-41A					130				
DC-GW-42									
DC-GW-43									
DC-GW-43A									
DC-GW-35						1000			
DC-GW-57									
Frequency of Detection	2/13	0/13	1/13	1/13	5/13	5/13	0/13	0/13	3/13
Minimum Concentration	28,000	ND	ND	ND	1 J	5		ND	2 J
Maximum Concentration	38,000	ND	10,000	12,000	15,000	180,000 E	ND	ND	2,600
Number of Samples	13	13	13	13	13	13	13	13	13
Lognormal Statistical Distribution									
Mean of ln value	10.3926506		9.210340372	9.392661929	4.897335	6.923147487			5.3113909
Standard Deviation of ln value	0.21593744		#DIV/0!	#DIV/0!	3.73078	5.085687337			4.0068767
H (0.95)	1.832				8.064	11.419			9.191
95 % UCL	37,427.62		#DIV/0!	#DIV/0!	8.34E+08	8.01E+15			2.57E+10

Table 3-2B
Site O
95 % UCL Groundwater Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Phenol	bis(2-Chloroethyl)ether	2-Chlorophenol	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Benzyl Alcohol	1,2-Dichlorobenzene	2-Methylphenol	bis-(2-Chloroisopropyl)ether	4-Methylphenol
DC-GW-38										
DC-GW-38A										
DC-GW-39	500		120	320	10,000 E		7,800	78 J		820
DC-GW-39A	1,100	91 J	58 J	290	15,000 E		11,000 E	120		1,100
DC-GW-40										
DC-GW-40A										
DC-GW-41										
DC-GW-41A										
DC-GW-42										
DC-GW-43										
DC-GW-43A										
DC-GW-35										
DC-GW-57										
Frequency of Detection	2/13	1/13	2/13	2/13	2/13	0/13	2/13	2/13	0/13	2/13
Minimum Concentration	500	ND	58 J	290	10,000 E	ND	7,800	78 J	ND	820
Maximum Concentration	1,100	91 J	120	320	15,000 E	ND	11,000 E	120	ND	1,100
Number of Samples	13	13	13	13	13	13	13	13	13	13
Lognormal Statistical Distribution										
Mean of ln value	6.61	4.510859507	4.423967377	5.719100959	9.413072926		9.133764782	4.572100285		6.856184
Standard Deviation of ln value	0.56	#DIV/0!	0.514101089	0.069607643	0.286707127		0.243083186	0.304609521		0.2077204
H (0.95)	2.20			1.775	1.883		1.883	1.927		1.843
95 % UCL	1,235.18	#DIV/0!	95.21	316.46	14,913.47		10,888.29	120.05		1053.85

All samples are presented in ug/l = micrograms per liter (i.e. ppb) except metals.
Metal analysis are presented in mg/l (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
No reporting limits were available for non-detect data

Table 3-2B
Site O
95 % UCL Groundwater Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	N-Nitroso-n-Dipropylamine	Hexachloroethane	Nitrobenzene	Isophorone	2-Nitrophenol	2,4-Dimethylphenol	Benzoic Acid	bis-2-(Chloroethoxy)methane	2,4-Dichlorophenol	1,2,4-Trichlorobenzene	Naphthalene
DC-GW-38											
DC-GW-38A											
DC-GW-39						350			30 J	270	
DC-GW-39A						400				200	
DC-GW-40											
DC-GW-40A											
DC-GW-41											
DC-GW-41A											
DC-GW-42											
DC-GW-43											
DC-GW-43A											
DC-GW-35											
DC-GW-57											
Frequency of Detection	0/13	0/13	0/13	0/13	0/13	2/13	0/13	0/13	1/13	2/13	2/13
Minimum Concentration	ND	ND	ND	ND	ND	350	ND	ND	ND	200	100
Maximum Concentration	ND	ND	ND	ND	ND	400	ND	ND	30 J	270	160
Number of Samples	13	13	13	13	13	13	13	13	13	13	13
Lognormal Statistical Distribution											
Mean of ln value						5.924698851			3.401197382	5.448369663	4.840172001
Standard Deviation of ln value						0.094420953			#DIV/0!	0.212205992	0.332342753
H (0.95)						1.775				1.843	1.9[illegible]
95 % UCL						394.47			#DIV/0!	266.08	160.82

Table 3-2B
Site O
95 % UCL Groundwater Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	4-Chloroaniline	Hexachlorobutadiene	4-Chloro-3-methylphenol	2-Methylnaphthalene	Hexachlorocyclopentadiene	2,4,6-Trichlorophenol	2,4,5-Trichlorophenol	2-Chloronaphthalene	2-Nitroaniline	Dimethyl Phthalate
DC-GW-38										
DC-GW-38A										
DC-GW-39	780			6 J						
DC-GW-39A										
DC-GW-40										
DC-GW-40A										
DC-GW-41										
DC-GW-41A										
DC-GW-42										
DC-GW-43										
DC-GW-43A										
DC-GW-35										
DC-GW-57										
Frequency of Detection	1/13	0/13	0/13	1/13	0/13	0/13	0/13	0/13	0/13	0/13
Minimum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration	780	ND	ND	6 J	ND	ND	ND	ND	ND	ND
Number of Samples	13	13	13	13	13	13	13	13	13	13
Lognormal Statistical Distribution										
Mean of ln value	6.659929392			1.791759469						
Standard Deviation of ln value	#DIV/0!			#DIV/0!						
H (0.95)										
95 % UCL	#DIV/0!			#DIV/0!						

Table 3-2B
Site O
95 % UCL Groundwater Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Acenaphthylene	3-Nitroaniline	Acenaphthene	2,4-Dinitrophenol	4-Nitrophenol	Dibenzofuran	2,4-Dinitrotoluene	2,6-Dinitrotoluene	Diethylphthalate	4-Chlorophenyl-Phenylether	Fluorene
DC-GW-38											
DC-GW-38A											
DC-GW-39											
DC-GW-39A											
DC-GW-40											
DC-GW-40A											
DC-GW-41											
DC-GW-41A											
DC-GW-42											
DC-GW-43											
DC-GW-43A											
DC-GW-35											
DC-GW-57											
Frequency of Detection	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13
Minimum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Number of Samples	13	13	13	13	13	13	13	13	13	13	13
Lognormal Statistical Distribution											
Mean of ln value											
Standard Deviation of ln value											
H (0.95)											
95 % UCL											

Table 3-2B
Site O
95 % UCL Groundwater Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	4-Nitroaniline	4,6-Dinitro-2-methylphenol	N-Nitrosodiphenylamine	4-Bromophenyl-phenylether	Hexachlorobenzene	Pentachlorophenol	Phenanthrene	Anthracene	Di-n-butyl phthalate	Fluoranthene
DC-GW-38										
DC-GW-38A						23 J				
DC-GW-39										
DC-GW-39A										
DC-GW-40										
DC-GW-40A									10 B	
DC-GW-41									7 J	
DC-GW-41A									10 B	
DC-GW-42										
DC-GW-43										
DC-GW-43A									6 BJ	
DC-GW-35										
DC-GW-57										
Frequency of Detection	0/13	0/13	0/13	0/13	0/13	1/13	0/13	0/13	4/13	0/13
Minimum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	6 BJ	ND
Maximum Concentration	ND	ND	ND	ND	ND	23 J	ND	ND	10 BJ	ND
Number of Samples	13	13	13	13	13	13	13	13	13	13
Lognormal Statistical Distribution										
Mean of ln value						3.135494216			2.085709951	
Standard Deviation of ln value						#DIV/0!			0.258212138	
H (0.95)									1.883	
95 % UCL						#DIV/0!			9.58	

Table 3-2B
Site O
95 % UCL Groundwater Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Pyrene	Butyl Benzyl phthalate	3,3'-Dichlorobenzidine	Benzo(a)anthracene	bis(2-ethylhexyl)phthalate	Chrysene	Di-n-octyl phthalate	Benzo(b)fluoranthene	Benzo(k)fluoranthene
DC-GW-38									
DC-GW-38A									
DC-GW-39									
DC-GW-39A									
DC-GW-40									
DC-GW-40A									
DC-GW-41					3 BJ	2 BJ			
DC-GW-41A									
DC-GW-42						11 B			
DC-GW-43									
DC-GW-43A									
DC-GW-35					2 BJ	3 BJ			
DC-GW-57									
Frequency of Detection	0/13	0/13	0/13	0/13	2/13	3/13	0/13	0/13	0/13
Minimum Concentration	ND	ND	ND	ND	2 BJ	2 BJ	ND	ND	ND
Maximum Concentration	ND	ND	ND	ND	3 BJ	11 BJ	ND	ND	ND
Number of Samples	13	13	13	13	13	13	13	13	13
Lognormal Statistical Distribution									
Mean of ln value					0.895879735	1.39655158			
Standard Deviation of ln value					0.286707127	0.89057138			
H (0.95)					1.883	2.738			
95 % UCL					2.98	12.15			

Table 3-2B
Site O
95 % UCL Groundwater Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene	Benzo(g,h,i)perylene	Dibenzo(a,h)anthracene
DC-GW-38				
DC-GW-38A				
DC-GW-39				
DC-GW-39A				
DC-GW-40				
DC-GW-40A				
DC-GW-41				
DC-GW-41A				
DC-GW-42				
DC-GW-43				
DC-GW-43A				
DC-GW-35				
DC-GW-57				
Frequency of Detection	0/13	0/13	0/13	0/13
Minimum Concentration	ND	ND	ND	ND
Maximum Concentration	ND	ND	ND	ND
Number of Samples	13	13	13	13
Lognormal Statistical Distribution				
Mean of ln value				
Standard Deviation of ln value				
H (0.95)				
95 % UCL				

Table 3-2C
Site O
95 % UCL Groundwater Data Summary for Metals
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Sample Depth	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead
DC-GW-38				16	159							20,400	
DC-GW-38A		200			35							15,900	3.270
DC-GW-39				133	536			8				147,000	
DC-GW-39A				123	500			11				171,000	6.350
DC-GW-40				25	161							19,600	
DC-GW-40A				17	152							16,800	
DC-GW-41				18	170							36,400	
DC-GW-41A				15	204							29,200	
DC-GW-42				23	184							36,600	
DC-GW-43					141							3,930	
DC-GW-43A				92								2,360	
DC-GW-35												111	
DC-GW-57												87	
Frequency of Detection		1/13	0/13	9/13	10/13	0/13	0/13	2/13	0/13	0/13	0/13	13/13	2/1[illegible]
Minimum Concentration		ND	ND	15	35	ND	ND	8	ND	ND	ND	87	3.27[illegible]
Maximum Concentration		200	ND	133	536	ND	ND	11	ND	ND	ND	171,000	6.35[illegible]
Number of Samples		13	13	13	13	13	13	13	13	13	13	13	12
Lognormal Statistical Distribution													
Mean of ln value		5.298317367		3.531435	5.1845893			2.23866841				9.205207059	8.4243[illegible]
Standard Deviation of ln value		#DIV/0!		0.926992	0.7491454			0.22518079				2.362112738	0.4692[illegible]
H (0.95)				2.738	2.414			1.843				5.328	2.092
95 % UCL		#DIV/0!		109.27	398.32			10.85				6,126,101.34	6,744.[illegible]

All samples are presented in ug/l= micrograms per liter (i.e. ppb) except metals.
Metal analysis are presented in mg/l (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
No reporting limits were available for non-detect data

Table 3-2C
Site O
95 % UCL Groundwater Data Summary for Metals
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	Tin	Vanadium	Zinc	Cyanide
DC-GW-38	4,340								41	20
DC-GW-38A									57	
DC-GW-39	5,460							42	101	
DC-GW-39A								55	40	
DC-GW-40	1,270								95	
DC-GW-40A	1,330								15	
DC-GW-41	4,110							504	23	
DC-GW-41A	1,520								24	
DC-GW-42	4,300								34	
DC-GW-43	2,300								26	
DC-GW-43A	1,520								24	
DC-GW-35									10	
DC-GW-57										
Frequency of Detection	9/13	0/13	0/13	0/13	0/13	0/13	0/13	3/13	12/13	1/13
Minimum Concentration	1,270	ND	ND	ND	ND	ND	ND	42	10	ND
Maximum Concentration	5,460	ND	ND	ND	ND	ND	ND	504	101	20
Number of Samples	13	13	13	13	13	13	13	13	13	13
Lognormal Statistical Distribution										
Mean of ln value	7.822409371							4.655859691	3.4917662	2.995732
Standard Deviation of ln value	0.593170652							1.363499261	0.68688309	#DIV/0!
H (0.95)	2.204							3.389	2.341	
95 % UCL	4,340.45							1,011.68	66.15	#DIV/0!

Table 3-2D
Site O
95 % UCL Groundwater Data Summary for Pesticides and PCBs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Sample Depth	Alpha-BHC	Beta-BHC	Delta-BHC	Lindane	Heptachlor	Aldrin	Heptachlor Epoxide	Endosulfan I	Dieldrin	4,4'-DDE	Endrin	Endosulfan II	4,4'-DDD	Endosulfan Sulfate	4,4'-DDT	Methoxychl
DC-GW-38																	
DC-GW-38A																	
DC-GW-39																	
DC-GW-39A																	
DC-GW-40																	
DC-GW-40A																	
DC-GW-41																	
DC-GW-41A																	
DC-GW-42																	
DC-GW-43																	
DC-GW-43A																	
DC-GW-35																	
DC-GW-57																	
Frequency of Detection		0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13
Minimum Concentration		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Number of Samples		13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Lognormal Statistical Distribution																	
Mean of ln value																	
Standard Deviation of ln value																	
H (0.95)																	
95 % UCL																	

All samples are presented in ug/l= micrograms per liter (i.e. ppb) except metals.
Metal analysis are presented in mg/l (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
No reporting limits were available for non-detect data

Table 3-2D
Site O
95 % UCL Groundwater Data Summary for Pesticides and PCBs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Endrin Ketone	Chlordane	Toxaphene	Aroclor-1016	Aroclor-1221	Aroclor-1232	Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260
DC-GW-38										
DC-GW-38A										
DC-GW-39										
DC-GW-39A										
DC-GW-40										
DC-GW-40A										
DC-GW-41										
DC-GW-41A										
DC-GW-42										
DC-GW-43										
DC-GW-43A										
DC-GW-35										
DC-GW-57										
Frequency of Detection	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13
Minimum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Number of Samples	13	13	13	13	13	13	13	13	13	13
Lognormal Statistical Distribution										
Mean of ln value										
Standard Deviation of ln value										
H (0.95)										
95 % UCL										

Table 3-8

Site P Soil Data Summary

Table 3-3
Site P
95% UCL Soil Data Summary for VOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Sample Depth (ft)	Chloromethane	Bromoethane	Vinyl Chloride	Chloroethane	Methylene Chloride	Acetone	Carbon Disulfide	1,1-Dichloroethane	1,1-Dichloroethene	trans-1,2-Dichloroethene	Chloroform	1,2-Dichloroethane	2-Butane (MEK)	1,1,1-Trichloroethane
DC-P1-53	0-10					18 B	1,025 BE							188 B	
DC-P2-54	25-35					5 BJ	1,036 BE							76 B	
DC-P5-55	25-35					2 BJ	333 BE							22 B	
DC-P5-56	10-25					5 BJ	413 BE							26 B	
Frequency of Detection		0/4	0/4	0/4	0/4	4/4	4/4	0/4	0/4	0/4	0/4	0/4	0/4	2/4	0/4
Minimum Concentration		ND	ND	ND	ND	2 BJ	413 BE	ND	ND	ND	ND	ND	ND	22 B	ND
Maximum Concentration		ND	ND	ND	ND	5 BJ	1,036 BE	ND	ND	ND	ND	ND	ND	188 B	ND
Number of Samples		4	4	4	4	4	4	4	4	4	4	4	4	4	4
Lognormal Statistical Distribution															
Mean of ln value						1.700598691	6.4267901							3.97907857	
Standard Deviation of ln value						0.903168325	0.59657325							1.00217214	
H (0.95)						5.95	3.906							6.675	
95 % UCL						183.29	2,835.83							4202.51	

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb) except metals.
Metal analysis are presented in mg/kg (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
No reporting limits were available for non-detect data.

Table 3-3
Site P
95% UCL Soil Data Summary for VOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Carbon Tetrachloride	Vinyl Acetate	Bromodichloromethane	1,2-Dichloropropane	trans-1,3-Dichloropropene	Trichloroethene	Dibromochloromethane	1,1,2-Trichloroethane	Benzene	cis-1,3-Dichloropropene	2-Chloroethyl Vinyl Ether	Bromoform	4-Methyl-2-pentanone	2-Hexanone
DC-P1-53									49				49	38
DC-P2-54													29 B	2 BJ
DC-P5-55														
DC-P5-56														
Frequency of Detection	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	1/4	0/4	0/4	0/4	2/4	2/4
Minimum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	29 B	2 BJ
Maximum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	49	ND	ND	ND	49	38
Number of Samples	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Lognormal Statistical Distribution														
Mean of ln value									3.8918203				3.629538064	2.16536667
Standard Deviation of ln value									#DIV/0!				0.370894808	2.082032769
H (0.95)									2.209				2.52	13.29
95 % UCL									#DIV/0!				69.27	660298961.77

Table 3-3
Site P
95% UCL Soil Data Summary for VOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Tetrachloroethene	1,1,2,2-Tetrachloroethane	Toluene	Chlorobenzene	Ethylbenzene	Styrene	Total Xylenes
DC-P1-53			413	138	119		450
DC-P2-54							
DC-P3-55							
DC-P5-56							
Frequency of Detection	0/4	0/4	1/4	1/4	1/4	0/4	1/4
Minimum Concentration	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration	ND	ND	413	138	119	ND	450
Number of Samples	4	4	4	4	4	4	4
Lognormal Statistical Distribution							
Mean of ln value			6.023447593	4.927253685	4.779123493		6.10924758
Standard Deviation of ln value			#DIV/0!	#DIV/0!	#DIV/0!		#DIV/0!
H (0.95)							
95 % UCL			#DIV/0!	#DIV/0!	#DIV/0!		#DIV/0!

Table 3-3B
Site P
95% UCL Soil Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Sample Depth (ft)	2,4-Dinitrophenol	4-Nitrophenol	Dibenzofuran	2,4-Dinitrotoluene	2,6-Dinitrotoluene	Diethylphthalate	4-Chlorophenyl-Phenylether	Fluorene	4-Nitroaniline	4,6-Dinitro-2-methylphenol	N-Nitrosodiphenylamine
DC-P1-53	0-10											
DC-P2-54	25-35											
DC-P5-55	25-35											
DC-P5-56	10-25											
Frequency of Detection		0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4	0/4
Minimum Concentration		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Number of Samples		4	4	4	4	4	4	4	4	4	4	4
Lognormal Statistical Distribution												
Mean of ln value												
Standard Deviation of ln value												
H (0.95)												
95 % UCL												

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb) except metals.
Metal analysis are presented in mg/kg (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
Metal analysis are presented in mg/kg (i.e. ppm)
No reporting limits were available for non-detect data.

Table 3-3C
Site P
95 % UCL Soil Data Summary for Metals
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Sample Depth (ft)	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead
DC-P1-53	0-10	5,013			126			4	16		50	12,750	
DC-P2-54	25-35	1,274							2			4,131	4 *
DC-P5-55	25-35	6,136		3	81				14		16	15,309	526 *
DC-P5-56	10-25	5,538		4	119				10		24	13,000	90 *
Frequency of Detection		4/4	0/4	2/4	3/4	0/4	0/4	1/4	4/4	0/4	3/4	4/4	3/4
Minimum Concentration		1,274	ND	3	81	ND	ND	ND	2	ND	16	4,131	4 *
Maximum Concentration		6,136	ND	4	126	ND	ND	4	16	ND	50	15,309	526 *
Number of Samples		4	4	4	4	4	4	4	4	4	4	4	4
Lognormal Statistical Distribution													
Mean of ln value		8.25275593		1.24245	4.669952			1.3862944	2.101844581		3.28756	9.222116	4.050468415
Standard Deviation of ln value		0.73984312		0.20342	0.240298			#DIV/0!	0.959725718		0.57756	0.602835	2.470345651
H (0.95)		5.097		2.475	2.639				5.95		3.906		16.37
95 % UCL		44,516.55		4.73	158.37			#DIV/0!	350.47		116.37	12,134.65	1.68E+13

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb) except metals.
Metal analysis are presented in mg/kg (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
Metal analysis are presented in mg/kg (i.e. ppm)
No reporting limits were available for non-detect data.

Table 3-3C
Site P
95 % UCL Soil Data Summary for Metals
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Manganese	Mercury	Nickel	Selenium	Silver	Thallium	Tin	Vanadium	Zinc	Cyanide
DC-P1-53	201 *	3.9	25 *					19	463 *	
DC-P2-54	93 *	0.6							17 *	13
DC-P5-55	623 *		15 *					22	49 *	15
DC-P5-56	710 *		23 *					16	74 *	
Frequency of Detection	4/4	2/4	3/4	0/4	0/4	0/4	0/4	3/4	4/4	2/4
Minimum Concentration	93 *	0.6	15 *	ND	ND	ND	ND	16	17 *	13
Maximum Concentration	710 *	3.9	25 *	ND	ND	ND	ND	22	463 *	15
Number of Samples	4	4	4	4	4	4	4	4	4	4
Lognormal Statistical Distribution										
Mean of ln value	5.708928973	0.4250755	3.02080675					8.287877059	3.6763662	2.6365
Standard Deviation of ln value	0.967490584	1.323564	0.27404492					9.278336954	0.7587269	0.10119
H (0.95)	6.244	8.32	2.639					59.4	5.097	2.209
95 % UCL	15,752.08	2,119.21	32.33					3.05E+160	491.25	15.97

Table 3-3D
Site P
95 % UCL Soil Data Summary for PCBs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Sample Depth (ft)	PCBs IEPA	PCBs EEI	TCDD IEPA	TCDD EEI
1	0-ft	1,500	3,690		
2A	0-ft	7,600	5,350		
2B	7-13	390	716		
3A	0-7	9,100	137,250		
3B	7-13	40	28		
4A	0-6	20,000	21,020		
4ADUP	0-6		15,510		
4B	6-13	54,000	149,600		
5A	0-6	32,000	112,930	18	28
5ADUP	0-6			17	
5B	6-14	20,000	12,050	4.1	5.1
6	0-8	120	90		
7A	0-6				
7B	8-16			1.8	44
8A	0-6			77	
8B	6-12				19
8C	13-18				37
8D	18-25				
8DDUP	18-25				56
9A	0-6			1.3	
9B	6-12				
9C	14-21				
9D	22-28			0.92	
10A				12	
10B					13
11A	0-6				
11B	8-18				
12	10-19				
13A	0-7				
13B	7-18			13	13
14	0-6			25	170
15	0-16				
16	0-18				
Frequency of Detection		10/33	11/33	10/33	9/33
Minimum Concentration		40	28	0.92	5.1
Maximum Concentration		54,000	149,600	77	170
Number of Samples		33	33	33	33
Lognormal Statistical Distribution					
Mean of ln value		8.088487715	8.68936554	2.05138787	3.288004491
Standard Deviation of ln value		2.512820919	2.87973093	1.44126192	1.014002116
H (0.95)		4.549	4.943	2.885	2.41
95 % UCL		5.77E+05	4.65E+06	4.58E+01	6.90E+01

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb) except metals.
Metal analysis are presented in mg/kg (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
Metal analysis are presented in mg/kg (i.e. ppm)
No reporting limits were available for non-detect data.

Table 3-9

Site Q Soil Data Summary

Table 3-4
Site Q
95% UCL Soil Data Summary for VOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Sample Depth (ft)	Chloromethane	Bromoethane	Vinyl Chloride	Chloroethane	Methylene Chloride	Acetone	Carbon Disulfide	1,1-Dichloroethane	1,1-Dichloroethene	trans-1,2-Dichloroethene
X101						15				24	240
X102						6 J					
X103											
X104											
X105						5 J	27				
X106											
X107											
X108						6 J					
X109											
X110						12 J					
X111											
Frequency of Detection		0/11	0/11	0/11	0/11	5/11	1/11	0/11	0/11	1/11	1/11
Minimum Concentration		ND	ND	ND	ND	5 J	ND	ND	ND	ND	ND
Maximum Concentration		ND	ND	ND	ND	15	27	ND	ND	24	ND
Number of Samples		11	11	11	11	11	11	11	11	11	11
Lognormal Statistical Distribution											
Mean of ln value						2.0771827	3.295837			3.17805383	5.480638923
Standard Deviation of ln value						0.4863	#DIV/0!			#DIV/0!	#DIV/0!
H (0.95)						2.107					
95 % UCL						12.42	#DIV/0!			#DIV/0!	#DIV/0!

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb) except metals.
Metal analysis are presented in mg/kg (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
No reporting limits were available for non-detect data.

Table 3-4
Site Q
95% UCL Soil Data Summary for VOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Chloroform	1,2-Dichloroethane	2-Butane (MEK)	1,1,1-Trichloroethane	Carbon Tetrachloride	Vinyl Acetate	Bromodichloromethane	1,2-Dichloropropane	trans-1,3-Dichloropropene	Trichloroethene
X101				10 J						6 J
X102	10 J									
X103										
X104										
X105										
X106				18						
X107										
X108										
X109										
X110										
X111										
Frequency of Detection	1/11	0/11	0/11	2/11	0/11	0/11	0/11	0/11	0/11	1/11
Minimum Concentration	ND	ND	ND	10 J	ND	ND	ND	ND	ND	ND
Maximum Concentration	10 J	ND	ND	18	ND	ND	ND	ND	ND	6 J
Number of Samples	11	11	11	11	11	11	11	11	11	11
Lognormal Statistical Distribution										
Mean of ln value	2.30258509			2.596478425						1.7917595
Standard Deviation of ln value	#DIV/0!			0.415627937						#DIV/0!
H (0.95)				2.049						
95 % UCL	#DIV/0!			19.15						#DIV/0!

Table 3-4
Site Q
95% UCL Soil Data Summary for VOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Dibromochloro methane	1,1,2-Trichlorothane	Benzene	cis-1,3-Dichloropropene	2-Chloroethyl Vinyl Ether	Bromoform	4-Methyl-2-pentanone	2-Hexanone	Tetrachloroethene
X101			5 J						
X102									
X103									
X104									
X105									5 J
X106									
X107									
X108									
X109									
X110									
X111									
Frequency of Detection	0/11	0/11	1/11	0/11	0/11	0/11	0/11	0/11	1/11
Minimum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration	ND	ND	5 J	ND	ND	ND	ND	ND	5 J
Number of Samples	11	11	11	11	11	11	11	11	11
Lognormal Statistical Distribution									
Mean of ln value			1.6094379						1.609437912
Standard Deviation of ln value			#DIV/0!						#DIV/0!
H (0.95)									
95 % UCL			#DIV/0!						#DIV/0!

Table 3-4
Site Q
95% UCL Soil Data Summary for VOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	1,1,2,2-Tetrachloroethane	Toluene	Chlorobenzene	Ethylbenzene	Styrene	Total Xylenes
X101		8 J				
X102						
X103						
X104						
X105		14				14
X106						
X107						
X108						
X109						
X110		8 J				
X111						
Frequency of Detection	0/11	3/11	0/11	0/11	0/11	1/11
Minimum Concentration	ND	8 J	ND	ND	ND	ND
Maximum Concentration	ND	14	ND	ND	ND	14
Number of Samples	11	11	11	11	11	11
Lognormal Statistical Distribution						
Mean of ln value		2.2659801				2.6390573
Standard Deviation of ln value		0.3230943				#DIV/0!
H (0.95)		1.946				
95 % UCL		12.39				#DIV/0!

Table 3-4B
Site Q
95 % UCL Soil Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Sample Depth (ft)	2,4-Dinitrophenol	4-Nitrophenol	Dibenzofuran	2,4-Dinitrotoluene	2,6-Dinitrotoluene	Diethylphthalate	4-Chlorophenyl-Phenylether	Fluorene	4-Nitroaniline
QD1										
QD2										
QD3										
X101	0-10									
X102										
X103										
X104										
X105										
X106										
X107										
X108										
X109										
X110										
X111										
Frequency of Detection		0/11	0/11	0/11	0/11	0/11	0/11	0/11	0/11	0/11
Minimum Concentration		ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration		ND	ND	ND	ND	ND	ND	ND	ND	ND
Number of Samples		11	11	11	11	11	11	11	11	11
Lognormal Statistical Distribution										
Mean of ln value										
Standard Deviation of ln value										
H (0.95)										
95 % UCL										

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb) except metals.
Metal analysis are presented in mg/kg (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
Metal analysis are presented in mg/kg (i.e. ppm)
No reporting limits were available for non-detect data.

Table 3-4B
Site Q
95 % UCL Soil Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	4,6-Dinitro-2-methylphenol	N-Nitrosodiphenylamine	4-Bromophenyl-phenylether	Hexachlorbenzene	Pentachlorophenol	Phenanthrene	Anthracene	Di-n-butyl phthalate
QD1								
QD2								
QD3								
X101								
X102								
X103								
X104								
X105								
X106								
X107								340 J
X108						76 J		310 J
X109								380 J
X110						73 J	62 J	250 J
X111								
Frequency of Detection	0/11	0/11	0/11	0/11	0/11	2/11	1/11	4/11
Minimum Concentration	ND	ND	ND	ND	ND	73 J	ND	250 J
Maximum Concentration	ND	ND	ND	ND	ND	76 J	62 J	380 J
Number of Samples	11	11	11	11	11	11	11	11
Lognormal Statistical Distribution								
Mean of ln value						4.310596391	4.127134385	5.756787521
Standard Deviation of ln value						0.028477947	#DIV/0!	0.17759847
H (0.95)						1.785		1.785
95 % UCL						75.72	#DIV/0!	355.24

Table 3-4B
Site Q
95 % UCL Soil Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Fluoranthene	Pyrene	Butyl Benzyl phthalate	3,3'-Dichlorobenzidine	Benzo(a)anthracene	bis(2-ethylhexyl)phthalate	Chrysene	Di-n-octyl phthalate
QD1								
QD2								
QD3						1,200,000 B		
X101						13,000 B		
X102						9,300 B		
X103						110,000,000 B		
X104						13,000 B		
X105						120,000 B		
X106						1,900 B		
X107			120 J			3,800 B		
X108					89 J	310 JB	110 J	
X109	160 J	170 J				1,000 B		
X110						1,500	110 J	
X111	140 J	140 J						
Frequency of Detection	2/11	2/11	1/11	0/11	1/11	11/11	2/11	0/11
Minimum Concentration	140 J	140 J	ND	ND	ND	310 JB	110 J	ND
Maximum Concentration	160 J	170 J	120 J	ND	89 J	110,000,000 B	110 J	ND
Number of Samples	11	11	11	11	11	11	11	11
Lognormal Statistical Distribution								
Mean of ln value	5.008408119	5.03872043	4.787491743		4.48863637	9.822014772	4.7004804	
Standard Deviation of ln value	0.094420953	0.13728903	#DIV/0!		#DIV/0!	3.692960596	0.00000	
H (0.95)	1.785	1.785				8.615	1.785	
95 % UCL	158.56	168.28	#DIV/0!		#DIV/0!	3.95E+11	110.00	

Table 3-4B
Site Q
95 % UCL Soil Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene	Benzo(g,h,i)perylene	Dibenzo(a,h)anthracene
QD1						
QD2						
QD3						
X101						
X102						
X103						
X104						
X105						
X106						
X107						
X108						
X109	87 J	96 J	84 J			
X110						
X111	110 J	88 J				
Frequency of Detection	2/11	2/11	1/11	0/11	0/11	0/11
Minimum Concentration	87 J	88 J	ND	ND	ND	ND
Maximum Concentration	110 J	96 J	84 J	ND	ND	ND
Number of Samples	11	11	11	11	11	11
Lognormal Statistical Distribution						
Mean of ln value	4.583194242	4.520842503	4.430816799			
Standard Deviation of ln value	0.165867627	0.061526335	#DIV/0!			
H (0.95)	1.785	1.785				
95 % UCL	108.92	95.34	#DIV/0!			

Table 3-4C
Area Q
95 % UCL Soil Data Summary for Metals
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Sample Depth (ft)	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper
X101		10,700 *	157 N*	13.70 N*S	1,220 N*	0.54 B	2,260 *	13,400	3,650 *	18.7	324
X102		5,710 *		1.40 BN*S	141 N*	0.49 B	3.9 *	18,000	12.1 *	7.4 B	18.7
X103		3,240 *	17,900 N*	216.00 N*S	1,680 N*	0.30 B	8.7	10,300	142 *	13.3 B	1,630
X104		3,500 *		1.60 BNW*	63.3 N*	0.31 B	1.1 B*	152,000	5.8 *	2.9 B	7.6
X105		237 *		0.47 BN*	188 N*		1.4 *	456 B	3 *		2.8 B
X106		3,250 *		0.93 BN*	3,620 N*		1.5 *	1,320	7 *	3.7 B	9
X107		5,630 *		2.70 N*S	103 N*	0.44 B	28.7 *	4,360	287 *	8.2 B	32.8
X108		3,330 *		3.30 N*S	150 N*		6.0 *	2,090	43.9 *	5.7 B	166
X109		5,590 *		3.00 N*S	123 N*	0.47 B	1.9 *	9,070	10.4 *	8.0 B	21.6
X110		1,030 *	48 *	19.30 N*S	1,120 N*		1.2 B*	413 B	40.8 *	6.9 B	226
X111		10,100 *		4.40 BN*S	170 N*	0.73 B	1.9 *	11,500.0	15.6 *	9.7 B	38
Frequency of Detection		11/11	3/11	11/11	11/11	7/11	11/11	11/11	11/11	10/11	11/11
Minimum Concentration		237 *	157 N*	0.47 BN*	103 N*	0.3 B	1.2 B*	413 B	3	2.9 B	7.6
Maximum Concentration		10,700 *	17,900 N*	216 N*S	3,620 N*	0.73 B	2,290 *	152,000	3,650	18.7	1,630
Number of Samples		11	11	11	11	11	11	11	11	11	11
Lognormal Statistical Distribution											
Mean of ln value		8.11447475	6.237212	1.42719	5.788628	-0.79934	1.6999	8.5719978	3.51755006	2.00185	3.82671
Standard Deviation of ln value		1.08594647	3.136306	1.69778	1.369103	0.311347	0.6866	1.7411317	2.07736228	0.55015	1.89712
H (0.95)		4.557	7.436	4.008	3.74	1.946	2.236	4.557	5.119	2.236	4.801
95 % UCL		2.88E+04	1.12E+08	151.45	4.21E+03	0.57	11.26	2.96E+05	8417.25	12.71	4946.64

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb) except metals.
Metal analysis are presented in mg/kg (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
No reporting limits were available for non-detect data.

Table 3-4C
Area Q
95 % UCL Soil Data Summary for Metals
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium
X101	63,500 *	7,690	2,940	606	4.90	153 N*	1,310 B	59.9 *S	3.3 N	268 B
X102	11,600 *	152 *	4,250	372		17.6 N*	1,030 B			
X103	80,500 *	195,000 *	1,350	1,270	0.25	101 N*	446 B		30.2 N	810 B
X104	5,450 *	18,100 *	4,600	275		8.1 BN	604 B			
X105	469 *	62.2 *	56.9 B	4				2.1 B*		
X106	2,170 *	41.1	2,350	62.3	0.14	6.5 BN	301 B			
X107	22,500 *	191 *	2,040	334		23.1 N*	898 B	1.5 *S		
X108	7,920 *	571 *	1,230 B	133	0.30	18.7 N*	598 B	0.33 B*W		
X109	10,900 *	52 *	2,830	455		18.9 N*	940 B			
X110	65,200 *	5,320 *	89.9 B	152	0.64	371 N*	2,430		28.9 N	476 B
X111	17,100 *	58.1 *	3,990	597		25.9 N*	25.9 N*			
Frequency of Detection	11/11	11/11	11/11	11/11	5/11	10/11	10/11	4/11	3/11	3/11
Minimum Concentration	469 *	41.1	56.9 B	4	0.14	6.5 *	25.9 N*	0.33 B*W	3.3 N	268 B
Maximum Concentration	80,500 *	195,000 *	4,600	1,270 *	4.9	371 *	2,430	59.9 *S	30.2 N	810 B
Number of Samples	11	11	11	11	11	11	11	11	11	11
Lognormal Statistical Distribution										
Mean of ln value	9.388819	6.544967	7.20542977	5.349559825	-0.682686	3.46550867	6.341563	1.0328541	2.6552	6.15114636
Standard Deviation of ln value	1.550019	2.881689	1.51654617	1.553834099	1.3812584	1.30284042	1.230719	2.1929323	1.2657	0.55316173
H (0.95)	4.008	6.851	4.008	4.008	3.479	3.209	3.209	5.119	3.479	2.236
95 % UCL	2.83E+05	2.28E+07	2.91E+04	5045.00 #	5.99	280.42	4220.89	1082.67	127.57	808.57

Table 3-4C
Area Q
95 % UCL Soil Data Summary for Metals
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Thallium	Vanadium	Zinc	Cyanide	Sulfate	Sulfide
X101		7.3 B	7,290 *	3.3	82.4	
X102		16	689			
X103	0.89 B		9,520 *	2.8	55.9	
X104		7.6 B	95 *			
X105			10.8 *		907	
X106		10 B	66.1 *			
X107		13.8	2,010 *		76.1	
X108		9.1 B	338 *		170	
X109		13.6 B	206 *		4,780	
X110			120 *		901	
X111		23.1 B	216 *		300	
Frequency of Detection	1/11	8/11	11/11	2/11	8/11	0/11
Minimum Concentration	ND	7.3 B	95 *	2.8	55.9	ND
Maximum Concentration	0.89 B	23.1	9,520 *	3.3	4,780	ND
Number of Samples	11	11	11	11	11	11
Lognormal Statistical Distribution						
Mean of ln value	-0.116534	2.459255228	5.8758931	1.11177	5.711578	
Standard Deviation of ln value	#DIV/0!	0.397682598	2.0464576	0.11618	1.548927	
H (0.95)		1.946	5.19	1.785	4.008	
95 % UCL	#DIV/0!	16.17	83,164.76	3.27	7.15E+03	

Table 3-4D
Area Q
95 % UCL Soil Data Summary for Pesticides and PCBs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Sample Depth (ft)	Alpha-BHC	Beta-BHC	Delta-BHC	Lindane	Heptachlor	Aldrin	Heptachlor Epoxide	Endosulfan I	Dieldrin	4,4'-DDE
X101											
X102											
X103											
X104											
X105											
X106											
X107											
X108											
X109											
X110											
X111											
Frequency of Detection		0/11	0/11	0/11	0/11	0/11	0/11	0/11	0/11	0/11	0/11
Minimum Concentration		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Number of Samples		11	11	11	11	11	11	11	11	11	11
Lognormal Statistical Distribution											
Mean of ln value											
Standard Deviation of ln value											
H (0.95)											
95 % UCL											

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb) except metals.
Metal analysis are presented in mg/kg (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
No reporting limits were available for non-detect data.

Table 3-4D
Area Q
95 % UCL Soil Data Summary for Pesticides and PCBs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Endrin	Endosulfan II	4,4'-DDD	Endosulfan Sulfate	4,4'-DDT	Methoxychlor	Endrin Ketone	Chlordane	Toxaphene
X101									
X102									
X103									
X104									
X105									
X106									
X107									
X108									
X109									
X110									
X111									
Frequency of Detection	0/11	0/11	0/11	0/11	0/11	0/11	0/11	0/11	0/11
Minimum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	ND
Number of Samples	11	11	11	11	11	11	11	11	11
Lognormal Statistical Distribution									
Mean of ln value									
Standard Deviation of ln value									
H (0.95)									
95 % UCL									

Table 3-4D
Area Q
95 % UCL Soil Data Summary for Pesticides and PCBs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Aroclor-1016	Aroclor-1221	Aroclor-1232	Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260
X101						110,000 P	83,000
X102						1,100 P	460
X103					500	2,300	1,500
X104						14,000 P	12,000
X105						22,000	6,500 P
X106						1,700 P	2,300
X107					4,800 P	11,000 E	8,800 PE
X108							
X109							
X110							
X111							
Frequency of Detection	0/11	0/11	0/11	0/11	2/11	7/11	7/11
Minimum Concentration	ND	ND	ND	ND	500	1,100 P	460
Maximum Concentration	ND	ND	ND	ND	4,800 P	110,000 P	83,000
Number of Samples	11	11	11	11	11	11	11
Lognormal Statistical Distribution							
Mean of ln value					7.345489648	8.948801418	8.538061936
Standard Deviation of ln value					1.599308024	1.642502513	1.672818967
H (0.95)					16.979	21.788	20.585
95 % UCL					2.98E+07	2.44E+09	1.11E+09

Table 3-10

Site Q Groundwater Data Summary

Table 3-5
Site Q
95% UCL Groundwater Data Summary for VOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Sample Depth	Chloromethane	Bromoethane	Vinyl Chloride	Chloroethane	Methylene Chloride	Acetone	Carbon Disulfide	1,1-Dichloroethane	1,1-Dichloroethene	trans-1,2-Dichloroethene	Chloroform
DC-GW-01							15					
DC-GW-02							9 BJ				1 J	
DC-GW-03							10 B					
DC-GW-04							14 B					
DC-GW-05							12 B				4 J	1 J
DC-GW-06							13 B					
DC-GW-07						23 J	400 B					
DC-GW-08						61 J	210 B					
DC-GW-09						2,200 BJ	7,100 B					
Frequency of Detection		0/9	0/9	0/9	0/9	3/9	9/9	0/9	0/9	0/9	2/9	1/9
Minimum Concentration		ND	ND	ND	ND	23 J	9 BJ	ND	ND	ND	1 J	ND
Maximum Concentration		ND	ND	ND	ND	2,200 BJ	7,100 B	ND	ND	ND	4 J	1 J
Number of Samples		9	9	9	9	9 9	9 9	9	9	9	9	9
Lognormal Statistical Distribution												
Mean of ln value						4.98086024	3.900355				0.693147181	0
Standard Deviation of ln value						2.40160266	2.3290187				0.980258143	#DIV/0!
H (0.95)						6.85	6.85				3.295	
95% UCL						874,149.82	209,615.79				10.13	#DIV/0!

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb) except metals.
Metal analysis are presented in mg/kg (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
Metal analysis are presented in mg/kg (i.e. ppm)

Table 3-5
Site Q
95% UCL Groundwater Data Summary for VOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	1,2-Dichloroethane	2-Butane (MEK)	1,1,1-Trichloroethane	Carbon Tetrachloride	Vinyl Acetate	Bromodichloromethane	1,2-Dichloropropane	trans-1,3-Dichloropropene	Trichloroethene	Dibromochloromethane	1,1,2-Trichlorothane	Benzene
DC-GW-01												9
DC-GW-02												24
DC-GW-03												1 J
DC-GW-04												14
DC-GW-05									2 J			1 J
DC-GW-06												1 J
DC-GW-07												2,000
DC-GW-08												2,000
DC-GW-09	3,000											2,000 J
Frequency of Detection	1/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	1/9	0/9	0/9	9/9
Minimum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1 J
Maximum Concentration	3,000	ND	ND	ND	ND	ND	ND	ND	2 J	ND	ND	2,000 J
Number of Samples	9	9	9	9	9	9	9	9	9	9	9	9
Lognormal Statistical Distribution												
Mean of ln value	8.006367568								0.693147181			3.4241159
Standard Deviation of ln value	#DIV/0!								#DIV/0!			3.34836663
H (0.95)												9.801
95% UCL	#DIV/0!								#DIV/0!			9.13E+08

Table 3-5
Site Q
95% UCL Groundwater Data Summary for VOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	cis-1,3-Dichloropropene	2-Chloroethyl Vinyl Ether	Bromoform	4-Methyl-2-pentanone	2-Hexanone	Tetrachloroethene	1,1,2,2-Tetrachloroethane	Toluene	Chlorobenzene	Ethylbenzene
DC-GW-01									14	
DC-GW-02					5 J			4 J	1 J	1 J
DC-GW-03									33	
DC-GW-04									380 E	
DC-GW-05									29	
DC-GW-06									7	
DC-GW-07				250				450	1,500	33 J
DC-GW-08				290				410	1,400	22 J
DC-GW-09				2,700 J	3,500 J			1,600 J	6,700 J	
Frequency of Detection	0/9	0/9	0/9	3/9	2/9	0/9	0/9	4/9	9/9	3/9
Minimum Concentration	ND	ND	ND	250	5 J	ND	ND	4 J	1 J	1 J
Maximum Concentration	ND	ND	ND	2,700 J	3,500 J	ND	ND	1,600 J	6,700 J	33
Number of Samples	9	9	9	9 9	9	9	9	9	9	9
Lognormal Statistical Distribution										
Mean of ln value				6.364116298	4.88497808			5.2223645	4.528472537	2.195850005
Standard Deviation of ln value				1.333053644	4.632313329			2.63171855	2.92859195	1.912437822
H (0.95)				4.091	13.473			7.616	8.341	5.776
95% UCL				9,708.37	2.31279E+16			7.07E+06	3.80E+07	2,779.41

Table 3-5
Site Q
95% UCL Groundwater Data Summary for VOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Styrene	Total Xylenes
DC-GW-01		2
DC-GW-02		230
DC-GW-03		
DC-GW-04		
DC-GW-05		
DC-GW-06		
DC-GW-07		180
DC-GW-08		160
DC-GW-09		
Frequency of Detection	0/9	4/9
Minimum Concentration	ND	2
Maximum Concentration	ND	230
Number of Samples	9	9
Lognormal Statistical Distribution		
Mean of ln value		4.09983929
Standard Deviation of ln value		2.27615325
H (0.95)		6.85
95% UCL		1.99E+05

Table 3-5B
Site Q
95 % UCL Groundwater Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Phenol	bis(2-Chloroethyl)ether	2-Chlorophenol	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Benzyl Alcohol	1,2-Dichlorobenzene	2-Methylphenol	bis(2-Chloroisopropyl)ether	4-Methylphenol	N-Nitroso-n-Dipropylamine
DC-GW-01									3 J		
DC-GW-02											
DC-GW-03			4 J		4						
DC-GW-04											
DC-GW-05											
DC-GW-06											
DC-GW-07	110,000 E		20,000 E		220 J	460	260	190 J		14,000 E	
DC-GW-08	190,000 E		33,000 E		250	490	300	350		23,000 E	
DC-GW-09	6,100 E		2,600 E		70 J	180	2,000	10 J		850	
Frequency of Detection	3/9	0/9	4/9	0/9	4/9	3/9	3/9	3/9	1/9	3/9	0/9
Minimum Concentration	6,100 E	ND	4.00 J	ND	4	180	260	10 J	ND	850	ND
Maximum Concentration	190,000 E	ND	33,000 E	ND	250	490	2,000	350	3 J	23,000 E	ND
Number of Samples	9	9	9	9	9	9	9	9	9	9	9
Lognormal Statistical Distribution											
Mean of ln value	10.826353		7.38932787		4.13747	5.83952958	6.288455522	4.469180773	1.098861229	8.778432818	
Standard Deviation of ln value	1.8478989		4.150175142		1.921341	0.56083876	1.138862233	1.901027382	#DIV/0!	1.778209297	
H (0.95)	5.776		12.003		5.776	2.45	3.741	5.776		5.468	
95 % UCL	1.21E+07		3.96E+14		2.01E+04	6.54E+02	4.64E+03	2.58E+04	#DIV/0!	9.82E+05	

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb) except metals.
Metal analysis are presented in mg/kg (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
Metal analysis are presented in mg/kg (i.e. ppm)

Table 3-5B
Site Q
95 % UCL Groundwater Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Hexachloroethane	Nitrobenzene	Isophorone	2-Nitrophenol	2,4-Dimethylphenol	Benzoic Acid	bis-(2-Chloroethoxy) methane	2,4-Dichlorophenol	1,2,4-Trichlorophenol	Naphthalene	4-Chloroanilline
DC-GW-01											
DC-GW-02					5 J	10 J					
DC-GW-03											
DC-GW-04											
DC-GW-05											
DC-GW-06											
DC-GW-07								1,900 E		41 J	14,000 E
DC-GW-08		100 J			2,800			14,000 E		42 J	15,000 E
DC-GW-09		820			62	600		7,600 E	390	70	4,400
Frequency of Detection	0/9	2/9	0/9	0/9	3/9	2/9	0/9	3/9	1/9	3/9	3/9
Minimum Concentration	ND	100 J	ND	ND	5 J	10 J	ND	1,900 E	ND	41 J	4,400
Maximum Concentration	ND	820	ND	ND	2,800	600	ND	14,000 E	390	70	15,000 E
Number of Samples	9	9	9	9	9	9	9	9	9	9	9
Lognormal Statistical Distribution											
Mean of ln value		5.657237263			4.5579823	4.3497574		8.677441767	5.966147	3.899912309	9.183992636
Standard Deviation of ln value		1.487847529			3.1858937	2.8951388		1.02338031	#DIV/0!	0.302122027	0.689036275
H (0.95)		4.422			12.408	8.341		3.444		2.063	2.642
95 % UCL		8.87E+03			1.79E+10	2.61E+07		3.44E+04	#DIV/0!	6.45E+01	2.35E+04

Table 3-5B
Site Q
95 % UCL Groundwater Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Hexachlorobutadiene	4-Chloro-3-methylphenol	2-Methylnaphthalene	Hexachlorocyclopentadine	2,4,6-Trichlorophenol	2,4,5-Trichlorophenol	2-Chloronaphthalene	2-Nitroanilline	Dimethyl Phthalate	Acenaphthylene	3-Nitroanilline	Acenaphthene
DC-GW-01												
DC-GW-02												
DC-GW-03												
DC-GW-04												
DC-GW-05												
DC-GW-06					4,100			1,700		3,900		
DC-GW-07					6,000			1,800				
DC-GW-08					1,800			2,000		460 J		
DC-GW-09												
Frequency of Detection	0/9	0/9	0/9	0/9	3/9	0/9	0/9	3/9	0/9	2/9	0/9	0/9
Minimum Concentration	ND	ND	ND	ND	1,800	ND	ND	1,700	ND	460 J	ND	ND
Maximum Concentration	ND	ND	ND	ND	6,000	ND	ND	2,000	ND	3,900	ND	ND
Number of Samples	9	9	9	9	9	9	9	9	ND	9	9	9
Lognormal Statistical Distribution												
Mean of ln value					8.17126631			7.5116093		7.199979161		
Standard Deviation of ln value					0.61538565			0.0824422		1.511444523		
H (0.95)					2.543			1.851		4.77		
95 % UCL					7.43E+03			1.94E+03		5.37E+04		

Table 3-5B
Site Q
95 % UCL Groundwater Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	2,4-Dinitrophenol	4-Nitrophenol	Dibenzofuran	2,4-Dinitrotoluene	2,6-Dinitrotoluene	Diethylphthalate	4-Chlorophenyl-Phenylether	Fluorene	4-Nitroaniline	4,6-Dinitro-2-methylphenol
DC-GW-01										
DC-GW-02										
DC-GW-03										
DC-GW-04										
DC-GW-05										
DC-GW-06										
DC-GW-07										
DC-GW-08										
DC-GW-09		80 J								
Frequency of Detection	0/9	1/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9
Minimum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration	ND	80 J	ND	ND	ND	ND	ND	ND	ND	ND
Number of Samples	9	9	9	9	9	9	9	9	9	9
Lognormal Statistical Distribution										
Mean of ln value		4.382026635								
Standard Deviation of ln value		#DIV/0!								
H (0.95)										
95 % UCL		#DIV/0!								

Table 3-5B
Site Q
95 % UCL Groundwater Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	N-Nitrosodiphenylamine	4-Bromophenyl-phenylether	Hexachlorbenzene	Pentachlorophenol		Phenanthrene	Anthracene	Di-n-butyl phthalate		Fluoranthene
DC-GW-01								12	BJ	
DC-GW-02								8	BJ	
DC-GW-03								5	BJ	
DC-GW-04								8	BJ	
DC-GW-05								5	BJ	
DC-GW-06								5	BJ	
DC-GW-07				24,000	E					
DC-GW-08				35,000	E					
DC-GW-09				310						
Frequency of Detection	0/9	0/9	0/9	3/9		0/9	0/9	6/9		0/9
Minimum Concentration	ND	ND	ND	310		ND	ND	5	BJ	ND
Maximum Concentration	ND	ND	ND	35000	E	ND	ND	12	BJ	ND
Number of Samples	9	9	9	9		9	9	9	9	9
Lognormal Statistical Distribution										
Mean of ln value				8.761828249				1.912017245		
Standard Deviation of ln value				2.626731413				0.363022539		
H (0.95)				7.616				2.13		
95 % UCL				2.37E+08				9.50		

Table 3-5B
Site Q
95 % UCL Groundwater Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Pyrene	Butyl Benzyl phthalate	3,3'-Dichlorobenzidine	Benzo(a)anthracene	bis(2-ethylhexyl)phthalate	Chrysene	Di-n-octyl phthalate	Benzo(b)fluoranthene
DC-GW-01					95			
DC-GW-02					160		7 J	
DC-GW-03					32		4 J	
DC-GW-04								
DC-GW-05					26			
DC-GW-06							2 J	
DC-GW-07								
DC-GW-08								
DC-GW-09								
Frequency of Detection	0/9	0/9	0/9	0/9	4/9	0/9	3/9	0/9
Minimum Concentration	ND	ND	ND	ND	26	ND	2 J	ND
Maximum Concentration	ND	ND	ND	ND	160	ND	7 J	ND
Number of Samples	9		9	9	9	9	9	9
Lognormal Statistical Distribution								
Mean of ln value					4.088220787		1.341783897	
Standard Deviation of ln value					0.869387828		0.627566451	
H (0.95)					2.965		2.642	
95 % UCL					2.16E+02		8.37E+00	

Table 3-5B
Site Q
95 % UCL Groundwater Data Summary for SVOCs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Benzo(k)fluoranthene	Indeno(1,2,3-cd)pyrene	Benzo(g,h,I)perylene	Dibenzo(a,h)anthracene
DC-GW-01				
DC-GW-02				
DC-GW-03				
DC-GW-04				
DC-GW-05				
DC-GW-06				
DC-GW-07				
DC-GW-08				
DC-GW-09				
Frequency of Detection	0/9	0/9	0/9	0/9
Minimum Concentration	ND	ND	ND	ND
Maximum Concentration	ND	ND	ND	ND
Number of Samples	9	9	9	9
Lognormal Statistical Distribution				
Mean of ln value				
Standard Deviation of ln value				
H (0.95)				
95 % UCL				

Table 3-5C
Site Q
95 % UCL Groundwater Data Summary for Metals
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
DC-GW-01			64	384							8,960			1,320
DC-GW-02			82	482							54,000			1,600
DC-GW-03			18								15,800			522
DC-GW-04			100	358							20,000			1,090
DC-GW-05											571			1,640
DC-GW-06				336							11,300			13,200.0
DC-GW-07			11								36,700			2,660
DC-GW-08			11								36,500			2,600
DC-GW-09			15					13	148		41,200			6,630
Frequency of Detection	0/9	0/9	7/9	4/9	0/9	0/9	0/9	1/9	1/9	0/9	9/9	0/9	0/9	9/9
Minimum Concentration	ND	ND	11	336	ND	ND	ND	ND	ND	ND	571	ND	ND	522
Maximum Concentration	ND	ND	100	482	ND	ND	ND	13	148	ND	54,000	ND	ND	132,000
Number of Samples	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Lognormal Statistical Distribution														
Mean of ln value			3.3664264	5.9565577				2.56494936	4.997212		9.6544731			7.694875369
Standard Deviation of ln value			0.9815698	0.15734466				#DIV/0!	#DIV/0!		1.3853379			0.968409597
H (0.95)			3.295	1.851							4.422			3.295
95 %UCL			147.18	4.34E+02				#DIV/0!	#DIV/0!		3.55E+05			10850.22

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb) except metals.
Metal analysis are presented in mg/kg (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
Metal analysis are presented in mg/kg (i.e. ppm)
No reporting limits were available for non-detect data

Table 3-5C
Site Q
95 % UCL Groundwater Data Summary for Metals
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc	Cyanide	Sulfate	Sulfide
DC-GW-01		64							25	1,560		
DC-GW-02		74.0							326			
DC-GW-03									26			
DC-GW-04									22			
DC-GW-05									313			
DC-GW-06									48			
DC-GW-07									172			
DC-GW-08									171			
DC-GW-09		112.0							4.31			
Frequency of Detection	0/9	3/9	0/9	0/9	0/9	0/9	0/9	0/9	9/9	1/9	0/9	0/9
Minimum Concentration	ND	64	ND	ND	ND	ND	ND	ND	4.31	ND	ND	ND
Maximum Concentration	ND	112	ND	ND	ND	ND	ND	ND	326	1560	ND	ND
Number of Samples	9	9	9	9	9	9	9	9	9	9	9	9
Lognormal Statistical Distribution												
Mean of ln value		4.393816							4.08026804	7.352441		
Standard Deviation of ln value		0.290403							1.46861268	#DIV/0!		
H (0.95)		1.946							4.422			
95 %UCL		103.11							1.73E+03	#DIV/0!		

Table 3-5D
Site Q
95 % UCL Groundwater Data Summary for Pesticides and PCBs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	Alpha-BHC	Beta-BHC	Delta-BHC	Lindane	Heptachlor	Aldrin	Heptachlor Epoxide	Endosulfan I	Dieldrin	4,4'-DDE	Endrin	Endosulfan II	4,4'-DDD	Endosulfan Sulfate
DC-GW-01														
DC-GW-02														
DC-GW-03														
DC-GW-04														
DC-GW-05														
DC-GW-06														
DC-GW-07														
DC-GW-08														
DC-GW-09														
Frequency of Detection	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9
Minimum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Number of Samples	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Lognormal Statistical Distribution														
Mean of ln value														
Standard Deviation of ln value														
H (0.95)														
95 % UCL														

All samples are presented in ug/kg = micrograms per kilogram (i.e. ppb) except metals.
Metal analysis are presented in mg/kg (i.e. ppm)
B= Compound detected in blank sample
E = Estimated value. Concentration detected exceeded the calibration range
J= Estimated value
ND = Not Detected
* = Duplicate analysis not within control limits
R = Spike sample recovery not within control limits
Metal analysis are presented in mg/kg (i.e. ppm)
No reporting limits were available for non-detect data

Table 3-5D
Site Q
95 % UCL Groundwater Data Summary for Pesticides and PCBs
Sauget Area 2 RI/FS Support Sampling Plan

Sample Identification Number	4,4'-DDT	Methoxychlor	Endrin Ketone	Chlordane	Toxaphene	Aroclor-1016	Aroclor-1221	Aroclor-1232	Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260
DC-GW-01												
DC-GW-02												
DC-GW-03												
DC-GW-04												
DC-GW-05												
DC-GW-06												
DC-GW-07												
DC-GW-08												
DC-GW-09												
Frequency of Detection	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9	0/9
Minimum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Number of Samples	9	9	9	9	9	9	9	9	9	9	9	9
Lognormal Statistical Distribution												
Mean of ln value												
Standard Deviation of ln value												
H (0.95)												
95 % UCL												

Table 3-11

Site R Groundwater Summary,

Shallow Hydrogeologic Unit

Table 1a: Historical Groundwater Data Summary for the UHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN	Number Detected	Total Samples	Percent Freq. Detection	Minimum Detection Limit	Maximum Detection Limit	Minimum Conc.	Maximum Conc. (a)	Mean Conc.	Standard Deviation	Maximum Detected Conc.	Normal 95% UCL (b)	Geometric Mean
VOCs (µg/L)													
1,1,1-Trichloroethane	71556	2	36	5.6	3.80E+0	7.60E+3	1.90E+0	3.80E+3	4.77E+2	8.91E+2	2.72E+3	7.21E+2	5.21E+1
1,1,2,2-Tetrachloroethane	79345	1	36	2.8	5.00E+0	1.40E+4	2.50E+0	7.00E+3	7.17E+2	1.48E+3	1.17E+2	1.12E+3	7.88E+1
1,1-Dichloroethane	75343	3	36	8.3	4.70E+0	9.40E+3	2.35E+0	4.70E+3	5.72E+2	1.07E+3	2.88E+3	8.66E+2	6.50E+1
1,1-Dichloroethene	75354	1	36	2.8	2.80E+0	5.60E+3	1.40E+0	2.80E+3	3.12E+2	5.94E+2	3.73E+2	4.75E+2	3.68E+1
1,2-Dichloroethane	107062	2	36	5.6	2.80E+0	5.60E+3	1.40E+0	1.65E+4	1.15E+3	3.53E+3	1.65E+4	2.11E+3	4.88E+1
2-Butanone	78933	1	10	10.0	1.00E+1	6.20E+3	5.00E+0	3.10E+3	6.34E+2	9.49E+2	6.20E+2	1.13E+3	1.73E+2
4-Methyl-2-pentanone	108101	2	13	15.4	1.00E+1	6.20E+3	5.00E+0	3.10E+3	4.85E+2	8.57E+2	2.06E+2	8.76E+2	1.04E+2
Acetone	67641	5	10	50.0	1.00E+1	2.00E+3	5.00E+0	6.90E+4	1.04E+4	2.15E+4	6.90E+4	2.16E+4	8.24E+2
Benzene	71432	21	36	58.3	4.40E+0	8.80E+3	2.20E+0	1.13E+4	1.27E+3	2.14E+3	1.13E+4	1.86E+3	2.36E+2
Bromoform	75252	1	36	2.8	4.70E+0	9.40E+3	2.35E+0	4.70E+3	4.96E+2	9.97E+2	6.23E+1	7.69E+2	5.70E+1
Chlorobenzene	108907	33	36	91.7	6.00E+0	6.00E+0	3.00E+0	1.58E+5	1.36E+4	2.96E+4	1.58E+5	2.17E+4	1.55E+3
Chloroethane	75003	1	36	2.8	1.00E+1	2.00E+4	5.00E+0	1.00E+4	1.05E+3	2.12E+3	2.00E+2	1.63E+3	1.21E+2
Chloroform	67663	3	36	8.3	1.60E+0	3.20E+3	8.00E-1	1.60E+3	2.00E+2	3.46E+2	4.62E+2	2.95E+2	2.60E+1
Methylene Chloride	75092	11	36	30.6	2.80E+0	5.60E+3	1.40E+0	2.24E+4	1.72E+3	4.91E+3	2.24E+4	3.07E+3	8.58E+1
Tetrachloroethene	127184	1	36	2.8	4.10E+0	8.20E+3	2.05E+0	4.10E+3	4.37E+2	8.70E+2	8.20E+1	6.75E+2	5.04E+1
Toluene	108883	8	36	22.2	5.00E+0	1.20E+4	2.50E+0	6.00E+3	7.73E+2	1.34E+3	3.62E+3	1.14E+3	1.04E+2
trans-1,2-Dichloroethene	156605	3	30	10.0	1.60E+0	3.20E+3	8.00E-1	1.13E+4	5.83E+2	2.06E+3	1.13E+4	1.20E+3	2.60E+1
Trichloroethene	79016	2	36	5.6	1.90E+0	3.80E+3	9.50E-1	4.61E+3	3.47E+2	8.35E+2	4.61E+3	5.76E+2	3.15E+1
Vinyl chloride	75014	2	36	5.6	1.00E+1	2.00E+4	5.00E+0	2.45E+4	1.76E+3	4.43E+3	2.45E+4	2.97E+3	1.43E+2
SVOCs (µg/L)													
1,2,4-Trichlorobenzene	120821	7	32	21.9	1.90E+0	2.00E+5	9.50E-1	1.00E+5	6.11E+3	1.98E+4	2.17E+3	1.19E+4	2.40E+1
1,2-Dichlorobenzene	95501	22	32	68.8	2.00E+0	2.00E+5	1.00E+0	1.00E+5	6.44E+3	1.97E+4	8.80E+3	1.22E+4	1.46E+2

Table 1a: Historical Groundwater Data Summary for the UHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN	Number Detected	Total Samples	Percent Freq. Detection	Minimum Detection Limit	Maximum Detection Limit	Minimum Conc.	Maximum Conc. (a)	Mean Conc.	Standard Deviation	Maximum Detected Conc.	Normal 95% UCL (b)	Geometric Mean
1,3-Dichlorobenzene	541731	4	32	12.5	1.90E+0	2.00E+5	9.50E-1	1.00E+5	6.04E+3	1.98E+4	8.68E+0	1.18E+4	1.72E+1
1,4-Dichlorobenzene	106467	19	32	59.4	4.40E+0	2.00E+5	2.20E+0	1.00E+5	6.27E+3	1.97E+4	1.58E+3	1.20E+4	1.79E+2
2,4,6-Trichlorophenol	88062	11	25	44.0	2.70E+0	2.00E+5	1.35E+0	1.00E+5	9.41E+3	2.22E+4	2.59E+4	1.67E+4	3.50E+2
2,4-Dichlorophenol	120832	14	25	56.0	2.70E+0	1.00E+5	1.35E+0	3.40E+5	2.86E+4	7.55E+4	3.40E+5	5.35E+4	5.23E+2
2,4-Dimethylphenol	105679	2	25	8.0	2.70E+0	2.00E+5	1.35E+0	1.00E+5	8.75E+3	2.32E+4	4.40E+4	1.64E+4	3.57E-1
2-Chloroaniline	95512	12	14	85.7	4.00E+4	1.00E+5	3.50E+1	3.00E+5	4.61E+4	8.07E+4	3.00E+5	8.16E+4	4.24E+3
2-Chloronaphthalene	91587	1	32	3.1	1.90E+0	2.00E+5	9.50E-1	1.00E+5	6.07E+3	1.98E+4	9.40E+2	1.18E+4	1.78E+1
2-Chlorophenol	95578	17	25	68.0	3.30E+0	2.00E+5	1.65E+0	5.40E+5	6.56E+4	1.59E+5	5.40E+5	1.18E+5	6.32E+2
2-Nitroaniline	88744	1	31	3.2	1.00E+1	1.00E+6	5.00E+0	5.00E+5	3.12E+4	1.00E+5	1.16E+3	6.08E+4	7.71E+1
2-Nitrochlorobenzene	88733	12	27	44.4	1.00E+1	4.00E+4	5.00E+0	3.40E+6	1.64E+5	6.52E+5	3.40E+6	3.70E+5	7.36E+2
3-Chloroaniline	108429	1	14	7.1	1.00E+1	2.00E+5	5.00E+0	1.00E+5	1.41E+4	2.85E+4	3.11E+3	2.66E+4	2.95E+2
3-Methylphenol	108394	2	8	25.0	1.00E+1	2.00E+5	5.00E+0	2.80E+5	8.28E+4	1.20E+5	2.80E+5	1.53E+5	2.41E+3
3-Nitrochlorobenzene	121733	5	11	45.5	1.00E+1	1.00E+5	5.00E+0	7.30E+5	9.52E+4	2.16E+5	7.30E+5	2.02E+5	1.37E+3
4-Chloro-3-methylphenol	59507	1	25	4.0	3.00E+0	2.00E+5	1.50E+0	1.00E+5	7.76E+3	2.22E+4	3.00E+0	1.51E+4	3.70E+1
4-Chloroaniline	106478	9	18	50.0	1.00E+1	4.00E+5	5.00E+0	2.00E+5	2.48E+4	5.04E+4	2.36E+4	4.43E+4	1.27E+3
4-Chlorophenol	106489	8	20	40.0	1.00E+1	2.00E+5	5.00E+0	2.10E+5	1.88E+4	5.02E+4	2.10E+5	3.73E+4	6.66E+2
4-Methylphenol	106445	1	4	25.0	1.00E+1	1.10E+2	5.00E+0	4.70E+4	1.18E+4	2.35E+4	4.70E+4	3.11E+4	8.97E+1
4-Nitroaniline	100016	3	31	9.7	1.00E+1	1.00E+6	5.00E+0	5.00E+5	3.12E+4	1.00E+5	6.22E+1	6.08E+4	9.01E+1
4-Nitrochlorobenzene	100005	11	27	40.7	1.00E+1	1.00E+5	5.00E+0	1.50E+6	6.71E+4	2.87E+5	1.50E+6	1.58E+5	4.87E+2
4-Nitrodiphenylamine	836306	3	19	15.8	1.00E+1	2.50E+3	5.00E+0	1.25E+3	1.63E+2	3.20E+2	6.27E+2	2.84E+2	2.50E+1
4-Nitrophenol	100027	5	25	20.0	2.40E+0	1.00E+6	1.20E+0	5.00E+5	3.86E+4	1.11E+5	1.30E+2	7.51E+4	1.02E+2
Aniline	62533	11	24	45.8	1.00E+1	4.00E+5	5.00E+0	2.00E+5	2.07E+4	4.54E+4	6.20E+4	3.60E+4	4.61E+2
Benzoic Acid	65850	2	4	50.0	1.00E+1	1.00E+1	5.00E+0	5.08E+4	1.31E+4	2.51E+4	5.08E+4	3.38E+4	2.16E+2
Benzyl alcohol	100516	2	5	40.0	1.00E+1	1.10E+1	5.00E+0	1.83E+3	4.03E+2	8.01E+2	1.83E+3	9.92E+2	3.43E+1
bis(2-Chloroethoxy)methane	111911	1	32	3.1	5.30E+0	2.00E+5	2.65E+0	1.00E+5	6.07E+3	1.98E+4	5.40E+0	1.18E+4	3.19E+1

Table 1a: Historical Groundwater Data Summary for the UHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN	Number Detected	Total Samples	Percent Freq. Detection	Minimum Detection Limit	Maximum Detection Limit	Minimum Conc.	Maximum Conc. (a)	Mean Conc.	Standard Deviation	Maximum Detected Conc.	Normal 95% UCL (b)	Geometric Mean
bis(2-Ethylhexyl)phthalate	117817	3	32	9.4	2.50E+0	2.00E+5	1.25E+0	1.00E+5	6.56E+3	1.98E+4	1.70E+4	1.23E+4	5.42E+1
Naphthalene	91203	4	32	12.5	1.60E+0	2.00E+5	8.00E-1	1.00E+5	8.12E+3	2.42E+4	8.60E+4	1.52E+4	1.63E+1
Nitrobenzene	98953	11	32	34.4	1.90E+0	2.00E+5	9.50E-1	1.00E+5	6.79E+3	1.97E+4	1.29E+4	1.25E+4	6.25E+1
Phenol	108952	18	25	72.0	1.50E+0	2.50E+2	7.50E-1	2.00E+6	2.23E+5	5.47E+5	2.00E+6	4.04E+5	1.69E+3

Footnotes:
All concentrations are in µg/L.
a) The maximum concentration is either one-half of an elevated detection limit or the maximum detected concentration.
b) The 95 percent upper confidence limit (UCL) assumes that data are normally distributed.

Table 1b: Summary of Chemicals not Detected in Groundwater from the UHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN
VOCs	
1,1,2-Trichloroethane	79005
1,2-Dichloropropane	78875
2-Chloroethyl Vinyl Ether	110758
2-Hexanone	591786
Acrolein	107028
Acrylonitrile	107131
Bis(chloromethyl)ether	542881
Bromodichloromethane	75274
Bromomethane	74839
Carbon disulfide	75150
Carbon tetrachloride	56235
Chloromethane	74873
cis-1,3-Dichloropropene	10061015
Dibromochloromethane	124481
Dichlorodifluoromethane	75718
Ethylbenzene	100414
Methyl Isoamyl Ketone	110123
m-Xylene	108383
o-Xylene	95476
Styrene	100425
Total 1,2-Dichloroethene	540590
trans-1,3-Dichloropropene	10061026
Trichlorofluoromethane	75694
Xylenes (total)	1330207
SVOCs	
1,2-Diphenylhydrazine	122667
2,4,5-Trichlorophenol	95954
2,4-Dinitrochlorobenzene	97007
2,4-Dinitrophenol	51285
2,4-Dinitrotoluene	121142
2,6-Dinitrotoluene	606202
2-Methylnaphthalene	91576
2-Methylphenol	95487
2-Nitrobiphenyl	86000
2-Nitrophenol	88755

Table 1b: Summary of Chemicals not Detected in Groundwater from the UHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN
3,3'-Dichlorobenzidine	91941
3,4-Dinitrochlorobenzene	610402
3-Nitroaniline	99092
4,6-Dinitro-2-methylphenol	534521
4-Bromophenyl-phenylether	101553
4-Chlorophenyl-phenylether	7005723
4-Nitrobiphenyl	92933
Acenaphthene	83329
Acenaphthylene	208968
Anthracene	120127
Benzidine	92875
Benzo[a]anthracene	56553
Benzo[a]pyrene	50328
Benzo[b]fluoranthene	205992
Benzo[g,h,i]perylene	191242
Benzo[k]fluoranthene	207089
bis(2-Chloroethyl)ether	111444
bis(2-chloroisopropyl)ether	108601
Butylbenzylphthalate	85687
Carbazole	86748
Chrysene	218019
Dibenzo[a,h]anthracene	53703
Dibenzofuran	132649
Diethylphthalate	84662
Dimethylphthalate	131113
Di-n-butylphthalate	84742
Di-n-octylphthalate	117840
Fluoranthene	206440
Fluorene	86737
Hexachlorobenzene	118741
Hexachlorobutadiene	87683
Hexachlorocyclopentadiene	77474
Hexachloroethane	67721
Indeno[1,2,3-cd]pyrene	193398
Isophorone	78591
n-Nitrosodimethylamine	62759
N-Nitroso-di-n-propylamine	621647

Table 1b: Summary of Chemicals not Detected in Groundwater from the UHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN
n-Nitrosodiphenylamine	86306
Pentachlorophenol	87865
Phenanthrene	85018
Pyrene	129000
Triphenylphosphate	115866

Footnotes:
A listing of chemicals that were routinely analyzed for in ground water but never detected above their respective sample quantitation limits (SQL)

Table 3-12

Site R Groundwater Summary,

Middle Hydrogeologic Unit

Table 2a: Historical Groundwater Data Summary for the MHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN	Number Detected	Total Samples	Percent Freq. Detection	Minimum Detection Limit	Maximum Detection Limit	Minimum Conc.	Maximum Conc. (a)	Mean Conc.	Standard Deviation	Maximum Detected Conc.	Normal 95% UCL (b)	Geometric Mean
VOCs (µg/L)													
1,1,1-Trichloroethane	71556	1	58	1.7	3.80E+0	1.90E+3	1.90E+0	9.50E+2	1.10E+2	1.78E+2	1.46E+2	1.48E+2	4.41E+1
1,1-Dichloroethane	75343	1	58	1.7	4.70E+0	2.40E+3	2.35E+0	1.20E+3	1.32E+2	2.20E+2	2.10E+2	1.80E+2	5.38E+1
1,1-Dichloroethene	75354	1	58	1.7	2.80E+0	1.40E+3	1.40E+0	7.00E+2	8.44E+1	1.35E+2	3.51E+1	1.14E+2	3.32E+1
1,2-Dichloroethane	107062	8	58	13.8	2.80E+0	1.40E+3	1.40E+0	9.20E+3	4.65E+2	1.66E+3	9.20E+3	8.24E+2	4.74E+1
4-Methyl-2-pentanone	108101	6	21	28.6	1.00E+1	5.00E+3	5.00E+0	3.10E+3	9.85E+2	1.05E+3	3.10E+3	1.36E+3	2.97E+2
Acetone	67641	6	9	66.7	1.20E+3	5.00E+3	2.29E+1	2.20E+4	4.77E+3	7.07E+3	2.20E+4	8.65E+3	1.09E+3
Benzene	71432	51	58	87.9	4.40E+0	5.00E+2	2.20E+0	9.98E+3	1.25E+3	1.85E+3	9.98E+3	1.65E+3	4.70E+2
Chlorobenzene	108907	58	58	100.0			1.93E+2	6.02E+4	5.38E+3	9.29E+3	6.02E+4	7.39E+3	2.59E+3
Chloroform	67663	1	58	1.7	1.60E+0	8.00E+2	8.00E-1	4.00E+2	5.86E+1	9.05E+1	1.21E+2	7.82E+1	2.07E+1
Chloromethane	74873	2	58	3.4	1.00E+1	5.00E+3	5.00E+0	2.50E+3	2.68E+2	4.59E+2	4.66E+2	3.67E+2	1.10E+2
Ethylbenzene	100414	2	58	3.4	7.20E+0	5.00E+3	3.60E+0	2.50E+3	2.01E+2	3.96E+2	1.37E+2	2.87E+2	7.69E+1
Methylene Chloride	75092	19	58	32.8	2.80E+0	1.40E+3	1.40E+0	2.26E+3	2.52E+2	3.89E+2	2.26E+3	3.36E+2	7.99E+1
m-Xylene	108383	2	14	14.3	1.00E+1	5.00E+3	5.00E+0	2.50E+3	4.42E+2	8.81E+2	1.73E+2	8.29E+2	8.76E+1
o-Xylene	95476	3	14	21.4	1.00E+1	5.00E+3	5.00E+0	2.50E+3	4.43E+2	8.80E+2	1.44E+2	8.30E+2	9.13E+1
Tetrachloroethene	127184	2	58	3.4	4.10E+0	2.10E+3	2.05E+0	1.05E+3	1.22E+2	1.96E+2	2.15E+2	1.64E+2	4.87E+1
Toluene	108883	26	58	44.8	6.00E+0	3.00E+3	3.00E+0	3.00E+3	4.41E+2	6.00E+2	3.00E+3	5.70E+2	1.35E+2
trans-1,2-Dichloroethene	156605	3	51	5.9	1.60E+0	8.00E+2	8.00E-1	6.09E+2	5.61E+1	1.12E+2	6.09E+2	8.20E+1	1.80E+1
Trichloroethene	79016	2	58	3.4	1.90E+0	1.00E+3	9.50E-1	5.00E+2	7.55E+1	1.17E+2	2.49E+2	1.01E+2	2.61E+1
Vinyl chloride	75014	1	58	1.7	1.00E+1	5.00E+3	5.00E+0	2.50E+3	2.89E+2	4.78E+2	1.29E+3	3.92E+2	1.14E+2
Xylenes (total)	1330207	2	7	28.6	2.50E+2	1.00E+3	1.25E+2	5.40E+2	4.18E+2	1.59E+2	5.40E+2	5.17E+2	3.78E+2
SVOCs (µg/L)													
1,2,4-Trichlorobenzene	120821	3	40	7.5	1.90E+0	5.00E+4	9.50E-1	2.50E+4	1.35E+3	4.43E+3	1.72E+2	2.50E+3	3.76E+1

Table 2a: Historical Groundwater Data Summary for the MHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN	Number Detected	Total Samples	Percent Freq. Detection	Minimum Detection Limit	Maximum Detection Limit	Minimum Conc.	Maximum Conc. (a)	Mean Conc.	Standard Deviation	Maximum Detected Conc.	Normal 95% UCL (b)	Geometric Mean
1,2-Dichlorobenzene	95501	21	40	52.5	1.90E+0	5.00E+4	9.50E-1	2.50E+4	2.29E+3	4.52E+3	6.77E+3	3.46E+3	2.09E+2
1,3-Dichlorobenzene	541731	3	40	7.5	1.90E+0	5.00E+4	9.50E-1	2.50E+4	1.33E+3	4.43E+3	1.80E+1	2.48E+3	3.55E+1
1,4-Dichlorobenzene	106467	25	40	62.5	4.40E+0	5.00E+4	2.20E+0	2.50E+4	1.57E+3	4.38E+3	8.88E+2	2.71E+3	2.92E+2
2,4,6-Trichlorophenol	88062	12	32	37.5	2.70E+0	5.00E+4	1.35E+0	2.50E+4	2.54E+3	5.43E+3	1.38E+4	4.12E+3	1.03E+2
2,4-Dichlorophenol	120832	19	32	59.4	2.70E+0	2.00E+3	1.35E+0	8.30E+4	1.17E+4	2.15E+4	8.30E+4	1.79E+4	3.39E+2
2,4-Dimethylphenol	105679	13	32	40.6	2.70E+0	5.00E+4	1.35E+0	2.50E+4	1.80E+3	4.89E+3	2.04E+3	3.22E+3	8.90E+1
2-Chloroaniline	95512	14	15	93.3	5.00E+4	5.00E+4	3.22E+3	3.29E+5	9.38E+4	1.01E+5	3.29E+5	1.37E+5	5.02E+4
2-Chlorophenol	95578	25	32	78.1	3.30E+0	2.00E+3	1.65E+0	1.60E+5	1.19E+4	2.98E+4	1.60E+5	2.08E+4	4.42E+2
2-Nitrochlorobenzene	88733	17	40	42.5	1.00E+1	5.00E+4	5.00E+0	4.63E+5	3.97E+4	9.01E+4	4.63E+5	6.31E+4	9.35E+2
3-Chloroaniline	108429	9	15	60.0	1.00E+1	5.00E+4	5.00E+0	5.72E+4	1.92E+4	1.66E+4	5.72E+4	2.62E+4	7.08E+3
3-Methylphenol	108394	2	6	33.3	2.00E+3	2.50E+4	1.00E+3	1.10E+5	2.76E+4	4.23E+4	1.10E+5	5.60E+4	8.85E+3
3-Nitrochlorobenzene	121733	6	11	54.5	1.00E+3	5.00E+4	5.00E+2	4.61E+5	9.05E+4	1.59E+5	4.61E+5	1.69E+5	9.26E+3
4-Chloroaniline	106478	13	18	72.2	1.00E+1	1.00E+5	5.00E+0	1.05E+5	3.94E+4	3.25E+4	1.05E+5	5.20E+4	1.23E+4
4-Chlorophenol	106489	19	31	61.3	1.00E+1	5.10E+3	5.00E+0	6.70E+4	1.04E+4	1.58E+4	6.70E+4	1.51E+4	8.56E+2
4-Nitrochlorobenzene	100005	15	40	37.5	1.00E+1	5.00E+4	5.00E+0	1.85E+5	2.10E+4	3.94E+4	1.85E+5	3.12E+4	7.85E+2
4-Nitrophenol	100027	1	32	3.1	2.40E+0	2.50E+5	1.20E+0	1.25E+5	7.87E+3	2.45E+4	2.40E+0	1.50E+4	4.18E+1
Aniline	62533	21	28	75.0	1.10E+1	1.00E+5	5.50E+0	6.85E+5	1.35E+5	1.93E+5	6.85E+5	1.94E+5	2.20E+4
bis(2-Ethylhexyl)phthalate	117817	1	40	2.5	1.00E+1	5.00E+4	5.00E+0	2.50E+4	1.55E+3	4.41E+3	1.15E+2	2.70E+3	1.26E+2
Chrysene	218019	1	40	2.5	2.50E+0	5.00E+4	1.25E+0	2.50E+4	1.34E+3	4.43E+3	3.77E+0	2.49E+3	3.84E+1
Fluoranthene	206440	1	40	2.5	2.20E+0	5.00E+4	1.10E+0	2.50E+4	1.33E+3	4.43E+3	6.58E+0	2.48E+3	3.48E+1
Naphthalene	91203	6	40	15.0	1.60E+0	5.00E+4	8.00E-1	2.50E+4	1.76E+3	5.05E+3	1.30E+4	3.08E+3	3.48E+1
Nitrobenzene	98953	10	40	25.0	1.90E+0	5.00E+4	9.50E-1	2.50E+4	2.03E+3	4.84E+3	1.40E+4	3.29E+3	6.88E+1
n-Nitrosodiphenylamine	86306	3	40	7.5	1.90E+0	5.00E+4	9.50E-1	2.50E+4	1.33E+3	4.43E+3	9.00E+0	2.48E+3	3.43E+1
Pentachlorophenol	87865	3	32	9.4	3.60E+0	2.50E+5	1.80E+0	1.25E+5	7.95E+3	2.45E+4	1.27E+3	1.51E+4	7.76E+1
Phenol	108952	26	32	81.3	1.50E+0	1.70E+0	7.50E-1	1.10E+6	7.49E+4	2.25E+5	1.10E+6	1.40E+5	1.11E+3

Table 2a: Historical Groundwater Data Summary for the MHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN	Number Detected	Total Samples	Percent Freq. Detection	Minimum Detection Limit	Maximum Detection Limit	Minimum Conc.	Maximum Conc. (a)	Mean Conc.	Standard Deviation	Maximum Detected Conc.	Normal 95% UCL (b)	Geometric Mean
Pyrene	129000	1	40	2.5	1.90E+0	5.00E+4	9.50E-1	2.50E+4	1.32E+3	4.44E+3	5.59E+0	2.47E+3	3.10E+1

Footnotes:
All concentrations are in µg/L.
a) The maximum concentration is either one-half of an elevated detection limit or the maximum detected concentration.
b) The 95 percent upper confidence limit (UCL) assumes that data are normally distributed.

Table 2b: Summary of Chemicals not Detected in Groundwater from the MHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN
VOCs	
1,1,2,2-Tetrachloroethane	79345
1,1,2-Trichloroethane	79005
1,2-Dichloropropane	78875
2-Butanone	78933
2-Chloroethyl Vinyl Ether	110758
2-Hexanone	591786
Acrolein	107028
Acrylonitrile	107131
Bis(chloromethyl)ether	542881
Bromodichloromethane	75274
Bromoform	75252
Bromomethane	74839
Carbon disulfide	75150
Carbon tetrachloride	56235
Chloroethane	75003
cis-1,3-Dichloropropene	10061015
Dibromochloromethane	124481
Dichlorodifluoromethane	75718
Methyl Isoamyl Ketone	110123
Styrene	100425
Total 1,2-Dichloroethene	540590
trans-1,3-Dichloropropene	10061026
Trichlorofluoromethane	75694
SVOCs	
1,2-Diphenylhydrazine	122667
2,3,7,8-Tetrachloro-dibenzo-p-di	1746016
2,4,5-Trichlorophenol	95954
2,4-Dinitrochlorobenzene	97007
2,4-Dinitrophenol	51285
2,4-Dinitrotoluene	121142
2,6-Dinitrotoluene	606202
2-Chloronaphthalene	91587
2-Methylnaphthalene	91576
2-Methylphenol	95487
2-Nitroaniline	88744

Table 2b: Summary of Chemicals not Detected in Groundwater from the MHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN
2-Nitrobiphenyl	86000
2-Nitrophenol	88755
3,3'-Dichlorobenzidine	91941
3,4-Dinitrochlorobenzene	610402
3-Nitroaniline	99092
4,6-Dinitro-2-methylphenol	534521
4-Bromophenyl-phenylether	101553
4-Chloro-3-methylphenol	59507
4-Chlorophenyl-phenylether	7005723
4-Methylphenol	106445
4-Nitroaniline	100016
4-Nitrobiphenyl	92933
4-Nitrodiphenylamine	836306
Acenaphthene	83329
Acenaphthylene	208968
Anthracene	120127
Benzidine	92875
Benzo[a]anthracene	56553
Benzo[a]pyrene	50328
Benzo[b]fluoranthene	205992
Benzo[g,h,i]perylene	191242
Benzo[k]fluoranthene	207089
Benzoic Acid	65850
Benzyl alcohol	100516
bis(2-Chloroethoxy)methane	111911
bis(2-Chloroethyl)ether	111444
bis(2-chloroisopropyl)ether	108601
Butylbenzylphthalate	85687
Carbazole	86748
Dibenzo[a,h]anthracene	53703
Dibenzofuran	132649
Diethylphthalate	84662
Dimethylphthalate	131113
Di-n-butylphthalate	84742
Di-n-octylphthalate	117840
Fluorene	86737
Hexachlorobenzene	118741

Table 2b: Summary of Chemicals not Detected in Groundwater from the MHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN
Hexachlorobutadiene	87683
Hexachlorocyclopentadiene	77474
Hexachloroethane	67721
Indeno[1,2,3-cd]pyrene	193398
Isophorone	78591
n-Nitrosodimethylamine	62759
N-Nitroso-di-n-propylamine	621647
Phenanthrene	85018
Triphenylphosphate	115866

Footnotes:
A listing of chemicals that were routinely analyzed for in ground water but never detected above their respective sample quantitation limits (SQL)

Table 3-13

Site R Groundwater Summary,

Deep Hydrogeologic Unit

Table 3a: Historical Groundwater Data Summary for the LHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN	Number Detected	Total Samples	Percent Freq. Detection	Minimum Detection Limit	Maximum Detection Limit	Minimum Conc.	Maximum Conc. (a)	Mean Conc.	Standard Deviation	Maximum Detected Conc.	Normal 95% UCL (b)	Geometric Mean
VOCs (µg/L)													
1,2-Dichloroethane	107062	8	50	16.0	2.80E+0	2.80E+2	1.40E+0	1.91E+3	1.90E+2	4.08E+2	1.91E+3	2.84E+2	4.83E+1
4-Methyl-2-pentanone	108101	5	34	14.7	2.50E+1	1.00E+3	1.25E+1	8.41E+2	2.71E+2	1.94E+2	8.41E+2	3.26E+2	1.98E+2
Acetone	67641	1	2	50.0	1.00E+3	1.00E+3	8.60E+1	5.00E+2	2.93E+2	2.93E+2	8.60E+1	6.34E+2	2.07E+2
Benzene	71432	26	50	52.0	4.40E+1	4.40E+2	6.60E+0	6.13E+2	2.40E+2	1.78E+2	6.13E+2	2.81E+2	1.73E+2
Chlorobenzene	108907	50	50	100.0			1.40E+2	7.38E+3	2.97E+3	1.61E+3	7.38E+3	3.34E+3	2.39E+3
Chloromethane	74873	1	50	2.0	1.00E+1	1.00E+3	5.00E+0	5.00E+2	1.75E+2	1.49E+2	4.66E+2	2.10E+2	1.05E+2
Ethylbenzene	100414	8	50	16.0	7.20E+0	1.00E+3	3.60E+0	5.00E+2	1.59E+2	1.17E+2	2.80E+2	1.86E+2	9.95E+1
Methylene Chloride	75092	16	50	32.0	2.80E+0	6.90E+2	1.40E+0	1.79E+3	1.58E+2	2.78E+2	1.79E+3	2.23E+2	5.82E+1
m-Xylene	108383	10	32	31.3	1.00E+2	1.00E+3	5.00E+1	9.62E+2	3.68E+2	2.72E+2	9.62E+2	4.47E+2	2.71E+2
o-Xylene	95476	8	31	25.8	1.00E+2	1.00E+3	5.00E+1	5.39E+2	2.80E+2	1.59E+2	5.39E+2	3.27E+2	2.29E+2
Tetrachloroethene	127184	7	50	14.0	4.10E+0	4.10E+2	2.05E+0	1.22E+3	1.05E+2	1.71E+2	1.22E+3	1.45E+2	5.64E+1
Toluene	108883	20	50	40.0	6.00E+0	6.00E+2	3.00E+0	2.07E+3	3.82E+2	4.88E+2	2.07E+3	4.96E+2	1.52E+2
trans-1,3-Dichloropropene	10061026	1	50	2.0	5.00E+0	1.00E+3	2.50E+0	7.20E+2	1.81E+2	1.63E+2	7.20E+2	2.19E+2	1.03E+2
Trichloroethene	79016	3	50	6.0	1.90E+0	1.00E+3	9.50E-1	5.00E+2	5.99E+1	8.40E+1	1.92E+2	7.95E+1	2.95E+1
Xylenes (total)	1330207	1	2	50.0	2.00E+2	2.00E+2	4.30E+1	1.00E+2	7.15E+1	4.03E+1	4.30E+1	1.18E+2	6.56E+1
SVOCs (µg/L)													
1,2,4-Trichlorobenzene	120821	8	44	18.2	1.90E+0	1.90E+3	9.50E-1	9.50E+2	1.10E+2	2.01E+2	1.38E+2	1.60E+2	3.92E+1
1,2-Dichlorobenzene	95501	42	44	95.5	2.00E+2	1.00E+3	6.00E+0	9.81E+3	2.14E+3	2.65E+3	9.81E+3	2.80E+3	7.76E+2
1,3-Dichlorobenzene	541731	6	44	13.6	1.90E+0	1.90E+3	9.50E-1	9.50E+2	9.91E+1	2.03E+2	1.74E+1	1.50E+2	3.19E+1
1,4-Dichlorobenzene	106467	23	44	52.3	4.40E+1	4.50E+3	2.20E+1	2.25E+3	3.15E+2	4.39E+2	4.56E+2	4.24E+2	2.04E+2
2,4,6-Trichlorophenol	88062	26	46	56.5	2.70E+0	2.80E+3	1.35E+0	3.03E+3	7.67E+2	7.82E+2	3.03E+3	9.57E+2	1.74E+2
2,4-Dichlorophenol	120832	29	46	63.0	2.70E+0	2.80E+3	1.35E+0	1.28E+4	3.10E+3	3.56E+3	1.28E+4	3.97E+3	4.94E+1

Table 3a: Historical Groundwater Data Summary for the LHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN	Number Detected	Total Samples	Percent Freq. Detection	Minimum Detection Limit	Maximum Detection Limit	Minimum Conc.	Maximum Conc. (a)	Mean Conc.	Standard Deviation	Maximum Detected Conc.	Normal 95% UCL (b)	Geometric Mean
2,4-Dimethylphenol	105679	19	46	41.3	2.70E+0	2.80E+3	1.35E+0	1.40E+3	1.75E+2	2.85E+2	5.63E+2	2.44E+2	6.49E+1
2-Chloroaniline	95512	11	12	91.7	5.00E+2	5.00E+2	2.50E+2	1.95E+5	5.11E+4	6.79E+4	1.95E+5	8.33E+4	1.52E+4
2-Chlorophenol	95578	29	46	63.0	3.30E+0	3.40E+3	1.65E+0	8.50E+3	1.66E+3	2.35E+3	8.50E+3	2.23E+3	2.80E+2
2-Nitroaniline	88744	1	46	2.2	1.00E+1	1.00E+4	5.00E+0	5.00E+3	5.02E+2	1.05E+3	2.19E+1	7.56E+2	1.28E+2
2-Nitrochlorobenzene	88733	34	46	73.9	1.00E+1	1.30E+3	5.00E+0	2.19E+5	5.26E+4	5.78E+4	2.19E+5	6.66E+4	5.42E+3
3,3'-Dichlorobenzidine	91941	1	44	2.3	1.67E+1	1.70E+4	8.35E+0	8.50E+3	7.53E+2	1.72E+3	4.70E+1	1.18E+3	1.96E+2
3-Chloroaniline	108429	10	12	83.3	1.00E+1	1.00E+3	5.00E+0	5.24E+4	1.76E+4	1.62E+4	5.24E+4	2.53E+4	6.18E+3
3-Nitrochlorobenzene	121733	4	8	50.0	1.00E+2	5.00E+2	5.00E+1	3.09E+4	6.41E+3	1.15E+4	3.09E+4	1.31E+4	8.38E+2
4-Chloroaniline	106478	10	12	83.3	4.00E+2	2.00E+3	2.00E+2	5.69E+4	2.27E+4	1.93E+4	5.69E+4	3.19E+4	1.13E+4
4-Chlorophenol	106489	25	50	50.0	1.00E+1	1.00E+4	5.00E+0	1.80E+4	3.18E+3	4.65E+3	1.80E+4	4.27E+3	4.18E+2
4-Nitroaniline	100016	1	46	2.2	1.00E+1	1.00E+4	5.00E+0	5.00E+3	5.04E+2	1.05E+3	1.26E+2	7.58E+2	1.34E+2
4-Nitrochlorobenzene	100005	33	46	71.7	1.00E+1	1.30E+3	5.00E+0	1.15E+5	2.41E+4	2.76E+4	1.15E+5	3.08E+4	3.12E+3
4-Nitrodiphenylamine	836306	2	44	4.5	1.00E+1	1.00E+4	5.00E+0	5.00E+3	4.53E+2	1.03E+3	1.07E+2	7.07E+2	1.20E+2
Aniline	62533	19	24	79.2	1.00E+3	1.00E+4	5.00E+2	4.80E+4	1.86E+4	1.68E+4	4.80E+4	2.42E+4	7.73E+3
Benzo[a]pyrene	50328	1	44	2.3	2.50E+0	2.60E+3	1.25E+0	1.30E+3	1.25E+2	2.67E+2	6.33E+0	1.92E+2	3.30E+1
Benzo[k]fluoranthene	207089	1	44	2.3	2.50E+0	2.60E+3	1.25E+0	1.30E+3	1.29E+2	2.68E+2	9.51E+0	1.96E+2	3.46E+1
bis(2-Chloroethyl)ether	111444	1	44	2.3	5.70E+0	5.80E+3	2.85E+0	2.90E+3	2.64E+2	5.91E+2	5.90E+0	4.10E+2	6.84E+1
bis(2-chloroisopropyl)ether	108601	1	44	2.3	5.70E+0	5.80E+3	2.85E+0	2.90E+3	2.64E+2	5.91E+2	5.90E+0	4.10E+2	6.84E+1
bis(2-Ethylhexyl)phthalate	117817	3	44	6.8	1.00E+1	1.00E+4	5.00E+0	5.00E+3	4.48E+2	1.03E+3	3.27E+1	7.02E+2	1.24E+2
Chrysene	218019	1	44	2.3	2.50E+0	2.60E+3	1.25E+0	1.30E+3	1.25E+2	2.67E+2	8.73E+0	1.92E+2	3.32E+1
Di-n-butylphthalate	84742	1	44	2.3	1.00E+1	1.00E+4	5.00E+0	5.00E+3	4.47E+2	1.03E+3	3.41E+1	7.01E+2	1.16E+2
Fluoranthene	206440	2	44	4.5	2.20E+0	2.20E+3	1.10E+0	1.10E+3	1.11E+2	2.33E+2	1.57E+1	1.69E+2	3.07E+1
Hexachlorocyclopentadiene	77474	1	44	2.3	1.00E+1	1.00E+4	5.00E+0	1.00E+4	5.60E+2	1.64E+3	1.00E+4	9.66E+2	1.19E+2
Naphthalene	91203	10	44	22.7	1.60E+0	1.60E+3	8.00E-1	8.00E+2	8.79E+1	1.74E+2	4.09E+1	1.31E+2	3.09E+1
Nitrobenzene	98953	15	44	34.1	1.90E+0	1.90E+3	9.50E-1	1.01E+3	1.96E+2	2.70E+2	1.01E+3	2.63E+2	5.16E+1

Table 3a: Historical Groundwater Data Summary for the LHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN	Number Detected	Total Samples	Percent Freq. Detection	Minimum Detection Limit	Maximum Detection Limit	Minimum Conc.	Maximum Conc. (a)	Mean Conc.	Standard Deviation	Maximum Detected Conc.	Normal 95% UCL (b)	Geometric Mean
n-Nitrosodiphenylamine	86306	1	44	2.3	1.90E+0	1.90E+3	9.50E-1	1.90E+3	1.20E+2	3.16E+2	1.90E+3	1.98E+2	2.52E+1
Pentachlorophenol	87865	6	46	13.0	3.60E+0	5.00E+3	1.80E+0	2.50E+3	2.09E+2	5.07E+2	1.16E+2	3.32E+2	4.05E+1
Phenol	108952	27	46	58.7	1.50E+0	1.50E+3	7.50E-1	3.30E+4	4.11E+3	7.93E+3	3.30E+4	6.03E+3	2.39E+2
Pyrene	129000	3	44	6.8	1.90E+0	1.90E+3	9.50E-1	9.50E+2	9.84E+1	2.04E+2	1.39E+1	1.49E+2	2.74E+1

Footnotes:
All concentrations are in µg/L.
a) The maximum concentration is either one-half of an elevated detection limit or the maximum detected concentration.
b) The 95 percent upper confidence limit (UCL) assumes that data are normally distributed.

Table 3b: Summary of Chemicals not Detected in Groundwater from the LHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN
VOCs	
1,1,1-Trichloroethane	71556
1,1,2,2-Tetrachloroethane	79345
1,1,2-Trichloroethane	79005
1,1-Dichloroethane	75343
1,1-Dichloroethene	75354
1,2-Dichloropropane	78875
2-Butanone	78933
2-Chloroethyl Vinyl Ether	110758
2-Hexanone	591786
Acrolein	107028
Acrylonitrile	107131
Bis(chloromethyl)ether	542881
Bromodichloromethane	75274
Bromoform	75252
Bromomethane	74839
Carbon disulfide	75150
Carbon tetrachloride	56235
Chloroethane	75003
Chloroform	67663
cis-1,3-Dichloropropene	10061015
Dibromochloromethane	124481
Dichlorodifluoromethane	75718
Methyl Isoamyl Ketone	110123
Styrene	100425
Total 1,2-Dichloroethene	540590
trans-1,2-Dichloroethene	156605
Trichlorofluoromethane	75694
Vinyl chloride	75014
SVOCs	
1,2-Diphenylhydrazine	122667
2,4,5-Trichlorophenol	95954
2,4-Dinitrochlorobenzene	97007
2,4-Dinitrophenol	51285
2,4-Dinitrotoluene	121142
2,6-Dinitrotoluene	606202

Table 3b: Summary of Chemicals not Detected in Groundwater from the LHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN
2-Chloronaphthalene	91587
2-Methylnaphthalene	91576
2-Methylphenol	95487
2-Nitrobiphenyl	86000
2-Nitrophenol	88755
3,4-Dinitrochlorobenzene	610402
3-Methylphenol	108394
3-Nitroaniline	99092
4,6-Dinitro-2-methylphenol	534521
4-Bromophenyl-phenylether	101553
4-Chloro-3-methylphenol	59507
4-Chlorophenyl-phenylether	7005723
4-Nitrobiphenyl	92933
4-Nitrophenol	100027
Acenaphthene	83329
Acenaphthylene	208968
Anthracene	120127
Benzidine	92875
Benzo[a]anthracene	56553
Benzo[b]fluoranthene	205992
Benzo[g,h,i]perylene	191242
bis(2-Chloroethoxy)methane	111911
Butylbenzylphthalate	85687
Carbazole	86748
Dibenzo[a,h]anthracene	53703
Dibenzofuran	132649
Diethylphthalate	84662
Dimethylphthalate	131113
Di-n-octylphthalate	117840
Fluorene	86737
Hexachlorobenzene	118741
Hexachlorobutadiene	87683
Hexachloroethane	67721
Indeno[1,2,3-cd]pyrene	193398
Isophorone	78591
n-Nitrosodimethylamine	62759
N-Nitroso-di-n-propylamine	621647

Table 3b: Summary of Chemicals not Detected in Groundwater from the LHU Zone Wells, Site R, Solutia Inc., W.G. Krummrich Plant, Sauget, IL

Analyte	CASRN
Phenanthrene	85018
Triphenylphosphate	115866

Footnotes:
A listing of chemicals that were routinely analyzed for in ground water but never detected above their respective sample quantitation limits (SQL)

Table 3-14

Summary of Benthic Macroinvertebrate Identification, ABRTF Effluent Plume (Advent, 1990)

TABLE 1. SUMMARY OF BENTHIC MACROINVERTEBRATE IDENTIFICATION

DISTANCE DOWNSTREAM (ft)	DISTANCE FROM LEW (ft)	ORGANISM IDENTIFICATION	NUMBER OBSERVED
10	159.5	CHIRONOMIDAE	1
10	159.5	OLIGOCHAETEA	1
20	99.5	OLIGOCHAETEA	1
40	108	PHYSIDAE	1
1550 (WING DAM)	250 – 300	TRICHOPTERA *(Hydropsyche orris or H. bidens)*	7

Table 3-15

Summary of Habitat Characteristics,

ABRTF Effluent Plume

(Advent, 1990)

TABLE 2. SUMMARY OF HABITAT CHARACTERISTICS OF THE MISSISSIPPI RIVER AT THE AMERICAN BOTTOMS OUTFALL AREA

DISTANCE DOWNSTREAM (ft)	DISTANCE FROM LEW (ft)	TOTAL WIDTH (ft)	TOTAL DEPTH (ft)	VELOCITY (ft/sec)	CLAY (%)	SILT (%)	VERY FINE SAND (%)	FINE SAND (%)	MEDIUM SAND (%)	COARSE SAND (%)	VERY COARSE SAND (%)	GRAVEL (%)	VEGETATION (%)	SUBMERGED LOGS (%)	OTHER PARTICULATE (COAL FINES)	OTHER PARTICULATE (GRAIN)
-140	30.0	1800	11.1	1.95	-	-	-	-	-	-	-	-	<1	<1	-	-
-140	130.0	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-
-140	170.0	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-
-5	199.5	1800	11.6	2.36	-	-	-	-	-	-	-	-	<1	<1	-	-
-3	136.5	1800	10.8	2.14	-	-	-	-	-	-	-	-	<1	<1	-	-
5	196.5	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-
10	97.5	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	X	X
10	136.5	1800	-	-	0.04	1.08	5.12	44.36	19.7	18.35	9.25	2.1	<1	<1	X	X
10	159.5	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-
10	173.0	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-
10	199.5	1800	-	-	0.06	0.49	3.77	44.29	23.08	16.82	8.27	2.62	<1	<1	X	X
15	195.5	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-
20	99.5	1800	-	-	1.21	11.83	27.93	37.36	4.63	2.94	4.36	9.74	<1	<1	X	X
20	136.5	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	X	X
20	160.0	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	X	-
20	196.5	1800	-	-	0.03	0.46	2.5	31.28	33.56	21.9	8.42	1.85	<1	<1	-	X
25	213.5	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	-	-
30	93.5	1800	-	-	0.53	7.78	23.39	50.9	8.6	4.13	1.62	3.05	<1	<1	-	-
30	147.5	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	X	X
30	195.5	1800	-	-	84.94	0.05	0.29	4.97	3.66	3.63	1.77	8.47	<1	<1	X	-
33	165.0	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	X	X
35	115.0	1800	11.4	1.63	-	-	-	-	-	-	-	-	<1	<1	-	-
35	142.5	1800	10.8	2.04	-	-	-	-	-	-	-	-	<1	<1	-	-
35	167.0	1800	10.7	2.30	-	-	-	-	-	-	-	-	<1	<1	-	-
35	198.5	1800	9.5	2.06	-	-	-	-	-	-	-	-	<1	<1	-	-
40	108.0	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	-	X
40	140.5	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	X	X
40	170.0	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	X	X
40	213.5	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	X	-
50	115.0	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	X	X
50	142.5	1800	-	-	-	-	-	-	-	-	-	-	<1	<1	X	X

TABLE 2. SUMMARY OF HABITAT CHARACTERISTICS OF THE MISSISSIPPI RIVER AT THE AMERICAN BOTTOMS OUTFALL AREA

DISTANCE DOWNSTREAM (ft)	DISTANCE FROM LEW (ft)	TOTAL WIDTH (ft)	TOTAL DEPTH (ft)	VELOCITY (ft/sec)	CLAY (%)	SILT (%)	VERY FINE SAND (%)	FINE SAND (%)	MEDIUM SAND (%)	COARSE SAND (%)	VERY COARSE SAND (%)	GRAVEL (%)	VEGETATION (%)	SUBMERGED LOGS (%)	OTHER PARTICULATE (COAL FINES)	OTHER PARTICULATE (GRAIN)
50	187.0	1800	-	-	-	-	-	-	-	-	-	-	< 1	< 1	X	X
50	192.5	1800	-	-	0	0.17	1.21	7.99	58.58	26.31	7.12	0.64	< 1	< 1	-	-
50	198.5	1800	-	-	0.06	0.65	2.66	20.99	12.75	16.19	24.18	22.52	< 1	< 1	X	-
85	75.0	1800	10.8	0.90	-	-	-	-	-	-	-	-	< 1	< 1	-	-
85	113.0	1800	10.5	1.90	-	-	-	-	-	-	-	-	< 1	< 1	-	-
85	141.0	1800	10.4	2.25	-	-	-	-	-	-	-	-	< 1	< 1	-	-
85	173.0	1800	10.2	2.32	-	-	-	-	-	-	-	-	< 1	< 1	-	-
100	75.0	1800	-	-	7.8	19.77	31.07	37.15	4.21	0	0	0	< 1	< 1	-	-
100	113.0	1800	-	-	-	-	-	-	-	-	-	-	< 1	< 1	X	X
100	141.0	1800	-	-	-	-	-	-	-	-	-	-	< 1	< 1	X	X
100	173.0	1800	-	-	0.04	0.67	4.05	38.8	23.25	22.15	9.26	1.82	< 1	< 1	X	X
150	30.0	1800	-	-	0.7	8.11	6.27	50.65	35.46	0.67	0.13	0.01	< 1	< 1	-	-
150	130.0	1800	-	-	0	0.59	4.77	49.95	24	15.16	5.63	0.4	< 1	< 1	-	-
150	170.0	1800	-	-	0.01	0.45	2.29	34.71	31.51	24.99	5.2	0.81	< 1	< 1	-	-
175	15.0	1800	3.0	0.81	3.9	18.46	18.09	59.41	0.14	0	0	0	< 1	< 1	-	-
175	130.0	1800	10.4	2.09	-	-	-	-	-	-	-	-	< 1	< 1	-	-
180	84.0	1800	9.4	1.47	-	-	-	-	-	-	-	-	< 1	< 1	-	-
185	172.0	1800	11.3	2.25	-	-	-	-	-	-	-	-	< 1	< 1	-	-
190	130.0	1800	-	-	-	-	-	-	-	-	-	-	< 1	< 1	X	X
200	84.0	1800	-	-	-	-	-	-	-	-	-	-	< 1	< 1	X	X
200	172.0	1800	-	-	-	-	-	-	-	-	-	-	< 1	< 1	X	X
460	20.0	1800	-	-	-	-	-	-	-	-	-	-	< 1	< 1	-	-
475	20.0	1800	4.4	2.25	1.59	20.43	31.91	45.6	0.33	0.02	0.05	0.07	< 1	< 1	-	-
475	80.0	1800	9.0	1.35	-	-	-	-	-	-	-	-	< 1	< 1	-	X
500	111.0	1800	9.0	1.90	-	-	-	-	-	-	-	-	< 1	< 1	-	-
520	178.0	1800	7.1	2.38	-	-	-	-	-	-	-	-	< 1	< 1	-	-
1000	25.0	1800	3.4	1.30	-	-	-	-	-	-	-	-	< 1	< 1	-	X
1020	86.0	1800	4.4	1.41	-	-	-	-	-	-	-	-	< 1	< 1	-	-
1020	130.0	1800	4.4	1.62	0.49	3.67	6.58	24.02	4.46	4.73	8.29	47.76	< 1	< 1	-	-
1500	67a	1800	2.5	0.63	-	-	-	-	-	-	-	-	< 1	WING DAM	-	-
1500	125a	1800	2.6	1.00	-	-	-	-	-	-	-	-	< 1	WING DAM	-	-

TABLE 2. SUMMARY OF HABITAT CHARACTERISTICS OF THE MISSISSIPPI RIVER AT THE AMERICAN BOTTOMS OUTFALL AREA

DISTANCE DOWNSTREAM (ft)	DISTANCE FROM LEW (ft)	TOTAL WIDTH (ft)	TOTAL DEPTH (ft)	VELOCITY (ft/sec)	CLAY (%)	SILT (%)	VERY FINE SAND (%)	FINE SAND (%)	MEDIUM SAND (%)	COARSE SAND (%)	VERY COARSE SAND (%)	GRAVEL (%)	VEGETATION (%)	SUBMERGED LOGS (%)	OTHER PARTICULATE (COAL FINES)	OTHER PARTICULATE (GRAIN)
1500	179a	1800	3.8	1.12	-	-	-	-	-	-	-	-	< 1	WING DAM	-	-
1600	250.0	1800	7.4	0.58	19.33	17.64	11.59	33.77	17.53	0.11	0.33	0	< 1	< 1	-	-
1600	375.0	1800	3.7	0.40	0.67	2.11	10.03	59.07	16.99	7.58	2.51	1.04	< 1	< 1	-	-

a – Distance from barge, which is 125ft from LEW

Table 3-16

Wing Dam Habitat Evaluation,

ABRTF Effluent Plume

(Advent, 1996)

TABLE 3-6. WING DAM HABITAT EVALUATION

Location	Average Velocity (ft/sec)	Total Depth (ft)	Substrate
Near Shore, fast water	1.80 (a)	0.5	cobble/gravel
Mid-channel, fast water	1.93 (b)	2.5	rip rap/sand
Wing dam side of riffle area	1.66 (c)	2.0	rip rap/sand cobble/gravel
Downstream side, center of wing dam	0.02 (d)	2.5	sand
Upstream side, center of wing dam	0.09 (e)	2.5	sand/rip rap
Center breaks River side of wing dam	2.62 (f)	2.5	sand/rip rap

NOTES:
Velocity measured at mid-depth.
(a) = Average of 1.90 and 1.70 ft/sec. at location a in Figure 2-2.
(b) = Average of 1.95 and 1.90 ft/sec. at location b in Figure 2-2.
(c) = One reading only at location c in Figure 2-2.
(d) = Average of 0.01 and 0.02 ft/sec. at location d in Figure 2-2.
(e) = One reading only at location e in Figure 2-2.
(f) = Average of 2.77 and 2.47 ft/sec. at location f in Figure 2-2.

Table 3-17

Particle Size Distribution of Sediments,

ABRTF Effluent Plume

(Advent, 1996)

TABLE 3-5. PARTICLE SIZE DISTRIBUTION OF SEDIMENTS COLLECTED AT TRANSECT SAMPLING SITES

Station	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	Water Velocity* (ft/sec)
S2000 at 300	0.75	99.17	0.09	0.00	1.60
S2000 at 150	0.00	93.57	3.33	3.10	0.12
S2000 at 30	18.01	37.00	35.43	9.60	0.06
S1900 at 300	4.84	93.24	1.10	0.83	1.07
S1900 at 150-A	0.01	84.25	10.94	4.80	0.00
S1900 at 150-B	0.01	84.05	11.13	4.80	0.00
S1900 at 150-C	0.01	79.58	15.61	4.80	0.00
S1900 at 30	1.39	38.85	50.26	9.50	0.00
S1800 at 300	41.55	58.35	0.10	0.00	0.81
S1800 at 150	0.00	95.81	2.90	1.29	0.04
S1800 at 30	0.00	80.06	10.93	9.01	0.16
S1700 at 300	100.00	0.00	0.00	0.00	0.59
S1700 at 150-A	4.32	91.56	4.13	0.00	0.04
S1700 at 150-B	4.32	91.72	3.97	0.00	0.04
S1700 at 150-C	4.32	92.01	3.67	0.00	0.04
S1700 at 30	3.51	89.41	4.80	2.28	0.00
S1600 at 300	100.00	0.00	0.00	0.00	1.27
S1600 at 150	47.17	51.30	0.95	0.58	0.16
S1600 at 30	0.00	95.47	3.46	1.07	0.00
S-100 at 300	0.54	98.28	1.18	0.00	1.50
S-100 at 150	0.98	96.80	1.02	1.20	1.65
S-100 at 30	0.35	96.78	2.42	0.45	0.70

* Water Velocity at 0.8 of Total Depth.

4.0 Previous Risk Assessments

4.1 Site R Human Health Risk Assessment

Dynamac Corporation's Fort Lee, New Jersey office and Geraghty & Miller's Bethpage, New York office prepared a Human Health Risk Assessment for Site R in July 1991 using data collected during an RI/FS required by an AOC with IEPA. The remainder of the text for this section has been drawn from this report.

Using data from prior site investigations, the Dynamac and Geraghty & Miller risk assessors identified 29 chemicals of potential concern (COPCs):

VOCs	SVOCs	Pesticides/PCBs	Metals
• Benzene	• Aniline	• alpha-BHC	• Antimony
• Chlorobenzene	• 4-Chloroaniline	• PCBs	• Arsenic
• 1,2-Dichloroethane			• Beryllium
• Dichloroethylene	• 1,2-Dichlorobenzene		• Boron
• Methyl Chloride	• Nitrobenzene		• Nickel
• Methylene Chloride	• 2-Nitrochlorobenzene		• Thallium
• Tetrachloroethylene			• Cyanide
• Vinyl Chloride	• Phenol		
	• 2-Chlorophenol		
	• 2,4-Dichlorophenol		
	• 2,4,6-Trichlorophenol		
	• Pentachlorophenol		
	• 2,4-Dimethylphenol		
	• Napthalene		

Potential exposure pathways are summarized below:

Potential Exposure Pathway	Chemical Source	Potential Exposure Scenario	Potential Receptors
Direct Contact	Clay Cap	Dermal Contact with and Incidental Ingestion of Soil	On-Site Maintenance Workers

Potential Exposure Pathway	Chemical Source	Potential Exposure Scenario	Potential Receptors
Air	Clay Cap	Inhalation of VOCs and Dust	On-Site Maintenance Workers
Surface Water	Groundwater Discharge to Surface Water	Dermal Contact with and Ingestion of River Sediments Fish Ingestion	Trespassing Users of Mississippi River Commercial and Recreational Users of Mississippi River

Potential risks due to direct contact and subsequent ingestion or dermal adsorption of constituents in, or adjacent to, landfilled materials were considered low because:

- The site is located in an exclusively industrial area and is fenced and patrolled by security personnel effectively eliminating the potential for residential exposure;
- Workers are the only likely receptors to be present at the site and they would be present for limited periods of time to implement remedial actions or complete maintenance activities;
- A 2 to 6 ft thick, intact, highly-vegetated clay cover prevented direct contact with landfill contents; and
- Use of appropriate health and safety measures would limit worker exposures.

Potential risks due to direct contact with surface water were considered low because:

- Swimming does not occur locally due to the highly urbanized and industrialized nature of the Sauget area;
- Chemical concentrations are likely to be low because of high dilution; and
- Exposure while fishing or boating would only be associated with incidental splash that is typically transient in nature and results in limited skin contact.

Potential risks due to inhalation of wind-blown dust from the landfill surface or entrained in the atmosphere by vehicular traffic associated with on-site remedial activities were considered low because:

- A thick clay cap covered the landfill;
- The cap was in good condition;
- Heavy vegetative cover on the cap would significantly limit dust emissions;
- With a depth to water averaging 12 ft, most excavated materials would be wet and not prone to dispersal by wind entrainment;
- Potentially-significant receptors were probably limited to on-site remediation workers with short term exposures; and
- Construction of a slurry wall and installation of a pump and treat system, the most likely remediation scenario, would not be likely to generate significant quantities of air-borne dust.

Potential risks due to inhalation of volatile organics from the landfill were considered low because:

- Remediation workers were the only potentially significant receptors;
- Escape of volatiles was limited by the vegetated, clay cap; and
- Most remediation activities would occur adjacent to but not in the landfill, thereby leaving the materials with the highest concentration of volatile chemicals undisturbed.

Potential risks due to ingestion of biota were considered significant because:

- Groundwater discharge from the landfill released an estimated 77 pounds per day of organic chemicals into the Mississippi River;
- Fish could accumulate at least one of the organic chemicals (chlorinated nitrobenzene) identified in Site R groundwater; and
- Commercial fishing was known to occur in the Mississippi River and recreational fishing was believed to occur.

Potential risks flora and fauna were considered significant because:

- Groundwater discharge from the landfill released an estimated 77 pounds per day of organic chemicals into the Mississippi River; and
- The Mississippi River was an active ecosystem.

Potential carcinogenic risks associated with realistic exposure scenarios for identified receptor groups indicated that the potential excess cancer risks for on-site workers and area residents consuming fish were less than 2.7×10^{-7} for all pathways combined. Even under worst-case exposure assumptions, the estimated excess lifetime carcinogenic risk for all pathways combined was 5.7×10^{-6}. Risk assessment results for the exposure pathways are summarized below:

Pathway	Worst-Case Exposures		Average-Case Exposures	
	On-Site Worker	Local Resident	On-Site Worker	Local Resident
Dermal Contact				
Surface Materials	4.5×10^{-7}	NA (1	6.2×10^{-8}	NA (1
Surface Water				
Adult	NA	1.3×10^{-6}	NA	NA
Child	NA	7.6×10^{-7}	NA	NA
Total	NA	2.1×10^{-6}	NA	NA
Incidental Ingestion				
Surface Materials	8.9×10^{-7}	NA	1.2×10^{-7}	NA
Surface Water				
Adult	NA	3.4×10^{-9}		
Child	NA	8.1×10^{-9}		
Total	NA	1.2×10^{-8}		
Inhalation				
Volatile Organics	9.5×10^{-7}	NA	1.1×10^{-8}	NA
Fish Ingestion				
Adult	NA	8.7×10^{-7}	NA	5.2×10^{-8}
Child	NA	4.9×10^{-7}	NA	2.9×10^{-8}
Total	NA	1.4×10^{-6}	NA	8.1×10^{-8}
Total	**2.3×10^{-6}**	**3.4×10^{-6}**	**1.9×10^{-7}**	**8.1×10^{-8}**
Overall Total (2	**5.7×10^{-6}**		**2.7×10^{-7}**	

Notes:

1) Not applicable, pathway not available to this receptor group.
2) Conservatively assumes that a receptor will be exposed via all pathways.

With respect to noncarcinogenic hazards, the analysis indicated that the hazard indices for all receptor groups and pathways combined were less than one for realistic exposure scenarios. Under worst-case assumptions, the combined hazard index was also less than one. Nitrobenzene and chloroaniline were the risk drivers. Risk assessment results for the exposure pathways are summarized below:

Pathway	Worst-Case Exposures		Average-Case Exposures	
	On-Site Worker	Local Resident	On-Site Worker	Local Resident
Dermal Contact				
Surface Materials	6.2×10^{-4}	NA (1	3.1×10^{-4}	NA (1
Surface Water				
Adult	NA	6.1×10^{-2}	NA	NA
Child	NA	2.2×10^{-1}	NA	NA
Incidental Ingestion				
Surface Materials	2.2×10^{-3}	NA	1.1×10^{-3}	NA
Surface Water				
Adult	NA	1.7×10^{-4}		
Child	NA	2.3×10^{-3}		
Inhalation				
Volatile Organics	5.0×10^{-3}	NA	2.1×10^{-4}	NA
Fish Ingestion				
Adult	NA	5.4×10^{-2}	NA	3.0×10^{-3}
Child	NA	1.7×10^{-1}	NA	1.0×10^{-2}
Total Adult	**7.9×10^{-3}**	**1.1×10^{-1}**	**1.6×10^{-3}**	**3.0×10^{-3}**
Total Child	**NA**	**3.9×10^{-1}**	**NA**	**1.0×10^{-2}**
Overall Total (2	**5.1×10^{-1}**		**1.5×10^{-2}**	

Notes:

1) Not applicable, pathway not available to this receptor group.
2) Conservatively assumes that a receptor will be exposed via all pathways.

Potential hazards to terrestrial biota were evaluated qualitatively. Due to the poor habitat available to support terrestrial wildlife, the presence of a clay cap on the landfill and the highly industrialized nature of the study area, potential terrestrial-wildlife exposures were likely to be limited. Consequently, risks to terrestrial organisms were likely to be limited.

Potential risks to aquatic organisms associated with groundwater releases to surface water were assessed quantitatively. This was done through acute toxicity bioassays for five species exposed to groundwater collected from three perimeter wells. Chronic toxicity bioassays were done for the most sensitive species tested. Bioassay results were used to derive a no observed effects concentration (NOEC) for site groundwater. This data, coupled with data on groundwater and surface-water flow rates, was used to derive an aquatic hazard index as a theoretical estimate of the potential hazards to aquatic organisms. Utilizing a safety factor of 10, the aquatic hazard index was found to equal 4.4 under average river flow conditions with no assumption for attenuation of toxicity with downstream distance or losses of toxic chemicals due to volatilization, adsorption, etc. For a 7Q10 river flow, the aquatic hazard index was 17.1.

Aquatic hazard index values greater than one suggested that, within the limitations of the methodology used to derive this number, potential impacts to aquatic life associated with groundwater discharge to the river could not be ruled out. Two conservative assumptions were used in calculating these results:

- Application of a ten-fold safety factor to provide a margin of safety for more sensitive species than those used in the groundwater bioassays; and
- Use of a simple dilution model to estimate constituent concentrations in surface water.

Although the data indicate that groundwater flowing into the river could have a potential impact on aquatic organisms, actual impacts were unknown. Testing of river water downstream of the American Bottoms Regional Treatment Facility outfall indicated that aquatic toxicity could not be measured using standard bioassay techniques in samples of river water collected immediately adjacent to the landfill.

Acute toxicity studies of river water samples collected near the landfill suggested that attenuation of toxicity was likely to be rapid.

4.2 Site R Ecological Risk Assessment

Environmental Science and Engineering's Amherst, New Hampshire office completed an ecological risk assessment for Site R in May 1995. The purpose of this risk assessment was to evaluate the potential for any adverse effects that constituents from the site might have on downstream ecological receptors within or depended upon the Mississippi River.

A reconnaissance of the site and surrounding area was performed on May 6, 1994. With the exception of a few trees, no natural (undisturbed) habitat appeared to remain on the site nor were any jurisdictional wetlands present. Birds were the only animals identified on site at the time of the visit. From the standpoint of terrestrial ecology, it was determined that all of the following factors precluded inclusion of a terrestrial component in the Ecological Risk Assessment:

- Presence of at least two feet of clean cap material;
- Lack of food and/or sparse vegetative cover;
- Low probability for recruitment of terrestrial species from surrounding areas; and
- Disturbed nature of the available habitat.

As a natural resource, the Mississippi River was considered very important.. However, the urban environment between Sauget and St. Louis and the physical (e.g. docks, barges and transfer stations) and the chemical (e.g. the ABRTF outfall) disturbances in the river could lead to defining this reach as a stressed ecosystem. Rip-rap along the western edge of the site provided shoreline stability but less than adequate riparian habitat for wetland-dependent birds or mammals. Organic chemicals in groundwater and the potential for migration to the Mississippi River presented an exposure pathway and potential risk to aquatic biota. This potential migration pathway and risk were the focus of the Ecological Risk Assessment. Only impacts to aquatic receptors that were directly or indirectly dependent on the river were considered in this assessment. Aquatic biota residing within or dependent on the Mississippi River downstream of Site R were considered the ecosystem at risk for this risk assessment.

With the exception of three constituents (Napthalene, 4-nitrodiphenylamine and 2,4-D), SVOCs observed in soil and groundwater at Site R were reported to consist primarily of four classes of compounds: Anilines, Chlorobenzenes, Phenols and Nitroaromatics. Anilines had the greatest reported mean concentration (82,000 to 100,000 ppb), followed by Nitroaromatics (31,000 to

75,000 ppb), Phenols (1,000 to 50,000 ppb) and Chlorobenzenes (100 to 3,000 ppb). Some of these constituents were considered to have the potential to cause adverse acute and/or chronic effects in fish and other aquatic biota. The central question of the risk assessment was, "Do the concentrations of individual COPCs in the Mississippi River predicted by the groundwater flow model meet or exceed currently available criteria, standards, or toxicity endpoints for surface water and sediment?"

Groundwater modeling indicated that predicted concentrations of VOCs in surface water were well below 1 ppb. Since AWQC for the VOCs found at Site R were greater than 50 ppb, VOCs were eliminated as constituents of concern. For the remaining constituents found at the site, only compounds that could be adequately modeled were included in the risk assessment. In addition, only compounds with a detection frequency greater than 5 percent and a concentration greater than 1 ppm were included as COPCs. Constituents with concentrations less than one ppm were eliminated because they would have a concentration well below instrument detection limits when groundwater mixed with surface water. PAHs, phthalate esters, ethers and cresols were eliminated on that basis. Other constituents eliminated from consideration because they did not meet selection criteria were Benzidine; Benzyl Alcohol; 1,3-Dichlorobenzene; 3,3-Dichlorobenzidine; 2,4-Dinitrotoluene; Hexachlorocyclopentadiene; Isophorone; 2-Methylphenol; n-Nitrosodiphenylamine; and Triphenylphosphate.

Metals were eliminated from consideration because the measured groundwater concentrations, when compared to the range of instrument detection limits, was less than a factor of three. In addition, most metal concentrations in groundwater were below levels expected for a highly industrialized area.

Although PCBs have a strong potential to bioaccumulate, they were eliminated from consideration because they were detected in less than 2 percent of the samples and, when detected, concentrations were less than 1 ppb. Of the pesticides, only 2,4-D met the criteria for inclusion in the risk assessment.

To estimate surface water concentration that fish or wildlife might be exposed to, the average surface-water exposure concentration of a constituent was determined by dividing the average groundwater loading rate to the river by the river's average daily flow. To estimate the

constituent concentrations in suspended sediment, the average daily groundwater-load was evenly distributed in the average daily, suspended-sediment load of the river. Mean suspended sediment concentrations were determined by dividing the mean groundwater-loading rate by the mean daily discharge of suspended sediment to yield a bulk suspended sediment concentration.

Hazard Indices were calculated for each COPC in surface water by dividing the modeled exposure concentration in surface water by the respective AWQC or NOEL/LOEC. Hazard indices were calculated for each COPC in sediment by dividing the modeled exposure concentration in sediment by the respective Sediment Quality Value (SQV). SQVs were calculated by multiplying the Koc times the AWQC. The bulk (suspended) SQV was then derived by multiplying this value by the percentage of organic carbon assumed to be present in the sediment.

The results of these calculations are summarized below:

Constituent of Potential Concern	Hazard Indices	
	Surface Water	Sediments
Anilines		
Aniline	2.87E-02	1.07E-01
2-Chloroaniline	4.06E-03	1.51-E03
3-Choroaniline	1.02E-02	3.99E-03
4-Chloroaniline	2.62E-02	1.15E-02
2-Nitroaniline	4.78E-08	5.12E-08
4-Nitroaniline	1.30E-08	6.72E-09
Phenols		
Phenol	2.37E-05	2.43E-05
2-Chlorophenol	3.20E-07	6.70E-09
4-Chlorophenol	3.70E-08	1.38E-09
2,4-Dichlorophenol	4.64E-08	3.61E-09
2,4,6-Triclorophenol	5.22E-06	1.73-E06
Pentachlorophenol	8.69E-06	4.87E-09
4-Methylphenol	1.38E-05	4.93E-06
2,4-Dimethyphenol	1.78E-06	1.24E-07
4-Nitrophenol	1.62E-10	2.28E-10
Chlorobenzenes		
1,2-Dichlorobenzene	4.30E-04	7.50E-06
1,4-Diclorobenzene	1.96E-05	3.42E-07
1,2,4-Trichlorobenzene	1.43E-06	4.61E-09

Constituent of Potential Concern	Hazard Indices	
	Surface Water	Sediments
Nitroaromatics		
Nitrobenzene	6.64E-06	5.45E-06
2-Nitrochlorobenzene	7.60E-05	1.29E-05
3-Nitrochlorobenzene	5.71E-04	6.57E-05
4-Nitroclorobenzene	5.14E-04	6.20E-05
Others		
Napthalene	6.06E-06	6.36E-08
4-Nitrodiphenylamine	NC	NC
2,4-D	9.71E-04	4.46E-05

Hazard Indices were not be calculated for 4-Nitrodiphenylamine because AWQC or NOEL/LOEC values were not available for this constituent.

All of the conservatively derived Hazard Indices for surface water and sediment were below 1.0. Therefore, the COPCs associated with Site R posed no apparent threat to aquatic biota.

In the uncertainty analysis, ES&E stated that:

> "Realistically, concentrations of COPCs in the Mississippi River would be expected to be higher in surface water and sediment near the landfill as this assessment assumed "immediate" mixing across the river. However, a mixing zone study conducted for the American Bottoms Regional Wastewater Treatment Facility in Sauget indicated that mixing for a point source would be vertically complete approximately 1000 feet downstream of the discharge. As the discharge from the Site R landfill is a diffuse source, the mixing would be more efficient, and any putative impacts to biota would be very localized."

Section 5

5.0 Data Gap Analysis

The AOC requires the SSP to include an analysis of the currently available data to determine those Sites that require additional data in order to define the extent of contamination for purposes of implementing a remedial action. A description of the number, types, and locations of additional samples to be collected shall be included in this section of the sampling plan.

Soils and Sediments Investigation - Respondents shall include a program to determine the extent of contamination of surface and subsurface soils at the Sites. The plan shall also determine the extent, including depth, of contamination of sediments in the Mississippi River. Samples of any leachate from the areas described as fill shall also be collected.

Surface Water Investigation - Respondents shall include a program to determine the areas of surface water contamination in the Mississippi River.

The November 24, 2000 Administrative Order on Consent Scope of Work identified the site characterization information needed to define the extent of contamination at Sauget Area 2 and prepare a Remedial Investigation/Feasibility Study. In addition, an analysis of currently available data was performed to determine the areas of the Sites that required characterization in order to prepare a Remedial Investigation/Feasibility Study that reflects current conditions at the Sites.

Identified data gaps are discussed in the following sections:

Section 5.1	Waste, Soil and Stormwater
Section 5.2	Groundwater
Section 5.3	Surface Water, Sediment and Biota
Section 5.4	Air
Section 5.5	Treatability Tests

Section 5.6 discusses the number and type of samples that will be collected to address identified data gaps. Section 6.0, Section 7.0, Section 8.0 and Section 9.0 describe, in detail, the number, type and location of the additional samples that will be collected as part of this

SSP. This characterization data will be used to prepare the Sauget Area 2 Human Health Risk Assessment, the Ecological Risk Assessment and the Remedial Investigation/Feasibility Study.

5.1 Waste, Soil and Stormwater

The AOC requires the SSP include a program for characterizing the waste materials at the Sites. This is to include an analysis of current information/data on past disposal practices at the Sites. For buried wastes, test pits/trenches and deep soil borings are required to determine waste depths and volume and to determine the extent of cover over fill areas. Soil gas surveys are also required for the areas on and around fill areas of the Sites. Geophysical characterization methods, such as ground penetrating radar or magnetometry, to further delineate potential "area of elevated concentration" drum removal areas are also to be included.

In addition, the SSP is to include a program to determine the extent of contamination of surface and subsurface soils at the Sites and collect samples of any leachate from the areas described as fill.

These AOC requirements will be met by collecting information to the address the following data gaps which were identified after a review of existing waste, soil and stormwater data:

Waste

- Waste Depth
- Waste Volume
- Drum "Area of Elevated Concentrations" (Magnetic Highs)
- Waste Chemical Characterization (TCLP Extracts)
- Leachate Chemical Characterization

Soil

- Extent of Cover
- Type of Cover
- Soil Gas Chemical Characterization (Total VOCs)
- Surface Soil Chemical Characterization
- Subsurface Soil Chemical Characterization

Stormwater

- Primary Discharge Routes
- Stormwater Chemical Characterization

5.2 Groundwater

The AOC requires that the SSP address the degree of hazard, the mobility of pollutants, discharge/recharge areas, regional and local flow direction and quality and local uses of groundwater. The plan is also to provide a strategy for determining horizontal and vertical distribution of contaminants and may include other hydraulic tests such as slug tests, and grain size analysis to assist in determining future potential remediation options. Upgradient samples are also to be included in the plan.

These AOC requirements will be met by collecting information to the address the following data gaps which were identified after a review of existing groundwater data:

Analytical Characterization

- Horizontal Distribution of Constituents
- Vertical Distribution of Constituents
- Upgradient Groundwater Quality

Groundwater Flow Direction

- Horizontal Groundwater Flow Direction
- Vertical Groundwater Flow Direction

Aquifer Characteristics

- Physical Properties (Grain Size, TOC, etc.)
- Hydraulic Conductivity (Permeability, Porosity)

5.3 Surface Water, Sediment and Biota

The AOC requires the SSP to include a program to determine the extent of contamination of surface and subsurface soils at the Sites. The plan is also to include means to determine the extent, including depth, of contamination of sediments in the Mississippi River. It is also to

include a program to determine the areas of surface water contamination in the Mississippi River.

In addition, the SSP requires a plan for collecting data for the purpose of assessing the impact, if any, to aquatic and terrestrial ecosystems within and adjacent to Sauget Area 2, including within the Mississippi River. The plan is required to include a description of the ecosystems affected, an evaluation of toxicity, an assessment of endpoint organisms, and the identification of exposure pathways. It is also to include a description of any toxicity testing or trapping to be included as part of the assessment.

These AOC requirements will be met by collecting information to the address the following data gaps which were identified after a review of existing surface water, sediment and biota data:

Surface Water

- Plume Discharge Area Chemical Characterization
- Upstream Chemical Characterization
- Downstream Chemical Characterization
- Toxicity Testing

Sediments

- Plume Discharge Area Chemical Characterization
- Upstream Chemical Characterization
- Downstream Chemical Characterization
- Toxicity Testing

Benthic Community

- Habitat Assessment
- Benthic Community Structure Evaluation

Aquatic Biota

- Habitat Assessment
- Whole Body Fish Tissue Chemical Characterization
- Fish Fillet Chemical Characterization

Terrestrial Biota

- Habitat Assessment
- Plant Tissue Chemical Characterization
- Earthworm Tissue Chemical Characterization

5.4 Air

The AOC requires the SSP to include a program to determine the extent of atmospheric contamination from the various source areas at the Sites. The program is to address the tendency of the substances identified through the waste characterization (i.e., PCBs) to enter the atmosphere, local wind patterns, and the degree of hazard.

These AOC requirements will be met by collecting information to the address the following data gaps that were identified after a review of existing air data:

Source Areas

- Upwind Chemical Characterization
- Downwind Chemical Characterization

5.5 Treatability Tests

The AOC requires the SSP to "include a program for any pilot test(s) necessary to determine the implementability and effectiveness of technologies where sufficient information is not otherwise available." Data gaps identified after a review of existing treatability test data are listed below:

Waste

- Off-Site Incineration
- Off-Site Disposal
- On-Site Thermal Desorption

Leachate

- On-Site Physical/Chemical Treatment
- Off-Site Physical/Chemical Treatment
- Off-Site Biological Treatment

5.6 Sample Number, Type and Location

The number and types of samples that will be collected to fill the identified data gaps are summarized below:

	Number of Samples							
Sample Type	**VOCs 8260B**	**SVOCs 8270C**	**Pest. 8081A**	**Herb. 8151A**	**PCBs 680**	**Dioxin 8280**	**Dioxin 8290**	**Metals 6010B**
Waste	50	50	50	50	50	50	0	50
Leachate	7	7	7	7	7	7	0	7
Soil	60	60	60	60	60	60	0	60
Groundwater	292	292	94	94	94	0	30	94
Surface Water	51	51	51	51	51	0	39	51
Sediment	51	51	51	51	51	39	0	51
Air	16	16	16	0	16	0	16	16
Stormwater	9	9	9	9	9	0	9	9
Fish Tissue	0	60	60	60	60	0	20	60
Earthworm Tissue	0	24	24	24	24	0	24	24
Plant Tissue	0	24	24	24	24	0	24	24
Total Number of Samples	536	644	446	430	446	156	162	446

Detailed descriptions of sample number, type and location are included in the following sections of the SSP:

Section 6.0 Waste, Soil and Stormwater Sampling Plan
Section 7.0 Groundwater Sampling Plan
Section 8.0 Surface Water, Sediment and Biota Sampling Plan
Section 9.0 Air Sampling Plan

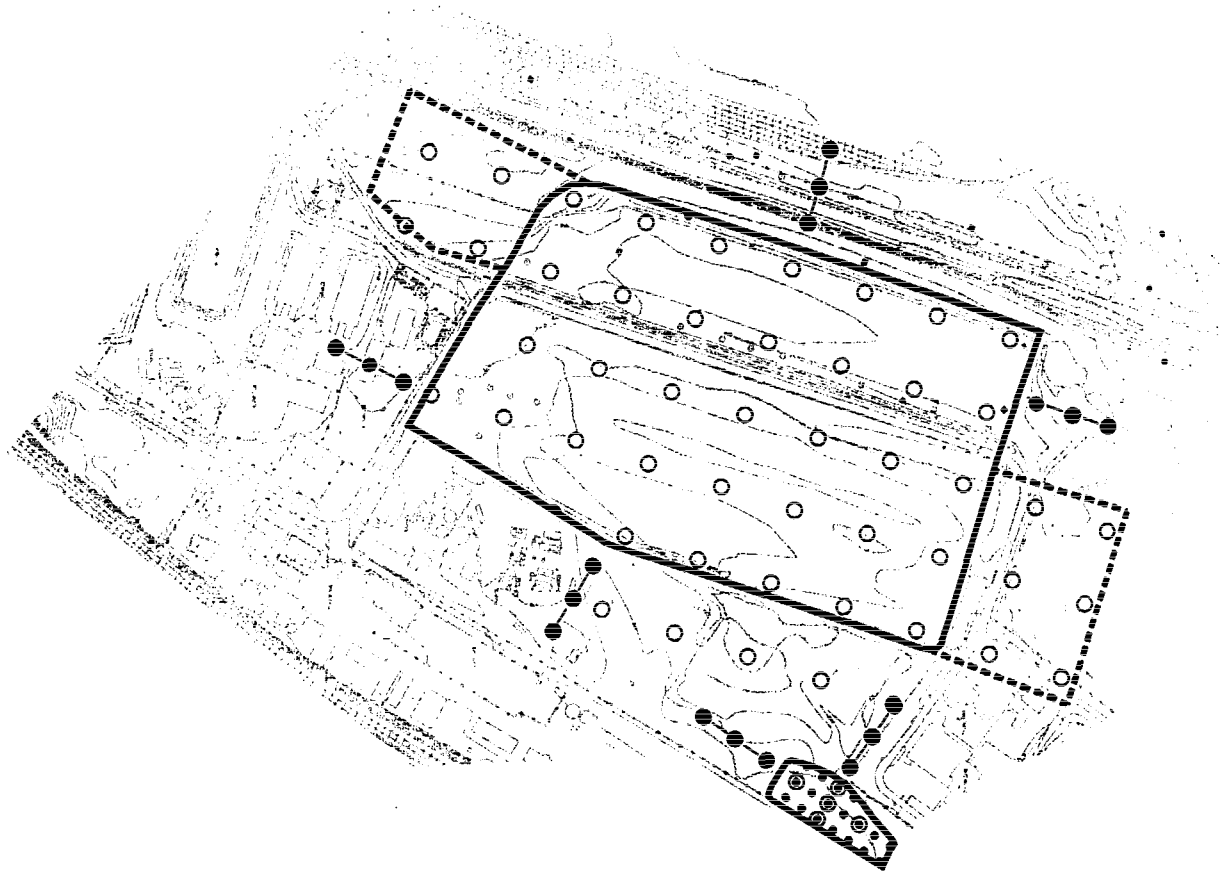
Sampling location maps are included at the end of this section.

Figure 5-1

Site O Waste, Soil, and Leachate

Sampling Locations

File: E:\2320010024.02\EPA\SOIL GAS.DWG Last edited: 05/10/02 @ 2:57 p.m. WC-ST.LOUIS, MO



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SCALE FEET

LEGEND

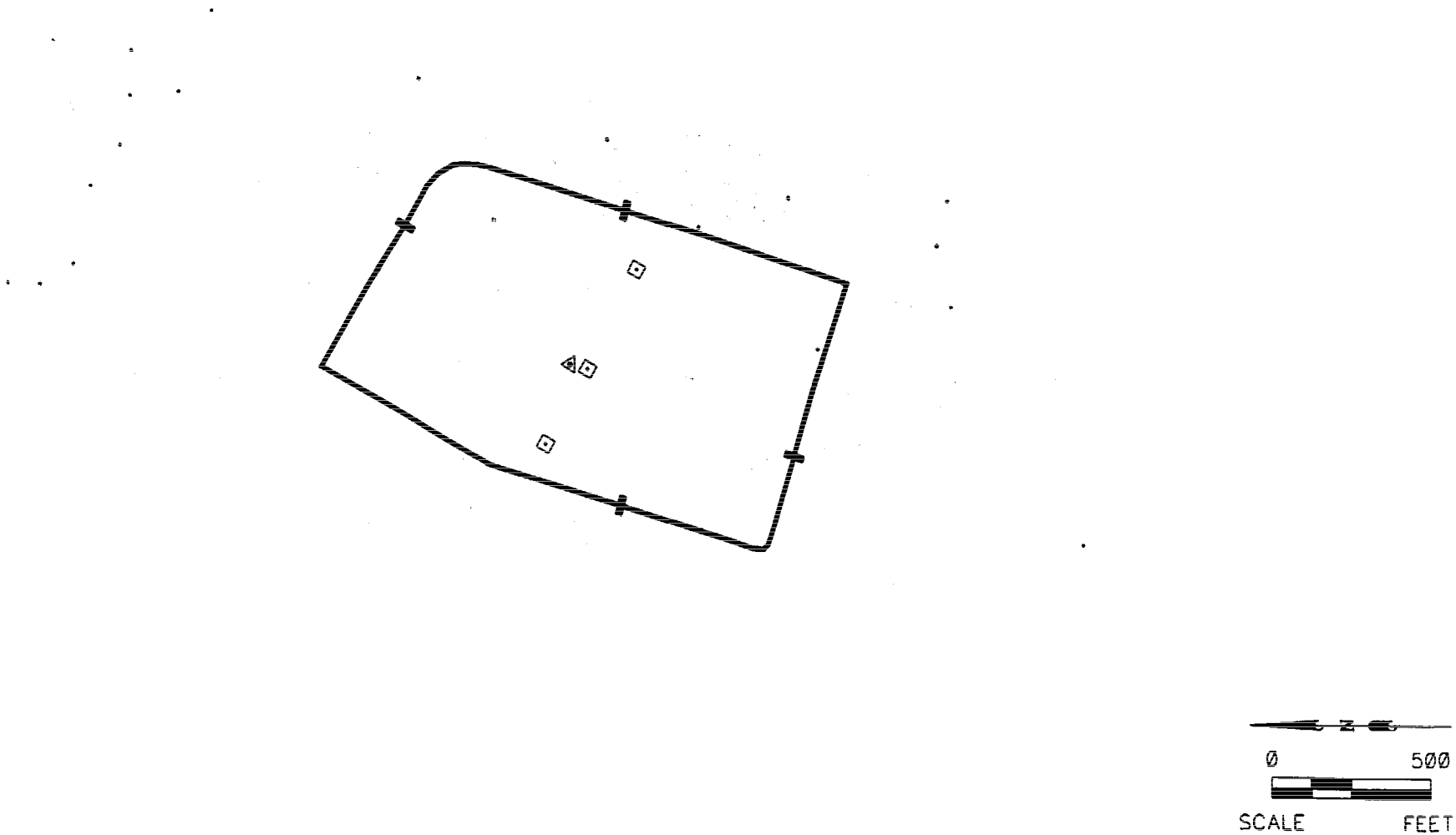
- Magnetometer Survey Locations
- Soil Gas Survey Locations
- Potential Soil Gas Survey Step Out Location

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN SAUGET, ILLINOIS	PROJECT NO. 2320010024.02
URS	
DRN. BY: djd 1/31/01 DSGN. BY: bv CHKD. BY:	Site O Soil Gas Sampling Locations
	FIG. NO. 3

Figure 5-2

Site O Soil Gas Sampling Locations

File: E:\2320010024.02\EPA\TEST TRENCH.DWG Last edited: 04/10/02 @ 10:01 a.m. WC-ST.LOUIS, MO



LEGEND

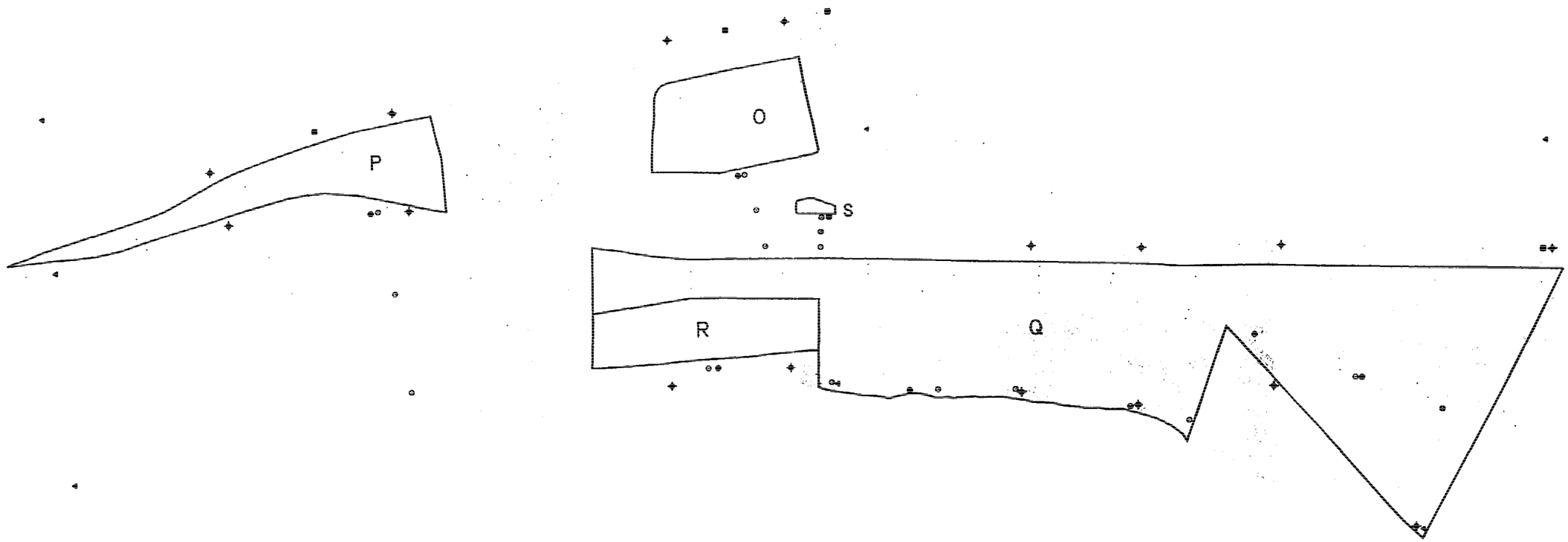
- Leachate Monitoring Well
- Test Trench (Area Extent of Waste)
- Waste Characterization Boring

Note: Trench size not to scale; approximate length=20 feet

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN SAUGET, ILLINOIS	PROJECT NO. 2320010024.02
URS	
DRN. BY: djd 1/31/01 DSGN. BY: bv CHKD. BY:	Site O Waste, Soil, and Leachate Sampling Locations
	FIG. NO. 2

Figure 5-3

Off-Site Soil and Upgradient Groundwater, Piezometer, Site-Related Groundwater, and Air Sampling Locations



LEGEND

- Offsite Soil and Upgradient/Groundwater Sampling Locations
- Site-Related Groundwater Sampling Locations
- Bedrock Monitoring Well
- Piezometer Cluster
- Air Sampling Location

Note: Data from Area 1 background locations will also be considered as background for Area 2

0 1000
SCALE FEET

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN SAUGET ILLINOIS		PROJECT NO. 2320010024.02
URS		
DRN. BY: djd 1/31/01 DSGN. BY: bv CHKD. BY:	Offsite Soil and Upgradient/Groundwater, Piezometer, Site-Related Groundwater, and Air Sampling Locations	FIG. NO. 4

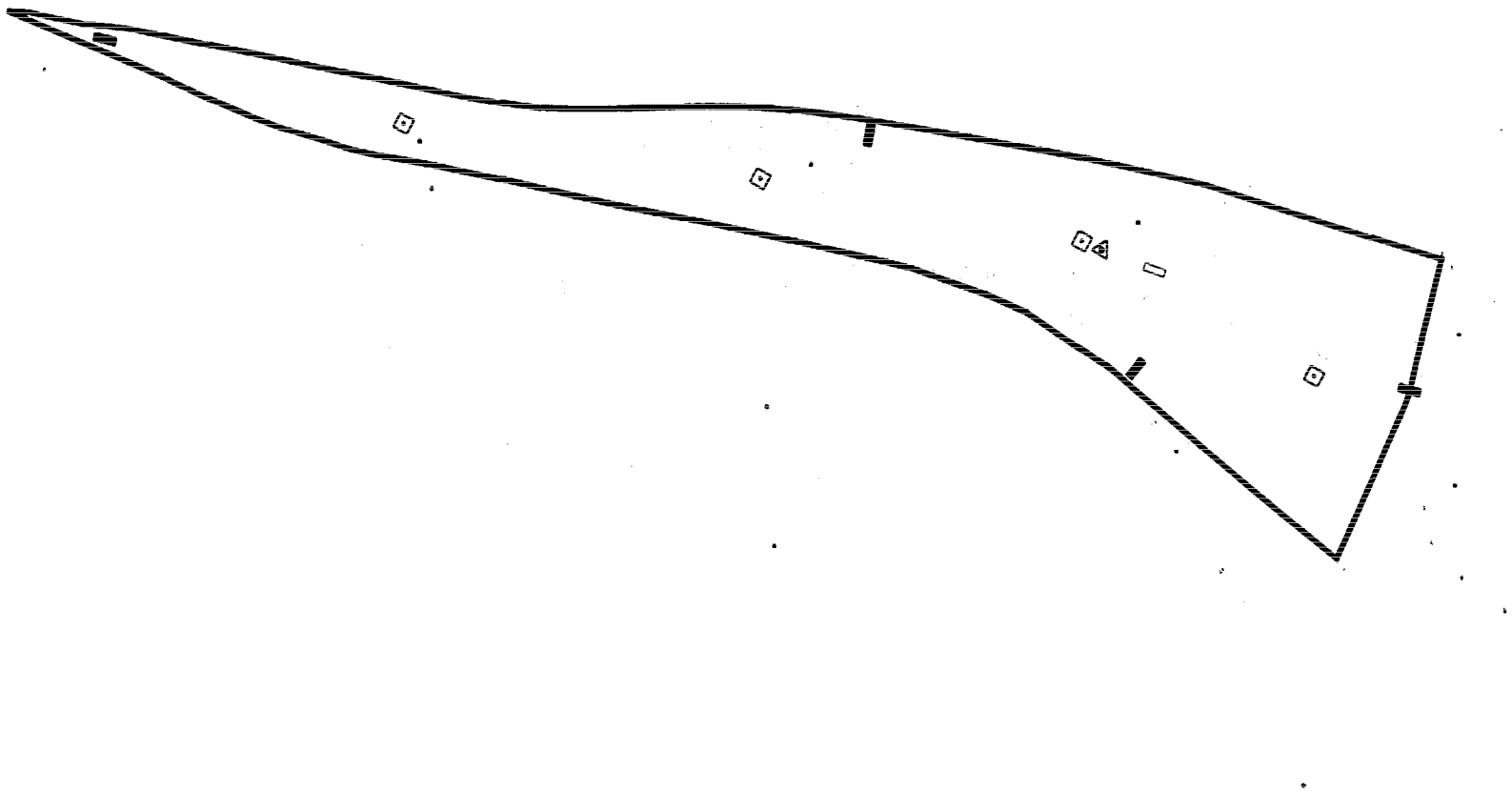
File: E:\2320010024.02\EPA\OFFSITE_SITE-RELATED FIG-4.DWG Last edited: 04/10/02 @ 10:38 a.m. WC-ST.LOUIS, MO

Figure 5-4

Site P Waste, Soil, and Leachate

Sampling Locations

File: E:\2320010024.02\EPA\TEST TRENCH.DWG Last edited: 04/10/02 @ 10:01 a.m. WC-ST.LOUIS, MO



LEGEND

- Leachate Monitoring Well
- Test Trench (Area Extent of Waste)
- Test Trench (Buried tank/drum Confirmation)
- Waste Characterization Boring

0 500
SCALE FEET

Note: Trench size not to scale; approximate length=20 feet

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN
SAUGET, ILLINOIS

PROJECT NO. 2320010024.02

URS

DRN. BY: djd 1/31/01
DSGN. BY: bv
CHKD. BY:

Site P Waste, Soil, and Leachate Sampling Locations

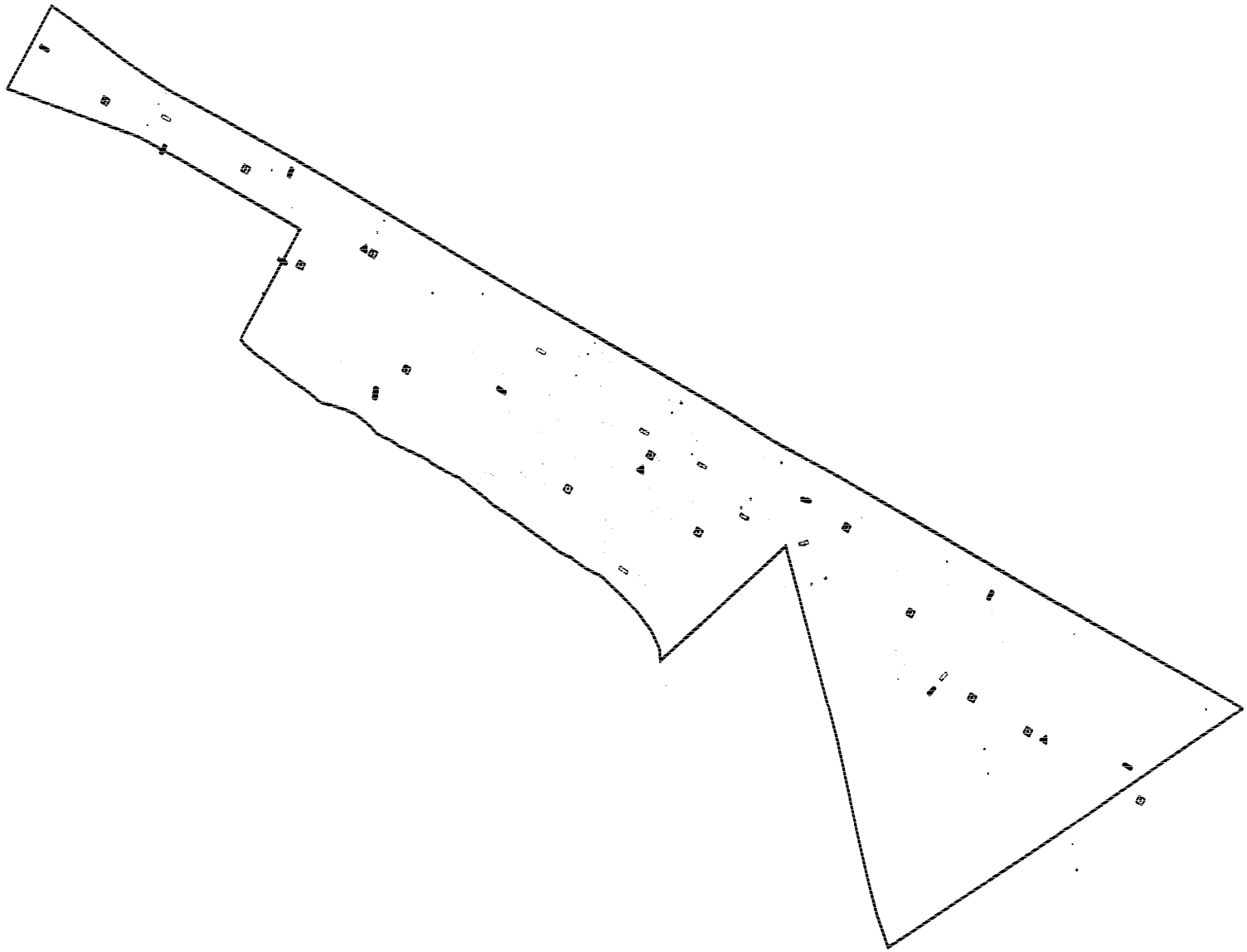
FIG. NO. 5

Figure 5-5

Site P Soil Gas Sampling and

Magnetometer Measurement Locations

File: E:\2320010024.02\EPA\TEST TRENCH.DWG Last edited: 04/10/02 @ 10:01 a.m. WC-ST.LOUIS, MO



LEGEND

- Leachate Monitoring Well
- Test Trench (Area Extent of Waste)
- Test Trench (Buried tank/drum Confirmation)
- Waste Characterization Boring

N

0 1000

SCALE FEET

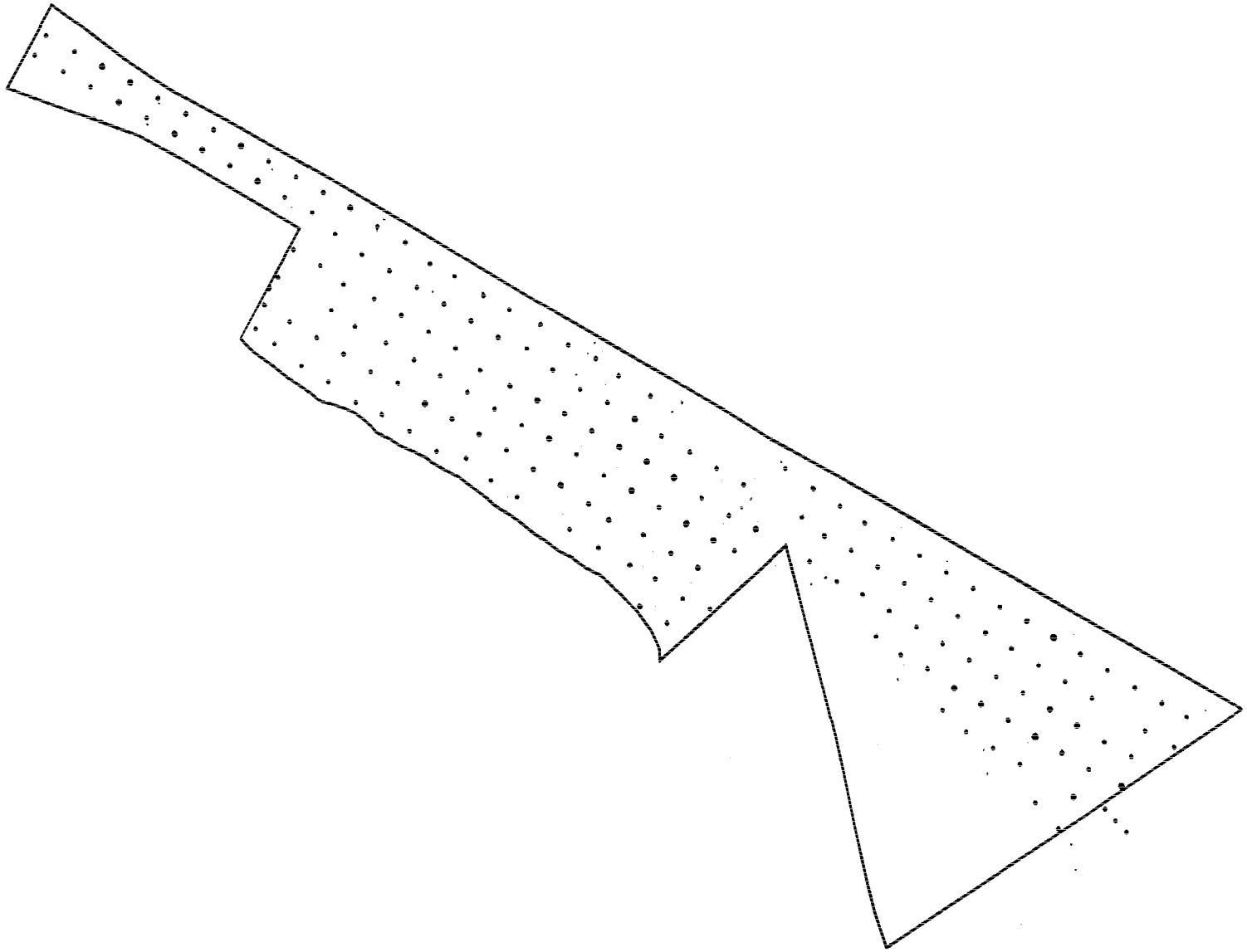
Note: Trench size not to scale; approximate length=20 feet

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN SAUGET, ILLINOIS	PROJECT NO. 2320010024.02
URS	
DRN. BY: djd 1/31/01 DSGN. BY: bv CHKD. BY:	Site Q Waste, Soil, and Leachate Sampling Locations
	FIG. NO. 7

Figure 5-6

Site Q Waste, Soil, Stormwater, and Leachate Sampling Locations

File: E:\2320010024.02\EPA\SOIL GAS.DWG Last edited: 04/10/02 @ 10:19 a.m. WC-ST.LOUIS, MO



LEGEND

- Magnetometer Survey Locations
- Soil Gas Survey Locations

N

0 1000

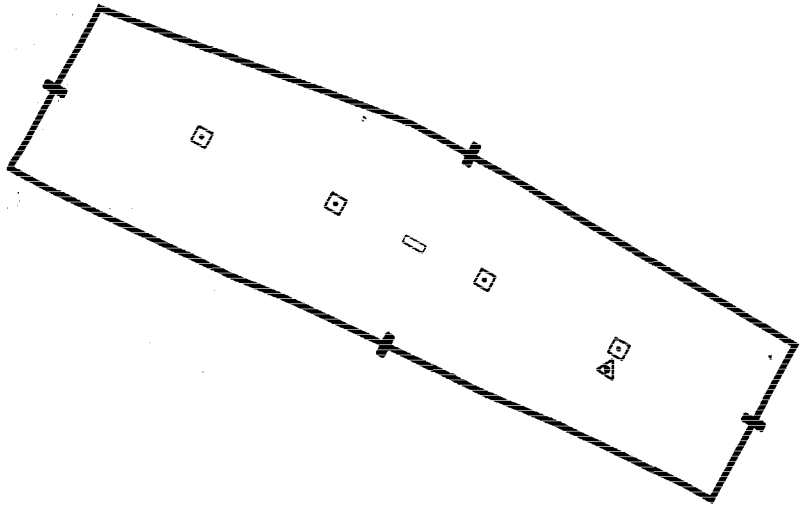
SCALE FEET

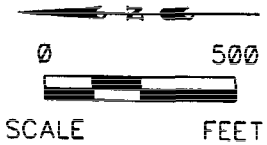
SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN SAUGET, ILLINOIS		PROJECT NO. 2320010024.02
URS		
DRN. BY:djd 1/31/01 DSGN. BY:bv CHKD. BY:	Site Q Soil Gas, XRF, and GC/MS Sampling and Magnetometer Measurement Locations	FIG. NO. 8

Figure 5-7

Site Q Soil Gas, XRF, and GC/MS Sampling and Magnetometer Measurement Locations

File: E:\2320010024.02\EPA\TEST TRENCH.DWG Last edited: 04/10/02 @ 10:01 a.m. WC-ST.LOUIS, MO





LEGEND

- Leachate Monitoring Well
- Test Trench (Area Extent of Waste)
- Test Trench (Buried tank/drum Confirmation)
- Waste Characterization Boring

Note: Trench size not to scale; approximate length=20 feet

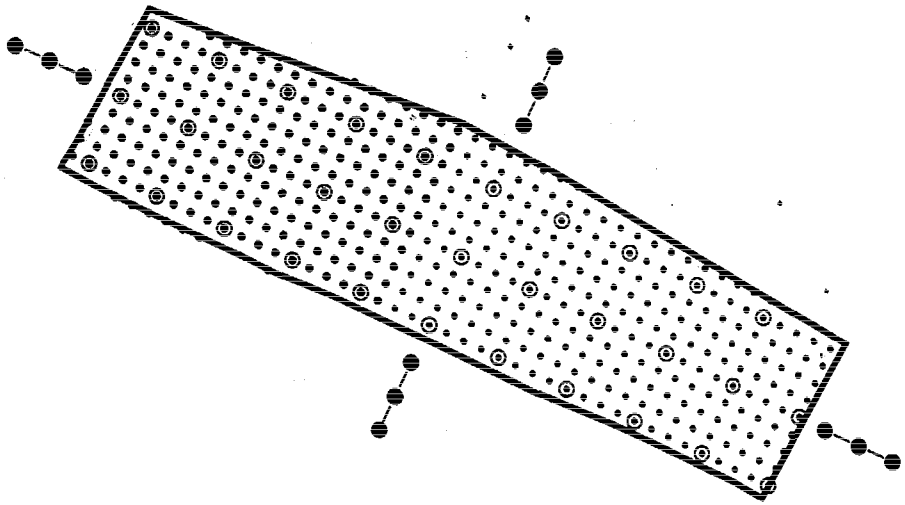
SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN SAUGET, ILLINOIS	PROJECT NO. 2320010024.02
URS	
DRN. BY: djd 1/31/01 DSGN. BY: bv CHKD. BY:	Site R Waste, Soil, and Leachate Sampling Locations
FIG. NO. 9	

Figure 5-8

Site R Waste, Soil, Stormwater, and Leachate

Sampling Locations

File: E:\2320010024.02\EPA\SOIL GAS.DWG Last edited: 04/10/02 @ 10:19 a.m. WC-ST.LOUIS, MO



0 500

SCALE FEET

LEGEND

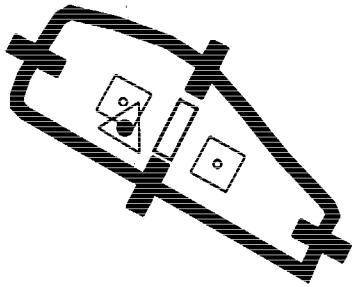
- Magnetometer Survey Locations
- Soil Gas Survey Locations
- Potential Soil Gas Survey Step Out Location

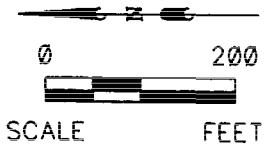
SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN SAUGET, ILLINOIS		PROJECT NO. 2320010024.02
URS		
DRN. BY: djd 1/31/01 DSGN. BY: bv CHKD. BY:	Site R Soil Gas Sampling and Magnetometer Measurement Locations	FIG. NO. 10

Figure 5-9

Site R Soil Gas Sampling and

Magnetometer Measurement Locations





LEGEND

- Leachate Monitoring Well
- Test Trench (Area Extent of Waste)
- Test Trench (Buried tank/drum Confirmation)
- Waste Characterization Boring

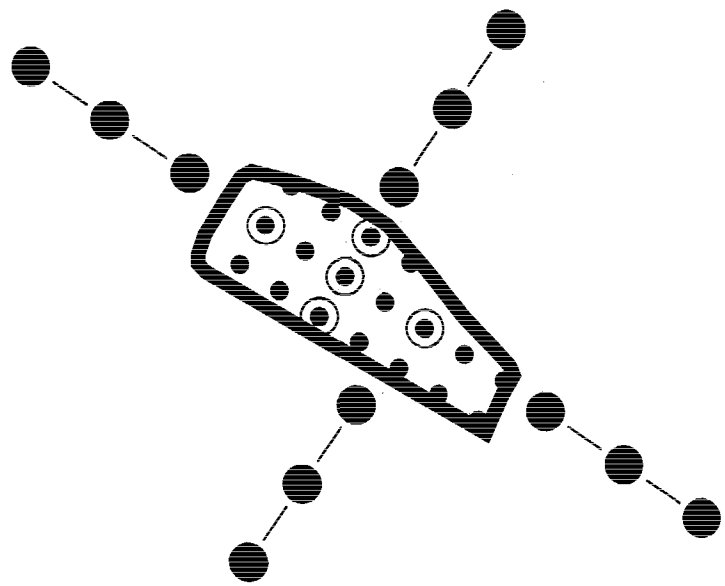
Note: Trench size not to scale; approximate length=20 feet

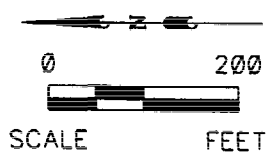
SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN SAUGET, ILLINOIS	PROJECT NO. 2320010024.02
URS	
DRN. BY: djd 1/31/01 DSGN. BY: bv CHKD. BY:	Site S Waste, Soil, and Leachate Sampling Locations
FIG. NO. 11	

Figure 5-10

Site S Waste, Soil, and Leachate

Sampling Locations





LEGEND

- Magnetometer Survey Locations
- Soil Gas Survey Locations
- Potential Soil Gas Survey Step Out Location

SAUGET AREA 2 RI/FS SUPPORT SAMPLING PLAN SAUGET, ILLINOIS		PROJECT NO. 2320010024.02
URS		
DRN. BY: djd 1/31/01 DSGN. BY: bv CHKD. BY:	Site S Soil Gas Sampling and Magnetometer Measurement Locations	FIG. NO. 12

Figure 5-11

Site S Soil Gas Sampling and

Magnetometer Measurement Locations

Section 6

6.0 Waste, Soil and Stormwater Sampling Plan

Waste and leachate samples will be collected at Sites O, P, Q, R and S to characterize the wastes present at each site. Surface and subsurface soil samples will be collected at each disposal site to provide information for the risk assessment. Stormwater samples will be collected at Sites Q and R to characterize run-off from these sites during storm conditions because these sites have drainage pathways to the Mississippi River. Stormwater samples will not be collected at Sites O, P, and S because they are located on the dry side of the floodwall and levee.

6.1 Areal Extent of Waste Disposal Areas

Available historical air photos will be obtained for Sites O, P, Q, R and S. These photos will be used to define the areal extent of each site over time and to determine the boundaries of each waste disposal area. Boundaries of Sites O, P, Q, R and S will be traced on each photo. To define the maximum extent of fill, the tracings for each site will be overlain and a line will be drawn around the outside limit of the composite waste-disposal area boundaries. Results of the analysis of historical air photos will be used to prepare a map for each site showing disposal area boundaries. If stereoscopic evaluation of historical air photographs allows identification of the deepest portion of a waste disposal area, one of the four waste characterization borings discussed below will be done at that location.

Test trenches will be used to confirm the boundaries of the waste disposal areas identified through air photo analysis. One trench will be installed on each side of a waste disposal area, a total of four trenches per site. Test trenches will start outside the defined boundary of the disposal area and move toward the defined boundary. When fill materials are encountered, the disposal area boundary will be compared to boundaries identified based on air photo analysis and considered confirmed. Trenching at that location will be terminated. Test trench locations will be determined with a GPS and recorded for future reference in the event drum removal is appropriate.

All excavated soil and fill material will be returned to the test trench with the exception of any intact drums, which will be removed provided confined space entry is not needed to retrieve a

drum. Trenches will not be entered to recover drums because of the danger inherent in such activities. Empty, intact drums will not be removed.

Recovered drums, if any, will be overpacked and stored pending disposal. Free product and contaminated soil resulting from rupture of drums during removal will be cleaned up by absorbing any liquid materials and placing the absorbent, solid waste and contaminated soil in bulk containers. Overpacked drums and bulk solid and liquid containers will be stored at a controlled-access, fenced Investigation Derived Waste (IDW) Storage Area to be constructed at Site R. Recovered drums will be stored until a sufficient quantity is present to constitute a truckload for off-site shipment or the investigation is complete, whichever comes first. Drum storage may be indefinite if they contain materials that can not be accepted by off-site disposal facilities. Any waste excavated that identifies the source of material present in the disposal area will be noted in the field log and photographed.

Trenching equipment will be hired on a per day basis. If all four planned boundary trenches are finished and there is adequate time before the end of a day, additional boundary trenching will be done for the remainder of the day.

Number of Test Trenches 24

6.2 Screening Surveys

6.2.1 Soil Gas Surveys

A soil gas survey will be conducted at Sites O, P, Q, R and S using a shallow soil probe (5 ft.) and on-site analysis of collected vapors for Total VOCs using an OVA or GC to assess the presence of soil vapors, possibly originating from waste materials, in the subsurface at these sites. With the exception of Site S, soil gas samples will be collected at the center points of a 200 by 200 ft. grid superimposed on each disposal site where accessible. Because of the relatively small size of Site S, five sample points will be employed, using one near each of the four edges and one in the middle of the site.

Site	Number of Samples
O	50
P	25
Q	238
R	30
S	5
Total Number of Samples	372

If detectable concentrations of Total VOCs are found in soil-gas samples at a disposal site boundary, the soil gas survey will be extended beyond that boundary. If extended beyond the site boundary, soil-gas samples will be collected along a single transect perpendicular to that boundary at a distance of 0, 100 and 200 ft. from the edge of the disposal site. If Total VOCs are detected in soil gas at the boundaries of each of the five disposal sites, as many as 60 additional soil gas samples may be collected:

Site	Number of Transects	Number of Samples
O	4	12
P	4	12
Q	4	12
R	4	12
S	4	12
	Total Number of Samples	60

If twelve additional soil gas samples are not adequate to define the extent of VOC-containing soils associated with each disposal site, additional soil gas samples will be collected at 100 ft. intervals along the four sampling transects at each disposal site until the limits of the impacted fill are found. If soil gas surveys need to extend into sites for which there are no property access agreements, soil gas sampling will be suspended until access is obtained.

6.2.2 GC/MS Field Screening Survey

Because of the larger size and limited extent of previous investigation data for Site Q, a field screening survey to address VOC and SVOC concentrations in soil samples will be conducted at this site. The objective of this effort will be to determine if areas of elevated VOC and SVOC

concentrations exist at this site using a grid-based sample approach. This data will be used to help identify sampling locations for the soil, waste, and leachate sampling efforts. Soil samples will be collected from the upper 5 feet using push technology and will be analyzed on-site for VOC and SVOC concentrations using a field GC/MS instrument. These samples will be collected at the center point of a 200 by 200 foot grid superimposed on Site Q, where accessible.

6.2.3 XRF Field Screening Survey

Because of the larger size and limited extent of previous investigation data for Site Q, a field screening survey to address metals concentrations in soil samples will be conducted at this site. The objective of this effort will be to determine if areas of elevated metals concentrations exist at this site using a grid-based sampling approach. This data will be used to help identify sampling locations for the soil, waste, and leachate sampling efforts. Soil samples will be collected from the upper 5 feet using push technology and will be analyzed on-site to determine the concentrations of the RCRA 8 metals by X-Ray Refraction technology (XRF). These samples will be collected at the center points of a 200 by 200 foot grid superimposed on Site Q, where accessible.

6.3 Buried Drum and Tank Identification

6.3.1 Magnetometer Surveys

Magnetometer surveys will be conducted at Sites P, Q, R and S to identify anomalies indicative of drum disposal or buried tanks. Magnetometer measurements will not be made at Site O because it was closed under the supervision of Sauget P/Chem Plant personnel in 1980. No drums were present at the time of closure. Magnetometer measurements will be made at locations determined by superimposing a 50 ft. by 50 ft. grid on each disposal site where accessible:

Site	Number of Measurements
P	768
Q	3,712
R	480
S	48
Total Number of Samples	5,008

6.3.2 Test Trenches

Test trenches will be installed at Sites P, Q, R and S to confirm the presence of buried drums or tanks. One test trench will be installed at each of Sites P, R, and S, and eight trenches will be installed at Site Q. Test trenches will not be installed at Site O because it was closed under the supervision of Sauget PChem Plant personnel in 1980. No drums were present at the time of closure. These waste disposal sites were used for disposal of municipal and industrial waste as well as construction debris. Magnetic anomalies are likely to be numerous, intense and widespread. If no location criteria, other than the presence of a magnetic anomaly, are used to determine whether a test trench is appropriate, disturbance of a significant portion of each disposal site is likely to result. Excessive trenching could result in unacceptable risks to the community, on-site workers and the environment.

Based on the above, four selection criteria will be used to identify where to install each test trench. Test trenching will be done at the location of the largest magnetic anomaly that coincides with:

- A soil gas concentration high;
- Drum or tank disposal locations identified by historical air photo interpretation;
- Areas of high groundwater concentrations identified in the 1998 Ecology and Environment Sauget Area 1 Data Tables/Maps Report; and
- Major magnetic anomalies reported in the 1988 Ecology and Environment document "Expanded Site Investigation, Dead Creek Project Sites at Cahokia/Sauget, Illinois".

All excavated soil and fill material will be returned to the test trench with the exception of any intact drums which will be removed provided confined space entry is not needed to retrieve a drum. Trenches will not be entered to recover drums because of the danger inherent in such activities. Test trench locations will be determined using GPS and recorded for future reference in the event drum removal is appropriate.

Recovered drums will be overpacked and stored pending disposal. Free product and contaminated soil resulting from rupture of drums during removal will be cleaned up by absorbing any liquid materials and placing the absorbent, solid waste and contaminated soil in bulk containers. Overpacked drums and bulk solid and liquid containers will be stored at a controlled-access, fenced Investigation Derived Waste (IDW) Storage Area to be constructed at Site R. Recovered drums will be stored until a sufficient quantity is present to constitute a truckload for off-site shipment, or the investigation is complete, whichever comes first. Drum storage may be indefinite if they contain materials that can not be accepted by off-site disposal facilities. Any waste excavated that identifies the source of material present in the disposal site will be noted in the field log and photographed.

6.4 Seep Survey and Investigation

A visual reconnaissance survey will be undertaken along the riverbank adjacent to Sites Q and R during a low-flow period to assess the presence of seeps and their impact, if any, on the Mississippi River. The locations of any seeps observed will located with a GPS, photographed, and if sufficient quantity is present, sampled for VOC, SVOC, PCB, dioxin, herbicide, pesticide, and metals. Where appropriate, several smaller seeps in close proximity to each other may be sampled as a single location. If sample volume is limited, sample containers will be prioritized and filled in the order of analytical parameters as presented above.

6.5 Waste Samples

To characterize waste materials at each site, four soil borings each will be installed at Site P and R, while three will be installed at Site O, twelve at Site Q, and two at Site S to characterize the waste materials. The results of the soil gas survey, XRF analysis, field GC/MS screening, and magnetometer surveys will be used, where applicable, to locate these soil borings.

Continuous samples of soil and waste material will be collected from grade to two feet below the bottom of the waste material, which is estimated to be a maximum of 40 ft. below grade. If wastes are encountered at depths greater than 40 ft. below ground surface (bgs), the boring will continue until the bottom of the waste is encountered. Scaled, color digital photographs will be taken of each waste sample to provide a record of materials present in each disposal site (Sites O, P, Q, R and S).

One composite waste sample will be collected at each boring location and analyzed for SVOCs, Pesticides, Herbicides, PCBs, Metals, and Dioxin. In addition, a portion of the composite waste sample from above the water table will be extracted using TCLP procedures and analyzed for this same suite of analytes. Visual observation and PID/FID readings will be used to identify whether or not waste is present in a continuous boring sample. If waste is present in a sample, it will be removed, segregated, temporarily stored and used at the completion of the soil boring to prepare a composite waste sample. Since VOC samples can not be composited without losing volatiles, the waste with the highest PID/FID readings will be used for VOC analysis.

Number of Composite Waste Samples: 25

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B
	Dioxin	Method 8280

Number of Composite Waste Sample (TCLP Extraction): 25

Analyses:	TCLP Extraction/VOCs	Method 8260B
	TCLP Extraction/SVOCs	Method 8270C
	TCLP Extraction/Pesticides	Method 8081A
	TCLP Extraction/Herbicides	Method 8151A
	TCLP Extraction/PCBs	Method 680
	TCLP Extraction/Metals	Method 6010B
	TCLP Extraction/Dioxin	Method 8280

6.6 Leachate Samples

A 2-inch diameter well, screened at the bottom of the fill material, will be installed in one waste characterization boring completed at Sites O, P, R, and S to characterize leachate. Three such wells will be installed at Site Q. Each well will be sampled and analyzed for the following parameters.

Number of Leachate Samples: 7

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Dioxin	Method 8280
	Metals	Method 6010B

6.7 Surface Soil Samples

Surface soil samples (0 to 0.5 ft.) will be collected at each disposal site at the location of each waste sample boring to provide information for the risk assessment. In addition, one surface soil sample will be collected in the field immediately south of Site Q to determine if chemicals of potential concern have been transported during overbank flows. Scaled, color digital photographs will be taken of each soil sample to provide a record of materials present in each disposal site (Sites O, P, Q, R and S). Each sample will be analyzed for the parameters listed below.

Number of Surface Soil Samples: 26

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B
	Dioxin	Method 8280

6.8 Subsurface Soil Samples

Subsurface soil samples (0.5 to 6 ft.) will be collected at each disposal site at the location of each waste sample boring to provide information for the Human Health Risk Assessment. In addition, one subsurface soil sample will be collected in the field immediately south of Site Q to determine if chemicals of potential concern have been transported during overbank flows. Scaled, color digital photographs will be taken of each soil sample to provide a record of materials present in each disposal site (Sites O, P, Q, R and S). Each sample will be analyzed for the parameters listed below.

Number of Subsurface Soil Samples: 26

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B
	Dioxin	Method 8280

6.9 Off-Site Soil Samples

Off-site soil samples will be collected at four locations east of the study area as generally shown in Figure 5-3. Samples will be collected from a depth of 0 to 0.5 ft. and 0.5 to 6 ft. below ground surface. In addition, data from the southern two background locations from the Sauget Area 1 investigation will be evaluated during the data analysis and risk assessment efforts.

Number of Background Soil Samples 8

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B
	Dioxin	Method 8280

6.10 Stormwater Runoff

Stormwater runoff grab samples will be collected at one location at Site R and two locations at Site Q because these sites have drainage pathways to the Mississippi River. These samples will be analyzed for VOCs, SVOCs, Pesticides, Herbicides, PCBs, Dioxin and Metals. This will be done in order to characterize runoff from these sites during storm conditions. Samples will be collected from the primary drainage route from each site to the Mississippi River. Samples will not be collected at Sites O, P, and S because they are located on the dry side of the floodwall and levee. Samples will be collected during three storms to determine variability of constituent concentrations in site runoff. First flush samples will be collected using an automated sampling device.

Number of Stormwater Runoff Samples 9

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B
	Dioxin	Method 8290.

Section 7

7.0 Groundwater Sampling Plan

Groundwater samples will be collected in the alluvial and bedrock aquifers downgradient of each of the waste disposal sites. The purpose of this sampling is to define the extent of migration away from the source areas and to provide information for the Human Health Risk Assessment. The locations of these sampling efforts will be based upon the results of screening surveys and will be biased towards locations that are downgradient of identified anomalies.

7.1 Site O

Groundwater samples will be collected at three sampling stations located on an east/west transect between the downgradient boundary of Site O and the upgradient boundary of Sites Q and R . These samples will be used to determine the nature and extent of constituent migration away from this waste disposal site. Unfiltered groundwater samples will be collected every 10 ft. from the water table to the bottom of the aquifer using push sampling technologies such as Geoprobe®, HydroPunch®, Microwell®, Waterloo Profiler® or equivalent and low-flow sampling techniques. Aquifer saturated thickness is estimated to be approximately 120 ft. with depth to water at 20 ft. bgs and bottom of the aquifer at 140 ft. bgs. All samples will be analyzed for volatile and semivolatile constituents. Additionally, unfiltered samples will be collected at 40 foot intervals (i.e., 20, 60, 100 and 140 bgs) and analyzed for pesticides, herbicides, PCBs, metals, and geochemical parameters.

Unfiltered groundwater samples will be collected at the top, middle and bottom of the saturated zone, i.e. 20, 80 and 140 ft. bgs, and analyzed for dioxin at the sampling station closest to Site O.

Number of 10 foot interval Groundwater Samples: 39

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C

Number of 40 foot interval Groundwater Samples: 12

Analyses:	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B

Geochemical Parameters:
ORP
DO
Ferrous Iron
Manganese
Nitrate
Sulfate
Alkalinity
Methane
Carbon Dioxide

Number of Dioxin Samples: 3

Analyses:	Dioxin	Method 8290

7.2 Site P

Groundwater samples will be collected at three sampling stations located on an east/west line between the downgradient boundary of Site P and the Mississippi River. These samples will be used to determine the nature and extent of constituent migration away from this waste disposal site. Unfiltered groundwater samples will be collected every 10 ft. from the water table to the bottom of the aquifer using push sampling technologies such as Geoprobe®, HydroPunch®, Microwell®, Waterloo Profiler® or equivalent and low-flow sampling techniques. Aquifer saturated thickness is estimated to be approximately 120 ft. with depth to water at 20 ft. bgs and bottom of the aquifer at 140 ft. bgs. All samples will be analyzed for volatile and semivolatile constituents. Additionally, unfiltered samples will be collected at 40 foot intervals (i.e., 20, 60, 100 and 140 bgs) and analyzed for pesticides, herbicides, PCBs, metals, and geochemical parameters.

Unfiltered groundwater samples will be collected at the top, middle and bottom of the saturated zone, i.e. 20, 80 and 140 ft. bgs, and analyzed for dioxin at the sampling station closest to Site P.

Number of 10 foot interval Groundwater Samples: 39

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C

Number of 40 foot interval Groundwater Samples: 12

Analyses:	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B

Geochemical Parameters:
- ORP
- DO
- Ferrous Iron
- Manganese
- Nitrate
- Sulfate
- Alkalinity
- Methane
- Carbon Dioxide

Number of Dioxin Samples: 3

Analyses:	Dioxin	Method 8290

7.3 Site Q

Groundwater samples will be collected at eight sampling stations located on two north/south transects between the downgradient boundary of Site Q and the Mississippi River. These samples will be used to determine the nature and extent of constituent migration away from this waste disposal site. Unfiltered groundwater samples will be collected every 10 ft. from the water table to the bottom of the aquifer using push sampling technologies such as Geoprobe®, HydroPunch®, Microwell®, Waterloo Profiler® or equivalent and low-flow sampling techniques. Aquifer saturated thickness is estimated to be approximately 120 ft. with depth to water at 20 ft. bgs and bottom of the aquifer at 140 ft. bgs. All samples will be analyzed for volatile and semivolatile constituents. Additionally, unfiltered samples will be collected at 40 foot intervals (i.e., 20, 60, 100 and 140 bgs) and analyzed for pesticides, herbicides, PCBs, metals, and geochemical parameters.

Unfiltered groundwater samples will be collected at the top, middle and bottom of the saturated zone, i.e. 20, 80 and 140 ft. bgs, and analyzed for dioxin at the two center sampling stations at Site Q.

Number of 10 foot interval Groundwater Samples: 104

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C

Number of 40 foot interval Groundwater Samples: 32

Analyses:	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B

Geochemical Parameters:
ORP
DO
Ferrous Iron
Manganese
Nitrate
Sulfate
Alkalinity
Methane
Carbon Dioxide

Number of Dioxin Samples: 6

Analyses:	Dioxin	Method 8290

7.4 Site R

Groundwater samples will be collected at one sampling station located between the downgradient boundary of Site R and the Mississippi River. This sample will be used to determine the nature and extent of constituent migration away from this waste disposal site. Unfiltered groundwater samples will be collected every 10 ft. from the water table to the bottom of the aquifer using push sampling technologies such as Geoprobe®, HydroPunch®, Microwell®, Waterloo Profiler® or equivalent and low-flow sampling techniques. Aquifer saturated thickness is estimated to be approximately 120 ft. with depth to water at 20 ft. bgs and bottom of the aquifer at 140 ft. bgs. All samples will be analyzed for volatile and semivolatile constituents. Additionally, unfiltered samples will be collected at 40 foot intervals (i.e., 20, 60, 100 and 140 bgs) and analyzed for pesticides, herbicides, PCBs, metals, and geochemical parameters.

Unfiltered groundwater samples will be collected at the top, middle and bottom of the saturated zone, i.e. 20, 80 and 140 ft. bgs, and analyzed for dioxin at the center sampling station at Site R.

Number of 10 foot interval Groundwater Samples: 13

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C

Number of 40 foot interval Groundwater Samples: 4

Analyses:	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B

Geochemical Parameters:
ORP
DO
Ferrous Iron
Manganese
Nitrate
Sulfate
Alkalinity
Methane
Carbon Dioxide

Number of Dioxin Samples: 3

Analyses:	Dioxin	Method 8290

7.5 Site S

Groundwater samples will be collected at three sampling stations between the downgradient boundary of Site S and the upgradient boundary of Sites Q and R. These samples will be used to determine the nature and extent of constituent migration away from the waste disposal site. Unfiltered groundwater samples will be collected every 10 ft. from the water table to the bottom of the aquifer using push sampling technologies such as Geoprobe®, HydroPunch®, Microwell®, Waterloo Profiler® or equivalent and low-flow sampling techniques. Aquifer saturated thickness is estimated to be approximately 120 ft. with depth to water at 20 ft. bgs and bottom of the aquifer at 140 ft. bgs. All samples will be analyzed for volatile and semivolatile constituents.

Additionally, unfiltered samples will be collected at 40 foot intervals (i.e., 20, 60, 100 and 140 bgs) and analyzed for pesticides, herbicides, PCBs, metals, and geochemical parameters.

Unfiltered groundwater samples will be collected at the top, middle and bottom of the saturated zone, i.e. 20, 80 and 140 ft. bgs, and analyzed for dioxin at the sampling station closest to Site S.

Number of 10 foot interval Groundwater Samples: 39

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C

Number of 40 foot interval Groundwater Samples: 12

Analyses:	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B

Geochemical Parameters:
ORP
DO
Ferrous Iron
Manganese
Nitrate
Sulfate
Alkalinity
Methane
Carbon Dioxide

Number of Dioxin Samples: 3

Analyses:	Dioxin	Method 8290

7.6 Upgradient Groundwater

Groundwater samples will be collected at four sampling stations located east of the Sauget Area 2 Sites. One sampling station will be located upgradient and east of Site P, two sampling stations will be located upgradient east of Sites O, S, R, and the northern portion of Site Q. The fourth sampling station will be located upgradient east of the southern portion of Site Q. Unfiltered groundwater samples will be collected every 10 ft. from the water table to the bottom of the aquifer using push sampling technologies such as Geoprobe®, HydroPunch®, Microwell®,

Waterloo Profiler® or equivalent and low-flow sampling techniques. Aquifer saturated thickness is estimated to be approximately 120 ft. with depth to water at 20 ft. bgs and bottom of the aquifer at 140 ft. bgs. All samples will be analyzed for volatile and semivolatile constituents. Additionally, unfiltered samples will be collected at 40 foot intervals (i.e., 20, 60, 100 and 140 bgs) and analyzed for pesticides, herbicides, PCBs, metals, and geochemical parameters.

Unfiltered groundwater samples will be collected at the top, middle and bottom of the saturated zone, i.e., 20, 80 and 140 ft. bgs, and analyzed for dioxin at the center background sampling station.

Number of 10 foot interval Groundwater Samples: 52

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C

Number of 40 foot interval Groundwater Samples: 16

Analyses:	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B
Geochemical Parameters:		ORP
		DO
		Ferrous Iron
		Manganese
		Nitrate
		Sulfate
		Alkalinity
		Methane
		Carbon Dioxide

Number of Dioxin Samples: 6

Analyses:	Dioxin	Method 8290

7.7 Groundwater Flow Direction

Nine piezometer clusters will be installed in the study area to define groundwater flow direction. Three piezometer clusters will be installed at the upgradient portion of the study area adjacent to Mississippi Avenue (Route 3). Another three piezometer clusters will be installed midway between the Mississippi River and Route 3. The final three piezometer clusters will be installed

at the downgradient edge of the study area adjacent to the Mississippi River. Each piezometer cluster will consist of three small-diameter (1-inch) wells completed in the shallow, intermediate and deep portions of the aquifer. Soil samples will be collected every five feet and at every change in formation in the nine deep piezometer borings. These soil samples will be tested for grain size, particle size distribution, porosity, bulk density, specific gravity, moisture content, pH and total organic carbon. Water levels will be measured quarterly for one year in each piezometer and used to prepare water-level elevation maps showing seasonal changes in groundwater level and flow direction.

Number of Shallow Piezometers:	9
Number of Intermediate Piezometers:	9
Number of Deep Piezometers:	9
Total Number of Piezometers	27

7.8 Groundwater Flow Rate

Falling and rising head slug tests will be performed on each piezometer installed as described in Section 3.7 using a slug of known volume and in-well, short-time interval, automatic water-level recorders. Aquifer hydraulic conductivity will be calculated for each piezometer using the falling head and rising head slug test data. Groundwater flow rates will be determined by using measured groundwater gradients and calculated aquifer hydraulic conductivities.

Number of Shallow Slug Tests:	9
Number of Intermediate Slug Tests:	9
Number of Deep Slug Tests:	9
Total Number of Slug Tests	27

7.9 Bedrock Groundwater

One bedrock well will be installed downgradient of each site at Sites O, P, R and S, and two bedrock wells will be installed downgradient of Site Q in order to determine the vertical extent of organic and inorganic constituents migrating vertically from each of these sites. Two wells will be utilized at Site Q due to the larger size and limited extent of previous investigation data for this site. Steel surface casings will be installed 5 feet into bedrock.

After installing the surface casing five feet into bedrock, the bedrock will be cored 20 ft below the bottom of the casing. Cores will be digitally photographed in color against a scale and evaluated for porosity by examination and petrographic thin sections. One thin section will be made for each two feet of bedrock core. A two-inch diameter, five-foot long screen and casing will be installed in the borehole. The screen will be filterpacked and grouted from three feet above the top of the filterpack to grade. Unfiltered groundwater samples will be collected from each completed and developed bedrock well and analyzed for those parameters listed below.

Water levels will be measured quarterly for one year in each bedrock well and used to prepare water-level elevation maps showing seasonal changes in groundwater level and flow direction. Falling and rising head slug tests will be performed on each bedrock well using a slug of known volume and in-well, short-time interval, automatic water-level recorders. Aquifer hydraulic conductivity will be calculated for each well using the falling head and rising head slug test data. Groundwater flow rates will be determined by using measured groundwater gradients and calculated aquifer hydraulic conductivities.

Unfiltered groundwater samples will be collected from each bedrock well and analyzed for dioxin.

Number of Groundwater Samples: 6

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B
	Dioxin	Method 8290

Geochemical Parameters:
- ORP
- DO
- Ferrous Iron
- Manganese
- Nitrate
- Sulfate
- Alkalinity
- Methane
- Carbon Dioxide

Section 8

8.0 Surface Water, Sediment and Biota Sampling Plan

Surface water, sediment and ecological samples will be collected in the Mississippi River. Surface water and sediments will also be collected from the two ponds located at the Southern end of Site Q. Terrestrial samples of biota will be collected from each of the five Sites. Samples will be analyzed to determine the concentration of site-related constituents in these media and to provide information for the risk assessments. Surface water and sediment samples will be collected from the Mississippi River along three transects running parallel to the river bank at the following three locations: 1) downgradient of Site P, 2) downgradient of Sites O, R, S and the northern end of Site Q, and 3) downgradient of the southern end of Site Q.

The three sampling transects will be located 50, 150 and 300 feet from shore. The location of these sample transects are based on Mississippi River sediment samples collected by USEPA in October and November, 2000. The following results were identified in that sampling:

	Distance From Riverbank		
Maximum Detected Concentration, ppb	**50 to 100 Feet**	**150 Feet**	**315 Feet**
Total VOCs	22,000	6,758	3,360
Total SVOCs	11,410	11,500	ND

Sediment sample analytical results and sampling location maps are included at the end of this section.

Benthic macroinvertabrates will be sampled at each of the nine sampling locations. This data will be used to evaluate benthic community structure (species richness and biomass) to provide data for the sediment triad evaluation. Bioassays will be conducted on surface water and sediment samples to determine the toxicity, if any, of these environmental media to sensitive organisms.

Fish will be sampled in three areas of the Mississippi River associated with the Sites: 1) downgradient of Site P, 2) downgradient of Sites O, R, S and the northern end of Site Q, and 3)

the southern end of Site Q. A food source approach has been used to select fish for fish tissue analysis:

Food Source	Fish	Trophic Level	Endpoint Organism
Omnivore	Channel Catfish	Bottom Feeder	Fish
Plankton	Shad (Large)	Forager	Osprey
	Shad (Small)	Forager	Great Blue Heron
Detritus	Buffalo (Fillets)	Omnivore	Recreational Fisher

Small shad will be those fish ranging in size from approximately 4 inches to 8 inches in length. Large shad will be those fish greater than 8 inches in length.

These fish tissue samples, collected in plume discharge areas, will be used to determine the impact, if any, of groundwater discharge on higher trophic level organisms. Fish will also be sampled in reference areas upstream and in areas downstream of Sauget Area 2 in order to assess the potential for downstream migration of constituents.

Information collected as part of the Surface Water, Sediment and Ecological Sampling Plan will be used in the Human Health Risk Assessment and the Ecological Risk Assessment. With five disposal sites located adjacent to or near the east bank of the Mississippi River, the primary ecological exposure pathway is groundwater water discharge to surface water. Other exposure pathways include terrestrial organism exposure to site soils and aquatic organism exposure to water and sediments in on-site ponded areas. These exposure pathways will be included in the site conceptual model section of the Ecological Risk Assessment Work Plan.

Aquatic endpoint organisms to be evaluated in the ERA are: 1) benthic macroinvertabrate, 2) fish, 3) great blue heron (small fish predator) and 4) osprey (large fish predator). Terrestrial endpoint organisms that will be evaluated in the ERA are: 1) plants, 2) prairie vole (herbivore), 3) short-tailed shrew (vermivore) and 4) red fox (predator). Ponded area endpoint-organisms to be evaluated in the ERA are 1) benthic macroinvertabrate and 2) fish or amphibians, if fish are not present.

Prior to implementation of the Surface Water, Sediment and Biota Sampling Plan, an aquatic reconnaissance survey of the Mississippi River will be conducted in conjunction with USEPA, IEPA, and USF&WS. During the survey, observations of water depth, flow velocity, substrate, aquatic vegetation, and other habitat-controlling conditions will be made in the sampling area. To confirm the locations of potential plume discharge areas, screening sediment samples will be collected along a single transect starting at the northern end of Site P and ending at the southern end of Site Q. The transect will be placed approximately 50 feet offshore and the screening sediment samples will be collected every 500 feet (a total of approximately 28 samples). The samples will be analyzed for volatile organic compounds using Method 8260B. Qualitative observations will be made of the presence of any benthic invertebrates and the grain size distribution. The results of the reconnaissance survey along with proposed sampling locations, will be presented to the USEPA in a concise technical memorandum.

This aquatic reconnaissance survey will also be used to locate the upstream reference locations and the downstream sampling locations. At least four of the nine downstream samples will be located in depositional areas. River currents and bathymetric data maintained by the U.S. Army Corps of Engineers and other agencies will be used to evaluate that downstream depositional areas are preferentially located along the eastern shore of the Mississippi River. Results of this data evaluation will be provided to the USEPA in a concise technical memorandum. Criteria for selection of the downstream samples are noted in Volume 3 of this SSP.

The detailed methodologies for collecting surface water, sediments and biological samples are specified in Volume 3 and Volume 4 of this SSP.

8.1 Site P

Surface water samples will be collected in the Mississippi River along three transects running parallel to the bank from the north to south end of Site P as shown in Figure 8-1. Transects will be located 50 feet, 150 feet and 300 feet from the bank. Three sampling stations will be located on each transect resulting in nine sampling stations within the plume discharge area associated with Sauget Area 2. One sampling station will be located at the center point of each transect. Another sampling station will be located half way between the center station and the upstream

end of each transect. A third sampling station will be located half way between the center station and the downstream end of each transect.

One surface water sample will be collected just above the surface water/sediment interface at each sampling station and analyzed for VOCs, SVOCs, Pesticides, Herbicides, PCBs, and Metals (both total and dissolved) to determine the concentration of these constituents in surface water within the groundwater discharge area. Surface water samples will also be analyzed for pH and hardness. Samples from five of the sampling locations will also be analyzed for dioxins. Dioxin samples will be collected at all three sampling stations on the transect located 50 feet from shore. Dioxin samples will be collected at the center sampling station on the transects located 150 feet and 300 feet from shore. Bioassays, using *Cerodaphnia* and Fat Head Minnows, will be performed on each surface water sample to evaluate surface water toxicity.

One sediment sample will be collected at each of the nine sampling stations and analyzed for VOCs, SVOCs, Pesticides, Herbicides, PCBs, and Metals to determine the concentration of these constituents in sediments. Sediments will also be analyzed for TOC, grain size and pH. Samples from five of the sampling locations will be analyzed for Dioxins. Dioxin samples will be collected at all three sampling stations on the transect located 50 feet from shore. Dioxin samples will be collected at the center sampling station on the transects located 150 feet and 300 feet from shore. Bioassays, using *Hyalella* and chironomids, will be performed on each sediment sample to determine sediment toxicity. Bioaccumulation tests will also be performed on sediment samples collected at the center sampling station on each transect.

Benthic community structure (species richness and biomass) will be determined using one grab samples collected at each of the nine sampling locations. Since the dominant river bottom substrate is sand, benthic communities are expected to be limited.

Three composite samples of each target fish species will be collected to determine the impact of groundwater discharge to surface water on bottom feeder, forager and predator fish. Fish tissue samples will be analyzed for VOCs, SVOCs, Pesticides, Herbicides, PCBs, Metals, and percent lipid. One composite sample of each target fish species will also be collected for dioxin analysis. Three to five fish of the same species will be collected for each composite. If not

enough of the target species are present to provide the tissue mass required for all chemical analyses, a species that uses the same food source will be collected and composited. This second species composite will be used to provide tissue mass for the remaining analytical methods.

Fish stomach contents will be examined and recorded to document food sources. Observations of the general physiologic condition of the fish will be made, including qualitative comments on health, behavioral abnormalities, and the presence/absence of lesions. Length and weight measurements will be maintained for those specimens that will be submitted for analyses.
A sample summary for Site P is as follows:

Number of Surface Water Samples: 9

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B (filtered and unfiltered for surface water)
	pH	EPA 150.1
	Hardness	EPA 130.2

Number of Sediment Samples: 9

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	TOC	Method 5310B
	Grain Size	ASTM D-422
	pH	Method 9045C
	Hardness	EPA 130.2

Number of Surface Water Dioxin Samples 5

Analyses: Dioxin Method 8290

Number of Sediment Dioxin Samples 5

Analyses: Dioxin Method 8280

Number of Benthic Community Structure Samples: 9

Number of Surface Water Bioassays

Cerodaphnia	9
Fat Head Minnow	9
	18

Number of Sediment Bioassays

Hyalella	9
Chironomids	9
	18

Number of Sediment Bioaccumulation Tests 3

Number of Fish Tissue Samples

Channel Catfish Composites (Whole Body)	3
Large Shad Composites (Whole Body)	3
Small Shad Composites (Whole Body)	3
Buffalo (Fillets)	3
	12

Analyses:	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B
	Percent lipid	AOAC 948.15

Number of Fish Tissue Dioxin Samples

Channel Catfish Composites (Whole Body)	1
Large Shad Composites (Whole Body)	1
Small Shad Composites (Whole Body)	1
Buffalo (Fillets)	1
	4

Analyses:	Dioxin	Method 8290

8.2 Sites O, R, S and Northern End of Site Q

Surface water samples will be collected in the Mississippi River along three transects running parallel to the bank from the north to south end of Site R as shown in Figure 8-1. Sites O and S and the northern end of Site Q are located upgradient of Site R. Transects will be located 50 feet, 150 feet and 300 feet from the bank. Three sampling stations will be located on each transect resulting in nine sampling stations within the plume discharge area associated with

Sauget Area 2. One sampling station will be located at the center point of each transect. Another sampling station will be located half way between the center station and the upstream end of each transect. A third sampling station will be located half way between the center station and the downstream end of each transect.

One surface water sample will be collected just above the surface water/sediment interface at each sampling station and analyzed for VOCs, SVOCs, pesticides, herbicides, PCBs, and metals (both total and dissolved) to determine the concentration of these constituents in surface water within the groundwater discharge area. Surface water samples will also be analyzed for pH and hardness. Samples from five of the sampling locations will also be analyzed for dioxins. Dioxin samples will be collected at all three sampling stations on the transect located 50 feet from shore. Dioxin samples will be collected at the center sampling station on the transects located 150 feet and 300 feet from shore. Bioassays, using *Cerodaphnia* and Fat Head Minnows, will be performed on each surface water sample to evaluate surface water toxicity.

One sediment sample will be collected at each of the nine sampling stations and analyzed for VOCs, SVOCs, pesticides, herbicides, PCBs, and metals to determine the concentration of these constituents in sediments. Sediments will also be analyzed for TOC, grain size and pH. Samples from five of the sampling locations will be analyzed for Dioxins. Dioxin samples will be collected at all three sampling stations on the transect located 50 feet from shore. Dioxin samples will be collected at the center sampling station on the transects located 150 feet and 300 feet from shore. Bioassays, using *Hyalella* and chironomids, will be performed on each sediment sample to determine sediment toxicity. Bioaccumulation tests will also be performed on sediment samples collected at the center sampling station on each transect.

Benthic community structure (species richness and biomass) will be determined using one grab samples collected at each of the nine sampling locations. Since the dominant river bottom substrate is sand, benthic communities are expected to be limited.

Three composite samples of each target fish species will be collected to determine the impact of groundwater discharge to surface water on bottom feeder, forager and predator fish. Fish tissue samples will be analyzed for VOCs, SVOCs, pesticides, herbicides, PCBs, metals, and percent

lipid. One composite sample of each target fish species will also be collected for dioxin analysis. Three to five fish of the same species will be collected for each composite. If not enough of the target species are present to provide the tissue mass required for all chemical analyses, a species that uses the same food source will be collected and composited. This second species composite will be used to provide tissue mass for the remaining analytical methods.

Fish stomach contents will be examined and recorded to document food sources. Observations of the general physiologic condition of the fish will be made, including qualitative comments on health, behavioral abnormalities, and the presence/absence of lesions. Length and weight measurements will be maintained for those specimens that will be submitted for analyses.

A sample summary for Sites O, R, S, and the northern end of Site O is as follows:

Number of Surface Water Samples: 9

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B (filtered and unfiltered for surface water)
	pH	EPA 150.1
	Hardness	EPA 130.2

Number of Sediment Samples: 9

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	TOC	Method 5310B
	Grain Size	ASTM D-422
	pH	Method 9045C
	Hardness	EPA 130.2

Number of Surface Water Dioxin Samples 5

Analyses: Dioxin Method 8290

Number of Sediment Dioxin Samples 5

Analyses: Dioxin Method 8280

Number of Benthic Community Structure Samples: 9

Number of Surface Water Bioassays

Cerodaphnia	9
Fat Head Minnow	9
	18

Number of Sediment Bioassays

Hyalella	9
Chironomids	9
	18

Number of Sediment Bioaccumulation Tests 3

Number of Fish Tissue Samples

Channel Catfish Composites (Whole Body)	3
Large Shad Composites (Whole Body)	3
Small Shad Composites (Whole Body)	3
Buffalo (Fillets)	3
	12

Analyses:		
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B
	Percent lipid	AOAC 948.15

Number of Fish Tissue Dioxin Samples

Channel Catfish Composites (Whole Body)	1
Large Shad Composites (Whole Body)	1
Small Shad Composites (Whole Body)	1
Buffalo (Fillets)	1
	4

Analyses: Dioxin Method 8290

8.3 Southern End of Site Q

Surface water samples will be collected in the Mississippi River along three transects running parallel to the bank from the south end of Site R to the south end of Site Q, as shown in Figure

8-1. Transects will be located 50 feet, 150 feet and 300 feet from the bank. Three sampling stations will be located on each transect resulting in nine sampling stations within the plume discharge area associated with Sauget Area 2. One sampling station will be located at the center point of each transect. Another sampling station will be located half way between the center station and the upstream end of each transect. A third sampling station will be located half way between the center station and the downstream end of each transect.

One surface water sample will be collected just above the surface water/sediment interface at each sampling station and analyzed for VOCs, SVOCs, pesticides, herbicides, PCBs, and metals (both total and dissolved) to determine the concentration of these constituents in surface water within the groundwater discharge area. Surface water samples will also be analyzed for pH and hardness. Samples from five of the sampling locations will also be analyzed for dioxins. Dioxin samples will be collected at all three sampling stations on the transect located 50 feet from shore. Dioxin samples will be collected at the center sampling station on the transects located 150 feet and 300 feet from shore. Bioassays, using *Cerodaphnia* and Fat Head Minnows, will be performed on each surface water sample to evaluate surface water toxicity.

One sediment sample will be collected at each of the nine sampling stations and analyzed for VOCs, SVOCs, pesticides, herbicides, PCBs, and metals to determine the concentration of these constituents in sediments. Sediments will also be analyzed for TOC, grain size and pH. Samples from five of the sampling locations will be analyzed for Dioxins. Dioxin samples will be collected at all three sampling stations on the transect located 50 feet from shore. Dioxin samples will be collected at the center sampling station on the transects located 150 feet and 300 feet from shore. Bioassays, using *Hyalella* and chironomids, will be performed on each sediment sample to determine sediment toxicity. Bioaccumulation tests will also be performed on sediment samples collected at the center sampling station on each transect.

Benthic community structure (species richness and biomass) will be determined using one grab samples collected at each of the nine sampling locations. Since the dominant river bottom substrate is sand, benthic communities are expected to be limited.

Three composite samples of each target fish species will be collected to determine the impact of groundwater discharge to surface water on bottom feeder, forager and predator fish. Fish tissue samples will be analyzed for VOCs, SVOCs, pesticides, herbicides, PCBs, metals, and percent lipid. One composite sample of each target fish species will also be collected for dioxin analysis. Three to five fish of the same species will be collected for each composite. If not enough of the target species are present to provide the tissue mass required for all chemical analyses, a species that uses the same food source will be collected and composited. This second species composite will be used to provide tissue mass for the remaining analytical methods.

Fish stomach contents will be examined and recorded to document food sources. Observations of the general physiologic condition of the fish will be made, including qualitative comments on health, behavioral abnormalities, and the presence/absence of lesions. Length and weight measurements will be maintained for those specimens that will be submitted for analyses.

A sample summary for the southern end of Site Q is as follows:

Number of Surface Water Samples: 9

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B (filtered and unfiltered for surface water)
	pH	EPA 150.1
	Hardness	EPA 130.2

Number of Sediment Samples: 9

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	TOC	Method 5310B
	Grain Size	ASTM D-422
	pH	Method 9045C
	Hardness	EPA 130.2

Number of Surface Water Dioxin Samples 5

Analyses:	Dioxin	Method 8290	
Number of Sediment Dioxin Samples			5
Analyses:	Dioxin	Method 8280	
Number of Benthic Community Structure Samples:			9
Number of Surface Water Bioassays			
Cerodaphnia			9
Fat Head Minnow			9
			18
Number of Sediment Bioassays			
Hyalella			9
Chironomids			9
			18
Number of Sediment Bioaccumulation Tests			3
Number of Fish Tissue Samples			
Channel Catfish Composites (Whole Body)			3
Large Shad Composites (Whole Body)			3
Small Shad Composites (Whole Body)			3
Buffalo (Fillets)			3
			12
Analyses:	SVOCs	Method 8270C	
	Pesticides	Method 8081A	
	Herbicides	Method 8151A	
	PCBs	Method 680	
	Metals	Method 6010B	
	Percent lipid	AOAC 948.15	
Number of Fish Tissue Dioxin Samples			
Channel Catfish Composites (Whole Body)			1
Large Shad Composites (Whole Body)			1
Small Shad Composites (Whole Body)			1
Buffalo (Fillets)			1
			4
Analyses:	Dioxin	Method 8290	

8.4 Upstream Reference Areas

Surface water and sediment samples will be collected at nine locations in the Mississippi River upstream of Sauget Area 2. Sampling locations will be selected during a reconnaissance survey conducted approximately one month prior to sample collection. The objective of this portion of the sampling program is to collect data to provide a baseline comparing urban-area impacts to site-related impacts. An additional objective is to collect data to provide an understanding of the background conditions of surface water and sediments for use in determining upstream contributions of constituents of concern.

One surface water sample will be collected just above the surface water/sediment interface at each sampling station and analyzed for analyzed VOCs, SVOCs, Pesticides, Herbicides, PCBs, Dioxins, and Metals (both filtered and unfiltered) to determine the concentration of these constituents in surface water. Surface water samples will also be analyzed for pH and hardness. Bioassays, using *Cerodaphnia* and Fat Head Minnows, will be performed on each surface water sample to evaluate surface water toxicity.
One sediment sample will be collected at each sampling station and analyzed VOCs, SVOCs, Pesticides, Herbicides, PCBs, Dioxins, and Metals to determine the concentration of these constituents in sediments. Sediments will also be analyzed for TOC, grain size and pH. Bioassays, using *Hyalella* and chironomids, will be performed on each sediment sample to determine sediment toxicity. Bioaccumulation tests will also be performed on each sediment samples. Benthic community structure (species richness and biomass) will be evaluated at each sampling location.

Three composite samples of each target fish species will be collected at the upstream reference area locations to determine background concentrations of constituents of concern in bottom feeder, forager and predator fish. Fish tissue samples will be analyzed for VOCs, SVOCs, Pesticides, Herbicides and PCBs. One composite sample of each target fish species will be collected for dioxin analysis. Three to five fish of the same species will be collected for each composite. If not enough of the target species are present to provide the tissue mass required for all chemical analyses, a species that uses the same food source will be collected and composited. This second species composite will be used to provide tissue mass for the remaining analytical methods.

Fish stomach contents will be examined and recorded to document food sources. Observations of the general physiologic condition of the fish will be made, including qualitative comments on health, behavioral abnormalities, and the presence/absence of lesions. Length and weight measurements will be maintained for those specimens that will be submitted for analyses.

A sample summary for the upstream reference areas is as follows:

Number of Surface Water Samples: 9

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B (filtered and unfiltered for surface water)
	pH	EPA 150.1
	Hardness	EPA 130.2

Number of Sediment Samples: 9

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	TOC	Method 5310B
	Grain Size	ASTM D-422
	pH	Method 9045C
	Hardness	EPA 130.2

Number of Surface Water Dioxin Samples 9

Analyses: Dioxin Method 8290

Number of Sediment Dioxin Samples 9

Analyses: Dioxin Method 8280

Number of Benthic Community Structure Samples: 9

Number of Surface Water Bioassays

Cerodaphnia	9
Fat Head Minnow	9
	18

Number of Sediment Bioassays

Hyalella	9
Chironomids	9
	18

Number of Sediment Bioaccumulation Tests 9

Number of Fish Tissue Samples

Channel Catfish Composites (Whole Body)	3
Large Shad Composites (Whole Body)	3
Small Shad Composites (Whole Body)	3
Buffalo (Fillets)	3
	12

Analyses:	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B
	Percent lipid	AOAC 948.15

Number of Fish Tissue Dioxin Samples

Channel Catfish Composites (Whole Body)	1
Large Shad Composites (Whole Body)	1
Small Shad Composites (Whole Body)	1
Buffalo (Fillets)	1
	4

Analyses:	Dioxin	Method 8290

8.5 Downstream Areas

Surface water and sediment samples will be collected at nine locations in the Mississippi River downstream of Sauget Area 2. Sampling locations will be selected during a reconnaissance survey conducted approximately one month prior to sample collection. The objective of the downstream sampling is to assess whether constituents of concern potentially released in the groundwater discharge areas have accumulated in downstream locations in close proximity of the Sites at concentrations that would pose an ecological risk. Noting that depositional areas contain the greatest benthic habitat, a minimum of four of the nine sampling locations will be placed in depositional areas.

One surface water sample will be collected just above the surface water/sediment interface at each sampling station and analyzed for VOCs, SVOCs, Pesticides, Herbicides, PCBs, Dioxins and Metals (both filtered and unfiltered) to determine the concentration of these constituents in surface water. Surface water samples will also be analyzed for pH and hardness. Bioassays, using *Cerodaphnia* and Fat Head Minnows, will be performed on each surface water sample to evaluate surface water toxicity.

One sediment sample will be collected at each sampling station and analyzed for VOCs, SVOCs, Pesticides, Herbicides, PCBs, Dioxins, and Metals to determine the concentration of these constituents in sediments. Sediments will also be analyzed for TOC, grain size and pH. Bioassays, using Hyalella and chironomids, will be performed on each sediment sample to determine sediment toxicity. Bioaccumulation tests will also be performed on each sediment sample. Benthic community structure (species richness and biomass) will be evaluated at each sampling location.

Composite samples of each target fish species will be collected downstream to determine background concentrations of constituents of concern in bottom feeder, forager and predator fish. Fish tissue samples will be analyzed for VOCs, SVOCs, Pesticides, Herbicides and PCBs. One composite sample of each target fish species will be collected for dioxin analysis at each location. Three to five fish of the same species will be collected for each composite. If not enough of the target species are present to provide the tissue mass required for all chemical analyses, a species that uses the same food source will be collected and composited. This second species composite will be used to provide tissue mass for the remaining analytical methods.

Fish stomach contents will be examined and recorded to document food sources. Observations of the general physiologic condition of the fish will be made, including qualitative comments on health, behavioral abnormalities, and the presence/absence of lesions. Length and weight measurements will be maintained for those specimens that will be submitted for analyses.

A sample summary for the downstream areas is as follows:

Number of Surface Water Samples: 9

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B (filtered and unfiltered for surface water)
	pH	EPA 150.1
	Hardness	EPA 130.2

Number of Sediment Samples: 9

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	TOC	Method 5310B
	Grain Size	ASTM D-422
	pH	Method 9045C
	Hardness	EPA 130.2

Number of Surface Water Dioxin Samples 9

Analyses: Dioxin Method 8290

Number of Sediment Dioxin Samples 9

Analyses: Dioxin Method 8280

Number of Benthic Community Structure Samples: 9

Number of Surface Water Bioassays

Cerodaphnia	9
Fat Head Minnow	9
	18

Number of Sediment Bioassays

Hyalella	9
Chironomids	9
	18

Number of Sediment Bioaccumulation Tests 9

Number of Fish Tissue Samples

Channel Catfish Composites (Whole Body)	3
Large Shad Composites (Whole Body)	3
Small Shad Composites (Whole Body)	3
Buffalo (Fillets)	3
	12

Analyses:	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B
	Percent lipid	AOAC 948.15

Number of Fish Tissue Dioxin Samples

Channel Catfish Composites (Whole Body)	1
Large Shad Composites (Whole Body)	1
Small Shad Composites (Whole Body)	1
Buffalo (Fillets)	1
	4

Analyses:	Dioxin	Method 8290

8.6 Terrestrial Assessment

Composite plant samples will be collected at the same location as the four surface soil samples collected at Sites O, P, R and S, and the eight surface soil samples collected at Site Q to determine the concentration of site-related constituents in vegetation. Sampling will focus on plants used by voles (herbivore endpoint organism) as a food source. Composite earthworm samples will also be collected at these locations to determine the concentration of site-related constituents in the vermivore endpoint organism's (shrew) food source. Samples will be analyzed for SVOCs, Pesticides, Herbicides, PCBs, Dioxin, and Metals.

Number of Composite Plant Samples: 24

Analyses:	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680

Dioxin	Method 8290
Metals	Method 6010B
Percent Moisture	EPA 160.3

Number of Composite Earthworm Samples: 24

Analyses:	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Dioxin	Method 8290
	Metals	Method 6010B
	Percent Lipid	AOAC 948.15

8.7 Ponded Area Habitat Assessment

Two ponded areas occur at the south end of Site Q. Surface water and sediment samples will be collected at three locations in the each of the ponded areas to determine the concentration of site-related constituents in these media. Samples will be analyzed for VOCs, SVOCs, Pesticides, Herbicides, PCBs, Dioxin and Metals (both filtered and unfiltered for surface water). Surface water samples will also be analyzed for pH and hardness. Sediments will also be analyzed for TOC, grain size and pH. Benthic community structure (species richness and biomass) will be determined using one grab sample collected at each of the six sediment sampling stations. Bioassays will be performed on the surface water and sediment samples to determine the toxicity of these two environmental media to sensitive test organisms. Bioaccumulation tests will also be performed on the sediment samples.

A summary of the samples to be collected from the two ponds is as follows:

Number of Surface Water Samples: 6

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	Metals	Method 6010B (filtered and unfiltered for surface water)
	pH	EPA 150.1
	Hardness	EPA 130.2

Number of Sediment Samples: 6

Analyses:	VOCs	Method 8260B
	SVOCs	Method 8270C
	Pesticides	Method 8081A
	Herbicides	Method 8151A
	PCBs	Method 680
	TOC	Method 5310B
	Grain Size	ASTM D-422
	pH	Method 9045C

Number of Surface Water Dioxin Samples 6

Analyses: Dioxin Method 8290

Number of Sediment Dioxin Samples 6

Analyses: Dioxin Method 8280

Number of Benthic Community Structure Samples: 6

Number of Surface Water Bioassays

Cerodaphnia	6
Fat Head Minnow	6
	12

Number of Sediment Bioassays

Hyalella	6
Chironomids	6
	12

Number of Sediment Bioaccumulation Tests 6

Figure 8-1

Generalized Sauget Area 2

Aquatic Sampling Sites

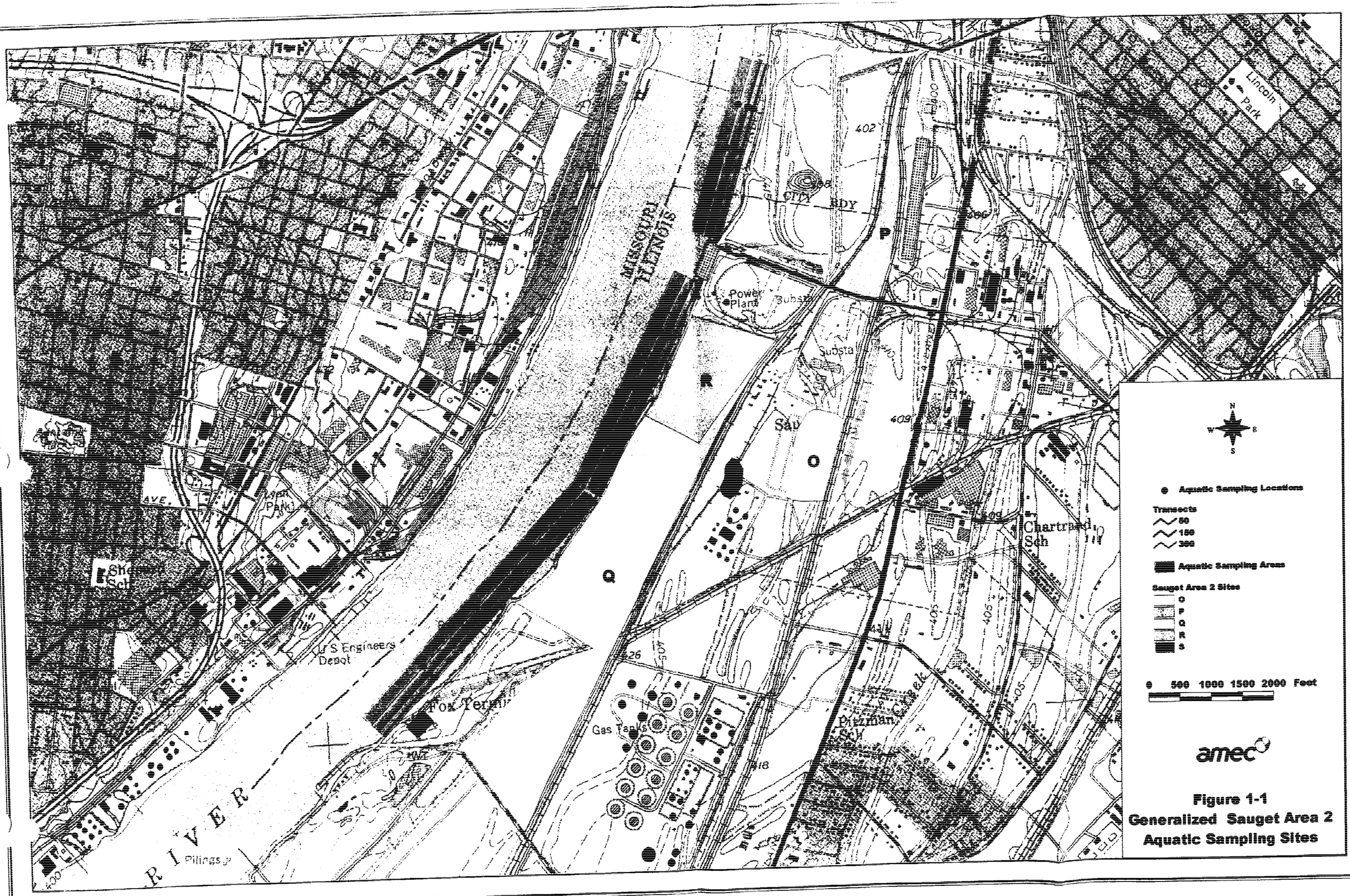


Figure 1-1
Generalized Sauget Area 2
Aquatic Sampling Sites

9.0 Air Sampling Plan

Ambient air samples will be collected to determine the tendency of site constituents to enter the atmosphere and local wind patterns. Air sampling data will be used in the Human Health Risk Assessment.

9.1 Site P

24-hour duration air samples will be collected at Site P to determine the tendency of site constituents to enter the atmosphere and local wind patterns. Two upwind and two downwind sorbent tube/PUF/PM2.5 samplers will be installed at the site during weather likely to produce emissions, e.g. hot and dry conditions in August.

Number of Air Samples:		4
Analyses:	VOCs	TO15/Method 8260B
	SVOCs	TO13/Method 8270C
	Pesticides	TO4/Method 8081A
	PCBs	TO4/Method 680
	Dioxin	TO 9/Method 8290
	Metals	Method 6010B

9.2 Sites O, R and S

24-hour duration air samples will be collected at Sites O, R and S to determine the tendency of site constituents to enter the atmosphere and local wind patterns. Two upwind and two downwind sorbent tube/PUF/PM2.5 samplers will be installed at the site during weather likely to produce emissions, e.g. hot and dry conditions in August. These sites are combined into one sampling area because of their close proximity.

Number of Air Samples:		4
Analyses:	VOCs	TO15/Method 8260B
	SVOCs	TO13/Method 8270C
	Pesticides	TO4/Method 8081A
	PCBs	TO4/Method 680
	Dioxin	TO 9/Method 8290

	Metals	Method 6010B

9.3 Site Q

24-hour duration air samples will be collected at Site Q to determine the tendency of site constituents to enter the atmosphere and local wind patterns. Four upwind and four downwind sorbent tube/PUF/PM2.5 samplers will be installed at the site during weather likely to produce emissions, e.g. hot and dry conditions in August.

Number of Air Samples: 8

Analyses:	VOCs	TO15/Method 8260B
	SVOCs	TO13/Method 8270C
	Pesticides	TO4/Method 8081A
	PCBs	TO4/Method 680
	Dioxin	TO 9/Method 8290
	Metals	Method 6010B

Section 10

10.0 Treatability Testing Plan

10.1 Off-Site Incineration

Treatability tests will be conducted on wastes in order to identify any characteristics of these materials that would prevent their treatment using off-site incineration. One composite sample will be made for each site from the samples collected from the waste characterization borings installed at each disposal site (Sites O, P, Q, R and S). These samples will be sent to an RCRA/TSCA-permitted, fixed-facility incinerator operator for waste profiling, material handling characterization and evaluation of the feasibility of disposing of the waste material by off-site incineration. Current plans call for sending aliquots of these samples to SafetyKleen who operates off-site thermal treatment facilities at Deer Park, Texas and Coffeyville, Kansas. SafetyKleen's Coffeyville facility is the only incinerator permitted to accept dioxin-containing materials from RCRA-listed processes and currently operates on a campaign-based schedule only. Another aliquot will be sent to Onyx Environmental who operates incinerators at Sauget, Illinois and Port Arthur, Texas. These four locations are the fixed-facility, hazardous waste incinerators closest to Sauget Area 2.

10.2 Off-Site Disposal

Treatability tests will be conducted on wastes in order to identify any characteristics of these materials that would prevent off-site disposal. One composite sample will be made for each site from the samples collected from the waste characterization borings installed at each disposal site (Sites O, P, Q, R and S). These samples will be sent to an RCRA/TSCA-permitted, landfill operator for waste profiling, material handling characterization and evaluation of the feasibility of disposing of the waste material by off-site landfilling. Current plans call for sending aliquots of these samples to SafetyKleen who operates an RCRA/TSCA permitted, off-site disposal facility at Lone Mountain, Oklahoma. Another aliquot will be sent to Waste Management who operates an RCRA/TSCA-permitted, off-site disposal facility at Emelle, Alabama. These two locations are the off-site, RCRA/TSCA-permitted, hazardous waste landfills closest to Sauget Area 2.

10.3 On-Site Thermal Desorption

Treatability tests will be conducted on wastes in order to identify any characteristics of these materials that would prevent their treatment using on-site thermal desorption. One composite sample will be made for each site from the samples collected from the waste characterization borings installed at each disposal site (Sites O, P, Q, R and S). These samples will be sent to a contractor who has a nation-wide permit for pyrolitic thermal desorption of RCRA-regulated materials, PCBs and Dioxin. The selected contractor will perform waste profiling, material handling characterization and evaluation of the feasibility of treating the waste material by thermal desorption. The contractor will be selected and identified to the Agency prior to composite waste sample shipment.

10.4 On-Site and Off-Site Physical/Chemical Leachate Treatment

Leachate treatability testing will be done to determine the physical/chemical processes needed to achieve pretreatment requirements for discharge to the American Bottoms POTW, i.e. no pass through and no interference. Leachate treatability tests will be conducted for each site on samples collected from the two-inch diameter leachate sampling wells installed at Sites O, P, Q, R and S as part of the Waste, Soil and Stormwater Sampling Plan. Treatability testing will be conducted by the Advent Group, Brentwood, Tennessee who currently provides technical consulting services to the American Bottoms Regional Treatment Facility

10.5 Off-Site Biological Leachate Treatment

Treatability testing will be done to determine if leachate can be discharged directly to the American Bottoms POTW without resulting in pass through and/or interference. Leachate treatability tests will be conducted for each site on samples collected from the two-inch diameter leachate sampling wells installed at Sites O, P, Q, R and S as part of the Waste, Soil and Stormwater Sampling Plan. Treatability testing will be conducted by the Advent Group, Brentwood, Tennessee who currently provides technical consulting services to the American Bottoms Regional Treatment Facility

Section 11

11.0 HUMAN HEALTH RISK ASSESSMENT WORK PLAN

This section of the Support Sampling Plan (SSP) presents a work plan for evaluating human health risks using data collected as part of the Remedial Investigation and Feasibility Study (RI/FS) for the Sauget Area 2 Site located in Sauget and Cahokia, Illinois. In addition, this work plan has been developed to satisfy the Scope of Work (SOW) for the RI/FS, provided as an attachment to the Administrative Order by Consent (AOC) entered into by the U.S. Environmental Protection Agency (USEPA) and the Sauget Area 2 Sites Group, as well as to be compliant with the National Contingency Plan (NCP) (USEPA, 1990). Specifically, the order requires the following:

> "The risk assessment shall focus on actual and potential risks to persons coming into contact with on-site contaminants as well as risks to the surrounding residential and industrial worker populations from exposure to contaminated soils, sediments, surface water, air, and ingestion of contaminated organisms in surrounding impacted ecosystems. Reasonable maximum estimates of exposure shall be defined for both current land use conditions and reasonable future land use conditions. It shall use data from the Site to identify the chemicals of concern, provide an estimate of how and to what extent human receptors might be exposed to these chemicals, and provide an assessment of the health effects associated with these chemicals. The evaluation shall project the potential risk of health problems occurring if no cleanup action is taken at the Site and establish target action levels for COCs (carcinogenic and non-carcinogenic). The risk evaluation shall be conducted in accordance with U.S. EPA guidance including, at a minimum: Risk Assessment Guidance for Superfund (RAGS) (EPA/540/1-89/002, December 1989) and RAGS Part D (EPA 540/R/97/033, January 1998). The risk assessment shall also include the following elements:
>
> - Hazard Identification (sources). The Respondents shall review available information on the hazardous substances present at the Site and identify the major contaminants of concern.
> - Dose-Response Assessment. Contaminants of concern should be selected based on their intrinsic toxicological properties.

- Conceptual Exposure/Pathway Analysis.
- Characterization of Site and Potential Receptors.
- Exposure Assessment. Respondents shall develop reasonable maximum estimates of exposure for both current land use conditions and potential land use conditions at the Site.
- Risk Characterization.
- Identification of Limitations/Uncertainties."

An evaluation of human health risks will be conducted to satisfy the AOC SOW following available guidance from the USEPA.

11.1 Risk Assessment Overview

A human health risk assessment (HHRA) will be conducted to address the aforementioned objectives and to comply with USEPA guidance for conducting a risk assessment including, but not limited to, the following:

- Risk Assessment Guidance for Superfund (RAGS): Volume 1 - Human Health Evaluation Manual (Part A) (USEPA, 1989a);
- Risk Assessment Guidance for Superfund (RAGS): Volume 1 - Human Health Evaluation Manual (Part D) (USEPA, 1998a);
- Human Health Evaluation Manual Supplemental Guidance; Standard Default Exposure Factors (USEPA, 1991a);
- Guidelines for Exposure Assessment (USEPA, 1992a);
- Land Use in the CERCLA Remedy Selection Process (USEPA, 1995a);
- USEPA Soil Screening Guidance: User's Guide and the Technical Background Document (USEPA, 1996a, b); and
- Exposure Factors Handbook (EFH) (USEPA, 1997a).

The HHRA will evaluate potential human health effects using the four step paradigm as identified by the USEPA (USEPA, 1989a). The steps are:

- Data Evaluation and Hazard Identification
- Toxicity Assessment
- Exposure Assessment
- Risk Characterization

Work Plan Organization

The HHRA work plan is organized into the following sections:

- Site Characterization – Section 11.2 of this work plan discusses the site and its environs, and presents a conceptual site model describing sources, potential migration pathways, and potentially impacted media.
- Hazard Identification – Section 11.3 of this work plan presents a discussion of how site data will be summarized, and a description of the process used for the selection of constituents of potential concern (COPCs) to be evaluated quantitatively in the risk assessment.
- Dose-Response Assessment – Section 11.4 of this work plan presents a discussion of the dose-response assessment process. The dose-response assessment evaluates the relationship between the magnitude of exposure (dose) and the potential for occurrence of specific health effects (response) for each COPC. Both potential carcinogenic and noncarcinogenic effects will be considered. The most current USEPA-verified dose-response values will be used when available.
- Exposure Assessment - Section 11.5 of this work plan presents a discussion of the exposure assessment process. The purpose of the exposure assessment is to provide a quantitative estimate of the magnitude and frequency of potential exposure to COPCs by a receptor. Potentially exposed individuals, and the pathways through which those individuals may be exposed to COPCs are identified based on the physical characteristics of the site, as well as the current and reasonably foreseeable future uses of the site and surrounding area. The extent of a receptor's exposure is estimated by constructing exposure scenarios that describe the potential pathways of exposure to COPCs and the activities and behaviors of individuals that might lead to contact with COPCs in the environment.

- Risk Characterization – Section 11.6 of this work plan presents a discussion of the risk characterization process and uncertainties associated with the risk assessment process. Risk characterization combines the results of the exposure assessment and the toxicity assessment to derive site-specific estimates of potentially carcinogenic and noncarcinogenic risks resulting from both current and reasonably foreseeable future potential human exposures to COPCs. The results of the risk characterization will be used to identify constituents of concern (COCs), which are the subset of those COPCs whose risks result in an exceedance of the target risk range of 10^{-6} to 10^{-4} for potential carcinogens and a target Hazard Index of 1 for noncarcinogens (that act on the same target organ) (USEPA, 1990; 1991b).
- Within any of the steps of the risk assessment process described above, assumptions must be made due to a lack of absolute scientific knowledge. Some of the assumptions are supported by considerable scientific evidence, while others have less support. The assumptions that introduce the greatest amount of uncertainty in this risk evaluation will be discussed in the Risk Characterization section of the HHRA report.
- Summary and Conclusions - Section 11.7 discusses the summary and conclusions section of the final report.
- References - Section 11.8 presents the references used in this work plan.

11.2 Site Characterization

The Sauget Area 2 Sites as defined in the AOC, encompass Sites O, P, Q, R, and S located within the Villages of Sauget and Cahokia, St. Clair County, Illinois. In addition, a field area immediately south of Site Q will be investigated. A detailed description of the Sites is presented in Section 2 of this RI/FS SSP. This work plan addresses the following media:

- Groundwater and leachate as identified in the SSP;
- Surface and subsurface soil as identified in the SSP;
- Surface water and sediment collected from the Mississippi River and Site Q, if present, as identified in the SSP; and
- Game fish collected from the Mississippi River and Site Q, if present, as identified in the SSP.

To guide identification of appropriate exposure pathways for evaluation in the risk assessment, a conceptual site model (CSM) for human health has been developed. The purpose of the CSM is to identify sources, potential migration pathways of constituents from sources to media where exposure can occur, and to identify potential human receptors. Potential exposure pathways and potential receptors are discussed in Section 11.5.

Conceptual Site Model

For the purposes of this CSM, the sources of constituents in environmental media are assumed to be the Sauget Area 2 Sites O, P, Q, R, and S.

Constituents in the Sites may have discharged to soils and from there leached to underlying groundwater. Volatile organic compounds (VOCs) in groundwater and/or leachate may volatilize into outdoor air and may infiltrate into indoor air in overlying buildings. Constituents in groundwater may discharge to the Mississippi River and to the Site Q ponds. Game fish in these water bodies may have accumulated constituents present in surface water and/or sediments. Figure 11-1 presents a CSM for Sauget Area 2. The CSM identifies potential sources, potential environmental release mechanisms, potential exposure pathways, potential exposure routes, and potential human receptors. Those potentially complete exposure pathways to be considered for further evaluation in the risk assessment are identified. Receptors and pathways are discussed in more detail in Section 11.5.

USEPA states that, "Sites that are surrounded by operating industrial facilities can be assumed to remain as industrial areas unless there is an indication that this is not appropriate" (USEPA, 1991b). This is consistent with the statement in the NCP that "... the assumption of future residential land use may not be justifiable if the probability that the site will support residential use in the future is small" (USEPA, 1990).

The Sites covered by the AOC have been used for industrial purposes for many years and use of these areas is expected to remain industrial. Therefore, receptors have been identified in the CSM based on an industrial land use scenario.

The CSM is meant to be a "living" model that can be updated and modified as additional data become available. The exposure scenarios proposed for quantitative evaluation in the risk assessment (see Section 11.5) have been identified based on this current CSM. However, the CSM will be reviewed and modified, as necessary, once the analytical data from the SSP program have become available. Any substantial changes in the CSM and, subsequently, the pathways for quantitative evaluation, will be discussed with USEPA prior to conduct of the risk assessment.

11.3 Hazard Identification

The purpose of the hazard identification process is two-fold: 1) to evaluate the nature and extent of release of constituents present at the site; and 2) to select a subset of constituents identified as COPCs for quantitative evaluation in the risk assessment. This step of the risk assessment will involve compiling and summarizing the RI/FS SSP data for the risk assessment, and selecting COPCs based on a series of screening steps.

11.3.1 Data Compilation

The RI/FS SSP has been developed to address the potential media and migration pathways identified in Section 11.2. Sampling to be conducted in support of the HHRA include the following:

- Shallow groundwater (the uppermost interval sampled from each groundwater sampling location);
- Leachate;
- Surface soil (0 - 0.5 feet below ground surface -- bgs);
- Subsurface soil (unsaturated soil 0.5 feet bgs to 6 feet bgs);
- Surface water;
- Sediment;
- Game fish fillet tissue; and
- 24-hour air samples.

Analytical data for use in the HHRA from background or reference locations will be available for the following media:

- Surface soil;
- Subsurface soil;
- Upgradient groundwater;
- Upstream surface water;
- Upstream sediment;
- Fish tissue; and
- Upwind 24-hour air samples.

The RI/FS SSP identifies the suites of analytes for each medium. Groundwater, leachate, surface water, sediment, soil and air samples will be analyzed for VOCs, semi-volatile organic compounds (SVOCs), pesticides, herbicides, polychlorinated biphenyls (PCBs), metals, and dioxins. Game fish fillet tissue will be analyzed for SVOCs, pesticides, herbicides, PCBs, metals, and dioxins. The sampling program is discussed in detail in Sections 6.0, 7.0, 8.0, and 9.0 of this RI/FS SSP.

Because the air samples are 24-hour samples collected at a single time point, they will not be used in the calculation of risks in the HHRA. However, the data will be compared to USEPA Region 9 Preliminary Remediation Goals (PRGs) for air (USEPA, 2000a).

Analytical data collected in support of the SSP will be compiled and tabulated in a database for statistical analysis. Summary statistics tables will be developed for each medium in each area, and will present for each constituent the minimum and maximum detected values, the arithmetic mean, the 95th percentile upper confidence limit (95% UCL) on the arithmetic mean (USEPA, 1992b), and the frequency of detection.

The following guidance documents will be used to calculate summary statistics and select exposure point concentrations (EPCs) for the COPCs:

- Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual, Part A (USEPA, 1989a);
- Supplemental Guidance to RAGS: Calculating the Concentration Term (USEPA, 1992b).

The EPC is defined as the 95% UCL or the maximum concentration, whichever is lower (USEPA, 1992b), or the arithmetic mean concentration, depending on the exposure scenario (see Section 11.3.1.2). Several statistics for the data must be calculated before the EPC can be determined. Section 11.3.1.1 describes how these summary statistics are calculated. Section 11.3.1.2 describes how this information is used to select EPCs for the risk assessment.

11.3.1.1 Summary Statistics

Summary statistics will be calculated based on the following. Constituents analyzed but never detected in a particular medium will not be included in the summary statistics for that medium. For constituents detected at least once in a particular medium, samples reported as "non-detect" by the laboratory will be assigned a value of one-half the sample quantitation limit in calculating summary statistics (USEPA, 1989a). Duplicate sample results will be averaged and treated as a single sample result when compiling summary statistics (USEPA, 1989b).

The calculation of the 95% UCL for a dataset appropriate for a risk assessment is dependent on the distribution of the data (USEPA, 1992b). If the data are normally distributed, the 95% UCL is calculated using the t-statistic (USEPA, 1992b) as follows:

where:

x = arithmetic mean of the untransformed data
t = the student-t statistic for n-1 degrees of freedom
n = the number of samples in the population
SD = the standard deviation of the untransformed data

However, if the data are lognormally distributed, the 95% UCL is calculated using the transformed data set and the H-statistic (USEPA, 1992b). The data are "transformed" by using

the natural logarithmic function, i.e., by calculating ln(x) for each x value in the data set using the following equation:

where:

e = base of the natural log, equal to 2.718

x = mean of the transformed data

SD = standard deviation of the transformed data

H = H-statistic

n = the number of samples in the population

The t-statistic and H-statistic values will be obtained from Gilbert (1987). There is currently a debate within USEPA on whether the H-statistic is an appropriate metric to be used to describe the upperbound of a non-normally distributed sample population for environmental programs (USEPA, 1998b). USEPA Regions 4 and 6 have recently accepted alternative methods for defining the upperbound concentration; these and the most current guidance available at the time of the conduct of the risk evaluation will be considered in the development of summary statistics for use in the HHRA.

The W-statistic test (Gilbert, 1987) is one test that can be used to determine whether a dataset is either more normally or lognormally distributed (USEPA, 1992b). The W-statistic will be calculated for each COPC in each medium for both the transformed and untransformed datasets. This information will be used as described below.

11.3.1.2 Selection of Exposure Point Concentrations

Because in many instances the W-statistic can not definitively describe the distribution as either normal or lognormal, and because there is no guidance as to how to choose an EPC when the dataset is neither normal nor lognormal, EPCs for upperbound or reasonable maximum exposure (RME) scenarios will be chosen using the following steps for each COPC in each medium if the t-statistic and H-statistic approach is used:

- The maximum value, the 95% UCL (untransformed) and the 95% UCL (transformed) will be calculated;
- The W-test will be performed on the untransformed and the transformed data;
- The W-test values will be compared;
- If the untransformed data have the higher W-statistic, the lower of the 95% UCL (untransformed) and the maximum value will be chosen as the EPC; and,
- If the transformed data have the higher W-statistic, the lower of the 95% UCL (transformed) and the maximum value will be chosen as the EPC.

Arithmetic mean concentrations will be used as EPCs for COPCs for the most likely exposure (MLE) scenarios. Tables presenting the EPC selection data for each medium will be presented in the report.

11.3.2 Selection of Constituents of Potential Concern

COPCs are a subset of the complete list of constituents detected in site media that are carried through the quantitative risk assessment process. Selection of COPCs focuses the analysis on the most likely risk "drivers." As stated in USEPA guidance (USEPA, 1993):

> "Most risk assessments are dominated by a few compounds and a few routes of exposure. Inclusion of all detected compounds at a site in the risk assessment has minimal influence on the total risk. Moreover, quantitative risk calculations using data from environmental media that may contain compounds present at concentrations too low to adversely affect public health have no effect on the overall risk estimate for the site. The use of a toxicity screen allows the risk assessment to focus on the compounds and media that may make significant contributions to overall risk."

Therefore, COPCs will be identified by comparing constituent-specific analytical data for environmental media to appropriate screening criteria and conducting a quantitative risk assessment for those constituents detected in an environmental medium in excess of the screening criteria.

Several factors are typically considered in selecting COPCs for a site, including background, frequency of detection, and toxicity, including essential nutrient status. Risk calculations will be conducted using the COPCs identified in this step.

COCs will then be identified in the risk characterization of the HHRA as those constituents whose risks result in an exceedance of the target risk range of 10^{-6} to 10^{-4} for potential carcinogens and a target Hazard Index of 1 for noncarcinogens (that act on the same target organ), (USEPA, 1990, 1991b). Remedial goals will be developed for COCs based on the exposure pathways evaluated in the risk assessment.

The steps to be used to identify COPCs are presented below.

11.3.2.1 Evaluation of Frequency of Detection and Essential Nutrient Status

A frequency of detection screen will be conducted on each medium (e.g., surface soil, subsurface soil, etc.). Constituents that are detected in fewer than 5% of samples, provided 20 samples are available, will not be included as COPCs. However, some of these constituents may be retained as COPCs based on professional judgment, considering factors such as the presence of a hotspot. In addition to the frequency of detection screen, essential nutrients (i.e., calcium, iron, magnesium, sodium and potassium) will not be included as COPCs (USEPA, 1989a).

11.3.2.2 Comparison to Background

Background and upgradient samples to be collected in the vicinity of the Sites present information on levels of constituents typical for the local area. The purpose of comparing site conditions to local background is to determine if site concentrations of constituents are representative of background concentrations, which, therefore, should not be included in risk calculations. Background comparisons will be conducted for each medium using site-specific background data. These background data will be evaluated in the context of data from the two southern background locations from Sauget Area 1 and other published information such as concentrations for rural and urban areas of Illinois published by the Illinois Environmental Protection Agency (IEPA, 1994, 1998).

The procedure for determining whether a constituent concentration is consistent with background will follow that developed by USEPA Region 4 (USEPA, 2000b). Maximum detected concentrations of constituents in environmental media at the site will be compared against two times the arithmetic mean site-specific background concentration. USEPA Region 4 states that although RAGS (USEPA, 1989a) allows the use of statistics in data evaluation, statistics may not be sufficiently conservative at this stage of the risk evaluation; and in most cases, there are not a sufficient number of samples for conducting a statistical analysis. Therefore, if maximum concentrations of constituents in an area are found to be less than two times the average background concentrations, then those constituents can be eliminated from quantitative evaluation in the risk assessment. Constituents whose concentrations are found to be above typical local background levels will be retained for evaluation in the next step of the hazard identification process (Toxicity Screen).

11.3.2.3 Toxicity Screen

A toxicity screen will be performed in accordance with USEPA Region 5 guidance (USEPA, 1998c). USEPA Region 5 guidance identifies the following three sources as appropriate screening levels for soil, in order of preference:

1) Most recent generic soil screening levels (SSLs) developed and presented in Appendix A of the Soil Screening Guidance (USEPA, 1996b). The SSLs are based on ingestion and inhalation (direct contact) and soil-to-groundwater exposure pathways for a residential scenario.
2) Site-specific SSLs derived using the methodology outlined in the above reference.
3) Most recent USEPA Region 9 PRGs (USEPA, 2000a).

The USEPA Region 9 PRGs are more comprehensive because values are provided for a longer list of constituents, and PRGs are available for both residential and industrial scenarios. Therefore, USEPA Region 9 PRGs for industrial soils and ambient air will be used to identify COPCs in soil and sediment, and to evaluate the 24-hour air data, respectively.

Groundwater in Sauget Area 2 is classified as Class I by IEPA. Groundwater in Sauget Area 2 is not used as a source of drinking water and there are ordinances in effect in the Villages of

Sauget and Cahokia (see information provided in Appendix 2) that prohibit the use of groundwater as drinking water. Therefore, groundwater will not be evaluated as a source of residential or industrial drinking water in the risk assessment. The risk assessment will evaluate potential incidental exposure to constituents in groundwater and/or leachate via volatilization of constituents to indoor and outdoor air, and via direct contact with groundwater and/or leachate during excavation activities. To provide a Class I evaluation of groundwater in Sauget Area 2, constituent concentrations in groundwater will be compared to IEPA Class I standards (35 Ill. Adm. Code 620.410). In a separate comparison, for the identification of COPCs to be evaluated quantitatively for the groundwater and surface water scenarios addressed in the risk assessment, constituent concentrations will be compared to IEPA Class II standards (35 Ill. Adm. Code 620.420).

For the Class I groundwater comparison, where Class I standards are not available, federal maximum contaminant levels (MCLs) (USEPA, 2000c) will be used; where MCLs are not available, the IEPA remediation objectives for Class I groundwater will be used (IEPA, 1998); where these are not available, the most current USEPA PRGs (USEPA, 2000a) for tap water will be used.

Fish tissue data will be compared to the USEPA Region 3 Risk-Based Concentrations (RBCs) for fish (USEPA, 2000d).

The PRGs and RBCs are periodically updated by USEPA. The most current criteria available will be used in the selection of COPCs. Constituents with maximum concentrations less than or equal to the screening criteria will not be included as COPCs. If no COPCs are identified for a medium, that medium will not be evaluated quantitatively in the HHRA.

Tables presenting the results of each screening step will be presented in the risk assessment report. The final list of COPCs for inclusion in the risk assessment will also be presented in the risk assessment and included in all subsequent risk calculations.

11.3.2.4 Data Quality Levels

The criteria identified in Section 11.3.2.3 have been used to develop the data quality levels (DQLs) to be used to identify appropriate practical quantitation limits (PQLs) for laboratory methods for the analytical program. The DQLs and PQLs are discussed in greater detail in the Quality Assurance Project Plan (QAPP) for Sauget Area 2 (see Volume 2B of the RI/FS SSP). The DQLs for the HHRA are presented in Appendix 5. The DQLs for soil and sediment are based on USEPA Region 9 PRGs (USEPA, 2000a) for residential soil, the DQLs for surface water and groundwater are based on the Class I groundwater standards (35 Ill. Adm. Code 620.410) and the hierarchy identified in the previous section. The DQLs for fish tissue are based on the USEPA Region 3 RBCs (USEPA, 2000d) for fish, and the DQLs for air are based on the USEPA Region 9 PRGs (USEPA, 2000a) for ambient air.

11.4 Dose-Response Assessment

The purpose of the dose-response assessment is to identify the types of adverse health effects a constituent may potentially cause, and to define the relationship between the dose of a constituent and the likelihood or magnitude of an adverse effect (response).

Adverse effects are defined by USEPA as potentially carcinogenic or noncarcinogenic (i.e., potential effects other than cancer). Dose-response relationships are defined by USEPA. The dose-response values for potentially carcinogenic effects are termed Cancer Slope Factors (CSFs) or Unit Risk Factors, and dose-response values for noncarcinogenic effects are termed Reference Doses (RfDs) or Reference Concentrations (RfCs). These values are available from USEPA sources, such as USEPA's Integrated Risk Information System (IRIS), an on-line computer database (USEPA, 2000e), and the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997b). Both sets of potential health effects will be evaluated in the risk assessment. The USEPA National Center for Environmental Assessment (NCEA) will be consulted if a constituent does not have a dose-response value in either IRIS or HEAST. Appropriate criteria may also be derived by qualified toxicologists using current USEPA-approved methodologies.

Dose-response values used in the risk assessment will be presented in tabular format. For each constituent the table will present the Chemical Abstracts Service (CAS) registry number, dose-response value, source, study animal, study method, and where appropriate, target organ, critical effect, uncertainty factors, and confidence level.

Dose-response values are available for inhalation and oral exposures. Oral dose-response values will be used to evaluate dermal exposures, provided appropriate dermal absorption values are available. COPCs will be evaluated quantitatively for the dermal exposure pathway. For inhalation pathways, reference concentrations (in units of mg/m^3) will be converted to reference doses (in units of mg/kg-day) for calculating risk for systemic toxicants. For direct acting toxicants, the oral, dermal, and inhalation pathways will be evaluated separately.

11.4.1 PCB Dose-Response

Risks from potential exposures to PCBs will be calculated using the most current guidance available from USEPA. Currently, USEPA-approved guidance is provided in IRIS (USEPA, 2000e). Total PCB concentrations will be calculated by summing the separate homolog concentrations. The total PCB concentrations will be multiplied by the verified cancer slope factors listed in IRIS (USEPA, 2000e). Guidance provided in IRIS specifies three tiers of human slope factors for environmental PCBs: high risk and persistence, low risk and persistence, and lowest risk and persistence. The choice of slope factors for use depends on the medium of exposure and PCB chlorine content, as outlined in IRIS (USEPA, 2000e). Thus, a slightly differing approach to calculating potential cancer risks will be taken for different media.

Non-cancer risks from potential exposures to PCBs will be calculated using the most conservative RfD for a PCB mixture. In addition, uncertainty surrounding the use of USEPA-verified toxicity criteria will be discussed.

11.4.2 Dioxin Dose-Response

The potential carcinogenic effects associated with exposure to dioxin and furan congeners in environmental media will be assessed in accordance with the approach developed by USEPA

(1989c) or final guidance available at the time the risk assessment is conducted. Risks will be calculated for 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) and the dioxin and furan congeners using the cancer slope factor for 2,3,7,8-TCDD listed in HEAST (USEPA, 1997b) and using toxic equivalency factors (TEFs). TEFs are fractions that equate the potential toxicity of each congener to that of 2,3,7,8-TCDD. The World Health Organization (WHO) (Van den Berg et al., 1998) has assigned a TEF to each of the dioxin and furan congeners. The TEFs are listed in Table 11-1. The exposure point concentration for each dioxin and furan congener will be multiplied by its TEF, resulting in a TCDD toxic equivalence concentration (TCDD-TEQ). The TCDD-TEQ values for each of the congeners will then be added together. The cancer slope factor for 2,3,7,8-TCDD will then be used to calculate potential carcinogenic risks resulting from potential exposure to 2,3,7,8-TCDD, and the dioxin and furan congeners.

11.5 Exposure Assessment

The purpose of the exposure assessment is to predict the magnitude and frequency of potential human exposure to each of the COPCs retained for quantitative evaluation in the HHRA. The first step in the exposure assessment process is the characterization of the setting of the site and surrounding area. Current and potential future site uses and potential receptors (i.e., people who may contact the impacted environmental media of interest) are then identified. Potential exposure scenarios appropriate to current and potential future site uses and receptors are then developed. Those potential exposure pathways for which COPCs are identified and are judged to be complete will be evaluated quantitatively in the risk assessment. Reasonable maximum exposure (RME) assumptions, and most likely exposure (MLE) assumptions based on appropriate USEPA guidance, will be employed in the quantitative risk assessment.

11.5.1 Identification of Potential Exposure Scenarios

Exposure scenarios are developed on the basis of the CSM for a site. The CSM for this study was presented in Section 11.2 (Figure 11-1). The CSM was used to develop the potential exposure scenarios identified below. The receptor scenarios are summarized on Table 11-2. Sauget Area 2, as identified by the AOC, has been used for industrial purposes for many years and use of these areas is expected to remain industrial. Therefore, industrial/commercial receptors will be evaluated for each site. Access to Sites O, P, Q, and part of S is unrestricted.

Site R is fenced and monitored by a 24-hour security camera. The southern portion of Site S is fenced. Although access is restricted in some areas, a trespasser receptor will be evaluated for each site as well as for the Mississippi River. Recreational use of the Mississippi River and the Site Q ponds for fishing will also be evaluated. If COPCs are identified for soils in the field area located just south of Site Q, the industrial/commercial receptors and the trespasser receptor will be evaluated for this area.

The exposure scenarios that will be evaluated are described below.

An on-site outdoor industrial worker will be evaluated at each Site for potential exposure to COPCs where identified in surface soil, and to COPCs that may volatilize into outdoor air from subsurface soil and underlying groundwater. Therefore, a potential total of six outdoor industrial worker receptors will be evaluated in the risk assessment.

A construction/utility worker will be evaluated for potential exposure at each Site to constituents in surface and subsurface soils. Construction/utility work is assumed to occur to a depth of 12 to 15 feet bgs. This depth is based on the depth of utilities in the area. This depth will be adjusted if necessary based on results of the RI. Where the water table surface lies within this interval, the construction worker will be evaluated for potential contact with COPCs in groundwater during excavation. The construction worker will also be evaluated for potential contact with COPCs in leachate during excavation. Therefore, a potential total of six construction/utility worker receptors will be evaluated in the risk assessment.

An on-site indoor industrial worker will be evaluated at each Site for potential exposure to COPCs via inhalation of volatile constituents present in indoor air due to vapor intrusion from groundwater and/or leachate. Analytical data for shallow groundwater collected from the RI/FS SSP wells will be used in the risk assessment. Therefore, a potential total of six indoor industrial worker receptors will be evaluated in this risk assessment.

A trespassing teenager will be evaluated at each Site for potential exposure to COPCs where identified in surface soil, and to COPCs that may volatilize into outdoor air from subsurface soil and underlying groundwater. The trespasser receptor for Site Q will also be evaluated for potential exposure to COPCs where identified in surface water and sediment in the Site Q

ponds. In addition, a trespasser receptor will be evaluated for potential exposure to COPCs where identified in surface water and sediment in the Mississippi River. Analytical data for the Mississippi River surface water and sediment transect points located closest to the shore will be used in the risk assessment. Therefore, a potential total of seven trespasser receptors will be evaluated in the risk assessment. The trespasser risks will be evaluated separately as well as each in conjunction with the Mississippi River trespasser risks.

Incidental ingestion and dermal contact with surface water and sediment and ingestion of game fish will be evaluated for two recreational fisher receptors: a Mississippi River fisher and a Site Q ponds fisher. The Mississippi River fisher will be evaluated using analytical data for fillets of game fish (catfish) collected in the Mississippi River, and analytical data for surface water and sediments from the transect points located closest to the shoreline. The Site Q ponds fisher will be evaluated using analytical data for surface water and sediment collected from the ponds, and for game fish fillets, if appropriate fish are located for collection in the ponds. There are historical reports of fishing activity in these ponds; therefore, if fish are not captured, models will be used to predict fish tissue concentration from surface water or sediment data (see Section 11.5.5).

Groundwater is not used as a source of drinking water in the area. Surface water serves as the source of the municipal water supply, and groundwater use is prohibited by the Villages of Sauget and Cahokia (see the information provided in Appendix 2). Therefore, groundwater will not be evaluated as a source of residential or industrial drinking water in the risk assessment. However, as noted in Section 11.3.2.3, groundwater analytical data will be compared to Illinois Class I groundwater standards as part of the risk assessment.

Final receptor selection will be made once site analytical data have been evaluated and COPCs identified. If no COPCs are identified in a particular medium (e.g., fish), and/or the potential exposure pathway, upon further investigation, is judged to be incomplete (e.g., recreational fishing), then the exposure scenarios associated with that medium/pathway will not be quantitatively evaluated in the HHRA. The potential receptors and their associated exposure scenarios are discussed below and summarized in Table 11-2.

11.5.2 Receptor Identification

The following subsections discuss the parameters that will be used to evaluate each of the potential receptors in the HHRA. Both RME and MLE scenarios will be evaluated for each receptor. As noted in Table 11-2, a total of 27 receptors will each be evaluated for RME and MLE scenarios. Exposure factors common to several of the receptors are discussed in Section 11.5.3.

11.5.2.1 Indoor Industrial Worker

Exposure assumptions for the indoor industrial worker under the RME and MLE scenarios are shown in Table 11-3. Where depth to groundwater is shallow (less than 25 to 30 feet bgs), it is possible an indoor industrial worker may be exposed indirectly to shallow groundwater/leachate via inhalation of volatile COPCs migrating from groundwater and the subsurface to indoor air of an industrial/commercial building.

11.5.2.2 Outdoor Industrial Worker

Exposure assumptions for the outdoor industrial worker under the RME and MLE scenarios are shown in Table 11-4. The outdoor industrial worker may contact COPCs in surface soil via incidental ingestion and dermal contact, and may inhale COPCs via volatilization from the surface and subsurface, and via particulate emissions from the surface. In addition, where depth to groundwater is shallow (less than 25 to 30 feet bgs), it is possible an outdoor industrial worker may be exposed indirectly to shallow groundwater/leachate via inhalation of volatile COPCs migrating from groundwater and the subsurface to outdoor air.

11.5.2.3 Construction/Utility Worker

Exposure assumptions for the construction/utility worker under the RME and MLE scenarios are shown in Table 11-5. Exposure media of interest in the evaluation of potential risk to a future construction/utility worker will potentially include surface soil, subsurface soil, leachate, and groundwater. Construction/utility work is assumed to occur to a depth of 12 to 15 feet bgs. Where the water table surface lies within this interval, the construction worker will be evaluated for

potential contact with COPCs in groundwater during excavation. Data for shallow groundwater and leachate will be combined and evaluated as one medium. Exposure could occur via incidental ingestion of and dermal contact with soil and shallow groundwater and/or leachate and via inhalation of fugitive dust and/or vapors from soil and groundwater and/or leachate. The soil ingestion rate listed in Table 11-5 for the construction worker under the MLE scenario is discussed in Section 11.5.3.

11.5.2.4 Trespassing Teenager

Exposure assumptions for the trespassing teenager under the RME and MLE scenarios are shown in Table 11-6. It is assumed that this receptor can be exposed to COPCs in surface soil via incidental ingestion, dermal contact, and inhalation of volatiles and particulates, and can be exposed indirectly to subsurface soil and/or groundwater via inhalation of volatile COPCs. Due to the remoteness of the sites, it is assumed that this receptor may be on the site for two hours per event; however, the receptor's entire daily exposure to soil via ingestion and dermal contact is assumed to come from the Sites. In addition, this receptor may be exposed to COPCs in sediment and surface water in the Mississippi River or the Site Q ponds. It is assumed that contact with surface water and sediment occurs continuously for 1 hour per event.

11.5.2.5 Recreational Fisher

Recreational fishing takes place in the Mississippi River and there are reports of fishing occurring in the Site Q ponds. As constituents in groundwater may discharge to these water bodies, COPCs may be present in surface water, sediment, and fish tissue. Therefore, a recreational fisher has the potential to be exposed to site-related COPCs through ingestion of fish and incidental ingestion and dermal contact with surface water and sediment. Recreational fishing will be evaluated separately for the Mississippi River and the Site Q ponds. The exposure assumptions for the fisher for the RME and MLE receptors are summarized in Table 11-7.

11.5.3 Exposure Parameters

11.5.3.1 Soil Ingestion Rate – Adult Construction Worker

Incidental soil ingestion occurs at all ages as a result of hand-to-mouth activities. Currently, there are little or no reliable quantitative data available for estimating adult soil ingestion rates. USEPA risk assessment guidance suggests a soil ingestion rate of 50 mg/day for adults in an industrial scenario (USEPA, 1991a).

USEPA presented an estimate of a soil ingestion rate for adults doing yard work of 480 mg/day in their supporting evidence for the commercial/industrial soil ingestion rate of 50 mg/day in the "Standard Default Exposure Factors" Directive (USEPA, 1991a); the 480 mg/day value was not presented in the table of default exposure factors. The Agency states: "For certain outdoor activities in the commercial/industrial setting (e.g., construction or landscaping), a soil ingestion rate of 480 mg/day may be used; however, this type of work is usually short-term and is often dictated by the weather. Thus, exposure duration would generally be less than one year and exposure frequency would vary according to site-specific construction/maintenance plans." However, some regions and state agencies have stipulated the use of this value to evaluate a construction worker exposure scenario. The Hawley (1985) study, which is the basis for the soil ingestion rate of 480 mg/day, was recently reviewed by the USEPA (USEPA, 1997a), which stated that, "Given the lack of supporting measurements, these estimates must be considered conjectural."

In the Hawley (1985) study, the author assumed that soil adheres to the surface area of the hands at a loading of 3.5 mg/cm^2. This value was based on a layer of soil on skin assumed to be 0.005 cm deep, a soil density of 1.5 g/cm^2, and 50% void space. Using the author's derived soil-to-skin adherence loading of 3.5 mg/cm^2 and assuming that the amount of soil covering a fraction of the hands (approximately 70 cm^2) is ingested twice a day, Hawley calculated a soil ingestion rate of 480 mg/day.

Hawley's 1985 analysis was one of the first published health risk assessments and was performed before any of the quantitative fecal tracer soil ingestion studies for either children or adults were conducted (Calabrese et al., 1989; Davis et al., 1990; Clausing et al., 1987;

Calabrese et al., 1990). Thus, the estimate of 480 mg/day predates all of our current knowledge about soil ingestion among both children and adults, as well as recent published data on soil-to-skin adherence rates.

In 1993, USEPA sponsored a workshop to evaluate soil-to-skin adherence data. As a result, a study to determine a more accurate characterization of soil-to-skin adherence was sponsored by the USEPA and conducted by John C. Kissel and associates at the University of Washington (Kissel et al., 1996; Holmes et al., 1998). The intent of this study was to resolve uncertainties and develop more accurate measures of soil-to-skin loading rates for individuals involved in various occupational and recreational activities. As reported in the Exposure Factors Handbook (EFH) (USEPA ,1997a), soil loading on skin surfaces as a result of various occupational and recreational activities was directly measured. This study indicates that soil loadings vary with the type of activity and the body parts contacted. As one would expect, adherence appears to be greatest during outdoor activities such as farming and gardening, and more soil/dust tends to adhere to the hands and knees than to other areas of the body.

Average hand soil loading factors are as presented in the EFH (USEPA, 1997a) for the adult outdoor workers evaluated by Kissel and Holmes. In every case, soil adherence during occupational exposure was measured to be considerably lower than Hawley's estimate of 3.5 mg/cm^2. The range of soil adherence loadings measured by Kissel and Holmes falls within the USEPA range of 0.2 to 1.0 mg/cm^2 (USEPA, 1992c).

For this evaluation, the construction worker receptor is assumed to be exposed to COPCs in surface and subsurface soils during excavation activity. Based on this exposure scenario, the "farmer" receptor provided in the EFH is considered to provide an upper-bound estimate of soil adherence. A soil ingestion rate can be calculated by substituting the soil adherence value for the receptor for the estimated value derived by Hawley (1985), as follows:

$$\frac{480\ mg/day}{3.5\,mg/cm^2} = \frac{\text{ingestion rate } (mg/day)}{\text{soil adherence } (mg/cm^2)}$$

The soil to hand adherence value for the "farmer" is 0.47 mg/cm^2. The calculated soil ingestion value is 64 mg/day; therefore, a soil ingestion rate of 64 mg/day is used for the MLE construction worker receptor in this risk evaluation.

Additional support for this value comes from a new paper by Kissel and coworkers (Kisselet al., 1998) that presents the results of a study of the transfer of soil from hand to mouth by intentional licking. Soil was loaded onto the skin by pressing the hand onto soil, and the amount transferred to the mouth was measured. The thumb sucking, finger mouthing, and palm licking activities resulted in geometric mean soil mass transfers of 7.4 to 16 mg per event. The author concludes that "transfer of 10 mg or more of soil from a hand to the oral cavity in one event is possible, but requires moderate soil loading and more than incidental hand-to-mouth contact." However, "the fraction of soil transferred from hand to mouth that is subsequently swallowed is unknown but may be less than 100 percent." In addition, "the adult volunteers in this study reported that the presence of roughly 10 mg of soil in the mouth is readily detected (and unpleasant). Repeated unintentional ingestión of that mass of soil by adults therefore seems unlikely. In light of this observation, the 480 mg per day estimate [of Hawley, 1985] would require hundreds or perhaps thousands of hand-to-mouth contacts that resulted in soil transfer per day."

Therefore, for the MLE scenario, a soil ingestion rate of 64 mg/day is used for the construction worker. For the RME scenario, a soil ingestion rate of 100 mg/day is assumed for the construction worker. This is the adult soil ingestion rate provided by USEPA (1991a).

11.5.3.2 Frequency of Exposure to COPCs in Soil

A meteorological factor is generally used to account for the fraction of the year during which exposure to constituents in soils may occur (Sheehan et al., 1991; USEPA, 1989a). It is reasonable to assume that direct contact with soil or intrusive activities will not occur for residential receptors during inclement weather, i.e., when it is raining or snowing, when the ground is wet or frozen, or when snow or ice (32 degrees F) are covering the ground. Thus the frequency of contact with potentially impacted soil is adjusted for these site-specific meteorological conditions (USEPA, 1989a).

There are only a few metrics that can be used to describe the fraction of the year when meteorological conditions are likely to limit exposure. These include temperature and the amount of precipitation per day and per year, which includes rain, snow and ice. While measures are collected hourly, the National Weather Service (NWS) reports the number of days

when precipitation is greater than 0.01 inches (one one-hundredth), greater than 0.1 inches (one tenth), and greater than 1 inch in their annual summary data. The number of days with precipitation greater than 0.1 inches is selected as the best representation of when exposure is likely to be limited by snow, rain, or ice. The National Oceanographic and Atmospheric Administration (NOAA) provides daily temperature data. It is assumed that exposure to soils is limited by temperatures less than 32 degrees F. Therefore, limiting the assumption of exposure to soils to those days with less than 0.1 inch of precipitation and temperatures above 32 degrees F is reasonable.

Based on ten years of meteorological data (1986-1995) for St. Louis provided by NOAA (1996) and the NWS (1986-1995), a meteorological factor is derived for use in the exposure equations. On the average, 66 days/year in this area receive 0.1 or greater inches of precipitation, and there are typically 27 days/year with a mean temperature of 32 degrees F or below. Accounting for days when both events occur (assumed to be 10% of the rain days or 6 days/year), the number of inclement days, 87, can be calculated (27 + 66 – 6 = 87). It is assumed that these days are evenly spaced throughout the course of the year. The meteorological factor is then calculated (87/365 = 24%). Thus it is assumed that exposure to soils will not occur for the "receptor" 24% of the assumed days of exposure (exposure frequency) due to weather restrictions.

The choice of a precipitation target of 0.1 inches is in keeping with guidance provided in the Compilation of Air Pollution Emission Factors, which assumes that soil suspension will not occur on days with more than 0.01 inches of precipitation (USEPA, 1995b). It is probable, however, that this metric both over- and under-estimates the potential exposure in some conditions. For, example, it is possible that some exposure to soils may occur on days when it rains just over 0.1 inches in the early morning and then the ground dries during the course of the day. Alternatively, significant rainfall, such as greater than 1 inch, is likely to saturate the soil for consecutive days, and several inches of snow (which may fall all on one day with one storm) may cover the ground and inhibit direct contact for several days. With both of these considerations in mind, it is likely that a meteorological factor based on inclement days defined as precipitation greater than 0.1 inches and average temperatures less than 32 degrees F is reasonable.

11.5.4 Quantification of Potential Exposures

To estimate the potential risk to human health that may be posed by the presence of COPCs at Sauget Area 2, it is first necessary to estimate the potential exposure dose of each COPC. The exposure dose is estimated for each constituent via each exposure pathway by which the receptor is assumed to be exposed. Exposure dose equations combine the estimates of constituent concentration in the environmental medium of interest with assumptions regarding the type and magnitude of each receptor's potential exposure to provide a numerical estimate of the exposure dose. The exposure dose is defined as the amount of COPC taken into the receptor and is expressed in units of milligrams of COPC per kilogram of body weight per day (mg/kg-day).

Exposure doses are defined differently for potential carcinogenic and noncarcinogenic effects. The Chronic Average Daily Dose (CADD) is used to estimate a receptor's potential intake from exposure to a COPC with noncarcinogenic effects. According to USEPA (1989a), the CADD should be calculated by averaging the dose over the period of time for which the receptor is assumed to be exposed. Therefore, the averaging period is the same as the exposure duration. For COPC with potential carcinogenic effects, however, the Lifetime Average Daily Dose (LADD) is employed to estimate potential exposures. In accordance with USEPA (1989a) guidance, the LADD is calculated by averaging exposure over the receptor's assumed lifetime (70 years). Therefore, the averaging period is the same as the receptor's assumed lifetime. The standardized equations for estimating a receptor's average daily dose (both lifetime and chronic) are presented below, followed by descriptions of receptor-specific exposure parameters and constituent-specific parameters.

11.5.4.1 Estimating Potential Exposure to COPCs in Soil

Both incidental ingestion of, and dermal contact with, COPCs in soil are assumed to occur for many of the receptors. The following equations are used to calculate the estimated exposure.

Average Daily Dose (Lifetime and Chronic) Following Incidental Ingestion of Soil (mg/kg-day):

$$ADD = \frac{CS \times SIR \times EF \times ED \times AAF_d \times CF}{BW \times AT}$$

where:

ADD	=	Average Daily Dose (mg/kg-day)
CS	=	Soil Concentration (mg/kg soil)
SIR	=	Soil Ingestion Rate (mg soil/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (year)
AAF_o	=	Oral-Soil Absorption Adjustment Factor (AAF) (chemical-specific) (unitless)
CF	=	Unit Conversion Factor (kg soil/10^6 mg soil)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

Average Daily Dose (Lifetime and Chronic) Following Dermal Contact with Soil (mg/kg-day):

$$ADD = \frac{CS \times SA \times AF \times EF \times ED \times AAF_d \times CF}{BW \times AT}$$

where:

ADD	=	Average Daily Dose (mg/kg-day)
CS	=	Soil Concentration (mg/kg soil)
SA	=	Exposed Skin Surface Area (cm^2/day)
AF	=	Soil to Skin Adherence Factor (mg soil/cm^2)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (year)
AAF_d	=	Dermal-Soil AAF (chemical-specific) (unitless)
CF	=	Unit Conversion Factor (kg soil/10^6 mg soil)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

11.5.4.2 Estimating Potential Exposure via Inhalation

Exposure to COPCs migrating from soil or groundwater to air is assumed to occur for many of the potential receptors. The equation used to estimate exposure to COPCs via inhalation is as follows:

Average Daily Dose (Lifetime and Chronic) Following Inhalation of COPC (mg/kg-day):

$$ADD = \frac{CA \times IR \times AAF_i \times ET \times EF \times ED}{BW \times AT}$$

where:

ADD	=	Average Daily Dose (mg/kg-day)
CA	=	Air Concentration (mg/m^3)
IR	=	Inhalation Rate (m^3 /hr)
AAF_i	=	Inhalation AAF (chemical-specific) (unitless)
ET	=	Exposure Time (hours/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (year)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

11.5.4.3 Estimating Potential Exposure to COPCs from Groundwater

Incidental contact with groundwater or surface water is assumed for several receptors. The equation used to estimate a receptor's potential exposure via incidental ingestion of groundwater is:

Average Daily Dose (Lifetime and Chronic) Following Ingestion of Water (mg/kg-day):

$$ADD = \frac{CW \times IR \times EF \times ED \times AAF_o}{BW \times AT}$$

where:

ADD	=	Average Daily Dose (mg/kg-day)
CW	=	Water Concentration (mg/L)
IR	=	Water Ingestion Rate (L/day)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (year)[1]
AAF_o	=	Oral-Water AAF (chemical-specific) (unitless)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

The equation used to estimate a receptor's potential exposure via dermal contact with groundwater is as follows:

Average Daily Dose (Lifetime and Chronic) Following Dermal Contact with Water (mg/kg-day):

$$ADD = \frac{CW \times SA \times PC \times ET \times EF \times ED \times AAF_d \times CF}{BW \times AT}$$

where:

ADD	=	Average Daily Dose (mg/kg-day)
CW	=	Water Concentration (mg/L)
SA	=	Exposed Skin Surface Area (cm^2)
PC	=	Dermal Permeability Constant (cm/hr) (chemical-specific)
ET	=	Exposure Time (hours/day)
EF	=	Exposure Frequency (days/year)
ED	=	Years Exposed (year)

AAF_d	=	Dermal-Water AAF (chemical-specific) (unitless)
CF	=	Unit Conversion Factor ($L/10^3cm^3$)
BW	=	Body Weight (kg)
AT	=	Averaging Time (days)

11.5.4.4 Estimating Potential Exposure From Food Consumption

A recreational fisher may be exposed to COPCs through ingestion of fish obtained from the Mississippi River or the Site Q ponds. The equation used to estimate a receptor's potential exposure via food consumption is:

Average Daily Dose (Lifetime and Chronic) Following Food Consumption (mg/kg-day):

$$ADD = \frac{CF \times IR \times AAF \times EF \times ED}{AT \times BW}$$

where:

ADD	=	Average Daily Dose (mg/kg-day)
CF	=	Concentration in Food (mg/kg)
IR	=	Ingestion Rate (kg/day)
AAF	=	Oral-diet AAF (chemical-specific) (unitless)
EF	=	Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
AT	=	Averaging Time (days)
BW	=	Body Weight (kg)

11.5.4.5 Absorption Adjustment Factors

Absorption adjustment factors (AAFs) are used in risk assessment to account for absorption differences between humans exposed to substances in environmental situations and experimental animals in the studies used to derive dose-response values.

To estimate the potential risk to human health that may be posed by the presence of substances in various environmental media (such as soil or groundwater) it is first necessary to estimate the human exposure dose, of each compound. The exposure dose is then combined with an estimate of the toxicity of the substance to produce an estimate of risk posed to human health.

The estimate of toxicity of a substance, termed the dose-response value, can be derived from human epidemiological data, but it is most often derived from experiments with laboratory animals. The dose-response value can be calculated based on the administered dose of the substance (similar to the human exposure dose) or, when data are available, based on the absorbed dose, or internal dose, of the substance.

In animals, as in humans, the administered dose of a substance is not necessarily completely absorbed. Moreover, differences in absorption exist between laboratory animals and humans, as well as between different media and routes of exposure. Therefore, it is not always appropriate to directly apply a dose-response value to the human exposure dose. In many cases, a correction factor in the calculation of risk is needed to account for differences between absorption in the dose-response study and absorption likely to occur upon human exposure to a substance. Without such a correction, the estimate of human health risk could be over- or under-estimated.

This correction factor is termed the absorption adjustment factor, or AAF. The AAF is used to adjust the human exposure dose so that it is expressed in the same terms as the doses used to generate the dose-response curve in the dose-response study. The AAF is the ratio between the estimated human absorption factor for the specific medium and route of exposure, and the known or estimated absorption factor for the laboratory study from which the dose-response value was derived.

$$AAF = \frac{\text{(fraction absorbed in humans for the environmental exposure)}}{\text{(fraction absorbed in the dose - response study)}}$$

The use of an AAF allows the risk assessor to make appropriate adjustments if the efficiency of absorption between environmental exposure and experimental exposure is known or expected to differ because of physiological effects and/or matrix or vehicle effects.

AAFs can have numerical values less than one or greater than one, depending on the particular circumstances at hand. When the dose-response curve is based on administered dose data, and if it is estimated that the fraction absorbed from the site-specific exposure is the same as the fraction absorbed in the laboratory study, then the AAF is 1. In the absence of detailed toxicological information on every compound of interest, it has been common practice for risk assessors to use a default AAF value of 1. This approach is not necessarily protective of public health, in some cases, because there are situations in which it is expected that the fraction absorbed from a site-related exposure would be higher than that in the laboratory study. There are also situations where the reverse could occur. Thus, use of AAFs in standard risk assessment calculations can provide more accurate and more realistic estimates of potential human health risk. The derivation of each AAF used in the risk assessment will be provided in an appendix to the risk assessment report.

11.5.5 Calculation of Exposure Point Concentrations

Exposure points are located where potential receptors may contact COPCs at or from the site. The concentration of COPCs in the environmental medium that receptors may contact must be estimated in order to determine the magnitude of potential exposure.

Measured data will be available for surface soil, subsurface soil, groundwater, leachate, and fish tissue (for the Mississippi River; fish tissue data may not be available for the Site Q ponds). Groundwater will be evaluated on a plume or well-by-well basis as appropriate. The exposure point concentration is defined as the lower of the maximum or 95th percentile UCL on the arithmetic mean concentrations (USEPA, 1992a) or other appropriate metric for the RME scenario and the arithmetic mean concentration for the MLE scenario.

Other pathways will require modeling to derive exposure point concentrations. These pathways include volatile chemicals in groundwater/leachate and the subsurface migrating upwards and

infiltrating into indoor and outdoor air, generation of fugitive dust and volatiles from undisturbed soils as well as during construction activities, and potentially calculation of game fish fillet constituent concentrations in the Site Q ponds.

The model to be used to predict indoor air concentrations of VOCs will be the model of Johnson and Ettinger recommended by the USEPA (1996a and 1997c) to predict concentrations of COPCs migrating from groundwater or soil to indoor air of an overlying building. Concentrations of volatile COPCs in outdoor air due to migration from subsurface soil and/or groundwater will be estimated using the methodology recommended by the American Society for Testing and Materials (ASTM, 1998).

The calculation of concentrations of non-VOC COPCs bound to soil in fugitive dust involves multiplying the soil exposure point concentrations by the concentration of dust in air as follows:

1) Ambient Air:
   COPC concentration in ambient air (mg/m^3) = Exposure point concentration in soil (mg/kg soil) x Dust concentration (kg soil/m^3)
   The dust concentration in air to be used in the evaluation of ambient outdoor air pathways in this risk evaluation is the inverse of the particulate emission factor derived in accordance with USEPA guidance (USEPA, 1996a).
2) Excavation Air (i.e., during construction activities):
   COPC concentration in excavation air (mg/m^3) = Exposure point concentration in soil (mg/kg soil) x Dust concentration (mg soil/m^3) x Unit correction factor (1 kg/10^6 mg)
   The dust concentration in air to be used in the evaluation of excavation air pathways in this risk evaluation is 60 ug/m^3. This value is the recommended concentration of respirable particulate with a mean diameter of 10 microns or less (PM10) for excavation activities (MADEP, 1995).

The concentrations of constituents in Site Q ponds game fish fillet tissue may be calculated using bioaccumulation factors. Bioaccumulation factors will be obtained from USEPA sources current at the time the risk assessment is conducted, or from scientific literature sources. The following equations will be used to predict fish fillet tissue concentrations:

1) Calculation of fish tissue concentration based on sediment concentrations:

$$C_F = C_{SED} \times BSAF \times [f_{LIPID}/f_{oc}]$$

where:

C_F	=	constituent concentration in fish tissue, wet weight (mg/kg)
C_{SED}	=	constituent concentration in sediment, dry weight (mg/kg)
BSAF	=	biota-sediment accumulation factor (kg organic carbon in sediment/kg lipid in fish)
f_{LIPID}	=	fraction of lipid in fish (kg lipid/kg wet weight fish)
f_{oc}	=	fraction of organic carbon in sediment (kg organic carbon/kg dry weight sediment)

2) Calculation of fish tissue concentration based on surface water concentration:

$$C_F = C_{W\text{-}D} \times BAF$$

where:

C_F	=	constituent concentration in fish tissue, wet weight (mg/kg)
$C_{W\text{-}D}$	=	constituent concentration in surface water, dissolved (mg/L)
BAF	=	bioaccumulation factor (L/kg)

11.6 Risk Characterization

The purpose of the risk characterization is to provide estimates of the potential risk to human health from exposure to COPCs at or from a site by receptors at or near a site. To accomplish this objective, this section will include quantitative estimates of potential carcinogenic and noncarcinogenic risk.

The results of the exposure assessment are combined with the results of the dose-response assessment to derive quantitative estimates of risk, or the probability of adverse health effects following assumed potential exposure to the COPCs. Using the exposure point concentrations

derived in the exposure assessment, each exposure pathway for each receptor will be evaluated for both potential carcinogenic and noncarcinogenic effects.

11.6.1 Carcinogenic Risk Characterization

The purpose of carcinogenic risk characterization is to estimate the upper-bound likelihood, over and above the background cancer rate, that a receptor will develop cancer in his or her lifetime as a result of exposure to a constituent in environmental media at the site. This likelihood is a function of the dose of a constituent (described in the Exposure Assessment) and the Cancer Slope Factor (CSF) (described in the Toxicity Assessment) for that constituent. The Excess Lifetime Cancer Risk (ELCR) is the likelihood over and above the background cancer rate, which currently in the U.S. is between 1 in 3 and 1 in 4 (Landis et al., 1998), that an individual will contract cancer in his or her lifetime. The risk value is expressed as a probability (e.g., 10^{-6}, or one in one million). The relationship between the ELCR and the estimated Lifetime Average Daily Dose (LADD) of a chemical may be expressed as:

$$ELCR = 1 - e^{-(CSF \times LADD)}$$

When the product of the CSF and the LADD is much greater than 1, the ELCR approaches 1 (i.e., 100 percent probability). When the product is less than 0.01 (one chance in 100), the equation can be closely approximated by:

$$ELCR = LADD\ (mg/kg\text{-}day) \times CSF\ (mg/kg\text{-}day)^{-1}$$

The product of the CSF and the LADD is unitless, and provides an upper-bound estimate of the potential carcinogenic risk associated with a receptor's exposure to that constituent via that pathway.

The potential carcinogenic risk for each exposure pathway will be calculated for each receptor. In current regulatory risk assessment, it is assumed that cancer risks are additive or cumulative. Pathway and area-specific risks will be summed to estimate the total site potential cancer risk for each receptor. A summary of the total cancer risks for each receptor group for each site will be presented in this section.

The results will be compared to the USEPA's target risk range of 10^{-4} to 10^{-6}. USEPA has established target risk ranges under the National Contingency Plan (NCP) or Superfund program (USEPA, 1990). Target risk levels refer to levels of cancer risk or hazard indices that are deemed acceptable by the USEPA or other regulatory agencies. These are levels below which the potential for adverse effects to humans are assumed to be negligible or inconsequential. The NCP establishes a target cancer risk range of 10^{-4} to 10^{-6} and a target hazard index of less than or equal to one (USEPA, 1990). The USEPA subsequently clarified that, "Where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted, unless there are adverse environmental impacts" (USEPA, 1991b).

Therefore, the screening criteria used to identify COPC are based on a 10^{-6} risk level, and a cumulative target risk level of 10^{-4} will be used to evaluate the risk assessment results. Any COPC that causes an exceedance of the 10^{-4} risk level for a particular receptor will be designated a COC. Both RME and MLE results will be considered in the identification of COCs. Remedial goals (RGs) will be calculated for each COC, based on the scenarios used in the risk assessment.

11.6.2 Noncarcinogenic Risk Characterization

The potential for exposure to a constituent to result in adverse noncarcinogenic health effects is estimated for each receptor by comparing the Chronic Average Daily Dose (CADD) for each COPC with the RfD for that COPC. The resulting ratio, which is unitless, is known as the Hazard Quotient (HQ) for that chemical. The HQ is calculated using the following equation:

$$HQ = \frac{CADD\ (mg/kg - day)}{RfD\ (mg/kg - day)}$$

The target HQ is defined as an HQ of less than or equal to one (USEPA, 1989). When the HQ is less than or equal to one, the RfD has not been exceeded, and no adverse noncarcinogenic effects are expected. If the HQ is greater than one, there may be a potential for adverse

noncarcinogenic health effects to occur; however, the magnitude of the HQ cannot be directly equated to a probability or effect level.

The total Hazard Index (HI) is calculated for each exposure pathway by summing the HQs for each individual chemical. The total site HI will be calculated for each potential receptor by summing the HIs for each pathway associated with the receptor. If the total site HI is greater than one for any receptor, a more detailed evaluation of potential noncarcinogenic effects based on specific health endpoints will be performed (USEPA, 1989a).

A summary of all HI for each receptor group for each site will be presented and compared to the USEPA's target hazard index of one. Any COPC that causes an exceedance of the Hazard Index of 1 for a particular receptor and target endpoint will be designated a COC. Both RME and MLE results will be considered in the identification of COCs. Remedial goals will be calculated for each COC, based on the scenarios used in the risk assessment.

11.6.3 Risk Assessment Refinement

The HHRA, as described, utilizes conservative exposure and toxicity parameters. The results of the HHRA will be reviewed and the risk drivers identified. The Sauget Area 2 Sites Group may choose to refine the risk estimates by using, for example, the following: site-specific exposure data (e.g., creel census), site-specific bioavailability factors, or probabilistic (or Monte Carlo) analysis. Use of such refinements, such as a probabilistic risk assessment, will allow the public to put the risks in perspective and provide information that the risk manager needs to more accurately characterize risks on a site-specific basis and to communicate the nature of the risks to the public.

11.6.4 Cumulative Risk

The risk assessment will be conducted for all media, and total site risks will be calculated for each receptor for each site. COCs for potentially carcinogenic and noncarcinogenic effects will be identified, and pathways that contribute significantly to target risk exceedances will be identified. RGs will be calculated for appropriate COCs in the appropriate medium.

11.6.5 Uncertainty Analysis

Uncertainty is introduced into the risk assessment in several places throughout the process. Every time an assumption is made, some level of uncertainty is introduced into the risk assessment. In accordance with USEPA guidance (USEPA, 1989a), the uncertainty associated with each step of the risk characterization process will be discussed in this section of the report.

There are many potential sources of uncertainty in the risk assessment process; some are more important than others. The major areas of uncertainty include: the adequacy of the sampling plan, the quality of the analytical data, assumptions about the frequency, duration, and magnitude of exposure, the receptors identified, assumptions made in the modeling performed to predict concentrations at locations where measurement data are lacking, and the availability and accuracy of dose-response data. The uncertainties will be discussed qualitatively in the report, including steps taken to compensate for uncertainty, and the impact on the risk assessment results.

11.7 Summary and Conclusions

A summary and conclusions section will contain discussions of the results of the risk assessment. The selection of final COC and the remedial goals for each COC will be presented.

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Figure 11-1

Conceptual Site Model for

Human Health Risk Assessment

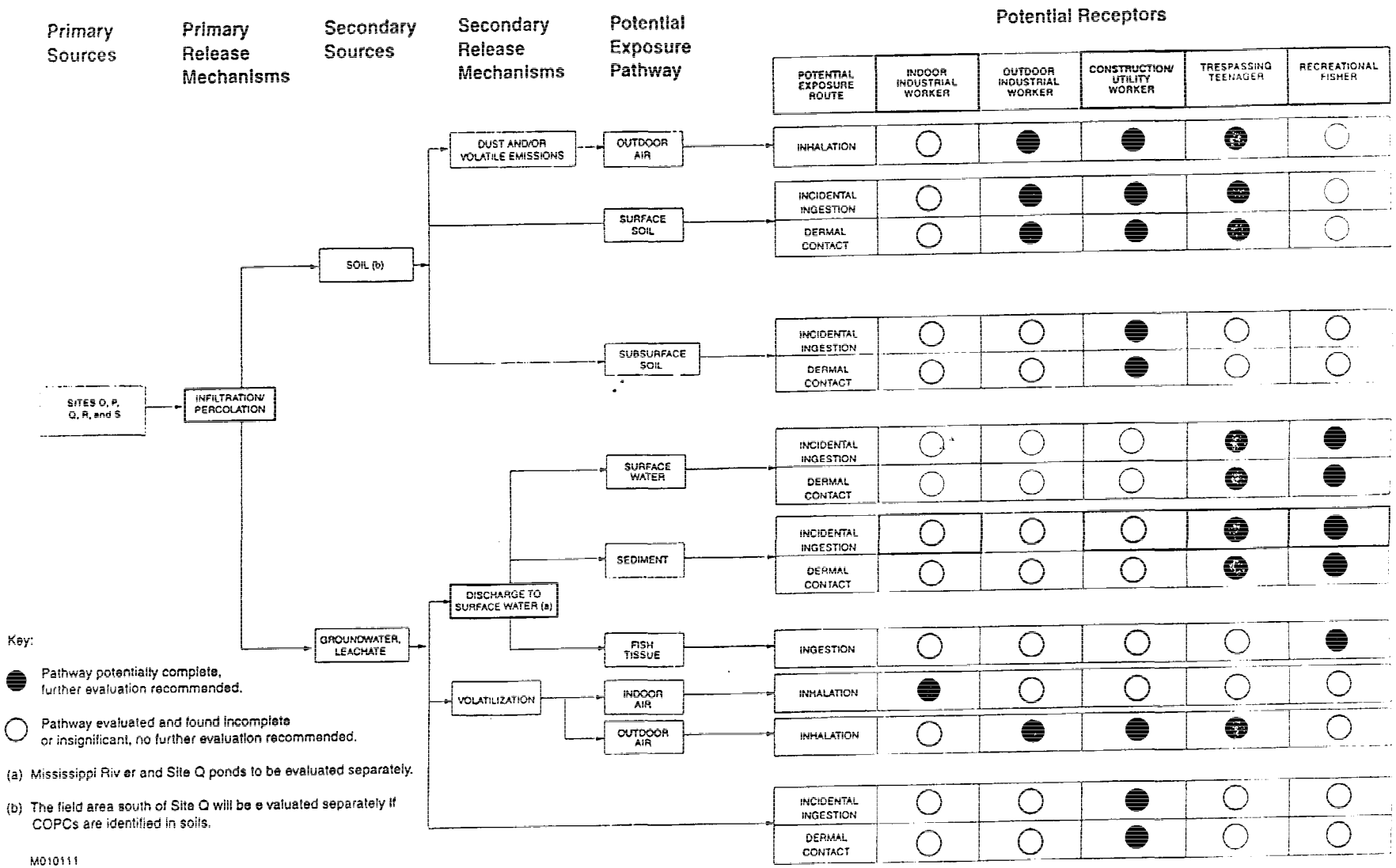

FIGURE 11-1
Conceptual Site Model for Human Health Risk Assessment
Sauget Area 2 RI/FS SSP
Sauget Area 2 Sites Group

Table 11-1

TEF for Dioxin and Furan Congeners

TABLE 11-1
TEFs FOR DIOXIN AND FURAN CONGENERS
SAUGET AREA 2 RI/FS SSP
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITES GROUP

CONSTITUENT	CAS NUMBER	TEF (a)
Dioxins		
2,3,7,8-TCDD	1746-01-6	1.0
1,2,3,7,8-PentaCDD	40321-76-4	1.0
1,2,3,4,7,8-HexaCDD	39227-28-6	0.1
1,2,3,6,7,8-HexaCDD	57653-85-7	0.1
1,2,3,7,8,9-HexaCDD	19408-74-3	0.1
1,2,3,4,6,7,8-HeptaCDD	35822-39-4	0.01
OctaCDD	3268-87-9	0.0001
Furans		
2,3,7,8-TetraCDF	51207-31-9	0.1
1,2,3,7,8-PentaCDF	57117-41-6	0.05
2,3,4,7,8-PentaCDF	57117-31-4	0.5
1,2,3,4,7,8-HexaCDF	70648-26-9	0.1
1,2,3,6,7,8-HexaCDF	57117-44-9	0.1
1,2,3,7,8,9-HexaCDF	72918-21-9	0.1
2,3,4,6,7,8-HexaCDF	60851-34-5	0.1
1,2,3,4,6,7,8-HeptaCDF	67562-39-4	0.01
1,2,3,4,7,8,9-HeptaCDF	55673-89-7	0.01
OctaCDF	39001-02-0	0.0001

Notes:
CAS- Chemical Abstracts Service.
CDD - Chlorodibenzodioxin.
CDF - Chlorodibenzofuran.
TEF - Toxicity Equivalency Factor.
(a) - Toxic Equivalency Factors for PCBs, PCDDs, PCDFs for Humans and Wildlife. Van den Berg, et al. December, 1998.

Table 11-2

Potential Receptors, Exposure Media and Exposure Pathways

TABLE 11-2
POTENTIAL RECEPTORS, EXPOSURE MEDIA AND EXPOSURE PATHWAYS
SAUGET AREA 2 RI/FS SSP
SAUGET AND CAHOKIA, IL
SAUGET AREA 2 SITES GROUP

Receptor	Site	Medium	Pathway
On-Site Outdoor Industrial Worker			
	O,P,Q,R,S, South of Site Q	Surface Soil	Incidental Ingestion Inhalation of Particulates/Volatiles Dermal Contact
6 Receptors		Groundwater	Inhalation of Volatiles in Outdoor Air
On-Site Indoor Industrial Worker			
6 Receptors	O,P,Q,R,S, South of Site Q	Groundwater	Inhalation of Volatiles in Indoor Air
Construction/Utility Worker			
	O,P,Q,R,S, South of Site Q	Surface Soil	Incidental Ingestion Inhalation of Particulates/Volatiles Dermal Contact
		Subsurface Soil	Incidental Ingestion Inhalation of Particulates/Volatiles Dermal Contact
6 Receptors		Groundwater/ Leachate	Incidental Ingestion Dermal Contact Inhalation of Volatiles in Outdoor Air
Trespassing Teenager			
	O,P,Q,R,S, South of Site Q	Surface Soil	Incidental Ingestion Inhalation of Particulates/Volatiles Dermal Contact
		Groundwater	Inhalation of Volatiles in Outdoor Air
	Q, Mississippi River	Surface Water	Incidental Ingestion Dermal Contact
		Sediment	Incidental Ingestion Dermal Contact
7 Receptors			
Recreational Fisher			
	Mississippi River, Site Q Ponds	Fish Fillets	Ingestion
		Surface Water	Incidental Ingestion Dermal Contact
2 Receptors		Sediment	Incidental Ingestion Dermal Contact

Total number of receptors = 27, each evaluated for Reasonable Maximum Exposure (RME) and Most Likely Exposure (MLE) scenarios.

Table 11-3

Summary of Potential Exposure

Assumptions -- Indoor Industrial Worker

TABLE 11-3
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - INDOOR INDUSTRIAL WORKER
SAUGET AREA 2 RI/FS SSP
SAUGET AND CAHOKIA, IL
SAUGET AREA 2 SITES GROUP

Parameter	RME On-Site Indoor Worker		MLE On-Site Indoor Worker	
Parameters Used in the Indoor Air Pathway				
Exposure Time (hr/day)	8	(a)	8	(a)
Exposure Frequency (days/year)	250	(b)	250	(b)
Exposure Duration (yr)	25	(b)	7	(c)
Inhalation Rate (m^3/hour)	1.6	(d)	1.0	(e)
Body Weight (kg)	70	(b)	70	(b)

Notes:
MLE - Most Likely Exposure.
RME - Reasonable Maximum Exposure.
(a) - USEPA, 1997a. Exposure Factors Handbook. 50th percentile time spent at work, males and females, all ages. EFH Table 15-68.
(b) - USEPA, 1991a. Standard Default Exposure Factors.
(c) - USEPA, 1997a. Exposure Factors Handbook. Recommended value for occupational tenure listed in EFH Table 1-2.
(d) - USEPA, 1997a. Exposure Factors Handbook. Inhalation rate for moderate activity listed in EFH Table 5-23.
(e) - USEPA, 1997a. Exposure Factors Handbook. Inhalation rate for light activity listed in EFH Table 5-23.

Table 11-4

Summary of Potential Exposure

Assumptions – Outdoor Industrial Worker

TABLE 11-4
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - OUTDOOR INDUSTRIAL WORKER
SAUGET AREA 2 RI/FS SSP
SAUGET AND CAHOKIA, IL
SAUGET AREA 2 SITES GROUP

Parameter	RME Future Outdoor Industrial Worker		MLE Future Outdoor Industrial Worker	
Parameters Used in the Outdoor Air Pathways				
Exposure Time (hr/day)	8	(a)	8	(a)
Exposure Frequency (days/year)	190	(i)	190	(i)
Exposure Duration (yr)	25	(b)	7	(c)
Inhalation Rate (m^3/hour)	1.6	(d)	1	(e)
Body Weight (kg)	70	(b)	70	(b)
Parameters Used in the Surface Soil Pathway				
Exposure Frequency (days/year)	190	(i)	190	(i)
Exposure Duration (yr)	25	(b)	7	(c)
Soil Ingestion Rate (mg/day)	50	(f)	30	(j)
Skin Contacting Medium (cm^2)	3339	(g)	3339	(g)
Soil on Skin (mg/cm^2)	0.02	(h)	0.02	(h)
Body Weight (kg)	70	(b)	70	(b)

Notes:
MLE - Most Likely Exposure.
RME - Reasonable Maximum Exposure.
(a) - USEPA, 1997a. Exposure Factors Handbook. 50th percentile time spent at work, males and females, all ages. EFH Table 15-68.
(b) - USEPA, 1991a. Standard Default Exposure Factors.
(c) - USEPA, 1997a. Exposure Factors Handbook. Recommended value for occupational tenure listed in EFH Table 1-2.
(d) - USEPA, 1997a. Exposure Factors Handbook. Inhalation rate for moderate activity listed in EFH Table 5-23.
(e) - USEPA, 1997a. Exposure Factors Handbook. Inhalation rate for light activity listed in EFH Table 5-23.
(f) - USEPA, 1997a. Exposure Factors Handbook. Average soil ingestion rates listed in EFH Table 1-2.
(g) - USEPA, 1997a. Exposure Factors Handbook. Represents 50th percentile values for males and females based on hands, forearms, and face listed in EFH Tables 6-2 and 6-3.
(h) - USEPA, 1997a. Exposure Factors Handbook. See Table 11-8 of this workplan for calculation.
(i) - Exposure frequency of 250 days (USEPA, 1991a) adjusted for percentage of days with inclement weather (24%), [250-(250*0.24) = 190]; see text.
(j) - Calabrese, E.J., et. al. 1990. Preliminary adult soil ingestion estimates; results of a pilot study. Regul. Toxicol. Pharmacol. 12:88-95. As cited in USEPA, 1997a. Exposure Factors Handbook. Low end of range.

Table 11-5

Summary of Potential Exposure

Assumptions – Construction Worker

TABLE 11-5
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - CONSTRUCTION WORKER
SAUGET AREA 2 RI/FS SSP
SAUGET AND CAHOKIA, IL
SAUGET AREA 2 SITES GROUP

Parameter	RME Future Construction/Utility Worker		MLE Future Construction/Utility Worker	
Parameters Used in the Surface Soil, Subsurface Soil and Groundwater/Leachate Inhalation Pathway				
Exposure Time (hr/day)	8	(a)	8	(a)
Exposure Frequency (days/year)	40	(b)	20	(c)
Exposure Duration (yr)	1	(d)	1	(d)
Inhalation Rate (m^3/hour)	2.5	(e)	1.5	(f)
Body Weight (kg)	70	(g)	70	(g)
Parameters Used in the Surface and Subsurface Soil Pathway				
Exposure Frequency (days/year)	40	(b)	20	(c)
Exposure Duration (yr)	1	(d)	1	(d)
Soil Ingestion Rate (mg/day)	100	(g)	64	(h)
Skin Contacting Medium (cm^2)	3339	(i)	3339	(i)
Soil on Skin (mg/cm^2)	0.19	(j)	0.19	(j)
Body Weight (kg)	70	(g)	70	(g)
Parameters Used in the Groundwater/Leachate Pathway				
Exposure Time (hr/event)	1	(k)	1	(k)
Exposure Frequency (days/year)	10	(k)	5	(k)
Exposure Duration (yr)	1	(d)	1	(d)
Water Ingestion Rate (l/event)	0.005	(l)	0.005	(l)
Skin Contacting Medium (cm^2)	3339	(i)	3339	(i)
Body Weight (kg)	70	(g)	70	(g)

Notes:
MLE - Most Likely Exposure.
RME - Reasonable Maximum Exposure.
(a) - USEPA, 1997a. Exposure Factors Handbook. 50th percentile time spent at work, males and females, all ages. EFH Table 15-68.
(b) - Exposure frequency is equivalent to 5 days per week for 2 months.
(c) - Exposure frequency is equivalent to 5 days per week for 1 month.
(d) - Construction activities are assumed to occur within a 1 year period.
(e) - USEPA, 1997a. Exposure Factors Handbook. Inhalation rate is the value for heavy activity for an outdoor worker listed in EFH Table 5-23.
(f) - USEPA, 1997a. Exposure Factors Handbook. Inhalation rate is the value for moderate activity for an outdoor worker listed in EFH Table 5-23.
(g) - USEPA, 1991a. Standard Default Exposure Factors.
(h) - ENSR-derived value; see text.
(i) - USEPA, 1997a. Exposure Factors Handbook. Represents 50th percentile values for males and females based on hands, forearms, and face listed listed in EFH Tables 6-2 and 6-3.
(j) - USEPA, 1997a. Exposure Factors Handbook. See Table 11-9 of this workplan for calculation.
(k) - Assumes that contact with water occurs only for a fraction of the total exposure duration and time.
(l) - USEPA, 1989a. Risk Assessment Guidance for Superfund, Volume I. Value is one-tenth of that assumed to occur during a swimming event.

Table 11-6

Summary of Potential Exposure

Assumptions -- Trespassing Teenager

TABLE 11-6
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - TRESPASSING TEENAGER
SAUGET AREA 2 RI/FS SSP
SAUGET AND CAHOKIA, IL
SAUGET AREA 2 SITES GROUP

Parameter	RME Trespassing Teenager (7 to 18 yrs)		MLE Trespassing Teenager (7 to 18 yrs)	
Parameters Used in the Surface Soil Pathway				
Exposure Frequency (days/year)	26	(a)	13	(b)
Exposure Duration (yr)	11	(c)	11	(c)
Soil Ingestion Rate (mg/day)	100	(d)	50	(e)
Skin Contacting Medium (cm^2)	4672	(f)	4672	(f)
Soil on Skin (mg/cm^2)	0.04	(g)	0.04	(g)
Body Weight (kg)	47	(h)	47	(h)
Parameters Used in the Outdoor Air Pathway				
Exposure Time (hr/day)	2	(i)	2	(i)
Exposure Frequency (days/year)	26	(a)	13	(b)
Exposure Duration (yr)	11	(c)	11	(c)
Inhalation Rate (m^3/hour)	1.2	(j)	1	(k)
Body Weight (kg)	47	(h)	47	(h)
Parameters Used in the Sediment Pathway (l)				
Exposure Frequency (days/year)	13	(b)	7	(m)
Exposure Duration (yr)	11	(c)	11	(c)
Soil Ingestion Rate (mg/day)	100	(d)	50	(e)
Skin Contacting Medium (cm^2)	6026	(f)	6026	(f)
Sediment on Skin (mg/cm^2)	1	(n)	1	(n)
Body Weight (kg)	47	(h)	47	(h)
Parameters Used in the Surface Water (l)				
Exposure Time (hr/event)	1	(o)	1	(o)
Exposure Frequency (days/year)	13	(b)	7	(m)
Exposure Duration (yr)	11	(c)	11	(c)
Water Ingestion Rate (l/event)	0.005	(p)	0.005	(p)
Skin Contacting Medium (cm^2)	6026	(f)	6026	(f)
Body Weight (kg)	47	(h)	47	(h)

Notes:
MLE - Most Likely Exposure.
RME - Reasonable Maximum Exposure.
(a) - 1 day per week for 26 weeks (6 months) of the year.
(b) - 1 day per 2 weeks for 26 weeks (6 months) of the year.
(c) - Trespassing teenager is assumed to range in age from 7 to 18. Therefore, total exposure duration is 11 years.
(d) - USEPA, 1991a. Standard Default Exposure Factors.
(e) - USEPA, 1997a. Exposure Factors Handbook. Average soil ingestion rate for an adult listed in EFH Table 1-2.
(f) - USEPA, 1997a. Exposure Factors Handbook. Average surface are of head, feet, hands, forearms and lower legs of males and females aged 7 to 18 listed in EFH Tables 6-6 to 6-8
(g) - USEPA, 1997a. Exposure Factors Handbook. See Table 11-10 of this workplan for calculation. Data for feet are not available; therefore, this value is based on hands, forearms, lower legs, and head.
(h) - USEPA, 1997a. Exposure Factors Handbook. Body weight is the average of males and females aged 7 to 18 listed in EFH Table 7-3
(i) - The trespassing teen is assumed to be on-site for two hours.
(j) - USEPA, 1997a. Exposure Factors Handbook. Inhalation rates is the value for moderate activity (children) listed in EFH Table 5-23.
(k) - USEPA, 1997a. Exposure Factors Handbook. Inhalation rates is the value for light activity (children) listed in EFH Table 5-23.
(l) - Sediment and surface water exposures for the Mississippi River will be evaluated separately; sediment and surface water exposures for the Site Q Ponds will be evaluated in conjunction with the Site Q soil and air pathways.
(m) - One day per 4 weeks for approximately six months of the year.
(n) - USEPA, 1992c. Dermal Exposure Assessment: Principles and Applications.
(o) - Assumed duration of wading event.
(p) - USEPA, 1989a. Risk Assessment Guidance for Superfund, Volume I. Value is one-tenth of that assumed to occur during a swimming event.

Table 11-7

Summary of Potential Exposure

Assumptions -- Recreational Fisher

TABLE 11-7
SUMMARY OF POTENTIAL EXPOSURE ASSUMPTIONS - RECREATIONAL FISHER
SAUGET AREA 2 RI/FS SSP
SAUGET AND CAHOKIA, IL
SAUGET AREA 2 SITES GROUP

Parameter	RME Adult Recreational Fisher		MLE Adult Recreational Fisher	
Parameters Used in the Fish Ingestion Pathway				
Exposure Frequency (days/year)	365	(a)	365	(a)
Exposure Duration (yr)	30	(b)	9	(c)
Fish Ingestion Rate (g/day)	8	(d)	1	(e)
Body Weight (kg)	70	(b)	70	(b)
Parameters Used in the Surface Water Pathway - Wading				
Exposure Time (hr/event)	1	(k)	1	(k)
Exposure Frequency (days/year)	22	(h)	3	(i)
Exposure Duration (yr)	30	(b)	9	(c)
Surface Water Ingestion Rate (l/event)	0.01	(f)	0.005	(j)
Skin Contacting Medium (cm^2)	6934	(g)	6934	(g)
Body Weight (kg)	70	(b)	70	(b)
Parameters Used in the Sediment Pathway - Wading				
Exposure Frequency (days/year)	22	(h)	3	(i)
Exposure Duration (yr)	30	(b)	9	(c)
Sediment Ingestion Rate (mg/day)	100	(b)	50	(m)
Skin Contacting Medium (cm^2)	6934	(g)	6934	(g)
Sediment on Skin (mg/cm^2)	1	(l)	1	(l)
Body Weight (kg)	70	(b)	70	(b)

Notes:
MLE - Most Likely Exposure.
RME - Reasonable Maximum Exposure.
(a) - Fish ingestion rates are based on 365 days per year.
(b) - USEPA, 1991a. Standard Default Exposure Factors.
(c) - USEPA, 1997a. Exposure Factors Handbook. Recommended average for time residing in a household. EFH Table 1-2.
(d) - USEPA, 1997a. Exposure Factors Handbook. 8 g/day is equivalent to approximately 22 fish meals of 129 g per year.
(e) - 1 g/day is equivalent to approximately three 129 g fish meals per year (equivalent to one fish meal per month in the three summer months).
(f) - USEPA, 1989a. Risk Assessment Guidance for Superfund, Volume I. Value is one-fifth of that assumed to occur during a swimming event.
(g) - USEPA, 1997a. Exposure Factors Handbook. Represents 50th percentile values for adult males and females based on hands, lower arms, lower legs, feet and head.
(h) - One day per week for 5 months.
(i) - One day per month during the three summer months.
(j) - USEPA, 1989a. Risk Assessment Guidance for Superfund, Volume I. Value is one-tenth of that assumed to occur during a swimming event.
(k) - Assumed duration of wading event.
(l) - USEPA, 1992c. Dermal Exposure Assessment: Principles and Applications.
(m) - USEPA, 1997a. Exposure Factors Handbook. Average soil ingestion rate for an adult listed in EFH Table 1-2.

Table 11-8

Soil Adherence Factors – Outdoor Industrial Worker

Table 11-9

Soil Adherence Factors – Construction Worker

TABLE 11-8
SOIL ADHERENCE FACTORS- OUTDOOR INDUSTRIAL WORKER
SAUGET AREA 2 RI/FS SSP
SAUGET AND CAHOKIA, IL
SAUGET AREA 2 SITES GROUP

Body Part	Outdoor Industrial Worker Scenario		
	Surface Area 50th percentile (cm^2) (a)	Soil Loading Groundskeeper (mg/cm^2) (b)	Total Soil Mass (mg)
Head	1,205	0.005	5.543
Hands	904	0.071	64.1485
Forearms	1,230	0.009	11.1438
Total	3,339		80.8
Area-Weighted Soil Adherence factor (mg/cm2) = Soil mass/Surface area =			0.02

Notes:
(a) - Data from USEPA (1997a), Tables 6-2, 6-3. Average of 50th percentile values for men and women (1/2 arm used as proxy for female forearm).
(b) - Data from USEPA (1997a), Table 6-12. Average of Groundskeeper Nos. 1,2,3,4, and 5.

TABLE 11-9
SOIL ADHERENCE FACTORS- CONSTRUCTION WORKER
SAUGET AREA 2 RI/FS SSP
SAUGET AND CAHOKIA, IL
SAUGET AREA 2 SITES GROUP

Body Part	Construction Worker Scenario		
	Surface Area 50th percentile (cm^2) (a)	Soil Loading Farmer (mg/cm^2) (a)	Total Soil Mass (mg)
Head	1,205	0.041	49.405
Hands	904	0.47	424.645
Forearms	1,230	0.13	159.9
Total	3,339		634.0
Area-Weighted Soil Adherence factor (mg/cm2) = Soil mass/Surface area =			0.19

Notes:
(a) - Data from USEPA (1997a), Tables 6-2, 6-3. Average of 50th percentile values for men and women (1/2 arm used as proxy for female forearm).
(b) - Data from USEPA (1997a), Table 6-12. Average of Farmer Nos. 1 and 2.

Table 11-10

Soil Adherence Factors – Trespassing

Teenager (7 to 18 Years)

TABLE 11-10
SOIL ADHERENCE FACTORS- TRESPASSING TEENAGER (7 TO 18 YEARS)
SAUGET AREA 2 RI/FS SSP
SAUGET AND CAHOKIA, IL
SAUGET AREA 2 SITES GROUP

Body Part	Trespassing Teenager (7 to 18 years)		
	Surface Area 50th percentile (a) (cm^2)	Soil Loading Soccer No. 1 (mg/cm^2) (b)	Total Soil Mass (mg)
Hands	715	0.1100	78.65
Forearms	894	0.0110	9.83
Lower legs	2,068	0.0310	64.11
Head	995	0.0120	11.94
Total	4,672	--	164.53
Area-Weighted Soil Adherence factor (mg/cm2) = Soil mass/Surface area =			0.04

Notes:
(a) - Data from USEPA (1997a). Based on average of boys (EFH Table 6-6) and girls (EFH Table 6-7) total body surface area , and mean percentages of total surface area for individual body parts EFH Table 6-8).
(b) - Data from USEPA (1997a) Table 6-12. Soccer No. 1 (measurements of boys aged 13-15). Measurements were not collected from feet; therefore, adherence factor is based on hands, forearms, lower legs, and head. This factor will be applied to the total body surface area of 6,026 cm^2 calculated in Table 11-6, which includes feet.

Section 12

12.0 ECOLOGICAL RISK ASSESSMENT WORK PLAN

This section outlines the approaches and methodologies to be used in the preparation of the ecological risk assessment (ERA) for the Sauget Area 2 Sites (the Sites) located in the Villages of Sauget and Cahokia, Illinois. Environmental concerns at the Sites are being addressed subject to an Administrative Order by Consent between the Sauget Area 2 Sites Group (the Group) and the U. S. Environmental Protection Agency (USEPA) Region V, pursuant to Section 106 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The Sites include five identified source areas (Sites O, P, Q, R, and S). Additionally, the Sites front approximately 8,000 linear feet of the Mississippi River.

This work plan was developed based on the following guidance material:

- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA 540-R-97-006, June 1997);
- *Guidelines for Ecological Risk Assessment* (EPA/630/R-95/002F, April 1998);
- *Framework for Ecological Risk Assessment* (EPA630/R-92/001);
- *Developing a Work Scope for Ecological Assessments* (Eco Update, Volume 1, Number 4, May 1992);
- U.S. EPA Region V Ecological Assessment Guidance;
- *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 540 G-80 004, October 1988); and
- *Issuance of Final Guidance: Ecological Risk Assessment and Risk Management Principles for Superfund Sites* (OSWER Directive 9285.7-28 P).

12.1 Scope and Objectives

The objective of the ERA is to evaluate the potential for adverse ecological effects to occur as a result of exposure to Site-related constituents by biological receptors living within the aquatic and terrestrial ecosystems located on or adjacent to the Sites. The ERA will be a baseline evaluation of ecological risks utilizing both historic data regarding the Sites and data to be collected as part of

future planned investigative activities within the Mississippi River and the five Sites. The ERA will be prepared using conservative, but realistic, assumptions about potential exposures and, since it is a baseline assessment, will assume no remedial action has occurred.

Specifically, the principal functions of the ERA described in this work plan are:

- Determine whether actual or potential ecological risks currently exist at the Sites;
- Identify those constituents present at the Sites that pose potential ecological risks; and
- Generate data and information for risk management and risk reduction decisions.

This work plan outlines the procedures by which data collected from aquatic and terrestrial sections of the Sites will be evaluated to assess the potential for adverse ecological effects. This ERA will evaluate current site data that will be collected through the following planned activities:

1. *Aquatic Systems*

   - Chemical analyses of sediment samples collected from the Mississippi River and on-Site ponds;
   - Community evaluation (species richness and total biomass) of benthic macroinvertebrates collected from the Mississippi River and on-Site ponds (should they be present);
   - Bioassay analyses of toxicity tests conducted on sediment collected from the Mississippi River and on-Site ponds;
   - Bioaccumulation studies on sediment samples collected from the Mississippi River and on-Site ponds;
   - Chemical analyses of surface water samples collected from the Mississippi River and on-Site ponds;
   - Bioassay analyses of toxicity tests conducted on surface water collected from the Mississippi River and on-Site ponds;

- Chemical analyses of fish tissue collected from the Mississippi River and on-Site ponds; and
- Observations of the fish community and feeding habits of fish collected from the Mississippi River and on-Site ponds.

2. *Terrestrial Systems*

- Chemical analyses of collocated surface soil, plant tissue, and earthworm samples collected from the five Sites.

The specific details of how these data will be collected are presented in separate Field Sampling Plans (FSPs) and Quality Assurance Project Plans (QAPPs). Specific documents have been developed for the Mississippi River (Volume 3A and 3B of the Support Sampling Plan) and terrestrial portions of the Sites adjacent to the river (Volume 4A and 4B of the Support Sampling Plan). It is the objective of this Ecological Risk Assessment work plan to describe how the data collected as per the FSPs and QAPPs will be evaluated to assess the potential for ecological risks associated with constituents of concern in the Mississippi River and the terrestrial portions of the Sites.

12.2 Work Plan Organization

This work plan is divided into the following sections:

- Ecological Risk Assessment Process;
- Ecological Setting;
- Selection of Chemicals of Potential Ecological Concern (COPECs);
- Identification of Receptors and Endpoints;
- Ecotoxicological Benchmarks;
- Wildlife Exposure Models;
- Risk Characterization;
- Uncertainties; and
- Report Preparation

12.3 Ecological Risk Assessment Process

USEPA has developed and issued structured guidance for conducting ERAs. In 1992, USEPA presented a general framework for conducting ERAs that outlined the concepts of assessment and measurement endpoints (USEPA, 1992a). The framework document was intended to be the first step in the promulgation of a simple and flexible structure for evaluating the potential for ecological risks within the USEPA. The framework document outlined the completion of an ERA in terms of:

- Problem Formulation – This is the first phase of the ERA during which the goals, breadth, and focus of the assessment are articulated;
- Analysis – The analysis phase consists of the technical evaluation of data. This phase is divided into the characterization of exposure and the characterization of ecological effects; and
- Risk Characterization – During this phase, the likelihood of the expression of adverse effects resulting from the exposure of a receptor to a stressor is evaluated.

This framework approach was further defined in 1998 with the publishing of USEPA's general guidelines for conducting ERAs (USEPA, 1998a). USEPA (1998a) placed new emphasis on ensuring that the results of the assessment can be used to support risk management decisions.

Almost concurrent with the issuance of the 1998 guidance document, an interim final programmatic guide to the development of ERAs under CERCLA was developed by the USEPA Office of Emergency & Remedial Response (USEPA, 1997a). This guide (Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments or "ERAGs") placed the three phases of the ERA process into a more structured eight-step process for the development of ERAs specifically at CERCLA sites. This allowed for a more proactive mechanism to measure the progress and organization of the ERA. The eight steps outlined in that document (and applied to the ERA being prepared for the Sites) are:

- Step 1 – Preliminary Screening Level, which includes a site visit, preliminary problem formulation, and preliminary toxicity evaluation.

- Step 2 – Screening Level, which includes development of exposure estimates and preliminary risk calculations. The step includes a Scientific/Management Decision Point **(SMDPa)**.
- Step 3 – Baseline Risk Assessment Problem Formulation, which includes toxicity evaluation, development of a preliminary site conceptual model and exposure pathways, and development of assessment endpoints. This step also includes a **SMDP (SMDPb)**.
- Step 4 – Study Design and DQO Development. This step includes development of the Work Plan, and Sampling and Analysis Plan based upon results of the previous three steps. This step also includes an **SMDP (SMDPc)**.
- Step 5 – Verification of Field Sampling Design. This step includes a determination of the feasibility of the field program as outlined in Step 4. This step includes an**SMDP (SMDPd)**.
- Step 6 - Site Investigation and Data Analysis. This step includes an **SMDP**.
- Step 7 – Risk Characterization. This step includes more refined and detailed quantification of potential site risks, and is generally a more realistic evaluation of risks than was performed in Step 2.
- Step 8 – Risk Management, which includes selection of alternatives in the Record of Decisions as a **SMDP (SMDPe)**.

SMDPs are checkpoints in the ERA process to:

- Verify that the work that was conducted at each step is complete;
- Determine whether the risk assessment is proceeding in a direction that will support decision making; and
- Determine the need, if any, for proceeding to the next step.

SMDPs provide the opportunity to further focus assessment approaches or add additional activities to address the specific goals of the ERA. They also provide the opportunity to exit the process where the weight-of-evidence supports no further action, since all eight steps may not be required for all site evaluations.

USEPA has also issued a set of risk management principles that are relevant to ERAs and that serve to supplement the ERA guidance (USEPA, 1999a). This directive, prepared by the Office of Solid Waste and Emergency Response (OSWER), recommends the following series of risk assessment/risk management questions be answered at each SMDP:

- What ecological receptors should be protected? Site-specific assessment endpoints should be identified that address chemical-specific potential adverse effects to local populations and communities of plants and animals. The role of structure and function of the endpoint becomes important in this decision (Keenan et al., 1999). For example, the structure of the benthic community itself (i.e., its diversity) may be less important to the local system than the higher trophic level it supports (i.e., its function as a food source for higher trophic level organisms).
- Is there an unacceptable ecological risk at the site? Ecological impacts can be readily apparent (e.g., loss of vegetation) or less apparent (e.g., slight change in benthic abundance). A variety of assessment and measurement endpoints may be needed to generate lines-of-evidence to determine whether a potential exists for an unacceptable ecological risk. It is also important to determine whether or not the observed "effect" is due to site-related constituents or from indigenous conditions (e.g., naturally reducing conditions causing a paucity of benthic organisms).

Remaining ecological risk assessment/risk management questions discussed in USEPA (1999a) emphasize issues related to remediation. However, they need to be kept in mind as the investigation and ecological risk assessment for the Sites are completed.

- Will the cleanup cause more ecological harm than current site contamination? Short-term and long-term effects of the contamination should be considered, as well as the ability of the system to recover from any disturbance related to remediation. For example, it may be counterproductive to remove a bottomland hardwood forest based on a presumed short-term ecological impact to a small mammal when the forest cannot be restored due to issues related to water management as well as the long period of time required for system recovery.

- What cleanup levels are protective? If a decision is made that a remedial action is required, the various lines-of-evidence that are used to evaluate the potential risks are revisited to determine an appropriate cleanup goal. The likelihood of the response alternatives to achieve success and the time frame for an ecological community to fully recover should be considered in the remedy selection. Generally, empirical data supporting a concentration/response gradient is the most appropriate to use for this assessment.

In addition to the above decisions, the OSWER Directive identifies six principles that risk managers should address when scoping ecological risk assessments or when making ecological risk management decisions (USEPA; 1999a). The principles are:

- Principle Number 1 – Reduce ecological risks to levels that will result in the recovery and maintenance of healthy local populations and communities of biota.
- Principle Number 2 – Coordinate with Federal, State, and/or Tribal Natural Resource Trustees.
- Principle Number 3 – Use site-specific ecological risk data to support cleanup decisions. Site-specific data are used to determine whether or not site releases present unacceptable risks and to develop quantitative cleanup levels that are protective.
- Principle Number 4 – Characterize site risks in terms of magnitude (i.e., the degree of observed or predicted responses of receptors to the range of contaminant levels), severity (i.e., how many and to what extent the receptors may be affected), distribution (i.e., aerial extent and duration over which effects may occur), and the potential for recovery of the affected receptors.
- Principle Number 5 – Communicate risks to the public.
- Principle Number 6 – Remediate unacceptable ecological risks.

One of the critical points in this memorandum is that USEPA has directed the ecological risk assessment process to examine populations, as opposed to individuals.

12.3.1 Consistency with the ERAGs Process

ERAGs (USEPA, 1997a) was used as a basis for the development of this ERA Work Plan. However, because of USEPA's desire to expedite certain aspects of the Remedial Investigation/Feasibility Study (RI/FS) process for the Sites, adjustments were made in the ERAGs process. A limited Step 1 (Screening Level Problem Formulation and Ecological Effects Evaluation) and Step 2 (Screening Level Exposure Estimate and Risk Calculation) have been conducted for a section of the Mississippi River as part of other environmental studies. A screening level assessment has been conducted for the terrestrial portion of the Sites on a qualitative basis using some historic data and assessment reports prepared by various regulatory agencies.

This Work Plan outlines the procedures to be used in the development of a Baseline Ecological Risk Assessment (BERA) for the aquatic and terrestrial communities at the Sites. This Work Plan continues the ERAGs process by detailing Step 3 (Baseline Risk Assessment Problem Formulation) in Sections 12.4 and 12.5 (identification of exposure pathways and conceptual site model), 12.6 (identification of chemicals of concern), and 12.7 (identification of assessment endpoints). Step 4 (Study Design and DQP Process) is outlined in Section 12.7 (identification of measurement endpoints and lines of evidence), Section 8 of this SSP and Volumes 3A, 3B, 4A, and 4B (work plan and sampling and analysis plan). Step 5 (Verification of Field Sampling Design) will be made during the preliminary site reconnaissance described in Volumes 3A, 3B, 4A, and 4B. Step 6 (Site Investigation and Data Analysis) will be completed during the implementation of the various sampling plans and the completion of Step 7 (Risk Characterization) is described in Section 12.8.

Regarding the use of SMDPs, discussions held with the USEPA, U.S. Fish and Wildlife Service, Illinois Environmental Protection Agency, and the government contractor served to consolidate SMPDa, SMDPb, and SMDPc. Discussions to be held following the preliminary site reconnaissance will serve as SMDPd.

12.3.2 Consistency with the DQO Process

The DQO process is a seven step, iterative planning approach used to prepare plans for the collection of environmental data. It will provide a systematic approach for determining the criteria that a sampling program should fulfill, the procedures to be used in the collection of the samples or measurements, determine tolerable error rates, and identify the number of samples or measurements that should be made (USEPA, 2000).

In keeping with the ERAGs process (USEPA, 1997a), Step 3 (Baseline Risk Assessment Problem Formulation) and Step 4 (Study Design and DQP Process) comprise the DQO process for the development of ERAs. As previously mentioned, Step 3 is described in Sections 12.4 and 12.5 (identification of exposure pathways and conceptual site model), 12.6 (identification of chemicals of concern), and 12.7 (identification of assessment endpoints). Step 4 is outlined in Section 12.7 (identification of measurement endpoints and lines of evidence), Section 8 of this SSP and Volumes 3A, 3B, 4A, and 4B (work plan and sampling and analysis plan). Further detail on the DQO process used in the development of sampling/analytical strategies is presented in Volumes 3A, 3B, 4A, and 4B.

12.4 Ecological Setting

The Sites are situated adjacent to the Mississippi River. The Sites, found within the villages of Sauget and Cahokia, Illinois, are generally located east of the Mississippi River, south of the MacArthur bridge railroad tracks, west of Illinois State Highway 3, and north of Cargill Road. The Sites front approximately 8,000 feet of the Mississippi River.

The Sauget Area 2 Sites includes five disposal areas, Sites O, P, Q, R, and S, adjacent, or in close proximity, to the Mississippi River. These five disposal areas were given letter designations by the Illinois Environmental Protection Agency (IEPA) in the 1980s. Two of these sites, Sites Q and R, are located on the wet side of the flood wall and levee which is operated and maintained by the US Army Corps of Engineers and the Metro East Sanitary District. The flood wall is designed to protect the City of East St. Louis and the Villages of Sauget and Cahokia from flooding. Sites O, P, and S are located on the dry side of the flood wall and levee.

Site O is located on Mobile Avenue in Sauget and occupies approximately 20 acres northeast of the American Bottoms Regional Wastewater Treatment Facility (ABRTF). Site P is located between the Illinois Central Gulf Railroad and the Terminal Railroad, and is north of Monsanto Avenue in the Village of Sauget. Site P occupies approximately 20 acres of land. Site Q occupies approximately 90 acres and is south of Sauget Site R and the old Union Electric Power Plant, west of the Illinois Central Gulf Railroad and the U.S. Corps of Engineers flood control levee, and east of the Mississippi River. The two ponds created by the borrow pit operations are located at the southern end of Site Q. Site R is located adjacent to the Mississippi and has had a temporary cap placed on it. Site S is a small disposal area west-southwest of Site O.

The following sections provide the basis for the problem formulation stage of the ERA in that the potential pathways and receptors are identified for future evaluation. The ecological condition section provides a general understanding of the ecological receptors and communities found within the Sites. At present, this is a general presentation of information as detailed evaluations have only been completed on a narrow corridor adjacent to the Sites (i.e., the Dead Creek corridor). Information detailing the characteristics of the ecosystems in each of the five Sites and in the Mississippi River adjacent to the Sites will be identified and compiled as part of the field data collection activities.

During the course of the field activities supporting the ERA, a more thorough understanding of the characteristics of the aquatic and terrestrial ecosystems associated with the Sites will be developed. Aquatic sampling will provide details of the fish and benthic invertebrate communities, as well as physical characteristics of the surface water and sediments in the Mississippi River adjacent to the Sites. During the terrestrial sampling, a description of the habitat and dominant vegetative communities will be developed. This plant community survey will include a determination of community makeup, density, frequency and abundance. The objective of that activity will be to build a general habitat cover type map for the Sites within the Sites and to prepare a basic inventory of the dominant plant and animal species indigenous to the area.

The Conceptual Site Model (CSM) then presents a hypothetical understanding of the potential pathways by which constituents may move through the environment and the receptors at risk

from exposure to those constituents. The CSM can be revised, as new site-related information becomes available.

12.4.1 Ecological Conditions

Sauget Area 2 is located in the floodplain of the Mississippi River in an area known as American Bottoms. Topographically, the area consists primarily of flat bottomland, although local topographic irregularities do occur. Generally, land surface in the American Bottoms slopes from north to south and from east to west, toward the Mississippi River. Land surface elevation ranges from 400 to 410 feet above Mean Sea Level (MSL) with little topographic relief.

The dominant ecological feature associated with the Sites is the Mississippi River. The floodplain area containing the Sites fronts approximately 14,000 linear feet of the Mississippi River. The terrestrial area is found within a category of ecosystems called floodplains, which are flat land surfaces where alluvial material has been laid down in old valleys over an extended time period. While anthropogenic influences have greatly modified the Mississippi River and the quality of its basic components, the river still influences the types of sediments and soils found near the Site, the types of aquatic organisms found within its influences, and the basic structure for the terrestrial habitat found adjacent to its shores.

The section of the Mississippi River adjacent to the Sites is called the Unimpounded Reach (USGS, 1999), which extends from St. Louis downstream to Cairo, Illinois. This section of the river, also called the Open River Reach, is characterized by channelized aquatic habitats, with terrestrial portions that have been protected from flooding by levees to support agriculture and other uses of the historic floodplain. This scenario reflects the conditions adjacent to the Site as the riverbank has been substantially sculpted by anthropogenic activities. A rock revetment covers approximately 2,250 feet of the riverbank adjacent to Site R, and the remainder of the riverbank has been developed as piers and other structures for barge traffic. In this reach of the Mississippi River there are almost no lotic or marsh habitats. Channel depth in the center of the channel is maintained at a minimum depth of nine feet to allow for barge traffic. The current is swift, with median flows ranging from 85,000 to 95,000 ft^3/second.

USGS (1999) notes that the characteristics of sediments and surface water in the Mississippi River below its confluence with the Missouri River (approximately two miles upstream of the Sites) have long differed from the reach upstream of the confluence. Two of the prominent reasons for those differences include both the City of St. Louis and the drainage basin of the Missouri River. St. Louis has had a significant effect on water quality within the river due to sewage and industrial discharges from within the city. Missouri Department of Natural Resources (1994) notes that an estimated 300 tons of ground garbage was discharged in the river daily in 1957, and as late as 1970, raw sewage was discharged directly into the river by the City of St. Louis (Corbett, 1997). The Missouri River drains an area with highly erodible soils and is the major source of sediments to the Mississippi River. This contribution of sediment leads to changes in water clarity, sedimentation of shallow areas, and the introduction of non-Site-related sediment-borne constituents.

Boyer (1984) notes that St. Louis contributes significant amounts of constituents from wastewater effluents, industrial discharges and urban runoff, including metals and organic compounds, such as PCBs. Pesticides and herbicides are significant contaminants in the Mississippi River. The reach upstream of the Missouri confluence contributes 40 to 50 percent of the pesticide and herbicide load within the Mississippi River, even though it represents only 22 percent of the flow from the entire river (Goolsby and Pereira, 1995).. USGS (1999) notes that surface water conditions in the Mississippi River have improved since the passage of the Federal Water Pollution Control Act in 1970, though concentrations of pesticides still exceed USEPA guidelines during low flow, high use periods of the year. Such concentrations of metals and organic compounds (that often exceed screening benchmarks) have the potential to affect biological communities.

Aquatic life within the river depends upon the presence of suitable habitat, which is a function of water and sediment characteristics. Areas of deep, swift water, such as found adjacent to the Sites, would be occupied by channel dwelling fishes and would probably not support habitat that would be used for spawning or as nurseries. Fremling et al. (1989) state that the Upper Mississippi River Basin supports at least 260 freshwater fish species. Fish in channel habitats are called riverine species and occur as either streamline forms that occupy the water column such as white bass (*Morone chrysops*) or bottom-dwelling forms, such as channel catfish (*Ictalurus punctatus*) (USGS, 1999). Other common riverine species identified by USGS (1999), based on Long-Term Resource Monitoring Program (LTRMP) catch data include sauger (*Stizostedion canadense*),

walleye (*Stizostedion vitreum*), and smallmouth buffalo (*Ictiobus bubalus*). Important prey species indigenous to the Unimpounded Reach area include gizzard shad (*Dorosoma cepedianum*) and emerald shiners (*Notropis atherinoides*).

While a survey of the terrestrial community in each of the Sites will be conducted, preliminary observations indicate that Sites O, P, R and S have been significantly impacted by anthropogenic activities. These activities include clearing and construction of roads and railroad lines, construction of buildings, and the development of industrial activities. These areas show signs of extensive clearing and/or disturbance, and they are vegetated either solely by herbaceous communities, or by herbaceous communities with a thin layer of early successional shrubs or trees.

Site Q is the one area having a significant quantity of floodplain forest still in evidence. USGS (1999) notes that floodplain forests are more structurally complex than upland forests and are generally differentiated into three strata. Those strata include a herbaceous ground cover layer, a shrub or sampling sub-canopy layer, and a tree layer that dominates the community. The major floodplain forest communities in the Upper Mississippi River System include those dominated by black willow (*Salix nigra*), those dominated by eastern cottonwood (*Populus deltoides*), those dominated by silver maples (*Acer saccharinum*) and those dominated by a mixed oak-hickory forest.

In 1997, a biological survey was conducted at select locations of Site Q as part of an Ecological Risk Assessment conducted by Ecology and Environment on behalf of the USEPA (USEPA, 1997b). The focus of the ERA was a small pond located in the northern portion of Site Q, and the two ponds located at the southern end of this Site. The ponds at the southern end have been identified as a location for sampling as part of the field activities to support this ERA. The northern pond was noted as being devoid of life, though the southern ponds did support populations of aquatic macrophytes and an amphibian (chorus frog, *Pseudacris triseriata*). Subsequently, a brief reconnaissance of the area in January 2001 noted that the two southern ponds were dry and did not contain any standing water. However, anecdotal statements made by USEPA personnel in April 2001 indicate that the ponds have refilled as a result of stormwater influence.

Plant species identified by the USEPA in their survey were cocklebur (*Xanthium strumarium*), common mullein (*Verbascum thapsus*), common evening primrose (*Oenothera biennis*), black-eyed Susan (*Rudbeckia serotina*) and eastern cottonwood. Identified mammals included eastern cottontail (*Sylvilagus floridanus*) and whitetailed deer (*Odocoileus virginianus*). Identified birds included red-winged blackbirds (*Agelaius phoeniceus*), American robin (*Turdus migratorius*), northern cardinal (*Cardinalis cardinalis*), field sparrow (*Spizella pusilla*), domesticated pigeons (*Columba livia*), American coot (*Fulica Americana*), common flicker (*Colaptes auratus*), American kestrel (*Falco sparverius*), and wild turkey (*Meleagris gallopavo*).

12.4.2 Threatened and Endangered Species

Endangered species are those organisms whose prospects for survival in an area are assumed to be in immediate danger because of a loss or change in habitat, over-exploitation, predation, competition, or disease. Threatened species are those who may become endangered if conditions surrounding the species begin, or continue to, deteriorate. There are two federally listed endangered species that can potentially be found at (or adjacent to) the Sites. Those species include the Indiana bat (*Myotis sodalis*) and pallid sturgeon (*Scaphirhynchus albus*). One federally listed threatened species that has been recorded in St. Clair County is the decurrent false aster (*Boltonia decurrens*). USEPA (1997b) noted that the decurrent false aster is found in alluvial prairie and marshland in river floodplains. It was concluded by USEPA (1997b) that it was unlikely that this species would be found at the Sites because of the history of extensive disturbance, though the USFWS has suggested that the habitat information is inaccurate.

A federally listed species that is known to winter in the region and identified in the area is the bald eagle (*Haliaeetus leucocephalus*). The bald eagle has been recently upgraded to threatened status from endangered by the U.S. Fish and Wildlife Service.

USEPA (1997b) did list several state-listed bird species that are likely to utilize the Sites. Those species include the black-crowned night heron (*Nycticorax nycticorax*), little blue heron (*Egretta caerulea*), snowy egret (*Egretta thula*), great egret (*Casmerodius albus*), and pied-billed grebe (*Podilymbus podiceps*). The great egret and pied-billed grebe are listed as threatened by the

State of Illinois; the other three species are listed as endangered by the State. Only the black-crowned night heron has been sighted within two miles of the Sites.

Additionally, there are 18 federally or state (either Illinois or Missouri) listed fish species that have been historically shown to be present in the main stem of the Mississippi River in the region of the Sites (USGS, 1999). Those species include:

Alabama shad	*Alosa alabamae*	highfin carpsucker	*Carpiodes velifer*
alligator gar	*Atractosteus spatula*	Iowa darter	*Etheostoma exile*
bigeye shiner	*Notropis boops*	lake sturgeon	*Acipenser fulvescens*
blacknose shiner	*Notropis heterolepis*	mooneye	*Hiodon tergisus*
brown bullhead	*Ameiurus nebulosus*	northern pike	*Esox lucius*
central mudminnow	*Umbra limi*	pallid sturgeon	*Scaphirhynchus albus*
crystal darter	*Crystallaria asprella*	sicklefin chub	*Macrhybopsis meeki*
flathead chub	*Platygobio gracilis*	sturgeon chub	*Macrhybopsis gelida*
greater redhorse	*Moxostoma valenciennesi*	trout-perch	*Percopsis omiscomaycus*

12.4.3 Sensitive Habitats

Sensitive habitats include those ecological systems that support endangered or threatened species (either federally or state listed) or support wetlands. Given the lack of endangered or threatened species that are expected to be found on the Sites (USEPA, 1997b), habitat to support these species is not expected to be present. Menzie-Cura (1999) noted that a pair of bald eagles attempted to nest on the southern end of Arsenal Island, south of the Sites, in 1993. While the pair failed in their first attempt, it is not know whether later attempts were successful. A nest was observed by Menzie-Cura in 1996, but it did not appear to be in use.

The Clean Water Act defines wetlands as "those areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated

soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (33 CFR 230.3).

A review of the National Wetland Inventory (NWI) map for the Sites, prepared by the U.S. Fish and Wildlife Service, indicates that a substantial portion of the Sites P and Q have been categorized as wetlands. These wetlands are listed as palustrine wetlands, dominated by deciduous forests, shrub/scrub plant species, or emergent plant species. Palustrine wetlands are bounded by uplands or any other type of wetlands and may be situated shoreward of lakes, river channels or in floodplains (Cowardin et al., 1979). Shrubs are woody plant species that range from 3 to 20 feet in height. Emergent plants are those species in which at least a portion of the foliage and all of the reproductive structures extend above the surface of any standing water. Typical of this type of plant include cattails (*Typha* sp.), common reed (*Phragmites australis*), rushes (*Juncus* sp.) and sedges (*Carex* sp.). Emergents are usually found in shallow water or on saturated soils. Details of these wetlands will be developed during the field activities to be conducted in support of this ERA.

12.5 Conceptual Site Model

One of the most critical elements of the ERA scoping process is the development of the CSM. The CSM describes the hypothesized source of COPECs, routes of exposure and transport, and ecological receptors associated with the Sites. The CSM serves as the rationale for the development of sampling plans and protocols, the selection of assessment and measurement endpoints, and the identification of receptors of concern.

The environmental fate of COPECs is determined by the cumulative interaction of transport and transformation processes (Paustenbach, 1987). Once released into the environment, the chemicals may partition among various media (e.g., soil, water, and air). The transport processes that define the movement of chemicals between compartments are highly dependent upon the physico-chemical properties of both the chemical and the environmental media, and thus, have a direct bearing on the potential risks to the exposed populations (Paustenbach, 1987). The ability of a chemical to proceed through a migration pathway and reach an exposed receptor is directly related to the chemical properties of the constituent and the physical characteristics of the pathway.

The following sections describe in greater detail the CSM for the aquatic and terrestrial pathways associated with the Sites.

12.5.1 Aquatic Pathways

The primary aquatic pathway of concern with the Sites is the potential discharge of groundwater containing COPECs to the Mississippi River. Two of the five Sites are located in close proximity to the east bank of the Mississippi River (Sites Q and R). The other three Sites (Sites O, P, and S) are located 1500 to 2000 feet east of the riverbank. Solid and liquid industrial and municipal wastes were disposed at these facilities from the 1950s to the 1980s. At two of the disposal sites, wastes were placed in former borrow pit excavations (Sites Q and R). Wastes were placed in excavations at two other disposal sites (Sites O and S), however, these excavations were made solely for the purpose of waste disposal. Wastes were placed on grade at the fifth disposal site (Site P). It is likely that the excavations at Sites Q and R went to or below the water table to maximize the amount of borrow. It is unlikely that the excavations for Sites O and S extended to the water table since these disposal sites needed only shallow excavations, 5 to 10 feet deep, to accommodate the materials placed in them.

Whether or not the waste disposal excavations extended to or below the water table, the potential exists for constituent migration through the groundwater system. The aquifer beneath Sauget Area 2 consists of three distinct hydrogeologic units: 1) the Upper Hydrogeologic Unit with fine-grained, silty sands, 2) the Middle Hydrogeologic Unit with clean, medium to coarse sand and 3) the Deep Hydrogeologic Unit with clean, medium to coarse sand and gravel. Leachate migrating from the waste disposal areas could enter these hydrogeologic units and then discharge to the river via groundwater. The ultimate discharge point for these units is the Mississippi River.

If constituents of concern are transported through the groundwater system, they would be discharged into the Mississippi River. COPECs that are discharged through groundwater will first pass through the sediments of the river channel prior to entering the water column. In coarse-grained sediments with little organic material, the dissolved groundwater-borne COPECs will pass directly to the water column. In fine-grained or organic rich sediments, a portion of the

groundwater-borne constituents may adhere to sediment particles. Whether the constituents remain in the sediment or are dissolved again will depend on its chemical characteristics. Those chemicals with high organic carbon partition coefficient (K_{oc}) values will have a greater affinity for sediment, especially sediment that is high in organic matter. Such constituents would tend to remain sorbed onto sediment particles and migration would occur as a result of sediment movement, not chemical movement.

The primary mechanisms by which chemicals migrate from sediments into the water column are through desorption from sediment particles, resuspension via physical disturbance and resuspension followed by food chain transport. COPECs that are dissolved in groundwater and adsorb onto sediment particles as groundwater wells up through the sediment base may desorb from the sediment particles over time, depending upon the K_{oc} value. For some high K_{oc} constituents, such as PCBs and chlorinated pesticides, desorption from sediment particles, especially those with a high organic content, is very slow, if not minimal. For other constituents, such as polycyclic aromatic hydrocarbons (PAHs) and organic solvents, desorption is much more rapid and can lead to a steady source of the constituent into the water column.

A physical disturbance of the sediment by anthropogenic activities like dredging and prop wash from boats, or natural activities such as flooding can cause resuspension of the chemicals within the sediment. This resuspension may be long- or short-term depending upon the size and solubility of the compound and the size of the sediment particle. Re-suspended particles to which these constituents are sorbed can be either organic matter or inorganic particulates. While in the water column, pelagic flora and fauna may be directly exposed to the re-suspended chemicals as they are transported downstream to other sites. These mobilized constituents in surface water may then be transported through the food chain to higher order trophic levels (i.e., piscivorous and omnivorous wildlife).

Once in the Mississippi River, the primary migration pathways for chemicals that are discharged from groundwater would be diffusion throughout the water body, and/or settling and bioaccumulation in the food chain. The process of diffusion is an ameliorating process because the compound is reduced in concentration. Constituents that are dissolved in groundwater and discharged into the river will pass through the sediment layer and be diffused by the larger volume of the receiving water body. Diffusion is further enhanced by the flow of water within the

river upstream to downstream by increasing the rate of diffusion and moving the diluted chemicals out of the recharge zone. For species of limited mobility or sensitive life stages that may inhabit the discharge zone in close proximity to the discharge point for long periods of time, the potential for adverse impacts from exposure can still exist. However, in a river of extreme volume and flow, such as the Mississippi River in the vicinity of the Sites, dilution can be a major limiting factor to the potential for exposure of aquatic organisms to elevated levels of COPECs.

The settling of suspended particles or precipitation of dissolved chemicals removes the compound from the water column, but may increase the direct exposure to benthic organisms and bottom-rooting aquatic plants. Food chain transport from primary producers through the various trophic levels of consumers is compound specific and can lead to exposure of receptors that either live on the Sites or that come into contact with Site-related constituents that have been transported off-Site. However, food chain transport through the food web that is based on the benthic community includes a major contribution from detritus and not from primary production from rooted vegetation or epiphytic and planktonic plant species.

Another potential migration pathway to the Mississippi River is discharge via storm water runoff. Because Sites O, P, and S are found east of the flood control dike that runs parallel to the river, stormwater runoff would not be a concern. This pathway is not likely to be a major migration pathway at the Sites west of the flood control dike because the areas are covered with vegetation, soil caps, or impermeable pavement. Should it occur, surface water runoff would carry COPECs to the Mississippi River that are either dissolved in the water or adsorbed onto sediment particles. While runoff from Site R is likely limited due to the vegetation over the present cap, there are some areas of Q where runoff may occur. However, it is not presently know whether runoff areas or patterns are such that they drain surface soils containing COPECs. A runoff study will be conducted as part of the remedial investigation activities planned for Site Q. Once in the river, dissolved or suspended COPECs in surface water would be diluted and transported as described above.

Due to the ecological significance of the Mississippi River and the recreational and commercial importance of its natural resources, the aquatic pathway is the most significant pathway associated with the Sites. As shown in Figure 12-1 (Aquatic Conceptual Site Model for the Mississippi River), constituents that are possibly released in groundwater can migrate through

the sediments into the water column in the vicinity of the discharge point. The sampling that will support this ERA, described in accompanying FSPs and QAPPs (Volumes 3A and 3B), is designed to investigate the magnitude of this potential release by examining the surface water and sediment in the likely discharge areas for groundwater. The biological sampling included in the field studies is intended to provide data on the conditions of vertebrates and invertebrates associated with the aquatic system for the purpose of evaluating the potential ecological effects resulting from a possible groundwater discharge.

As noted in Section 12.4.1, a number of sources of constituents similar to those found in the Mississippi River adjacent to the Sites and in on-Site areas, including agricultural runoff, wastewater treatment facilities, industrial discharges, and non-point pollution sources, exist upstream of the Sauget Sites. With the high velocity and large volume of water in the river in the vicinity of the Sites, rapid downstream transport (i.e., toward the Sites) of materials from these upstream sources is expected. It will be necessary to use care when evaluating the potential for adverse ecological effects and identifying those that are Site-related versus those that are not. To account for the potential effects of these upstream sources and the effects of high velocity, appropriate reference locations will be utilized to place any suspected effects in the context of regional conditions and to serve as a comparison for the determination of Site-related effects.

The aquatic pathways described in this section also apply to the ponded areas located in the southern portion of Site Q. COPECs that are present in the surrounding soils may migrate into the ponds, thereby exposing biota that use or live in the ponds. As previously mentioned, the ponds were drained and have recently refilled as a result of stormwater influence. As such, the aquatic community that is present is extremely limited and probably restricted to early successional aquatic plants and some early colonizing benthic invertebrates. However the ponds may serve as a water source for terrestrial vertebrates and a breeding spot for amphibians or aquatic birds. A conceptual CSM for the ponded areas within Site Q is presented as Figure 12-3.

12.5.2 Terrestrial Pathways

The migration of COPECs within soils may result in either direct exposure through contact with the soil or indirect exposure through the food chain to faunal communities supported by the available habitat at the Sites. Biota may come in direct contact with chemicals in soil while foraging and/or burrowing. The vectors by which chemicals in the soil may potentially be introduced into biota are direct ingestion (primary source), dermal absorption, or inhalation. The USEPA has determined that inhalation comprises less than 0.1% of total exposure and direct contact comprises approximately 1 to 11% of total exposure (USEPA, 2000). Indirect exposure occurs when a COPEC is assimilated by a species (e.g., prey/food item) at one trophic level, bioaccumulated by that trophic level, and transferred to the next trophic level through consumption.

Chemicals in surface soils may potentially move from the soils up the food chain through bioaccumulation and biomagnification processes. Soil dwelling organisms (i.e., soil invertebrates and small mammals) may bioaccumulate chemicals from direct and incidental ingestion and through direct contact with the soil.

The terrestrial pathways at the Sites are associated with the five Sites. Site O includes four lagoons that were capped with two feet of clay in 1980. Between 1966/67 and 1978, these lagoons were used to dispose of clarifier sludge from the Sauget Physical Chemical Wastewater Treatment Plant (a publicly owned treatment works). During its operation the treatment plant and associated lagoons received and treated industrial and municipal wastewater. It has been reported that approximately 10 million gallons per day of wastewater was treated, more than 95% of which was from area industries.

Site P was operated as an IEPA-permitted landfill from 1973 to approximately 1980, accepting general wastes, including diatomaceous earth filter cake and non-chemical wastes. Site P is currently inactive and partially covered by parking areas; however, access to this part of the Sites is not restricted.

Site Q is a former subsurface and surface disposal area that accepted various wastes including municipal waste, liquid chemical wastes, septic tank pumpings, drums, organic and inorganic wastes, solvents, pesticides and paint sludges. It also took plant trash, waste from other industrial facilities and demolition debris. Most of Site Q is covered with highly permeableblack cinders. Site S was a disposal area. The northern portion of this part of the Site is grassed and its southern portion is covered with gravel and fenced.

Site R is a closed industrial-waste disposal area that accepted hazardous and non-hazardous bulk liquid and solid chemical wastes and drummed chemical wastes that included organics, inorganics, solvents, pesticides, and metals. The Site is capped with a clay cover whose thickness ranges from 2 feet to approximately 8 feet.

As shown in the Terrestrial Conceptual Site Models, terrestrial receptors may be exposed to constituents located in these Sites. A CSM for the terrestrial portion of the Sites is presented as Figures 12-2. If constituents are present in surface soils, the migration pathways described above could lead to the possible exposure of plant and wildlife receptors to Site-related constituents. Surface soil sampling in each area is intended to characterize the constituents present in soil in areas frequented by biological receptors. The biological sampling is intended to provide data to support an assessment of the potential for adverse ecological effects from the presence of these constituents.

Terrestrial receptors may also be exposed to COPECs present in air and in surface water. Both of these pathways are considered to be minor. Compounds with a high degree of volatilization (e.g., volatile organic compounds) can expose mammals to vapors that produce ecological effects. However, noting the age of the Sites, the partial coverage by caps and impermeable layers, and the level of historic disturbance which would act to accelerate the volatilization process, this pathway is considered to be insignificant (Sample and Suter, 1994).

Terrestrial receptors may be exposed to COPECs in water and sediments. Most small mammals (particularly rodents) obtain their water through ingestion of plants with high water content, rain puddles collected on the ground or on impervious surfaces, and from dew (Vaughn, 1986). Larger carnivores may drink from ponds, rivers, puddles, or lakes. Terrestrial receptors may also be exposed to COPECs in surface water (and sediment) through either incidental ingestion or through

direct contact. Birds may be exposed through the accumulation of soil and sediment by use of these materials as grit.

12.6 Selection of Chemicals of Potential Ecological Concern (COPECs)

The QAPP/FSP lists target analytes for the Sites. These target analytes include volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, herbicides, polychlorinated biphenyls (PCBs), dioxin/furans, and metals. The list of analytes has been developed in discussions with the USEPA.

The results of the proposed sampling and analysis of surface water, sediments, surface soils, and biota, will be used to select the list of COPECs. The number of proposed samples and the sample locations, in both the terrestrial and aquatic environments have been selected in discussions with the USEPA and are designed to reflect worst-case conditions in the two ecosystems.

Constituents will be retained on the list of COPECs and carried through the screening process if they exhibit any of the following characteristics:

- Toxic – Produce a harmful effect (is toxic), based on the scientific literature or direct measures of toxicity, to the receptors likely to inhabit the Mississippi River in the vicinity of the Sites and the terrestrial environment found within the five Sites. The ecological effect (e.g., survival, reproductive impacts, or growth impacts), either acute or chronic, is considered to be harmful if there is greater than 20% difference between the test species and its reference/background counterpart;
- Bioaccumulative – Likely to bioconcentrate or biomagnify in the aquatic and terrestrial food chains likely to be at, or adjacent to, the Sites (determined as a constituents with an octanol-water partition coefficient (K_{ow}) greater than 1,000 [*Great Lakes Water Quality Initiative* (GLWQI) (40 CFR 122 et al., 1995)]; and
- Persistent – Likely to remain in environmental media over time frames that are long, relative to the life spans or exposure periods of receptors likely to inhabit the Mississippi River in the vicinity of the Sites and the terrestrial environment found within the five Sites.

For those constituents that are shown to be potentially toxic, bioaccumulative or persistent, additional screening parameters will be utilized to refine the list of COPECs. The criteria for final selection and evaluation include:

- Comparison to Background – The ERA will eliminate a constituent that occurs below the maximum concentration measured at a local reference area for a given medium.
- Frequency of Detection – The ERA will retain a constituent for evaluation if the constituent is detected in more that 5% of samples from a particular medium.

Ecotoxicological profiles for the COPECs will be included within the ERA.

12.7 Identification of Receptors and Endpoints

The analysis portion of the ERA includes the estimation of potential exposures of biological receptors to Site-related COPECs and the determination of the potential effects associated with those exposures. The assessment of effects is the determination of the relationship between the concentrations of COPECs potentially identified in various matrices at the Sites and the responses of ecological receptors to these concentrations. Exposure to ecological receptors will occur either directly through mechanisms.such as ingestion, incidental contact, or inhalation, or indirectly through the consumption of prey species containing elevated concentrations of COPECs. Indirect or food chain exposure can potentially result in unacceptable risks to higher trophic level organisms without their being in close proximity to the Sites. This section outlines those components that will be utilized in the assessment of the potential ecological effects associated with the exposure of ecological receptors to COPECs at the Sites.

12.7.1 Identification of Receptors of Interest

The first step in the assessment of effects is the identification of those receptors of interest (ROIs) that will be evaluated in the ERA. As it is not feasible to evaluate the relationship of all potential chemicals of interest to every species at the Sites, ROIs have been selected to represent the organisms that might be present at the Sites most often or are likely to be most sensitive to the effects of the COPECs. Selection criteria for aquatic ROIs include the following

factors specified in USEPA guidance (1989a, 1992, 1994, 1997a, 1998): (1) the occurrence of potentially complete pathways for exposure of ecological resources to chemicals in environmental media; (2) resident communities or species exposed to the highest concentrations of chemicals in environmental media; (3) species or functional groups considered to be essential to, or indicative of, the normal functioning of the affected habitat; and (4) the feasibility of completing a quantitative assessment for the identified pathways and receptors.

Species were selected as ROIs for this assessment based on the following criteria:

- Relative abundance and ecological importance within the identified habitats;
- Availability and quality of appropriate ecotoxicological research;
- The sensitivity of the organism to the COPECs;
- Importance of the trophic level in the ecosystem;
- The relative mobility and type of feeding habits; and
- The ability to bioaccumulate COPECs.

The following ROIs have been selected for use in preparing this ERA:

For the Mississippi River aquatic community:

- The benthic macroinvertebrate community;
- Local fin fish;
- Mink (*mustela vison*); and
- Osprey (*Pandion haliaetus*).

Benthic invertebrates were selected as ROIs because they have the greatest exposure to bottom sediments that potentially contain COPECs and they are an important link in the aquatic food chain as a food source for bottom feeding fish species in the river. The use of macroinvertebrates as biological indicators of pollution in freshwater ecosystems has distinct advantages over purely physical and/or chemical analyses (Hellawell, 1977). Physical and chemical analyses reflect the characteristics of a waterbody during a single point-in-time whereas,

biomonitoring reflects environmentally induced changes that occur over a long period of time (sometimes a year or more). Therefore, if a constituent happens to be either at extremely low levels or absent at the time of physical and chemical analysis, a false reading as to the environmental quality of an ecosystem can be obtained.

Secondly, a broad range of constituents may affect an ecosystem, some of which may not have been identified yet. Relying solely on the physical and chemical analyses to evaluate potential ecological effects may lead to missing an important ecological effect. However, biological measures can be used to ensure that such effects are identified. Though care needs to be taken when interpreting the results of biological investigations. For example, measures of abundance are more relevant than measures of community structure when evaluating benthic communities, because abundance (not diversity) is more closely tied to the most important role of the benthic community (which is serving as a prey base for higher trophic level receptors). The absence of a sensitive indicator species may not be an indication that the benthic community as a whole is not performing its function as a food source for fish and other vertebrates. Similarly, effects to biological indicators indicate that further analysis needs to be performed to determine the exact nature of the stressor (e.g., physical disturbance, specific chemical stressor, etc.).

Local finfish were selected as ROIs because they are the dominant organism in the water column and they may be exposed to COPECs in sediments and surface water. Fish represent a food source to higher order predators (both aquatic and semi-aquatic) and are important for both recreational and commercial fisheries.

The mink and osprey were selected as upper trophic level ROIs because the biological success of local populations of these organisms can be tied to the environmental health of supporting habitats. Both bird species are either found in the area, or have the potential for being found in the area. They all feed on fish, so they can be tied via the food web to the sediments and surface water of the Mississippi River. Additionally, both species are sensitive to constituents that biomagnify up the food web.

For the riverbank/floodplain terrestrial community:

- Prairie vole (*Microtus ochrogaster)*
- Short-tail shrew (*Blarina brevicauda*); and
- Red fox (*Vulpes fulva).*

The prairie vole was selected as a ROI because it is likely to be the dominant herbivore within the habitat provided by the Sites and with its small home range, could likely spend its entire life span within a Site. Shrews were chosen as an ROI because a large portion of their diet are earthworms that live within the soils of the Sites. The red fox is an upper trophic level carnivore potentially feeding on either shrews or other small rodents within the Sites.

For the riverbank/floodplain aquatic community within site-related ponds (only if water and aquatic organisms are present in the ponds at the time of the ERA supporting field activities):

- The benthic macroinvertebrate community and;
- Finfish or amphibians.

As discussed in Section 12.4.1, during a brief reconnaissance of Site Q conducted in January 2001, it was observed that the ponds did not contain standing water. If the ponds have refilled by the time the field studies to support this ERA are conducted, the benthic invertebrate community will be examined to assess the potential for the reestablishment of the benthic food base. However, even if the ponds have refilled with water, a finfish population will likely not to have been reestablished. The reestablishment of a finfish population will not likely occur until such time as a flood event overflows the bank of the Mississippi River and stocks the pond. However, the possibility for future impacts to fish will be examined through the evaluation of concentrations of COPECs that are identified in surface water.

While the ponds may not at present support a finfish population, they may support a breeding population of amphibians. Historic information (USEPA, 1997b) indicates that frogs were identified in the vicinity of the ponds. As a steady source of water is required for most

amphibians to breed, COPECs that are found in surface water have the potential to impact amphibians during a sensitive point in their life cycle. Therefore, if no finfish are present, concentrations of COPECs in surface water will be evaluated for their potential to impact amphibians.

12.7.2 Assessment and Measurement Endpoints

The next step in the ecological risk assessment process is the identification of those endpoints that will be utilized in the ERA to evaluate the ecological effects associated with the potential exposure of ROIs to COPECs. Assessment endpoints are statements of the characteristics or attributes of the environment that are to be protected. This ERA will evaluate the following assessment endpoints:

- Assessment Endpoint #1: Evaluate the potential for adverse changes in the survival, reproduction , and growth of finfish populations utilizing the Mississippi River in the vicinity of the Sites resulting from exposures to COPECs in sediments, surface waters, and/or prey;
- Assessment Endpoint #2: Evaluate the potential for adverse changes in the survival, reproduction, and growth of populations of piscivorous species utilizing the Mississippi River in the vicinity of the Sites resulting from exposures to COPECs in prey;
- Assessment Endpoint #3: Evaluate the potential for adverse changes in the survival, reproduction, and growth of populations of vermivorous wildlife utilizing the five Sites resulting from exposures to COPECs in prey;
- Assessment Endpoint #4: Evaluate the potential for adverse changes in the survival, reproduction, and growth of populations of herbivorous wildlife utilizing the five Sites resulting from exposures to COPECs in soils and/or prey;
- Assessment Endpoint #5: Evaluate the potential for adverse changes in the survival, reproduction, and growth of populations of carnivorous wildlife utilizing the five Sites resulting from exposures to COPECs in prey; and

- Assessment Endpoint #6: Evaluate the potential for adverse changes in the survival, reproduction, and growth of potential finfish populations within the two ponds, or the potential for adverse changes in the reproductive potential of amphibian populations breeding within the two ponds located in Site Q resulting from exposures to COPECs in surface waters.

The assessment will evaluate ecological risks relative to these assessment endpoints in the Mississippi River and the five Sites. Data to evaluate these endpoints will be collected during a series of field studies as specified in QAPPs and FSPs that have been prepared separately.

Since the above assessment endpoints generally can not be measured directly, measurement endpoints have been identified. There are four types of measurement endpoints or lines of evidence that will be used to assess the status and potential changes in the attributes of the environment. The lines of evidence are:

1) Determination of the potential for ecological effects by the comparison of COPEC concentrations to media-specific *ecotoxicological benchmarks* derived from the literature;
2) Biological survey data of various ROIs which are direct estimates of the assessment endpoint;
3) Bioassays which are direct measures of the relative toxicity of constituents in a particular matrix; and
4) Estimation of potential for ecological effects from estimated exposures of higher trophic level organisms to COPECs based on food chain modeling.

A weight-of-evidence approach (as detailed in Section 12.8) weighs each of the measurement endpoints by considering:

- The strength of association between the measurement endpoints and the assessment endpoints;
- Data quality; and
- Study design and execution.

The strength of association refers to how well a measurement endpoint represents an assessment endpoint. The greater the correlation between the measurement and assessment endpoints, the greater the weight given to that measure of effect in the risk analysis.

The weight assigned a measurement endpoint also depends on the quality of the data as well as the overall study design and execution. The FSPs and QAPPs describe a sampling program that will provide information to evaluate each measurement endpoint. However, the ERA must evaluate the sampling effort and variability and uncertainties associated with the results following implementation. The risk characterization gives higher weight to measurement endpoints that are based on good quality data and are obtained using study designs that account for confounding variables.

Considerable uncertainty is associated with estimating potential ecological risks, because ecological systems are complex and exhibit high natural variability. Measurement endpoints typically have specific strengths and weaknesses related to the factors discussed above. Therefore, it is common practice to use more than one measurement endpoint to evaluate each assessment endpoint. Measurement endpoints are as follows:

Assessment Endpoint #1: Evaluate the potential for adverse changes in the survival, reproduction, and growth of finfish populations utilizing the Mississippi River in the vicinity of the Sites resulting from exposures to COPECs in sediments, surface waters, and/or prey.

Measurement Endpoints for Assessment Endpoint #1

a. The ability of Site-related surface water to support viable populations of finfish will be evaluated by comparing survival rates of bioassay test organisms in surface water collected from adjacent to the Sites to the survival rates of bioassay test organisms in surface water from relevant reference areas;
b. The ability of Site-related surface water to support viable populations of finfish will be evaluated by comparing concentrations of COPECs identified in Site-related surface water to concentrations of COPECs identified in surface water from relevant reference areas;

c. The ability of Site-related surface water to support viable populations of finfish will be evaluated by comparing concentrations of COPECs identified in Site-related surface water to State and Federal Ambient Water Quality Criteria for the protection of fish;

d. The ability of Site-related surface water to support viable populations of finfish will be evaluated by comparing whole body concentrations of COPECs in selected fish species caught in the vicinity of the Sites to body burdens of COPECs in fish from relevant reference areas. This comparison will provide a measure of the degree of exposure to Site-related fish;

e. The ability of Site-related surface water to support viable populations of finfish will be measured by comparing whole body concentrations of COPECs in selected fish species caught in the vicinity of the Sites to relevant fish body burden and tissue residue data from the literature (e.g., Jarvinen and Ankely, 1999). If the evaluation of measurement endpoint 1d indicates a potential concern with tissue concentrations from site-related areas, then measurement endpoint 1e will be conducted. If the evaluation of measurement endpoint 1d does not indicate a potential concern with tissue concentrations in site-related areas, then this measurement endpoint (1e) will not be performed;

f. The ability of the benthic community to perform its role as a prey base for finfish will be evaluated by comparing the survival rates of bioassay test organisms in Site-related sediments to the survival rates of bioassay test organisms in relevant reference sediment samples;

g. The ability of the benthic community to perform its role as a prey base for finfish will be evaluated by comparing concentrations of COPECs in Site-related sediments to concentrations of COPECs in relevant reference areas;

h. The ability of the benthic community to perform its role as a prey base for finfish will be evaluated by comparing the concentrations of COPECs in Site-related sediments to appropriate sediment quality benchmarks for the protection of benthic macroinvertebrates; and

i. Measures of benthic macroinvertebrate community function in Site-related sediments will be compared to the same measures in relevant reference sediments;

Rationale for Measurement Endpoints 1a through 1i

Because of the ecological, recreational and commercial importance of fish populations in the Mississippi River, the release of Site-related COPECs at sufficient concentrations could have an ecological impact to these resources. As described above, to evaluate this potential effect, a number of lines of evidence will be examined.

The measurement endpoints identified above were selected to evaluate the potential pathways that would result in the exposure of fish to Site-related COPECs. Those endpoints associated with surface water measurements are intended to provide an assessment of the ability of that matrix to support fish. The most critical of those measurements, the surface water bioassays, is intended to identify, in comparison to reference sites in other sections of the Mississippi, whether surface water in Site-related areas significantly affects the survival of finfish. If the bioassays indicate that, compared to relevant reference areas and across chemical gradients, the survival of test species is impaired when exposed to Site-related water, then the subsequent chemical analyses and comparison to both reference values and screening values will help identify which COPEC may be producing the toxicity.

While the evaluation of surface water will provide an estimate of the ability of fish to exist in Site-related waters, the analyses of fish tissue will provide a direct measurement of the potential for ecotoxicological impacts from exposure of fish to COPECs. The measure of concentrations of COPECs within fish tissue will be a direct measure of the assimilative and bioaccumulative capacity of COPECs that may be identified in surface water and will be a measure of the potential toxicity of those COPECs to fish. Care will be used when interpreting these data because discriminating between Site-related and non-Site-related causes is difficult in wide ranging species such as fish. Additionally, measurement of COPECs within fish tissue will allow for the assessment of the potential exposure and possible effects to higher trophic level organisms that feed on fish.

The evaluation of the benthic macroinvertebrate community provides a measurement of its ability to function as a prey base for finfish. By examining the benthic community through multiple measurement endpoints, as identified in the sediment triad approach, the ERA will be able to correlate chemical concentrations in sediments with measures of toxicity and biological integrity, while comparing the measured concentrations to literature values of possible effects. The benthic

community assessment, the most critical measure, will provide evidence of the ability macroinvertebrates to live in sediment found in Site-related areas. The chemical analyses will help identify which of the COPECs may be responsible for any observed toxicity. This approach will be further enhanced by the inclusion of bioaccumulation studies that examine the potential for migration of chemicals bound within the sediments to biota living within it.

Assessment Endpoint #2: Evaluate the potential for adverse changes in the survival, reproduction, and growth of populations of piscivorous species utilizing the Mississippi River in the vicinity of the Sites resulting from exposures to COPECs in prey.

Measurements Endpoints for Assessment Endpoint #2

a. Potential risks to mink will be estimated by comparing an estimated average daily dose for each potential COPEC to a toxicity reference value for each potential COPEC identified in the literature. Exposure concentrations to mink will be estimated using finfish COPEC body burdens and a food chain model; and
b. Potential risks to ospreys will be estimated by comparing an estimated average daily dose for each potential COPEC to a toxicity reference value for each potential COPEC identified in the literature. Exposure concentrations to ospreys will be estimated using finfish COPEC body burdens and a food chain model described in Section 12.7.6.

Rational for Measurement Endpoints 2a through 2c

While COPECs that have been identified in fish may not produce direct ecotoxicological effects in fish, if the constituents are bioaccumulative, they may have the potential for producing effects in higher trophic level organisms that feed on fish. This may result in indirect impacts to more wide-ranging species, to species that are especially sensitive to particular COPECs, or to species that have been assigned special status because of low population levels or habitat requirements. For that reason, a food chain model will be employed to assess the potential exposure of two piscivorous wildlife species to COPECs in fish tissue. Using COPECs identified in small forage fish (four inches to ten inches in length), the potential for ecological risks to mink feeding along the Mississippi River and in the on-Site ponds (if there are fish present) will be

calculated. The potential for ecological risks to osprey feeding along the Mississippi River will be calculated using COPECs identified in large forage fish (six inches to fourteen inches). For each species, the Average Daily Dose (ADD) of COPECs will be compared to toxicity reference values (TRVs) for that species identified from the literature. If the ADDs exceed the TRVs in a large number of locations, then the potential exists for adverse effects.

Assessment Endpoint #3: Evaluate the potential for adverse changes in the survival, reproduction, and growth of populations of vermivorous wildlife utilizing the five Sites resulting from exposures to COPECs in prey.

Measurements Endpoints for Assessment Endpoint #3

a. Potential risks to short-tail shrews will be estimated by comparing an estimated daily dose for each potential COPEC to a TRV for each potential COPEC identified in the literature. Exposure concentrations to short-tail shrews will be estimated using earthworm COPEC body burdens and a food chain model described in Section 12.7.6.

Rational for Measurement Endpoint 3a.

Vermivorous wildlife have been identified by the USEPA as a trophic level of concern at the five Sites. Because the 1/3 of the diet of these animals is earthworms, which live in contact with soils containing COPECs and can potentially accumulate COPECs, potential ecological risks to vermivorous wildlife will be evaluated by using COPEC earthworm tissue residue data to estimate ADDs for short-tail shrews. Earthworm residue data will be collected by the use of earthworm bioassay tests using soil collected from the five Sites. ADDs will be compared to TRVs and if the ADDs exceed the TRVs in a large number of locations, then the potential may exist for adverse effects to short-tailed shrews.

Assessment Endpoint #4: Evaluate the potential for adverse changes in the survival, reproduction, and growth of populations of herbivorous wildlife utilizing the five Sites resulting from exposures to COPECs in soils and/or vegetation.

Measurements Endpoints for Assessment Endpoint #4

a. The ability of the plant community to provide habitat for herbivorous wildlife will be measured by the comparison of concentrations of COPECs in surface soils at the Sites to appropriate surface soil quality benchmarks for the protection of plants; and
b. Potential risks to prairie voles will be estimated by comparing an estimated daily dose of each potential COPEC to a TRV for each potential COPEC identified in the literature. Exposure concentrations to prairie voles will be estimated using plant COPEC tissue concentrations and a food chain model described in Section 12.7.6.

Rational for Measurement Endpoints 4a through 4c

If soil contains COPECs, plant roots may be in constant contact with, or at least in close proximity to, constituents that can be either toxic to plants or that can be translocated up into the various parts of a plant and then consumed by higher order trophic level receptors. Cell membrane barriers within roots act to restrict the movement of COPECs into the root cortex; thereby, limiting the translocation and the actual expression of ecological effects. However, there is the potential that certain COPECs may accumulate in various plant tissues and then be consumed by herbivorous wildlife. The collection of plant tissue for chemical analysis will provide a direct measurement of the uptake potential of COPECs by plants and will allow for the assessment of impacts to higher trophic level organisms. Ecological risks to herbivorous wildlife will be estimated through the determination of ADDs for a prairie vole and comparison of the ADD to the TRV derived from the literature. If the ADD exceeds the TRV at a large number of locations, then there is the potential for adverse ecological risks.

Screening of COPECs against soil benchmarks allows for the estimation of potential ecological impacts to plants at the five Sites. However, this is a highly conservative assessment as the development of soil screening benchmarks is still in its infancy, and the existing data are often dependent upon weak correlations, laboratory conditions, and extreme uncertainty factors.

Assessment Endpoint #5: Evaluate the potential for adverse changes in the survival, reproduction, and growth of populations of carnivorous wildlife utilizing the five Sites resulting from exposures to COPECs in prey.

Measurement Endpoints for Assessment Endpoint #5

Potential risks to the red fox will be estimated by comparing estimated daily dose of COPECs to TRVs identified in the literature. Exposure concentrations to red fox will be estimated using plant COPEC tissue concentrations, earthworm COPEC tissue residue concentrations, and a food chain model described in Section 12.7.6 that estimate COPEC body burdens in prairie voles and shrews.

Rational for Measurement Endpoints 5a

Estimated concentrations of COPECs in the prairie vole and the short-tail shrew may not produce direct ecotoxicological effects. However, if the constituents are bioaccumulative, they may have the potential for producing effects at higher trophic levels. This may result in indirect impacts to more wide-ranging species, to species that are especially sensitive to particular COPECs, or to species that have special status because of population levels or habitat requirements. For that reason, a food chain model will be employed to assess the potential exposure of an upper level carnivore (the red fox) to COPECs in voles and shrews. Using estimated concentrations of COPECs in prairie voles and short-tail shrews, the potential for ecological risks to red fox feeding within the five Sites will be calculated. The Average Daily Dose (ADD) of COPECs will be calculated and compared to toxicity reference values (TRVs) for the red fox. If the ADD exceeds the TRV in a large number of locations, then the potential exists for adverse effects.

Assessment Endpoint #6: Evaluate the potential for adverse changes in the survival, reproduction, and growth of potential finfish populations within the two ponds, or the potential for adverse changes in the reproductive potential of amphibian populations breeding within the two ponds located in Site Q resulting from exposures to COPECs in surface waters.

Measurement Endpoints for Assessment Endpoint #6

As previously indicated, in January 2001 the two ponds located in Site Q did not contain standing water, though more recent information provided by the USEPA indicates that the ponds have refilled. Information from previous studies (USEPA, 1997b) indicates that the ponds contained water and did support a standing population of fish. While the ponds may be filled during the ERA supporting field activities, it is highly unlikely that they would have developed a finfish community by that time. Therefore, should the ponds be filled at the time of the ERA supporting field activities and contain a finfish population, then the same measurement endpoints used for evaluating the fish population in the Mississippi River (measurement endpoints 1a through 1i) will be used for evaluating the viability of a potential aquatic community within the ponds. However, the pond could provide breeding habitat for amphibians (chorus frogs have been historically identified in the vicinity of the ponds). If a finfish community is not present at the time of the ERA supporting field activities, then concentrations of each potential COPEC that may be identified in surface water will be compared to TRVs for its associated COPEC that have been identified in the literature to evaluate the potential for ecological risks to breeding amphibians. Bioassay data will also provide information on the likelihood of COPECs in surface water to impact the ability of amphibians to breed within the ponds.

Methodologies for collecting the data required to measure the effects are described in separate FSPs and QAPPs for both the aquatic and terrestrial portions of the Sites.

12.7.3 Ecotoxicological Benchmarks

As described in Section 12.7.2, some of the measurement endpoints to be used in the assessment of potential risks to ecological receptors in the terrestrial and aquatic environments include the comparison of ecotoxicological benchmarks to Site-related data for various media. These benchmarks are risk-based screening concentrations that will be used to evaluate the concentrations of chemicals detected in surface water, sediment, and surface soil in aquatic and terrestrial areas of interest at, and adjacent to, the Sites. They are species- and chemical-specific,

and will represent chemical concentrations in a matrix below which adverse effects will not likely occur.

However, the benchmarks are not intended to serve as reference levels that will trigger specific actions if exceeded. The exceedance of a benchmark is not confirmation that an ecological impact is occurring. Rather, the benchmarks are primarily intended to help focus and prioritize project objectives and data requirements during the planning and implementing of site-specific investigations, by identifying constituents and particular areas of sites that may pose potential risks to aquatic and terrestrial ecological receptors.

12.7.3.1 Surface Water Screening Benchmarks

Concentrations of COPECs identified in surface water will be compared to the National Ambient Water Quality Criteria (NAWQC) (USEPA, 1996). Acute and chronic NAWQC values were developed for the protection of aquatic life in freshwater environments. Acute and chronic Tier II Secondary Values (SVs) will also be used during the screening process when a NAWQC is unavailable. Together, these criteria or benchmarks provide an initial basis for evaluating potential impacts to ecological receptors. The surface water screening benchmarks are described below.

National Ambient Water Quality Criteria and Tier II Secondary Values

Acute NAWQC values are calculated as ½ the final acute value, which is the fifth percentile of the distribution of 48- to 96-hour LC_{50} values or equivalent EC_{50} values for each criterion chemical. Acute values correspond to concentrations that would cause less than 50% mortality in 5% of the exposed population in a brief exposure. Chronic NAWQC values are the final acute value divided by the final acute:chronic ratio (Suter, 1996). NAWQCs are available for a limited number of compounds.

In the absence of NAWQCs, Tier II SVs will be calculated using the methodology presented in the *Great Lakes Water Quality Initiative* (GLWQI) (40 CFR 122 et al., 1995). Tier II acute and chronic SVs are based upon fewer data than are required for the calculation of NAWQCs and safety factors to account for the lack of complete data. The use of safety factors is designed to result in concentrations that are expected to be lower (i.e., more stringent) in approximately 80%

of the cases than the NAWQC for a chemical calculated with sufficient test data (Suter, 1996). NAWQCs for the protection of aquatic life are based on thresholds for statistically significant effects on individual responses of fish and aquatic invertebrates. Those thresholds correspond to approximately 25% reductions in the parameters (i.e., survival, growth or reproduction) of chronic fish tests (Suter et al., 1987). Because of the compounding individual responses across life stages, the chronic NAWQCs frequently correspond to much more than 20% effects on a continuously exposed fish population (Barnthouse et al., 1990). Therefore, an exceedance of the chronic Tier II SV is assumed to correspond to a 20% or greater effect (i.e., reduction) on the survival, growth, or fecundity of the fish community. The acute and chronic Tier II SVs used in this assessment and their derivation are described in detail in Suter and Mabrey (1994) and Suter (1996).

For compounds including the dioxins and furans, toxicity equivalent factors (TEFs) have been developed for fish (Van den Berg et al., 1998.) that indicate the relative potency of the individual 2,3,7,8-substituted congeners to the toxicity of 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD). These TEFs will be used to evaluate surface water concentrations of the dioxin and furan congeners.

To assess the potential for ecotoxicological impacts to amphibians breeding in the ponds, concentrations of COPECs in the surface water of the ponds will be compared to relevant benchmarks. The scientific literature will be evaluated to determine appropriate benchmarks for amphibians. If none are available out of the literature, then AWQC values will be used instead.

12.7.3.2 Sediment Screening Benchmarks

Ontario Lowest Effects Levels (LELs) and Severe Effects Levels (SELs) (Persaud et al., 1993) will be used for screening sediments. If LEL and SEL values are unavailable for a chemical constituent, a hierarchical approach to identifying other sediment benchmarks will be used. If LEL and SEL values are not available, then the order in which other sources will be considered in the identification of a benchmark for a particular constituent include:

1. Threshold Effect Level (TEL) and Probable Effects Level (PEL) values developed by Smith et al. (1996)

2. USEPA Sediment Quality Benchmarks or Criteria (SQBs and SQCs, respectively) (USEPA, 1998b); and
3. National Oceanic and Atmospheric Administration (NOAA) Effects Range-Low (ER-L) and Effects Range-Median (ER-M) values (Long et al., 1995).

These values will be used for screening purposes. An exceedance of these screening benchmarks does not necessarily indicate that the benthic community has been adversely effected for the reasons described below.

Lowest Effects Levels and Severe Effects Levels

The Ontario Ministry of the Environment (MOE) has prepared provincial sediment quality guidelines (SQGs) using the Screening Level Concentration (SLC) Approach. The SLC approach estimates the highest concentration of a particular constituent in sediment that can be tolerated by approximately 95% of benthic infauna (Neff et al., 1988). The SLC is derived from synoptic data on sediment chemical concentrations and benthic invertebrate distributions. These values are based on Ontario sediments and benthic species from a wide range of geographical areas within the province (Persaud et al., 1990). The guidelines define levels of ecotoxic effects and are based on the chronic, long-term effects of constituents on benthic organisms. The Lowest Effects Level (LEL) is the level at which actual ecotoxic effects may become apparent. However, the LEL is a concentration of a particular constituent in sediments that can be tolerated by the majority of benthic organisms. The Severe Effects Level (SEL) indicates the level at which pronounced disturbance of the sediment-dwelling community may be expected. This is the sediment concentration of a compound that may potentially be detrimental to the majority of benthic species (Persaud et al., 1993).

The SELs for organic constituents will be normalized for the site-specific total organic content within the sediment at each location. Concentrations of organic compounds detected in sediment at each location will be compared to the TOC-normalized SEL to determine the magnitude or probability of the potential for an ecological impact on the benthic macroinvertebrate community at that location.

LELs and SELs are screening values used for the identification of potential ecological impacts in sediments. They do not take into account site-specific attributes such as bioavailability,

bioaccumulation, or the acclimation of organisms to the presence of a COPEC. Therefore, they must be used in conjunction with other sediment screening tools such as field observations and bioassays.

Threshold Effect Level and Probable Effect Level Values

If MOE SQGs are not available for a particular constituent, then TEL and PEL values will be utilized for comparison of sediment concentrations. TEL and PEL values were developed based on a review of sediment chemistry and bioassay data stored in the Biological EffectsData Base for Sediments (BEDS), along with parameters that can affect bioavailability. The TEL values are based on the geometric mean of the 15th percentile concentration from the *effect* data set and the 50th percentile from the *no effect* data set. The PEL is calculated from the *effect* data set and the 85th percentile concentration of the *no effect* data set.

Sediment Quality Criteria and Sediment Quality Benchmarks

If MOE SQGs and TEL/PEL values are not available, then USEPA SQCs and SQBs (USEPA, 1998) values will be utilized for comparison of sediment concentrations. The USEPA SQCs and SQBs were derived by the equilibrium partitioning (EqP) method which uses the K_{ow} and determines the sorption capacity of the sediment by the mass fraction of organic carbon in the sediment (USEPA, 1998b). The SQCs and SQBs are based on the toxicity of compounds in water expressed as the NAWQC or Tier II Secondary Chronic Values (SCVs) and partitioning of the constituent between sediment organic matter and pore water. These benchmarks are calculated using the site-specific TOC content in the sediments at each location. If USEPA SQBs or SQCs are unavailable, SQBs derived by Jones et al. (1997) using the NAWQC or Tier II SCVs will be used.

Similarly, the dioxins and furans, toxicity equivalent factors (TEFs) have been developed for fish (Van den Berg et al., 1998.) that indicate the relative potency of the individual 2,3,7,8-substituted congeners to the toxicity of 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD). These TEFs will be used with the EqP approach to evaluate sediment concentrations of the dioxin and furan congeners.

It is important to note that because of the use of water quality criteria as allowable porewater concentrations, they are likely to be overprotective of benthic organisms. Therefore, they must

be used in conjunction with other sediment screening tools such as field observations and bioassays.

NOAA Effects Range-Low and Effects Range-Median Values

If none of the other benchmarks are available for a particular constituents, then the NOAA Effects Range-Low (ER-L) and Effects-Range-Median (ER-M) values will be used. The NOAA ER-L and ER-M values correspond to the tenth and fiftieth percentile of estuarine sediment concentrations reported to be associated with some level of toxic effects (Long et al., 1995). NOAA uses them as concentrations above that adverse effects may begin or are predicted to begin among sensitive life stages and/or species as determined in sublethal tests. It is important to note that because of the limitations used in the development of the NOAA values, the exceedance of a benchmark is not confirmation of an adverse effect, only the indication of the potential for an adverse effect. These limitations, such as the confounding influence of multiple chemicals and the lack of consideration of bioavailability in screening value development, require interpretation of all available site-specific data prior to concluding that an adverse effect does exist.

12.7.3.3 Soil Screening Benchmarks

To determine if the chemical concentrations in surface soils may be toxic to the plant community, the detected concentrations will be compared to Lowest Observed Effects Concentrations (LOECs) as determined in laboratory phytotoxicity studies (Will and Suter, 1995, and Efromyson et al., 1997). The soil screening benchmarks are based on data provided by toxicity studies in the field or more commonly in greenhouse and growth chamber settings. These studies evaluated the effects of chemicals on various trees, wildflowers, grasses, and vegetable species. The plants were exposed to a variety of concentrations, soil types (with differing physicochemical properties), and exposure periods. Measurement endpoints common to the phytotoxicity tests included growth and yield parameters which represent a greater than 20% adverse effect. Growth and yield measurements are direct estimates of the potential impacts to the plant community.

As with sediments, a hierarchical approach to identifying soil benchmarks for screening potential constituents of concern in soils will be used. The benchmarks in order of their evaluation are as follows:

1. ONRL vegetative benchmarks (Efromyson et al., 1997);
2. USEPA Draft Ecological Soil Screening Levels (USEPA, 2000);
3. Canadian Soil Screening Values (British Columbia Regulation 375/96, 1997)
4. Dutch Soil Intervention Values; and
5. NOAEL/LOAEL identified in literature sources such as Eisler (2000a, 2000b, and 2000c).

12.7.4 Toxicity Tests

The ERA will use laboratory surface water and sediment bioassays conducted on samples collected from the Mississippi River to evaluate the toxicity of these two matrices to fish and macroinvertebrates. The toxicity of the surface water and sediment samples will be determined by comparing survival in Site samples to survival in reference surface water and sediment samples collected from the Mississippi River. Statistically significant decreases in survival relative to reference samples will be considered a COPEC-related effect when they can be directly related to exposures associated with COPECs in the surface water and sediments.

12.7.5 Wildlife Screening Benchmarks

Potential ecological impacts to wildlife ROIs will be assessed by comparing potential exposures to ROIs (calculated using a simplified food chain models) to wildlife benchmarks identified from the literature. The wildlife benchmarks are toxicity reference values (TRVs) that are derived from available toxicological data.

Two TRVs will be derived for each chemical and wildlife ROI. One will be based on the no-observed-adverse-effect-level (NOAEL) and the other will be based on the lowest-observed-adverse-effect-level (LOAEL). The NOAEL corresponds to the highest dose at which no adverse

effects on growth, reproduction, or survival have been observed. The LOAEL corresponds to the lowest dose at which adverse effects on growth, reproduction or survival have been observed. The ERA will indicate whether the NOAEL and LOAELs are bounded or unbounded. Bounded values are those data sets where a NOAELs and LOAELs has been determined for a certain chemical. An unbounded data set is an NOAEL for which there are no LOAELs, thereby adding uncertainty by not having an identified point at which a chemical may first illicit an effect. Unbounded TRVs will be identified as a source of uncertainty. TRVs for wildlife ROIs (both aquatic and terrestrial) will be reported in units of COPEC exposure per unit bodyweight per day (mg COPEC/kg bw-day) for a specified effect to the receptor. For the ERA, TRVs for wildlife ROIs will be derived from laboratory study results by generally following the methodology of Sample et al. (1996). The following literature sources will be used in the selection of the TRVs:

- U.S. Fish and Wildlife Service biological reports prepared by R. Eisler;
- Toxicological studies cited in Sample et al. (1996);
- U.S. Army Corps of Engineers Waterways Experiment Station online database;
- Ecotox – Ecological Modeling and Ecotoxicology database by L.A. Jorgensen, S.E. Jorgensen, and S.N. Nielsen, Elsevier Publishers, 2000;
- Computer online databases, such as Toxline, Biosis, Wildlife Fisheries Review, Pollution Abstracts, and Environmental Abstracts;
- USEPA Ecotox database; and
- Other readily available literature.

When reviewing the toxicological literature and selecting the most appropriate study for TRV development, several factors will be considered, including:

- Taxonomic relationship between the test animal and the indicator species;
- Use of laboratory animals or domesticated species;
- Ecological relevance of the study endpoints; studies with toxicity endpoints, such as reproduction, growth, behavior and developmental endpoints will be targeted. Sensitive endpoints such as reproductive or developmental toxicity will be preferentially selected because they are closely related to the selected assessment endpoints;

- Toxicological studies in which the chemical was administered through the diet of the test species will be preferred over studies using other oral dosing methods, such as gavage; and
- Long-term studies representing chronic exposure will be preferentially selected.

Species specific toxicity studies may not be available for all COPECs. For mammalian species, smaller animals have higher metabolic rates and are usually more resistant to toxic chemicals because of more rapid rates of detoxification. It has been shown that metabolism is proportional to body surface area which, for lack of direct measurements, can be expressed in terms of body weight (bw) raised to the 3/4 power ($bw^{3/4}$) (Travis and White, 1988; Travis et al., 1990; and USEPA, 1992b). If the dose (d) itself has been calculated in terms of unit body weight (i.e., mg/kg), then the dose per unit body surface area (D) equates to:

$$D = \frac{d \; x \; bw}{bw^{3/4}} = d \; x \; bw^{1/4}$$

The assumption is that the effective dose per body surface area for species "a" and "b" would be equivalent. Therefore, knowing the body weights of two species and the dose (d_b) producing a given effect in species "b," the dose (d_a) producing the same effect in species "a" can be determined. Using this approach, if a NOAEL is available for a test species ($NOAEL_t$), the equivalent NOAEL for a wildlife species ($NOAEL_w$) will be calculated using the adjustment factor for differences in body size:

$$NOAEL_w = NOAEL_t \left(\frac{bw_t}{bw_w} \right)^{1/4}$$

This methodology is equivalent to that the USEPA uses in their carcinogenicity assessments and Reportable Quantity documents for adjusting from animal data to an equivalent human dose.

For the dioxins and furans, toxicity equivalent factors (TEFs) have been developed for mammalian wildlife receptors (Van den Berg et al., 1998.) that indicate the relative potency of the individual 2,3,7,8-substituted congeners to the toxicity of 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD). These TEFs will be used to develop congener-specific TRVs to evaluate the potential effects to mammalian wildlife receptors of the 2,3,7,8-substituted dioxin and furan congeners.

For avian receptors, however, there are reports in the literature (e.g., studies cited in Sample et al.. 1996) that state that the above relationship for the majority of chemicals reduces to a factor of one (exponent = 0). That is, there does not seem to be a scaling related to body weight or surface area for birds.

For the dioxins and furans, toxicity equivalent factors (TEFs) have been developed for avian wildlife receptors (Van den Berg et al., 1998.) that indicate the relative potency of the individual 2,3,7,8-substituted congeners to the toxicity of 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD). These TEFs will be used to develop congener-specific TRVs to evaluate the potential effects to avian wildlife receptors of the 2,3,7,8-substituted dioxin and furan congeners.

In cases where a NOAEL for a specific chemical is not available, but a LOAEL has been determined experimentally, or where the NOAEL is from a subchronic study, the chronic NOAEL will be estimated. USEPA (1993) suggests the use of uncertainty factors of 1 to 10 for subchronic NOAEL to chronic NOAEL and LOAEL to NOAEL estimation. Based on the available literature, uncertainty factors will be derived for extrapolating from study results to wildlife chronic NOAEL and LOAEL benchmarks.
If toxicological animal studies are not available for a particular COPEC, then quantitative structure activity relationships will be considered and a surrogate chemical will be selected when possible. If the COPEC can not be assessed quantitatively, then the risks associated with the constituent will be qualitatively discussed.

TRVs for each constituent and each ROI will be submitted to USEPA for review and approval prior to preparation of the ERA. In order to conservatively assess the potential for ecological risks from the presence of PCBs in the terrestrial environment, mink (*Mustela vison*) TRVs for PCBs will be used as a surrogate TRV for the short-tailed shrew.

12.7.6 Wildlife Exposure Models

For the wildlife ROIs, a generalized exposure model will be utilized to estimate exposure to the selected wildlife species. Exposure to each COPEC will be estimated by calculating an average daily dose (ADD) using (1) exposure media-specific concentrations, (2) estimated or measured exposure-point concentrations for prey, and (3) receptor-specific exposure parameters. The ADD represents the amount of a chemical that an individual member of a receptor population would ingest if the individual foraged at least a portion of the time within the area used to develop exposure-point concentrations.

Exposure point concentrations for wildlife receptors are best expressed as average COPEC concentrations in prey, surface water, and sediment or soil within the receptors' foraging area. Air is not considered a pathway of concern for this ERA. ADDs for ROIs will be developed based on procedures outlined in Sample et al. (1996) and USEPA (1993). For this ERA, it is assumed that food items are obtained from a particular area and environmental medium as a function of an Area Use Factor (AUF) and a Seasonal Use Factor (SUF). The AUF accounts for relative foraging times based on the ratio of the amount of habitat containing COPECs from a particular on-Site location to the species-specific foraging area. The SUF accounts for the portion of the year that an ROI may be exposed to Site-related COPECs. The total ADD is the sum of ADDs for each of the pathways (i.e., food, surface water, and sediment and/or soil), adjusted for the seasonal duration of exposure and normalized to body weight.

The surface water input for both the red fox and the mink will use water from both the Mississippi River and from the ponds in Site Q, if water is present and samples are collected. If pond water is included, the water input value will include data from the two water sources presented on an area weighted basis, using the length of shoreline as the basis for the weighing. The formula for calculating the ADD is as follows:

$$ADD = (Dose_{food} + (Dose_{sediment} \text{ or } Dose_{soil}) + Dose_{water}) \times SUF$$

where:

ADD	=	Average daily dose of COPEC (mg/kg BW/day);
$Dose_{food}$	=	Dose of COPEC in food (mg/kg BW/day);
$Dose_{sediment}$	=	Dose of COPEC in sediment (mg/kg BW/day), aquatic ROIs;
$Dose_{soil}$	=	Dose of COPEC in soil (mg/kg BW/day), terrestrial ROIs;
$Dose_{water}$	=	Dose of COPEC in water (mg/kg BW/day);
SUF	=	Seasonal Use Factor (unitless); and

The individual terms of the equation are calculated as:

$$Dose_x = IR_x \times C_x \times AUF$$

where:

$Dose_x$	=	Dose of the particular medium in mg/kg BW/day or L/kg BW/day;
IR_x	=	Ingestion rate of medium in mg/kg BW/day (wet weight) or L/kg BW/day;
C_x	=	Concentration of COPEC in particular medium in mg/kg or mg/L; (The average concentration of a COPEC from an area of interest will be used as the exposure point concentration, this value will be replaced with more realistic assumptions or site-specific prey data as appropriate); and
AUF	=	Area Use Factor (unitless).

The development of exposure estimates will be made for each of the wildlife ROIs, except the red fox, on a site by site basis, using data from each of the five Sites on an individual basis. Data from each sample location will be included in the exposure estimation for that particular site. For the red fox, the five Sites will be considered in total in the determination of exposure estimates. The results of surface soil, surface water, plant, and earthworm chemical analyses will be examined using both the mean and 95th Upper Confidence Limit (UCL) for the determination of exposure. Noting that the five areas are not contiguous, an area weighted value will be applied to the Sites in relationship to the entire area east of the Mississippi River,

south of the MacArthur bridge railroad tracks, west of Illinois State Highway 3, and north of Cargill Road.

12.7.6.1 Exposure Model Input Parameters

Receptor-specific exposure parameters from the scientific literature will be used estimate the ADD for each ROI. Receptor-specific exposure parameters include body weight, food ingestion rate, water ingestion rate, and incidental sediment or soil ingestion rate. An additional exposure parameter, foraging habitat and range will be used to determine the size and type of areas for assessment. The species-specific life history parameters used to calculate exposure for various ROIs are listed below. All exposure parameters are from USEPA (1993) and/or Sample and Suter (1996). The primary citation is indicated adjacent to the parameter.

To estimate the potential COPEC exposure concentrations for the mink foraging either along the Mississippi River or at the edges of the ponds, the following assumptions will be made:

- Body weight = 550 g (using female as sensitive endpoint; Mitchell, 1961);
- Food ingestion rate = 0.137 kilograms/ day (Bleavins and Aulerich, 1981);
- Sediment consumption = negligible (Sample and Suter, 1994);
- Water consumption = 0.099 L/d (Sample and Suter, 1994);
- Diet consists of 100% fish (actual diet composition is dominated by mammals (46%), then fish (15%), amphibians (13%), and birds (8%); however for purposes o f this ERA, the diet will be assumed to be 100% fish, Sample and Suter, 1994);
- Home range = 770 hectare (range size and shape depends on habitat, being usually linear along streams and circular in marshes, USEPA, 1993)
- SUF = 100%;
- AUF = 100% (conservatively assumes that foraging range equal to the length of shoreline abutting the Sites; USEPA, 1993); and
- Habitat = Mink are found associated with aquatic habitats of all kinds, including waterways such as rivers, streams, lakes, ditches, swamps, marshes and backwater areas (USEPA, 1993).

To estimate COPEC exposure concentrations potentially experienced by the osprey foraging along the Mississippi River, the following assumptions will be made:

- Body weight = 1,568 g (using female as sensitive endpoint; Brown and Amadon, 1968);
- Food ingestion rate = 0.21 g/g of BW/d (Poole, 1983);
- Sediment consumption = negligible (USEPA, 1993);
- Water consumption = 0.051 g/g of BW/d (USEPA, 1993);
- Diet consists of 100% fish (USEPA, 1993);
- Foraging radius = 1.7 km (Dunstan, 1973);
- SUF = 100%;
- AUF = 25% (assume foraging range equal to ¼ the size of the Sites; Dunstan, 1973); and
- Habitat = USEPA (1993) reports that the majority of osprey populations in the United States are associated with marine environments, but large inland rivers, lakes and reservoirs may support this species. Habitat usage is dependent upon the presence of good nesting sites (e.g., tops of isolated and often dead trees and man-made structures) in proximity to open, shallow water with a plentiful supply of fish. USEPA (1993) further reports that osprey are almost exclusively piscivorous and that osprey will most successfully feed on slow-moving fish that eat benthic organisms in shallow waters and fish that remain near the water's surface.

To estimate COPEC exposure concentrations potentially experienced by the short-tail shrew foraging within the Sites, the following assumptions will be made:

- Body weight = 0.015 kg (Schlessinger and Potter, 1974);
- Food ingestion rate = 0.49 g/g of BW/d; Barrett and Stuek, 1976);
- Soil consumption = 0.00117 kg/d (Talmage and Walton, 1993);
- Water consumption = 0.033 L/d (Chew, 1951);
- Diet consists of 31.4% earthworms (the remainder is reported as being insects and plants, Whitaker and Ferraro, 1963), for purposes of this ERA, the diet of the short-

tailed shrew will be considered to consist of 67% of earthworms and 33% of other terrestrial invertebrates, chemical residue data from the earthworms will be developed using bioassay/bioaccumulation tests using soil samples from the Sites terrestrial invertebrate residue data will be developed through the laboratory analysis of composite samples from the Sites);

- Home range = 0.39 ha (Buckner, 1966);
- SUF = 100%,
- AUF = 100% (This is a conservative assessment that assumes that the shrew will spend it entire life within an area containing elevated COPEC concentrations and that the limited number of soil samples that will be collected are representative of soil conditions throughout a given area); and
- Habitat = USEPA (1993) notes that short-tailed shrews inhabit a variety of habitats and are common in areas with abundant vegetative cover, though they require cool, moist habitats because of their high metabolic rates and water-loss rates.

To estimate COEPC exposure concentrations potentially experienced by the prairie vole foraging within the Sites, the following assumptions will be made:

- Body weight = 41.6 g (Abramasky and Tracy, 1980);
- Food ingestion rate = 0.10 g/g of BW/d (Dice, 1922);
- Soil consumption = 2.4% (Beyer et al., 1994);
- Water consumption = 0.21 g/g of BW/d (Dice, 1922);
- Diet consists of 100% plant material (USEPA, 1993);
- Home range = 0.098 ha (Jike et al., 1988);
- SUF = 100%;
- AUF = 100% (This is a conservative assessment that assumes that the prairie vole will spend it entire life within an area containing elevated COPEC concentrations and that the limited number of soil samples that will be collected are representative of soil conditions throughout a given area); and
- Habitat = USEPA (1993) reports that the prairie vole inhabits a wide variety of prairie plant communities and moisture regimes, including riparian, short-grass and tall-

grass prairie communities. They generally prefer areas of dense vegetation and their presence in a habitat depends upon the presence of suitable cover for their runways.

To estimate COPEC exposure concentrations potentially experienced by the red fox foraging within the Sites, the following assumptions will be made:

- Body weight = 4.13 kg (using female as sensitive endpoint; Storm et al., 1976);
- Food ingestion rate = 0.14 g/g of BW/d; Sargeant, 1978);
- Soil consumption = 0.0126 kg/d (Sample and Suter, 1984);
- Surface water consumption = 0.38 L/d (Sample and Suter, 1994);
- Diet consists of 68.8% mammals and 10.4% plants (the remainder of the diet is assumed to be uncontaminated insects, birds and miscellaneous items, Sample and Suter, 1994);
- Territory size = 96 ha (using female as sensitive endpoint; Ables, 1974);
- SUF = 100%;
- AUF = 100% (This is a conservative assessment that assumes that the red fox will spend it entire life within an area containing elevated COPEC concentrations and that the limited number of soil samples that will be collected are representative of soil conditions throughout a given area); and
- Habitat = Red foxes are the most widely distributed carnivore in the world and will inhabit areas ranging from arctic habitats to temperate deserts (USEPA, 1993). They prefer broken and diverse upland habitats, such as occur in most agricultural areas.

12.7.6.2 Exposure Model Modifications for the Red Fox

As described above, the generalize exposure model will be utilized to estimate exposure values for each potential COPEC to the red fox based on ingestion of food and water from the Sites. The food parameter described in Section 12.7.6.1 includes both a plant and animal component. While direct measurements of the concentrations of COPECs in plant material will be made for each of the Sites, concentrations in animal prey will not be measured, but will have to be estimated. The estimation of the concentration of COPECs in prey species will be made based

on the guidance outlined in USEPA (1999b). A compound-specific bioconcentration factor (BCF) consists of biotransfer factors (Ba) and ingestion rates. A biotransfer factor is the ratio of the compound concentration in fresh (wet) weight animal tissue to the daily intake of the compound by the animal through the ingestion of food items and media (soil, sediment, and/or surface water). The following formula is used to derive the BCFs for the ingestion of prey by the red fox:

$$BCF_{F-A} = Ba_A \times IR_F$$

where:

BCF_{F-A}	=	Bioconcentration factor for food item (prey to red fox) in mg of COPEC/kg FW tissue / mg COPEC/kg FW food item);
Ba_A	=	COPEC-specific biotransfer factor applicable for the animal (day/kg FW tissue) as presented in Appendix D to USEPA (1999b) (As a Ba_A is not presented specifically for the prairie vole, the BA_A for the deer mouse (*Peromyscus maniculatus*) will be used in the development of the BCF_{F-A} values); and
IR_F	=	Red fox ingestion rate (kg FW/day)

The red fox exposure calculations will be based on the following pathways:

1. Soil to plant to vole to red fox;
2. Soil to earthworm to short-tailed shrew to red fox;
3. Soil to plant to red fox; and
4. Soil to red fox through incidental ingestion.

To fill all the terms of the exposure model calculation, direct measurements of soil concentrations of COPECs for incidental ingestion will be used, as will direct measurements of COPECs in plants. Using the measurement of COPECs in plants, the BCF_{F-A} will be applied to the ADD calculated for the voles for each COPEC, as described in USEPA (1999b). That resulting value will then be included in the exposure model calculations as the concentration of each COPEC in animal prey for the red fox.

12.8 Risk Characterization

Risk characterization combines Site-related exposures and the potential for ecotoxicological effects to estimate the likelihood of ecological risks. The risk characterization is conducted for each line of evidence and then a weight-of-evidence approach is used to evaluate effects for each assessment endpoint. For the ideal risk assessment, there are three lines of evidence; literature-derived single chemical toxicity data which indicates the potential effects of the COPEC concentrations measured in site media, biological surveys of the potentially affected system which indicate the actual state of the potentially affected environment, and toxicity tests with ambient media which indicate the potential effects of COPEC concentrations measured in site media.

Procedurally, the risk characterization is performed for each assessment endpoint by (1) screening all measured COPECs against toxicological benchmarks and background concentrations (where possible, exposure-response gradients will be developed to help ascertain a more precise understanding of the potential for impacts to receptors) ; (2) estimating the potential effects of the COPECs identified at the Site; (3) estimating the effects of ambient media based on the media toxicity test results (if conducted); (4) logically integrating the lines of evidence to characterize risks to the endpoint, and (5) listing and discussing the uncertainties in the assessment.

12.8.1 Risk Characterization of the Fish Community

The characterization of risks to the fish community endpoint will be determined through the evaluation of multiple lines of evidence. Those lines of evidence are described below.

12.8.1.1 Surface Water Toxicity Testing

The first and strongest line of evidence is toxicity testing conducted on surface water samples collected from Site-related areas. Surface water toxicity tests will demonstrate the exposure-response relationship between the frequency of significant toxic responses and the concentrations of COPECs measured in the media. Responses that are statistically significantly different between the Site-related samples and the reference location samples are assumed to be indicative of surface water that has a Site-related toxic effect. Test responses used in the surface water

assessment include the survival of an invertebrate (*Ceriodaphnia dubia*) and a minnow (*Pimephales promelas*).

12.8.1.2 Analysis of Surface Water Chemical Data

The next line of evidence (both in number and in relative weight) consists of the comparison of COPEC concentrations identified in surface water samples with ecotoxicological benchmarks identified in Section 12.7.3. The mathematical comparison of a constituent concentration to an ecotoxicological benchmark is known as the Hazard Quotient (HQ). These HQs are calculated using the following equation:

$$HQ = \frac{\text{Media-Specific Constituent Concentration or Total Estimate of Exposure}}{\text{Ecotoxicological Benchmark (in comparable units)}}$$

If the HQ is less than, or equal to, one, then it is concluded that the potential for impacts to ecological receptors is absent or minimal. If the HQ is greater than one, then it is concluded that a *potential* for impacts to ecological receptors exists. The magnitude of the exceedance over one may be related to the magnitude of the potential for impact. The level of conservatism in the benchmark, however, must be taken into consideration as a comparison of chemical data to strongly conservative benchmarks may be overprotective of the resource and exaggerate the potential for an ecological risk. As part of the comparison process, the spatial distribution of exceedances will be examined. Exceedances at a large number of sampling points will indicate the potential for more widespread, or community level risks, as opposed to the exceedance at a single point which would suggest potential impacts only to an individual assumed to reside at that one location for its entire life. Additionally, exceedances of chronic benchmarks, but not acute values, will be considered to be indicative of potential ecological risks to sensitive individuals. The exceedance of an acute value over a large number of sampling points will be considered to be indicative of the potential for community-wide ecological risks.

Calculations of HQs will take into account spatial and temporal factors as these are related to the likelihood that effects might occur in populations of biota. Some COPECs may cause adverse effects through similar mechanisms of action. To account for this interaction, the HQs

for such COPECs will be summed across compounds grouped according to the specific toxicological effect that they may have.

The next line of evidence in characterizing ecological risks to the fish community is the comparison of COPEC concentrations identified in surface water collected in Site-related areas to surface water samples collected in similar, non-Site related reference environments. An exceedance of Site-related results versus reference area results will indicate the potential for ecological impacts to aquatic organisms found within the study area.

12.8.1.3 Analysis of Fish Body Burden Data

Another line of evidence to be used in the evaluation of the fish community will be the fish tissue body burden data that is developed for Site-related and reference area specimens. Tissue data from Site-related fish will be compared to data from reference specimens, and to NOAEL and LOAEL benchmarks for the determination of the potential for adverse effects. Concentrations of COPECs in Site-related fish tissue must have an HQ of one or greater, to be considered at a sufficient concentration to potentially produce a Site-related adverse effect. Concentrations of COPECs identified in upstream fish tissue will be compared to tissue from Site-related fish in an attempt to apportion Site-related COPEC body burdens.

12.8.1.4 Analysis of Sediment Toxicity, Biological and Chemical Data

Benthic invertebrates found within Site-related sediments will be evaluated as a prey base for the fish community. Should impacts to the benthic community be detected, it is assumed that this would potentially impact the ability of the fish community to utilize this resource for food. The extent of the impacted area will be compared to the foraging ranges of fish species to evaluate potential effects of reduced prey availability. As part of the development of this line of evidence, sediment bioassays will be assessed to determine the direct toxicity of sediments to benthic invertebrates.

Toxicity testing will be conducted on sediment samples collected in accordance with the QAPP and FSP. Sediment toxicity tests will demonstrate the exposure-response relationship between the frequency of significant toxic responses and the concentrations of COPECs measured in the

Site-related and reference sediments. Responses that are statistically significant between Site-related and reference samples are assumed to be indicative of sediments that demonstrate Site-related effects. Test responses used in the sediment assessment include the survival of two invertebrates, *Hyalella azteca* and *Chironomus tentans*.

Another line of evidence for evaluating the ability of the benthic community to serve as a prey base for the fish community will be biological surveys of the benthic community. Species richness and abundance metrics will be developed for Site-related benthic communities. Metric values that significantly differ between Site-related areas and reference areas will indicate the potential for ecological effects from Site-related COPECs.

Concentrations of COPECs that are identified in Site-related sediments will be evaluated by comparison to background and to sediment benchmarks in the same manner as surface water concentrations are evaluated in Section 12.8.1.2. Exceedance of LEL, ER-L, or similar benchmarks by sediment COPEC concentrations, where the SEL or ER-M is not exceeded, will be considered to be indicative of the potential for ecological risks to sensitive individuals. The exceedance of SEL, ER-M, or similar upper range benchmarks by sediment COPEC concentrations over a large number of sampling points will be considered indicative of the potential for community-wide ecological risks.

12.8.2 Risk Characterization of Amphibians

Concentrations of COPECs in surface water within the ponds will be evaluated for the potential to impact amphibians breeding in the ponds. Concentrations of COPECs identified with the surface water of the ponds will be compared to ecotoxicological benchmarks considered to be protective of amphibians using the HQ process described in Section 12.8.6. If the HQ is less than, or equal to, one, then it is concluded that the potential for impacts to ecological receptors is absent or minimal. If the HQ is greater than one, then it is concluded that a*potential* for impacts to amphibian breeding in the ponds exists. The magnitude of the exceedance over one may be related to the magnitude of the potential for impact. The level of conservatism in the benchmark, however, must be taken into consideration as a comparison of chemical data to strongly conservative benchmarks may be overprotective of the resource and exaggerate the potential for an ecological risk.

12.8.3 Risk Characterization of Piscivorous Wildlife

Risks to piscivorous wildlife will be assessed through the evaluation of a single line of evidence for the three species being evaluated. Using the exposure parameters and food-web modeling methodologies described in Section 12.7.6, fish COPEC body burden data will be utilized to determine potential exposures (ADDs) for each species. ADDs will be compared to wildlife TRVs using the HQ methodology outlined in Section 12.8.1.2. Those COPECs with a HQ of 1 or greater over a large number of sampling points will be considered to pose a potentially unacceptable ecological risk to the ROIs.

As this assessment is based on conservative exposure parameters that may not be Site-specific, exceedance of the TRV will indicate only the potential for an adverse effect and suggest the need for further analysis to confirm that potential. The magnitude of potential exceedances and the spatial distribution of the potential exceedances will be utilized to assess whether the potential for adverse effects may be to a single endpoint organism or to the local population of that species. To support the differentiation between potential ecological impacts to individuals versus potential ecological impacts to communities, exceedances of NOAEL-based TRVs, where the LOAEL-based TRV is not exceeded, will indicate the potential for an ecological risk to a sensitive individual. Exceedances of LOAEL-based TRVs will be indicative of more community-wide potential ecological effects. Additional biological survey data such as the identification of an endpoint species during the field surveys or the identification of data such as Audubon Society Christmas bird counts will be compiled to further assist with the evaluation of potential population versus individual ecological risks.

12.8.4 Risk Characterization of Vermivorous Wildlife

Risks to vermivorous wildlife will be assessed through the evaluation of a single line of evidence. Using the exposure parameters and food-chain modeling methodologies described in Section 12.7.7, earthworm COPEC body burden data will be utilized to determine potential exposures (ADDs) for the ROI. ADDs will be compared to wildlife TRVs using the HQ methodology outlined in Section 12.8.1.2. Those COPECs with a HQ of one or greater will be considered to pose a potentially unacceptable ecological risk to the ROI.

As the exceedance of a HQ indicates the potential for an ecological impact to an individual receptor at a specific location, it is the focus of this ERA to determine the potential for ecological risks to the population. To asses that potential, an estimation will be made of the population of short-tailed shrews at each of the Sites, based on habitat availability, home range of the organisms and size of each of the Sites. Using the distribution of COPECs in earthworms and terrestrial invertebrates and the exposure estimation procedures outlined in Section 12.7, an estimation will be made of whether COPECs exist at each of the Sites at concentrations sufficient to impact the respective shrew population.

As this assessment is based on conservative exposure parameters that may not be site specific, exceedance of the TRV will indicate the potential for an adverse effect and suggest the need for further analysis to confirm that potential. To support the differentiation between potential ecological impacts to individuals versus potential ecological impacts to communities, exceedances of NOAEL-based TRVs, where the LOAEL-based TRV is not exceeded, will indicate the potential for an ecological risk to a sensitive individual. Exceedances of LOAEL-based TRVs will be indicative of more community-wide potential ecological effects.

12.8.5 Risk Characterization of Herbivorous Wildlife

Risks to herbivorous wildlife will be assessed through the evaluation of two lines of evidence. The more significant line is the analysis of potential food chain impacts to the population of herbivorous mammals in the Sites. Using the exposure parameters and food-chain modeling methodologies described in Section 12.7.6, plant tissue COPEC data will be utilized to determine hypothetical exposures (ADDs) for the ROI. ADDs will be compared to wildlife TRVs using the HQ methodology outlined in Section 12.8.1.2. Those COPECs with a HQ of one of greater will be considered to potentially pose an unacceptable ecological risk to the ROI.

As the exceedance of a HQ indicates the potential for an ecological impact to an individual receptor at a specific location, it is the focus of this ERA to determine the potential for ecological risks to the population. To asses that potential, an estimation will be made of the population of prairie voles at each of the Sites, based on habitat availability, home range of the organisms and size of each of the Sites. Using the distribution of COPECs in plant tissue samples

collected across each of the Sites and the exposure estimation procedures outlined in Section 12.7, an estimation will be made of whether COPECs exist at each of the Sites at concentrations sufficient to impact the vole population.

The second line of evidence will be the evaluation of the plant community to serve as both habitat and a food source to herbivorous wildlife. The evaluation of potential impacts to plants will be completed through the screening of surface soil data against soil benchmarks.

12.8.6 Risk Characterization of Carnivorous Wildlife

Risks to carnivorous wildlife will be assessed through the evaluation of a single line of evidence. Using the exposure parameters and food-chain methodologies described in Section 12.7.6, ADDs for the red fox will be calculated. ADDs will be compared to wildlife TRVs using the HQ methodology outlined in Section 12.8.1.2. Those COPECs with a HQ of one or greater over a large number of sampling points will be considered to pose a potentially unacceptable ecological risk to the ROI.

As the exceedance of a HQ indicates the potential for an ecological impact to an individual receptor at a specific location, it is the focus of this ERA to determine the potential for ecological risks to the population. To asses that potential, an estimation will be made of the population of red fox across all of the Sites as a whole, based on habitat availability, home range of the organisms and size of each of the Sites. Using the distribution of COPECs in plant tissue samples collected across the Sites and the exposure estimation procedures outlined in Section 12.7, an estimation will be made of whether COPECs exist at all Sites at concentrations sufficient to impact the red fox population.

This assessment is based on conservative exposure parameters and hypothetical body burdens in prey species. As such it is considered to be a screening-level assessment. The exceedance of an HQ is only the indication of the potential for an adverse effect, and not the confirmation of one. To support the differentiation between potential ecological impacts to individuals versus potential ecological impacts to communities, exceedances of NOAEL-based TRVs, where the LOAEL-based TRV is not exceeded, will indicate the potential for an ecological risk to a sensitive individual. Exceedances of LOAEL-based TRVs will be indicative of more community-

wide potential ecological effects. Additional analyses would be necessary to further refine the estimates of ecological risk, should they be identified in the development of this ERA.

12.8.7 Uncertainty Analysis

Following the characterization of risks, sources of uncertainty and variability within the ERA will be identified. The impact associated with these uncertainties will be qualitatively addressed. A qualitative sensitivity analyses will be conducted for the more important exposure parameters that are used in the wildlife exposure models and for the TRVs that are used to estimate risks to the representative wildlife species.

12.9 Ecological Risk Assessment Report

The findings of the ERA will be presented in a Baseline Ecological Risk Assessment (BERA) report.

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Figure 12-1

Aquatic Conceptual Site Model

for the Mississippi River

Ecological Risk Assessment

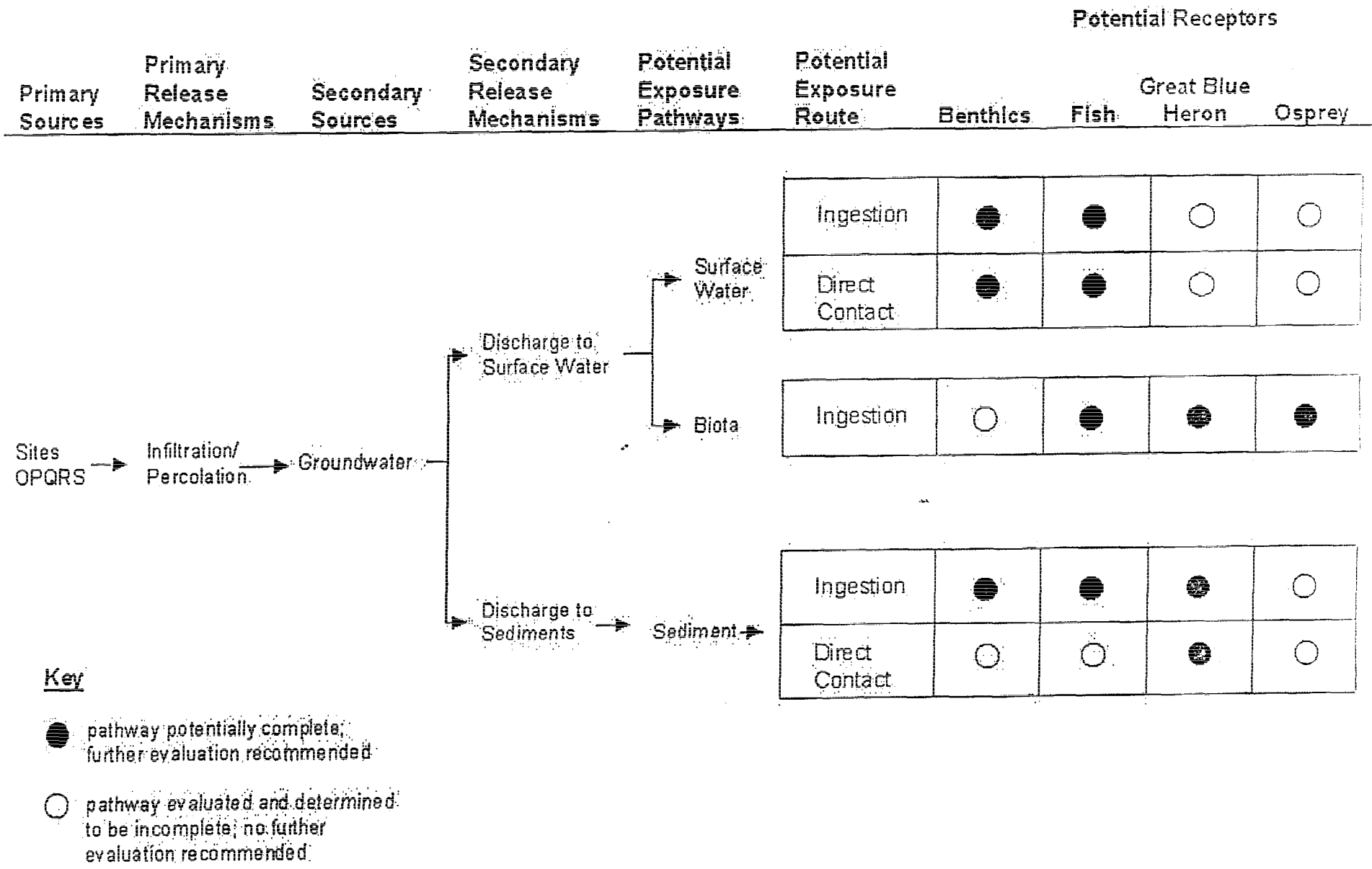


Figure 1A
Aquatic Conceptual Site Model for the Mississippi River Ecological Risk Assessment
Sauget Area 2 RI/FS SSP
Sauget Area 2 Sites Group

Figure 12-2

Aquatic Conceptual Site Model

for the Ponded Area

Ecological Risk Assessment

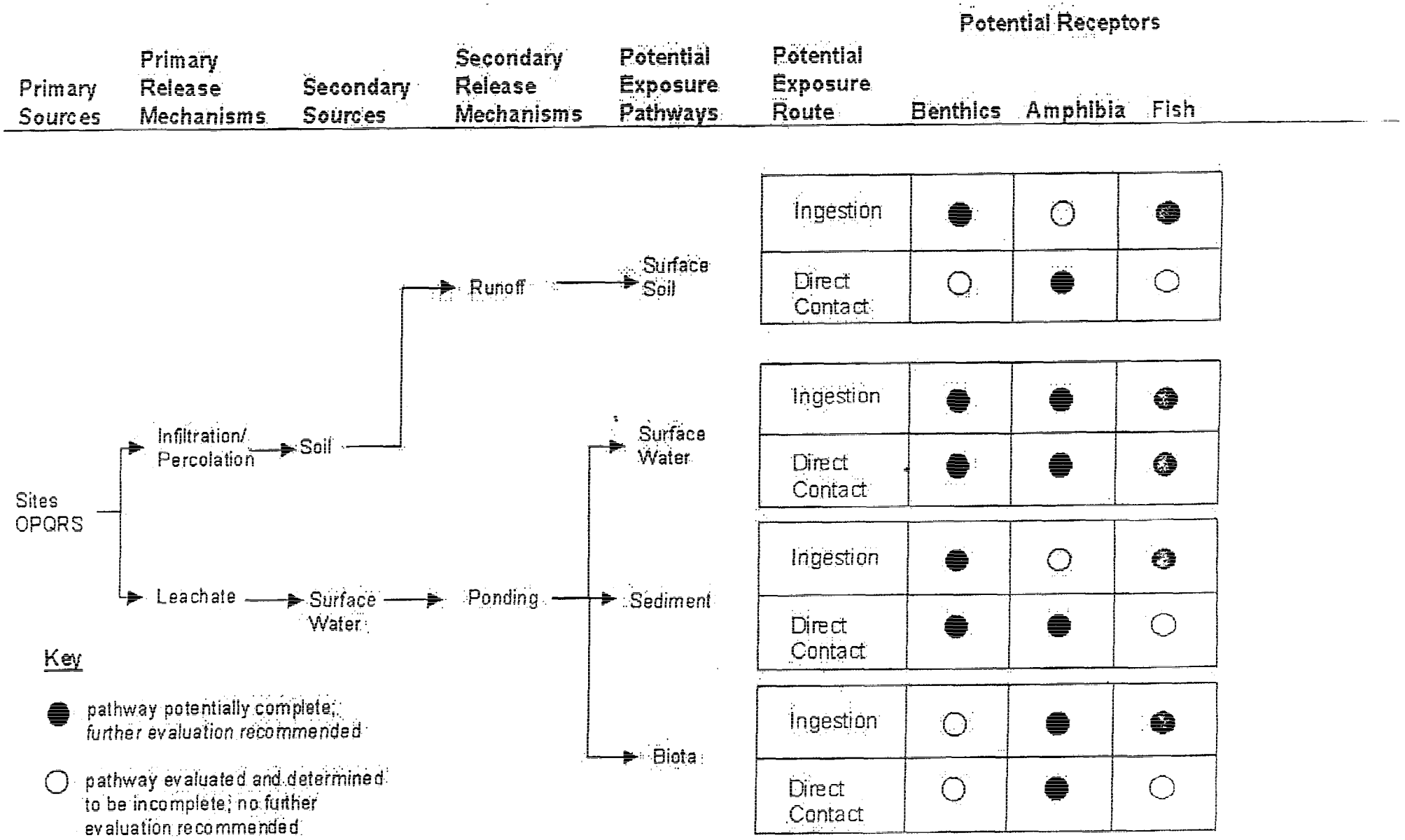
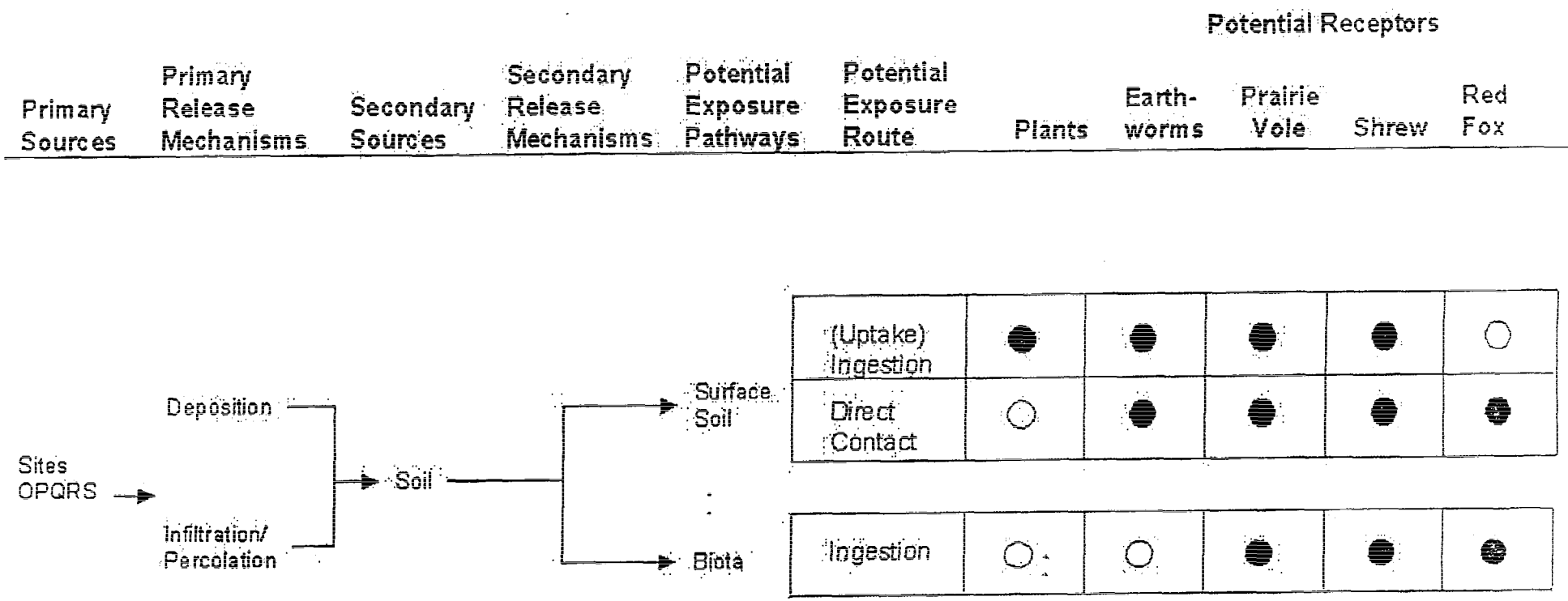


Figure 1B
Aquatic Conceptual Site Model for the Ponded Area Ecological Risk Assessment
Sauget Area 2 RI/FS SSP
Sauget Area 2 Sites Group

Figure 12-3

Terrestrial Conceptual Site Model for Ecological Risk Assessment



Key

● pathway potentially complete; further evaluation recommended

○ pathway evaluated and determined to be incomplete; no further evaluation recommended

Figure 2
Terrestrial Conceptual Site Model for Ecological Risk Assessment
Sauget Area 2 RI/FS SSP
Sauget Area 2 Sites Group

Section 13

13.0 RI/FS Report Work Plan

13.1 Introduction

The AOC requires preparation and implementation of a streamlined Remedial Investigation/Feasibility Study (RI/FS) for the Site. The purpose of the streamlined RI is to:

- Characterize the materials present in the waste disposal sites;
- Determine the extent of migration of constituents via the soil, groundwater, surface water, sediments and air pathways:
- Assess the associated risk to human health and the environment.

The streamlined FS will evaluate remedial alternatives for addressing the impact to human health and/or to the environment from affected soil, stormwater, groundwater, surface water, sediments, biota and air.

As specified by the AOC, the streamlined RI/FS will include the following:

Executive Summary
Streamlined Remedial Investigation

- Site Description and Background
  - Site Location and Physical Setting.
  - Present and Past Facility Operations and Disposal Practices
  - Geology/Hydrology/Hydrogeology
  - Current and Past Groundwater Usage in the Site Area
  - Surrounding Land Use and Populations
  - Sensitive Ecosystems
  - Meteorology/Climatology
- Previous Removal/Remedial Actions
  - Scope and Objectives
  - Duration
  - Nature and Extent of Constituents Treated or Controlled
  - Monitoring
  - Removal and/or Treatment Technologies
  - Treatment Levels
- Streamlined Remedial Investigation
- Data Validation
- Analytical Data
- Source, Nature and Extent of Contamination
- Groundwater Fate and Transport

- Constituent Characteristics
- Groundwater Fate and Transport Processes
- Groundwater Constituent Migration Trends
- Groundwater Modeling

Streamlined Risk Assessments

- Human Health Risk Assessment
- Ecological Risk Assessment

Streamlined Feasibility Study

- Identification of Remedial Action Objectives
- Determination of Remedial Action Scope
- Determination of Remedial Action Schedule
- Identification of and Compliance with ARARs
- Identification and Analysis of Remedial Action Alternatives
- Detailed Analysis of Alternatives
  - Effectiveness
    - Overall Protection of Public Health and the Environment
    - Compliance with ARARs and Other Criteria, Advisories, and Guidance
    - Long Term Effectiveness and Permanence
    - Reduction of Toxicity, Mobility, or Volume Through Treatment
      - Treatment process(s) employed and the material(s) it will treat
      - Amount of the hazardous or toxic materials to be destroyed or treated
      - Degree of reduction expected in toxicity, mobility, or volume
      - Degree to which treatment will be irreversible
      - Type and quantity of residuals that will remain after treatment
      - Whether the alternative will satisfy the preference for treatment
    - Short Term Effectiveness
      - Protection of the Community
      - Protection of the Workers
      - Environmental Impacts
      - Time Until Response Objectives are Achieved
  - Implementability
    - Technical Feasibility
    - Administrative Feasibility
    - Availability of Services and Materials
    - State and Community Acceptance
  - Cost
    - Direct Capital Costs
    - Indirect Capital Costs
    - Long Term Operation and Maintenance Costs
- Comparative Analysis of Remedial Action Alternatives

This RI/FS Work Plan is consistent with the requirements of the AOC and the SOW. Furthermore, the USEPA document "Guidance on Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA/540/G-89/004) was used a guidance document during

preparation of the work plan, as required by the AOC. This RI/FS Work Plan was developed through a four-step process including:

- Review of historical background information;
- Review of the AOC and SOW;
- Review of guidance; and
- Identification of information and data needs.

13.1.1 Objectives

In accordance with the AOC and SOW, an RI/FS Support Sampling Plan was prepared independently of the RI/FS Work Plan. The SSP will involve collecting waste, soil, stormwater, groundwater, surface water, sediment, biota and air samples for laboratory analysis and evaluating the resulting data to characterize the Sauget Area 2. The objective of the RI/FS Support Sampling Plan is to further determine the extent of potential contamination at the Site beyond that already defined by previous Site investigations. The SSP contains a description of equipment specifications, required analyses, sample types, and sample locations and frequencies.

As stated above, this R1/FS Work Plan addresses waste, soil, stormwater, groundwater, surface water, sediment, biota and air at Sauget Area 2. The overall objective of the R1/FS process is to gather information from previous and current site investigations, evaluate media in the areas of concern and provide evaluations and comparisons that are sufficient to support informed risk management decisions. More specifically, the objectives of the RI are to:

- Collect all data and information that will be gathered during the implementation of the SSP;
- Incorporate these data into a comprehensive data report;
- Evaluate the extent of migration in soil, groundwater, surface water, sediment and air;
- Assess risk to human health and the environment; and
- Evaluate potential technologies required to meet remedial action objectives.

The RI/FS will be based on site characterization information and data that will be collected as part of the field activities defined in the Support Sampling Plan.

The primary objective of the FS is to ensure that appropriate remedial alternatives are developed and evaluated such that relevant information concerning the remedial action options can be presented to USEPA for selection of an appropriate remedy. The FS involves developing a list of remedial alternatives that will potentially protect human health and the environment based on information that was collected during the RI and previous investigations. These alternatives will be evaluated against the nine criteria provided in 40 CFR 300.430:

- Overall protection of human health and the environment;
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs);
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short term effectiveness;
- Implementability;
- Cost;
- State acceptance; and
- Community acceptance.

The SSP, RI and FS activities will be conducted concurrently so that data collected during the SSP can influence the development of remedial alternatives in the FS. This, in turn, may result in additional data needs that can be addressed in the remainder of the RI. As data are collected during the SSP, the need for additional sampling and data collection will be determined.

Additional objectives of the RI/FS are to comply with the NCP and to satisfy all requirements stated in the AOC, the SOW and appropriate guidance documents.

13.1.2 Organization of Work Plan

The organization of this Work Plan is as follows:

Section 13.1	Introduction
Section 13.2	Remedial Investigation
Section 13.3	Risk Evaluations
Section 13.4	Remedial Action Objectives, Goals and Scope
Section 13.5	Feasibility Study
Section 13.6	References

Section 13.1 discusses relevant background and regulatory information pertaining to the RI/FS, project objectives and organization of the Work Plan. Section 13.2 describes the RI and RI components such as the RI/FS Support Sampling Plan; data collection, validation and organization; human health and ecological risk assessments and preparation of the RI report. Section 13.3 reviews the identification and documentation of remedial action objectives for the Site. Section 13.4 discusses the FS and FS components such as analysis of RI data, evaluation and selection of remedial alternatives and preparation of the draft and final FS report.

13.2 Remedial Investigation

This RI/FS Work Plan, in conjunction with the Support Sampling Plan, provides a general explanation of the objectives of the study and the scope of work. Further, these Work Plans describe the study's purpose and goals while also serving as a valuable tool for assigning responsibilities and setting the project's schedule and cost.

13.2.1 Site Description and Background

The initial task involved in implementation of an RI/FS is to characterize the Sauget Area 2 Sites and surrounding area with data and information that have been previously collected. The site description and background section of the RI/FS will summarize available data on the physical, demographic and other characteristics of the Sauget Area 2 Sites and surrounding areas. This discussion will concentrate on those characteristics necessary to evaluate and select potentially appropriate remedial actions. Data to be collected for the RI/FS and incorporated into this section will come from the SSP and past investigations.

Site description and background will be broken down into the following sub-sections:

- Sites Description and Background
  - Sites Location and Physical Setting
  - Present and Past Facility Operations and Disposal Practices
  - Geology/Hydrology/Hydrogeology
  - Current and Past Groundwater Usage in the Site Area
  - Surrounding Land Use and Populations
  - Sensitive Ecosystems
  - Meteorology/Climatology

Information on the location and physical setting of each disposal site, present and past facility operations and disposal practices, geology/hydrology/hydrogeology, current and past groundwater usage in the Site area, surrounding land use, sensitive ecosystems and meteorology/climatology were presented in Section 2.0. This information will be updated and expanded, if appropriate, and incorporated into the RI.

Available data and facts about local and regional ground-water conditions and uses specific to each disposal site and surrounding area will be assembled. Local ground-water recharge and discharge areas will be identified. Groundwater flow directions and quality will be discussed. State, county, city, and village records will be searched to identify any potential ground-water usage in the study area.

A background review of previous groundwater studies in Sauget Area 2 and the surrounding area was conducted during the preparation of Section 3.0. The RI Report will incorporate all available groundwater quality information to provide a thorough presentation of the existing groundwater data for the area from previous years of environmental investigations. The RI Report will provide tables displaying the frequency of detection, maximum, minimum, average and 95 percent confidence interval concentrations of compounds detected in ground water underlying Sauget Area 2.

13.2.2 Previous Removal Actions

This section of the RI/FS will describe the previous removal actions in Sauget Area 2. Previous information, if relevant, will be organized as follows:

- Previous Removal/Remedial Actions
  - Scope and Objectives
  - Duration
  - Nature and Extent of Constituents Treated or Controlled
  - Monitoring
  - Removal and/or Treatment Technologies
  - Treatment Levels

13.2.3 Data Validation

The ground-water laboratory results associated with RI sampling will be validated to determine the following:

- If the proper chain-of-custody was maintained;
- If proper methods were used;
- If holding times were met;
- If proper detection limits were achieved;
- If method blanks, field blanks, and/or trip blanks indicated any contamination;
- If relative percent differences (RPD) between a sample and it's duplicate were within control limits;
- If surrogate recoveries were within method established control limits; If any matrix interference was evident; and
- If laboratory control samples (LCS), LCS duplicate recoveries and RPI)s were within laboratory control Emits.

The data validation will be performed in accordance with USEPA SW846 methodologies. The data validation procedures are discussed in further detail in Volume 6 of the Support Sampling Plan.

13.2.4 Analytical Data

The Analytical Data section will present all quantifiable data collected for the RI/FS. This section will summarize existing data and include the additional data to be collected in accordance with the Support Sampling Plan. The data will include waste, soil, stormwater, groundwater,surface water, sediments, biota and air impact information.

As required by the AOC, analytical data received during a monthly reporting period will be submitted with the report for that period.

After completion of SSP fieldwork, receipt of laboratory analytical results and completion of data validation, the validated data will be compiled into a Data Report. Analytical data will be provided in tabular form along with maps showing the areal and vertical distribution of Total VOCs, SVOCs, indicator Metals, Pesticides, Herbicides, PCBs and Dioxin in waste, soil, stormwater, groundwater, surface water, sediments and air. This Data Report will be submitted

to USEPA, IEPA and their designees. It will also be provided to the data end users, i.e. the human health risk assessor, the ecological risk assessor and the RI/FS Report preparer, for use in preparing their reports.

13.2.5 Source, Nature and Extent of Contamination

This section of the RI will summarize the:

- Available site characterization data including the locations of hazardous substances, pollutants or contaminants;
- Quantity, volume, size or magnitude of the impacts; and
- Physical/chemical attributes of the hazardous pollutants or contaminants.

13.2.6 Groundwater Fate and Transport

To achieve the objectives of the RI/FS, definitive knowledge of the transport and fate of constituents in the subsurface is essential. Risk assessment and remediation of ground-water constituents require an understanding of how chemicals move through and interact with the subsurface environment. Groundwater fate and transport will addressed in the RI by addressing the following issues:

- Constituent Characteristics
- Groundwater Fate and Transport Processes
- Groundwater Constituent Migration Trends
- Groundwater Modeling

Results from the review of existing data and from the SSP will be combined in the analyses of ground-water constituent fate and transport processes. If information on a constituent release is available, the observed extent of the constituent may be used in assessing the rate of migration and the fate of such constituent over the period between release and monitoring. Constituent fate and transport evaluation may also be based on site physical characteristics and source characteristics.

As appropriate, an analytical or numerical ground-water model will be used to better define the groundwater movement and trends. Models aid the data reduction process by providing the user with a structure for organizing and analyzing field data. Detailed numerical models (e.g., numerical codes) provide relatively greater accuracy and resolution because they are capable of representing spatial variations in site characteristics and irregular geometries. Aquifer response parameters and geologic information from previous subsurface and hydrogeologic investigations will be integrated into the model to enable simulations of the uppermost water-bearing zone in static conditions and under given stresses (i.e., extraction or injection). The data obtained from these aquifer flow simulations will provide information pertaining to natural ground-water movement and groundwater reactions to stresses. This information will be used in support of the subsequent evaluations of the most effective remedial alternatives.

13.3 Risk Evaluations

13.3.1 Human Health Risk Assessment

A streamlined Human Health Risk Assessment (HHRA) will be conducted separately from the SSP and other RI activities. This streamlined risk assessment is intermediate in scope between the limited risk evaluation undertaken for emergency removal actions and the conventional baseline assessment normally conducted for remedial actions. It will focus on actual and potential risks to industrial, commercial and construction workers from exposure to contaminated soils, stormwater, groundwater, sediments, surface water and air and to recreational fishers from ingestion of potentially impacted biota in surrounding ecosystems. Reasonable maximum estimates of exposure and most likely estimates of exposure will be defined for both current land use conditions and reasonable future land use conditions.

In general, this evaluation will: 1) use analytical data from the disposal sites to identify the chemicals of concern, 2) provide an estimate of how and to what extent people might be exposed to these chemicals and 3) provide an assessment of the health effects associated with these chemicals. It will project the potential risk of health problems occurring if no cleanup action is taken at the Site and establish target action levels for both carcinogenic and non-carcinogenic constituents of concern (COCs). The risk evaluation will be conducted in general

conformance with relevant aspects of the Risk Assessment Guidance for Superfund (RAGS)(EPA/540/1-89/002, December 1989).

The Human Health Risk Assessment Work Plan included in Section 11.0 outlines the relevant requirements of the SOW and AOC and provides details that will be included in the Risk Assessment Report. The streamlined risk assessment will be conducted by ENSR concurrent with the preparation of the RI. While the streamlined Human Health Risk Assessment will be submitted to the Agency as a stand-alone document, a summary of the HHRA will be included in the Draft and Final RI/FS Report. Findings from the streamlined risk evaluation will be incorporated into the RI/FS and will be used in the overall evaluation of remedial alternatives.

The Human Health Risk Assessment will comply with USEPA guidance for conducting risk assessments including, but not limited to, the following:

- Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual (Parts A and D)(USEPA, 1989a and 1998a);
- USEPA Soil Screening Level: Technical Guidance Manual (USEPA, 1996a);
- Human Health Evaluation Manual Supplemental Guidance; Standard Default Exposure Factors. OSWER Directive 9285.6-03 (USEPA, 1991a);
- Exposure Factors Handbook (USEPA, 1997a); and
- Land Use in CERCLA Remedy Selection Process. 0SWER Directive No. 9355.7-04 (USEPA, 1995).

The HHRA will consist of the following sections:

- Site Characterization

  As described in Section 11.2 of the Human Health Risk Assessment Work Plan, the HHRA Report will discuss the Site and its environs, and present a conceptual Site model describing source areas, potential migration pathways, and potentially impacted media.

- Hazard Identification

As described in Section 11.3 of the Human Health Risk Assessment Work Plan, the HHRA Report will present a discussion of Site data and a description of the constituents of potential concern (COPCs). Constituents of concern (COCs) will be identified as a subset of those COPCs. Compounds identified as COCs will be those that: 1) present risks greater than the acceptable risk range of $1x10^{-6}$ to $1x10^{-4}$ for potential carcinogens and/or 2) a Hazard Index of 1.0 for noncarcinogens acting on the same target organ.

- Dose Response Assessment

As described in Section 11.4 of the Human Health Risk Assessment Work Plan, the HHRA Report will present a discussion of the dose-response assessment process. The dose-response assessment evaluates the relationship between the magnitude of exposure (dose) and the carcinogenic and noncarcinogenic effects. The most current, USEPA-verified dose-response values will be used when available.

- Exposure Assessment

As described in Section 11.5 of the Human Health Risk Assessment Work Plan, the HHRA Report will present a discussion of the exposure assessment process. The purpose of the exposure assessment is to provide a quantitative estimate of the magnitude and frequency of potential exposure to COPCs. Potentially-exposed individuals, and the pathways through which those individuals may be exposed to COPCs, are identified based on the physical characteristics of the Site, as well as the current and reasonably foreseeable future uses of the Site and surrounding area. The extent of a receptor's exposure is estimated by constructing exposure scenarios that describe the potential pathways of exposure to COPCs and the activities and behaviors of individuals that might lead to contact with COPCs in the environment.

- Risk Characterization

As described in Section 11.6 of the Human Health Risk Assessment Work Plan, the HHRA Report will present a discussion of the risk characterization process and uncertainties

associated with the risk assessment process. Risk characterization combines the results of the exposure assessment and the toxicity assessment to derive site-specific estimates of potential carcinogenic and noncarcinogenic risks resulting from both current and reasonably foreseeable potential human exposures. Within any of the steps of the risk evaluation process described above, assumptions must be made due to a lack of absolute scientific knowledge. Some of the assumptions are supported by considerable scientific evidence, while others have less support. The assumptions that introduce the greatest amount of uncertainty in this risk evaluation are discussed in this section of the HHRA Report.

- Summary and Conclusions

As described in Section 11.8 of the Human Health Risk Assessment Work Plan, the HHRA Report will present a summary of the results of the HHRA.

13.3.2 Ecological Risk Assessment

In accordance with the AOC, a streamlined Ecological Risk Assessment (ERA) will be included in the RI/FS. It will be consistent with USEPA guidance document "Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessments (EPA/540/R/97/006, June 1997)". Furthermore, the Ecological Risk Assessment will contain the following information as required by the SOW.

- Hazard Identification (Sources);
- Dose-Response Assessment;
- Conceptual Exposure/Pathway Analysis;
- Characterization of Site and Potential Receptors; Select Chemical, Indicator Species, and End Points; Exposure Assessment;
- Toxicity Assessment/Ecological Effects Assessment;
- Risk Characterization; and
- Identification of Limitations /Uncertainties.

An Ecological Risk Assessment Work Plan, included in Section 12.0 of this submittal, outlines the relevant requirements of the SOW and AOC, and provides details that will be included in the Ecological Risk Assessment Report. The Ecological Risk Assessment will be conducted by AMEC concurrent with the development of the RI/FS. Findings from the Ecological Risk Assessment will be incorporated into the RI/FS written submittal.

13.4 Remedial Action Objectives, Goals and Scope

Identifying the objectives, goals and scope for a remedial action is a critical step in the RI/FS process and in the conduct of remedial actions. Remedial action objectives, goals and scope are discussed in Section 13.4.1, Section 13.4.2 and Section 13.4.3, respectively.

13.4.1 Remedial Action Objectives

Site-specific Remedial Action Objectives (RAOs) protective of human health and the environment will be developed for Sauget Area 2. RAOs will be based on all of the information generated through this study, the evaluation of potential human-health risks and consideration of preliminary remediation goals. These objectives will specify the contaminant(s) and media of concern, the exposure route(s) and receptor(s) and an acceptable contaminant level or range of levels for each exposure route. RAOs will be developed by taking the these factors into consideration:

- Prevention or abatement of actual or potential exposure to nearby human populations, (including workers), animals, or the food chain from hazardous substances, pollutants, or contaminants;
- Prevention or abatement of actual or potential contamination of drinking water supplies and ecosystems;
- Stabilization or elimination of hazardous substances in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release;
- Treatment or elimination of hazardous substances, pollutants, or contaminants in soils or sediments that may migrate;
- Elimination of threat of fire or explosion;

- Acceptable chemical-specific contaminant levels, or range of levels, for all exposure routes; and

- Mitigation or abatement of other situations or factors that may pose threats to public health, welfare, or the environment

13.4.2 Remedial Action Goals

Preliminary Remedial Action Goals (PRGs) will be developed based on readily available information such as chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) or other reliable information. PRGs will be modified, as necessary, as more information becomes available during the RI/FS. Final remediation goals will be determined when the remedy is selected. Remediation goals will establish acceptable exposure levels that are protective of human health and the environment and will be developed by considering the following:

ARARs under federal environmental or State environmental or facility siting laws, if available, and the following factors:

- For systemic toxicants, acceptable exposure levels will represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety;

- For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between $1x10^{-6}$ and $1x10^{-4}$ using information on the relationship between dose and response;

- Factors related to technical limitations such as detection/quantification limits for contaminants;

- Factors related to uncertainty; and

- Other pertinent information.

- Safe Drinking Water Act Maximum Contaminant Level Goals (MCLGs) will be attained by remedial actions for ground or surface waters that are current or potential sources of drinking water: 1)) if they are set at levels above zero 2) and the MCLGs are relevant and

appropriate under the circumstances of the release based on the NCP factors established in §300.400(g)(2). If an MCLG is determined not to be relevant and appropriate, the corresponding Safe Drinking Water Act Maximum Contaminant Level (MCL) will be attained where relevant and appropriate to the circumstances of the release;

Safe Drinking Water Act MCLs will be attained by remedial actions for ground or surface waters that are current or potential sources of drinking water where: 1) the MCLG for a contaminant is zero and 2) the MCL is relevant and appropriate under the circumstances of the release based on the NCP factors in §300.400(g)(2);

Water quality criteria established under sections 303 or 304 of the Clean Water Act will be attained where relevant and appropriate under the circumstances of the release; and

An Alternate Concentration Limit (ACL) may be established in accordance with CERCLA Section 121(d)(2)(B)(ii).

13.4.3 Remedial Action Scope

The RI/FS will support the determination of the appropriate scope of the remedial action by defining the broad scope and specific objectives and addressing the protectiveness of the remedial action. The scope of the action could be, for example, site stabilization, source mitigation, or surface cleanup or "area of elevated concentration" removal of hazardous substances. The main emphasis will be on addressing media in all areas where acute, short-term and chronic, long-term threats to human health and the environment are present.

13.5 Feasibility Study

A Feasibility Study (FS) is typically conducted in three phases: 1) development of alternatives, 2) screening of alternatives and 3) detailed analysis of alternatives. However, the specific point at which the first phase ends and the second phase begins is not distinct. Therefore, the development and screening of alternatives will be performed concurrently, if deemed necessary and appropriate. The NCP provides considerable latitude regarding the scope of this screening and development phase. As stated in NCP §300.430(a)(1)(ii)(C):

"Site specific data needs, the evaluation of alternatives, and the documentation of the selected remedy should reflect the scope and complexity of the site problems being addressed."

The NCP preamble emphasizes the principle of streamlining, which the USEPA applies in managing the Superfund program as a whole, and in conducting individual remedial action projects. In accordance with the principle of streamlining, an alternatives screening step may not even be deemed necessary prior to detailed analysis.

13.5.1 Development of Alternatives

The primary objective of this phase of the FS is to develop an appropriate array of options that will be analyzed more fully in the detailed analysis phase of the FS. Appropriate options to ensure the protection of human health and the environment may involve:

- Complete elimination or destruction of hazardous substances with concentrations outside acceptable risk ranges;
- Reduction of concentrations of hazardous substances to acceptable health-based risk levels;
- Prevention of exposure to hazardous substances via engineering or institutional controls; or
- Some combination of the above.

Alternatives for remediation are developed by assembling combinations of technologies into alternatives that address impacted environmental media on either a site-wide basis or for an identified area. This process consists of six general steps that are presented below:

- Develop remedial action objectives specifying the constituents of interest, exposure pathways, and preliminary remediation goals that permit a range of treatment and containment alternatives to be developed. The preliminary remediation goals are developed on the basis of chemical-specific ARARs, when available, other available information and site-specific risk-related factors;

- Develop general response actions defining containment, removal, treatment or other actions, singly or in combination, that may be taken to satisfy the remedial action objectives for the Site;

- Identify areas to which general response actions might be applied, taking into account the requirements for protectiveness as identified in the remedial action objectives and the chemical and physical characterization of the Site;

- Identify and screen the technologies applicable to each general response action to eliminate those that cannot be implemented technically at the Site. The general response actions are further defined to specify remedial technology types, e.g., the general response action of treatment can be further defined to include chemical or biological technology types;

- Identify and evaluate technology process options to select a representative process for each technology type retained for consideration. Although specific processes are selected for alternative development and evaluation, these processes are intended to represent the broader range of process options within a general technology type; and

- Assemble the selected representative technologies into alternatives representing a range of treatment and containment combinations, as appropriate.

For those situations in which numerous remediation options are appropriate and developed, the assembled alternatives may need to be refined and screened to reduce the number of alternatives that will be analyzed in detail. This screening aids in streamlining the Feasibility Study process while ensuring that the most promising alternatives are being considered.

Based on the analysis of the nature and extent of contamination and on the cleanup objectives that may be developed, as described in the previous section, a limited number of alternatives appropriate for addressing the removal action objectives will be identified and addressed. Whenever practicable, the alternatives will also consider the CERCLA preference for treatment over conventional containment or land disposal approaches.

Based on the available information, only the most qualified technologies that apply to the media or source of contamination will be discussed in the EE/CA. The use of presumptive remedy guidance, as appropriate and applicable to any of the disposal sites in Sauget Area 2, will also provide an immediate focus for the identification and analysis of alternatives.- The guidance includes, but is not limited to: Implementing Presumptive Remedies (EPA 540-R-97-029,

October 1997). Presumptive remedies involve the use of remedial technologies that have been consistently selected at similar sites or for similar contamination.

A limited number of alternatives, including any identified presumptive remedies, will be selected for detailed analysis. Each of the alternatives shall be described with enough detail so that the entire treatment process can be understood. Technologies that may apply to the media or source of contamination shall be listed in the RI/FS.

A preliminary list of alternatives that may be relevant for Sauget Area 2 consists of, but is not limited to:

- Removal and off-site incineration of waste and/or soil;
- Removal and on-site thermal desorption of waste and/or soil;
- Removal and on-site disposal of waste and/or soil;
- Removal and off-site disposal of waste and/or soil;
- Containment of waste and soil;
- Recovery and on-site treatment of groundwater; and
- Recovery and off-site treatment of groundwater.

13.5.2 Screening of Alternatives

The purpose of the screening evaluation is to reduce the number of alternatives that will undergo a more thorough and extensive analysis. Thus, defined alternatives are evaluated more generally in this phase than during the detailed analysis; however, evaluations will be sufficiently detailed to the extent that the alternatives can be distinguished. The screening evaluation involves evaluating the defined alternatives against the short-term and long-term aspects of three broad criteria: effectiveness, implementability, and cost. During the detailed analysis, the alternatives will be screened against nine specific criteria and their individual factors rather than the three general criteria used in screening. Consequently, a significant time

savings can be realized in cases where numerous alternatives are identified if the screening process is carefully implemented. The three screening criteria are briefly discussed below:

- Effectiveness Evaluation

  A key aspect of the screening evaluation is the effectiveness of each alternative in protecting human health and the environment. Each alternative will be evaluated as to its effectiveness in providing protection and the reductions in toxicity, mobility or volume that it will achieve. Both the short-term and long-term components of effectiveness will be evaluated; short-term referring to the construction and implementation period, and long-term referring to the period after the remedial action is complete.

- Implementability Evaluation

  Implementability, as a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative, is used during screening to evaluate the combinations of process options with respect to conditions at the Site. Technical feasibility refers to the ability to construct, reliably operate and meet technology-specific regulations for process options until a remedial action is complete. It also includes operation, maintenance, replacement and monitoring of technical components of an alternative, if required, after the remedial action is complete. Administrative feasibility refers to the ability to obtain approvals from other offices and agencies; the availability of treatment, storage, and disposal services; and the capacity, requirements for and availability of specific equipment and technical specialists.

- Cost Evaluation

  The focus of this evaluation will be to make comparative estimates for alternatives with relative accuracy so that cost decisions among alternatives will be sustained as the accuracy of cost estimates improves beyond the screening process. The procedure used to develop cost estimates for alternative screening are similar to those used for the detailed analysis; the only differences are in the degree of alternative refinement and in the degree to

which components are developed. Cost estimates for screening alternatives typically will be based on a variety of cost-estimating data. Bases for screening cost estimates may include cost curves, generic unit costs, vendor information, conventional cost-estimating guides and prior similar estimates as modified by Site-specific information.

Alternatives with the most favorable composite evaluation of all factors will be retained for further consideration during the detailed analysis. Alternatives selected for further evaluation will, where practical, preserve the initially developed range of treatment and containment technologies. It is not a requirement that the entire range of alternatives originally developed be preserved if all alternatives in a portion of the range do not represent distinct viable options.

13.5.3 Detailed Analysis of Alternatives

13.5.3.1 Alternatives Array Document

Prior to proceeding with the detailed analysis of alternatives, an Alternatives Array Document will be prepared. This document will: 1) summarize the Remedial Action Objectives that were previously determined, 2) list each of the initially selected technologies and 3) provide the basis for selection. Furthermore, it will provide details of the Alternative Screening Evaluation including the results of the study in a tabular form. Finally, the document will propose a list of remedial alternatives for inclusion in the Detailed Analysis of Alternatives Study. This document will be included in the RI/FS Report.

The Alternatives Array Document will also summarize, in table format, the pertinent ARARs. These tables will be developed in accordance with USEPA guidance and existing State laws. The USEPA defines three types of ARARs: 1) chemical specific, 2) location specific and 3) action specific.

Chemical-specific ARARs include those laws and requirements that regulate the release to the environment of materials having certain chemical or physical characteristics or containing specified chemical compounds. These requirements generally establish health-based or risk-based concentration limits or discharge limitations for specific hazardous substances.

Maximum Contaminant Levels promulgated under the Safe Drinking Water Act and the analogous Illinois Groundwater Quality Standards are important ARARs for this Sauget Area 2. Location-specific ARARs are those requirements that relate to the geographical or physical position of the site rather than to the nature of the contaminants or the proposed site remedial actions. These ARARs typically deal with environmentally sensitive areas, e.g., wetlands, flood plains, fault zones, etc., and may limit the remedial actions that can be implemented or may impose additional constraints on the remedial action.

Action-specific ARARs are requirements that define acceptable treatment and disposal procedures for hazardous substances. These ARARs generally set performance, design or other similar action-specific controls or restrictions on particular kinds of activities related to management of hazardous substances or pollutants. These requirements are triggered by the particular remedial activities that are selected to achieve remedial action objectives.

13.5.3.2 Detailed Analysis Implementation

The Detailed Analysis of Alternatives will include a technical description of each alternative that outlines the strategy involved and identifies the key ARARs associated with each alternative. It will also include a discussion that profiles the performance of that alternative with respect to each of the nine evaluation criteria. This evaluation will include a table summarizing the results of this analysis.

The nine evaluation criteria for Detailed Alternative Analysis are as follows:

- **Overall Protection of Human Health and the Environment** - Addresses whether or not the remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled through treatment, engineering controls or institutional controls. The effectiveness of each alternative in protecting human health and the environment will be discussed in a consistent manner. Assessments conducted under other evaluation criteria, including long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs, where practicable, will be included in the discussion. The discussion will also focus on how each alternative achieves adequate protection and describe how the alternative will reduce, control or eliminate risks at a site through the use of treatment, engineering or institutional controls. This evaluation will also identify any unacceptable short-term impacts.

- **Compliance with ARARs** - Addresses whether or not the remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes and/or provide grounds for invoking a waiver. A separate table will be included in the FS that details all Federal and State ARARs. The detailed analysis shall summarize which requirements are applicable or relevant and appropriate to an alternative and describe how the alternative meets those requirements. A summary table may be employed to list potential ARARs. In addition to ARARs, other Federal or State advisories, criteria or guidance to be considered (TBC) may be identified.

- **Long-Term Effectiveness and Permanence** - Refers to the ability of the remedy to maintain reliable protection of human health and the environment over time once cleanup goals have been met. This evaluation assesses the extent and effectiveness of the controls that may be required to manage risk posed by treatment residuals and/or untreated wastes at a site. The following components will be considered for each alternative: 1) magnitude of risk and 2) adequacy and reliability of controls. The effectiveness of an alternative refers to its ability to meet the objective within the scope of the remedial action. This Section of the RI/FS will evaluate each alternative against the scope of the remedial action and against each specified objective for disposition of the wastes and the level of cleanup desired. These objectives will be discussed in terms of protectiveness of public health and the environment from short-term or acute threats and from chronic or long-term threats.

- **Reduction of Toxicity, Mobility, or Volume through Treatment** - Is the anticipated performance of the treatment technologies a remedy may employ. As required by USEPA, an evaluation based upon the following factors will be performed for each alternative:

  - Treatment process or processes employed and the material(s) it will treat;
  - Amount of the hazardous materials to be destroyed or treated;
  - Degree of reduction expected in toxicity, mobility, or volume;
  - Degree to which treatment will be irreversible;
  - Type and quantity of residuals that will remain after treatment; and
  - Whether the alternative will satisfy the preference for treatment.

- **Short-Term Effectiveness** - Addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup goals are achieved. The short-term effectiveness criterion will address the effects of the alternative during implementation before the remedial objectives have been met. Alternatives will also be evaluated with respect to their effects on human health and the environment following implementation. The following factors will be addressed, as appropriate, for each alternative:

  Protection of the Community - This factor will address any risk to the affected community that may result from implementation of the proposed action, whether from air quality impacts, fugitive dusts, transportation of hazardous materials, or other sources.

  Protection of the Workers - This factor will assess any threats to site workers and the effectiveness and reliability of protective measures that would be taken.

Environmental Impacts - This factor evaluates the potential adverse environmental acts from the implementation of each alternative. The factor also assesses the reliability of mitigation measures in preventing or reducing the potential impacts.

Time Until Remedial Objectives Are Achieved - This factor estimates the time needed to achieve protection for the site itself or for individual elements or threats associated with the Site.

- **Implementability** - Is the technical and administrative feasibility of the remedy including the availability of materials and services needed to implement a particular option. The implementability criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. The following factors will be considered under this criterion:

  Technical Feasibility - The RI/FS will assess the ability of the technology to implement the remedy. The following factors will be described:

  - Degree of difficulty in constructing and operating the technology;
  - Reliability of the technology;
  - Availability of necessary services and materials;
  - Scheduling aspects of implementing the alternatives during and after implementation;
  - Potential impacts to the local community during construction operations; and
  - Environmental conditions with respect to set-up and construction and operation.

  Administrative Feasibility - The administrative feasibility factor evaluates those activities needed to coordinate with other offices and agencies. The administrative feasibility of each alternative will be evaluated including the need for off-site permits, adherence to applicable non-environmental laws and concerns of other regulatory agencies. Factors that will be considered include, but are not limited to, statutory limits, permits and waivers.

  Availability of Services and Materials - The RI/FS will determine if off-site treatment, storage, and disposal capacity, equipment, personnel, services, materials and other resources necessary to implement an alternative will be available in time to maintain the removal schedule. Several important availability factors are:

  - Personnel and technology;
  - Off-site treatment, storage, and disposal;
  - Services and materials; and
  - Prospective technologies.

- **Cost** - Includes estimated capital costs, operation and maintenance costs and net present worth costs. Each alternative will be evaluated to determine it's projected costs. The evaluation will compare each alternative's capital and operation and maintenance costs. Net present worth of alternatives will also be calculated. The following items will be presented:

  Direct Capital Costs - Costs for construction, materials, land, transportation,. Analysis of samples, and treatment.

Indirect Capital Costs - Costs for design, legal fees, and permits.

Long-Term Operation and Maintenance Costs - Costs for maintenance and long-term monitoring.

- **State Acceptance** - USEPA will consider and address IEPA acceptance of an alternative in making a recommendation and in the final selection of a remedy in the ROD.
- **Community Acceptance** - USEPA will consider and address community acceptance of an alternative in making a recommendation and in the final selection of a remedy in the ROD.

The criteria listed above will be used to effectively compare each of the technologies. These criteria are categorized into the three groups listed below:

- **Threshold Criteria** - Overall protection of human health and the environment and compliance with ARARs (unless a specific ARAR is waived) are threshold requirements that each alternative must meet in order to be eligible for selection.

- **Primary Balancing Criteria** - The five primary balancing criteria are: 1) long-term effectiveness and permanence; 2) reduction of toxicity, mobility, or volume through treatment; 3) short-term effectiveness; 4) implementability; and 5) cost.

- **Modifying Criteria** - State and community acceptance are modifying criteria that the USEPA will consider in remedy selection. Section 121 of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) provides for state involvement in remedy selection while Sections 113 and 117 provide for public participation during remedy selection. These two criteria are applied to the remedy selection process following receipt of comments on the FS (for support agency acceptance) and after the public comment period following publication of a Proposed Remedial Action Plan. Therefore, these modifying criteria will not be addressed specifically in the FS.

13.5.4 Comparative Analysis of Remedial Action Alternatives

After the potential remedial alternatives are described and individually assessed against the evaluation criteria described previously, a comparative analysis will be conducted to evaluate the relative performance of each alternative in relation to each of the criteria. The purpose of

this analysis will be to identify advantages and disadvantages of each alternative relatively, allowing for direct comparisons. Alternatives will also be compared against the removal action objectives.

13.5.5 Draft RI/FS Report

At the conclusion of the field activities, sample analyses and individual studies that are described above, a Draft RI/FS Report will be prepared and submitted to USEPA, IEPA and its designees. The consultant who will perform this work has not been selected yet. The Draft RI/FS Report will contain an Executive Summary that will provide a general overview of the contents of the RI/FS including a brief discussion of Sauget Area 2 and the current and potential threats posed by site conditions. The Executive Summary will also identify the scope and objectives of the remedial action(s) as well as any removal action alternatives.

The Remedial Investigation portion of the Draft RI/FS Report will summarize data collected during the SSP implementation and will provide supplemental information gathered from past investigations. It will accurately describe the nature of the sources, the extent of constituent migration via the soil, groundwater, surface water, sediment and air pathways and the concentrations of constituents present in these environmental media. Details and results from Support Sampling Plan implementation along with the results groundwater fate and transport modeling, waste and groundwater treatability studies and the streamlined Human Health and Ecological Risk Assessments will be included in the Draft RI/FS Report.

The Feasibility Study portion of the Draft RI/FS Report will list the selected remedial action objectives, include all details pertaining to the selection of remedial alternatives, preliminary evaluation and screening of alternatives and detailed evaluation and selection of alternatives. Finally, the selected remedial action alternatives will be evaluated and compared based upon information and objectives that were developed during this study. Correspondence from the regulatory agencies will be provided in the appendices to the Draft RI/FS Report.

The Draft RI/FS Report will have the following format:

Executive Summary

Streamlined Remedial Investigation

- Sites Description and Background
  - Sites Location and Physical Setting
  - Present and Past Facility Operations and Disposal Practices
  - Geology/Hydrology/Hydrogeology
  - Current and Past Groundwater Usage in the Sauget Area 2 Area
  - Surrounding Land Use and Populations
  - Sensitive Ecosystems
  - Meteorology/Climatology
- Previous Removal/Remedial Actions
  - Scope and Objectives
  - Duration
  - Nature and Extent of Constituents Treated or Controlled
  - Monitoring
  - Removal and/or Treatment Technologies
  - Treatment Levels
- Streamlined Remedial Investigation
- Data Validation
- Analytical Data
- Source, Nature and Extent of Contamination
- Groundwater Fate and Transport
  - Constituent Characteristics
  - Groundwater Fate and Transport Processes
  - Groundwater Constituent Migration Trends
  - Groundwater Modeling

Streamlined Risk Evaluations

- Human Health Risk Assessment
- Ecological Risk Assessment

Streamlined Feasibility Study

- Identification of Remedial Action Objectives
- Determination of Remedial Action Scope
- Determination of Remedial Action Schedule
- Identification of and Compliance with ARARs
- Identification and Analysis of Remedial Action Alternatives
- Detailed Analysis of Alternatives
  - Effectiveness
    - Overall Protection of Public Health and the Environment
    - Compliance with ARARs and Other Criteria, Advisories, and Guidance
    - Long Term Effectiveness and Permanence

- Reduction of Toxicity, Mobility, or Volume Through Treatment
  - Treatment process(s) employed and the material(s) it will treat
  - Amount of the hazardous or toxic materials to be destroyed or treated
  - Degree of reduction expected in toxicity, mobility, or volume
  - Degree to which treatment will be irreversible
  - Type and quantity of residuals that will remain after treatment
  - Whether the alternative will satisfy the preference for treatment
- Short Term Effectiveness
  - Protection of the Community
  - Protection of the Workers
  - Environmental Impacts
  - Time Until Response Objectives are Achieved
- Implementability
  - Technical Feasibility
  - Administrative Feasibility
  - Availability of Services and Materials
  - State and Community Acceptance
- Cost
  - Direct Capital Costs
  - Indirect Capital Costs
  - Long Term Operation and Maintenance Costs

- **Comparative Analysis of Remedial Action Alternatives**

13.5.6 Final RI/FS Report

At the conclusion of all activities and after the Agency's review of the Draft RI/FS Report, a Final RI/FS Report that includes all information pertaining to this project will be submitted to USEPA, IEPA and its designees

13.6 References

CFR, July 1997. National Oil and Hazardous Substances Pollution Contingency Plan (NCP), Part 300

USDOE, December 1993. Environmental Guidance - Remedial Investigation/Feasibility Study (RI/FS) Process, Elements and Techniques Guidance

USEPA, October 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. EPA/540/G-89/004

USEPA, December, 1989. Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part A, Interim Final. EPA/540/1-89/002 (Publication 9285.7-01B)

USEPA, 1989a and 1998a, Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Parts A and D)

USEPA, 1991a, Human Health Evaluation Manual Supplemental Guidance; Standard Default Exposure Factors. OSWER Directive 9285.6-03

USEPA, 1992a. Evaluation of Ground-Water Extraction Remedies: Phase II, Volume II 1-Summary Report Office of Emergency and Remedial Response, Washington, D.C. USEPA Publication 9355.4-05A.

USEPA, 1992b. Evaluation of Ground-Water Extraction Remedies: Phase II, Volume 2 - Case Studies and Updates. Office of Emergency and Remedial Response, Washington, D.C. USEPA Publication 9355.4-05A.

USEPA, October 1992c. Guide for Conducting Treatability Studies Under CERCLA, Final EPA/540/R-92/071a

USEPA, August 1993a. Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA. EPA 540-R-93-057

USEPA, September 1993b. OSWER Directive No. 9355.0-49FS, Presumptive Remedy for CERCLA Municipal Landfill Sites. EPA 540-F-93-035

USEPA, 1995, Land Use in CERCLA Remedy Selection Process. OSWER Directive No. 9355.7-04.

USEPA, 1996a, Soil Screening Level: Technical Guidance Manual

USEPA, 1997a, Exposure Factors Handbook

USEPA, June 1997b. Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessments. EPA/540/R/97/006

USEPA, October 1997c. Implementing Presumptive Remedies, A Notebook of Guidance and Resource Materials. EPA 540-R-97-029

USEPA, January 1998. Risk Assessment Guidance for Superfund (RAGS). EPA 540/R/97/033

14.0 Project Organization

The Sauget Area 2 Sites Group Technical Committee will be responsible for project direction and implementation. Technical committee members are:

AmerenUE	Paul Pike
BFI Waste Systems of NA, Inc.	Steve Doss
Blue Tee	Gary Uphoff
Cerro	Joseph Grana
Ethyl	John Street/Donna Parks
ExxonMobil	Daniel Burnham
Solutia	Bruce Yare
Waste Management	Patrick Craig

The Technical Committee will be responsible for technical project quality and will manage the data collection and interpretation portions of the project in particular the Support Sampling Plan, the HHRA, the ERA and the RI/FS Report. It will also be responsible for ensuring the efficient transfer of soil, groundwater, surface water, sediment and air sampling and analytical information from the data collection contractors to the data interpretation contractors. Regular project meetings will be held with the project team during data collection and interpretation activities. These meetings will ensure smooth integration of the two functions and will facilitate preparation of the Field Sampling Report, the Data Report, the Human Health Risk Assessment Report, the Ecological Risk Assessment Report and the RI/FS Report.

Steven D. Smith, the Project Coordinator, will assist the SA2SG Technical Committee and coordinate with USEPA. An independent project manager, who will be retained and given responsibility for managing day to day project activities, will report to the Technical Committee.

URS was retained to perform the Waste, Soil and Stormwater Sampling Plan; the Groundwater Sampling Plan and the Air Sampling Plan. Robert Veenstra will be the Project Officer and Steve Shroff will be the Project Manager for these sampling plans.

AMEC Environmental was retained to perform the Surface Water, Sediment and Ecological Sampling Plan.

VOC, SVOC, Pesticide, Herbicide, PCB, Dioxin and Metals analyses will be performed by STL Savannah Laboratories of Savannah, Georgia. STL Sacramento Laboratories of Sacramento, California will perform the Dioxin analyses. Michelle Owens of STL Savannah Labs and Robert Hrabak of STL Sacramento Labs will be responsible for managing sample analyses.

URS was retained to perform data validation, management and mapping. John Kearns will be responsible for leading the team that will validate the waste, soil, stormwater, groundwater and air data and the surface water, sediment and biota data. Rudy Torrini will be responsible for leading the team that will prepare the database. In addition, Mr. Torrini's team will be responsible for compiling dot maps showing distribution of Total VOCs, SVOCs, Pesticides, Herbicides, PCBs, Dioxin TEQs and selected Metals in waste, soil, stormwater, groundwater and air as well as surface water and sediments.

ENSR was retained to perform the Human Health Risk Assessment and AMEC was retained to perform the Ecological Risk Assessment. Lisa Bradley will manage the ENSR risk assessment team and Charles Harmon will manage the AMEC risk assessment team.

A contractor will be retained to perform the RI/FS.

Resumes of these project personnel are included at the end of this section.

The SA2SG understands that USEPA is responsible for the Community Relations Plan (CRP) required by the NCP and that the Agency will take the lead in community relations and public participation activities. SA2SG intends to support the Agency's community relations and public participation efforts and will participate as appropriate. SA2SG will also facilitate meaningful public participation through the documents that it produces. SA2SG anticipates that whatever CRP the USEPA provides will be NCP compliant and thus meet any obligations SA2SG may have relative to subsequent cost recovery actions that it might pursue.

Section 15

15.0 Project Schedule

Work required by the Sauget Area 2 AOC SOW will take a total of 20 months to perform. As required by the AOC, the RI/FS will be completed 12 months after collection of the last sample.

Major project work elements, and their duration, are given below along with the start dates needed to meet a September/October 2001 ecological sampling schedule. Starting dates are contingent on approval of the RI/FS Support Sampling Plan by July 1, 2001.

Work Element	Work Element Duration (Months)	Project Duration (Months)	Anticipated Starting Date
• **Project Start Up**	2	2	June 1, 2002
– Access (Legal and Physical)			
– Historical Records Review			
– Historical Air Photo Review			
– Soil Gas Surveys			
– Magnetometer Surveys			
– Ecological Reconn Survey			
• **Mobilization**	1	3	August 1,2002
• **Field Sampling**	5	8	August 15, 2002
– Waste, Soil, Stormwater and Air			
– Groundwater			
– Surface Water, Sediment and Biota			
• **Treatability Tests**			
– Concurrent with Data Management			
– Concurrent with Risk Evaluation			
• **Data Management**	4	12	January 1, 2003
– Sample Analysis			
– Data Validation			
– Data Management			
– Data Mapping			
– Data Report			
• **Risk Evaluation**	4	16	April 1, 2003
– Human Health Risk Assessment			
– Ecological Risk Assessment			
• **RI/FS Report**	4	20	September 1, 2003

Appendix 1

Sauget Area 2 AOC

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

NOV 24 2000

REPLY TO THE ATTENTION OF
(S-6J)

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mr. Steven D. Smith
Project Coordinator
Solutia, Inc.
575 Maryville Centre Drive
St. Louis, Missouri 63141

Re: Administrative Order by Consent for Sauget Area 2 Site, St. Clair County, Illinois

Dear Mr. Smith:

Enclosed please find an executed copy of the Administrative Order by Consent issued for the Sauget Area 2 Site pursuant to Sections 106 and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9606 and 9622. Thank you for your cooperation in this matter.

If you have any questions regarding this Order, please contact Michael McAteer, Remedial Project Manager, at 312/886-4663.

Sincerely yours,

William E. Muno, Director
Superfund Division

Enclosure

cc: Thomas V. Skinner, Director
Illinois EPA

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

IN THE MATTER OF:	)	Docket No. V-W-'01-C-622
	)	
SAUGET AREA 2 SITE	)	ADMINISTRATIVE ORDER BY
	)	CONSENT PURSUANT TO
SAUGET AND CAHOKIA, ILLINOIS	)	SECTION 106 OF THE
	)	COMPREHENSIVE
	)	ENVIRONMENTAL RESPONSE,
Respondent(s):	)	COMPENSATION, AND
	)	LIABILITY ACT OF 1980,
See Attachment A	)	as amended, 42 U.S.C.
	)	§ 9606(a)
	)	

I. JURISDICTION AND GENERAL PROVISIONS

This Administrative Order by Consent ("the Order") is entered voluntarily by the United States Environmental Protection Agency ("U.S. EPA") and the Respondent(s). The Order is issued pursuant to the authority vested in the President of the United States by Sections 104, 106(a), 107 and 122 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended ("CERCLA"), 42 U.S.C. §§ 9604, 9606(a), 9607 and 9622. This authority has been delegated to the Administrator of the U.S. EPA by Executive Order No. 12580, January 23, 1987, 52 Federal Register 2923, and further delegated to the Regional Administrators by U.S. EPA Delegation Nos. 14-14-A, 14-14-C and 14-14-D, and to the Director, Superfund Division, Region 5, by Regional Delegation Nos. 14-14-A, 14-14-C and 14-14-D.

U.S. EPA sent Special Notice of Liability letters, pursuant to Section 122(e)(1) of CERCLA, 42 U.S.C. § 9622(e)(1), requesting that the action that is the subject of this Order be performed. The Special Notice of Liability letters were sent to parties which were identified by U.S. EPA as potentially responsible. Respondents are the only recipients who responded positively to the Special Notice of Liability Letter. Respondents have joined together to perform the work under this Order as a group calling itself the Sauget Area 2 Sites Group (hereinafter referred to as "Group").

This Order requires the Respondent(s) to conduct a Remedial Investigation and Feasibility Study (RI/FS) for the Site designated as Sauget Area 2 (generally depicted in the figure included in the SOW, attached hereto as Attachment B) located within the Villages of Sauget and Cahokia, St. Clair County, Illinois. Specifically, Respondent(')s(') RI/FS shall gather data and evaluate response actions pursuant to 40 C.F.R. § 300.430(e), to address the environmental concerns in connection with Sauget Area 2 and the source areas within Area 2, designated as Sites O, P, Q, R and S.

A copy of this Order will also be provided to the State of Illinois, which has been notified of the issuance of this Order pursuant to Section 106(a) of CERCLA, 42 U.S.C. § 9606(a). The U.S. EPA has also notified the Federal Natural Resource Trustee of the negotiations in this action pursuant to the requirements of Section 122(j) of CERCLA.

Respondent(')s(') participation in this Order shall not constitute an admission of liability or of U.S. EPA's findings or determinations contained in this Order except in a proceeding to enforce the terms of this Order. Respondent(s) agree to comply with and be bound by the terms of this Order. In any action by U.S. EPA or the United States to enforce the terms of this Consent Order, Respondent(s) consents to and agrees not to contest the authority or jurisdiction of the Regional Administrator to issue or enforce this Consent Order, and agrees not to contest the validity of this Order or its terms.

II. PARTIES BOUND

This Order applies to and is binding upon U.S. EPA, and upon Respondent(s) and Respondent(')s(') heirs, receivers, trustees, successors and assigns. Any change in ownership or corporate status of Respondent(s) including, but not limited to, any transfer of assets or real or personal property shall not alter such Respondent(')s(') responsibilities under this Order. Respondent(s) are jointly and severally liable for carrying out all activities required by this Order. Compliance or noncompliance by one or more Respondent(s) with any provision of this Order shall not excuse or justify noncompliance by any other Respondent.

Respondent(s) shall ensure that their contractors, subcontractors, and representatives receive a copy of this Order, and comply with this Order. Respondent(s) shall be responsible for any noncompliance with this Order.

III. U.S. EPA FINDINGS OF FACT

Based on available information, including the Administrative Record in this matter, U.S. EPA hereby finds, and, for purposes of enforceability of this Order only, the Respondents stipulate only for the purposes of this Order that the factual statutory prerequisites under CERCLA necessary for issuance of this Order have been met. U.S. EPA's findings and this stipulation include the following:

1. The source areas for the Sauget Area 2 Site consist of five known disposal areas adjacent, or in close proximity, to the Mississippi River. The five disposal areas are known as Sites O, P, Q, R and S (see figure in attached SOW). The sites are labeled with letter designations for reference purposes only. The fact that source areas have separate letter designations does not necessarily mean that the areas are separate or distinct in terms of contents, ownership, and/or operating history. The fact that the source areas have been determined to comprise a single Site, Sauget Area 2, does not necessarily mean that the

source areas within Area 2 have the same contents or share the same ownership or operating history.

SITE O: Located on Mobile Avenue in Sauget, Illinois, occupies approximately 20 acres of land to the northeast of the American Bottoms Regional Wastewater Treatment Facility (ABRTF). An access road to the ABRTF runs through the middle of the site. Site O consists of four inactive sludge dewatering lagoons associated with the old Sauget Physical Chemical Wastewater Treatment Plant. Currently, the lagoons are covered with clay and are vegetated. During their operation the treatment plant and the associated lagoons received and treated industrial waste and municipal wastes. Of approximately 10 million gallons per day of wastewater treated at the Sauget Physical Chemical Plant, more than 95% was from area industries. The lagoons operated from approximately 1965 to 1978.

SITE P: Site P occupies approximately 20 acres of land located between the Illinois Central Gulf Railroad and the Terminal Railroad and north of Monsanto Avenue in the Village of Sauget. On information and belief, Site P was operated as a landfill from 1973 to an unknown date in the early 1980s. According to available Illinois EPA records, the landfill accepted "general wastes," including diatomaceous earth filter cake from Edwin Cooper (a/k/a Ethyl Corporation) and nonchemical wastes from Monsanto. Periodic State inspections of Site P also documented that the landfill contained drums labeled "Monsanto ACL-85, Chlorine Composition," drums of phosphorus pentasulfide from Monsanto and Monsanto ACL filter residues and packaging. Site P is currently inactive and covered and access to the site is unrestricted.

SITE Q: Site Q is a former subsurface/surface disposal area which occupies approximately 90 acres. The site is located in the Villages of Sauget and Cahokia, Illinois, and is bordered by Sauget Site R and the old Union Electric Power Plant on the north; the Illinois Central Gulf Railroad and the United States Corps of Engineers (U.S. COE) flood control levee on the east; and the Mississippi River on the west. U.S. EPA conducted a CERCLA removal action at Site Q in 1995. This removal action involved the excavation of PCBs, organics, metals, and dioxin contaminated soils and drums which had been scoured out of the fill area and were spilling directly into the adjacent waters of the Mississippi River. U.S. EPA recovered its costs for this removal in a subsequent administrative settlement. U.S. EPA conducted a second CERCLA removal action at Site Q beginning in October of 1999 and into early 2000. During this removal action, U.S. EPA has excavated more than 2,000 drums and more than 7,000 cubic yards of contaminated soils containing metals, PCBs, and organics. The Mississippi River has flooded and inundated Site Q and Site R (see below) many times during the last several years. Leachate from Site Q has in the past migrated and potentially could continue to migrate into the Mississippi River. Most of Site Q is covered with highly permeable black cinders. Operations for a barge loading facility and construction debris disposal areas now operate on top of parts of Site Q. Access to this site is also unrestricted.

SITE R: Located on the river side of the flood control levee immediately adjacent to the Mississippi River in Sauget, Illinois and just north and west of parts of Site Q, Site R, also known as the "Sauget Toxic Dump," "Monsanto Landfill," and the "River's Edge Landfill," is a former industrial waste subsurface/surface disposal area owned by Solutia, Inc. Site R was used as a disposal area by owner Monsanto for its industrial and chemical wastes from approximately 1957-1977. Samples taken on Site R revealed high levels of organics, PCBs, metals, and dioxins. The organics present in Site R include chlorobenzenes, chlorophenols and analine derivatives. Leachate from the Site R has in the past migrated and potentially could continue to migrate into the Mississippi River. As noted above, the Mississippi River floods parts of Site R on occasion. Access to Site R is restricted by fencing and is monitored by a 24-hour camera. In 1979, Monsanto completed the installation of a clay cover on Site R to cover waste, limit infiltration through the landfill, and prevent direct contact with fill material. The cover's thickness ranges from 2 feet to approximately 8 feet. As constructed, the cover does not provide for permanent containment of the chemical wastes and other contaminants in the landfill. In 1985, Monsanto installed a 2,250 foot long rock revetment along the east bank of the Mississippi River adjacent to Site R. The purpose of the stabilization project was to prevent further erosion of the riverbank and thereby minimize potential for the surficial release of waste material from the landfill. As constructed, the revetment does not provide for the permanent containment of the chemical wastes and other contaminants in the landfill. On February 13, 1992, the State of Illinois and Monsanto signed a consent decree entered in St. Clair County Circuit Court requiring further remedial investigations and feasibility studies to be conducted by Monsanto on Site R. The results of the Remedial Investigation/Feasibility Study were submitted to Illinois EPA in 1994. As of the date of this Order, a final remedy for the Site has still not been determined.

SITE S: Site S is located on Village of Sauget property and is situated to the west-southwest of Site O. Historic aerial photographs indicate that Site S was a drum disposal area. In 1995, Illinois EPA took samples at the Site. The Site S sample results indicated the presence of high levels of BNAs, pesticides, PCBs, and metals. PCBs were found in every sample. The northern portion of Site S is grassed and the southern portion of the Site is covered with gravel and fenced.

2. Information on the types of wastes disposed of and the types and levels of contamination found at the Sauget Area 2 Site have been compiled from a variety of cited sources and are listed in a document entitled "Volume 2, Sauget Area 2 - Data Tables/Maps" completed for U.S. EPA by Ecology & Environment, Inc., and dated February 1998.

Known contaminants at the Sauget Area 2 Site are as follows:

SITE O: Soil samples collected from Site O have revealed elevated levels of volatile organic compounds (VOCs) such as 1,1,1 trichloroethane (1,410 ppb), benzene (30,769

ppb), 4-methyl-2-pentanone (7,692 ppb), toluene (29,487 ppb), chlorobenzene (58,974 ppb), ethylbenzene (166,667E ppb), and total xylenes (615,385E ppb). Elevated levels of semi-volatile organics (SVOCs) were also detected including 1,4-dichlorobenzene (112,821 ppb), 1,2-dichlorobenzene (606,000 ppb), 1,4-dichlorobenzene (1,030,000 ppb), 1,2,4-trichlorophenol (26,923 ppb), naphthalene (34,615 ppb), 2-methylnaphthalene (160,256 ppb), n-nitrosodiphenylamine (50,000J ppb), pentachlorophenol (1,620,000 ppb), phenanthrene (230,000 ppb), fluoranthene (74,000 ppb), pyrene (282,051 ppb), butyl benzyl phthalate (3,846,154E ppb), benzo(a)anthracene (121,795 ppb), 1,2,4-trichlorobenzene (65.3 ppm) and chrysene (282,051 ppb). Elevated levels of PCBs were also detected in Site O soils including aroclor 1232 (30,366 ppb) and aroclor 1242 (1,871,795 ppb). Elevated levels of dioxins were also detected in Site O soils including tetrachlorodibenzo-p-dioxin (170 ng/g). Elevated levels of heavy metals were also detected in Site O soils including cadmium (31 ppm), copper (341 ppm), mercury (6.3 ppm), nickel (136 ppm) and zinc (1,398 ppm).

Groundwater samples collected from Site O have indicated the presence of elevated levels of VOCs including methylene chloride (52,000 ppb), trans-1,2-dichloroethene (14,000 ppb), 2-butanone (62,000 ppb), trichloroethene (83,000 ppb), benzene (190,000 ppb), 4-methyl-2-pentanone (38,000 ppb), tetrachloroethene (10,000 ppb), 1,1,2,2-tetrachoroethane (12,000 ppb), toluene (15,000 ppb), and chlorobenzene (180,000E ppb). Elevated levels of SVOCs were also detected in groundwater at Site O including phenol (1,100 ppb), 1,4-dichlorobenzene (15,000E ppb), 1,2-dichlorobenzene (11,000E ppb), 4-methylphenol (1,100 ppb), and 4-chloroanaline (780 ppb). Elevated levels of heavy metals have also been detected in groundwater at Site O including arsenic (133 ppb), cadmium (11 ppb), and lead (6,350 ppb).

SITE P: Soil samples collected from Site P have revealed elevated levels of VOCs such as toluene (413 ppb), and total xylenes (450 ppb). Elevated levels of SVOCs were also detected including phenol (3,875J ppb), 1,4-dichlorobenzene (8,875J ppb), 1,2-dichlorobenzene (3,625J ppb) and di-n-butyl phthalate (16,250J ppb). Elevated levels of metals were also found in soils, such as lead (526 ppm), mercury (3.9 ppm) and cyanide (15 ppm).

SITE Q: Soil samples collected from Site Q have revealed elevated levels of organic compounds including 1,4-dichlorobenzene (1,200,000 ppb), bis(2-ethylhexyl)phthalate (1,100,000 ppb), di-n-butyl phthalate (900,000 ppb), chlorobenzene (100,000 ppb), ethylbenzene (790,000 ppb), toluene (2,400,000 ppb), 4-methyl-2-pentanone (250,000 ppb), and o-xylene (2,300,000 ppb). Elevated levels of PCBs were also detected in Site Q soils including aroclor 1254 (360,000 ppb), aroclor 1248 (70,000 ppb), and aroclor 1260 (16,000,000 ppb). An elevated level of 2,3,7,8-TCDD (dioxin) was also detected in Site Q soil at a concentration of 3.31 ppb. Elevated levels of heavy metals were also detected in soil samples collected from Site Q including antimony (17,900N ppm), arsenic (216 NS ppb), cadmium (152,000 ppm), chromium (3,650 ppm), copper (1,630

ppm), lead (195,000 ppm), mercury (4.9 ppm), nickel (371 N ppm), selenium (59.9 ppm), silver (30.2 N ppm), thallium (.89 B ppm), and zinc (9,520 ppm).

Groundwater samples collected from Site Q have revealed the presence of elevated levels of VOCs including 1,2 dichloroethane (3,000 ppb), benzene (2,000J ppb), 4-methyl-2-pentanone (2,700J ppb), 2-hexanone (3,500J ppb), toluene (1,600J ppb), and chlorobenzene (6,700J ppb). Elevated levels of SVOCs were also detected including phenol (190,000E ppb), 2-chlorophenol (33,000E ppb), 4-methylphenol (23,000E ppb), 2,4-dimethylphenol (2,800 ppb), 2,4-dichlorophenol (14,000E ppb), 4-chloroaniline (15,000E ppb), 2,4,6-trichlorophenol (6,000 ppb), 2-nitroaniline (2,000 ppb), pentachlorophenol (35,000E ppb), and acenaphthylene (3,900 ppb). Elevated levels of arsenic (100 ppb) and cyanide (1,560 ppb) were also detected in Site Q groundwater.

Site R: This site has been sampled extensively by U.S. EPA, Illinois EPA, and Monsanto starting in the early 1980s. A summary of the data collected at Site R are presented here. Sediment samples collected from a drainage ditch surrounding Site R showed VOC concentrations ranging from .002 to .035 ppm. SVOC concentrations in sediments ranged from .045 to 3.99 ppm. PCBs were detected at concentrations ranging from .08 to 1.5 ppm. Elevated levels of metals, particularly aluminum, iron and magnesium were also detected. Sediment samples collected adjacent to the Mississippi River on the west side of Site R showed SVOC contamination ranging from .001 to 7.7 ppm. PCBs were also detected at concentrations ranging from .00001 to .23 ppm. Soil samples collected from Site R showed elevated levels of VOCs ranging from .15 to 5,800 ppm. SVOCs were found at levels ranging from .017 to 19,000 ppm. Pesticides were found at levels ranging from .011 to 99 ppm and PCBs were detected at levels ranging from .075 to 4,800 ppm. Elevated levels of arsenic, chromium, lead, nickel and mercury were also detected in Site R soils.

Leachate samples located directly east of Site R adjacent to the Mississippi River were also collected. SVOC concentrations in the leachate ranged from .6 to 12.3 ppb. Pesticide concentrations ranged from .5 to 3.0 ppb and PCBs were detected at .08 ppb. Dioxin/furan concentrations ranged from .0001 to .0014 ppm. Cyanide was also detected at 71 ppb. Surface water samples were also collected from the adjacent waters of the Mississippi River near Site R, dioxins were found in the water ranging in concentration from .0001 to .0007 ppm.

Extensive groundwater investigations have also been conducted at Site R. Samples collected from wells on and immediately downgradient of Site R have shown high levels of VOCs in concentrations up to 38,136 ppb. SVOC concentrations have also been detected as high as 2,973,885 ppb.

Site S: Soil samples collected from Site S have shown elevated concentrations of VOCs including 1,1,1-trichloroethane (12,000 ppb), 4-methyl-2-pentanone (93,000 ppb),

toluene (990,000 ppb), ethylbenzene (450,000 ppb), and total xylene (620,000 ppb). Elevated levels of SVOCs were also detected including naphthalene (200,000 ppb), di-n-butyl phthalate (1,500,000J ppb), butyl benzyl phthalate (490,000J ppb), bis(2-ethylhexyl)phthalate (20,000,000J ppb), and di-n-octyl phthalate (310,000 ppb). PCBs were also detected at elevated concentrations including aroclor 1248 (85,000pc ppb), aroclor 1254 (69,000c ppb), and aroclor 1260 (41,000pc ppb). Elevated levels of heavy metals were also detected in Site S soils including copper (139 ppm), lead (392 ppb), mercury (3.5 ppm), and zinc (327 ppm).

3. On information and belief, parties which generated wastes which were disposed of, released into and/or transported wastes to the Sauget Area 2 Site, include, but are not limited to, the following:

SITE O: Rogers Cartage Company, Midwest Rubber Reclaiming (Division of Empire Chem., Inc.), Amax Zinc Corporation, Mobil Oil Corporation, Monsanto Chemical Company, Ethyl Corporation, Ethyl Petroleum Additives, Inc., and Clayton Chemical Co. (Division of Emerald Environmental, LLC.), Cerro Copper Products Company, Blue Tee Corp., Gold Fields American Corporation, American Zinc, Lead and Smelting Company; American Zinc Company, and Wiese Planning and Engineering.

SITE P: Monsanto Chemical Company, Kerr-McGee Chemical Corporation, and Edwin Cooper.

SITE Q and/or R: Monsanto Chemical Company, Barry Weinmiller Steel Fabrication, Crown Cork & Seal Company, Inc., Dennis Chemical Company, Inc., Inmont Corporation, U.S. Paint Corporation, Kerr McGee Chemical Corporation, Dow Chemical, Mallinckrodt Chemical, Myco-Gloss, Clayton Chemical Company, United Technologies Corporation, AALCO Wrecking Company, Inc., Abco Trash Service & Equip. Company, Able Sewer Service, Ajax Hickman Hauling, Amax Zinc, Atlas Service Company, Banjo Iron Company, Becker Iron & Metal Corporation, Belleville Concrete Cont. Company, Bi-State Parks Airport, Bi-State Transit Company, Boyer Sanitation Service, Browning-Ferris Industries of St. Louis, C&E Hauling, Cargill Inc., Century Electric Company, Circle Packing Company, Corkery Fuel Company, David Hauling, State of Illinois Department of Transportation, Disposal Service Company, Dore Wrecking Company, Dotson Disposal "All" Service, Edgemont Construction, Edwin Cooper Inc., Eight & Trendy Metal Company, Evans Brothers, Finer Metals Company, Fish Disposal, Fruin-Colnon Corporation, Gibson Hauling, H.C. Fournie Inc., H.C. Fournie Plaster, Hilltop Hauling, Huffmeier Brothers, Hunter Packing Company, Lefton Iron & Metal Company, Midwest Sanitation, Mississippi Valley Control, Obear Nestor, Roy Baur, Thomas Byrd, and Trash Men Inc.

SITE S: Clayton Chemical Co. (Division of Emerald Environmental, LLC.)

NON SITE-SPECIFIC GENERATORS/TRANSPORTERS: Rogers Cartage Company, Browning Ferris Industries, Inc., Browning Ferris Industries of St. Louis, Inc., C&E Hauling Company, Disposal Services Company, Hilltop Hauling, Inc., Paul Sauget, and National Vendors

4. On information and belief, parties which own and/or operate, or previously owned and/or operated, portions of the waste disposal areas at Sauget Area 2 include, but are not limited to, the following:

SITE O: Village of Sauget and the Sauget Sanitary Development and Research Assn.

SITE P: Solutia, Inc., Chicago Title & Trust Company (Trust numbers 1083190 and 1083190), City of East St. Louis, Gulf-Mobile & Ohio Railroad, Southern Railway System, Magna Trust Company (Trust numbers 03-90-0744-00 and 22-358), Metro East Sanitary District, Norfolk Southern Corp., SI Enterprises L.P., Union Electric Company, and Cahokia Trust Properties and Sauget and Company.

SITE Q: Alton & Southern Railroad, Village of Cahokia, Monsanto Company, Norfolk Southern Corporation, Notre Dame Fleeting and Towing Services, Patgood Inc., Phillips Pipe Line Company, Pillsbury Company (leasee), River Port Terminal and Fleeting Company, Village of Sauget, St. Louis Grain Company, Union Electric Company, Cahokia Trust Properties, Eagle Marine Industries Inc., Sauget & Company (c/o Paul Sauget), Industrial Salvage & Disposal Company, Clayton Chemical Company, Con-Agra, Inc., and Peavey Company.

SITE R: Monsanto Chemical Company, Solutia, Inc., Cahokia Trust Properties and Sauget and Company.

SITE S: A-1 Oil Corporation, Russell Bliss, Bliss Waste Oil Inc., Chemical Waste Management, Onyx Environmental Services, Norfolk Southern Corporation, Village of Sauget, Monsanto Chemical Company, and Clayton Chemical Co. (Division of Emerald Environmental LLC).

IV. CONCLUSIONS OF LAW AND DETERMINATIONS

Based on the U.S. EPA's Findings of Fact set forth above, and the Administrative Record in this matter, U.S. EPA has determined that:

1. The Sauget Area 2 Site is a "facility" as defined by Section 101(9) of CERCLA, 42 U.S.C. § 9601(9).

2. The substances described in Section III, paragraph 2 are "hazardous substances" as defined by Section 101(14) of CERCLA, 42 U.S.C. § 9601(14).

3. Each Respondent is a "person" as defined by Section 101(21)of CERCLA, 42 U.S.C. § 9601(21).

4. Respondent(s) listed in Section III, paragraph 4, are the past and present "owners or operators" of the Sauget Area 2 Site, as defined by Section 101(20) of CERCLA, 42 U.S.C. § 9601(20). The Respondent(s) listed in Section III, paragraph 3, are persons who generated or who arranged for disposal or transport for disposal of hazardous substances at one or more source areas within the Sauget Area 2 Site. Respondent(s) are therefore liable persons under Section 107(a) of CERCLA, 42 U.S.C. § 9607(a).

5. The conditions described in the U.S. EPA's Findings of Fact above constitute an actual or threatened "release" into the "environment" as defined by Sections 101(8) and (22) of CERCLA, 42 U.S.C. §§ 9601(8) and (22).

6. The conditions present at the Site constitute a threat to public health, welfare, or the environment based upon the factors set forth in Section 300.415(b)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan, as amended ("NCP"), 40 C.F.R. Part 300. These factors include, but are not limited to, the following:

a. actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants or contaminants; this factor is present at the Site due to the presence of elevated levels of contaminants, including VOCs, SVOCs, PCBs, dioxins, pesticides, and metals, in the surface soils and sediments of the disposal areas of the Site (i.e., Sites O, P, Q, R and S).

b. actual or potential contamination of drinking water supplies or sensitive ecosystems; this factor is present at the Site due to the presence of elevated levels of contaminants, including VOCs, SVOCs, and metals, in groundwater. The source of drinking water for local residents is assumed to be primarily from surface water sources located upstream of the Site. Despite the fact that the Villages of Cahokia and Sauget have ordinances prohibiting the use of groundwater as a potable water supply, many residences in the Cahokia area continue to use private wells for domestic uses. Contaminated groundwater is discharging into the adjacent waters of the Mississippi River. The Mississippi River contains a variety of ecosystems which may be damaged by the types of contamination found at Sauget Area 2. The closest intake for drinking water supplies along the Mississippi River is approximately 65 miles downstream from the St. Louis Metro area at Chester, Illinois.

c. high levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface, that may migrate; this factor is present at the Site due to the existence of elevated levels of VOCs, SVOCs, PCBs, dioxins, pesticides and metals in soil at the Site.

d. weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released; this factor is present at the Site due to existence of elevated levels of VOCs,

SVOCs, PCBs, dioxins, pesticides and metals in the soils within each component of Sauget Area 2 (Sites O, P, Q, R and S) which may be released directly into the Mississippi River as a result of flooding on the River. Those areas most vulnerable to inundation by the Mississippi River are Sites Q and R which are situated within the river-side of the Corps of Engineers' flood control levee. In 1995, during a major flood event on the Mississippi River, drums of waste material (PCBs) were scoured out of the side of Site Q and were washed into the River and along the bank of the River.

7. The actual or threatened release of hazardous substances from the Site may present an imminent and substantial endangerment to the public health, welfare, or the environment within the meaning of Section 106(a) of CERCLA, 42 U.S.C. § 9606(a).

8. The actions required by this Order, if properly performed, are consistent with the NCP, 40 C.F.R. Part 300, as amended, and with CERCLA, and are reasonable and necessary to protect the public health, welfare, and the environment.

V. ORDER

Based upon the foregoing Findings of Fact, Conclusions of Law and Determinations, and the Administrative Record for this Site, it is hereby ordered and agreed that Respondent(s) shall comply with the following provisions, including but not limited to all attachments to this Order, and all documents incorporated by reference into this Order, and perform the following actions:

1. Designation of Contractor, Project Coordinator, On-Scene Coordinator or Remedial Project Manager

Respondent(s) shall perform the actions required by this Order themselves and/or retain a contractor to undertake and complete the requirements of this Order. Respondent(s) shall notify U.S. EPA of Respondent(')s(') qualifications and/or the name and qualifications of contractor(s) which Respondents will be considering to use to complete the requirements of this Order, as applicable, within 10 business days of the effective date of this Order. Respondent(s) shall also notify U.S. EPA of the name and qualifications of any other contractors or subcontractors retained to perform work under this Order at least 5 business days prior to commencement of such work. U.S. EPA retains the right to disapprove of the Respondent(s) or any of the contractors and/or subcontractors retained by the Respondent(s) within 10 days of notification of the Respondent(s). If U.S. EPA disapproves a selected contractor, Respondent(s) shall retain a different contractor within 10 business days following U.S. EPA's disapproval, and shall notify U.S. EPA of that contractor's name and qualifications within 15 business days of U.S. EPA's disapproval.

Within 5 business days after the effective date of this Order, the Respondent(s) shall designate a Project Coordinator who shall be responsible for administration of all the Respondent(')s(') actions required by the Order. Respondent(s) shall submit the designated coordinator's name, address, telephone number, and qualifications to U.S. EPA. U.S. EPA retains the right to disapprove of any

Project Coordinator named by the Respondent(s) within 10 days of notification by the Respondent(s). If U.S. EPA disapproves a selected Project Coordinator, Respondent(s) shall retain a different Project Coordinator within 10 business days following U.S. EPA's disapproval and shall notify U.S. EPA of that person's name and qualifications within 10 business days of U.S. EPA's disapproval. Receipt by Respondent(')s(') Project Coordinator of any notice or communication from U.S. EPA relating to this Order shall constitute receipt by all Respondent(s).

The U.S. EPA has designated Michael McAteer of the Remedial Response Branch, Region 5, as its Remedial Project Manager ("RPM"). Respondent(s) shall direct all submissions required by this Order to the RPM at 77 West Jackson Boulevard (SR-6J), Chicago, Illinois 60604-3590, by certified or express mail. Respondent(s) shall also send a copy of all submissions to Thomas Martin, Associate Regional Counsel, 77 West Jackson Boulevard, (C-14J), Chicago, Illinois, 60604-3590. All Respondent(s) are encouraged to make their submissions to U.S. EPA on recycled paper (which includes significant postconsumer waste paper content where possible) and using two-sided copies, and, at U.S. EPA request, on CD ROM disks.

U.S. EPA and Respondent(s) shall have the right, subject to the immediately preceding paragraph, to change their designated RPM or Project Coordinator. U.S. EPA shall notify the Respondent(s), and Respondent(s) shall notify U.S. EPA, as early as possible before such a change is made, but in no case less than 24 hours before such a change. The initial notification may be made orally but it shall be promptly followed by a written notice within two business days of oral notification.

2. Work to Be Performed

Respondent(s) shall develop and submit to U.S. EPA an RI/FS report (Task 3 of the SOW) in accordance with the attached Scope of Work ("SOW"). The attached SOW is incorporated into and made an enforceable part of this Order.

The RI/FS report shall be consistent with, at a minimum, the U.S. EPA guidance entitled, "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (U.S. EPA, Office of Emergency and Remedial Response, October 1988) and any other guidance that U.S. EPA uses in conducting an RI/FS.

2.1 RI/FS Support Sampling Plan

Within 90 calendar days of the effective date of this Order, the Respondent(s) shall submit to U.S. EPA for approval a draft RI/FS Support Sampling Plan (Task 1 of the SOW) that is consistent with this Order and the SOW.

U.S. EPA may approve, disapprove, require revisions to, or modify the draft RI/FS Support Sampling Plan. If U.S. EPA requires revisions, Respondent(s) shall submit a revised Support Sampling Plan incorporating all of U.S. EPA's required revisions within 30 calendar days of receipt of U.S. EPA's notification of the required revisions.

In the event of U.S. EPA disapproval of the revised Support Sampling Plan, Respondent(s) may be deemed in violation of this Order; however, approval shall not be unreasonably withheld by U.S. EPA. In such event, U.S. EPA retains the right to terminate this Order, conduct a complete Support Sampling Plan and the sampling activities, and obtain reimbursement for costs incurred in conducting the plan and the sampling activities from the Respondent(s).

Respondent(s) shall not commence or undertake any support sampling activities at the Site without prior U.S. EPA approval.

2.1.1 Health and Safety Plan

As part of the RI/FS Support Sampling Plan, the Respondent(s) shall submit for U.S. EPA review and comment a plan that ensures the protection of the public health and safety (Task 1, Section D, of the SOW) during performance of on-site work under this Order. This plan shall comply with applicable Occupational Safety and Health Administration ("OSHA") regulations found at 29 C.F.R. Part 1910. If U.S. EPA determines it is appropriate, the plan shall also include contingency planning. Respondent(s) shall incorporate all changes to the plan recommended by U.S. EPA, and implement the plan during the pendency of the support sampling.

2.1.2 Quality Assurance and Sampling

As part of the RI/FS Support Sampling Plan, the Respondent(s) shall ensure that all sampling and analyses performed pursuant to this Order conforms to U.S. EPA direction, approval, and guidance regarding sampling, quality assurance/quality control ("QA/QC"), data validation, and chain of custody procedures. Respondent(s) shall ensure that the laboratory used to perform the analyses participates in a QA/QC program that complies with U.S. EPA guidance.

Upon request by U.S. EPA, Respondent(s) shall have such a laboratory analyze samples submitted by U.S. EPA for quality assurance monitoring. Respondent(s) shall provide to U.S. EPA the quality assurance/quality control procedures followed by all sampling teams and laboratories performing data collection and/or analysis. Respondent(s) shall also ensure provision of analytical tracking information consistent with, at a minimum, OSWER Directive No. 9240.0-2B, "Extending the Tracking of Analytical Services to PRP-Lead Superfund Sites."

Upon request by U.S. EPA, Respondent(s) shall allow U.S. EPA or its authorized representatives to take split and/or duplicate samples of any samples collected by Respondent(s) or its (their) contractors or agents while performing work under this Order. Respondent(s) shall notify U.S. EPA not less than 10 business days in advance of any sample collection activity. U.S. EPA shall have the right to take any additional samples that it deems necessary.

2.2 RI/FS Report

Within 12 months after the collection of the last field sample as part of the Remedial Investigation (Task 2), the Respondent(s) shall submit to U.S. EPA for approval a draft RI/FS Report (Task 3 of the SOW) that is consistent with this Order and the SOW.

U.S. EPA may approve, disapprove, require revisions to, or modify the draft RI/FS Report. If U.S. EPA requires revisions, Respondent(s) shall submit a revised RI/FS Report incorporating all of U.S. EPA's required revisions within 30 days of receipt of U.S. EPA's notification of the required revisions.

In the event of U.S. EPA disapproval of the revised RI/FS Report, Respondent(s) may be deemed in violation of this Order; however, approval shall not be unreasonably withheld by U.S. EPA. In such event, U.S. EPA retains the right to terminate this Order, conduct a complete RI/FS, and obtain reimbursement for costs incurred in conducting the RI/FS from the Respondent(s).

The revised report shall also include the following certification signed by a person who supervised or directed the preparation of that report:

> Under penalty of law, I certify that, to the best of my knowledge, after appropriate inquiries of all relevant persons involved in the preparation of this RI/FS Report, the information submitted is true, accurate, and complete.

Respondent(s) shall not commence or undertake any remedial actions at the Site without prior U.S. EPA approval.

2.4 Reporting

Respondent(s) shall submit a monthly written progress report to U.S. EPA concerning actions undertaken pursuant to this Order, beginning 30 calendar days after the effective date of this Order, until termination of this Order, unless otherwise directed in writing by the RPM. These reports shall describe all significant developments during the preceding period, including the work performed and any problems encountered, analytical data received during the reporting period, and developments anticipated during the next reporting period, including a schedule of work to be performed, anticipated problems, and planned resolutions of past or anticipated problems.

Any Respondent that owns any portion of the Sauget Area 2 Site shall, at least 30 days prior to the conveyance of any interest in real property at the Site, give written notice of this Order to the transferee and written notice of the proposed conveyance to U.S. EPA and the State. The notice to U.S. EPA and the State shall include the name and address of the transferee. The party conveying such an interest shall require that the transferee will provide access as described in Section V.3 (Access to Property and Information).

2.5 Additional Work

In the event that the U.S. EPA or the Respondent(s) determine(s) that additional work is necessary to accomplish the objectives of the RI/FS Report, notification of such additional work shall be provided to the other part(y)(ies) in writing at least 10 days prior to the date the work must begin. Upon request of the Respondent(s), U.S. EPA's time frame for the initiation of additional work may be extended for good cause. Any additional work which Respondent(s) determine(s) to be necessary shall be subject to U.S. EPA's written approval prior to commencement of the additional work. Respondent(s) shall complete, in accordance with standards, specifications, and schedules U.S. EPA has approved, any additional work Respondent(s) has (have) proposed, and which U.S. EPA has approved in writing or that U.S. EPA has determined to be necessary, and has (have) provided written notice of pursuant to this paragraph.

If the Respondent(s) disagree(s) with the U.S. EPA over the necessity for an additional work item(s) or the required schedule, the Respondent(s) have the right to appeal such disputes under Section VIII, Dispute Resolution. Stipulated penalties shall accrue, but need not be paid, during the dispute resolution period concerning the specific penalties at issue. If Respondents prevail upon resolution, Respondents shall pay only penalties as the resolution requires. In its unreviewable discretion, U.S. EPA may waive its right to demand all or a portion of the stipulated penalties due.

3. Access to Property and Information

Respondent(s) shall provide or obtain access to the Site and off-site areas to which access is necessary to implement this Order, and shall provide access to all records and documentation related to the conditions at the Site and the actions conducted pursuant to this Order. Such access shall be provided to U.S. EPA employees, contractors, agents, consultants, designees, representatives, and State of Illinois representatives. These individuals shall be permitted to move freely at the Site and appropriate off-site areas to which Respondent(s) have access in order to conduct actions which U.S. EPA determines to be necessary. Respondent(s) shall submit to U.S. EPA, upon receipt, the results of all sampling or tests and all other data generated by Respondent(s) or its (their) contractor(s), or on the Respondent(')s(') behalf during implementation of this Order.

Where work or action under this Order is to be performed in areas owned by or in possession of someone other than Respondent(s), Respondent(s) shall use its (their) best efforts to obtain all necessary access agreements within 10 calendar days after U.S. EPA approval of the RI/FS Support Sampling Plan (Task 1), or as otherwise specified in writing by the RPM. Respondent(s) shall immediately notify U.S. EPA within 2 business days if, after using its (their) best efforts, it is (they are) unable to obtain such agreements. Respondent(s) shall describe in writing its (their) efforts to obtain access. U.S. EPA may, in its discretion, then assist Respondent(s) in gaining access, to the extent necessary to effectuate the actions described herein, using such means as

U.S. EPA deems appropriate. Respondent(s) shall reimburse U.S. EPA for all costs and attorneys fees incurred by the United States in obtaining such access.

4. Record Retention, Documentation, Availability of Information

Respondent(s) shall preserve all documents and information in their possession relating to work performed under this Order, or relating to the hazardous substances found on or released from the Site, for six years following completion of the actions required by this Order. At the end of this six-year period and at least 60 days before any document or information is destroyed, Respondent(s) shall notify U.S. EPA that such documents and information are available to U.S. EPA for inspection, and upon request, shall provide the originals or copies of such documents and information to U.S. EPA. In addition, Respondent(s) shall provide copies of any such non-privileged documents and information retained under this Section at any time before expiration of the six-year period at the written request of U.S. EPA.

If Respondent(s) assert a privilege in lieu of providing documents, they shall provide U.S. EPA with the following: (1) the title of the document, record, or information; (2) the date of the document, record, or information; (3) the name and title of the author of the document, record, or information; (4) the name and title of each addressee and recipient; (5) a description of the contents of the document, record, or information; and (6) the privilege asserted by Respondent(s). However, no documents, reports, or other information created or generated pursuant to the requirements of this Order shall be withheld on the grounds that they are privileged.

5. Off-site Shipments

All hazardous substances, pollutants or contaminants removed off-site pursuant to this Order for treatment, storage or disposal shall be treated, stored, or disposed of at a facility in compliance, as determined by U.S. EPA, with the U.S. EPA Revised Off-Site Rule, 40 C.F.R. § 300.440.

6. Compliance With Other Laws

Respondent(s) shall perform all activities required pursuant to this Order in accordance with all the requirements of all federal and state laws and regulations. U.S. EPA has determined that the activities contemplated by this Order are consistent with the National Contingency Plan ("NCP").

Except as provided in Section 121(e) of CERCLA and the NCP, no permit shall be required for any portion of the activities conducted entirely on-site. Where any portion of the activities requires a federal or state permit or approval, the Respondent(s) shall submit timely applications and take all other actions necessary to obtain and to comply with all such permits or approvals.

This Order is not, and shall not be construed to be, a permit issued pursuant to any federal or state statue or regulation.

7. Emergency Response and Notification of Releases

If any incident, or change in Site conditions, during the activities conducted pursuant to this Order causes or threatens to cause an additional release of hazardous substances from the Site or an endangerment to the public health, welfare, or the environment, the Respondent(s) shall immediately take all appropriate action to prevent, abate or minimize such release or endangerment caused or threatened by the release. Respondent(s) shall also immediately notify the RPM or, in the event of his unavailability, shall notify the Regional Duty Officer, Emergency Response Branch, Region 5 at (312) 353-2318, of the incident or Site conditions. If Respondent(s) fail(s) to respond, U.S. EPA may respond to the release or endangerment and reserves the right to recover costs associated with that response.

Respondent(s) shall submit a written report to U.S. EPA within 7 business days after each release, setting forth the events that occurred and the measures taken or to be taken to mitigate any release or endangerment caused or threatened by the release and to prevent the recurrence of such a release. Respondent(s) shall also comply with any other notification requirements, including those in CERCLA Section 103, 42 U.S.C. § 9603, and Section 304 of the Emergency Planning and Community Right-To-Know Act, 42 U.S.C. § 11004.

VI. AUTHORITY OF THE U.S. EPA REMEDIAL PROJECT MANAGER

The RPM shall be responsible for overseeing the implementation of this Order. The RPM shall have the authority vested in an RPM by the NCP, including the authority to halt, conduct, or direct any activities required by this Order, or to direct any other response action undertaken by U.S. EPA or Respondent(s) at the Site. Absence of the RPM from the Site shall not be cause for stoppage of work unless specifically directed by the RPM.

VII. REIMBURSEMENT OF OVERSIGHT COSTS FOR RI/FS

Respondent(s) shall pay all oversight costs of the United States related to the Site that are not inconsistent with the NCP.

U.S. EPA will send Respondent(s) a bill for "oversight costs" on an annual basis. U.S. EPA's bill will include an Itemized Cost Summary. "Oversight costs" are all costs, including, but not limited to, direct and indirect costs, that the United States incurs in reviewing or developing plans, reports and other items pursuant to this Order. "Oversight costs" shall also include all costs, including direct and indirect costs, paid by the United States in connection with the Site.

Respondent(s) shall, within 45 calendar days of receipt of a bill, remit a cashier's or certified check for the amount of the bill made payable to the "Hazardous Substance Superfund," to the following address:

U.S. Environmental Protection Agency
Superfund Accounting
P.O. Box 70753
Chicago, Illinois 60673

Respondent(s) shall simultaneously transmit a copy of the check to the Director, Superfund Division, U.S. EPA Region 5, 77 West Jackson Blvd., Chicago, Illinois, 60604-3590. Payments shall be designated as "Response Costs - Sauget Area 2 Site" and shall reference the payor(')s(') name and address, the EPA site identification number (05XX/0558), and the docket number of this Order.

In the event that any payment is not made within the deadlines described above, Respondent(s) shall pay interest on the unpaid balance. Interest is established at the rate specified in Section 107(a) of CERCLA, 42 U.S.C. § 9607(a). The interest shall begin to accrue on the 45th day after the Respondent's receipt of the bill. Interest shall accrue at the rate specified through the date of the payment. Payments of interest made under this paragraph shall be in addition to such other remedies or sanctions available to the United States by virtue of Respondent(')(s)(') failure to make timely payments under this Section.

If any dispute over costs is resolved before payment is due, the amount due will be adjusted as necessary. If the dispute is not resolved before payment is due, Respondent(s) shall pay the full amount of the uncontested costs into the Hazardous Substance Fund as specified above on or before the due date. Within the same time period, Respondent(s) shall pay the full amount of the contested costs into an interest-bearing escrow account. Respondent(s) shall simultaneously transmit a copy of both checks to the RPM. Respondent(s) shall ensure that the prevailing party or parties in the dispute shall receive the amount upon which they prevailed from the escrow funds plus interest within 20 calendar days after the dispute is resolved.

VIII. DISPUTE RESOLUTION

The parties to this Order shall attempt to resolve, expeditiously and informally, any disagreements concerning this Order.

If the Respondent(s) object(s) to any U.S. EPA action taken pursuant to this Order, including billings for costs, the Respondent(s) shall notify U.S. EPA in writing of its (their) objection(s) within 14 calendar days of such action, unless the objection(s) has (have) been informally resolved. This written notice shall include a statement of the issues in dispute, the relevant facts upon which the dispute is based, all factual data, analysis or opinion supporting Respondent(')s(') position, and all supporting documentation on which the Respondent(s) rely (hereinafter the "Statement of Position").

U.S. EPA and Respondent(s) shall within 15 calendar days of U.S. EPA's receipt of the Respondent(')(s)(') Statement of Position, attempt to resolve the dispute through formal negotiations (Negotiation Period). The Negotiation Period may be extended at the sole discretion of U.S. EPA. U.S. EPA's decision regarding an extension of the Negotiation Period shall not constitute a U.S. EPA action subject to dispute resolution or a final Agency action giving rise to judicial review.

An administrative record of any dispute under this Section shall be maintained by U.S. EPA. The record shall include the written notification of such dispute, and the Statement of Position served pursuant to the preceding paragraph.

Any agreement reached by the parties pursuant to this Section shall be in writing, signed by all parties, and shall upon the signature by the parties be incorporated into and become an enforceable element of this Order. If the parties are unable to reach an agreement within the Negotiation Period, the Director of the Superfund Division of Region 5, U.S. EPA will issue a written decision on the dispute to the Respondent(s). The decision of U.S. EPA shall be incorporated into and become an enforceable element of this Order upon Respondent(')(s)(') receipt of the Division Director's decision regarding the dispute.

Respondent(')(s)(') obligations under this Order shall not be tolled by submission of any objection for dispute resolution under this Section. Following resolution of the dispute, as provided by this Section, Respondent(s) shall fulfill the requirement that was the subject of the dispute in accordance with the agreement reached or with U.S. EPA's decision, whichever occurs. No U.S. EPA decision made pursuant to this Section shall constitute a final Agency action giving rise to judicial review.

IX. FORCE MAJEURE

Respondent(s) agree(s) to perform all requirements under this Order within the time limits established under this Order, unless the performance is delayed by a force majeure. For purposes of this Order, a force majeure is defined as any event arising from causes beyond the control of Respondent(s) or of any entity controlled by Respondent(s), including but not limited to its (their) contractors and subcontractors, that delays or prevents performance of any obligation under this Order despite Respondent(')(s)(') best efforts to fulfill the obligation. Force majeure does not include financial inability to complete the work or increased cost of performance.

Respondent(s) shall notify U.S. EPA orally within 24 hours after Respondent(s) become aware of any event that Respondent(s) contend(s) constitute a force majeure, and in writing within 7 calendar days after Respondent(s) become aware of any events which constitute a force majeure. Such notice shall: identify the event causing the delay or anticipated delay; estimate the anticipated length of delay, including necessary demobilization and re-mobilization; state the measures taken or to be taken to minimize the delay; and estimate the timetable for implementation of the measures. Respondent(s) shall take all reasonable measures to avoid and minimize the delays. Failure to comply with the notice provision of this Section shall be grounds for U.S. EPA

to deny Respondent(s) an extension of time for performance. Respondent(s) shall have the burden of demonstrating by a preponderance of the evidence that the event is a force majeure, that the delay is warranted under the circumstances, and that best efforts were exercised to avoid and mitigate the effects of the delay.

If U.S. EPA determines a delay in performance of a requirement under this Order is or was attributable to a force majeure, the time period for performance of that requirement shall be extended as deemed necessary by U.S. EPA. Such an extension shall not alter Respondent (')s(') obligation to perform or complete other tasks required by the Order which are not directly affected by the force majeure.

X. STIPULATED AND STATUTORY PENALTIES

For each calendar day, or portion thereof, that Respondent(s) fail(s) to fully perform any requirement of this Order in accordance with the schedule established pursuant to this Order, Respondent(s) shall be liable as follows:

Deliverable/Activity	Penalty For Days 1-7	Penalty For ≥ 7 Days
Failure to Submit a Draft Support Sampling Plan, or RI/FS Report	$1,000/Day	$2,500/Day
Failure to Submit a revised Support Sampling Plan, or RI/FS Report	$1,000/Day	$2,500/Day
Failure to Submit a Data Report	$500/Day	$1,000/Day
Late Submittal of Progress Reports or Other Miscellaneous Reports/Submittals	$250/Day	$500/Day
Failure to Meet any Scheduled Deadline in the Order	$250/Day	$500/Day

Upon receipt of written demand by U.S. EPA, Respondent(s) shall make payment to U.S. EPA within 20 calendar days and interest shall accrue on late payments in accordance with Section VII of this Order (Reimbursement of Costs).

Even if violations are simultaneous, separate penalties shall accrue for separate violations of this Order. Penalties accrue and are assessed per violation per day. Penalties shall accrue regardless of whether U.S. EPA has notified Respondent(s) of a violation or act of noncompliance. The payment of penalties shall not alter in any way Respondent(')(s)(') obligation(s) to complete the performance of the work required under this Order. Stipulated penalties shall accrue, but need not be paid, during any dispute resolution period concerning the particular penalties at issue. If Respondent(s) prevail(s) upon resolution, Respondent(s) shall pay only such penalties as the resolution requires. In its unreviewable discretion, U.S. EPA may waive its rights to demand all or a portion of the stipulated penalties due under this Section.

The stipulated penalties set forth above shall not be the sole or exclusive remedy for violations of this Order. Violation of any provision of this Order may subject Respondent(s) to civil penalties of up to twenty-seven thousand five hundred dollars ($27,500) per violation per day, as provided in Section 106(b)(1) of CERCLA, 42 U.S.C. § 9606(b)(1). Respondent(s) may also be subject to punitive damages in an amount up to three times the amount of any cost incurred by the United States as a result of such violation, as provided in Section 107(c)(3) of CERCLA, 42 U.S.C. § 9607(c)(3). Should Respondent(s) violate this Order or any portion hereof, U.S. EPA may carry out the required actions unilaterally, pursuant to Section 104 of CERCLA, 42 U.S.C. § 9604, and/or may seek judicial enforcement of this Order pursuant to Section 106 of CERCLA, 42 U.S.C. § 9606.

XI. RESERVATION OF RIGHTS

Except as specifically provided in this Order, nothing herein shall limit the power and authority of U.S. EPA or the United States to take, direct, or order all actions necessary to protect public health, welfare, or the environment or to prevent, abate, or minimize an actual or threatened release of hazardous substances, pollutants or contaminants, or hazardous or solid waste on, at, or from the Site. Further, nothing herein shall prevent U.S. EPA from seeking legal or equitable relief to enforce the terms of this Order. U.S. EPA also reserves the right to take any other legal or equitable action as it deems appropriate and necessary, or to require the Respondent(s) in the future to perform additional activities pursuant to CERCLA or any other applicable law.

XII. OTHER CLAIMS

By issuance of this Order, the United States and U.S. EPA assume no liability for injuries or damages to persons or property resulting from any acts or omissions of Respondent(s). The United States or U.S. EPA shall not be a party or be held out as a party to any contract entered into by the Respondent(s) or its (their) directors, officers, employees, agents, successors, representatives, assigns, contractors, or consultants in carrying out activities pursuant to this Order.

Except as expressly provided in Section XIII (Covenant Not to Sue), nothing in this Order constitutes a satisfaction of or release from any claim or cause of action against the Respondent(s) or any person not a party to this Order, for any liability such person may have under CERCLA, other statutes, or the common law, including but not limited to any claims of the United States for costs, damages and interest under Sections 106(a) or 107(a) of CERCLA, 42 U.S.C. §§ 9606(a), 9607(a). Nothing in this Order prevents claims or causes of actions from being asserted and/or pursued against the United States for activities that would subject it to liability under 42 U.S.C. § 9607.

This Order does not constitute a preauthorization of funds under Section 111(a)(2) of CERCLA, 42 U.S.C. § 9611(a)(2). The Respondent(s) waive(s) any claim to payment under Sections 106(b), 111, and 112 of CERCLA, 42 U.S.C. §§ 9606(b), 9611, and 9612, against the United States or the Hazardous Substance Superfund arising out of any action performed under this Order.

No action or decision by U.S. EPA pursuant to this Order shall give rise to any right to judicial review except as set forth in Section 113(h) of CERCLA, 42 U.S.C. § 9613(h).

XIII. COVENANT NOT TO SUE

Except as otherwise specifically provided in this Order, upon issuance of the U.S. EPA notice referred to in Section XVII (Notice of Completion), U.S. EPA covenants not to sue Respondent(s) for judicial imposition of damages or civil penalties or to take administrative action against Respondent(s) for any failure to perform actions agreed to in this Order except as otherwise reserved herein.

This Order does not address past response costs incurred at the Sauget Area 2 Site and U.S. EPA reserves its right to sue or to take administrative action against Respondent(s) and other potentially responsible parties under Section 107(a) of CERCLA, 42 U.S.C. § 9607(a), for recovery of past response costs incurred by the United States in connection with this action or this Order

Except as otherwise specifically provided in this Order, in consideration and upon Respondent(')s(') payment of the oversight costs specified in Section VIII of this Order, U.S. EPA covenants not to sue or to take administrative action against Respondent(s) under Section 107(a) of CERCLA, 42 U.S.C. § 9607(a), for recovery of oversight costs incurred by the United States in connection with this Order. This covenant not to sue shall take effect upon the receipt by U.S. EPA of the payments required by Section VII (Reimbursement of Costs).

This covenant not to sue is conditioned upon the complete and satisfactory performance by Respondent(s) of (its/their) obligations under this Order. This covenant not to sue extends only to the Respondent(s) and does not extend to any other person.

XIV. CONTRIBUTION PROTECTION

With regard to claims for contribution against Respondent(s) for matters addressed in this Order, the Parties hereto agree that the Respondent(s) is (are) entitled to protection from contribution actions or claims to the extent provided by Sections 113(f)(2) and 122(h)(4) of CERCLA, 42 U.S.C. §§ 9613(f)(2) and 9622(h)(4). In the event a Respondent expressly withdraws from or is formally removed from the Sauget Area 2 Sites Group, such Respondent will not receive contribution protection under this Order for matters under this Order not addressed and paid for during its membership in the Group.

Nothing in this Order precludes parties from asserting any claims, causes of action or demands against any persons not parties to this Order for indemnification, contribution, or cost recovery.

XV. INDEMNIFICATION

Respondent(s) agree(s) to indemnify, save and hold harmless the United States, its officials, agents, contractors, subcontractors, employees and representatives from any and all claims or causes of action: (a) arising from, or on account of, acts or omissions of Respondent(s) and Respondent(')(s)(') officers, heirs, directors, employees, agents, contractors, subcontractors, receivers, trustees, successors or assigns, in carrying out actions pursuant to this Order; and (b) for damages or reimbursement arising from or on account of any contract, agreement, or arrangement between (any one or more of) Respondent(s), and any persons for performance of work on or relating to the Site, including claims on account of construction delays. Nothing in this Order, however, requires indemnification by Respondent(s) for any claim or cause of action against the United States based on negligent, fraudulent or criminal action taken solely and directly by U.S. EPA or its officials, agents, contractors, subcontractors, employees and representatives (not including oversight or approval of plans or activities of the Respondent(s)).

XVI. MODIFICATIONS

Except as otherwise specified in Section V.2 (Work To Be Performed), if any party believes modifications to any plan or schedule are necessary during the course of this project, they shall conduct informal discussions regarding such modifications with the other parties. Any agreed-upon modifications to any plan or schedule shall be memorialized in writing within 7 business days; however, the effective date of the modification shall be the date of the RPM's oral direction. Any other requirements of this Order may be modified in writing by mutual agreement of the parties. Any modification to this Order shall be incorporated into and made an enforceable part of this Order.

If Respondent(s) seek permission to deviate from any approved plan or schedule, Respondent(')(s)(') Project Coordinator shall submit a written request to U.S. EPA for approval outlining the proposed modification and its basis.

No informal advice, guidance, suggestion, or comment by U.S. EPA regarding reports, plans, specifications, schedules, or any other writing submitted by the Respondent(s) shall relieve Respondent(s) of their obligations to obtain such formal approval as may be required by this Order, and to comply with all requirements of this Order unless it is formally modified.

XVII. NOTICE OF COMPLETION

When U.S. EPA determines that all work has been fully performed in accordance with this Order, except for certain continuing obligations required by this Order (e.g., record retention, payment of costs), U.S. EPA will provide written notice to the Respondent(s). Such notice will be given not before the public comment period for the Proposed Plan has closed.

XVIII. SUBMITTALS/CORRESPONDENCE

Any notices, documents, information, reports, plans, approvals, disapprovals, or other correspondence required to be submitted from one party to another under this Order, shall be deemed submitted either when hand-delivered or as of the date of receipt by certified mail/return receipt requested, express mail, or facsimile.

Submissions to Respondent(s) shall be addressed to:

Mr. Steven D. Smith, Project Coordinator
Solutia Inc.
575 Maryville Centre Drive
P.O. Box 66760
St. Louis, MO 63141

With copies to:

Linda W. Tape
Thompson Coburn LLP
One Firstar Plaza
St. Louis, MO 63101

Submissions to U.S. EPA shall be addressed to:

Michael McAteer
U.S. EPA - Region 5
77 West Jackson Boulevard (SR-6J)
Chicago, Illinois 60604-3590

With copies to:

Thomas J. Martin
Associate Regional Counsel
U.S. EPA - Region 5
77 West Jackson Boulevard (C-14J)
Chicago, Illinois 606064-3590

Submissions to Illinois shall be addressed to:

Candy Morin
Illinois Environmental Protection Agency
Remedial Project Management Section
Division of Land Pollution Control
1021 N. Grand Avenue E.
P.O. Box 19276
Springfield, Illinois 62794-9276

XIX. SEVERABILITY

If a court issues an order that invalidates any provision of this Order or finds that Respondent(s) have sufficient cause not to comply with one or more provisions of this Order, Respondent(s) shall remain bound to comply with all provisions of this Order not invalidated by the court's order.

XX. EFFECTIVE DATE

This Order shall be effective upon signature by the Director, Superfund Division, U.S. EPA Region 5.

IN THE MATTER OF:

SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS

SIGNATORIES

This Agreement shall be executed by the Respondents in multiple counterparts, each of which shall be deemed an original, but all of which shall constitute one and the same instrument. Each undersigned representative of a signatory to this Administrative Order on Consent certifies that he or she is fully authorized to enter into the terms and conditions of this Order and to bind such signatory, its directors, officers, employees, agents, successors and assigns, to this document.

Agreed this 17th day of November, 2000

By : _____
T. M. Milton
Major Projects Manager

Exxon Mobil Corporation
3225 Gallows Road
Fairfax, VA 22037

IN THE MATTER OF:

SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS

SIGNATORIES

This Agreement shall be executed by the Respondents in multiple counterparts, each of which shall be deemed an original, but all of which shall constitute one and the same instrument. Each undersigned representative of a signatory to this Administrative Order on Consent certifies that he or she is fully authorized to enter into the terms and conditions of this Order and to bind such signatory, its directors, officers, employees, agents, successors and assigns, to this document.

Agreed this 22 day of Nov, 2000

By _____
DAN HERNANDEZ
V Pres Elevator Operations

For: Peavey Company, a division of ConAgra, Inc.
One ConAgra Drive
Omaha, NE 68102

IN THE MATTER OF:

SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS

SIGNATORIES

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Agreed this 22 day of NOV 2000

By _____

DAN HERNANDEZ
V. Pres Elevator Operation

For: ConAgra, Inc.
One ConAgra Drive
Omaha, NE 68102

IN THE MATTER OF:

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SAUGET AND CAHOKIA, ILLINOIS

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Agreed this 20th day of Nov., 2000

FOR: American Zinc, Lead and Smelting Company; American Zinc Company; Gold Fields American Corporation;(predecessors to Blue Tee Corp.) and Blue Tee Corp.

By Terrance Gileo Faye
Special Counsel to Blue Tee Corp.

Terrance Gileo Faye, Esq.
Babst, Calland, Clements & Zomnir, P.C.
1 North Maple Avenue
Greensburg, PA 15601
Phone: 724-837-6221
Fax: 724-837-0971
E-mail: tfaye@westol.com

IN THE MATTER OF:

SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS
ADMINISTRATIVE ORDER ON CONSENT

SIGNATORIES

Each undersigned representative of a signatory to this Administrative Order on Consent certifies that he or she is fully authorized to enter into the terms and conditions of this Order and to bind such signatory, its directors, officers, employees, agents, successors and assigns, to this document.

Agreed this 17 day of November, 2000

BY: _____
Everett King

11-17-00

Title: Vice President/Controller

FOR: CERRO COPPER PRODUCTS CO.

Location Address: 3000 Mississippi Ave
Sauget, Illinois 62206

Mailing Address: P.O. Box 66800
St. Louis, Missouri 63166-6800

IN THE MATTER OF:

SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS

SIGNATORIES

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Agreed this 17 day of Nov., 2000

Pharmacia Corporation, formerly known as Monsanto Company

Name: Michael R. Foresman

Name: Michael R. Foresman
Title: President, Solutia Management Company, Inc., Agent for Solutia Inc., Attorney-in-Fact for Pharmacia Corporation

IN THE MATTER OF:

SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS

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Agreed this 17 day of Nov., 2000

Solutia Inc.

By: Michael R. Foresman

Name: Michael R. Foresman

Title: President, Solutia Management Company, Inc., Agent for Solutia Inc.

IN THE MATTER OF:

SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS
ADMINISTRATIVE ORDER ON CONSENT

SIGNATORIES

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Agreed this 17th day of Nov., 2000

FOR: Union Electric Company
(company name)

Title: Senior Vice President
Ameren Services Company (Agent for Union Electric)

Address: One Ameren Plaza
1901 Chouteau Avenue
St. Louis, MO 63103

IN THE MATTER OF:

SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS

SIGNATORIES

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Agreed this 17th day of November, 2000

By _____

Vice President -- Product Supply, Ethyl Corporation

for Ethyl Corporation,

Ethyl Petroleum Additives, Inc., and

Edwin Cooper Corporation

330 South Fourth Street
Richmond, Virginia 23219

IN THE MATTER OF:

SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS
ADMINISTRATIVE ORDER ON CONSENT

SIGNATORIES

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Agreed this 17th day of November, 2000

BY: _____

Jack Dowden

FOR: CHEMICAL WASTE MANAGEMENT, INC.

Title: Midwest Area Director, Closed Site Management Program

Address: Waste Management, Inc.
720 Butterfield Road
Lombard, IL 60148

IN THE MATTER OF:

SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS

SIGNATORIES

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Agreed this 20th day of November, 2000

Eagle Marine Industries, Inc. (formerly Notre Dame Fleeting and Towing, Inc. and which merged with Riverport Terminal and Fleeting, Inc.)

By _____
Richard D. Burke

IN THE MATTER OF:

SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS

SIGNATORIES

This Agreement shall be executed by the Respondents in multiple counterparts, each of which shall be deemed an original, but all of which shall constitute one and the same instrument. Each undersigned representative of a signatory to this Administrative Order on Consent certifies that he or she is fully authorized to enter into the terms and conditions of this Order and to bind such signatory, its directors, officers, employees, agents, successors and assigns, to this document.

Agreed this 17 day of November, 2000

By _____
CYPRUS AMAX MINERALS CORPORATION
PHELPS DODGE CORPORATION

IN THE MATTER OF:

SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS

SIGNATORIES

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Agreed this 20th day of November, 2000

By _____
BFI Waste Systems of North America, Inc.

Title: Manager, CERCLA Activities

Address: Steve Doss
C/o Allied Waste Industries, Inc.
15880 N. Greenway-Hayden Loop
Scottsdale, AZ 85260

IN THE MATTER OF:

SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS

SIGNATORIES

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Agreed this 17 day of Nov., 2000

The Pillsbury Company

By

IT IS SO ORDERED AND AGREED

BY:_____ DATE:_____
William E. Muno, Director
Superfund Division
United States Environmental Protection Agency
Region 5

IN THE MATTER OF:

SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS

IT IS SO ORDERED AND AGREED

BY: _____ DATE: 11-24-00
William E. Muno, Director
Superfund Division
United States Environmental Protection Agency
Region 5

ATTACHMENT A

SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS
ADMINISTRATIVE ORDER ON CONSENT

American Zinc, Lead and Smelting Company
American Zinc Company
Cyprus Amax Minerals Company (successor to Amax Zinc)
Phelps Dodge Corporation
Gold Fields American Corporation
Blue Tee Corp.
Union Electric d/b/a AmerenUE
BFI Waste Systems of North America, Inc.
Cerro Copper Products Co.
Chemical Waste Management, Inc.
ConAgra, Inc.
Eagle Marine Industries, Inc. (formerly known as Notre Dame Fleeting and Towing Inc., and which merged with Riverport Terminal and Fleeting Inc.)
Edwin Cooper Corporation.
Ethyl Corporation
Ethyl Petroleum Additives, Inc.
Exxon Mobil Corporation
Pharmacia Corporation, formerly known as Monsanto Company
Peavey Company, a division of ConAgra, Inc.
Pillsbury Company
Solutia Inc.

ATTACHMENT B

SCOPE OF WORK FOR
STREAMLINED REMEDIAL INVESTIGATION AND FEASIBILITY STUDY
AT
SAUGET AREA 2 SITE
SAUGET AND CAHOKIA, ILLINOIS

PURPOSE:

The purpose of this Scope of Work (SOW) is to set forth requirements for the preparation of a streamlined Remedial Investigation and Feasibility Study (RI/FS). The RI shall evaluate the nature and extent of contamination resulting from the disposal/deposition of contaminants in the Sauget Area 2 Site (Sites O, P, Q, R and S) and also assess the risk from this contamination on human health and the environment. The FS Report shall evaluate alternatives for addressing the impact to human health and/or the environment from the contamination at the Sauget Area 2 Site. The RI and FS Reports shall be conducted, at a minimum, consistent with the "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (U.S. EPA, Office of Emergency and Remedial Response, October 1988) and any other guidance that U.S. EPA uses in conducting a RI/FS, as well as any additional requirements in the Administrative Order. (Any such guidance evolving or published during the conduct of the RI/FS will be provided to the Respondents at a reasonable time frame prior to the due date for submittal of appropriate interim or final deliverables identified in this SOW). The Respondents shall furnish all personnel, materials, and services necessary for, or incidental to, performing the RI/FS at the Sauget Area 2 Site, except as otherwise specified herein.

At the completion of the RI/FS, U.S. EPA will be responsible for the selection of a Site remedy and will document this selection in a Record of Decision (ROD). The remedial action selected by U.S. EPA will meet the cleanup standards specified in CERCLA Section 121. That is, the selected remedial action will be protective of human health and the environment, will be in compliance with, or include a waiver of, applicable or relevant and appropriate requirements of other laws, will be cost-effective, will utilize permanent solutions and alternative treatment technologies or resource recovery technologies, to the maximum extent practicable, and will address the statutory preference for treatment as a principal element. The final RI/FS reports, as adopted by U.S. EPA, and the risk evaluation/assessment will, with the administrative record, form the basis for the selection of the Site's remedy and will provide the information necessary to support the development of the ROD.

As specified in CERCLA Section 104(a)(1), as amended by SARA, U.S. EPA will provide

oversight of the Respondents' activities throughout the RI/FS, including all field sampling activities. The Respondents will support U.S. EPA's initiation and conduct of activities related to the implementation of oversight activities.

SCOPE:

The tasks to be completed as part of this RI/FS are:

Task 1.	RI/FS Support Sampling Plan
Task 2.	Remedial Investigation
Task 3.	RI/FS Report
Task 4.	Progress Reports

TASK 1: RI/FS SUPPORT SAMPLING PLAN

Within 90 calendar days of the effective date of the Administrative Order, Respondents shall submit a Sampling Plan to U.S. EPA and Illinois EPA that addresses all data acquisition activities. The objective of this RI/FS support sampling is to further determine the extent of contamination at the Site beyond that already identified by previous site investigations. The plan shall contain a description of equipment specifications, required analyses, sample types, and sample locations and frequency. The plan shall address specific hydrologic, hydrogeologic, and air transport characterization methods including, but not limited to, geologic mapping, geophysics, field screening, drilling and well installation, flow determination, and soil/water/sediment/waste sampling to determine extent of contamination.

Respondents shall identify the data requirements of specific remedial technologies that may be necessary to evaluate remedial activities in the RI/FS and the Respondents shall provide a schedule stating when events will take place and when deliverables will be submitted.

The RI/FS Support Sampling Plan shall include the following information:

A. Site Background

A brief summary of the Site location, general Site physiography, hydrology and geology shall be included. A summary description of the data already available shall be included which will highlight the areas of known contamination and the levels detected. Tables shall be included to display the minimum and maximum levels of detected contaminants across the Site.

B. Data Gap Description

Respondents shall make an analysis of the currently available data to determine the

areas of the Site which require additional data in order to define the extent of contamination for purposes of implementing a remedial action. A description of the number, types, and locations of additional samples to be collected shall be included in this section of the sampling plan.

Descriptions of the following activities shall also be included:

i. Waste Characterization

Respondents shall include a program for characterizing the waste materials at the Site. This shall include an analysis of current information/data on past disposal practices at the Site. For buried wastes, test pits/trenches and deep soil borings shall be proposed in the plan to determine waste depths and volume and to determine the extent of cover over fill areas when such information is not already known. Soil gas surveys shall also be proposed for the areas on and around fill areas of the site. Geophysical characterization methods, such as ground penetrating radar or magnetometry, to further delineate potential "hot spot" drum removal areas shall also be included.

ii. Hydrogeologic Investigation

The plan shall include the methods to evaluate the degree of hazard, the mobility of pollutants, discharges/recharge areas, regional and local flow direction and quality, and local uses of groundwater. The plan shall also develop a strategy for determining horizontal and vertical distribution of contaminants and may include other hydraulic tests such as slug tests, and grain size analysis to assist in determining future potential remediation options where such information has not already been obtained. Upgradient samples shall be included in the plan.

iii. Soils and Sediments Investigation

Respondents shall include a program to determine the extent of contamination of surface and subsurface soils at the Site. The plan shall also require sediment sampling in the Mississippi River bed, with the results of this sampling being considered in the Human Health and Ecological Risk Assessments.

Samples of leachate, if any, from the areas described as fill shall also be collected.

iv. Surface Water Investigation

Respondents shall include procedures for sampling of surface water in the Mississippi River (adjacent to the sites and downstream of the sites, with the results of this sampling being considered in the Human Health and Ecological Risk Assessments.

v. Air Investigation

Respondents shall include a program to determine the extent of atmospheric contamination from the various source areas at the Site. The program shall address the tendency of the substances identified through the waste characterization to enter the atmosphere, local wind patterns, and the degree of hazard.

vi. Ecological Assessment

Respondents shall include a plan for collecting data for the purpose of assessing the impact, if any, to aquatic and terrestrial ecosystems within and adjacent to the Sauget Area 2 Site, including within the Mississippi River, as a result of the disposal, release and migration of contaminants. The plan shall include a description of the ecosystems affected, an evaluation of toxicity, an assessment of endpoint organisms, and the exposure pathways. The plan shall also include a description of any toxicity testing or trapping to be included as part of the assessment. The ecological assessment shall be conducted in accordance with U.S. EPA guidance, including Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (June 5, 1997; EPA 540-R-97-006).

vii. Pilot Tests

Respondents shall include a program for any pilot test(s) necessary to determine the implementability and effectiveness of technologies where sufficient information is not otherwise available.

C. Sampling Procedures

Respondents shall include a description of the depths of sampling, parameters to be analyzed, equipment to be used, decontamination procedures to be followed, sample quality assurance, data quality objectives and sample management procedures to be utilized in the field. All sampling and analyses performed shall conform to U.S. EPA direction, approval, and guidance regarding sampling, quality assurance/quality control ("QA/QC"), data validation, and chain of custody procedures. Respondents shall

ensure that the laboratory used to perform the analyses participates in a QA/QC program that complies with U.S. EPA guidance.

Upon request by U.S. EPA, Respondents shall have such a laboratory analyze samples submitted by U.S. EPA for quality assurance monitoring. Respondents shall provide to U.S. EPA the QA/QC procedures followed by all sampling teams and laboratories performing data collection and/or analysis. Respondents shall also ensure provision of analytical tracking information consistent with OSWER Directive No. 9240.0-2B, Extending the Tracking of Analytical Services to PRP-Lead Superfund Sites.

Upon request by U.S. EPA, Respondents shall allow U.S. EPA or its authorized representatives to take split and/or duplicate samples of any samples collected by Respondents or their contractors or agents. Respondents shall notify U.S. EPA not less than 10 business days in advance of any sample collection activity. U.S. EPA shall have the right to take any additional samples that it deems necessary.

D. Health and Safety Plan

Respondents shall prepare a Site safety plan which is designed to protect on-site personnel, area residents and nearby workers from physical, chemical and all other hazards posed by this sampling event. The safety plan shall develop the performance levels and criteria necessary to address the following areas:

- General requirements
- Personnel
- Levels of protection
- Safe work practices and safe guards
- Medical surveillance
- Personal and environmental air monitoring
- Personal hygiene
- Decontamination - personal and equipment
- Site work zones
- Contaminant control
- Contingency and emergency planning (including response to fires/explosions)
- Logs, reports and record keeping

The safety plan shall, at a minimum, follow U.S. EPA guidance document Standard Operating Safety Guides (Publication 9285.1-03, PB92-963414, June 1992), and all OSHA requirements as outlined in 29 C.F.R. Part 1910.

E. Schedule

Respondents shall include a schedule which identifies timing for initiation and completion of all tasks to be completed as part of this RI/FS Support Sampling Plan.

TASK 2: REMEDIAL INVESTIGATION

Respondents shall conduct the Remedial Investigation according to the U.S. EPA approved Sampling Plan and schedule. Respondents shall coordinate activities with U.S. EPA's Remedial Project Manager (RPM). Respondents shall provide the RPM with all laboratory data.

TASK 3: REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)

Within 12 months of the collection of the last field sample as part of the Remedial Investigation (Task 2) (as designated by the U.S. EPA RPM), Respondents shall submit to U.S. EPA for approval a draft RI/FS report addressing all of the Sauget Area 2 Site. The RI/FS shall be consistent with the administrative order and this SOW. The RI/FS report shall be completed in accordance with the following requirements:

1 Executive Summary
2 Site Characterization

- 2.1 Site Description and Background
  - 2.1.1 Site Location and Physical Setting
  - 2.1.2 Present and Past Facility Operations and Disposal Practices
  - 2.1.2 Geology/Hydrology/Hydrogeology
  - 2.1.3 Current and past groundwater usage in the site area
  - 2.1.4 Surrounding Land Use and Populations
  - 2.1.5 Sensitive Ecosystems
  - 2.1.6 Meteorology/Climatology

- 2.2 Groundwater Fate and Transport

  - Contaminant Characteristics
  - Groundwater Fate and Transport Processes
  - Groundwater Contaminant Migration Trends
  - Groundwater Modeling

2.3 Previous Removal/Remedial Actions
2.4 Source, Nature, and Extent of Contamination
2.5 Analytical Data
2.6 Human Health Risk Assessment
2.7 Ecological Risk Assessment

3 Identification of Remedial Action Objectives

3.1 Determination of Remedial Action Scope
3.2 Determination of Remedial Action Schedule
3.3 Identification of and Compliance with ARARs

4 Identification and Analysis of Remedial Action Alternatives
5 Detailed Analysis of Alternatives

5.1 Effectiveness
5.1.1 Overall Protection of Public Health and the Environment
5.1.2 Compliance with ARARs and Other Criteria, Advisories, and Guidance
5.1.3 Long-Term Effectiveness and Permanence
5.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment
5.1.5 Short-Term Effectiveness

5.2 Implementability
5.2.1 Technical Feasibility
5.2.2 Administrative Feasibility
5.2.3 Availability of Services and Materials
5.2.4 State and Community Acceptance

5.3 Cost
5.3.1 Direct Capital Costs
5.3.2 Indirect Capital Costs
5.3.3 Long-Term Operation and Maintenance

6 Comparative Analysis of Remedial Action Alternatives

7 Schedule for RI/FS Report Submission

RI/FS Outline:

1 Executive Summary

The Executive Summary shall provide a general overview of the contents of the RI/FS report. It shall contain a brief discussion of the Site and the current and/or potential threat posed by conditions at the Site.

2 Site Characterization

The RI/FS report shall summarize available data on the physical, demographic, and other characteristics of the Site and the surrounding areas. Specific topics which shall be addressed in the site characterization are detailed below. The site characterization shall concentrate on those characteristics necessary to evaluate and select an appropriate remedy.

2.1 Site Description and Background

The site description includes current and historical information. The following types of information shall be included, where available and as appropriate, to the site-specific conditions and the scope of the remedial action.

2.1.1 Site Location and Physical Setting
2.1.2 Present and Past Facility Operations and Disposal Practices
2.1.2 Geology/Hydrology/Hydrogeology
2.1.3 Current and past groundwater usage in the site area
2.1.4 Surrounding Land Use and Populations
2.1.5 Sensitive Ecosystems
2.1.6 Meteorology/Climatology

2.2 Groundwater Fate and Transport

- Contaminant Characteristics
- Groundwater Fate and Transport Processes
- Groundwater Contaminant Migration Trends
- Groundwater Modeling

2.3 Previous Removal Actions

The site characterization section shall also describe any previous removal and remedial

actions at the Site. Previous information, if relevant, shall be organized as follows:

* The scope and objectives of the previous removal action(s)
* The amount of time spent on the previous removal action(s)
* The nature and extent of hazardous substances, pollutants, or contaminants treated or controlled during the previous removal action(s) (including all monitoring conducted)
* The technologies used and/or treatment levels used for the previous removal action(s).

2.4 Source, Nature and Extent of Contamination

This section shall summarize the available site characterization data for the Sauget Area 2 Site, including the locations of the hazardous substances, pollutants, or contaminants; the quantity, volume, size or magnitude of the contamination; and the physical and chemical attributes of the hazardous pollutants or contaminants.

2.5 Analytical Data

This section shall present the available data, including, but not limited to, soil, groundwater, surface water, sediments, and air. This section should discuss any historical data gaps that were identified, and the measures taken to develop all necessary additional data.

2.6 Human Health Risk Assessment

The risk assessment shall focus on actual and potential risks to persons coming into contact with on-site contaminants as well as risks to the surrounding residential and industrial worker populations from exposure to contaminated soils, sediments, surface water, air, and ingestion of contaminated organisms in surrounding impacted ecosystems. Reasonable maximum estimates of exposure shall be defined for both current land use conditions and reasonable future land use conditions. It shall use data from the Site to identify the chemicals of concern, provide an estimate of how and to what extent human receptors might be exposed to these chemicals, and provide an assessment of the health effects associated with these chemicals. The evaluation shall project the potential risk of health problems occurring if no cleanup action is taken at the Site and establish target action levels for COCs (carcinogenic and non-carcinogenic). The risk evaluation shall be conducted in accordance with U.S. EPA guidance including, at a minimum: Risk Assessment Guidance for Superfund (RAGS) (EPA/540/1-89/002, December 1989) and RAGS Part D (EPA 540/R/97/033, January

1998). The risk assessment shall also include the following elements:

- Hazard Identification (sources). The Respondents shall review available information on the hazardous substances present at the Site and identify the major contaminants of concern.

- Dose-Response Assessment. Contaminants of concern should be selected based on their intrinsic toxicological properties.

- Conceptual Exposure/Pathway Analysis.

- Characterization of Site and Potential Receptors.

- Exposure Assessment. Respondents shall develop reasonable maximum estimates of exposure for both current land use conditions and potential land use conditions at the Site.

- Risk Characterization.

- Identification of Limitations/Uncertainties.

2.7 Ecological Risk Assessment

The ecological risk assessment shall be conducted in accordance with U.S. EPA guidance including, at a minimum: Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessments, (EPA/540/R/97/006, June 1997).

The ecological risk assessment shall describe the data collection activities conducted as part of Task 1(B)(vi) as well as the following information:

- Hazard Identification (sources). The Respondents shall review available information on the hazardous substances present at and adjacent to the Site and identify the major contaminants of concern.

- Dose-Response Assessment. Contaminants of concern should be selected based on their intrinsic toxicological properties.

- Prepare Conceptual Exposure/Pathway Analysis.

- Characterization of Site and Potential Receptors.

- Select Chemicals, Indicator Species, and End Points. In preparing the assessment, the Respondents shall select representative chemicals, indicator species (species that are especially sensitive to environmental contaminants), and end points on which to concentrate.

- Exposure Assessment. The exposure assessment will identify the magnitude of actual exposures, the frequency and duration of these exposures, and the routes by which receptors are exposed. The exposure assessment shall include an evaluation of the likelihood of such exposures occurring and shall provide the basis for the development of acceptable exposure levels.

- Toxicity Assessment/Ecological Effects Assessment. The toxicity and ecological effects assessment will address the types of adverse environmental effects associated with chemical exposures, the relationships between magnitude of exposures and adverse effects, and the related uncertainties for contaminant toxicity (e.g., weight of evidence for a chemical's carcinogenicity).

- Risk Characterization. During risk characterization, chemical-specific toxicity information, combined with quantitative and qualitative information from the exposure assessment, shall be compared to measured levels of contaminant exposure levels and the levels predicted through environmental fate and transport modeling. These comparisons shall determine whether concentrations of contaminants at or near the Site are affecting or could potentially affect the environment.

- Identification of Limitations/Uncertainties. Respondents shall identify critical assumptions (e.g., background concentrations and conditions) and uncertainties in the report.

3 Identification of Remedial Action Objectives

The RI/FS shall develop remedial and, where appropriate, removal action objectives, taking into consideration the following factors:

* Prevention or abatement of actual or potential exposure to nearby human populations, (including workers), animals, or the food chain from hazardous substances, pollutants, or contaminants;

* Prevention or abatement of actual or potential contamination of drinking water supplies and ecosystems;

* Stabilization or elimination of hazardous substances in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release;

* Treatment or elimination of hazardous substances, pollutants, or contaminants in soils or sediments that may migrate;

* Elimination of threat of fire or explosion;

* Acceptable chemical-specific contaminant levels, or range of levels, for all exposure routes.

* Mitigation or abatement of other situations or factors that may pose threats to public health, welfare, or the environment.

3.1 Determination of Remedial Action Scope

The RI/FS shall define the broad scope and specific short-term and long-term objectives of the remedial action and address the protectiveness of the remedial action.

3.2 Determination of Remedial Action Schedule

The general schedule for remedial action and, where appropriate, removal activities shall be developed, including both the start and completion time for the remedial action.

3.3 Identification of and Compliance with ARARs

The RI/FS report shall identify all applicable, relevant and appropriate requirements at both the federal and state levels that will apply to the remedial action. The RI/FS shall also describe how the ARARs will be met.

4 Identification and Analysis of Remedial Action Alternatives

Based on the analysis of the nature and extent of contamination and on the cleanup objectives developed in the previous section, a limited number of alternatives appropriate for addressing the remedial action objectives shall be identified and assessed. Whenever practicable, the alternatives shall also consider the CERCLA preference for treatment over conventional containment or land disposal approaches.

The use of presumptive remedy guidance, if appropriate and applicable to any of the disposal areas of the Sauget Area 2 Site, may also provide an immediate focus to the identification and analysis of alternatives. This guidance includes, but is not limited to: Implementing Presumptive Remedies (EPA 540-R-97-029, October 1997). Presumptive remedies involve the use of remedial technologies that have been consistently selected at similar sites or for similar contamination.

A limited number of alternatives, including any identified presumptive remedies, shall be selected for detailed analysis. Each of the alternatives shall be described with enough detail so that the entire treatment process can be understood. Technologies that may apply to the media or source of contamination shall be listed in the RI/FS report.

The preliminary list of alternatives to address soil, sediments, wastes, and groundwater contamination at the Sauget Area 2 Site shall consist of, but is not limited to, treatment technologies (i.e., thermal methods), removal and off-site treatment/disposal, removal and an on-site disposal, in-place containment, and natural attenuation.

5 Detailed Analysis of Alternatives

Defined alternatives are evaluated against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost.

5.1 Effectiveness

The effectiveness of an alternative refers to its ability to meet the objective regarding the scope of the remedial action. The "Effectiveness" discussion for each alternative shall evaluate the degree to which the technology would mitigate threats to public health and the environment. Criteria to be considered include:

5.1.1 Overall Protection of Public Health and the Environment

How well each alternative protects public health and the environment shall be discussed in a consistent manner. Assessments conducted under other evaluation criteria, including long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs shall be included in the discussion. Any unacceptable short-term impacts shall be identified. The discussion shall focus on how each alternative achieves adequate protection and describe how the alternative will reduce, control, or eliminate risks at the Site through the use of treatment, engineering, or institutional controls.

5.1.2 Compliance with ARARs and Other Criteria, Advisories, and Guidance

The detailed analysis shall summarize which requirements are applicable or relevant and appropriate to an alternative and describe how the alternative meets those requirements. A summary table may be employed to list potential ARARs. In addition to ARARs, other federal or state advisories, criteria, or guidance to be considered (TBC) may be identified.

5.1.3 Long-Term Effectiveness and Permanence

This evaluation assesses the extent and effectiveness of the controls that may be required to manage risk posed by treatment of residuals and/or untreated wastes at the Site. The following components shall be considered for each alternative: magnitude of risk; and adequacy and reliability of controls.

5.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Respondents' analysis shall address U.S. EPA's policy of preference for treatment including an evaluation based upon the following subfactors for a particular alternative:

* The treatment process(es) employed and the material(s) it will treat
* The amount of the hazardous or toxic materials to be destroyed or treated
* The degree of reduction expected in toxicity, mobility, or volume
* The degree to which treatment will be irreversible
* The type and quantity of residuals that will remain after treatment
* Whether the alternative will satisfy the preference for treatment

5.1.5 Short-Term Effectiveness

The short-term effectiveness criterion addresses the effects of the alternative during implementation before the remedial objectives have been met. Alternatives shall also be evaluated with respect to their effects on human health and the environment following implementation. The following factors shall be addressed as appropriate for each alternative:

* Protection of the Community
* Protection of the Workers
* Environmental Impacts
* Time Until Response Objectives are Achieved

5.2 Implementability

This section is an assessment of the implementability of each alternative in terms of the technical and administrative feasibility and the availability of the goods and services necessary for each alternative's full execution. The following factors shall be considered under this criterion:

5.2.1 Technical Feasibility

The degree of difficulty in constructing and operating the technology; the reliability of the technology, the availability of necessary services and materials; the scheduling aspects of implementing the alternatives during and after implementation; the potential impacts on the local community during construction operation; and the environmental conditions with respect to set-up and construction and operation shall be described. Potential future removal actions shall also be discussed. The ability to monitor the effectiveness of the alternatives may also be described.

5.2.2 Administrative Feasibility

The administrative feasibility factor evaluates those activities needed to coordinate with other offices and agencies. The administrative feasibility of each alternative shall be evaluated, including the need for off-site permits, adherence to applicable non-environmental laws, and concerns of other regulatory agencies. Factors that shall be considered include, but are not limited to, the following: statutory limits, permits and waivers.

5.2.3 Availability of Services and Materials

The RI/FS must determine if off-site treatment, storage, and disposal capacity, equipment, personnel, services and materials, and other resources necessary to implement an alternative shall be available in time to maintain the remedial schedule.

5.2.4 State and Community Acceptance

State and community acceptance will be considered by U.S. EPA before a final

remedial action is decided upon. Respondents need only mention in the RI/FS report that U.S. EPA will consider and address State and community acceptance of an alternative when making a recommendation and in the final selection of the alternative in the ROD.

5.3 Cost

Each alternative shall be evaluated to determine its projected costs. The evaluation should compare each alternative's capital and operation and maintenance costs. The present worth of alternatives should be calculated.

5.3.1 Direct Capital Costs

Costs for construction, materials, land, transportation, analysis of samples, treatment shall be presented.

5.3.2 Indirect Capital Costs

Cost for design, legal fees, permits shall be presented.

5.3.3 Long-Term Operation and Maintenance Costs

Costs for maintenance and long-term monitoring shall be presented.

6 Comparative Analysis of Remedial Action Alternatives

Once remedial action alternatives have been described and individually assessed against the evaluation criteria described in Section 5, above, a comparative analysis shall be conducted to evaluate the relative performance of each alternative in relation to each of the criteria. The purpose of the analysis shall be to identify advantages and disadvantages of each alternative relative to one another so that key trade offs that would affect the remedy selection can be identified.

7 Schedule for RI/FS Report Submission

The Respondents shall hold monthly meetings with the U S. EPA and Illinois EPA to review the RI/FS progress.

As part of the Risk Assessment work, and within 8 months following the collection of the last field sample as part of the Remedial Investigation (Task 2), Respondents shall

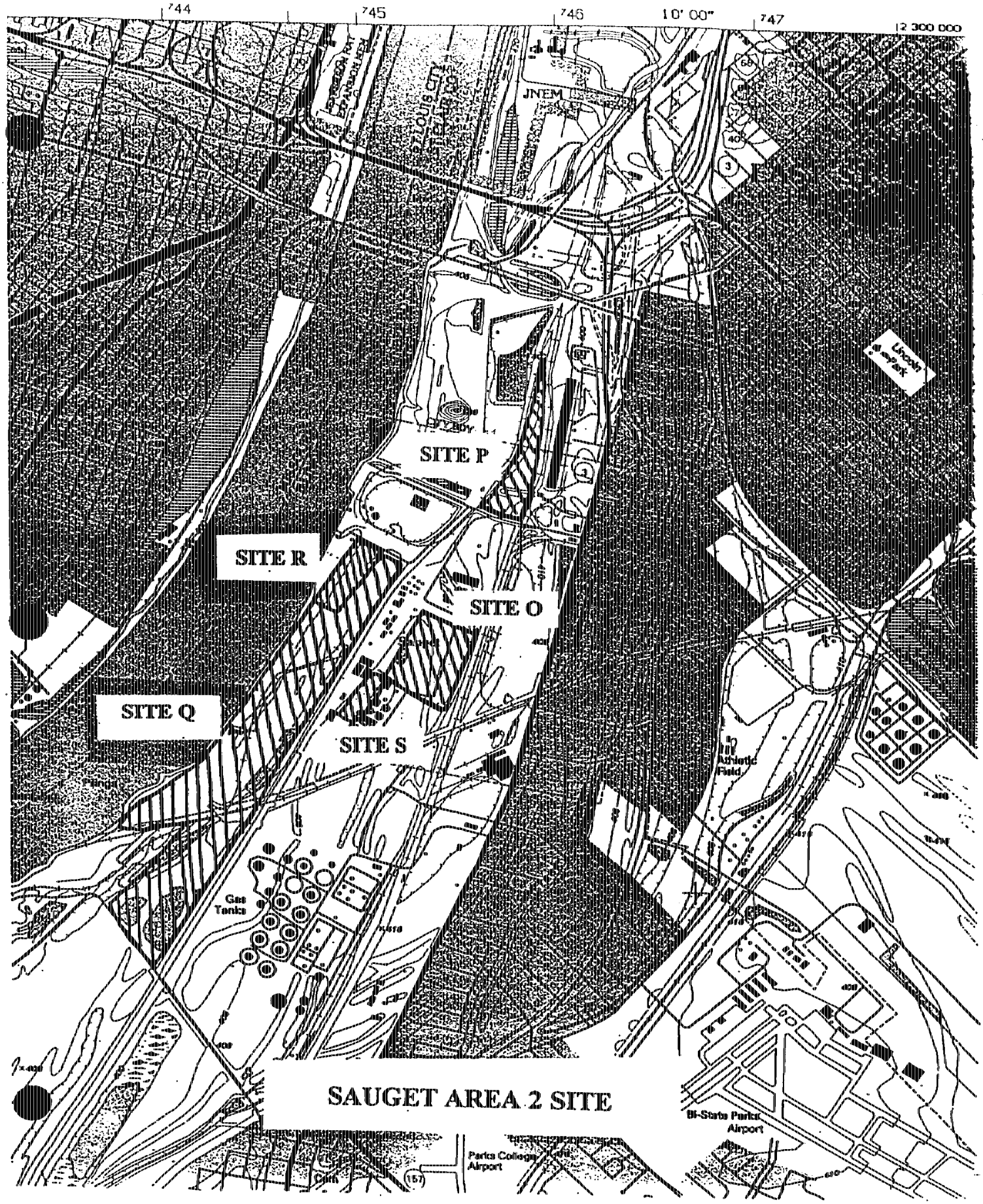
present at a meeting the alternatives to undergo a more detailed analysis.

A draft RI/FS report shall be submitted to U.S. EPA and Illinois EPA within 12 months following the collection of the last field sample as part of the Remedial Investigation (Task 2)(as designated by the RPM). The amended RI/FS report if required, shall be submitted to U.S. EPA and Illinois EPA within 30 days of the receipt of U.S. EPA's comments on the draft RI/FS report.

Following U.S. EPA approval of the RI/FS report, U.S. EPA will issue a Proposed Plan to the public wherein U.S. EPA will propose one, or a combination, of the alternatives evaluated in the FS. Public comments will be solicited and evaluated before U.S. EPA makes a final decision on a remediation plan. The final decision will be documented in the ROD for the Sauget Area 2 Site.

TASK 6: PROGRESS REPORTS

Respondents shall submit a monthly written progress report to U.S. EPA and Illinois EPA concerning actions undertaken pursuant to the Order and this SOW, beginning 30 calendar days after the effective date of the Order, until termination of the Order, unless otherwise directed in writing by the RPM. These reports shall describe all significant developments during the preceding period, including the work performed and any problems encountered, analytical data received during the reporting period, and developments anticipated during the next reporting period, including a schedule of work to be performed, anticipated problems, and planned resolutions of past or anticipated problems.



SAUGET AREA 2 SITE

Appendix 2

Groundwater Use Ordinances

ORDINANCE NO. 99-5

AN ORDINANCE PROHIBITING THE USE OF GROUNDWATER AS A POTABLE WATER SUPPLY BY THE INSTALLATION OR USE OF POTABLE WATER SUPPLY WELLS OR BY ANY OTHER METHOD

WHEREAS, certain properties in the Village of Sauget, Illinois, have been used over a period of time for commercial/industrial purposes; and

WHEREAS, because of said use, concentrations of certain chemical constituents in the groundwater beneath the Village may exceed Class I groundwater quality standards for potable resource groundwater, as set forth in 35 Illinois Administrative Code Part 620, or Tier 1 residential remediation objectives, as set forth in 35 Ill. Adm. Code Part 742; and

WHEREAS, the Village of Sauget desires to limit potential threats to human health from groundwater contamination while facilitating the redevelopment and productive use of properties that are the source of said chemical constituents;

NOW, THEREFORE, BE IT ORDAINED BY THE VILLAGE COUNCIL IN THE VILLAGE OF SAUGET, ILLINOIS:

Section One: Use of groundwater as a potable water supply prohibited.

The use or attempted use of groundwater from within the corporate limits of the Village as a potable water supply by the installation or drilling of wells or by any other method is hereby prohibited.

Section Two: Penalties

Any person violating the provisions of this ordinance shall be subject to a fine of up to "200.00" for each violation.

Section Three: Definitions.

"Person" is any individual, partnership, co-partnership, firm, company, limited liability company, corporation, association, joint stock company, trust, estate, political subdivision, or any other legal entity, or their representatives, agents or assigns.

"Potable water" is any water used for human or domestic consumption, including, but not limited to, water used for drinking, bathing, swimming, washing dishes, or preparing foods.

Section Four: Repealer.

All ordinances or parts of ordinances in conflict with this ordinance are hereby repealed insofar as they are in conflict with this ordinance.

Section Five: Severablity.

If any provision of this ordinance or its application to any person or under any circumstances is adjudged invalid, such adjudication shall not affect the validity of the ordinance as a whole or of any portion not adjudged invalid.

Section Six: Effective Date.

This ordinance shall be in full force and effect from and after its passage, approval and publication, as required by law.

INTRODUCED AND READ FOR THE FIRST TIME: October 12, 1999

READ FOR THE SECOND TIME:
(under suspension of rules): October 12, 1999

READ FOR THE THIRD TIME:
(under suspension of rules): October 12, 1999

ADOPTED AND ENACTED: October 12, 1999

ROLL CALL VOTE:
Ayes: Adels, McDaniel, Rich, Cates, Thacatan, Saugat
Nays: None
Absent: None
Unfilled Vacancy:

APPROVED: October 12, 1999

APPROVED:
Paul Saugat
President (mayor) Pro Temore

ATTEST:
Betty Lou Wilson
Village Clerk

ORDINACE No. 981

AN ORDINANCE PROHIBITING THE USE OF GROUNDWATER AS A POTABLE WATER SUPPLY BY THE INSTALLATION OR USE OF POTABLE WATER SUPPLY WELLS OR BY ANY OTHER METHOD

WHEREAS, certain properties in the Village of Cahokia, Illinois, have been used over a period of time for commercial/industrial uses; and

WHEREAS, because of said use, concentrations of certain chemical constituents in the groundwater beneath the Village may exceed Class I groundwater quality standards for potable resource groundwater, as set forth in 35 Administrative Code Part 620, or Tier 1 residential remediation objectives, as set forth in 35 Ill. Admin. Code Part 742; and

WHEREAS, the Village of Cahokia desires to limit potential threats to human health from groundwater contamination while facilitating the redevelopment and productive use of properties that are the source of said chemical constituents;

NOW, THEREFORE, BE IT ORDAINED BY THE VILLAGE BOARD IN THE VILLAGE OF CAHOKIA, ILLINOIS:

Section One: Use of groundwater as a potable water supply prohibited.

The use or attempted use of groundwater from within the corporate limits of the Village as a potable water supply by the installation or drilling of wells or by any other method is hereby prohibited.

Section Two: Penalties.

Any person violating the provisions of this ordinance shall be subject to a fine of up to $1,000.00 for each violation.

Section Three: Definitions.

"Person" is any individual, partnership, co-partnership, firm, company, limited liability company, corporation, association, joint stock company, trust, estate, political subdivision, or any other legal entity, or their representatives, agents or assigns.

"Potable water" is any water used for human or domestic consumption, including, but not limited to, water used for drinking, bathing, swimming, washing dishes, garden or lawn watering, or preparing foods..

Section Four: Repealer.

All ordinances or parts of ordinances in conflict with this ordinance are hereby repealed insofar as they are in conflict with this ordinance.

Section Five: Severability.

If any provision of this ordinance or its application to any person or under any circumstances is adjudged invalid, such adjudication shall not affect the validity of the ordinance as a whole or of any portion not adjudged invalid.

Section six: Effective Date.

This ordinance shall be in full force and effect from and after its passage, approval and publication, as required by law.

ADOPTED: 6-06-2000
(Date)

Renee Brown
(Village Clerk)

ADOPTED: 6-06-2000
(Date)

Michael Kaye
(Mayor)

Officially published this 21st day of June, 2000.

STATE OF ILLINOIS)
)
COUNTY OF ST. CLAIR) SS
)
VILLAGE OF CAHOKIA)

CERTIFICATE OF VILLAGE CLERK

I, Jessie Brown, Clerk of the Village of Cahokia, St. Clair County, Illinois, do hereby certify that as such Village Clerk of the Village of Cahokia, Illinois, I am legal custodian and keeper of the journal of the proceedings of the Village of Cahokia Board of Trustees of said Village, and I do certify that the attached documents are true and faithful copies of said documents. I do further certify that the original of said documents are now remaining on file and of record in my said office.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of the Village of Cahokia, Illinois, the 6 day of June, A.D. 200

Jessie Brown
Jessie Brown, Village Clerk
Village of Cahokia, Illinois

(SEAL)

** TOTAL PAGE.04 **

Appendix 3

Groundwater Flow Conditions

(Geraghty & Miller, 1994)

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APPENDIX G

GROUNDWATER FLOW CONDITIONS

Groundwater flow at Site R has been monitored routinely since 1983. Additional information on groundwater flow and aquifer characteristics of the three hydrogeologic zones within the unconsolidated aquifer was developed during RI activities in 1992. These activities included collecting water-level measurements under static conditions and conducting an aquifer test. This information was used to supplement previous data and to calibrate a three-dimensional groundwater flow model (Appendix H). Section 1 discusses groundwater flow conditions; Section 2 provides results of the aquifer test; and Section 3 provides a discussion of groundwater discharge calculations.

1.0 GROUNDWATER FLOW

Section 1.1 provides a description of groundwater flow conditions based on data collected prior to December 1992. Section 1.2 discusses results of modeling performed to assess the impact of the 1993 Mississippi River flood on the groundwater system.

1.1 NORMAL RIVER STAGES

As discussed in Section 2.6 of the RI Report (Historical Groundwater Use and Flow Patterns), regional groundwater flow in the three hydrogeologic zones is to the west, towards the Mississippi River. Water levels measured on June 3, 1992 in the shallow, intermediate, and deep zones are shown on Figures 1, 2, and 3, respectively. These data are summarized in Table 1.

Figure 1 shows that a groundwater mound exists in the shallow zone at Site R. The existence of this mound has been previously documented in the RI work plan. It is apparently due to low permeability units beneath the area that reduce drainage rates from the shallow zone after periods of precipitation or high river stage. Groundwater flows to the east and south from the mound, but must eventually flow west toward the river. Historical data and the groundwater model (Appendix H) indicate that the eastern flow reaches a stagnation point (where the eastward

flow meets the regional westward flow) which is generally between Site R and the levee. Its exact location depends on the magnitude of the regional westward flow and river stage. At the stagnation point, water from the shallow zone flows downward into the intermediate zone. Water which flows south from the mound eventually turns to the west under the influence of the regional flow patterns.

Both the easterly and southerly flow from the mound are included in the model. The easterly flow is included in the intermediate zone estimate of groundwater discharge to the river. Wells screened in the intermediate zone adjacent to the river encounter this flow. Shallow wells along the river in the southern portion of Site R and in the Expanded Study Area encounter the southern flow.

Figures 2 and 3 show that groundwater flow in the intermediate and deep zones on June 3, 1992 was toward the river. Water-level data from well clusters screened in the intermediate and deep zones (GM-27B and GM-27C, P-8 and GM-56C, and GM-28B and GM-28C) indicates that there is an upward gradient from the deep zone to the intermediate zone (Table 1). This is to be expected because these wells are adjacent to the Mississippi River, which is a major groundwater discharge boundary. Groundwater flows from the lower portion of the aquifer up toward the river.

During periods of high river stage, when the river rises higher than the water table, gradients in the intermediate and deep zones are reversed. Flow in all three zones is toward the east, but eventually reaches a stagnation point where the eastward gradient equals the westward regional gradient. This "riverbank storage effect" can last from several days to a few weeks. The response of all three zones to varying river stages was demonstrated in hydrographs provided in the RI Work Plan (Geraghty & Miller 1990).

Analytical data from the well cluster located adjacent to the flood control levee (GM-62A, GM-62B, and GM-62C) indicate that there has been little, if any, transport of constituents from Site R to the east. The concentrations of total VOCs and total SVOCs are less than 150 ug/L

in each of these wells. These concentrations are several orders of magnitude lower than the concentrations detected in Site R wells.

1.2 FLOOD CONDITIONS

In order to assess the impact of extreme conditions, such as those in the flood of 1993, a scenario which simulated even worse conditions was run on the model. A flood stage of 48 ft was assumed to last for 60 days. The flow field at the end of the 60-day period was then used to estimate the flow velocities to the east. The actual flood crest was 49.5 ft on August 1, 1993, and river levels dropped by 10 ft (to 39.5 ft) within two weeks.

The modeling results estimate that under the extreme conditions simulated, groundwater in the intermediate zone would travel approximately 6.5 ft/day. In the deep zone groundwater would travel approximately 8.3 ft/day. Water levels in the shallow zone did not reach equilibrium in the 60-day period modeled. Water-level measurements obtained from wells east of the flood wall on July 24, 1993 (when the river stage was 46.5 ft) were used to calculate a groundwater velocity of 0.06 ft/day in the shallow zone.

Within the actual groundwater flow environment, constituents dissolved in the groundwater would move more slowly than the predicted groundwater velocities because various factors such as adsorption and biodegradation can retard their movement. No retardation coefficients were considered in the modeled scenario.

2.0 AQUIFER TEST

An aquifer test was conducted to provide site-specific hydraulic characteristics necessary to calibrate the three-dimensional groundwater flow model for the area and to calculate concentrations of constituents discharging to the Mississippi River for use in the risk assessment. During June 15 through 19, 1992, a step-drawdown test, constant-rate aquifer test, and recovery

test were conducted. The site-specific aquifer coefficients determined from this testing include transmissivity, hydraulic conductivity, and storage coefficient

2.1 FIELD TESTING

Prior to testing, two 6,000-gallon Calgon carbon adsorption units were delivered to the site, set up in series, and filled with 40,000 pounds of activated carbon to treat the discharge water on site. Piping was then installed from the well to the carbon units and from the carbon unit discharge line to a line which was connected to the American Bottoms treatment facility. The American Bottoms facility issued a permit for this discharge before testing was initiated.

A step-drawdown test was conducted to evaluate the optimum pumping rate for the constant-rate aquifer test. Based on this test, a flow rate of 350 gallons per minute (gpm) was selected for the constant-rate test. A network of 22 wells was monitored on a regular basis using three different types of monitoring equipment. Pressure transducers were used to monitor water-level changes in 16 monitoring wells, automatic Steven's water-level recorders were used on three wells, and manual measurements were collected in three wells. Table 2 provides a summary of the method used to monitor each well. The water-level measurements collected during the test are provided in Attachment A.

During the test, water samples were collected from the carbon unit influent, lead vessel effluent, and final effluent after 6, 24, and 48 hours, for laboratory analysis of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and herbicides. The final effluent sample collected 24 hours into the test was also analyzed for cyanide, ammonia, metals, and pesticides. Analysis was performed by Savannah Laboratories, Savannah, Georgia. Field analyses of the phenol in lead vessel effluent were conducted to monitor for breakthrough.

At approximately 12 hours into the test, the river stage began to rise as a result of a storm event that had occurred upriver several days earlier (Figure 4). Water levels within the wells

began to rise in response to the river, and the cone of depression that had been established began to diminish.

Drawdown in the intermediate and deep zones was plotted after 550 minutes of pumping to show the effect of pumping prior to the impact of rising river stage on these zones (Figure 5). Review of Figure 5 shows that approximately 1 ft of drawdown was induced at a distance of 100 to 150 ft from pumping well TW-1, and drawdown appeared to extend to the site boundaries. Approximately 0.2 ft of drawdown was observed in wells along the eastern border of Site R, approximately 0.4 ft of drawdown was observed in wells along the northern boundary, and approximately 0.1 ft of drawdown was observed in wells along the southern boundary of the site.

After approximately 1000 minutes of pumping, the rising river stage reduced drawdown in intermediate and deep zone wells, and the cone of influence decreased in size (Figure 6). Along the southern boundary of the area of influence, water levels rose to 0.2 ft above the static level in well GM-55C and 0.59 ft in well GM-28C. Along the northern boundary, water levels rose to 1.2 ft above the static level. The effect of the rising river stage is less apparent in the intermediate and deep zone wells in the vicinity of well TW-1, where drawdown data did not change significantly (Figure 6). Eastern perimeter wells exhibited increased drawdowns at 1000 minutes and were apparently unaffected by elevated river stage. This is most likely due to their distance from the river.

After 51 hours of pumping, the constant-rate drawdown test was completed, and recovery measurements were collected for 4 hours. This information was used to confirm the results of the drawdown test. Recovery water-level measurements are provided in Attachment A.

2.2 METHODS OF EVALUATION

Different types of aquifers respond to pumping in different ways. Several analytical solutions were used to evaluate the test data, to determine whether the aquifers could be characterized as confined or semi-confined.

Unconfined aquifer conditions were analyzed using the non-equilibrium method of Neuman or the methods of Theis and Cooper-Jacob with Jacob's correction for reduction in saturated thickness. The applicability of the semi-confined (leaky) solution of aquifer conditions was analyzed using the non-equilibrium method of Hantush, with storage in the overlying unpumped aquifer zone.

Except for the Jacob distance-drawdown solution, all of the methods were applied with the support of AQTESOLV, a Geraghty & Miller Modeling Group aquifer test analysis software package. Data utilized by the Jacob distance-drawdown solution were plotted on semilog paper.

AQTESOLV is an interactive, menu driven program that provides graphical curve matching techniques for quick and efficient analysis of aquifer test data. The option was utilized in which the analyst interactively matches type curves to the time-drawdown data directly on the computer screen. Data relevant to the configuration of the aquifer test are presented in Table 3.

2.2.1 Theis Method

If an unconfined aquifer does not exhibit a delayed water-table response, then the Theis Method for unsteady flow in confined aquifers can be applied once the drawdown data are corrected as follows:

$$S' = S - \frac{S^2}{2m}$$

where S' = equivalent confined aquifer drawdown

S = observed drawdown under unconfined conditions

m = aquifer thickness (pretesting)

Correction of drawdown data was unnecessary, however, because dewatering of the aquifer was insignificantly small in relation to the total saturated thickness of the aquifer. The Theis type-curve exhibited a close match with the log-log plots of drawdown versus time for the intermediate zone wells.

2.2.2 Neuman Method

Water levels near a pumping well in unconfined aquifers often tend to decline at a slower rate than that described by the Theis solution. Log-log plots of time-drawdown exhibit a three phase S-shape curve due to the phenomenon of "delayed water-table response." The second phase is characterized by gravity drainage of the pore spaces that is not instantaneous. A delay in the release of this stored water causes the increase of drawdown to slow with time, and thus deviate from the Theis curve (Kruseman and de Ridder 1990). Data from the three deep zone wells corresponded to the flow regime described by the Neuman solution. The applicability of the Neuman method to this aquifer is based on the premise that slow drainage from low permeability zones and horizontal-to-vertical anisotropy cause a delayed yield of water released from storage.

2.2.3 Hantush Method

When a well is pumped in a leaky aquifer, the well discharge comes from storage within the aquifer, vertical leakage from stored water in the aquitard, and leakage through the aquitard from the overlying unpumped aquifer. The leaky-confined aquifer analytical solution was also applied to the time-drawn data from the deep zone wells because aquifer deposits in the water-table zone beneath Site R consist of poorly sorted, fine grained material of low permeability, and drawdown in this zone was negligible.

2.2.4 Jacob (Distance-Drawdown) Method

Simultaneous drawdown measurements in several observation wells, each at a different distance from the pumped well, were plotted on semilog paper to show the straight line distance-drawdown relationship. This distance-drawdown graph was used to calculate the aquifer transmissivity and storativity. Distance-drawdown graphs were plotted for data from groups of intermediate and deep zone wells to determine the aquifer characteristics for those zones.

2.3 INTERPRETATION OF RESULTS

2.3.1 Water-Table Zone

Observation wells screened in the poorly sorted, fine grained material of this zone recorded maximum drawdown ranging from 0.08 to 0.15 ft. This small drawdown was not sufficient to establish drawdown behavior from natural fluctuations in water-level elevations. Thus, the aquifer characteristics of the water-table zone were not estimated through the analysis of aquifer test data.

2.3.2 Intermediate Zone

Time-drawdown measurements in the intermediate zone wells exhibited the characteristic shape of the Theis type-curve (Figures 7 through 11). The decline in measured drawdown beginning about 800 minutes after the start of pumping indicates the recovery in water-levels induced by aquifer recharge from the river. Table 4 presents trasmissivity values for all observation wells that produced a sufficient drawdown response; values ranged from about 22,000 to 38,200 square feet per day (ft^2/day). Values of storativity calculated with the Theis method range from .004 to .013 (Table 4). Estimates of transmissivity obtained with the Theis solution were closely reproduced with the Cooper-Jacob (semilog) method for Well B-24C (Figure 12) and the Neuman method for Well B-26B (Figure 13).

The Jacob distance-drawdown method was applied to a group of intermediate zone wells (P-5, P-9, P-10, B-26B) at 10, 100, and 500 minutes into the aquifer test. This method yielded inconsistent results that ranged from 24,702 ft^2/day to 51,463 ft^2/day (Figure 14). These estimates were not considered to be as reliable as individual well analysis.

2.3.3 Deep Zone

Several minutes into the aquifer test, the increase in drawdown in the deep zone wells began to slow and deviate from the Theis type-curve. This phenomenon, in which the drawdown curve approaches horizontal, is characteristic of the aquifer response to delayed gravity drainage of water released from storage (Figure 15 and 16). Calculation of transmissivities with the Neuman solution for deep zone Wells GM-56C and GM-57C were 23,961 ft^2/day and 29,736 ft^2/day. Under normal circumstances, the time-drawdown curve increases in slope and once again conforms to the Theis curve. However, the water-level recovery in the observation wells induced by recharge from the river masked the typical third phase of the Neuman curve.

The effect of leakage through an overlying confining unit on drawdown is comparable to that of delayed drainage. Therefore, the Hantush (leaky confined) solution was used to determine if it was the appropriate analytical model for this aquifer. The deep zone transmissivities calculated with the Hantush method yielded one low estimate of 15,580 ft^2/day (Well GM-56C), and two more representative estimates of 30,859 ft^2/day for Well GM-57C, and 31,162 ft^2/day for Well GM-28C (Figures 17 through 19). However, the Hantush type-curve did not fit the time-drawdown data as well as the Neuman type-curve. Although the Hantush solution yielded similar results to the Neuman solution, its applicability to this aquifer system for analysis of the aquifer test is not the appropriate selection. The Neuman theoretical model identifies most closely with this aquifer system and provides the best interpretation of the time-drawdown data.

The Jacob distance-drawdown analysis was also performed on the group of deep zone wells (GM-28C, GM-56C, and GM-57C) at 10, 100, and 500 minutes into the aquifer test (Figure 20). The method yielded consistent results but the transmissivities were lower than estimates computed

for individual time-drawdown plots. Values of transmissivity with the Jacob method ranged from 17,154 ft^2/day to 22,055 ft^2/day. The distance-drawdown results for the intermediate and deep zone wells were lower than individual well estimates. However, the groundwater flow model was calibrated with transmissivity values based on the higher estimates obtained from individual well plots. Thus, simulated remedial pumping rates will produce conservative estimates of capture zones since they are based on values in the higher range of transmissivity estimates.

3.0 GROUNDWATER DISCHARGE CALCULATIONS

As one of the first steps of the risk assessment, a list of chemicals of concern (COC) was selected for the groundwater at Site R. In order to complete the evaluation of risks associated with exposure to river water affected by the ground water, predicted concentrations of the COCs in the river were calculated. Geraghty & Miller used the groundwater model described in Appendix H and the concentrations of the COCs in the wells to complete these calculations.

Several steps were involved in the process. First, because the rate of groundwater discharge to the river changes with varying river stage, data were obtained from the U.S. Army Corps of Engineers (COE) which show the daily, percent frequency of occurrence for every river stage on record in 1-ft increments, i.e., the percent of days in a given period that each river stage occurred. The data included the 130-year period from January 1861 to December 1991.

Using these data, a range of river stages was selected for the discharge calculations. The lower limit of this range was 374 ft above mean sea level (msl), the lowest river stage on record. The upper limit of the range was 410 ft above msl. Groundwater level data and the model indicate that the hydraulic gradient in the aquifer reverses above this level, so there would be no discharge to the river. These river stages and their frequency of occurrence are shown in columns 1 and 2 of Table 5.

The model was used to predict the groundwater discharge to the river at each river stage in the range. A separate calculation was done for each of the three hydrogeologic zones (Columns

3, 5, and 7 of Table 5). These predicted discharge rates at each river stage were then multiplied by the frequency of occurrence for that stage. These products (columns 4, 6, and 8 of Table 5) were summed to obtain a weighted average daily discharge for each aquifer zone. This represents the average volume of ground water which flows into the river each day from each aquifer zone along the entire length of the landfill (2,000 ft). In the next step, the length of the river frontage was divided into segments. Each hydrogeologic zone was treated separately and was divided into one segment for each well screened in that zone. The percent of river frontage represented by each well segment was multiplied by the average daily discharge for that aquifer zone and then by the concentration in that well of each COC. These products were summed to obtain a weighted average daily loading of each COC to the river for each aquifer zone. These were then summed across the three zones to obtain a total average daily loading to the river for each COC.

To obtain the predicted concentration of each COC in the river, these daily loadings will be divided by the flow rate in the river. Both average exposure and reasonable maximum exposure (RME) scenarios will be considered in the risk assessment. Calculations of the river concentrations of each COC will be shown in the risk assessment.

The discharge across all zones for all river stages was summed in Column 9 of Table 5. This number (795,000 gallons/day) will be used for calculating percent dilution in the evaluation of aquatic hazard indices in the risk assessment).

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Table 1 Water Level Elevations in Monitoring Wells at Sauget Site R, June 3, 1992, Monsanto Company, Sauget, Illinois

Well No	Measuring Point Elevation (1)	Depth to Water (2)	Water Level Elevation (1)
Shallow Wells			
B-21A	428.53	29.93	398.60
B-22A	428.16	28.79	399.37
B-24A	422.49	22.17	400.32
B-25A	428.47	30.95	397.52
B-26A	423.71	26.37	397.34
B-28A	423.04	25.25	397.79
B-29A	429.03	31.97	397.06
B-31B	421.68	28.45	393.23
P-6	421.78	24.92	396.86
P-7	421.82	22.96	398.86
P-14	424.36	24.93	399.43
GM-62A	425.75	31.99	393.76
GM-65A	424.11	32.66	391.45
GM-66A	422.73	27.79	394.94
Intermediate Wells			
GM-27B	426.04	36.63	389.41
GM-28B	423.88	34.15	389.73
B-21B	428.37	36.12	392.25
B-22B	428.16	37.55	390.61
B-23B	428.17	33.97	394.20
B-24B	422.28	31.70	390.58
B-24C	422.52	32.02	390.50
B-25B	427.35	34.84	392.51
B-26B	423.62	33.29	390.33
B-27B	425.83	34.26	391.57
B-28B	423.08	32.55	390.53
B-29B	429.06	36.69	392.37
B-30B	430.52	38.02	392.50
B-31C	421.88	28.70	393.18
P-1	423.11	33.18	389.93
P-2	423.15	33.26	389.89
P-3	423.43	33.27	390.16
P-4	421.82	31.70	390.12
P-5	422.12	32.31	389.81
P-8	421.79	32.02	389.77
P-9	423.14	33.38	389.76
P-10	423.43	33.19	390.24
P-11	422.30	32.68	389.62
P-12	423.75	34.45	389.30
P-13	424.32	34.90	389.42
GM-62B	426.16	32.42	393.74
GM-66B	423.20	34.05	389.15
TW-1	423.14	32.47	390.67
Deep Wells			
GM-27C	426.76	36.60	390.16
GM-28C	423.78	33.98	389.80
GM-55C	422.88	32.32	390.56
GM-56C	422.16	31.16	391.00
GM-57C	424.02	34.06	389.96
GM-62C	427.03	33.30	393.73
GM-66C	423.46	34.37	389.09
Bedrock Wells			
GM-106	424.82	29.73	395.09
B-102	423.84	31.74	392.10

(1) Elevation in feet above mean sea level.
(2) Depth to water in feet below measuring point.
The water-level for Well B-21A may be representative of a water level in the 2-ft section of blank casing at the bottom of the well, and not representative of the water table zone. This water level was not used in the groundwater model.

Table 2. Wells Monitored During the June 1992 Aquifer Test, Sauget Site R, Monsanto Company, Sauget, Illinois.

Well Number	Pressure Transducer	Stevens Recorder	Manual Measurement
Water-Table Zone			
P-7	X	-	-
B-24A	X	-	-
B-25A	X	-	-
B-26A	X	-	-
Intermediate Zone			
P-5	X	-	-
P-8	X*	-	-
P-9	X	-	-
P-10	X	-	-
B-24C	X*	-	-
B-25B	X	-	-
B-26B	X*	-	-
B-30B	-	-	X
B-31C	-	-	X
GM-27B	-	X	-
GM-28B	X	-	-
Test Well 1	X	-	-
Deep Zone			
GM-27C	-	X	-
GM-28C	X	-	-
GM-55C	-	-	X
GM-56C	X*	-	-
GM-57C	X	-	-
Bedrock Zone			
GM-106	-	X	-

* Backup transducer was installed

Table 3 Data Used to Define the Configuration of the June 1992 Aquifer Test, Sauget, Illinois

Well Number	Distance From Pumped Well to Observation Well	Maximum Drawdown	Saturated Thickness	Well Depth	Depth From Static Water Level to Top of Screen	Depth From Static Water Level to Bottom of Screen
Water-Table Zone						
B-24A	118	.08	90	27.5	0	2.6
B-25A	625	.07	90	35.2	0	1.7
B-26A	355	.15	90	33.2	0	3.8
P-7	102	.05	90	33	2.7	7.7
Intermediate Zone						
B-24C	118	.98	90	69	22.9	32.9
P-10	143	.97	90	54	11.4	16.4
P-9	104	.99	90	50	7.7	12.7
B-25B	625	.33	90	49.5	0.8	10.8
P-5	272	.36	90	54.5	13.3	18.3
B-26B	433	.46	90	49.8	2.4	12.4
GM-28B	772	.22	90	93	34.4	54.4
P-8	112	--	90	53.5	12.5	17.5
TW-1*	0	34.8	90	108	41.5	73.5
Deep Zone						
GM-57C	368	.77	90	116	60	80
GM-28C	772	.21	90	107	51	71
GM-56C	150	1.21	90	111	58.1	78.1

* Pumping Rate = 350 gpm; screened interval is from the lower intermediate zone to the upper deep zone.
-- Not reported due to problems with pressure transducer.

Table 4. Estimates of Aquifer Characteristics Obtained Through Interpretation of Observation Well Drawdown Data From the June 1992 Aquifer Test, Sauget Site R, Monsanto Company, Sauget, Illinois.

Well Number	Method	Aquifer Test	Transmissivity Ft²/Min	Transmissivity Ft²/Day	Hydraulic Conductivity Ft/Day	Storage Coefficient
Intermediate Zone						
P-5	Theis	Unconfined	26.55	38,232	425	.012
P-9	Theis	Unconfined	15.28	22,003	244	.0134
P-10	Theis	Unconfined	15.19	21,874	243	.0083
B-24C	Theis	Unconfined	23.8	34,272	381	.0042
	Cooper-Jacob	Unconfined	22.53	32,443	360	.0045
B-26B	Theis	Unconfined	22.22	31,996	356	.0065
	Neuman	Unconfined	20.3	29,232	325	.007 (Sy)
Deep Zone						
GM-57C	Hantush	Leaky	21.43	30,859	343	.0004
	Neuman	Unconfined	20.65	29,736	330	.0055 (Sy)
GM-56C	Hantush	Leaky	10.82	15,580	173	.0013
	Neuman	Unconfined	16.64	23,961	266	.016 (Sy)
GM-28C	Hantush	Leaky	21.64	31,162	346	.0001
Distance-Drawdown Evaluation						
Intermediate Wells	Jacob	Unconfined				
10 minutes			35.74	51,463	572	.0055
100 minutes			23.8	34,309	381	.0025
500 minutes			17.2	24,702	274	.0146
Deep Wells	Jacob	Unconfined				
10 minutes			15.32	22,055	245	.0005
100 minutes			12.61	18,163	202	.0028
500 minutes			11.91	17,154	191	.0104

Table 5 Estimate of Average Daily Ground-Water Discharge to Mississippi River, Sauget Site R, Monsanto Company, Sauget, Illinois

1 River-Stage Elevation (ft above MSL)	2 Frequency of Occurence (% of days)	3 Q Shallow	4 Q x % Shallow	5 Q Intermediate	6 Q x % Intermediate	7 Q Deep	8 Q x % Deep	9 Total Q x %
374	0.2	0.00024	0.00000048	0.6496	0.0012992	0.6228	0.0012456	0.00254528
375	0.5	0.00037	0.00000185	0.634	0.00317	0.608	0.00304	0.00621185
376	1.5	0.0005	0.0000075	0.6184	0.009276	0.5932	0.008898	0.0181815
377	2.2	0.00063	0.00001386	0.6028	0.0132616	0.5784	0.0127248	0.02600026
378	2.3	0.00076	0.00001748	0.5872	0.0135056	0.5636	0.0129628	0.02648588
379	3	0.00089	0.0000267	0.5716	0.017148	0.5488	0.016464	0.0336387
380	3.8	0.00102	0.00003876	0.556	0.021128	0.534	0.020292	0.04145876
381	3.9	0.00109	0.00004251	0.5406	0.0210834	0.5194	0.0202566	0.04138251
382	4.6	0.00116	0.00005336	0.5252	0.0241592	0.5048	0.0232208	0.04743336
383	4.2	0.00124	0.00005208	0.5098	0.0214116	0.4902	0.0205884	0.04205208
384	4.9	0.00131	0.00006419	0.4944	0.0242256	0.4756	0.0233044	0.04759419
385	4.9	0.00138	0.00006762	0.479	0.023471	0.461	0.022589	0.04612762
386	5.5	0.00142	0.0000781	0.4638	0.025509	0.4462	0.024541	0.0501281
387	4.5	0.00145	0.00006525	0.4486	0.020187	0.4314	0.019413	0.03966525
388	4.4	0.00149	0.00006556	0.4334	0.0190696	0.4166	0.0183304	0.03746556
389	4.1	0.00152	0.00006232	0.4182	0.0171462	0.4018	0.0164738	0.03368232
390	4.1	0.00156	0.00006396	0.403	0.016523	0.387	0.015867	0.03245396
391	3.5	0.00158	0.0000553	0.3878	0.013573	0.3724	0.013034	0.0266623
392	3.5	0.00159	0.00005565	0.3726	0.013041	0.3578	0.012523	0.02561965
393	3.5	0.00161	0.00005635	0.3574	0.012509	0.3432	0.012012	0.02457735
394	3.6	0.00162	0.00005832	0.3422	0.0123192	0.3286	0.0118296	0.02420712
395	2.7	0.00164	0.00004428	0.327	0.008829	0.314	0.008478	0.01735128
396	2.9	0.00164	0.00004756	0.3116	0.0090364	0.2992	0.0086768	0.01776076
397	2.5	0.00164	0.000041	0.2962	0.007405	0.2844	0.00711	0.014556
398	2.2	0.00164	0.00003608	0.2808	0.0061776	0.2696	0.0059312	0.01214488
399	2.1	0.00164	0.00003444	0.2654	0.0055734	0.2548	0.0053508	0.01095864
400	1.8	0.00164	0.00002952	0.25	0.0045	0.24	0.00432	0.00884952
401	1.8	0.00163	0.00002934	0.235	0.00423	0.2256	0.0040608	0.00832014
402	1.3	0.00161	0.00002093	0.22	0.00286	0.2112	0.0027456	0.00562653
403	1.4	0.0016	0.0000224	0.205	0.00287	0.1968	0.0027552	0.0056676
404	1.1	0.00158	0.00001738	0.19	0.00209	0.1824	0.0020064	0.00411378
405	1.2	0.00157	0.00001884	0.175	0.0021	0.168	0.002016	0.00413484
406	0.9	0.00154	0.00001386	0.1602	0.0014418	0.1537	0.0013833	0.00283896
407	0.9	0.00152	0.00001368	0.1454	0.0013086	0.1394	0.0012546	0.00257688
408	1.1	0.00149	0.00001639	0.1306	0.0014366	0.1251	0.0013761	0.00282909
409	0.9	0.00147	0.00001323	0.1158	0.0010422	0.1108	0.0009972	0.00205263
410	0.8	0.00144	0.00001152	0.101	0.000808	0.0965	0.000772	0.00159152
Weighted Average Daily Discharge	98.3		0.00135768 (Shallow)		0.4047248 (Intermediate)		0.3888462 (Deep)	0.79492865 (Total)

* - Rate of ground-water discharge to river (million gallons per day).

Table 5. Estimate of Average Daily Ground-Water Discharge to Mississippi River, Sauget Site R, Monsanto Company, Sauget, Illinois

1 River-Stage Elevation (ft above MSL)	2 Frequency of Occurence (% of days)	3 Q Shallow	4 Q x % Shallow	5 Q Intermediate	6 Q x % Intermediate	7 Q Deep	8 Q x % Deep	9 Total Q x %
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375	0.5	0.00037	0.00000185	0.634	0.00317	0.608	0.00304	0.00621185
376	1.5	0.0005	0.0000075	0.6184	0.009276	0.5932	0.008898	0.0181815
377	2.2	0.00063	0.00001386	0.6028	0.0132616	0.5784	0.0127248	0.02600026
378	2.3	0.00076	0.00001748	0.5872	0.0135056	0.5636	0.0129628	0.02648588
379	3	0.00089	0.0000267	0.5716	0.017148	0.5488	0.016464	0.0336387
380	3.8	0.00102	0.00003876	0.556	0.021128	0.534	0.020292	0.04145876
381	3.9	0.00109	0.00004251	0.5406	0.0210834	0.5194	0.0202566	0.04138251
382	4.6	0.00116	0.00005336	0.5252	0.0241592	0.5048	0.0232208	0.04743336
383	4.2	0.00124	0.00005208	0.5098	0.0214116	0.4902	0.0205884	0.04205208
384	4.9	0.00131	0.00006419	0.4944	0.0242256	0.4756	0.0233044	0.04759419
385	4.9	0.00138	0.00006762	0.479	0.023471	0.461	0.022589	0.04612762
386	5.5	0.00142	0.0000781	0.4638	0.025509	0.4462	0.024541	0.0501281
387	4.5	0.00145	0.00006525	0.4486	0.020187	0.4314	0.019413	0.03966525
388	4.4	0.00149	0.00006556	0.4334	0.0190696	0.4166	0.0183304	0.03746556
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390	4.1	0.00156	0.00006396	0.403	0.016523	0.387	0.015867	0.03245396
391	3.5	0.00158	0.0000553	0.3878	0.013573	0.3724	0.013034	0.0266623
392	3.5	0.00159	0.00005565	0.3726	0.013041	0.3578	0.012523	0.02561965
393	3.5	0.00161	0.00005635	0.3574	0.012509	0.3432	0.012012	0.02457735
394	3.6	0.00162	0.00005832	0.3422	0.0123192	0.3286	0.0118296	0.02420712
395	2.7	0.00164	0.00004428	0.327	0.008829	0.314	0.008478	0.01735128
396	2.9	0.00164	0.00004756	0.3116	0.0090364	0.2992	0.0086768	0.01776076
397	2.5	0.00164	0.000041	0.2962	0.007405	0.2844	0.00711	0.014556
398	2.2	0.00164	0.00003608	0.2808	0.0061776	0.2696	0.0059312	0.01214488
399	2.1	0.00164	0.00003444	0.2654	0.0055734	0.2548	0.0053508	0.01095864
400	1.8	0.00164	0.00002952	0.25	0.0045	0.24	0.00432	0.00884952
401	1.8	0.00163	0.00002934	0.235	0.00423	0.2256	0.0040608	0.00832014
402	1.3	0.00161	0.00002093	0.22	0.00286	0.2112	0.0027456	0.00562653
403	1.4	0.0016	0.0000224	0.205	0.00287	0.1968	0.0027552	0.0056476
404	1.1	0.00158	0.00001738	0.19	0.00209	0.1824	0.0020064	0.00411378
405	1.2	0.00157	0.00001884	0.175	0.0021	0.168	0.002016	0.00413484
406	0.9	0.00154	0.00001386	0.1602	0.0014418	0.1537	0.0013833	0.00283896
407	0.9	0.00152	0.00001368	0.1454	0.0013086	0.1394	0.0012546	0.00257688
408	1.1	0.00149	0.00001639	0.1306	0.0014366	0.1251	0.0013761	0.00282909
409	0.9	0.00147	0.00001323	0.1158	0.0010422	0.1108	0.0009972	0.00205263
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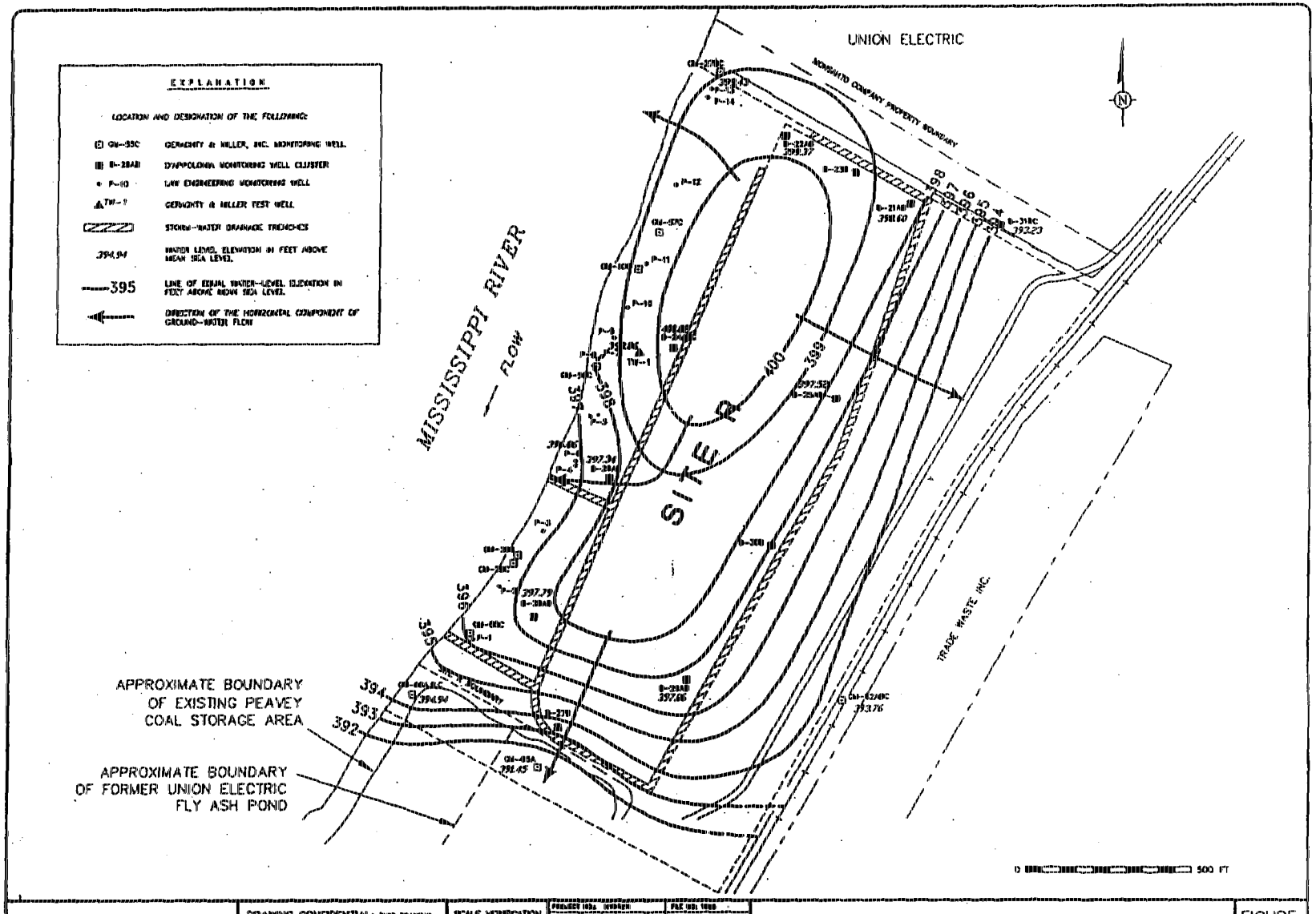
Weighted Average Daily Discharge	98.3		0.00135766 (Shallow)		0.4047248 (Intermediate)		0.3888442 (Deep)	0.79492865 (Total)

Q - Rate of ground-water discharge to river (million gallons per day).



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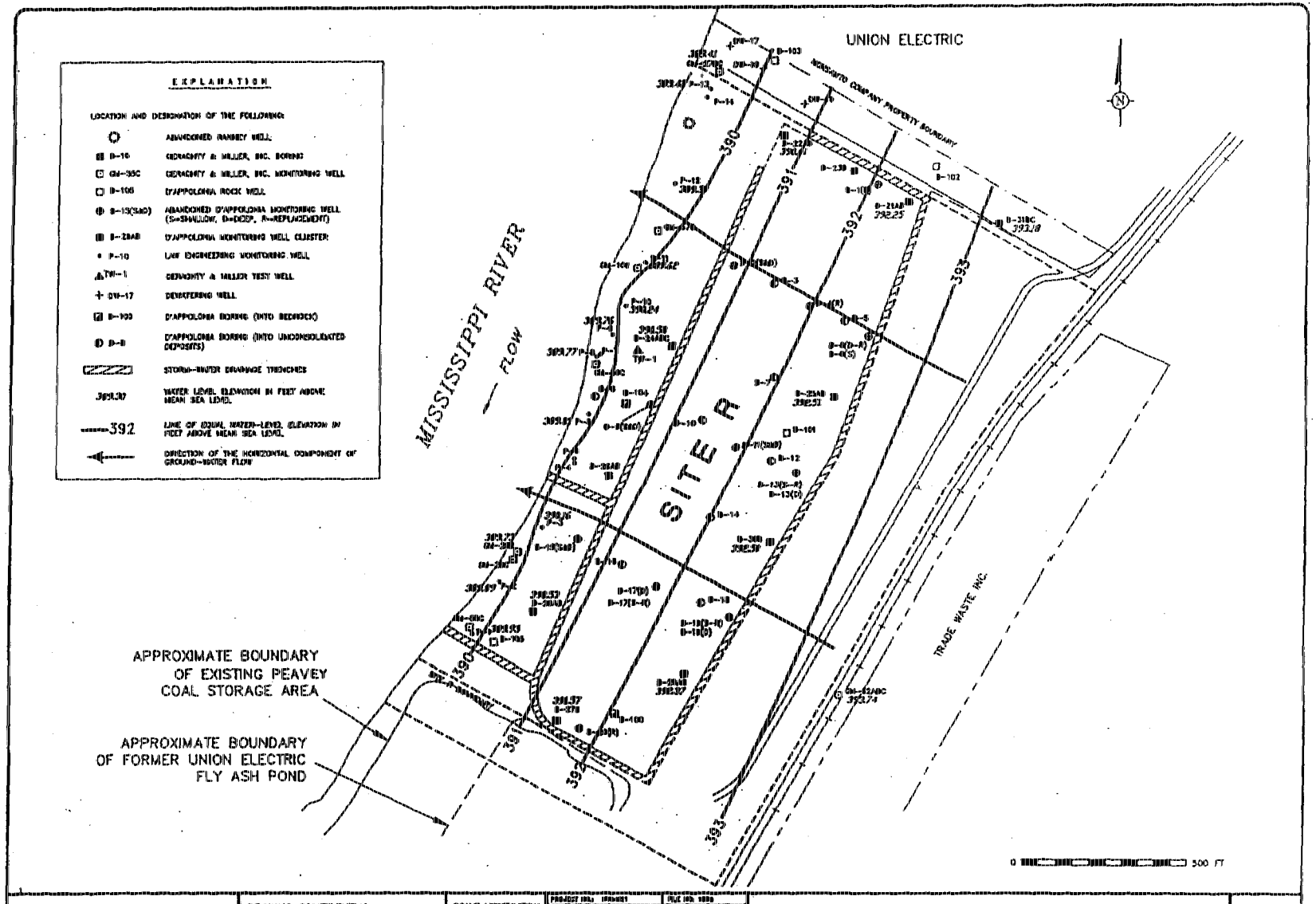
USE TO VERIFY FIGURE REPRODUCTION SCALE

WATER LEVEL ELEVATIONS IN THE SHALLOW ZONE ON JUNE 3, 1992

MONSANTO CHEMICAL COMPANY
SAUGET SITE R, ILLINOIS

FIGURE 1



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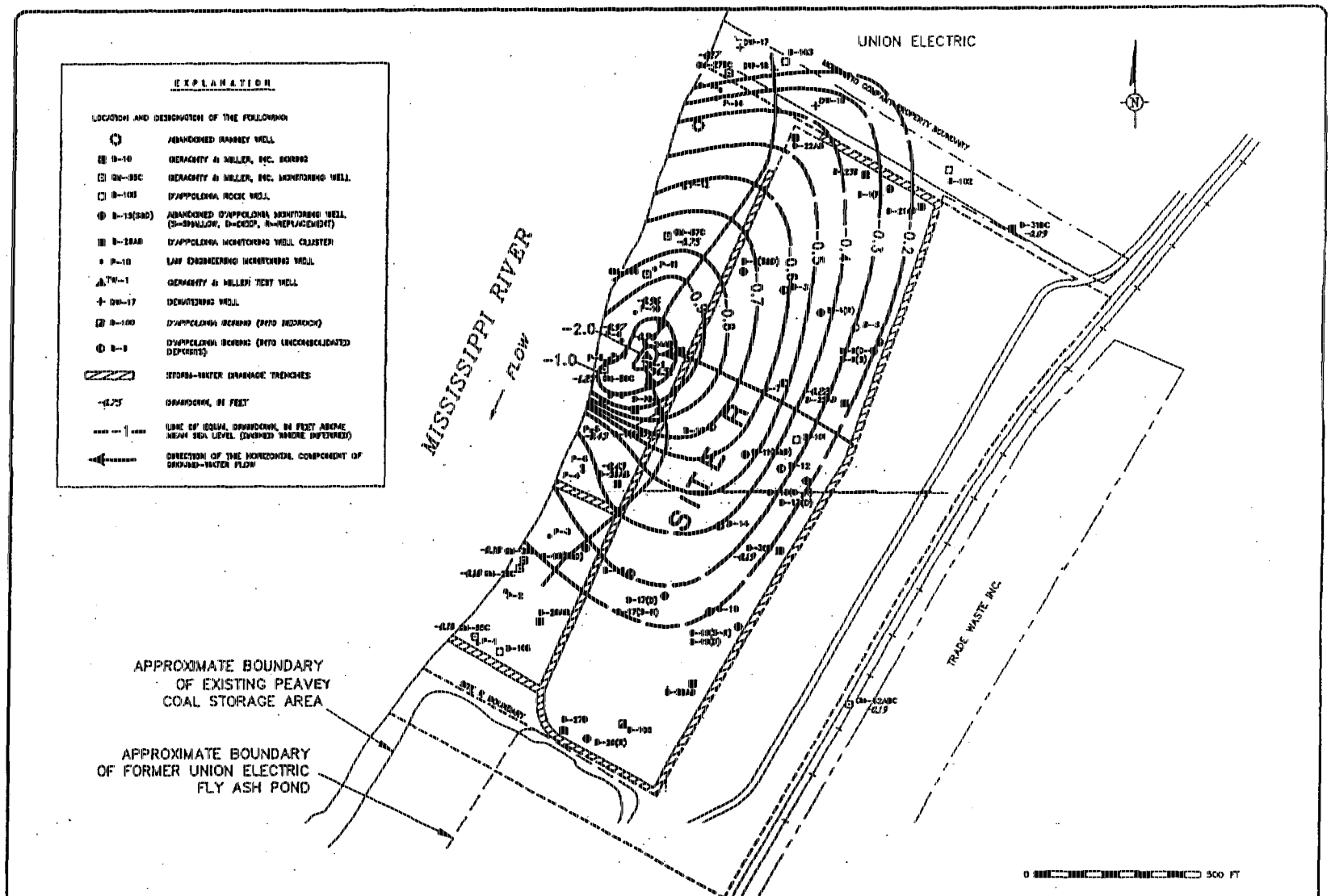
WATER-LEVEL ELEVATIONS IN THE INTERMEDIATE ZONE ON JUNE 3, 1992

MONSANTO COMPANY
SAUGET, ILLINOIS

FIGURE 2



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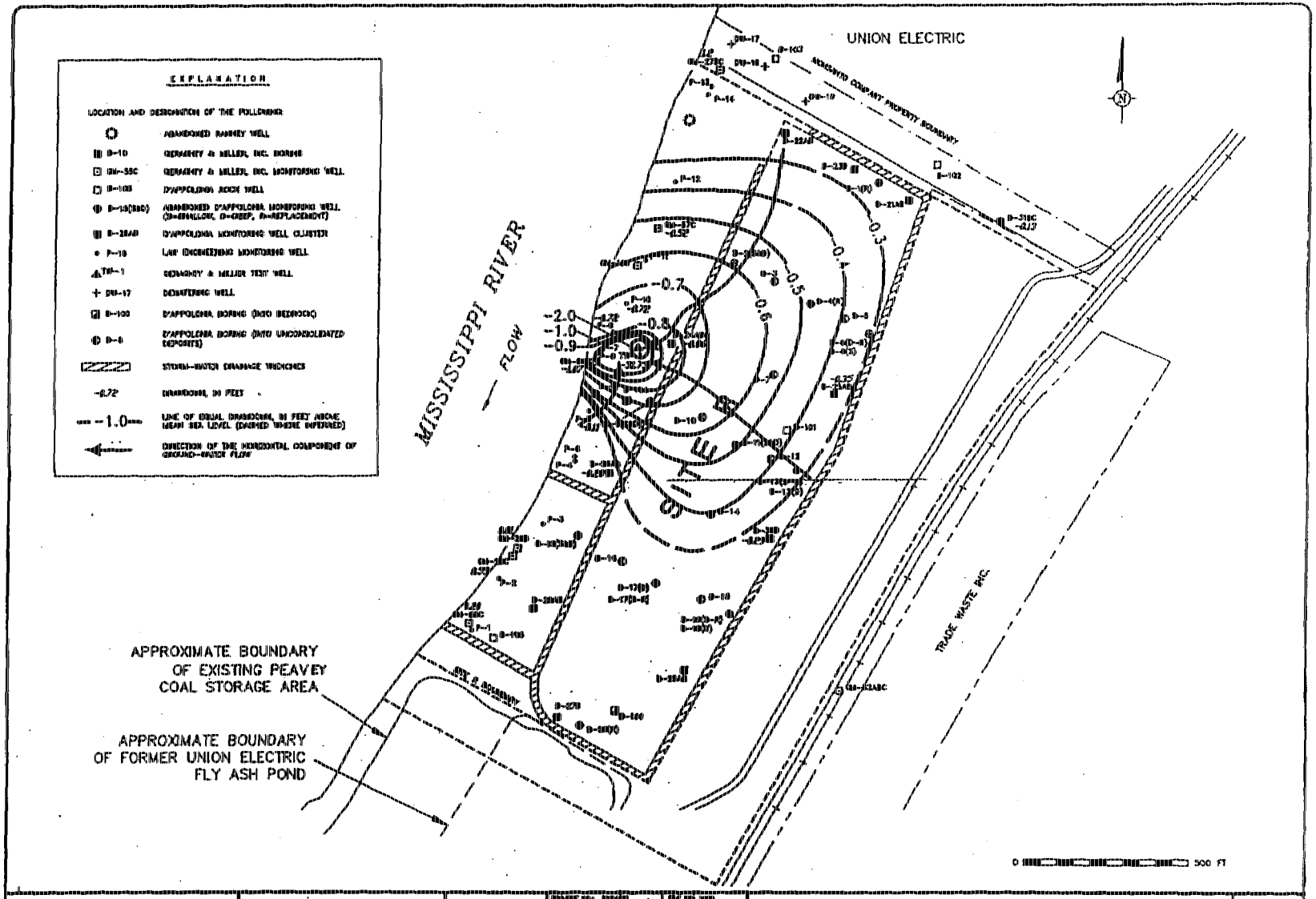
DRAWDOWN IN THE INTERMEDIATE AND DEEP AQUIFERS AFTER 550 MINUTES OF PUMPING ON JUNE 17, 1992

MONSANTO COMPANY
SAUGET, ILLINOIS

FIGURE 5



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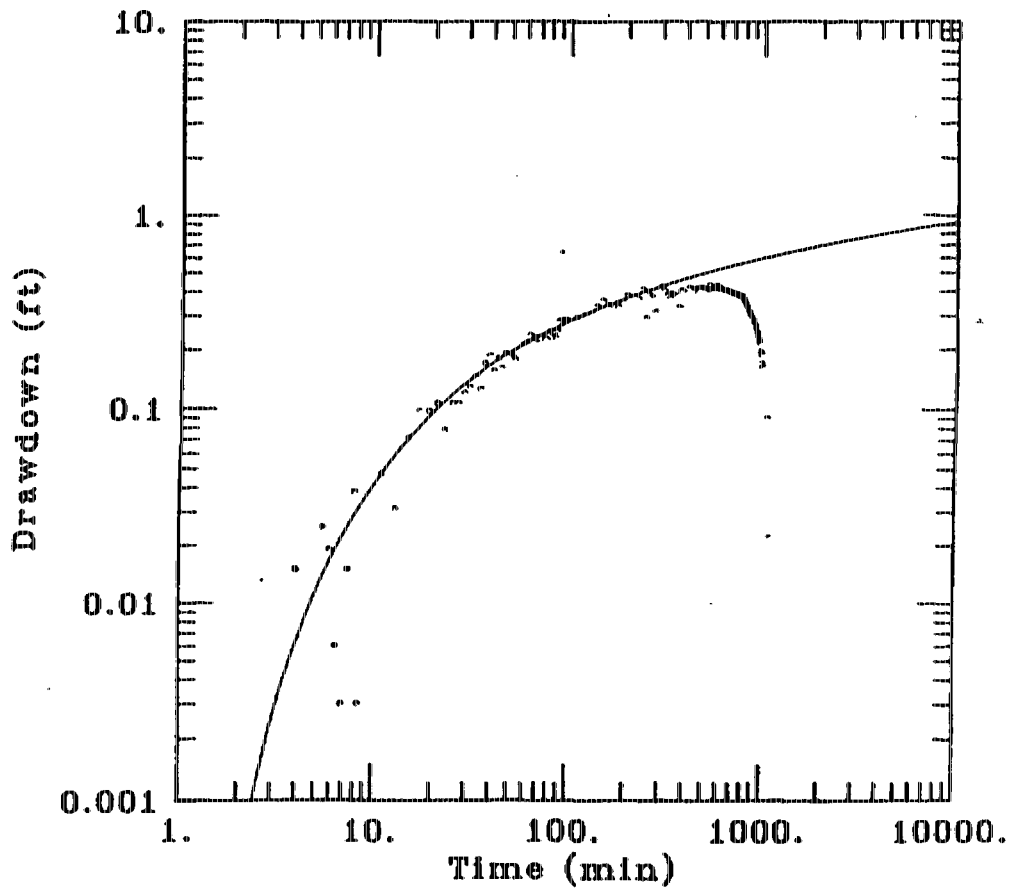
SCALE VERIFICATION

DRAWDOWN IN THE INTERMEDIATE AND DEEP AQUIFERS AFTER 1,000 MINUTES OF PUMPING ON JUNE 18, 1992

FIGURE 6

GERAGHTY & MILLER	Client: MONSANTO
Project No.: NY64207	Location: SAUGET, ILLINOIS

P-5



DATA SET:
P-5.AQT
07/08/92

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Theis

TEST DATE:
JUNE 17, 1992

TEST WELL:
TW-1

OBS. WELL:
P-5

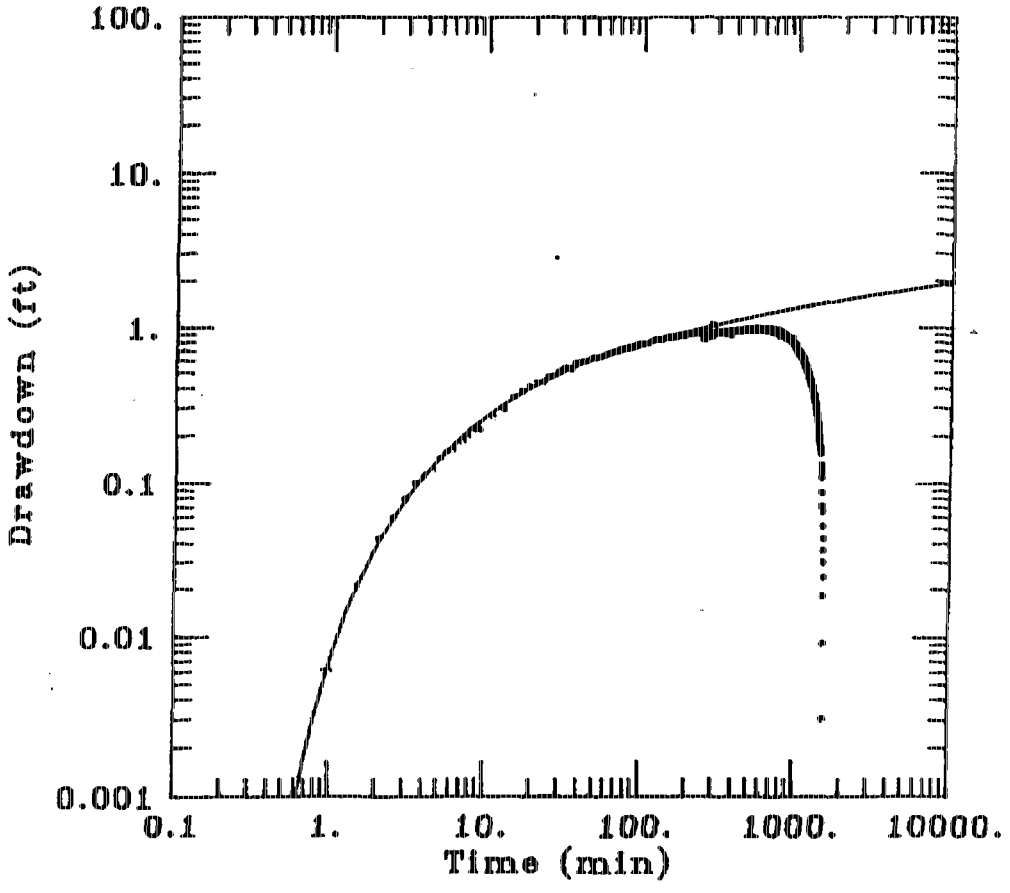
ESTIMATED PARAMETERS:
T = 26.55 ft^2/min
S = 0.01176

TEST DATA:
Q = 16.8 ft^3/min
r = 272. ft
b = 90. ft

Figure 7

GERAGHTY & MILLER	Client: MONSANTO
Project No.: NY64207	Location: SAUGET, ILLINOIS

P-9



DATA SET:
p-9.aqt
07/01/92

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Theis

TEST DATE:
JUNE 17, 1992

TEST WELL:
TW-1

OBS. WELL:
P-9

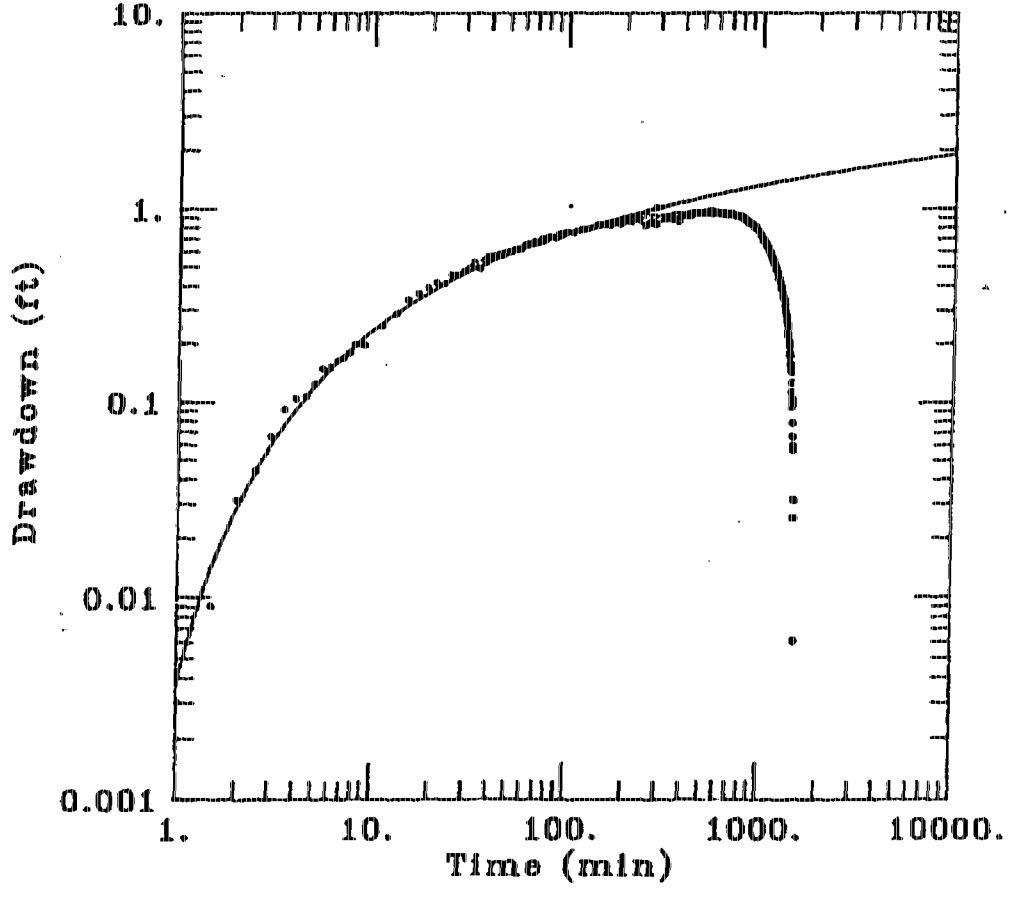
ESTIMATED PARAMETERS:
T = 15.28 ft^2/min
S = 0.01342

TEST DATA:
Q = 46.8 ft^3/min
r = 104. ft
b = 90. ft

Figure 8

GERAGHTY & MILLER	Client: MONSANTO
Project No.: NY64207	Location: SAUGET, ILLINOIS

P-10



DATA SET:
p-10.aqt
07/01/92

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Theis

TEST DATE:
JUNE 17, 1992

TEST WELL:
TW-1

OBS. WELL:
P-10

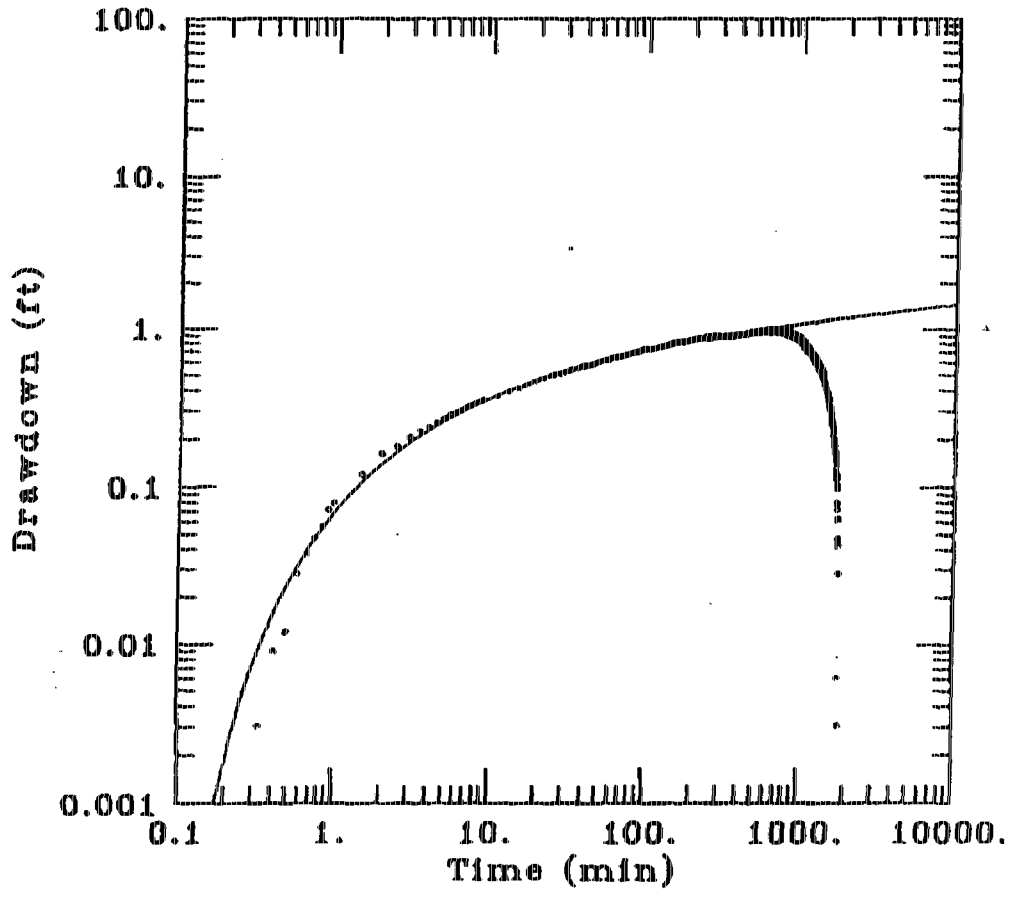
ESTIMATED PARAMETERS:
T = 15.19 ft^2/min
S = 0.008326

TEST DATA:
Q = 46.8 ft^3/min
r = 143. ft
b = 90. ft

Figure 9

G & M	Client: MONSANTO
Project No.: NY64207	Location: SAUGET, ILLINOIS

B-24C



DATA SET:
B-24C.AQT
07/08/92

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Theis

TEST DATE:
JUNE 17, 1992

TEST WELL:
TW-1

OBS. WELL:
B-24C

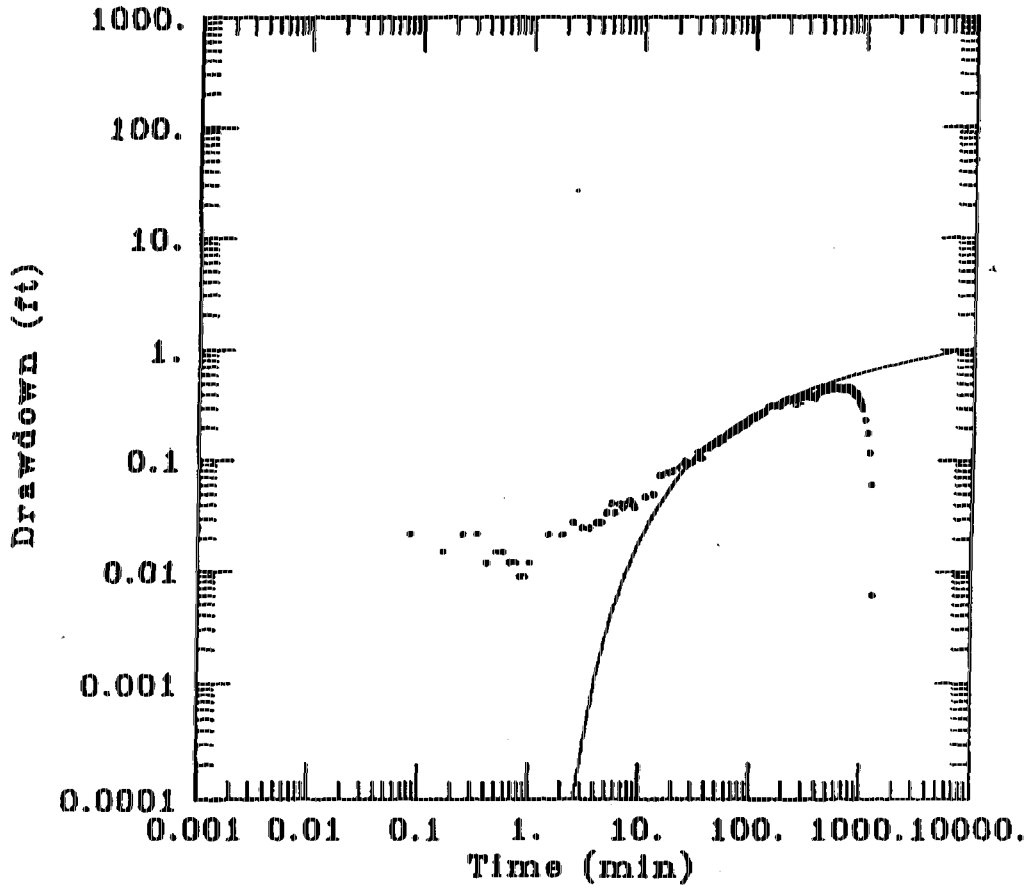
ESTIMATED PARAMETERS:
T = 23.8 ft^2/min
S = 0.004155

TEST DATA:
Q = 46.8 ft^3/min
r = 118. ft
rc = 0.5 ft
rw = 0.5 ft
b = 90. ft

Figure 10

GERAGHTY & MILLER	Client: MONSANTO
Project No.: NY64207	Location: SAUGET, ILLINOIS

B-26B



DATA SET:
B-26B.AQT
07/08/92

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Theis

TEST DATE:
JUNE 17, 1992

TEST WELL:
TW-1

OBS. WELL:
B-26B

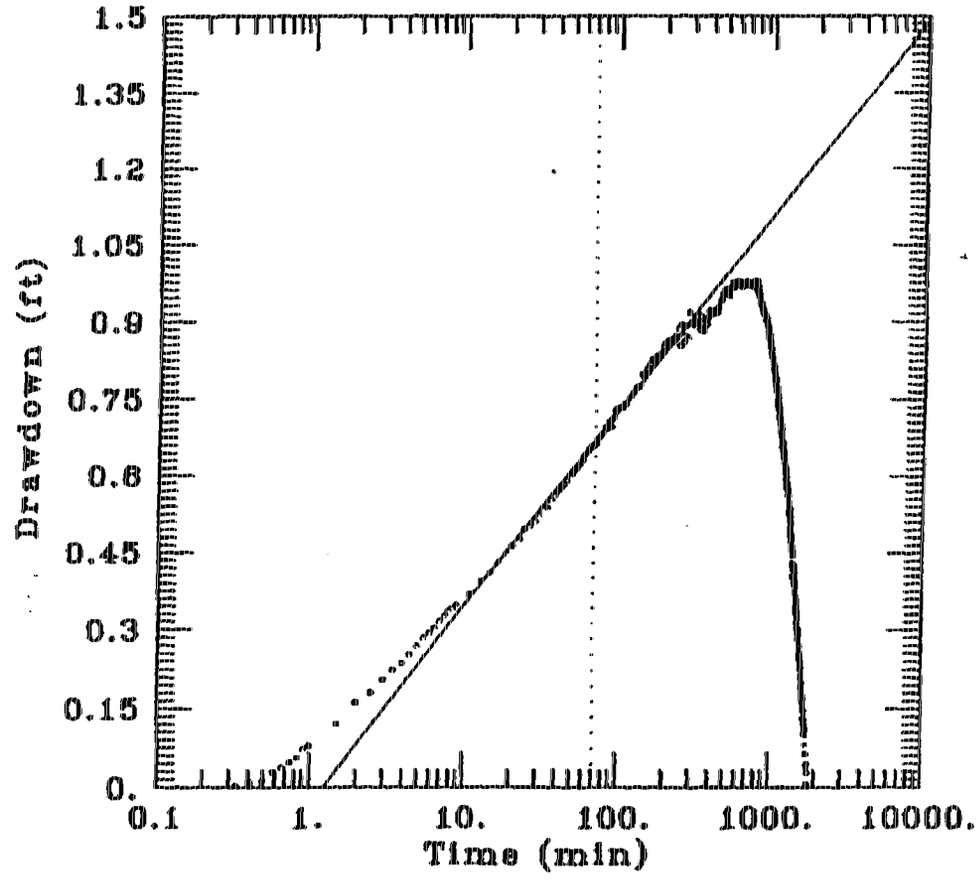
ESTIMATED PARAMETERS:
T = 22.22 ft^2/min
S = 0.006535

TEST DATA:
Q = 46.8 ft^3/min
r = 433. ft
rc = 0.5 ft
rw = 0.5 ft
b = 90. ft

Figure 11

G & M	Client: MONSANTO
Project No.: NY64207	Location: SAUGET, ILLINOIS

B-24C



DATA SET:
B-24C.AQT
07/08/92

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Cooper-Jacob

TEST DATE:
JUNE 17, 1992

TEST WELL:
TW-1

OBS. WELL:
B-24C

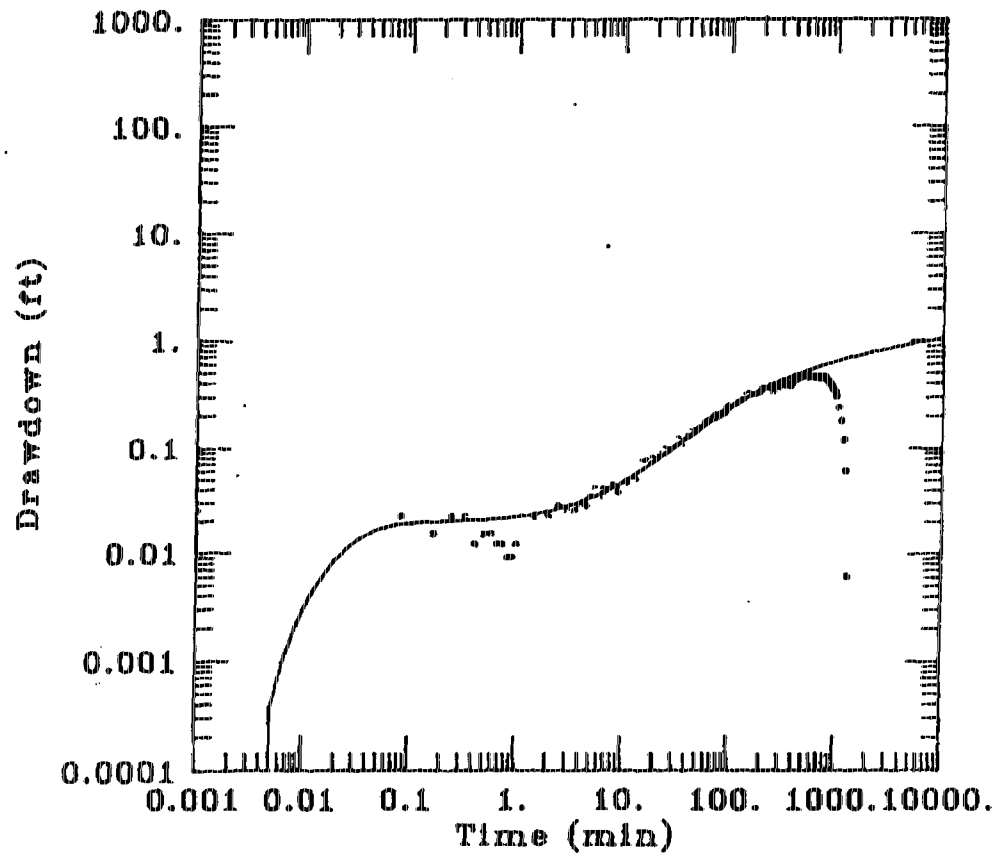
ESTIMATED PARAMETERS:
T = 22.53 ft^2/min
S = 0.004504

TEST DATA:
Q = 46.8 ft^3/min
r = 118. ft
rc = 0.5 ft
rw = 0.5 ft
b = 90. ft

Figure 12

GERAGHTY & MILLER	Client: MONSANTO
Project No.: NY64207	Location: SAUGET, ILLINOIS

B-26B



DATA SET:
b-26b.aqt
07/01/92

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Neuman

TEST DATE:
JUNE 17, 1992

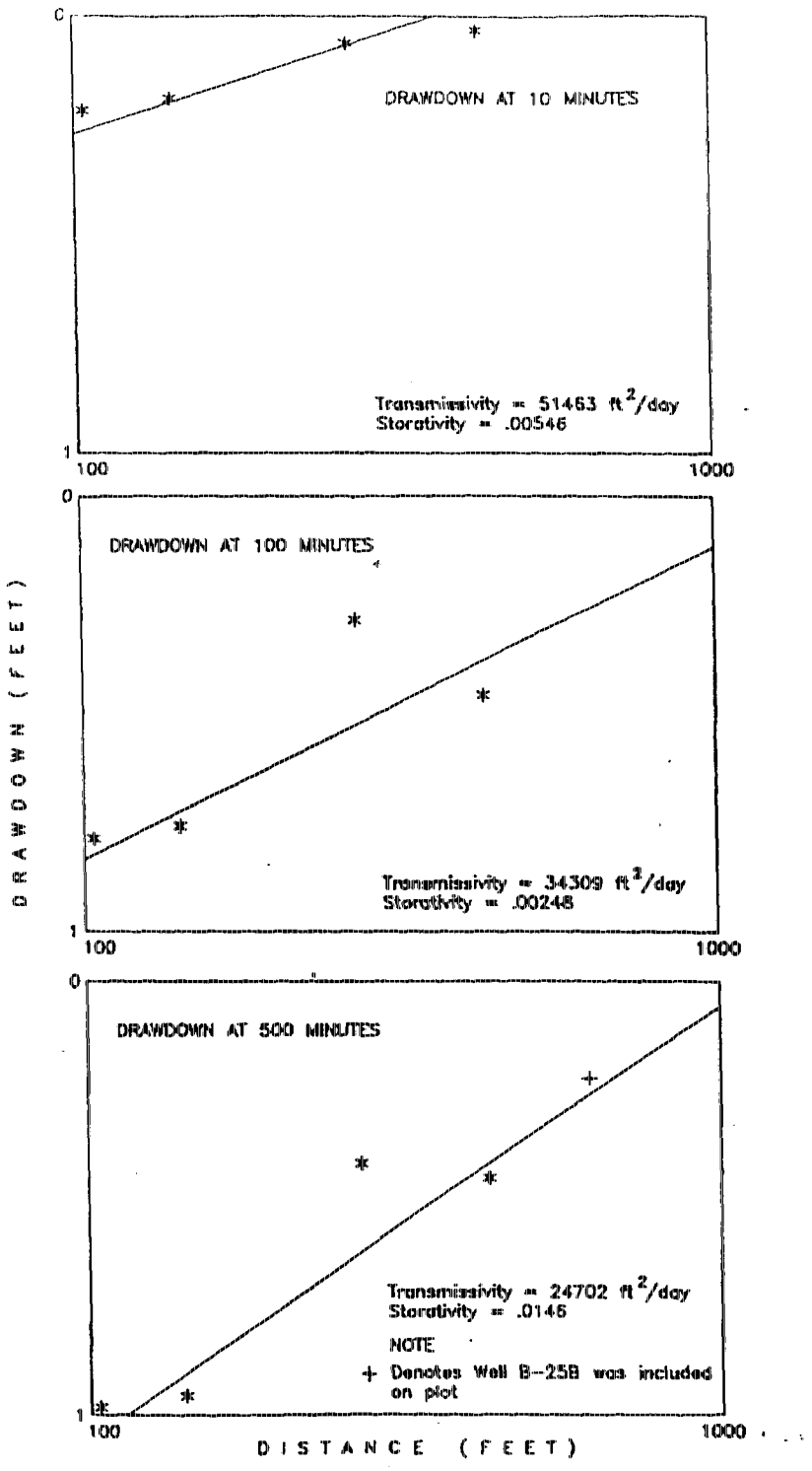
TEST WELL:
TW-1

OBS. WELL:
B-26B

ESTIMATED PARAMETERS:
T = 20.3 ft^2/min
S = 6.8199E-06
Sy = 0.007037
β = 0.8

TEST DATA:
Q = 46.8 ft^3/min
r = 433. ft
rc = 0.5 ft
rw = 0.5 ft
b = 90. ft
TEST WELL:
t.o.n. = 41.5 ft
b.o.n. = 73.5 ft
OBS. WELL:
t.o.n. = 2.4 ft
b.o.n. = 12.4 ft

Figure 13



GERAGHTY & MILLER, INC.
Environmental Services

JACOB DISTANCE-DRAWDOWN PLOTS OF FOUR INTERMEDIATE ZONE WELLS AT 10, 100, AND 500 MINUTES INTO THE AQUIFER TEST

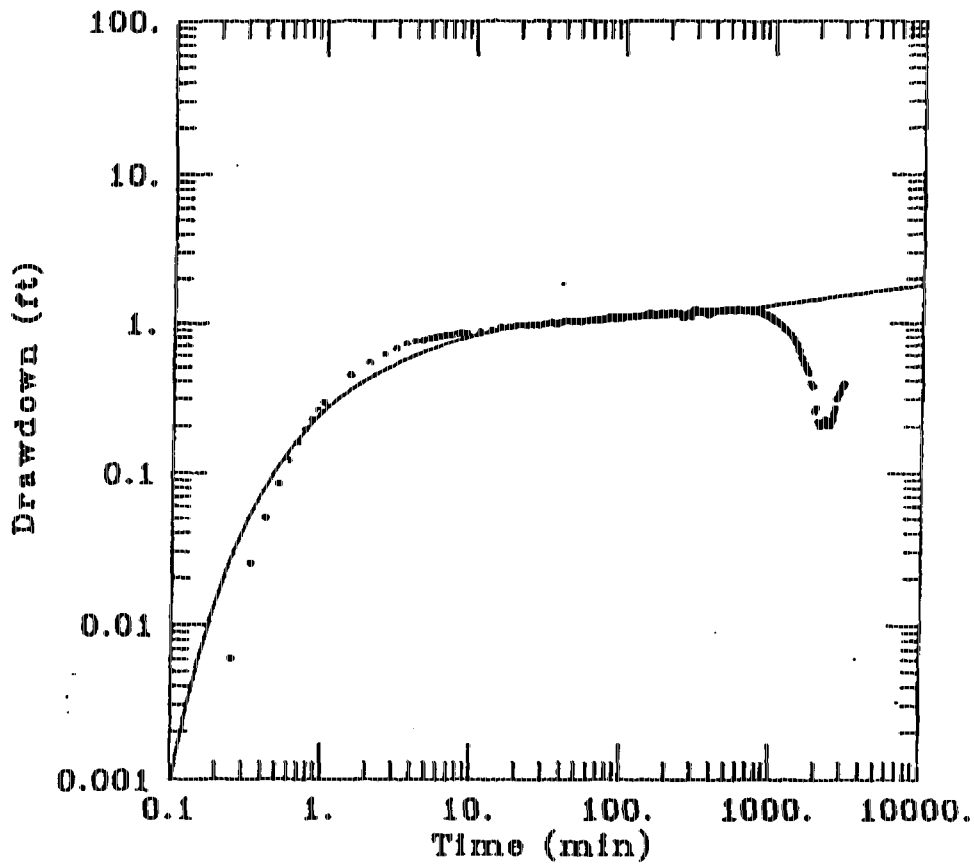
MONSANTO COMPANY
SAUGET, ILLINOIS

FIGURE 14

DRAFTER: CS | APPROVED: LM | CHECKED: SF | DRAWING: IN. .DB | FILE NO.: 1556 | PRJCT NO.: NY64207 | DWG L 2-8-93

GERAGHTY & MILLER	Client: MONSANTO
Project No.: NY64207	Location: SAUGET, ILLINOIS

GM-56C



DATA SET:
GM-56C.AQT
06/29/92

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Neuman

TEST DATE:
JUNE 17, 1992

TEST WELL:
TW-1

OBS. WELL:
GM-56C

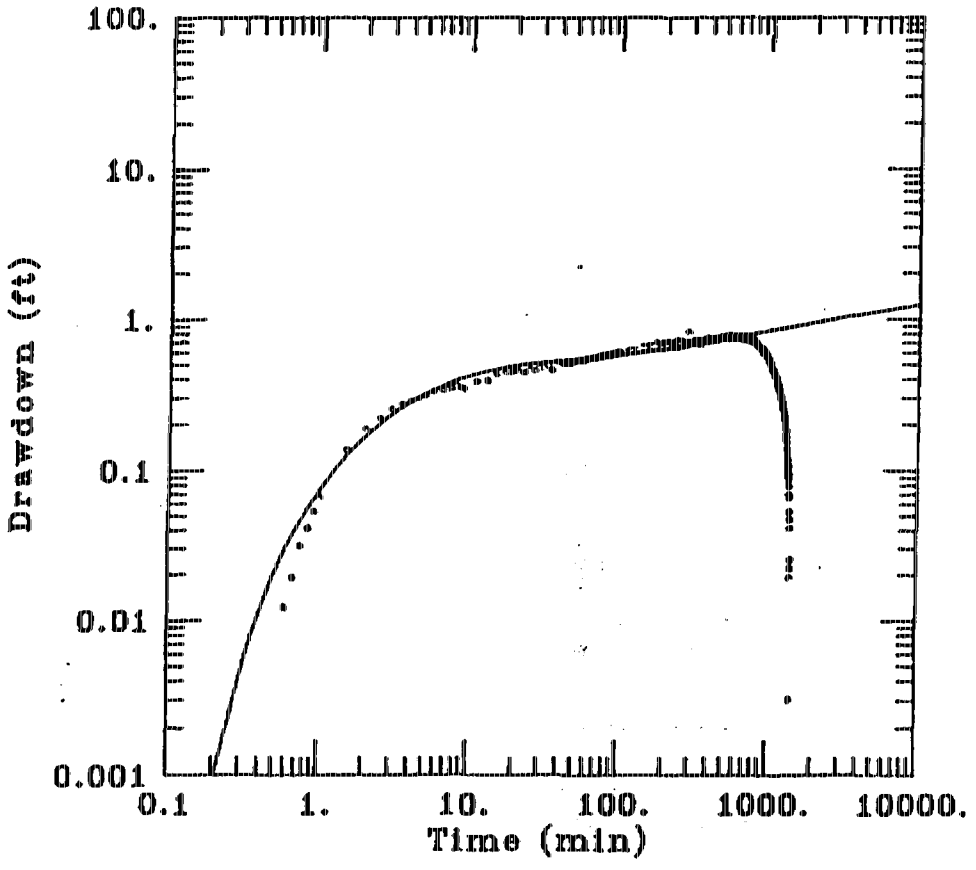
ESTIMATED PARAMETERS:
T = 16.64 ft^2/min
S = 0.001341
Sy = 0.01647
β = 0.03

TEST DATA:
Q = 46.8 ft^3/min
r = 150.5 ft
rc = 0.5 ft
rw = 0.5 ft
b = 90. ft
TEST WELL:
t.o.s. = 41.5 ft
b.o.s. = 73.6 ft
OBS. WELL:
t.o.s. = 58.1 ft
b.o.s. = 78.1 ft

Figure 15

GERAGHTY & MILLER	Client: MONSANTO
Project No.: NY64207	Location: SAUGET, ILLINOIS

GM-57C



DATA SET:
gm-57c.aqt
07/01/92

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Neuman

TEST DATE:
JUNE 17, 1992

TEST WELL:
TW-1

OBS. WELL:
GM-57C

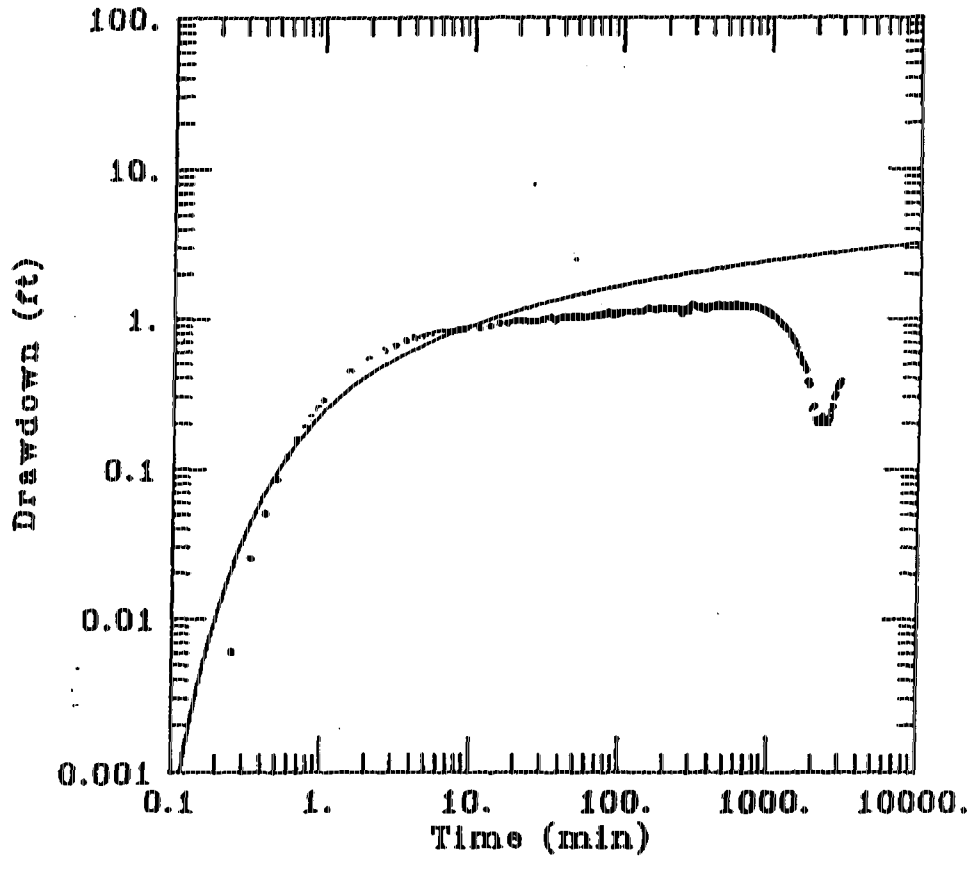
ESTIMATED PARAMETERS:
T = 20.65 ft^2/min
S = 0.0005388
Sy = 0.005517
β = 0.1

TEST DATA:
Q = 46.8 ft^3/min
r = 368. ft
rc = 0.5 ft
rw = 0.5 ft
b = 90. ft
TEST WELL:
t.o.s. = 41.5 ft
b.o.s. = 73.5 ft
OBS. WELL:
t.o.s. = 60. ft
b.o.s. = 80. ft

Figure 16

GERAGHTY & MILLER	Client: MONSANTO
Project No.: NY64207	Location: SAUGET, ILLINOIS

GM-56C



DATA SET:
gm-56c.aqt
06/25/92

AQUIFER TYPE:
Leaky

SOLUTION METHOD:
Hantush

TEST DATE:
JUNE 17, 1992

TEST WELL:
TW-1

OBS. WELL:
GM-56C

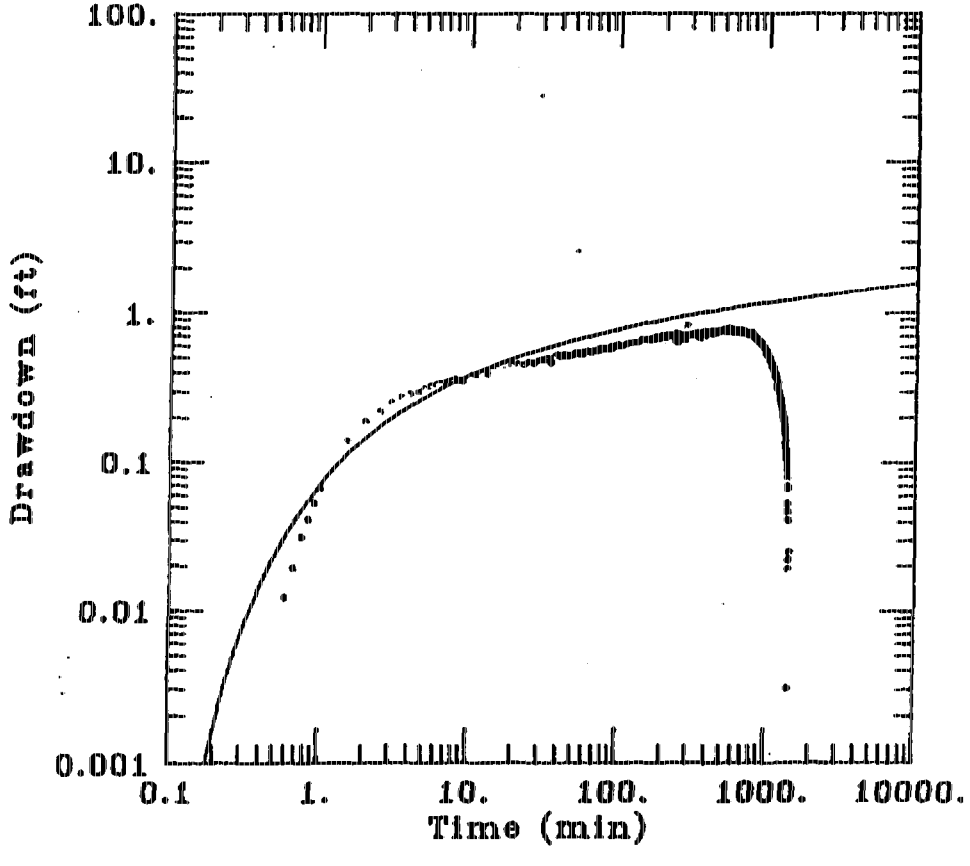
ESTIMATED PARAMETERS:
T = 10.82 ft^2/min
S = 0.001283
β = 0.0001

TEST DATA:
Q = 46.8 ft^3/min
r = 135. ft
rc = 0.5 ft
rw = 0.5 ft
b = 90. ft
TEST WELL:
t.o.s. = 41.5 ft
b.o.s. = 73.5 ft
OBS. WELL:
t.o.s. = 58.1 ft
b.o.s. = 78.1 ft

Figure 17

GERAGHTY & MILLER	Client: MONSANTO
Project No.: NY64207	Location: SAUGET, ILLINOIS

GM-57C



DATA SET:
gm-57c.aqt
07/01/92

AQUIFER TYPE:
Leaky

SOLUTION METHOD:
Hantush

TEST DATE:
JUNE 17, 1992

TEST WELL:
TW-1

OBS. WELL:
GM-57C

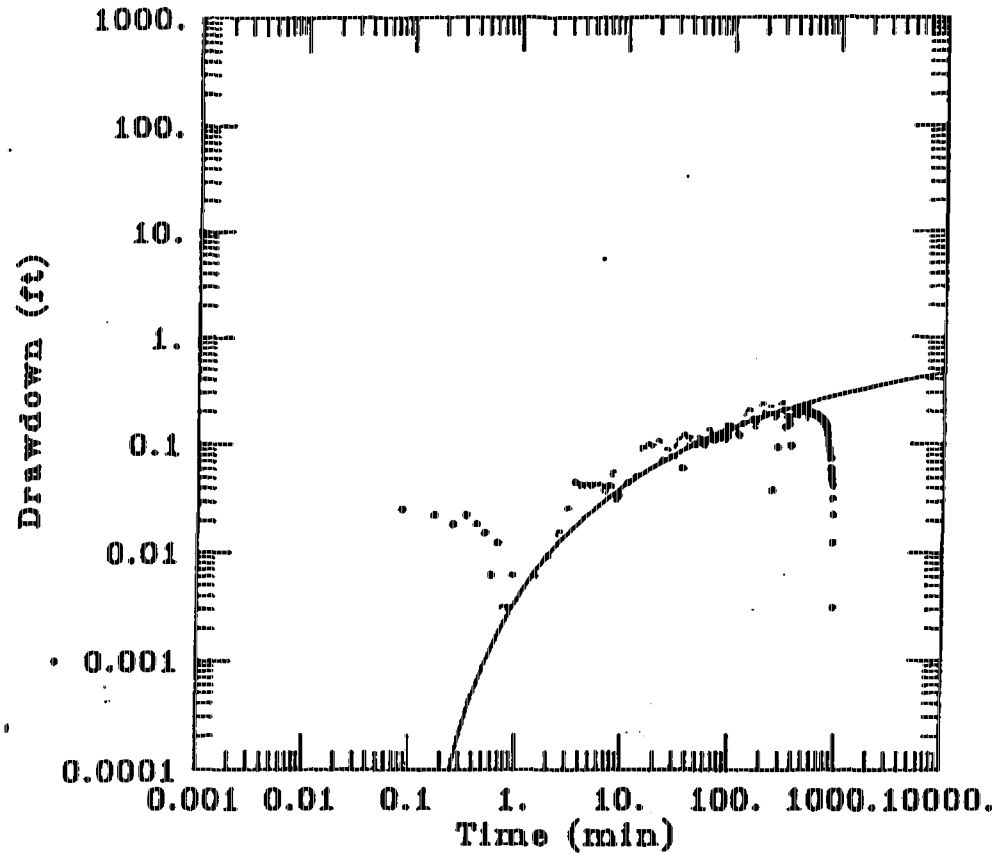
ESTIMATED PARAMETERS:
T = 21.43 ft^2/min
S = 0.0004317
β = 0.0001

TEST DATA:
Q = 46.8 ft^3/min
r = 368. ft
rc = 0.5 ft
rw = 0.5 ft
b = 90. ft
TEST WELL:
t.o.s. = 41.5 ft
b.o.s. = 73.5 ft
OBS. WELL:
t.o.s. = 60. ft
b.o.s. = 80. ft

Figure 18

GERAGHTY & MILLER	Client: MONSANTO
Project No.: NY64207	Location: SAUGET, ILLINOIS

GM-28C



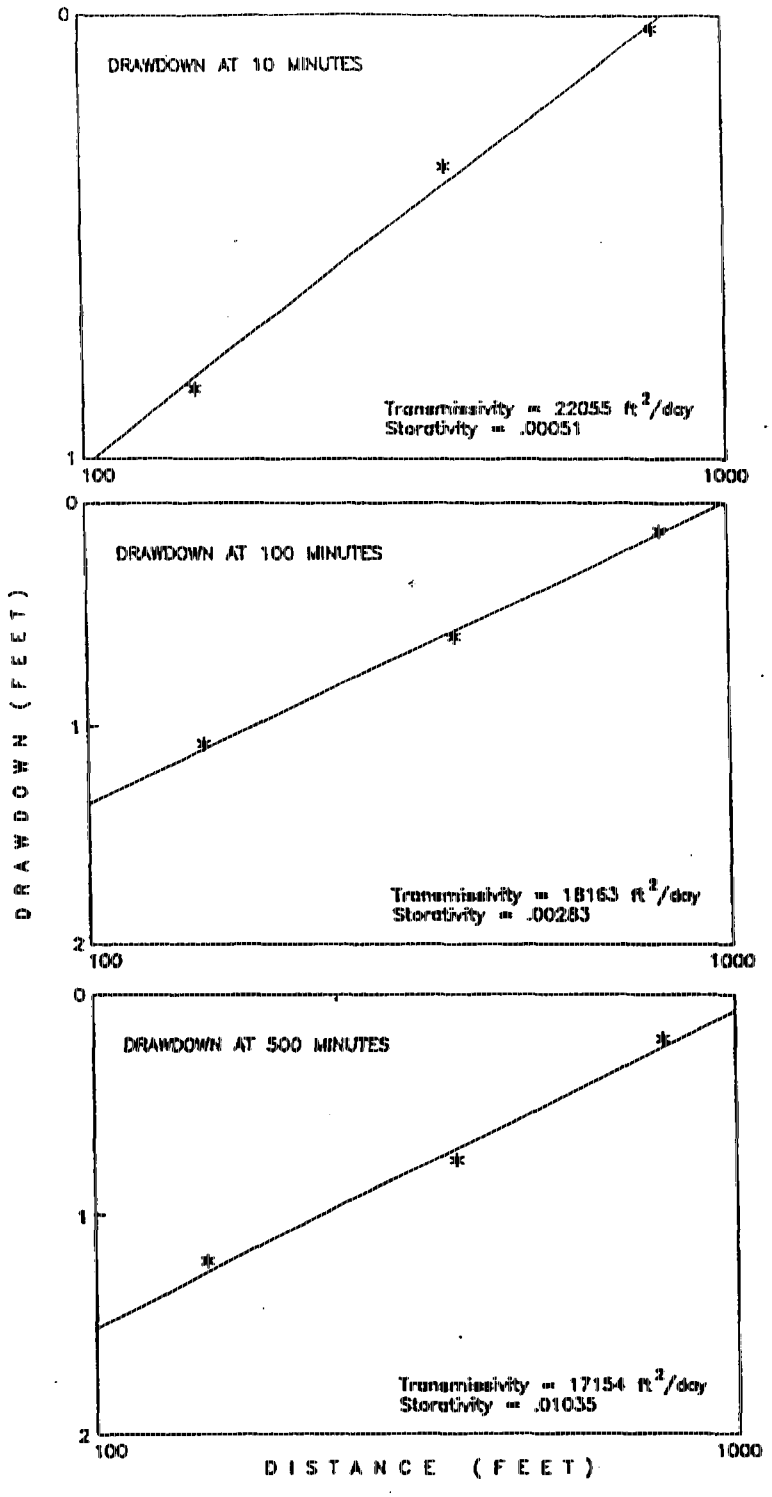
DATA SET:
gm-28c.aqt
07/01/92

AQUIFER TYPE:
Leaky
SOLUTION METHOD:
Hantush
TEST DATE:
JUNE 17, 1992
TEST WELL:
TW-1
OBS. WELL:
GM-28C

ESTIMATED PARAMETERS:
T = 21.64 ft^2/min
S = 0.0001029
β = 2.

TEST DATA:
Q = 46.8 ft^3/min
r = 772. ft
rc = 0.5 ft
rw = 0.5 ft
b = 90. ft
TEST WELL:
t.o.s. = 41.5 ft
b.o.s. = 73.5 ft
OBS. WELL:
t.o.s. = 51. ft
b.o.s. = 71. ft

Figure 19



GERAGHTY & MILLER, INC.
Environmental Services

JACOB DISTANCE-DRAWDOWN PLOTS OF THREE DEEP ZONE WELLS AT 10, 100, AND 500 MINUTES INTO THE AQUIFER TEST

MONSANTO COMPANY
SAUGET, ILLINOIS

FIGURE 20

DRAFTER: GS | APPROVED: LM | CHECKED: SF | DRAWING: BL, AC | FILE NO.: 1558 | PRJCT NO.: NY64207 | DWG. 2-9-93

Appendix 4

Groundwater Model

(Geraghty & Miller, 1994)

DEVELOPMENT OF A THREE-DIMENSIONAL GROUND-WATER FLOW MODEL FOR SAUGET SITE R, SAUGET, ILLINOIS

February 1993

Prepared for

Monsanto Company
800 North Lindergh Boulevard
St. Louis, Missouri 63167

Prepared by

Geraghty & Miller, Inc.
125 East Bethpage Road
Plainview, New York 11803
(516) 249-7600

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1. Location of Sauget Site R, Monsanto Company, Sauget, Illinois.

2. Locations of monitoring wells in the vicinity of Sauget, Illinois.

3. Cross Section A-A', Sauget Site R, Monsanto Company, Sauget, Illinois.

FIGURES (continued)

4. Finite-difference mesh of the Monsanto ground-water flow model.

5. Portion of the finite-difference mesh near Sauget Site R illustrating placement of boundary conditions in Layer 1.

6. Portion of the finite-difference mesh near Sauget Site R illustrating placement of recharge zones in Layer 1.

7. Portion of the finite-difference mesh near Sauget Site R illustrating placement of hydraulic conductivity zones in Layer 1.

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9. Calibrated water-table contours in Layer 1 showing residuals for the steady-state calibration.

10. Calibrated potentiometric surface in Layer 2 showing residuals for the steady-state calibration.

11. Calibrated potentiometric surface in Layer 3 showing residuals for the steady-state calibration.

12. Comparison between observed and computed water levels.

13. Configuration of the water-table, November 1985.

14. Potentiometric surface of the Intermediate Zone, November 1985.

15. Potentiometric surface of the Deep Zone, November 1985.

16. Model-calculated water-table contours in Layer 1 for the transient high-water analysis.

17. Model-calculated potentiometric surface in Layer 2 for the transient high-water analysis.

18. Model-calculated potentiometric surface in Layer 3 for the transient high-water analysis.

LM:MONSANTO SITE R MODELING REPORT\MODEL.TOC\NY642.11

DEVELOPMENT OF A
THREE-DIMENSIONAL
GROUND-WATER FLOW MODEL FOR
SAUGET SITE R,
SAUGET, ILLINOIS

1.0 INTRODUCTION

Monsanto Company retained Geraghty & Miller, Inc. to construct a three-dimensional ground-water flow model for Sauget Site R and surrounding area in Sauget, Illinois. The purpose of the project was to develop a calibrated model to simulate ground-water flow at Sauget Site R, which is shown on Figure 1. Contained in this report is the documentation of the model construction and calibration. The model was calibrated successfully to low flow conditions representing base flow to the Mississippi River using water-level data measured in November 1988. This time period represented a prolonged period of base flow conditions in the Mississippi River. The model was further tested by calibrating to high river stage conditions which occurred in November 1985.

A ground-water model is a powerful tool for analyzing current ground-water flow conditions and for predicting the impacts of remedial actions on the ground-water system. Development of an accurate model requires the integration of all available data defining the flow system. The current Sauget model incorporates all ground-water data collected through August 1992, including results from the June 1992 aquifer test conducted at Site R.

The scope of the ground-water flow modeling analysis included three main tasks: (1) data review and organization, (2) conceptual model development, and (3) model calibration. The purpose of the ground-water flow analysis was to develop a calibrated steady-state, ground-water model suitable for predicting water levels over a wide range of future conditions and potential system stresses.

The data review phase of the ground-water flow analysis examined all data pertinent to the ground-water system. In general, four fundamental types of information are required

for modeling a particular hydrogeologic system: (1) geologic framework, (2) hydraulic properties, (3) water levels, and (4) fluid sources and sinks (pumping rates, recharge, etc.). The data review and organization phase resulted in development of a modeling database. This database facilitates the integration and analysis of data about the hydrogeologic system. The database forms the foundation of the conceptual model and provides the necessary information used during the model construction and calibration.

The Monsanto database includes geologic information from the extensive work Geraghty & Miller and other consultants have conducted at Sauget Site R and Monsanto's W.G. Krummrich plant in Sauget, Illinois. Water levels have been monitored biannually since 1984 and water-level recording instruments have provided continuous water-level data at nine locations in the area during that time period. Sources and sinks in the ground-water system include the Mississippi River, the Harding Ditch and associated tributaries, as well as the small lakes located to the north of the Harding Ditch.

The conceptual model, a succinct description of the important components of the ground-water system, was developed on the basis of the data review. The conceptual model formulates input data for the mathematical model by identifying initial values for hydraulic parameters. The conceptual model also guides calibration of the numerical model and aids in interpreting model results. The conceptual model of the ground-water flow system is presented in the next section.

After developing a conceptual understanding of the ground-water flow system, the numerical model was constructed. Model construction consisted of discretizing the flow system into rectangular blocks, assigning aquifer properties to each block, and estimating ground-water sources and sinks. Model data sets were constructed for the USGS Modular Three-Dimensional Flow Model, also know as MODFLOW (McDonald and Harbaugh 1988). MODFLOW is a well-accepted public domain software package for modeling three-dimensional ground-water flow.

Model calibration refers to the process of adjusting hydraulic parameters to obtain a reasonable match between water levels measured in the field and water levels calculated by the model. The Site R model was calibrated to water levels measured in November 1988 (base flow conditions) and to water levels measured during a flood event in November 1985. The 1988 calibration is termed a steady-state calibration and represents base flow conditions in the ground-water basin. The 1985 calibration was performed transiently to a short-term flood event where ground-water gradients were reversed in the vicinity of the Mississippi River and Sauget Site R. Quantitative or statistical comparisons were made between the site water-level data and model-computed heads for the steady-state calibration, while only a qualitative comparison was made for the transient calibration. The transient calibration was evaluated qualitatively because only one set of measurements was available for a large transient event. Thus, there was more uncertainty involved in the transient analysis than in the steady-state calibration.

2.0 CONCEPTUAL MODEL

2.1 GEOLOGY

Sauget Site R and the surrounding area included in the ground-water flow model are located in southwestern Illinois on the flood plain of the Mississippi River, named the American Bottoms (Figure 1). The flood plain is surrounded by bedrock bluffs on the eastern boundary of the model and across the Mississippi on the western boundary of the model. The flood plain contains unconsolidated deposits composed of recent alluvium (Cahokia Alluvium) which overlies glacial material (Henry Formation). Underlying the unconsolidated deposits is Mississippian and Pennsylvanian limestone and dolomite with lesser amounts of sandstone and shale. The average thickness of the unconsolidated material across the model area is approximately 130 ft.

To simplify the flow system and thus the model, the unconsolidated deposits were categorized into three hydrogeologic zones. They are as follows: the water-table (shallow)

zone (Layer 1), intermediate zone (Layer 2), and deep zone (Layer 3). The following discussion will be limited to these three zones. The bedrock is not included in the model because it is not an important aquifer due to low permeability. Although the water-table, intermediate, and deep zones have variable thicknesses, a uniform thickness and depth interval was assigned to each subsurface zone for the purpose of modeling. The thickness of each zone is provided later in this section. These zone distinctions are based on the differences in subsurface lithologic conditions. Wells used to guide the modeling effort are shown on the site location map (Figure 2). Delineation of the three zones and their relationships to the layers are shown on the generalized east-west cross section found on Figure 3. The cross section lies in the western portion of the model area, which has good geologic control due to extensive drilling by Geraghty & Miller and others at Sauget Site R and at the W.G. Krummrich plant. The geology is fairly uniform throughout the model area and, therefore, only an east-west cross section is necessary.

The water-table zone consists of the Cahokia Alluvium (recent deposits), which is an unconsolidated, fine-grained silty sand. For the purposes of the model, the layer is considered to be 30 ft thick, starting at the water table and continuing down to the medium sand deposits of the Henry Formation (bottom elevation of the layer is 365 ft msl). The cross section (Figure 3) shows Layer 1 to be a low permeability zone with fine-grained silty sand deposits predominating.

The intermediate zone is much coarser than the overlying water-table zone. This zone contains medium-grained sand representing the upper portion of the Henry Formation, a Wisconsinan glacial outwash in the form of valley-train deposits. Valley train deposits are long narrow bodies of outwash, deposited by meltwater streams far beyond the terminal moraine and confined within the walls of a valley. The Henry Formation is characterized by medium to coarse sand becoming coarser with depth. Thickness of model Layer 2 is 45 ft. This corresponds well to the range of thickness in the cross section (Figure 3).

Below the intermediate zone is the deep zone (Layer 3) which is marked by coarser deposits of the lower portion of the Henry Formation. In some areas, till and/or boulder zones were encountered 10 to 15 ft above the bedrock. The coarser deposits are delineated by the model to be 35 ft thick (Figure 3).

2.2 PREVIOUS NUMERICAL MODELING STUDY

A modeling study of the entire American Bottoms ground-water flow system was conducted by the Illinois State Water Survey Division (Ritchey et al. 1984). The purpose of this study was to conduct a detailed investigation of the flow systems in the area. Then current hydrologic data pertaining to the area were compiled, a computer model was developed to simulate the movement of the ground water, ground-water levels in the area were analyzed, and future ground-water levels were predicted. Documentation of the model, including a user guide, was also included.

The compilation of hydrogeologic information included the distribution of pumpage in the area including the major and minor pumping centers and pumpage from wells adjacent to the Mississippi River. A series of hydrographs from the years 1940 to 1981 were plotted and included in the report.

The ground-water model used was a modified form of the Illinois State Water Survey aquifer model (Prickett and Lonnquist 1971). Modifications were made to incorporate river stage and precipitation. The model was calibrated by history matching two 5-year periods with constant 1-month time steps. Hydrographs of actual and simulated water levels of ten observation wells and the nearest model well for the two 5-year periods were presented. The model was found to consistently calculate water levels within 2 ft of the actual measured water level within a specified area of interest.

Ground-water levels were evaluated with the aid of ground-water level exceedance plots. Ground-water level exceedance probability plots were constructed for ten model wells

by compiling the maximum yearly water levels from monthly simulated values. Plots were based on simulation of the 30-year period from 1951-1980. Mississippi River stage was also simulated during the 30-year period from 1951-1980.

2.3 HYDRAULIC PROPERTIES

In 1986, Geraghty & Miller compiled hydraulic properties that were determined from aquifer tests and slug tests run by Geraghty & Miller and other consultants (Geraghty & Miller, 1986b). These data are listed in Table 1. In general, the hydraulic conductivities of the intermediate and deep zones are much greater than that of the shallow water-table zone.

A detailed aquifer test was conducted by Geraghty & Miller in June 1992. The results from this test indicate that the intermediate and deep zones have approximately equal permeability with an average of 315 ft/d (Table 2). The storage coefficient was calculated to be 0.007. The overall transmissivity of the combined intermediate and deep zones was found to be about 30,000 ft^2/d which was used in the model, and 15,000 ft^2/d was applied to each zone. The construction of the model is described in Section 3.0.

2.4 RECHARGE

Average annual rainfall in the Sauget area is approximately 34 inches. Based on a 30-year average (1951 to 1980) for precipitation in the Sauget area, 13 inches of precipitation are estimated to infiltrate into the ground as recharge to the aquifer system. The calibrated steady-state model represents base flow conditions, so a lower value of recharge was used (about 9 inches/year).

3.0 GROUND-WATER FLOW MODEL CONSTRUCTION

3.1 CODE SELECTION

Ground-water flow in the Sauget area was modeled with the USGS Modular Three-Dimensional Finite-Difference Ground-Water Flow Model (McDonald and Harbaugh 1988), also known as MODFLOW. The three-dimensional capabilities of this code are appropriate for the proper treatment of the vertically variable hydrostratigraphy (three distinct aquifer zones) and boundary conditions at the study site. MODFLOW is also well documented, publicly available, and generally accepted within the scientific community.

Prior to the simulation of ground-water flow at Sauget Site R and vicinity using MODFLOW, the model was calibrated using an automatic (inverse) parameter estimation algorithm incorporated into the MODFLOW code by Duffield (1988). The inverse algorithm systematically selects a set of user-specified hydraulic parameter values that provide a least-squares match between observed and calculated water levels. Hydraulic parameters estimated in the Sauget model include: (1) hydraulic conductivity in the water-table zone (Layer 1), (2) vertical leakance across the water-table/intermediate and intermediate/deep boundaries, (3) vertical leakance of the Mississippi River bottom sediments, and (4) precipitation recharge. The transmissivity of the intermediate and deep zones (Layers 2 and 3, respectively) was maintained at the value estimated from the June 1992 aquifer test and was not changed during calibration.

3.2 MODEL CONFIGURATION

3.2.1 Discretization

The Monsanto model includes Sauget Site R, the entire W.G. Krummrich facility, and a large amount of the surrounding area, as shown on Figure 4. The model grid covers 58 square miles around the Sauget area with an east-west dimension of 44,000 ft and a north-

south dimension of 37,000 ft. The model is much larger than the area of interest to incorporate regional ground-water flow effects at the site scale. The model extends to the bedrock bluffs east and west of the site (across the Mississippi River) and to Old Prairie Dupont Creek south of the site. The northern boundary of the model coincides with the center of a pumping cone of depression caused by dewatering efforts near the Poplar Street Bridge.

In the finite-difference modeling technique used in MODFLOW, the aquifer is divided into rectangular regions known as cells. The maximum cell dimension in the Sauget model is 1,000 ft. These large cells were placed away from the areas of interest. Finer grid spacings were used near Sauget Site R and the W.G. Krummrich Plant. The smallest cells measure 250 ft on a side. A portion of the finite-difference grid covering Site R and the Krummrich Plant is shown on Figure 5. This figure is provided to illustrate the finer detail used to model these areas.

The model contains three layers representing the Cahokia Alluvium (Layer 1) and Henry Formation (Layers 2 and 3). The upper model layer is unconfined and the lower two layers are semiconfined, although there are no continuous aquitards separating any of the model layers. The flow of ground water between model layers is represented in the model using a leakance term. The leakance term incorporates the lower vertical permeability characteristic of most glaciofluvial deposits to retard the movement of ground water between the three aquifer zones.

3.2.2 Boundary Conditions

To represent the variety of physical boundaries to the aquifer system in the Sauget area, several types of boundary conditions were prescribed in the ground-water flow model. A boundary condition is a numerical representation of a physical boundary or process effecting the aquifer system. These physical boundaries and processes include: (1) surface-water bodies and streams (Mississippi River and the lakes northeast of the site), (2)

production wells in the Sauget area, (3) the vertical and lateral limit of the unconsolidated aquifer system, and (4) precipitation recharge.

Two primary types of numerical boundary conditions were used in the Monsanto model to represent these physical boundaries to the system. The model boundary conditions are termed constant head and flux boundaries. A third type of boundary condition, called a head-dependent flux boundary condition, was not employed in this model. The latter may be used to represent drains, for example, but there are no such features in the area.

For the purposes of calibration, constant head boundaries in the upper model layer were used to represent all surface water features including the Mississippi River, the Harding Ditch, and other small streams. In a constant head boundary cell, the ground-water level is fixed at a specified point for the duration of the simulation. This provides a continuous source or sink for ground water in the surrounding aquifer. The water-level value specified in a constant head which represents a surface stream is equal to the water elevation on the stream. A river stage of 381 ft msl was estimated for the Mississippi River from the gauging station at St. Louis, Market Street (Mile 179.6). Elevations for the remaining surface-water bodies were estimated from USGS topographic maps of the area.

A constant flux boundary condition represents a continuous and constant inflow or outflow of water within a model cell. Rather than specifying a constant water elevation, a constant discharge or recharge rate is used. Constant flux boundary conditions typically represent wells, recharge, or areas of no ground-water flow (the flux is zero). The latter are termed no-flow boundaries. Boundary conditions in Layer 1 are shown on Figure 5. The outer edge of cells on Figure 5 are assumed to be no-flow boundaries, except where specified as another type of boundary condition.

Constant flux boundary conditions were used in the model to represent: (1) recharge from precipitation, (2) production wells north of the site, and (3) the limit of the unconsolidated deposits (no-flow boundaries). A special form of no-flow boundary was used

to represent the northern boundary of the model in all layers and the southern boundary in Layers 2 and 3. These boundaries were selected so as to be parallel with the regional ground-water flow directions. In this manner, the ground-water flow lines (or stream tubes) represent the model boundary. In theory, ground water does not flow across stream lines, and thus a no-flow boundary is formed.

The northern boundary was also selected to bisect the cone of depression surrounding a production center. This boundary takes advantage of the symmetry of the cone of depression and uses streamlines entering the production zone from the east and west. Thus, only half of the cone of depression around the pumping center is simulated. Consequently, only half of the pumping rate for these wells was used in the model.

The remaining no-flow boundaries included the eastern and western boundaries in all layers and the base of the model (bedrock surface). The eastern and western boundaries represent the bedrock bluffs as shown on Figure 4. It is assumed that the volume of water entering or leaving the unconsolidated aquifer system from the bedrock is insignificant compared to the volume of water entering from precipitation and induced leakage from the river.

Three discrete zones of recharge were defined in the model in Layer 1. The primary recharge zone covers most of the model and received 8.8 inches per year (in/yr)(2.0×10^{-3} ft/day). A second recharge zone was used to simulate an anomalous ground-water mound in the W.G. Krummrich Plant. This zone received 370 in/yr (8.4×10^{-2} ft/day). The third recharge zone represents the clay cap which was installed over the landfill at Site R, adjacent to the Mississippi River. Recharge zone No. 3 received 2.63 in/yr (6.00×10^{-4} ft/day). The location of these zones is shown on Figure 6.

The model recharge rate of 8.8 in/yr is below the average of 13 in/yr, as discussed in Section 2.5. The lower rate was used to simulate base flow conditions during dry periods

of the year. The model was calibrated to the period around November 1988 when the Mississippi River was at a relatively constant but low stage.

3.3 AQUIFER PARAMETERS

Aquifer parameters such as hydraulic conductivity, transmissivity, and vertical leakance were assigned to each cell in the model using the concept of parameter zonation. This philosophy of modeling specifies several discrete values of each parameter which are assigned to groups (zones) of cells. Aquifer properties defined in the model include: (1) hydraulic conductivity of Layer 1, (2) transmissivity of Layers 2 and 3, (3) vertical leakance between model layers, and (4) bottom elevation for Layer 1.

Layer 1 was divided into three separate hydraulic conductivity zones having values of 6.2, 1.0, and 0.4 ft per day (ft/day). These values were determined during the calibration process. These hydraulic conductivity zones are referred to as Zones 1, 4, and 5, respectively. Zone 1 represents the hydraulic conductivity of the Cahokia Alluvium, Zone 4 represents the hydraulic conductivity of the landfill, and Zone 5 represents the bottom sediments of the Mississippi River. The distribution of hydraulic conductivity zones in Layer 1 is shown on Figure 7.

The calibrated values of hydraulic conductivity in Layer 1 for Zones 1, 4, and 5 fall within the range of field measurements for the Cahokia Alluvium (0.25 to 17.01 ft/day). Hydraulic conductivity Zone 1 (6.2 ft/day) represents average conditions across Layer 1, the low permeability layer. The value given by the model is very close to the average field hydraulic conductivity (4.42 ft/day) which is the range of silty sand. Hydraulic conductivity Zone 4 (1.0 ft/day) represents the filled portion of Sauget Site R which is estimated to be less permeable than the surrounding area due to the reworked nature of the landfill material. Zone 5 has a hydraulic conductivity of 0.4 which represents the Mississippi River bottom sediments, which are finer grained than the Cahokia Alluvium.

The transmissivity of the Henry Formation was defined in two zones (2 and 3 in the model). Zone 2 represents Layer 2 which has a transmissivity of 15,000 ft^2/day. Zone 3 represents Layer 3 which also has a transmissivity of 15,000 ft^2/day. Both Zones 2 and 3 are part of the glacial Henry Formation. The transmissivity values used in layers 2 and 3 were derived from the results of the June 1992 aquifer test. These values were not refined during calibration.

The leakage of water between the three layers was treated using a leakance term. The leakance term was calculated using the vertical permeabilities and the thickness of the layers. Five leakance zones were determined during the calibration. The vertical leakances between Layers 1 and 2 are 0.0063 day^{-1} (Zone 1, Water-table Layer/Intermediate Layer), 1.0×10^{-9} day^{-1} (Zone 3, water-table layer/intermediate layer in the landfill area), and 0.42 day^{-1} (Zone 4, Mississippi River/Intermediate Layer). Figure 8 depicts the vertical leakance zones in Layer 1. The leakance between Layer 2 and 3 has a value of 1.00 day^{-1} (Zone 2, Intermediate Layer/Deep Layer). The leakance for Zone 5 in the intermediate layer/deep layer (Mississippi River) is 0.25 day^{-1}.

A summary of the hydraulic parameter zones and their model calibrated values are shown in Table 3, which also includes the recharge values discussed in the previous section. All values were estimated using the automatic calibration procedure which is described in the next section.

4.0 STEADY-STATE MODEL CALIBRATION

4.1 CALIBRATION TECHNIQUE

A ground-water model is calibrated by adjusting aquifer properties (hydraulic conductivity, transmissivity, and vertical leakance) and boundary conditions within reasonable limits to obtain an acceptable match between observed and calculated ground-water levels. The reasonable limits within which parameters may be varied is determined by field testing

and by values reported in the scientific literature. Many single-well aquifer tests and slug tests were used to set reasonable limits for hydraulic conductivity in the Sauget area. An acceptable match between water levels measured in the field and those calculated by the model is determined through graphical and statistical analysis of residuals. A residual is the difference between observed water levels (field measurements) and water levels calculated by the model.

The model was calibrated using a nonlinear least-squares technique known as the Marquardt Algorithm (Marquardt 1963). This technique is often referred to as "automatic calibration" or inverse modeling. Inverse techniques determine optimum aquifer parameter values for a given model configuration (grid spacing and boundary conditions) which provide the best statistical calibration. The calibration for the model was arrived at through an iterative procedure involving inverse model runs and subsequent redefinition of aquifer parameter zones and boundary conditions. Parameter values for the final calibrated model were described in the previous section.

Two types of calibrations were performed on the Sauget model. The first step consisted of calibrating the model to base flow (steady-state) conditions in the Mississippi River. The steady-state calibration was performed by comparing model-calculated water levels to those measured in the field during November 1988. This period represents a prolonged base flow period. The second calibration compared model calculations to a flood event in the Mississippi River in November 1985. The latter was a transient calibration which is discussed in Section 5.0.

4.2 CALIBRATION TARGETS

A critical component of any model calibration is a set of measured ground-water levels to compare with model calculations. These observed or measured ground-water levels are known as calibration targets. The goal in selecting calibration targets is to define a set of targets that are reliable and well distributed throughout the area of the model.

Calibration targets were selected for the model using a three-step procedure. In the first step, the November and December water levels for the years 1984 through 1988 were compiled to chose the year that would most closely represent steady state ground-water flow conditions in the area. The months of November and December were chosen because they are typically closest to base flow conditions in the Mississippi River. The standard deviation for each of the wells was also computed to assess the variability in water level measurements. Water levels from 1988 were chosen during the first phase of target selection because of prolonged base flow conditions in the Mississippi River which imparted a low standard deviation in water level measurements.

During the second phase of target selection, wells with a 1988 reading and a low standard deviation were included in the list of targets. Wells exhibiting a large standard deviation (> 3 ft) were not included in the list of targets; however, it was necessary to choose some wells near the Mississippi River with a high standard deviation. The high standard deviation is due to the extreme fluctuation in water levels near the Mississippi River because of the river's variation over time. Most of the standard deviations away from the river were less than 3 ft and near the river the deviation was approximately 6 ft. The 1988 readings were chosen because these measurements were made during a prolonged period of base flow conditions in the Mississippi River.

During the third phase of target selection, clusters of wells were reduced in number. Many of the wells are closely grouped around the landfill, for example. In order not to significantly bias the automatic calibration procedure, not all wells around the landfill were used in the calibration. Wells were chosen to provide an even distribution over the study area. Using this three-step approach, 69 target wells were chosen from a total of 164 wells. The water-table zone (Layer 1) contains the greatest number of calibration targets (30). The calibration targets in the intermediate (23) and deep (16) zones are fewer in number, but well distributed. The locations of calibration targets within the model are shown on Figures 9 through 11. These wells are also summarized in Table 4.

4.3 STEADY-STATE CALIBRATION RESULTS

One of the most important parameters used in evaluating a calibration is the residual. A residual is calculated for each calibration target by subtracting the model-calculated water level from the observed water level. A residual near zero signifies a close match between the model and observed field conditions. The sign of the residual, positive or negative, is just as important as the magnitude of the residual. Negative residuals occur where the model-calculated water levels are higher than observed. Conversely, positive residuals indicate that the model-calculated water levels are too low.

In discussing the quality of a model calibration, the following criteria must be considered: (1) the average of all residuals (residual mean) should be close to zero; (2) the variation in residuals (residual standard deviation) should be low; (3) the distribution of residuals within the model should be random; and (4) the flow patterns predicted by the model should match field observations. Most of these factors are subjective; however, all must be evaluated when determining the quality of a calibration.

All criteria listed above were satisfied in the model calibration. The residual mean (0.03 ft) was close to zero. The residual standard deviation (1.04 ft) is very low. The residuals are fairly well distributed and ground-water flow directions match field observations. Flow is toward the Mississippi River in all three layers with ground-water mounding in Layer 1 at the landfill and W.G. Krummrich plant. Figures 9 through 11 illustrate the potentiometric surfaces for the three model layers in the vicinity of Site R.

A statistical analysis of residuals quantifies the match between the simulated water levels and actual water-level measurements. The two important statistics discussed above include the residual mean and the residual standard deviation. For good calibration, the residual mean should be close to zero. This implies that positive residuals (areas where the model water levels are too low) and negative residuals (model water levels are higher than observed) are equally balanced within the model domain. In the model, the residual mean

is 0.03 ft. In addition to a residual mean close to zero, the residual standard deviation should be low. The model residual standard deviation was 1.04 ft. This means that most model residuals are in error by no more than 1.04 ft. In fact, 27 of the 69 residuals are less than 0.5 ft. The residual standard deviation should also be much less than the total change in head across the site. In this case, the total water-level change across the modeled area is about 23 ft. The residual standard deviation is less than five percent of this number. Residuals for each well are listed in Table 4.

The next test of a good calibration is the spatial distribution of residuals. There are two ways of looking at spatial distribution. The first involves plotting the observed versus calculated water levels. In a perfect calibration, the calculated water levels would equal the observed water levels. The scatter of actual residuals around this perfect line is a graphical means of evaluating spatial distribution of residuals. Such a plot is presented in Figure 12. This plot illustrates that residuals at high and low points in the flow system have a random error of ± 1.0 ft. That is, there is an even scatter among the residuals and the errors are evenly distributed between high and low water levels.

The second type of spatial analysis involves plotting the residuals on a site map. Positive or negative residuals should not cluster in any area, i.e., they should be randomly distributed. Figures 9 through 11 show the residuals in Layers 1 through 3 for the areas near Site R and the W.G. Krummrich plant. There are no wells and associated residuals located outside the area displayed by Figures 9 through 11.

Residuals in Layer 1 are well distributed around Site R, however, there is minor clustering of negative residuals around the ground-water mound located in the W.G. Krummrich plant, and the overall distribution of residuals is slightly biased toward higher water levels. Layer 1 also has a number of high residuals located in the landfill. This is due to the destabilizing effect of the Mississippi River on water levels.

5.0 TRANSIENT CALIBRATION RESULTS

The steady-state calibration discussed in the previous section compared model-calculated results to water levels measured in November 1988. This calibration represents average base-flow conditions in the Mississippi River. In order to demonstrate that the ground-water flow model constructed for Sauget is valid for higher water-level events as well, a transient calibration was also performed.

The transient calibration compared model-calculated water levels to those measured in November 1985 when the Mississippi River was at a much higher stage than in November 1988. The Mississippi River stage used in the transient calibration was 410 ft msl, compared to a stage of 381 ft msl used in the steady-state calibration. The November 1985 water levels are contoured in Figures 13 through 15 for the shallow, intermediate, and deep zones, respectively.

The transient calibration differed from the steady-state calibration in that ground-water levels in the aquifer were not at equilibrium. The Mississippi River was rising for about 1 week prior to the ground-water level measurements. Consequently, the ground-water levels were also still rising. To simulate these conditions, the water-level distribution calculated by the steady-state model was used as initial conditions in the transient calibration. Next, the Mississippi River stage was increased to 410 ft msl. This was the river stage reached just prior to the round of ground-water level measurements. The model was then run for 7 days and the model-calculated heads were contoured.

Only a qualitative comparison was made between model-calculated heads and observed heads because only one round of water-level measurements (November 1985) were available for comparison during a period when high river stage lasted for several weeks. In an ideal transient calibration, water levels are available at numerous times for comparison with the model results.

The model configuration for the transient calibration was identical to the steady-state model, with two exceptions: (1) a uniform storage coefficient was assumed in each layer (no storage coefficient is necessary in a steady-state model), and (2) the recharge rate was increased 10 percent because there was a significant amount of precipitation during the week prior to the water-level measurements. The storage coefficients were adjusted during the calibration to obtain a qualitative match between the observed and calculated water levels. The final storage coefficients were 0.1 in Layer 1, and 0.03 in Layers 2 and 3. These storage values are close to those obtained from pumping test analyses (0.07, 0.04 and 0.09) as discussed in Section 2.

The final calibrated ground-water levels simulated in the transient model one week after raising the Mississippi River level are presented in Figures 16 through 18 for model Layers 1 through 3, respectively. Both the model-generated figures and those contoured from observed data (Figures 22 to 24) show a reversal in ground-water flow directions near the Mississippi River. During this time frame, ground water flowed away from the river into the aquifer. A point of converging ground-water flow is clearly identified between the Krummrich Plant and Site R. This reversal in gradient near the river occurs in all three aquifer zones. In addition to the reversal in gradient, both model results and observed water levels increased to levels above 400 ft msl between Site R and the Mississippi River.

The two methods used to calibrate the model each clearly illustrate that the numerical ground-water flow model accurately represents the aquifer system at Site R and its vicinity for both high and low flow conditions.

6.0 REFERENCES

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Table 1. Summary of Hydraulic Conductivity and Storage Coefficient Data Available Prior to the June 1992 Aquifer Test.

Zone	Source	Well Number or Location	Depth (ft)	Hydraulic Conductivity (ft/day)	Storage Coefficient (dimensionless)	
Upper (Layer 1)	Slug Test (G&M, 1986b)	GM-1	36	3.07	0.01	
	Slug Test (G&M, 1986b)	GM-2	44	0.25	0.1	
	Slug Test (G&M, 1986b)	GM-3	36	0.47	0.1	
	Aquifer Test (G&M, 1986b)	B-1	10.5	0.51	--	
	Aquifer Test (G&M, 1986b)	B-10	35.5	17.01	--	
	Aquifer Test (G&M, 1986b)	B-11	25.5	5.67	--	
	Aquifer Test (G&M, 1986b)	B-15	45.5	3.97	--	
				4.42	0.07	Avg.
Intermediate (Layer 2)	Aquifer Test (1986b)	WGK Plant	65	441.18	0.04	
Deep (Layer 3)	Aquifer Test (G&M, 1986b)	Mobil Oil Corp. St. Clair County T2N, R10W Section 25	114	387.70	0.1	
	Aquifer Test (G&M, 1986b)	Ranney Well Sauget Site R	99	374.33	0.082	
				381.02	0.09	Avg.

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Table 2. Estimates of aquifer characteristics obtained through interpretation of data from the June 1992 aquifer test, Sauget, Illinois.

Well Number	Method	T* (ft²/d)	K** (ft/d)	S***
Intermediate Zone				
P-5	Theis	38,000	420	0.012
P-9	Theis	22,000	240	0.013
P-10	Theis	22,000	240	0.0083
B-24C	Theis	34,000	380	0.0042
	Cooper-Jacob	32,000	360	0.0045
B-26B	Theis	32,000	360	0.0065
	Neuman	29,000	320	0.007
Deep Zone				
GM-57C	Hantush	31,000	340	0.0004
	Neuman	30,000	330	0.0055
GM-56C	Hantush	16,000	170	0.0013
	Neuman	24,000	270	0.016
GM-28C	Hantush	31,000	350	0.0001
	Average:	28,400	315	0.007

* Transmissivity (for the combined Intermediate/Deep Zones)

** Hydraulic Conductivity

*** Storage Coefficient (Specific Yield for Neuman Method)

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Table 3. Summary of Hydraulic Parameters used in the Monsanto Model.

Parameter Type	Zone	Value	Representation
Hydraulic Conductivity			
K(ft/day)	1	6.2	Water-table Layer (Cahokia Alluvium)
K(ft/day)	4	1.0	Site R (Water-Table Layer)
K(ft/day)	5	0.4	Mississippi River (Water-Table Layer)
Transmissivity			
T(ft^2/day)	2	15,000	Intermediate Layer (Henry Formation)
T(ft^2/day)	3	15,000	Deep Layer (Henry Formation)
Vertical Leakance			
Kv(day^{-1})	1	0.0063	Water-Table Layer/Intermediate Layer
Kv(day^{-1})	2	1.00	Intermediate Layer/Deep Layer
Kv(day^{-1})	3	1.0×10^{-9}	Water-table/Intermediate Layer in the landfill area
Kv(day^{-1})	4	0.42	Mississippi River/Intermediate Layer
Kv(day^{-1})	5	0.23	Intermediate Layer/Deep Layer (Mississippi River)
Recharge			
R(ft/day)	1	0.002	Water-Table Layer
R(ft/day)	2	0.084	Mounding at the W.G. Krummrich Plant (Water-Table Layer)
R(ft/day)	3	0.0006	Landfill Cap at Site R (Water-Table Layer)

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Table 4. Comparison between observed and computed water levels in the steady-state calibration.

Well	Row	Column	Layer	Observed Head (ft above msl)	Computed Head (ft above msl)	Residual (ft)
GM-1	26	32	1	393.970	395.077	-1.11
GM-4A	33	22	1	388.720	389.829	-1.11
GM-4B	33	22	2	388.510	389.493	-0.983
GM-4C	33	22	3	390.530	389.492	1.04
GM-5	36	20	1	387.930	388.705	-0.775
GM-6A	38	24	1	389.390	390.439	-1.05
GM-6B	38	24	2	389.440	390.124	-0.684
GM-9A	35	29	1	394.810	392.909	1.90
GM-9B	35	29	2	391.540	392.427	-0.887
GM-9C	35	29	3	391.250	392.426	-1.18
GM-10A	28	28	1	395.740	396.468	-0.728
GM-10B	28	28	2	391.520	392.023	-0.503
GM-10C	28	28	3	391.400	392.009	-0.609
GM-11	24	30	1	392.530	392.929	-0.399
GM-12A	30	32	1	393.270	394.804	-1.53
GM-12B	30	32	2	393.600	394.465	-0.865
GM-12C	30	32	3	393.260	394.464	-1.20
GM-15	29	30	1	392.960	393.918	-0.958
GM-16A	25	27	1	391.480	391.800	-0.320
GM-16B	25	27	2	391.420	391.468	-0.048
GM-17A	36	23	1	389.220	390.255	-1.03
GM-17B	36	23	2	389.220	389.936	-0.716
GM-17C	36	23	3	388.950	389.935	-0.985
GM-18A	42	21	1	388.530	389.171	-0.641
GM-18B	42	21	2	388.610	388.855	-0.245
GM-19B	41	17	2	386.530	386.498	0.03192
GM-19C	41	17	3	386.580	386.497	0.08292
GM-20A	38	18	1	387.260	387.388	-0.128
GM-20B	38	18	2	387.110	387.072	0.03819
GM-22A	40	16	1	386.710	386.691	0.01897
GM-26A	31	16	1	386.380	386.443	-0.063
GM-26B	31	16	2	386.110	386.127	-0.017
GM-27C	36	8	3	383.040	382.213	0.827
GM-28B	42	10	3	382.700	382.531	0.169
GM-29	32	28	1	397.480	397.467	0.01282
GM-30	32	31	1	395.380	394.289	1.09
GM-31C	44	22	3	388.780	389.080	-0.300

Table 4. Comparison between observed and computed water levels in the steady-state calibration. (continued)

Well	Row	Column	Layer	Observed Head (ft above msl)	Computed Head (ft above msl)	Residual (ft)
GM-45	30	28	1	403.040	402.708	-0.332
GM-46	31	29	1	401.520	401.128	0.392
GM-54B	44	20	2	388.390	388.417	-0.027
GM-55C	44	9	3	383.260	382.366	0.894
GM-56C	40	9	3	383.490	382.359	1.13
GM-57C	38	9	3	382.910	382.208	0.702
GM-58A	44	21	1	388.540	389.212	-0.672
GM-60A	36	15	1	386.010	385.941	0.06854
GM-60B	36	15	2	386.020	385.612	0.408
GM-60C	36	15	3	386.080	385.611	0.469
GM-61A	43	17	1	386.810	387.066	-0.256
GM-62A	41	13	1	385.420	385.365	0.05530
GM-62B	41	13	2	385.420	384.728	0.692
GM-62C	41	13	3	385.440	384.726	0.714
GM-63A	42	15	1	386.170	386.155	0.01485
B-21B	37	11	2	384.250	383.640	0.610
B-22A	37	9	1	396.300	392.283	4.02
B-24A	39	10	1	398.110	395.667	2.44
B-24B	39	10	2	383.170	382.659	0.511
B-24C	39	10	3	383.270	382.668	0.602
B-26A	41	10	1	392.500	394.400	-1.90
B-26B	41	10	2	383.200	382.645	0.555
B-27B	44	11	2	383.800	383.171	0.629
B-28A	43	10	1	394.320	393.846	0.474
B-28B	43	10	2	383.280	382.774	0.506
B-29A	43	12	1	394.090	390.691	3.40
B-31C	37	12	3	384.880	384.315	0.565
P-1	44	9	2	383.000	382.342	0.658
P-8	40	9	2	382.730	382.317	0.413
P-12	37	8	2	382.530	382.194	0.336
BK-3	30	29	2	392.130	392.614	-0.484
WB-6	39	33	1	394.240	396.027	-1.79

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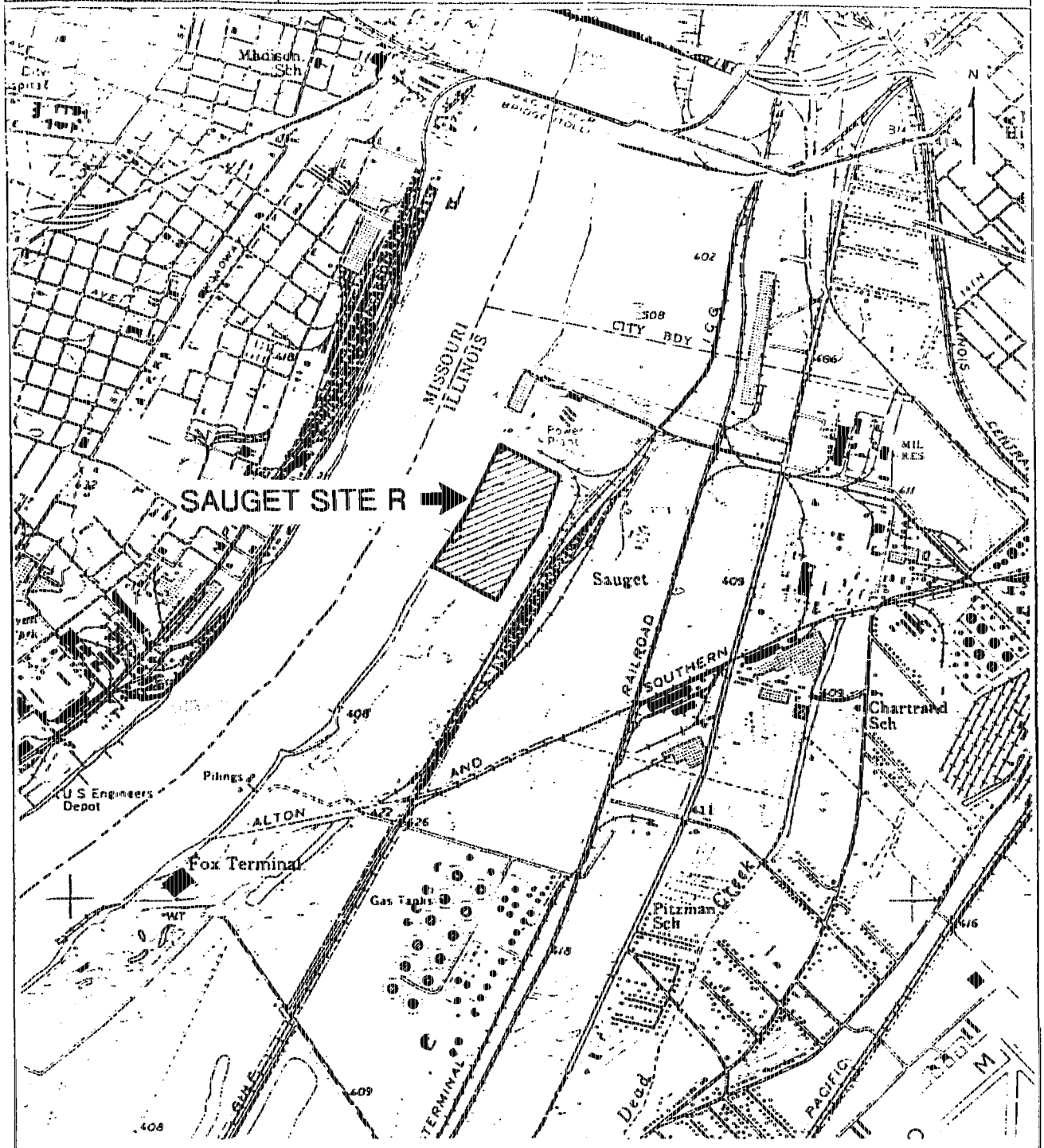
COMPILED BY: L. MUSIKER	DATE: 11/4/92	SCALE:	PREPARED FOR:
PREPARED BY: V. CARUNCHO	FILE NO: 1558 NY64211		
PROJECT MGR.: L. MUSIKER			

MONSANTO COMPANY
St. Louis, Missouri



SOURCE: USGS CAHOKIA QUAD, 1974

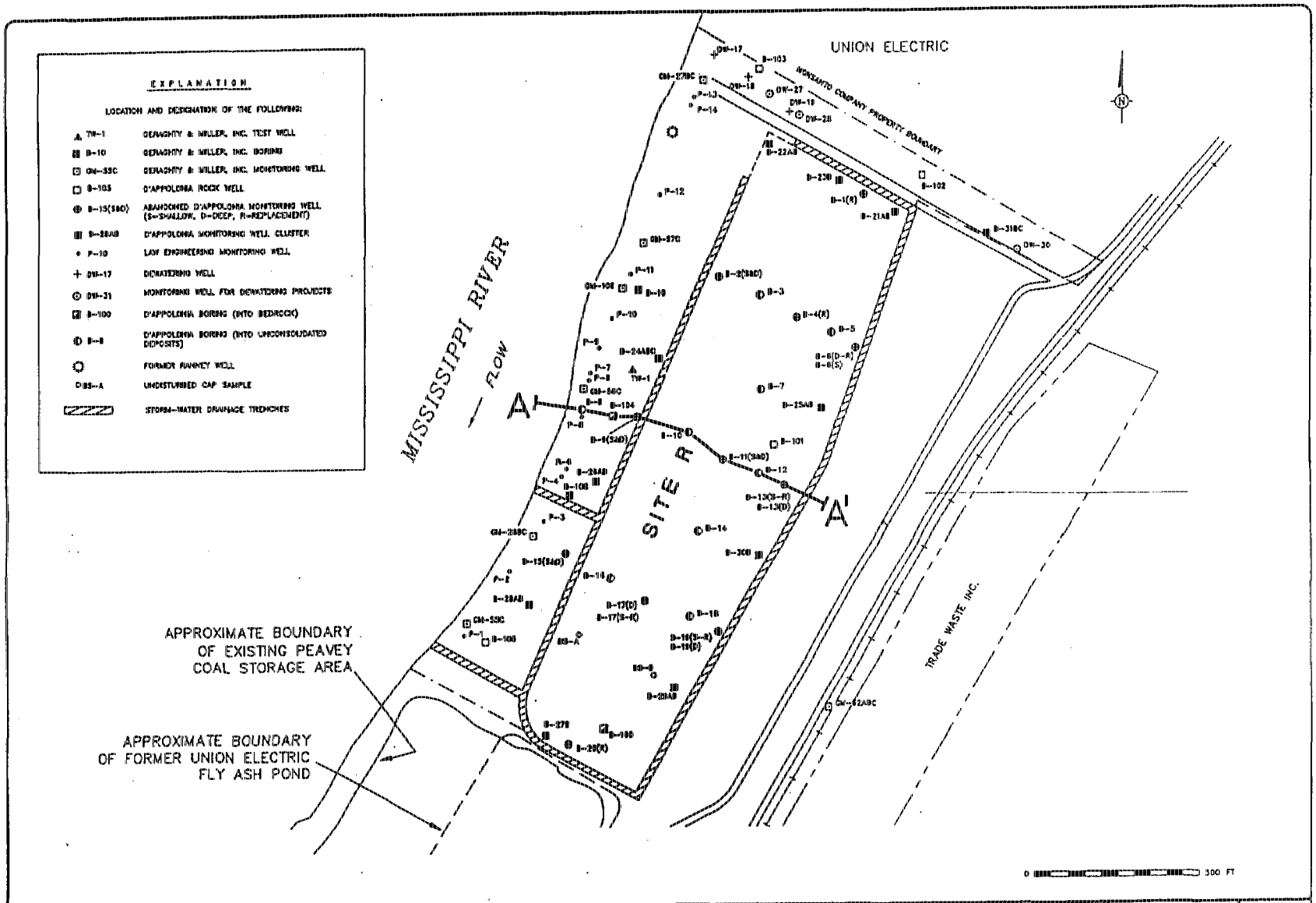
0 2000 FT

SUBJECT:

LOCATION OF SAUGET SITE R, Monsanto Company, Sauget, Illinois

FIGURE 1

141881



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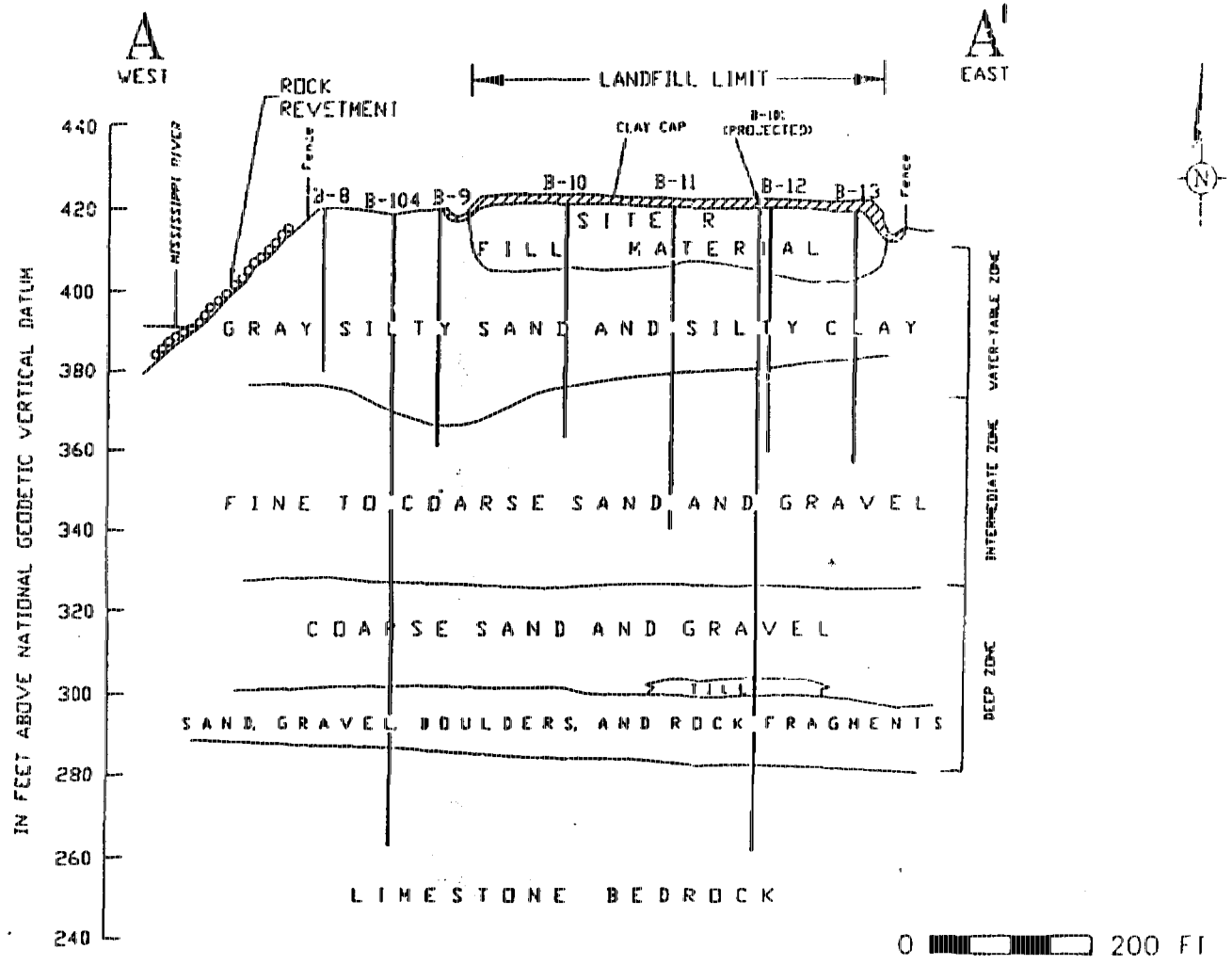
CHECKED BY	[illegible]	DATE	
APPROVED BY	[illegible]	DATE	

LOCATIONS OF MONITORING WELLS AND SOIL BORINGS, SAUGET SITE R

MONSANTO COMPANY
SAUGET, ILLINOIS

FIGURE 2

DWG DATE: 8-9-94 | PROJ NO.: NY6421 | FILE NO. 1558 | DRAWING: SEC-AA' | CHECKED: L. MUSIKER | APPROVED: L. MUSIKER | DRAFTER: [illegible]



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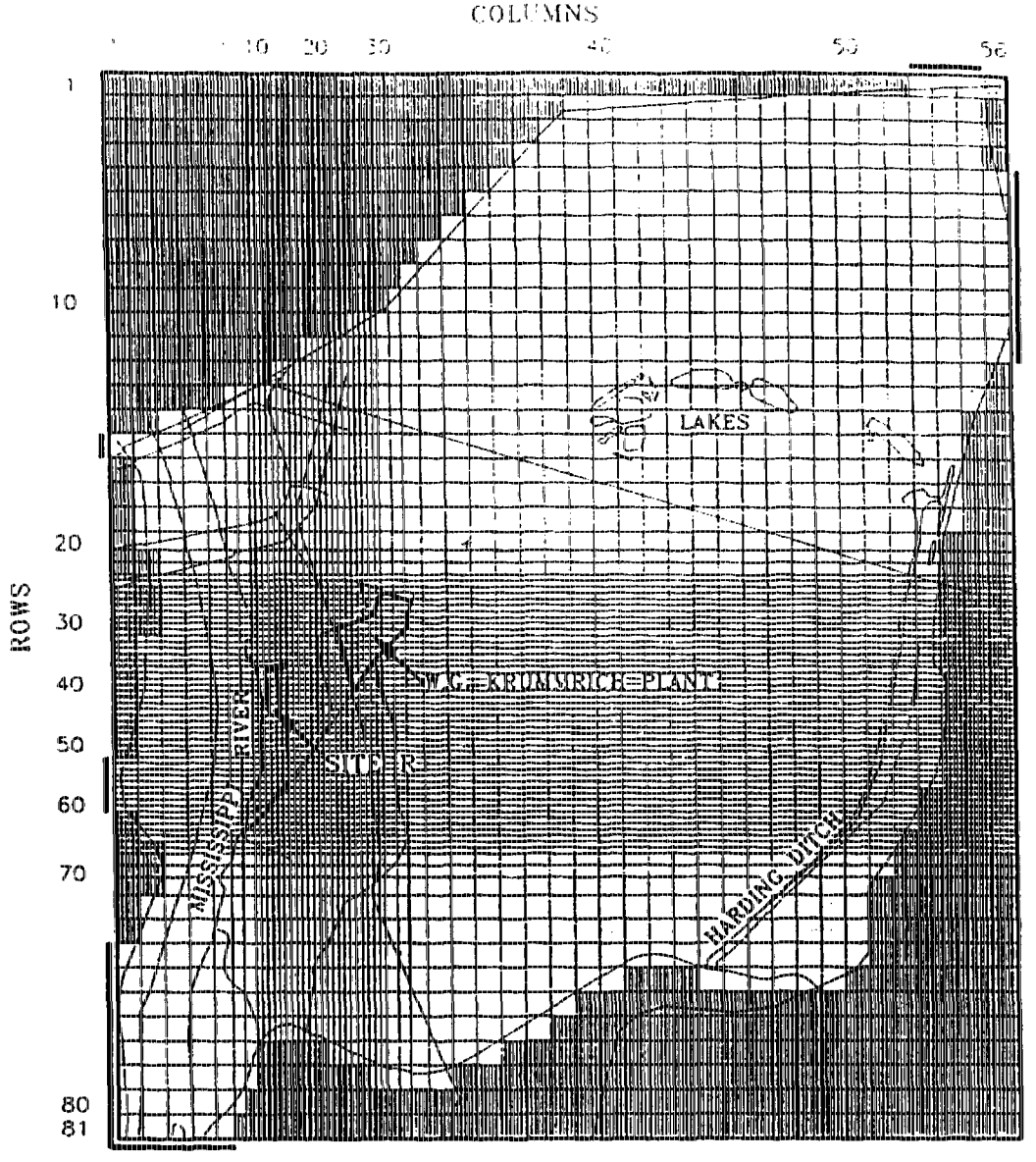
Environmental Services

CROSS SECTION A-A', SAUGET SITE R, Monsanto Company, Sauget, Illinois

FIGURE 3



LEGEND

- No Flow Cells
- No-Flow Boundary
- Finite-Difference Cell

FEET
0 3500 7000 10500

GERAGHTY & MILLER, INC.
Environmental Services

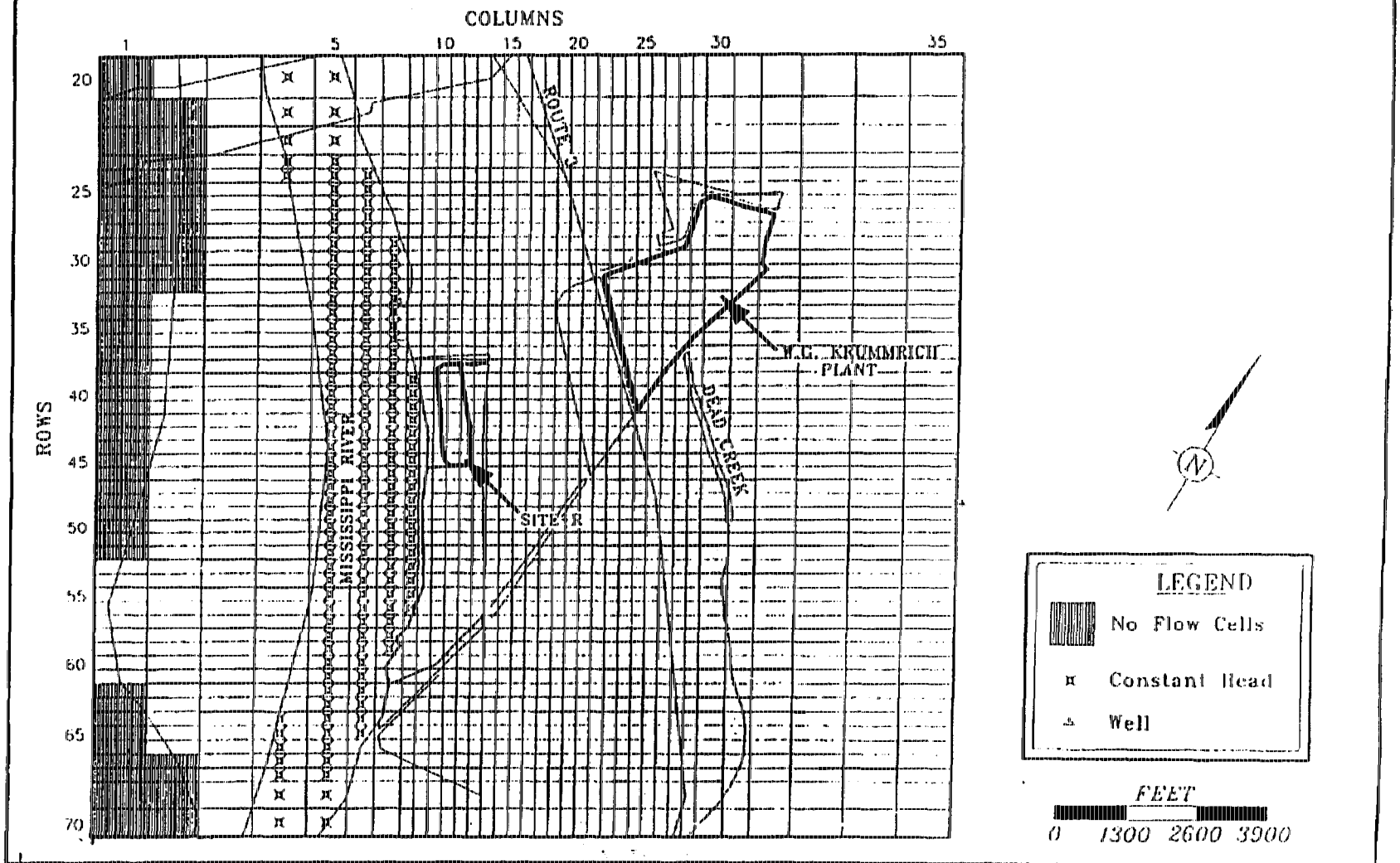
Finite-Difference Mesh of the Monsanto Ground-Water Flow Model.

Monsanto Company
Sauget, Illinois

FIGURE 4

DRAFTER: CWS | APPROVED: JOR | CHECKED: JOR | DRAWING: MONSANTO | FILE NO.: FIG4.DWG | PRJCT NO.: NY642.08 | DWG DATE: 18/10/92

DWG DATE: 18/10/92 | PRJCT NO.: NY642.08 | FILE NO: FIG5.DWG | DRAWING: MONSANTO | CHECKED: JOR | APPROVED: JOR | DRAFTER: CMS



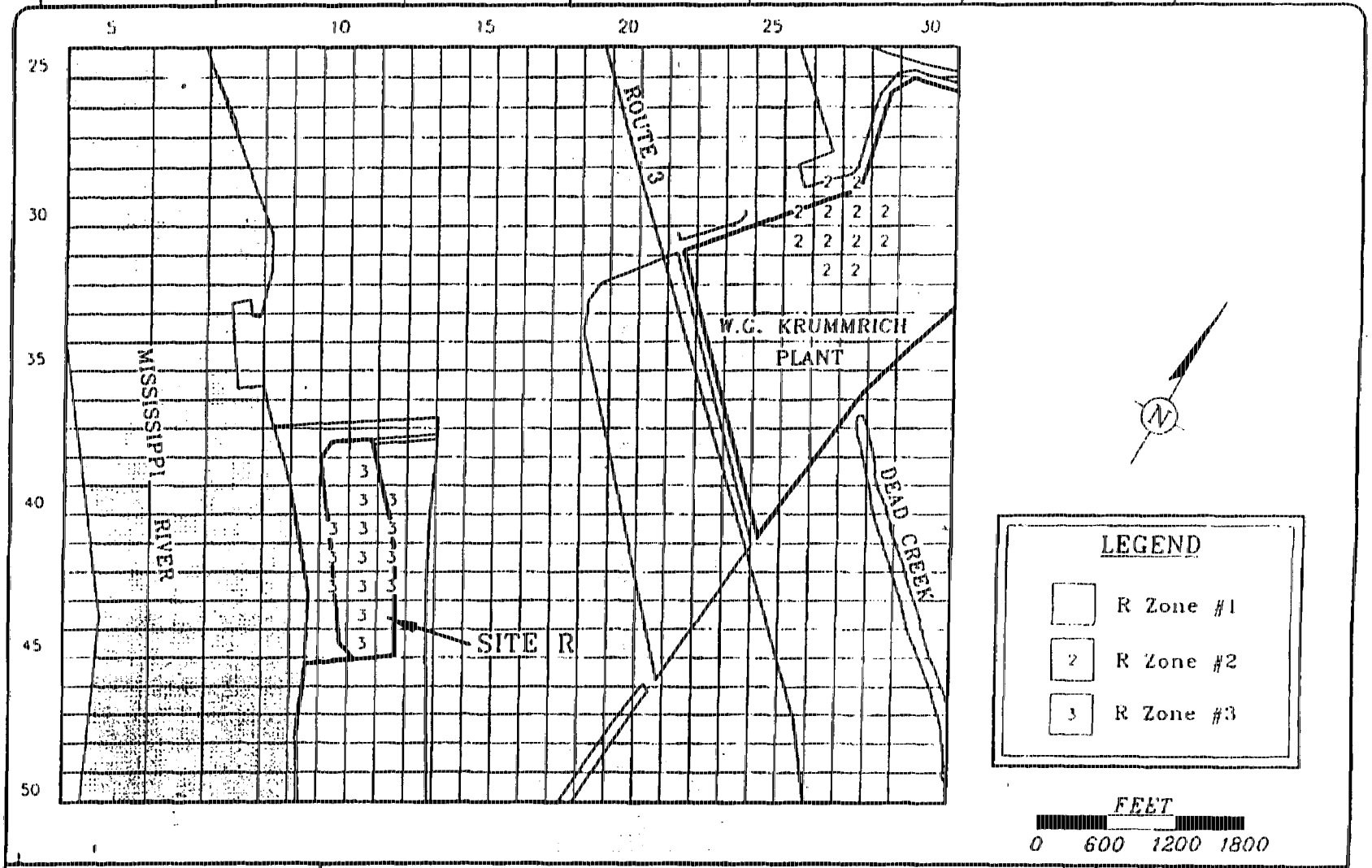
GERAGHTY & MILLER, INC.
Environmental Services

Portion of the Finite-Difference Mesh near Sauget Site R Illustrating Placement of Boundary Conditions in Layer 1.

Monsanto Company
Sauget, Illinois

FIGURE
5

DWG . 18NOV92 | PRJCT NO · NY642.08 | FILE NO.: FIG6.DWG | DRAWING: MON... | CHECKED: JOR | APPROVED: JOR | DRAFTER: ...



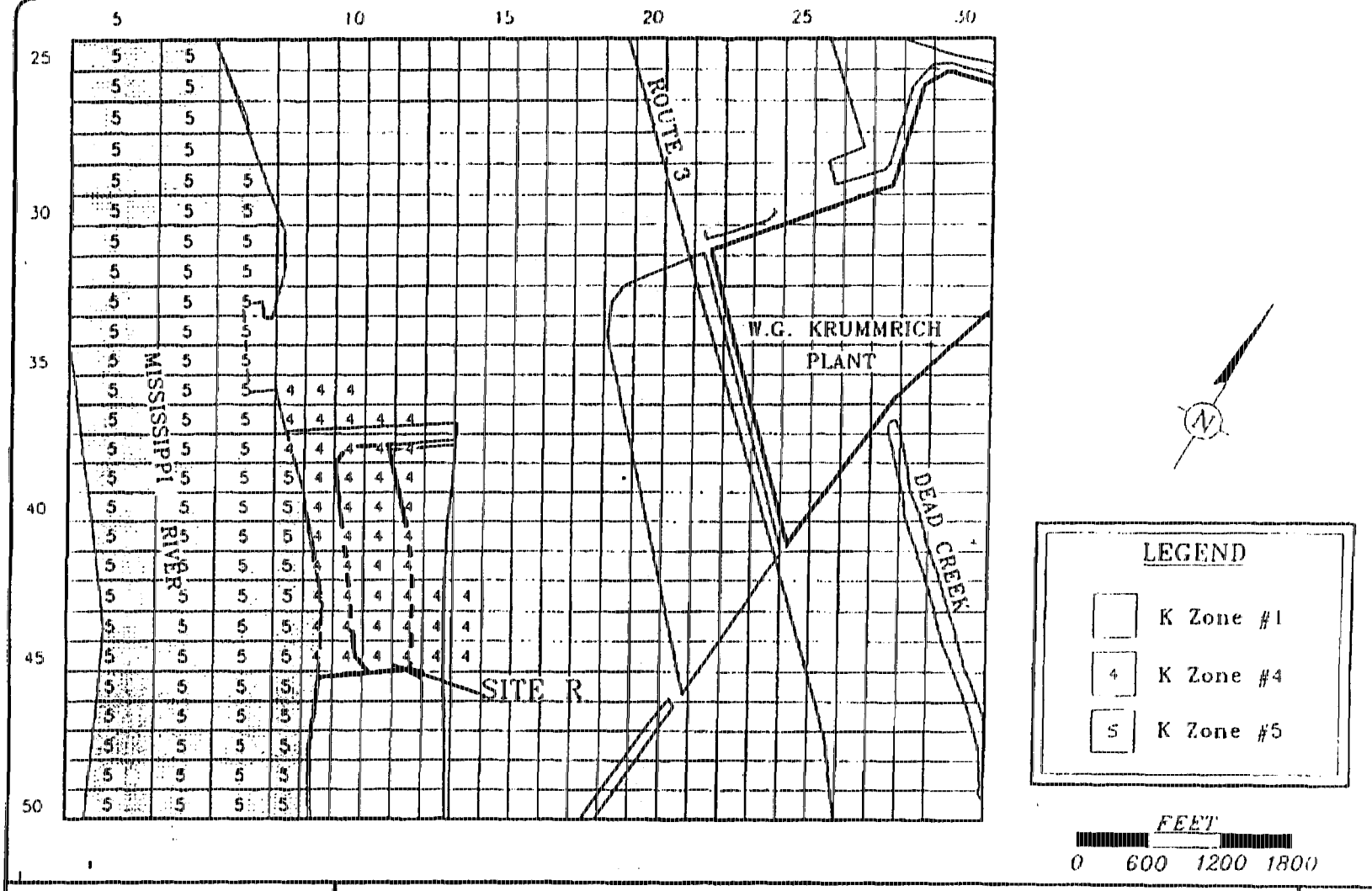
GERAGHTY & MILLER, INC.
Environmental Services

Portion of the Finite-Difference Mesh near Sauget Site R Illustrating Placement of Recharge Zones in Layer 1.

Monsanto Company
Sauget, Illinois

FIGURE 6

DWG DATE: 18NOV92 | PROJECT NO.: NY6642.08 | FILE NO.: FIG7.DWG | DRAWING: MONSANTO | CHECKED: JOR | APPROVED: JOR | DRAFTER: CMS



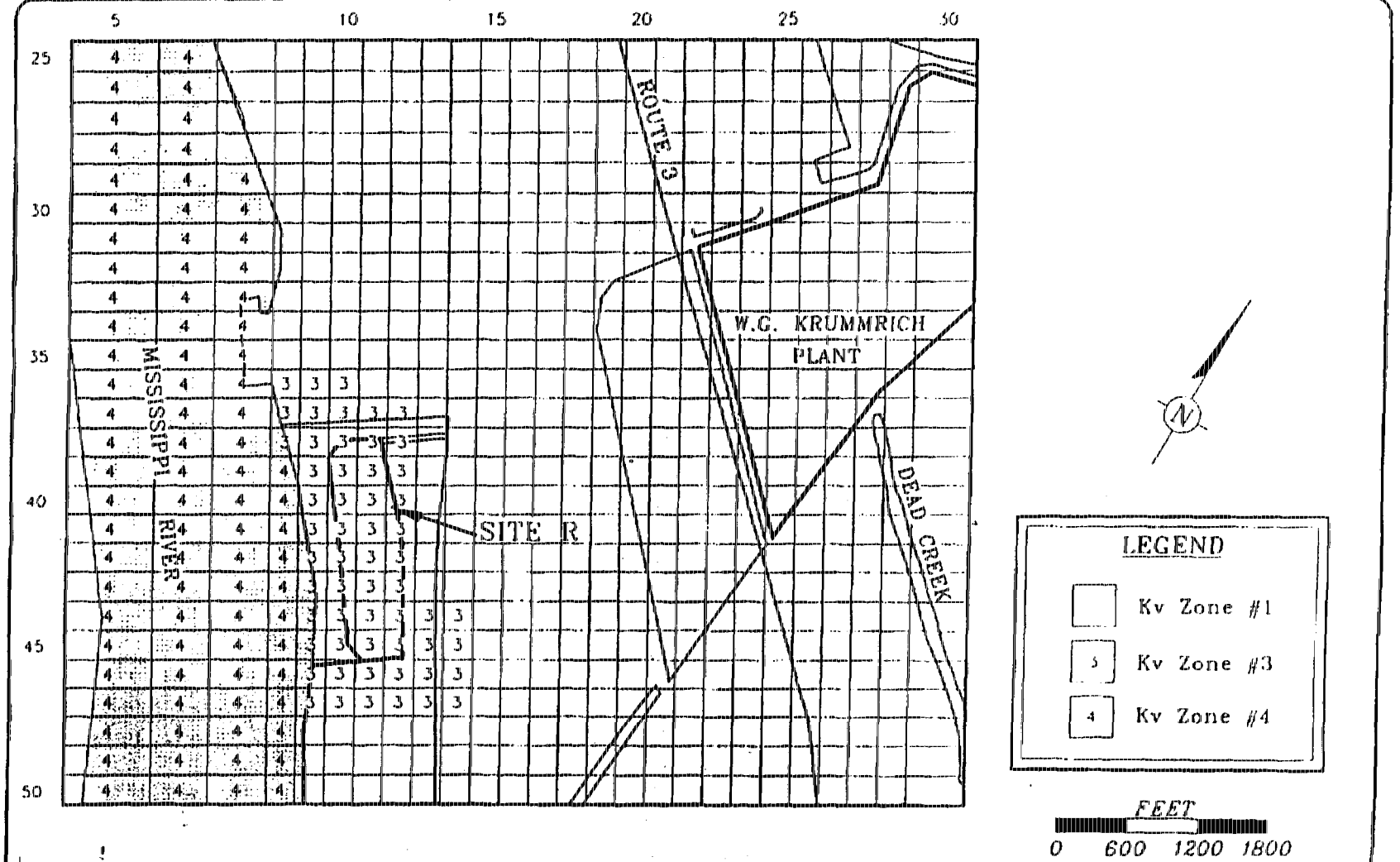
GERAGHTY & MILLER, INC.
Environmental Services

Portion of the Finite-Difference Mesh near Sauget Site R Illustrating Placement of Hydraulic Conductivity Zones in Layer 1.

Monsanto Company
Sauget, Illinois

FIGURE 7

DWG D... 18NOV92 | PRJCT NO. NY642 08 | FILE NO : FIG8 DWG | DRAWING. MONSANTO | CHECKED: JOR | APPROVED JOR | DRAFTER CMS



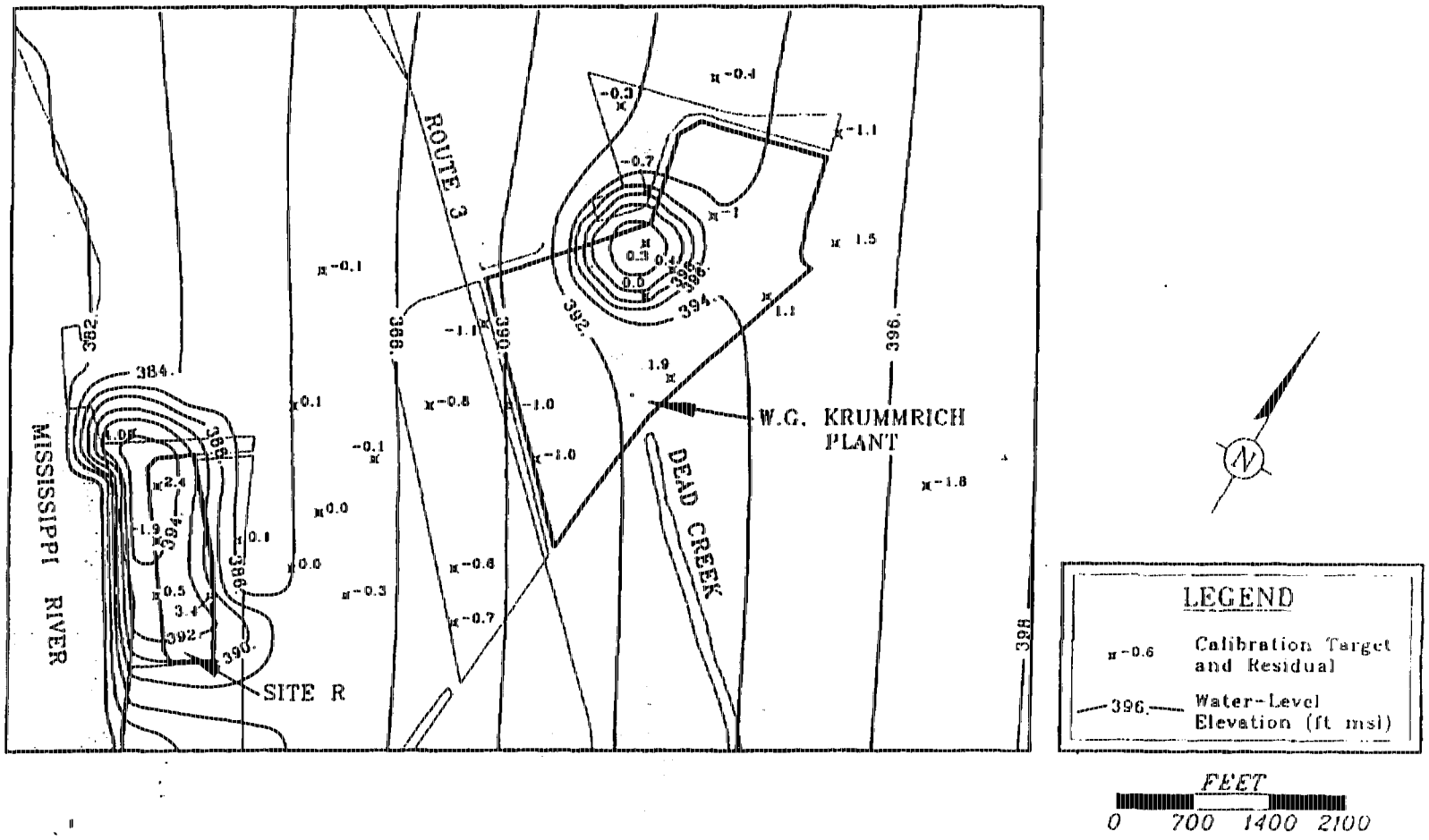
GERAGHTY & MILLER, INC.
Environmental Services

Portion of the Finite-Difference Mesh near Sauget Site R Illustrating Placement of Leakance Zones in Layer 1.

Monsanto Company
Sauget, Illinois

FIGURE
8

DWG D..... 19NOV92 | PRJCT NO: NY642 08 | FILE NO: FIG9 DWG | DRAWING: MONSANTO | CHECKED: JOR | APPROVED: JOR | DRAFTER: C.M.



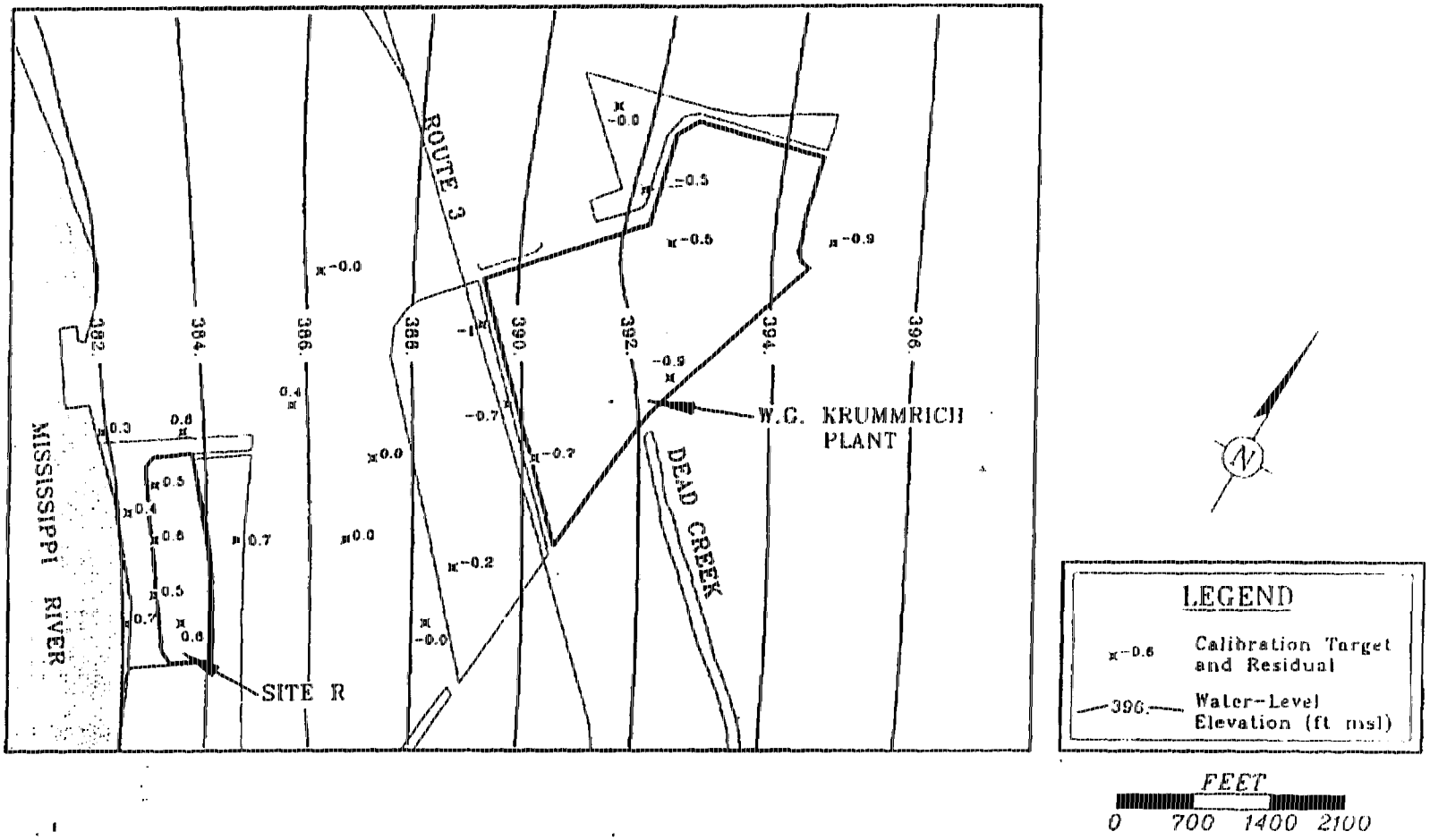
GERAGHTY & MILLER, INC.
Environmental Services

Calibrated Water-Table Contours in Layer 1 Showing Residuals for the Steady-State Calibration.

Monsanto Company
Sauget, Illinois

FIGURE 9

DWG DATE 19NOV92 | PRJCT NO NY642 08 | FILE NO: FIG10.DWG | DRAWING: MONSANTO | CHECKED JOR | APPROVED JOR | DRAFTER GMS



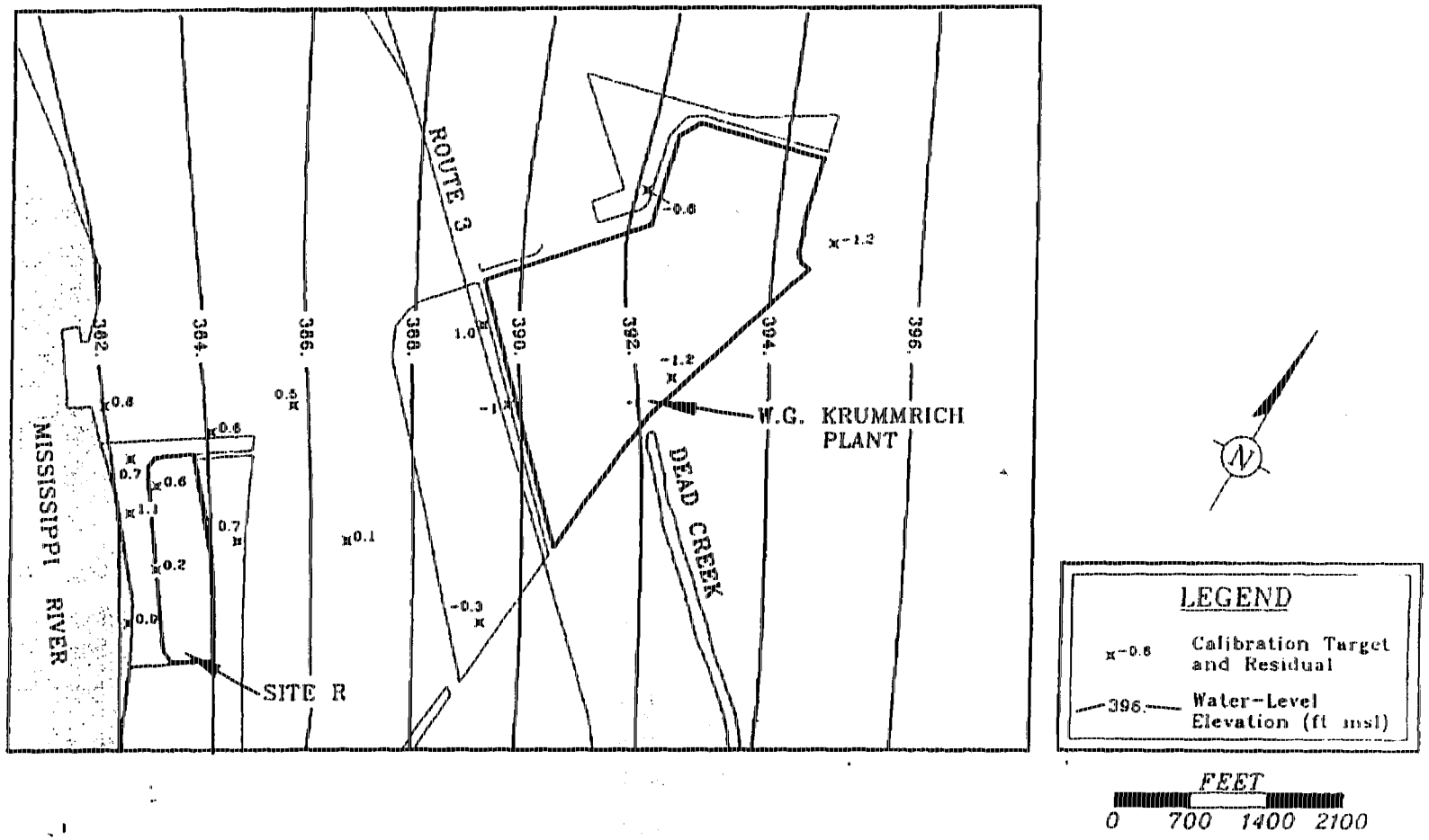
GERAGHTY & MILLER, INC.
Environmental Services

Calibrated Potentiometric Surface in Layer 2 Showing Residuals for the Steady-State Calibration.

Monsanto Company
Sauget, Illinois

FIGURE
10

DWG L. . 19NOV92 | PRJCT NO: NY642.08 | FILE NO: FIG11.DWG | DRAWING: MONSanto | CHECKED: JOR | APPROVED: JOR | DRAFTER: CMS

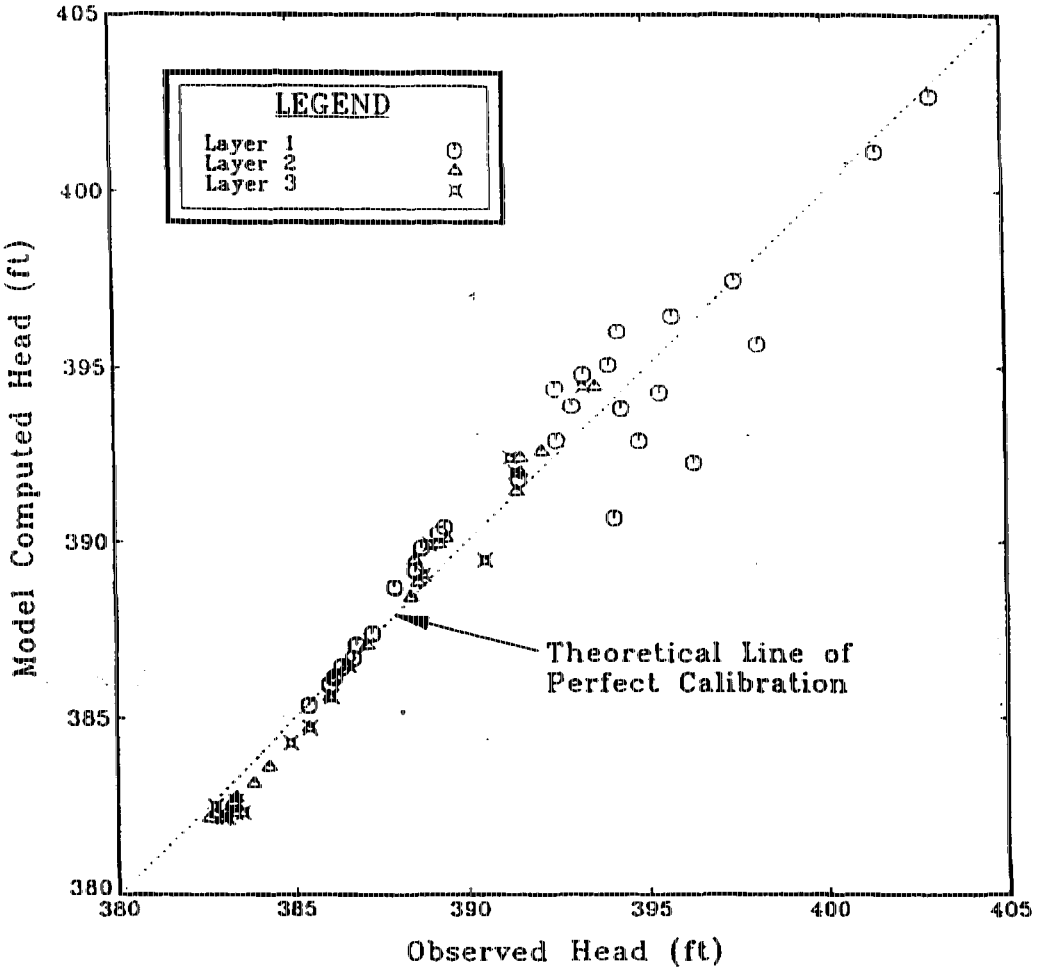


GERAGHTY & MILLER, INC.
Environmental Services

Calibrated Potentiometric Surface in Layer 3 Showing Residuals for the Steady-State Calibration.

Monsanto Company
Sauget, Illinois

FIGURE 11



GERAGHTY & MILLER, INC.
Environmental Services

Comparison Between Observed and Computed Water Levels.

Monsanto Company
Sauget, Illinois

FIGURE 12

DRAFTER: CMS | APPROVED: JOR | CHECKED: JOR | DRAWING: MONSANTO | FILE NO.: FIG12.DWG | PRJCT NO.: HY642.08 | DWG DATE: 19NOV92

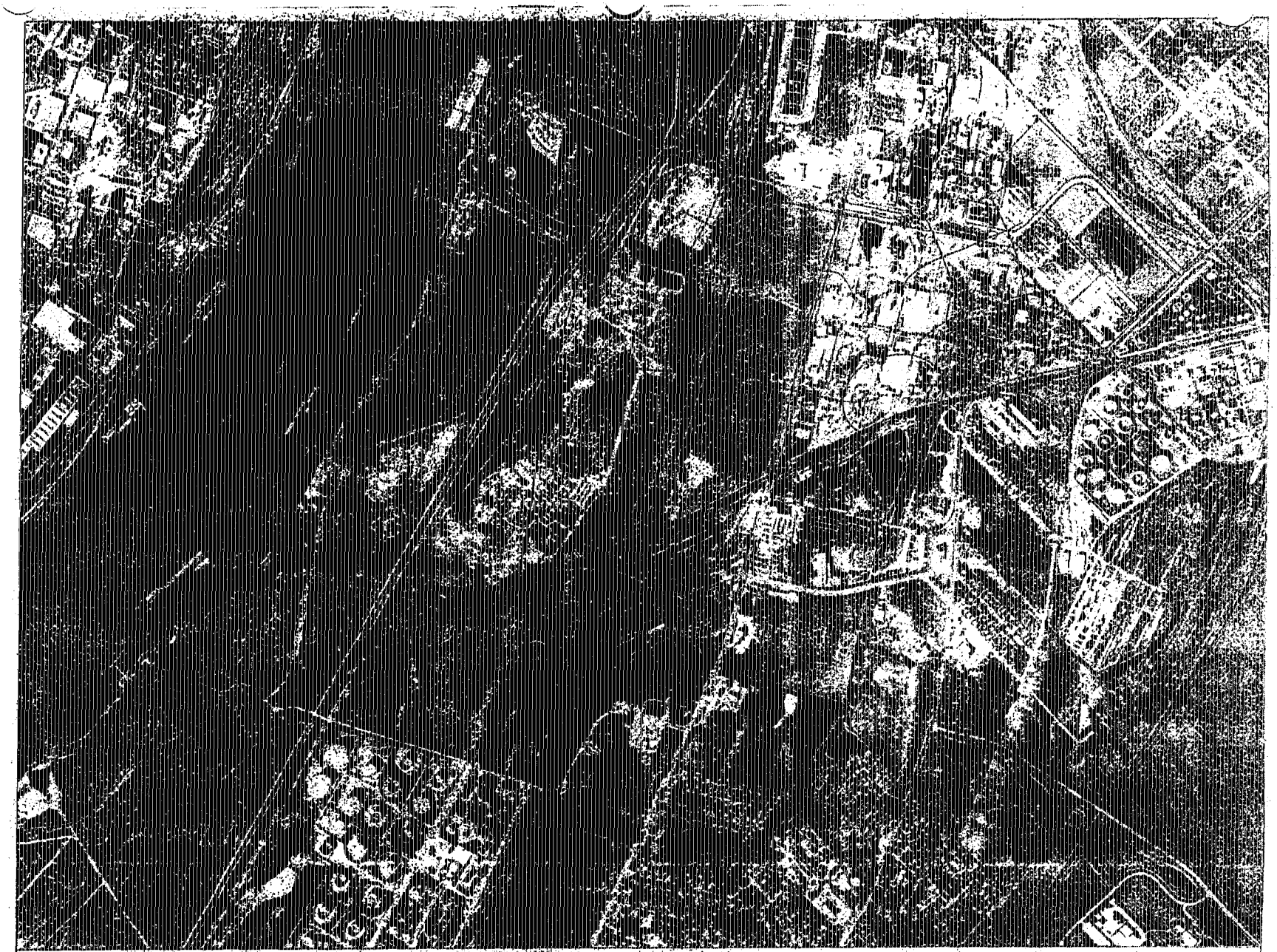
EXPLANATION

CONFIGURATION OF THE WATER TABLE

NOVEMBER 1985

MONSANTO COMPANY
Sauget, Illinois

FIGURE 13



EXPLANATION

POTENTIOMETRIC SURFACE OF THE
INTERMEDIATE ZONE
NOVEMBER 1985

MONSANTO COMPANY
Sauget, Illinois

FIGURE 14

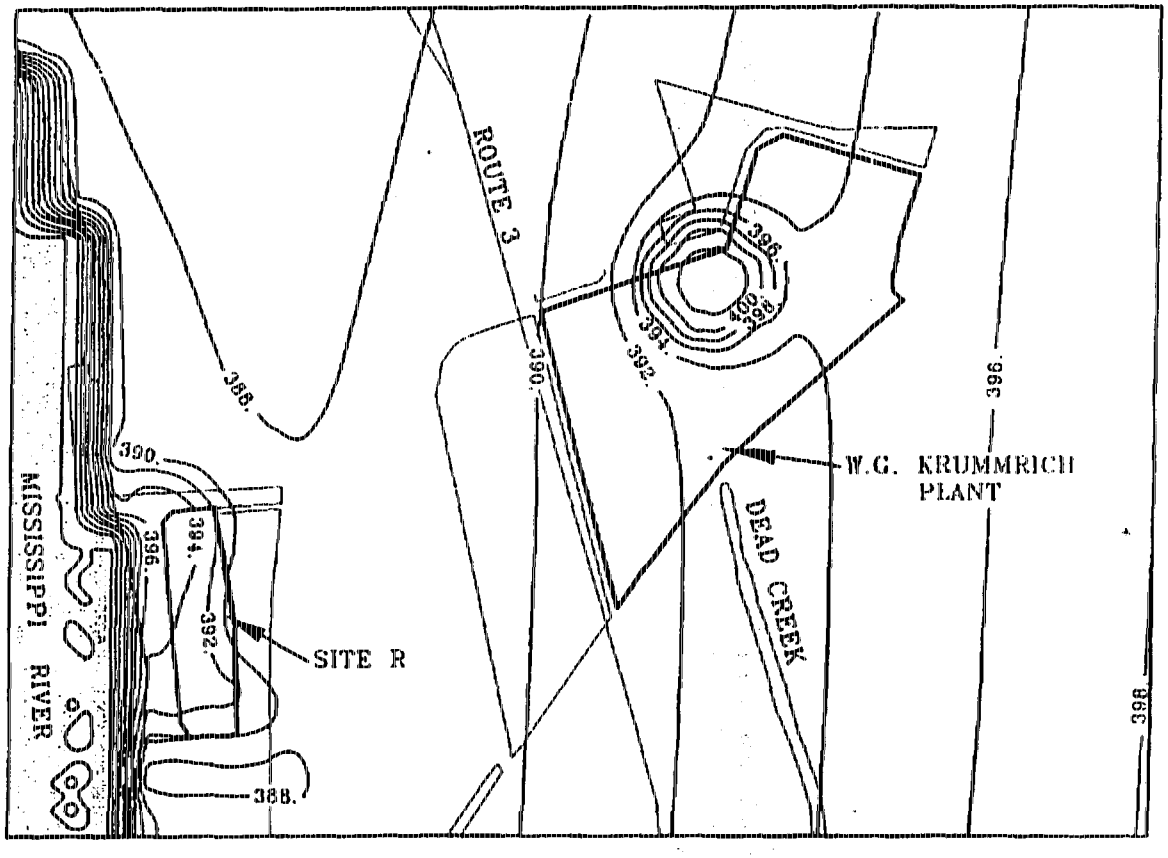
POTENTIOMETRIC SURFACE
OF THE DEEP ZONE

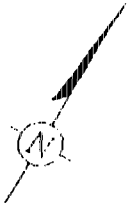
NOVEMBER 1985

MONSANTO COMPANY
Sauget, Illinois

FIGURE 15

DWG DATE: 19NOV92 | PRJCT NO.: NY642.08 | FILE NO.: FIG16.DWG | DRAWING: MONSANTO | CHECKED: JOR | APPROVED: JOR | DRAFTER: CRC





LEGEND

396 — Water-Level Elevation (ft msl)

FEET

0 700 1400 2100

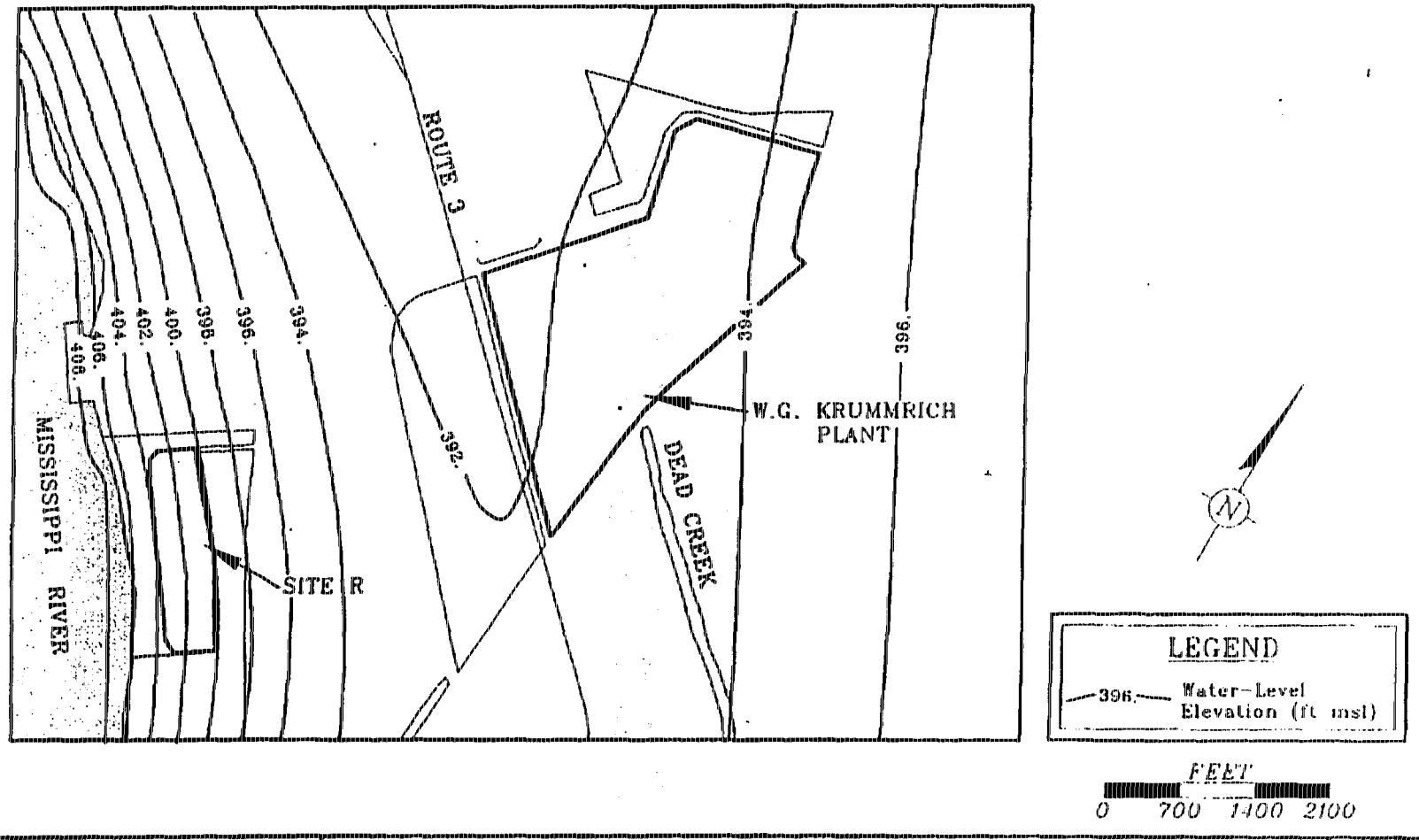
GERAGHTY & MILLER, INC.
Environmental Services

Model Calculated Water-Table Contours in Layer 1 for the Transient High-Water Analysis.

Monsanto Company
Sauget, Illinois

FIGURE 16

DWG DATE 19NOV92 | PRJCT NO. NY642.08 | FILE NO. FIG17.DWG | DRAWING: MONSANTO | CHECKED: JOR | APPROVED: JOR | DRAFTER: CMS



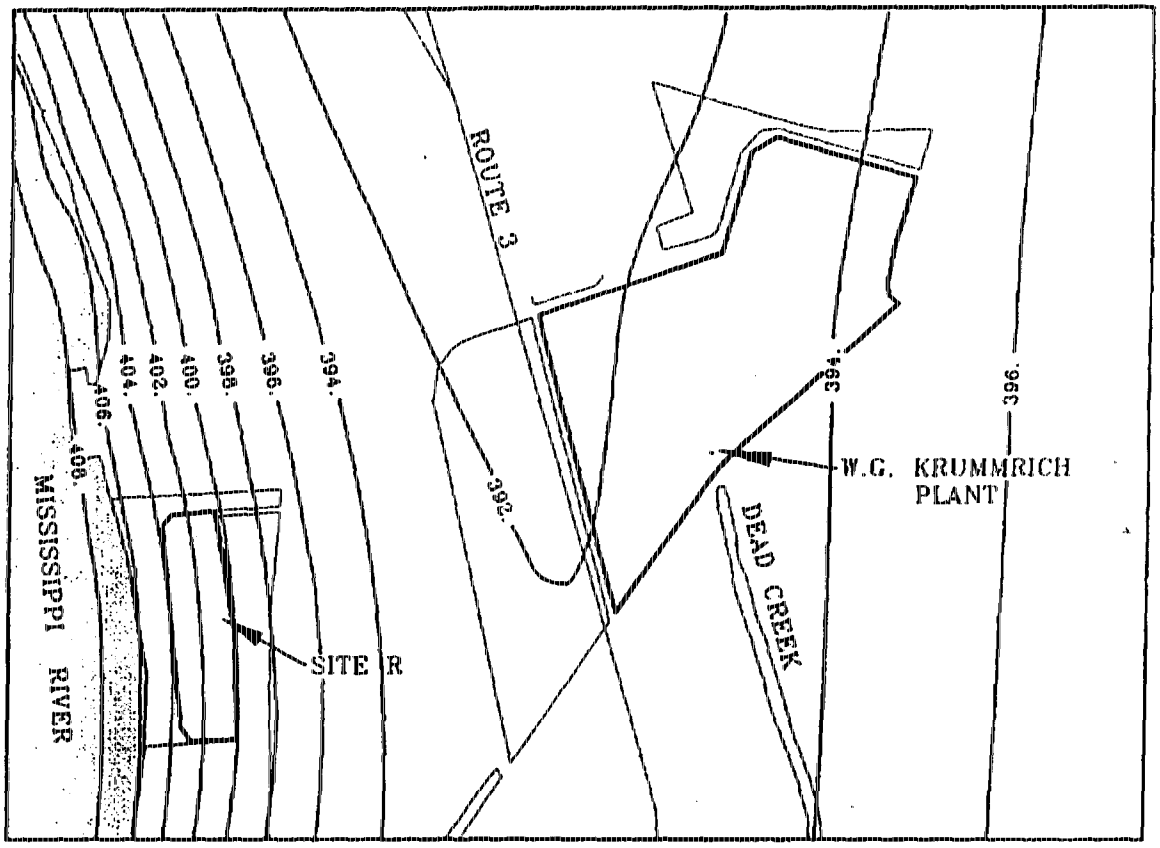
GERAGHTY & MILLER, INC.
Environmental Services

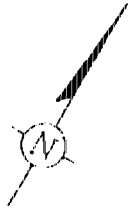
Model Calculated Potentiometric Surface in Layer 2 for the Transient High-Water Analysis.

Monsanto Company
Sauget, Illinois

FIGURE
17

DWG DATE: 19NOV92 | PRJCT NO.: NY642.08 | FILE NO.: FIG18.DWG | DRAWING: MONSANTO | CHECKED: JOR | APPROVED: JOR | DRAFTER: CMS





LEGEND

—396— Water-Level Elevation (ft msl)

FEET

0 700 1400 2100

GERAGHTY & MILLER, INC.
Environmental Services

Model Calculated Potentiometric Surface in Layer 3 for the Transient High-Water Analysis.

Monsanto Company
Sauget, Illinois

FIGURE 18

Appendix 5

Human Health Risk Assessment DQL Tables

TABLE 1
DATA QUALITY LEVELS (DQLs) FOR SOIL AND SEDIMENT
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	REGION 9 SOIL PRGS (mg/kg) (c)	DQL BASIS
TCL Volatiles			
1,1,1-Trichloroethane	71-55-6	6.35E+02	PRG
1,1,2,2-Tetrachloroethane	79-34-5	3.84E-01	PRG
1,1,2-Trichloroethane	79-00-5	8.43E-01	PRG
1,1-Dichloroethane	75-34-3	5.89E+02	PRG
1,1-Dichloroethylene	75-35-4	5.36E-02	PRG
1,2-Dichloroethane	107-06-2	3.46E-01	PRG
1,2-Dichloroethylene (total)	540-59-0	4.30E+01 (p)	PRG
1,2-Dichloropropane	78-87-5	3.51E-01	PRG
2-Butanone	78-93-3	7.33E+03	PRG
2-Hexanone	591-78-6	7.87E+02 (m)	PRG
4-Methyl-2-pentanone	108-10-1	7.87E+02	PRG
Acetone	67-64-1	1.57E+03	PRG
Benzene	71-43-2	6.54E-01	PRG
Bromodichloromethane	75-27-4	1.02E+00	PRG
Bromoform	75-25-2	6.16E+01	PRG
Bromomethane	74-83-9	3.90E+00	PRG
Carbon Disulfide	75-15-0	3.55E+02	PRG
Carbon tetrachloride	56-23-5	2.39E-01	PRG
Chlorobenzene	108-90-7	1.52E+02	PRG
Chloroethane	75-00-3	3.03E+00	PRG
Chloroform	67-66-3	2.44E-01	PRG
Chloromethane	74-87-3	1.23E+00	PRG
cis-1,3-Dichloropropene	10061-01-5	7.00E-01 (g)	PRG
Dibromochloromethane	124-48-1	1.11E+00	PRG
Ethyl Benzene	100-41-4	1.50E+03	PRG
Methylene chloride	75-09-2	8.88E+00	PRG
Styrene	100-42-5	4.60E+03	PRG
Tetrachloroethene	127-18-4	5.69E+00	PRG
Toluene	108-88-3	5.90E+02	PRG
Total Xylenes	1330-20-7	1.40E+03	PRG
trans-1,3-Dichloropropene	10061-02-6	7.00E-01 (g)	PRG
Trichloroethene	79-01-6	2.77E+00	PRG
Vinyl chloride	75-01-4	1.47E-01	PRG
TCL Semi-Volatiles			
1,2,4-Trichlorobenzene	120-82-1	6.46E+02	PRG
1,2-Dichlorobenzene	95-50-1	9.00E+02	PRG
1,3-Dichlorobenzene	541-73-1	1.32E+01	PRG

TABLE 1
DATA QUALITY LEVELS (DQLs) FOR SOIL AND SEDIMENT
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	REGION 9 SOIL PRGS (mg/kg) (c)		DQL BASIS
1,4-Dichlorobenzene	106-46-7	3.44E+00		PRG
2,2'-oxybis(1-Chloropropane) (s)	108-60-1	2.88E+00	(s)	PRG
2,4,5-Trichlorophenol	95-95-4	6.11E+03		PRG
2,4,6-Trichlorophenol	88-06-2	4.42E+01		PRG
2,4-Dichlorophenol	120-83-2	1.83E+02		PRG
2,4-Dimethylphenol	105-67-9	1.22E+03		PRG
2,4-Dinitrophenol	51-28-5	1.22E+02		PRG
2,4-Dinitrotoluene	121-14-2	1.22E+02		PRG
2,6-Dinitrotoluene	606-20-2	6.11E+01		PRG
2-Chloronaphthalene	91-58-7	3.85E+03		PRG
2-Chlorophenol	95-57-8	6.34E+01		PRG
2-Methylnaphthalene	91-57-6	5.60E+01	(f)	PRG
2-Methylphenol	95-48-7	3.06E+03		PRG
2-Nitroaniline	88-74-4	3.49E+00		PRG
2-Nitrophenol	88-75-5	4.89E+02	(n)	PRG
3,3'-Dichlorobenzidine	91-94-1	1.08E+00		PRG
3-Nitroaniline	99-09-2	3.49E+00	(o)	PRG
4,6-Dinitro-2-methylphenol	534-52-1	NA		NA
4-Bromophenyl phenyl ether	101-55-3	NA		NA
4-Chloraniline	106-47-8	2.44E+02		PRG
4-Chloro-3-methylphenol	59-50-7	NA		NA
4-Chlorophenol phenyl ether	7005-72-3	NA		NA
4-Methylphenol	106-44-5	3.06E+02		PRG
4-Nitroaniline	100-01-6	3.49E+00	(o)	PRG
4-Nitrophenol	100-02-7	4.89E+02		PRG
Acenaphthene	83-32-9	3.68E+03		PRG
Acenaphthylene	208-96-8	3.68E+03	(h)	PRG
Anthracene	120-12-7	2.19E+04		PRG
Benz[a]anthracene	56-55-3	6.21E-01		PRG
Benzo[a]pyrene	50-32-8	6.21E-02		PRG
Benzo[b]fluoranthene	205-99-2	6.21E-01		PRG
Benzo[g,h,i]perylene	191-24-2	2.30E+03	(a)	PRG
Benzo[k]fluoranthene	207-08-9	6.21E+00		PRG
bis(2-Chloroethoxy)methane	111-91-1	NA		NA
bis(2-Chloroethyl)ether	111-44-4	2.11E-01		PRG
bis(2-Ethylhexyl)phthalate	117-81-7	3.47E+01		PRG
Butyl benzyl phthalate	85-68-7	1.22E+04		PRG
Carbazole	86-74-8	2.43E+01		PRG
Chrysene	218-01-9	6.21E+01		PRG

TABLE 1
DATA QUALITY LEVELS (DQLs) FOR SOIL AND SEDIMENT
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	REGION 9 SOIL PRGS (mg/kg) (c)	DQL BASIS
Dibenz[a,h]anthracene	53-70-3	6.21E-02	PRG
Dibenzofuran	132-64-9	2.91E+02	PRG
Diethylphthalate	84-66-2	4.89E+04	PRG
Dimethyl phthalate	131-11-3	6.10E+05	PRG
Di-n-butyl phthalate	84-74-2	6.11E+03	PRG
Di-n-octyl phthalate	117-84-0	1.22E+03	PRG
Fluoranthene	206-44-0	2.29E+03	PRG
Fluorene	86-73-7	2.64E+03	PRG
Hexachlorobenzene	118-74-1	3.04E-01	PRG
Hexachlorobutadiene	87-68-3	6.24E+00	PRG
Hexachlorocyclopentadiene	77-47-4	4.23E+02	PRG
Hexachloroethane	67-72-1	3.47E+01	PRG
Indeno[1,2,3-cd]pyrene	193-39-5	6.21E-01	PRG
Isophorone	78-59-1	5.12E+02	PRG
Naphthalene	91-20-3	5.59E+01	PRG
Nitrobenzene	98-95-3	1.96E+01	PRG
N-Nitroso-di-n-propylamine	621-64-7	6.95E-02	PRG
N-Nitrosodiphenylamine	86-30-6	9.93E+01	PRG
Pentachlorophenol	87-86-5	2.98E+00	PRG
Phenanthrene	85-01-8	2.20E+04 (b)	PRG
Phenol	108-95-2	3.67E+04	PRG
Pyrene	129-00-0	2.31E+03	PRG
TAL Metals			
Aluminum	7429-90-5	7.61E+04	PRG
Antimony	7440-36-0	3.13E+01	PRG
Arsenic	7440-38-2	3.90E-01	PRG
Barium	7440-39-3	5.37E+03	PRG
Beryllium	7440-41-7	1.54E+02	PRG
Cadmium	7440-43-9	3.70E+01	PRG
Calcium	7440-70-2	NA	NA
Chromium	7440-47-3	2.10E+02 (e)	PRG
Cobalt	7440-48-4	4.69E+03	PRG
Iron	7439-89-6	2.35E+04	PRG
Lead	7439-92-1	4.00E+02	PRG
Magnesium	7439-95-4	NA	NA
Manganese	7439-96-5	1.76E+03	PRG
Nickel	7440-02-0	1.56E+03	PRG
Potassium	7440-09-7	NA	NA

TABLE 1
DATA QUALITY LEVELS (DQLs) FOR SOIL AND SEDIMENT
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	REGION 9 SOIL PRGS (mg/kg) (c)		DQL BASIS
Selenium	7782-49-2	3.91E+02		PRG
Silver	7440-22-4	3.91E+02		PRG
Sodium	7440-23-5	NA		NA
Thallium	7440-28-0	5.20E+00		PRG
Vanadium	7440-62-2	5.47E+02		PRG
Copper	7440-50-8	2.91E+03		PRG
Zinc	7440-66-6	2.35E+04		PRG
Pesticides				
Alpha-BHC	319-84-6	9.02E-02		PRG
Beta-BHC	319-85-7	3.16E-01		PRG
Delta-BHC	319-86-8	4.37E-01	(j)	PRG
Gamma-BHC (Lindane)	58-89-9	4.37E-01		PRG
Aldrin	309-00-2	2.86E-02		PRG
alpha-Chlordane	5103-71-9	1.60E+00	(l)	PRG
gamma-Chlordane	5103-74-2	1.60E+00	(l)	PRG
Chlordane	57-74-9	1.60E+00		PRG
Chlorobenzilate	510-15-6	1.80E+00		PRG
1,2-Dibromo-3-Chloropropane	96-12-8	4.54E-01		PRG
4,4'-DDD	72-54-8	2.44E+00		PRG
4,4'-DDE	72-55-9	1.72E+00		PRG
4,4'-DDT	50-29-3	1.72E+00		PRG
Diallate	2303-16-4	7.97E+00		PRG
Dieldrin	60-57-1	3.04E-02		PRG
Endosulfan I	959-98-8	3.70E+02	(k)	PRG
Endosulfan II	33213-65-9	3.70E+02	(k)	PRG
Endosulfan sulfate	1031-07-8	3.70E+02	(k)	PRG
Endrin	72-20-8	1.83E+01		PRG
Endrin aldehyde	7421-93-4	1.83E+01	(l)	PRG
Endrin Ketone	53494-70-5	1.83E+01	(l)	PRG
Heptachlor	76-44-8	1.08E-01		PRG
Heptachlor epoxide	1024-57-3	5.34E-02		PRG
Hexachlorobenzene	118-74-1	3.04E-01		PRG
Hexachlorocyclopentadiene	77-47-4	4.23E+02		PRG
Isodrin	465-73-6	NA		NA
Methoxychlor	72-43-5	3.06E+02		PRG
Toxaphene	8001-35-2	4.42E-01		PRG

TABLE 1
DATA QUALITY LEVELS (DQLs) FOR SOIL AND SEDIMENT
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	REGION 9 SOIL PRGS (mg/kg) (c)		DQL BASIS
Herbicides				
2,4-D	94-75-7	6.86E+02		PRG
2,4-DB	94-82-6	4.89E+02		PRG
2,4,5-TP	93-72-1	4.89E+02		PRG
2,4,5-T	93-76-5	6.11E+02		PRG
Dalapon	75-99-0	1.83E+03		PRG
Dicamba	1918-00-9	1.83E+03	(d)	PRG
Dichloroprop	120-36-5	NA		NA
Dinoseb	88-85-7	6.11E+01		PRG
MCPA	94-74-6	3.06E+01		PRG
MCPP	93-65-2	6.11E+01		PRG
4-Nitrophenol	100-02-7	4.89E+02		PRG
Pentachlorophenol	87-86-5	2.98E+00		PRG
Dioxins and Furans				
2,3,7,8-TCDD	1746-01-6	1.00E-03	(q)	USEPA, 1998
1,2,3,7,8-PentaCDD	40321-76-4	1.00E-03	(q)	USEPA, 1998
1,2,3,4,7,8-HexaCDD	39227-28-6	1.00E-03	(q)	USEPA, 1998
1,2,3,6,7,8-HexaCDD	57653-85-7	1.00E-03	(q)	USEPA, 1998
1,2,3,7,8,9-HexaCDD	19408-74-3	1.00E-03	(q)	USEPA, 1998
1,2,3,4,6,7,8-HeptaCDD	35822-39-4	1.00E-03	(q)	USEPA, 1998
OctaCDD	3268-87-9	1.00E-03	(q)	USEPA, 1998
2,3,7,8-TetraCDF	51207-31-9	1.00E-03	(q)	USEPA, 1998
1,2,3,7,8-PentaCDF	57117-41-6	1.00E-03	(q)	USEPA, 1998
2,3,4,7,8-PentaCDF	57117-31-4	1.00E-03	(q)	USEPA, 1998
1,2,3,4,7,8-HexaCDF	70648-26-9	1.00E-03	(q)	USEPA, 1998
1,2,3,6,7,8-HexaCDF	57117-44-9	1.00E-03	(q)	USEPA, 1998
1,2,3,7,8,9-HexaCDF	72918-21-9	1.00E-03	(q)	USEPA, 1998
2,3,4,6,7,8-HexaCDF	60851-34-5	1.00E-03	(q)	USEPA, 1998
1,2,3,4,6,7,8-HeptaCDF	67562-39-4	1.00E-03	(q)	USEPA, 1998
1,2,3,4,7,8,9-HeptaCDF	55673-89-7	1.00E-03	(q)	USEPA, 1998
OctaCDF	39001-02-0	1.00E-03	(q)	USEPA, 1998
PCBs				
Total PCBs	NA	1.00E+00	(r)	TSCA

TABLE 1
DATA QUALITY LEVELS (DQLs) FOR SOIL AND SEDIMENT
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	REGION 9 SOIL PRGS (mg/kg) (c)	DQL BASIS

Notes:
(a) Due to structural similarities, the value for Pyrene was used.
(b) Due to structural similarities, the value for Anthracene was used.
(c) USEPA Region 9 Preliminary Remediation Goals Table. November, 2000.
Value for residential soil was used.
(d) A PRG for residential soil not provided; because Dicamba and Dalapon have the same toxicity values, the PRG for Dalapon was used here.
(e) Value for total Chromium.
(f) Due to structural similarities, the value for Naphthalene was used.
(g) Value for 1,3-Dichloropropene used.
(h) Due to structural similarities, the value for Acenaphthene was used.
(i) Due to structural similarities, the value for Chlordane was used.
(j) Due to structural similarities, the value for gamma-BHC was used.
(k) Due to structural similarities, the value for Endosulfan was used.
(l) Due to structural similarities, the value for Endrin was used.
(m) Due to structural similarities, the value for 4-Methyl-2-Pentanone was used.
(n) Due to structural similarities, the value for 4-Nitrophenol was used.
(o) Due to structural similarities, the value for 2-Nitroaniline was used.
(p) Value for cis-1,2-Dichloroethylene used.
(q) USEPA, 1998. Approach for Addressing Dioxin in Soil at CERCLA and RCRA Sites.
Value for dioxins. [OSWER Directive 9200.4-26].
(r) Disposal of Polychlorinated Biphenyl (PCBs) Final Rule. (Mega Rule);
Federal Register 63 (124): 35384-35474 (June 29, 1998).
(s) Synonym of bis(2-chloroisopropyl)ether.
CAS = Chemical Abstracts Service.
CDD = Chlorodibenzodioxin.
CDF = Chlorodibenzofuran.
DQL = Data Quality Level.
NA - Not Available.
PCB = Polychlorinated Biphenyl.
PRG = USEPA Region 9 Preliminary Remediation Goal (USEPA, 2000b).
TAL = Target Analyte List.
TCL = Target Compound List.
TSCA = Toxic Substances Control Act.

TABLE 2
DATA QUALITY LEVELS (DQLs) FOR SURFACE WATER AND GROUNDWATER
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	Selected DQL (a) (mg/L)	DQL Basis
TCL Volatiles			
1,1,1-Trichloroethane	71-55-6	2.0E-01	CLASS I
1,1,2,2-Tetrachloroethane	79-34-5	5.5E-05	PRG
1,1,2-Trichloroethane	79-00-5	5.0E-03	CLASS I
1,1-Dichloroethane	75-34-3	7.0E-01	TACO
1,1-Dichloroethylene	75-35-4	7.0E-03	CLASS I
1,2-Dichloroethane	107-06-2	5.0E-03	CLASS I
1,2-Dichloroethylene (total)	540-59-0	7.0E-02 (c)	CLASS I
1,2-Dichloropropane	78-87-5	5.0E-03	CLASS I
2-Butanone	78-93-3	1.9E+00	PRG
2-Hexanone	591-78-6	1.6E-01 (g)	PRG
4-Methyl-2-pentanone	108-10-1	1.6E-01	PRG
Acetone	67-64-1	7.0E-01	TACO
Benzene	71-43-2	5.0E-03	CLASS I
Bromodichloromethane	75-27-4	8.0E-02	MCL
Bromoform	75-25-2	8.0E-02	MCL
Bromomethane	74-83-9	9.8E-03	TACO
Carbon Disulfide	75-15-0	7.0E-01	TACO
Carbon tetrachloride	56-23-5	5.0E-03	CLASS I
Chlorobenzene	108-90-7	1.0E-01	TACO
Chloroethane	75-00-3	4.6E-03	PRG
Chloroform	67-66-3	8.0E-02	MCL
Chloromethane	74-87-3	1.5E-03	PRG
cis-1,3-Dichloropropene	10061-01-5	1.0E-03	TACO
Dibromochloromethane	124-48-1	8.0E-02	MCL
Ethyl Benzene	100-41-4	7.0E-01	MCL
Methylene chloride	75-09-2	5.0E-03	CLASS I
Styrene	100-42-5	1.0E-01	CLASS I
Tetrachloroethene	127-18-4	5.0E-03	CLASS I
Toluene	108-88-3	1.0E+00	CLASS I
Total Xylenes	1330-20-7	1.0E+01	CLASS I
trans-1,3-Dichloropropene	10061-02-6	1.0E-03	TACO
Trichloroethene	79-01-6	5.0E-03	CLASS I
Vinyl chloride	75-01-4	2.0E-03	CLASS I
TCL Semi-Volatiles			
1,2,4-Trichlorobenzene	120-82-1	7.0E-02	CLASS I
1,2-Dichlorobenzene	95-50-1	6.0E-01	CLASS I
1,3-Dichlorobenzene	541-73-1	6.0E-01 (p)	CLASS I
1,4-Dichlorobenzene	106-46-7	7.5E-02	CLASS I
2,2'-oxybis(1-Chloropropane) (o)	108-60-1	2.7E-04	PRG
2,4,5-Trichlorophenol	95-95-4	7.0E-01	TACO
2,4,6-Trichlorophenol	88-06-2	6.4E-03	TACO
2,4-Dichlorophenol	120-83-2	2.1E-02	TACO
2,4-Dimethylphenol	105-67-9	1.4E-01	TACO

TABLE 2
DATA QUALITY LEVELS (DQLs) FOR SURFACE WATER AND GROUNDWATER
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	Selected DQL (a) (mg/L)		DQL Basis
2,4-Dinitrophenol	51-28-5	1.4E-02		TACO
2,4-Dinitrotoluene	121-14-2	2.0E-05		TACO
2,6-Dinitrotoluene	606-20-2	1.0E-04		TACO
2-Chloronaphthalene	91-58-7	4.9E-01		PRG
2-Chlorophenol	95-57-8	3.5E-02		TACO
2-Methylnaphthalene	91-57-6	2.5E-02	(d)	TACO
2-Methylphenol	95-48-7	3.5E-01		TACO
2-Nitroaniline	88-74-4	2.1E-03		PRG
2-Nitrophenol	88-75-5	2.9E-01	(h)	PRG
3,3'-Dichlorobenzidine	91-94-1	2.0E-02		TACO
3-Nitroaniline	99-09-2	2.1E-03	(i)	PRG
4,6-Dinitro-2-methylphenol	534-52-1	NA		NA
4-Bromophenyl phenyl ether	101-55-3	NA		NA
4-Chloraniline	106-47-8	2.8E-02		TACO
4-Chloro-3-methylphenol	59-50-7	NA		NA
4-Chlorophenol phenyl ether	7005-72-3	NA		NA
4-Methylphenol	106-44-5	3.5E-01	(n)	TACO
4-Nitroaniline	100-01-6	2.1E-03	(l)	PRG
4-Nitrophenol	100-02-7	2.9E-01		PRG
Acenaphthene	83-32-9	4.2E-01		TACO
Acenaphthylene	208-96-8	4.2E-01	(b)	TACO
Anthracene	120-12-7	2.1E+00		TACO
Benz[a]anthracene	56-55-3	1.3E-04		TACO
Benzo[a]pyrene	50-32-8	2.0E-04		CLASS I
Benzo[b]fluoranthene	205-99-2	1.8E-04		TACO
Benzo[g,h,i]perylene	191-24-2	2.1E-01	(e)	TACO
Benzo[k]fluoranthene	207-08-9	1.7E-04		TACO
bis(2-Chloroethoxy)methane	111-91-1	NA		NA
bis(2-Chloroethyl)ether	111-44-4	1.0E-02		TACO
bis(2-Ethylhexyl)phthalate	117-81-7	6.0E-03		CLASS I
Butyl benzyl phthalate	85-68-7	1.4E+00		TACO
Carbazole	86-74-8	3.4E-03		PRG
Chrysene	218-01-9	1.5E-03		TACO
Dibenz[a,h]anthracene	53-70-3	3.0E-04		TACO
Dibenzofuran	132-64-9	2.4E-02		PRG
Diethylphthalate	84-66-2	5.6E+00		TACO
Dimethyl phthalate	131-11-3	3.6E+02		PRG
Di-n-butyl phthalate	84-74-2	7.0E-01		TACO
Di-n-octyl phthalate	117-84-0	1.4E-01		TACO
Fluoranthene	206-44-0	2.8E-01		TACO
Fluorene	86-73-7	2.8E-01		TACO
Hexachlorobenzene	118-74-1	1.0E-03		MCL
Hexachlorobutadiene	87-68-3	8.6E-04		PRG
Hexachlorocyclopentadiene	77-47-4	5.0E-02		CLASS I
Hexachloroethane	67-72-1	7.0E-03		TACO

TABLE 2
DATA QUALITY LEVELS (DQLs) FOR SURFACE WATER AND GROUNDWATER
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	Selected DQL (a) (mg/L)	DQL Basis
Indeno[1,2,3-cd]pyrene	193-39-5	4.3E-04	TACO
Isophorone	78-59-1	1.4E+00	TACO
Naphthalene	91-20-3	2.5E-02	TACO
Nitrobenzene	98-95-3	3.5E-03	TACO
N-Nitroso-di-n-propylamine	621-64-7	1.0E-02	TACO
N-Nitrosodiphenylamine	86-30-6	1.0E-02	TACO
Pentachlorophenol	87-86-5	1.0E-03	CLASS I
Phenanthrene	85-01-8	2.1E+00 (f)	TACO
Phenol	108-95-2	1.0E-01	CLASS I
Pyrene	129-00-0	2.1E-01	TACO
TAL Metals			
Aluminum	7429-90-5	5.0E+01	MCL
Antimony	7440-36-0	6.0E-03	CLASS I
Arsenic	7440-38-2	5.0E-02	CLASS I
Barium	7440-39-3	2.0E+00	CLASS I
Beryllium	7440-41-7	4.0E-03	CLASS I
Cadmium	7440-43-9	5.0E-03	CLASS I
Calcium	7440-70-2	NA	NA
Chromium	7440-47-3	1.0E-01 (r)	CLASS I
Cobalt	7440-48-4	1.0E+00	CLASS I
Iron	7439-89-6	5.0E+00	CLASS I
Lead	7439-92-1	7.5E-03	CLASS I
Magnesium	7439-95-4	NA	NA
Manganese	7439-96-5	1.5E-01	CLASS I
Nickel	7440-02-0	1.0E-01	CLASS I
Potassium	7440-09-7	NA	NA
Selenium	7782-49-2	5.0E-02	CLASS I
Silver	7440-22-4	5.0E-02	CLASS I
Sodium	7440-23-5	NA	NA
Thallium	7440-28-0	2.0E-03	CLASS I
Vanadium	7440-62-2	4.9E-02	TACO
Copper	7440-50-8	6.5E-01	CLASS I
Zinc	7440-66-6	5.0E+00	CLASS I
Pesticides			
Alpha-BHC	319-84-6	3.0E-05	TACO
Beta-BHC	319-85-7	2.0E-04 (m)	CLASS I
Delta-BHC	319-86-8	2.0E-04 (m)	CLASS I
Gamma-BHC (Lindane)	58-89-9	2.0E-04	CLASS I
Aldrin	309-00-2	4.0E-05	TACO
alpha-Chlordane	5103-71-9	2.0E-03 (j)	CLASS I
gamma-Chlordane	5103-74-2	2.0E-03 (j)	CLASS I
Chlordane	57-74-9	2.0E-03	CLASS I
Chlorobenzilate	510-15-6	2.5E-04	PRG

TABLE 2
DATA QUALITY LEVELS (DQLs) FOR SURFACE WATER AND GROUNDWATER
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	Selected DQL (a) (mg/L)		DQL Basis
1,2-Dibromo-3-Chloropropane (DBCP)	96-12-8	2.0E-04		TACO
4,4'-DDD	72-54-8	1.1E-04		TACO
4,4'-DDE	72-55-9	4.0E-05		TACO
4,4'-DDT	50-29-3	1.2E-04		TACO
Diallate	2303-16-4	1.1E-03		PRG
Dieldrin	60-57-1	2.0E-05		TACO
Endosulfan I	959-98-8	4.2E-02	(k)	TACO
Endosulfan II	33213-65-9	4.2E-02	(k)	TACO
Endosulfan sulfate	1031-07-8	4.2E-02	(k)	TACO
Endrin	72-20-8	2.0E-03		CLASS I
Endrin aldehyde	7421-93-4	2.0E-03	(l)	CLASS I
Endrin Ketone	53494-70-5	2.0E-03	(l)	CLASS I
Heptachlor	76-44-8	4.0E-04		CLASS I
Heptachlor epoxide	1024-57-3	2.0E-04		CLASS I
Hexachlorobenzene	118-74-1	1.0E-03		MCL
Hexachlorocyclopentadiene	77-47-4	5.0E-02		CLASS I
Isodrin	465-73-6	NA		NA
Methoxychlor	72-43-5	4.0E-02		CLASS I
Toxaphene	8001-35-2	3.0E-03		CLASS I
Herbicides				
2,4-D	94-75-7	7.0E-02		CLASS I
2,4-DB	94-82-6	2.9E-01		PRG
2,4,5-TP	93-72-1	5.0E-02		CLASS I
2,4,5-T	93-76-5	3.6E-01		PRG
Dalapon	75-99-0	2.0E-01		CLASS I
Dicamba	1918-00-9	1.1E+00		PRG
Dichloroprop	120-36-5	NA		NA
Dinoseb	88-85-7	7.0E-03		CLASS I
MCPA	94-74-6	1.8E-02		PRG
MCPP	93-65-2	3.6E-02		PRG
4-Nitrophenol	100-02-7	2.9E-01		PRG
Pentachlorophenol	87-86-5	1.0E-03		CLASS I
Dioxins and Furans				
2,3,7,8-TCDD	1746-01-6	3.00E-08		MCL
1,2,3,7,8-PentaCDD	40321-76-4	3.00E-08		MCL
1,2,3,4,7,8-HexaCDD	39227-28-6	3.00E-08		MCL
1,2,3,6,7,8-HexaCDD	57653-85-7	3.00E-08		MCL
1,2,3,7,8,9-HexaCDD	19408-74-3	3.00E-08		MCL
1,2,3,4,6,7,8-HeptaCDD	35822-39-4	3.00E-08		MCL
OctaCDD	3268-87-9	3.00E-08		MCL
2,3,7,8-TetraCDF	51207-31-9	3.00E-08		MCL
1,2,3,7,8-PentaCDF	57117-41-6	3.00E-08		MCL
2,3,4,7,8-PentaCDF	57117-31-4	3.00E-08		MCL

TABLE 2
DATA QUALITY LEVELS (DQLs) FOR SURFACE WATER AND GROUNDWATER
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	Selected DQL (a) (mg/L)	DQL Basis
1,2,3,4,7,8-HexaCDF	70648-26-9	3.00E-08	MCL
1,2,3,6,7,8-HexaCDF	57117-44-9	3.00E-08	MCL
1,2,3,7,8,9-HexaCDF	72918-21-9	3.00E-08	MCL
2,3,4,6,7,8-HexaCDF	60851-34-5	3.00E-08	MCL
1,2,3,4,6,7,8-HeptaCDF	67562-39-4	3.00E-08	MCL
1,2,3,4,7,8,9-HeptaCDF	55673-89-7	3.00E-08	MCL
OctaCDF	39001-02-0	3.00E-08	MCL
PCBs			
Total PCBs	NA	5.0E-04	CLASS I

Notes:
(a) - The DQL was determined by taking the Illinois Groundwater Quality Standards for Class I: Potable Resource Groundwater (35 Ill. Adm. Code 620.410). Where a Class I value is not available, the MCL value is used (USEPA, 2000a). Where a MCL is not available a TACO Class I value is used (IEPA, 1998). Where a TACO Class I value is not available, the USEPA Resion 9 PRG (USEPA, 2000b) for Tapwater is used. Surface water will be evaluated for incidential ingestion of water only - fish tissue will be collected. Therefore, ambient water quality criteria for ingestion of organisms were not used in the developement of DQLs.
(b) Due to structural similarities, the value for Acenaphthene was used.
(c) Value for cis-1,2-Dichloroethylene.
(d) Due to structural similarities, the value for Naphthalene was used.
(e) Due to structural similarities, the value for Pyrene was used.
(f) Due to structural similarities, the value for Anthracene was used.
(g) Due to structural similarities, the value for 4-Methyl-2-Pentanone was used.
(h) Due to structural similarities, the value for 4-Nitrophenol was used.
(i) Due to structural similarities, the value for 2-Nitroaniline was used.
(j) Due to structural similarities, the value for Chlordane was used.
(k) Due to structural similarities, the value for Endosulfan was used.
(l) Due to structural similarities, the value for Endrin was used.
(m) Due to structural similarities, the value for gamma-BHC was used.
(n) Due to structural similarities, value for 2-Methylphenol was used.
(o) Synonym of Bis(2-chloroisopropyl)ether.
(p) Due to structural similarities, value for 1,2-Dichlorobenzene was used.
CAS = Chemical Abstracts Service.
CDD = Chlorodibenzodioxin.
CDF = Chlorodibenzofuran.
CLASS I = Groundwater Quality Standards for Class I: Potable Resource Groundwater. 35 Ill. Adm. Code 620.410.
DQL = Data Quality Level.
MCL - Maximum Contaminant Level. (USEPA, 2000a)
PCB = Polychlorinated Biphenyl.
PRG = USEPA Region 9 Preliminary Remediation Goal (USEPA, 2000b).
TACO - Tiered Approach to Corrective Action Objectives (IEPA, 1998).
TAL = Target Analyte List.
TCL = Target Compound List.
NA = Not available.

TABLE 3
DATA QUALITY LEVELS (DQLs) FOR FISH TISSUE
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	DQL (n) (mg/kg)	Basis
TCL Semi-Volatiles			
1,2,4-Trichlorobenzene	120-82-1	1.4E+01	N
1,2-Dichlorobenzene	95-50-1	1.2E+02	N
1,3-Dichlorobenzene	541-73-1	1.2E+00	N
1,4-Dichlorobenzene	106-46-7	1.3E-01	C
2,2'-oxybis(1-Chloropropane)	108-60-1 (m)	4.5E-02	C
2,4,5-Trichlorophenol	95-95-4	1.4E+02	N
2,4,6-Trichlorophenol	88-06-2	2.9E-01	C
2,4-Dichlorophenol	120-83-2	4.1E+00	N
2,4-Dimethylphenol	105-67-9	2.7E+01	N
2,4-Dinitrophenol	51-28-5	2.7E+00	N
2,4-Dinitrotoluene	121-14-2	2.7E+00	N
2,6-Dinitrotoluene	606-20-2	1.4E+00	N
2-Chloronaphthalene	91-58-7	1.1E+02	N
2-Chlorophenol	95-57-8	6.8E+00	N
2-Methylnaphthalene	91-57-6	2.7E+01	N
2-Methylphenol	95-48-7	6.8E+01	N
2-Nitroaniline	88-74-4	NA	O
2-Nitrophenol	88-75-5 (a)	1.1E+01	N
3,3'-Dichlorobenzidine	91-94-1	7.0E-03	C
3-Nitroaniline	99-09-2	NA	O
4,6-Dinitro-2-methylphenol	534-52-1	1.4E-01	N
4-Bromophenyl phenyl ether	101-55-3	NA	O
4-Chloraniline	106-47-8	5.4E+00	N
4-Chloro-3-methylphenol	59-50-7	NA	O
4-Chlorophenol phenyl ether	7005-72-3	NA	O
4-Methylphenol	106-44-5	6.8E+00	N
4-Nitroaniline	100-01-6	NA	O
4-Nitrophenol	100-02-7	1.1E+01	N
Acenaphthene	83-32-9	8.1E+01	N
Acenaphthylene	208-96-8 (b)	8.1E+01	N
Anthracene	120-12-7	4.1E+02	N
Benz[a]anthracene	56-55-3	4.3E-03	C
Benzo[a]pyrene	50-32-8	4.3E-04	C
Benzo[b]fluoranthene	205-99-2	4.3E-03	C
Benzo[g,h,i]perylene	191-24-2 (c)	4.1E+01	N
Benzo[k]fluoranthene	207-08-9	4.3E-02	C
bis(2-Chloroethoxy)methane	111-91-1	NA	O
bis(2-Chloroethyl)ether	111-44-4	2.9E-03	C
bis(2-Ethylhexyl)phthalate	117-81-7	2.3E-01	C
Butyl benzyl phthalate	85-68-7	2.7E+02	N
Carbazole	86-74-8	1.6E-01	C
Chrysene	218-01-9	4.3E-01	C
Dibenz[a,h]anthracene	53-70-3	4.3E-04	C
Dibenzofuran	132-64-9	5.4E+00	N

TABLE 3
DATA QUALITY LEVELS (DQLs) FOR FISH TISSUE
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	DQL (n) (mg/kg)	Basis
Diethylphthalate	84-66-2	1.1E+03	N
Dimethyl phthalate	131-11-3	1.4E+04	N
Di-n-butyl phthalate	84-74-2	1.4E+02	N
Di-n-octyl phthalate	117-84-0	2.7E+01	N
Fluoranthene	206-44-0	5.4E+01	N
Fluorene	86-73-7	5.4E+01	N
Hexachlorobenzene	118-74-1	2.0E-03	C
Hexachlorobutadiene	87-68-3	4.0E-02	C
Hexachlorocyclopentadiene	77-47-4	9.5E+00	N
Hexachloroethane	67-72-1	2.3E-01	C
Indeno[1,2,3-cd]pyrene	193-39-5	4.3E-03	C
Isophorone	78-59-1	3.3E+00	C
Naphthalene	91-20-3	2.7E+01	N
Nitrobenzene	98-95-3	6.8E-01	N
N-Nitroso-di-n-propylamine	621-64-7	4.5E-04	C
N-Nitrosodiphenylamine	86-30-6	6.4E-01	C
Pentachlorophenol	87-86-5	2.6E-02	C
Phenanthrene	85-01-8 (d)	4.1E+02	N
Phenol	108-95-2	8.1E+02	N
Pyrene	129-00-0	4.1E+01	N
TAL Metals			
Aluminum	7429-90-5	1.4E+03	N
Antimony	7440-36-0	5.4E-01	N
Arsenic	7440-38-2	2.1E-03	C
Barium	7440-39-3	9.5E+01	N
Beryllium	7440-41-7	2.7E+00	N
Cadmium	7440-43-9 (f)	1.4E+00	N
Calcium	7440-70-2	NA	B
Chromium	7440-47-3 (g)	2.0E+03	N
Cobalt	7440-48-4	8.1E+01	N
Iron	7439-89-6	4.1E+02	N
Lead	7439-92-1	NA	O
Magnesium	7439-95-4	NA	O
Manganese	7439-96-5 (h)	1.9E+02	N
Nickel	7440-02-0	2.7E+01	N
Potassium	7440-09-7	NA	B
Selenium	7782-49-2	6.8E+00	N
Silver	7440-22-4	6.8E+00	N
Sodium	7440-23-5	NA	B
Thallium	7440-28-0	9.5E-02	N
Vanadium	7440-62-2	9.5E+00	N
Copper	7440-50-8	5.4E+01	N
Zinc	7440-66-6	4.1E+02	N

TABLE 3
DATA QUALITY LEVELS (DQLs) FOR FISH TISSUE
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.		DQL (n) (mg/kg)	Basis
PCBs				
Total PCBs	NA		1.6E-03	C
Pesticides				
Alpha-BHC	319-84-6		5.0E-04	C
Beta-BHC	319-85-7		1.8E-03	C
Delta-BHC	319-86-8	(i)	1.8E-03	C
Gamma-BHC (Lindane)	58-89-9		2.4E-03	C
Aldrin	309-00-2		1.9E-04	C
alpha-Chlordane	5103-71-9	(j)	9.0E-03	C
gamma-Chlordane	5103-74-2	(j)	9.0E-03	C
Chlordane	57-74-9		9.0E-03	C
Chlorobenzilate	510-15-6		1.2E-02	C
1,2-Dibromo-3-Chloropropane (DBCP)	96-12-8		2.3E-03	C
4,4'-DDD	72-54-8		1.3E-02	C
4,4'-DDE	72-55-9		9.3E-03	C
4,4'-DDT	50-29-3		9.3E-03	C
Diallate	2303-16-4		NA	O
Dieldrin	60-57-1		2.0E-04	C
Endosulfan I	959-98-8	(k)	8.1E+00	N
Endosulfan II	33213-65-9	(k)	8.1E+00	N
Endosulfan sulfate	1031-07-8	(k)	8.1E+00	N
Endrin	72-20-8		4.1E-01	N
Endrin aldehyde	7421-93-4	(l)	4.1E-01	N
Endrin Ketone	53494-70-5	(l)	4.1E-01	N
Heptachlor	76-44-8		7.0E-04	C
Heptachlor epoxide	1024-57-3		3.5E-04	C
Hexachlorobenzene	118-74-1		2.0E-03	C
Hexachlorocyclopentadiene	77-47-4		9.5E+00	N
Isodrin	465-73-6		NA	O
Methoxychlor	72-43-5		6.8E+00	N
Toxaphene	8001-35-2		2.9E-03	C
Herbicides				
2,4-D	94-75-7		1.4E+01	N
2,4-DB	94-82-6		1.1E+01	N
2,4,5-TP	93-72-1		1.1E+01	N
2,4,5-T	93-76-5		1.4E+01	N
Dalapon	75-99-0		4.1E+01	N
Dicamba	1918-00-9		4.1E+01	N
Dichloroprop	120-36-5		NA	O
Dinoseb	88-85-7		1.4E+00	N
MCPA	94-74-6		6.8E-01	N
MCPP	93-65-2		1.4E+00	N
4-Nitrophenol	100-02-7		1.1E+01	N

TABLE 3
DATA QUALITY LEVELS (DQLs) FOR FISH TISSUE
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	DQL (n) (mg/kg)	Basis
Pentachlorophenol	87-86-5	2.6E-02	C
Dioxins and Furans			
2,3,7,8-TCDD	1746-01-6	2.5E-05	(o)
1,2,3,7,8-PentaCDD	40321-76-4	2.5E-05	(o)
1,2,3,4,7,8-HexaCDD	39227-28-6	2.5E-05	(o)
1,2,3,6,7,8-HexaCDD	57653-85-7	2.5E-05	(o)
1,2,3,7,8,9-HexaCDD	19408-74-3	2.5E-05	(o)
1,2,3,4,6,7,8-HeptaCDD	35822-39-4	2.5E-05	(o)
OctaCDD	3268-87-9	2.5E-05	(o)
2,3,7,8-TetraCDF	51207-31-9	2.5E-05	(o)
1,2,3,7,8-PentaCDF	57117-41-6	2.5E-05	(o)
2,3,4,7,8-PentaCDF	57117-31-4	2.5E-05	(o)
1,2,3,4,7,8-HexaCDF	70648-26-9	2.5E-05	(o)
1,2,3,6,7,8-HexaCDF	57117-44-9	2.5E-05	(o)
1,2,3,7,8,9-HexaCDF	72918-21-9	2.5E-05	(o)
2,3,4,6,7,8-HexaCDF	60851-34-5	2.5E-05	(o)
1,2,3,4,6,7,8-HeptaCDF	67562-39-4	2.5E-05	(o)

TABLE 3
DATA QUALITY LEVELS (DQLs) FOR FISH TISSUE
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	DQL (n) (mg/kg)	Basis
1,2,3,4,7,8,9-HeptaCDF	55673-89-7	2.5E-05	(o)
OctaCDF	39001-02-0	2.5E-05	(o)

Notes:
C = USEPA, 2000e, Based on carcinogenic USEPA Region 3 RBC value.
N = USEPA, 2000e, Based on non-carcinogenic USEPA Region 3 RBC value.
O = No RBC available; therefore, no DQL developed.
CAS = Chemical Abstracts Service.
CB = Chlorobiphenyl.
CDD = Chlorodibenzodioxin.
CDF = Chlorodibenzofuran.
DQL = Data Quality Level.
NA = Not Available.
PCB = Polychlorinated Biphenyl.
RBC = USEPA Region 3 Risk Based Concentration (USEPA, 2000d).
TAL = Target Analyte List.
TCL = Target Compound List.
(a) Due to structural similarities, the value for 4-Nitrophenol was used.
(b) Due to structural similarities, the value for Acenaphthene was used.
(c) Due to structural similarities, the value for Pyrene was used.
(d) Due to structural similarities, the value for Anthracene was used.
(f) Value for Cadmium-food.
(g) Value for Chromium III.
(h) Value for Manganese-food.
(i) Due to structural similarities, the value for Beta BHC was used.
(j) Due to structural similarities, the value for Chlordane was used.
(k) Due to structural similarities, the value for Endosulfan was used.
(l) Due to structural similarities, the value for Endrin was used.
(m) Synonym of Bis(2-Chloroisopropyl) ether.
(n) DQLs for fish tissue based on USEPA Region 3 RBCs (USEPA, 2000d).
(o) - Food and Drug Administration (FDA) Action Level; as reported in:
USEPA. 1984. Ambient Water Quality Criteria Document for 2,3,7,8-Tetrachlorodibenzo-p-dioxin. EPA 440/5-84-007.
Cordel, Frank. 1981. The Use of Epidemiology in The Regulation of Dioxins in The Food Supply. Regulatory Toxicology and Pharmacology 1:379-387.

TABLE 4
DATA QUALITY LEVELS (DQLs) FOR AIR
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	DQL (a) (ug/m^3)	
TCL Volatiles			
1,1,1-Trichloroethane	71-55-6	1.0E+03	NC
1,1,2,2-Tetrachloroethane	79-34-5	3.3E-02	C
1,1,2-Trichloroethane	79-00-5	1.2E-01	C
1,1-Dichloroethane	75-34-3	5.2E+02	NC
1,1-Dichloroethylene	75-35-4	3.8E-02	C
1,2-Dichloroethane	107-06-2	7.4E-02	C
1,2-Dichloroethylene (total)	540-59-0 (c)	3.7E+01	NC
1,2-Dichloropropane	78-87-5	9.9E-02	C
2-Butanone	78-93-3	1.0E+03	NC
2-Hexanone	591-78-6 (d)	8.3E+01	NC
4-Methyl-2-pentanone	108-10-1	8.3E+01	NC
Acetone	67-64-1	3.7E+02	NC
Benzene	71-43-2	2.5E-01	C
Bromodichloromethane	75-27-4	1.1E-01	C
Bromoform	75-25-2	1.7E+00	C
Bromomethane	74-83-9	5.2E+00	NC
Carbon Disulfide	75-15-0	7.3E+02	NC
Carbon tetrachloride	56-23-5	1.3E-01	C
Chlorobenzene	108-90-7	6.2E+01	NC
Chloroethane	75-00-3	2.3E+00	C
Chloroform	67-66-3	8.4E-02	C
Chloromethane	74-87-3	1.1E+00	C
cis-1,3-Dichloropropene	10061-01-5 (e)	4.8E-01	C
Dibromochloromethane	124-48-1	8.0E-02	C
Ethyl Benzene	100-41-4	1.1E+03	NC
Methylene chloride	75-09-2	4.1E+00	C
Styrene	100-42-5	1.1E+03	NC
Tetrachloroethene	127-18-4	3.3E+00	C
Toluene	108-88-3	4.0E+02	NC
Total Xylenes	1330-20-7	7.3E+02	NC
trans-1,3-Dichloropropene	10061-02-6 (e)	4.8E-01	C
Trichloroethene	79-01-6	1.1E+00	C
Vinyl chloride	75-01-4	2.2E-01	C
TCL Semi-Volatiles			
1,2,4-Trichlorobenzene	120-82-1	2.1E+02	NC
1,2-Dichlorobenzene	95-50-1	2.1E+02	NC
1,3-Dichlorobenzene	541-73-1	3.3E+00	NC
1,4-Dichlorobenzene	106-46-7	3.1E-01	C
2,2'-oxybis(1-Chloropropane)	108-60-1 (b)	1.9E-01	C
2,4,5-Trichlorophenol	95-95-4	3.7E+02	NC
2,4,6-Trichlorophenol	88-06-2	6.2E-01	C
2,4-Dichlorophenol	120-83-2	1.1E+01	NC
2,4-Dimethylphenol	105-67-9	7.3E+01	NC

TABLE 4
DATA QUALITY LEVELS (DQLs) FOR AIR
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	DQL (a) (ug/m^3)	
2,4-Dinitrophenol	51-28-5	7.3E+00	NC
2,4-Dinitrotoluene	121-14-2	7.3E+00	NC
2,6-Dinitrotoluene	606-20-2	3.7E+00	NC
2-Chloronaphthalene	91-58-7	2.9E+02	NC
2-Chlorophenol	95-57-8	1.8E+01	NC
2-Methylnaphthalene	91-57-6 (f)	3.1E+00	NC
2-Methylphenol	95-48-7	1.8E+02	NC
2-Nitroaniline	88-74-4	2.1E-01	NC
2-Nitrophenol	88-75-5 (g)	2.9E+01	NC
3,3'-Dichlorobenzidine	91-94-1	1.5E-02	C
3-Nitroaniline	99-09-2 (h)	2.1E-01	NC
4,6-Dinitro-2-methylphenol	534-52-1	NA	-
4-Bromophenyl phenyl ether	101-55-3	NA	-
4-Chloraniline	106-47-8	1.5E+01	NC
4-Chloro-3-methylphenol	59-50-7	NA	-
4-Chlorophenol phenyl ether	7005-72-3	NA	-
4-Methylphenol	106-44-5	1.8E+01	NC
4-Nitroaniline	100-01-6 (h)	2.1E-01	NC
4-Nitrophenol	100-02-7	2.9E+01	NC
Acenaphthene	83-32-9	2.2E+02	NC
Acenaphthylene	208-96-8 (i)	2.2E+02	NC
Anthracene	120-12-7	1.1E+03	NC
Benz[a]anthracene	56-55-3	2.2E-02	C
Benzo[a]pyrene	50-32-8	2.2E-03	C
Benzo[b]fluoranthene	205-99-2	2.2E-02	C
Benzo[g,h,i]perylene	191-24-2 (j)	1.1E+02	NC
Benzo[k]fluoranthene	207-08-9	2.2E-01	C
bis(2-Chloroethoxy)methane	111-91-1	NA	-
bis(2-Chloroethyl)ether	111-44-4	5.8E-03	C
bis(2-Ethylhexyl)phthalate	117-81-7	4.8E-01	C
Butyl benzyl phthalate	85-68-7	7.3E+02	NC
Carbazole	86-74-8	3.4E-01	C
Chrysene	218-01-9	2.2E+00	C
Dibenz[a,h]anthracene	53-70-3	2.2E-03	C
Dibenzofuran	132-64-9	1.5E+01	NC
Diethylphthalate	84-66-2	2.9E+03	NC
Dimethyl phthalate	131-11-3	3.7E+04	NC
Di-n-butyl phthalate	84-74-2	3.7E+02	NC
Di-n-octyl phthalate	117-84-0	7.3E+01	NC
Fluoranthene	206-44-0	1.5E+02	NC
Fluorene	86-73-7	1.5E+02	NC
Hexachlorobenzene	118-74-1	4.2E-03	C
Hexachlorobutadiene	87-68-3	8.6E-02	C
Hexachlorocyclopentadiene	77-47-4	7.3E-02	NC
Hexachloroethane	67-72-1	4.8E-01	C

TABLE 4
DATA QUALITY LEVELS (DQLs) FOR AIR
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	DQL (a) (ug/m^3)	
Indeno[1,2,3-cd]pyrene	193-39-5	2.2E-02	C
Isophorone	78-59-1	7.1E+00	C
Naphthalene	91-20-3	3.1E+00	NC
Nitrobenzene	98-95-3	2.1E+00	NC
N-Nitroso-di-n-propylamine	621-64-7	9.6E-04	C
N-Nitrosodiphenylamine	86-30-6	1.4E+00	C
Pentachlorophenol	87-86-5	5.6E-02	C
Phenanthrene	85-01-8 (k)	1.1E+03	NC
Phenol	108-95-2	2.2E+03	NC
Pyrene	129-00-0	1.1E+02	NC
TAL Metals			
Aluminum	7429-90-5	5.1E+00	NC
Antimony	7440-36-0	NA	-
Arsenic	7440-38-2	4.5E-04	C
Barium	7440-39-3	5.2E-01	NC
Beryllium	7440-41-7	8.0E-04	C
Cadmium	7440-43-9	1.1E-03	C
Calcium	7440-70-2	NA	-
Chromium	7440-47-3 (l)	2.3E-05	C
Cobalt	7440-48-4	NA	-
Iron	7439-89-6	NA	-
Lead	7439-92-1	NA	-
Magnesium	7439-95-4	NA	-
Manganese	7439-96-5	5.1E-02	NC
Nickel	7440-02-0 (m)	8.0E-03	C
Potassium	7440-09-7	NA	-
Selenium	7782-49-2	NA	-
Silver	7440-22-4	NA	-
Sodium	7440-23-5	NA	-
Thallium	7440-28-0	NA	-
Vanadium	7440-62-2	NA	-
Copper	7440-50-8	NA	-
Zinc	7440-66-6	NA	-
PCBs			
Total PCBs	NA	3.4E-03	C
Dioxins and Furans			
2,3,7,8-TCDD	1746-01-6	4.5E-08	C
1,2,3,7,8-PentaCDD	40321-76-4 (n)	4.5E-08	C
1,2,3,4,7,8-HexaCDD	39227-28-6 (n)	4.5E-08	C
1,2,3,6,7,8-HexaCDD	57653-85-7 (n)	4.5E-08	C
1,2,3,7,8,9-HexaCDD	19408-74-3 (n)	4.5E-08	C
1,2,3,4,6,7,8-HeptaCDD	35822-39-4 (n)	4.5E-08	C

TABLE 4
DATA QUALITY LEVELS (DQLs) FOR AIR
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.		DQL (a) (ug/m^3)	
OctaCDD	3268-87-9	(n)	4.5E-08	C
2,3,7,8-TetraCDF	51207-31-9	(n)	4.5E-08	C
1,2,3,7,8-PentaCDF	57117-41-6	(n)	4.5E-08	C
2,3,4,7,8-PentaCDF	57117-31-4	(n)	4.5E-08	C
1,2,3,4,7,8-HexaCDF	70648-26-9	(n)	4.5E-08	C
1,2,3,6,7,8-HexaCDF	57117-44-9	(n)	4.5E-08	C
1,2,3,7,8,9-HexaCDF	72918-21-9	(n)	4.5E-08	C
2,3,4,6,7,8-HexaCDF	60851-34-5	(n)	4.5E-08	C
1,2,3,4,6,7,8-HeptaCDF	67562-39-4	(n)	4.5E-08	C
1,2,3,4,7,8,9-HeptaCDF	55673-89-7	(n)	4.5E-08	C
OctaCDF	39001-02-0	(n)	4.5E-08	C
Pesticides				
Alpha-BHC	319-84-6		1.1E-03	C
Beta-BHC	319-85-7		3.7E-03	C
Delta-BHC	319-86-8	(o)	3.7E-03	C
Gamma-BHC (Lindane)	58-89-9		5.2E-03	C
Aldrin	309-00-2		3.9E-04	C
alpha-Chlordane	5103-71-9	(p)	1.9E-02	C
gamma-Chlordane	5103-74-2	(p)	1.9E-02	C
Chlordane	57-74-9		1.9E-02	C
Chlorobenzilate	510-15-6		2.5E-02	C
1,2-Dibromo-3-Chloropropane (DBCP)	96-12-8		2.1E-01	NC
4,4'-DDD	72-54-8		2.8E-02	C
4,4'-DDE	72-55-9		2.0E-02	C
4,4'-DDT	50-29-3		2.0E-02	C
Diallate	2303-16-4		1.1E-01	C
Dieldrin	60-57-1		4.2E-04	C
Endosulfan I	959-98-8	(q)	2.2E+01	NC
Endosulfan II	33213-65-9	(q)	2.2E+01	NC
Endosulfan sulfate	1031-07-8	(q)	2.2E+01	NC
Endrin	72-20-8		1.1E+00	NC
Endrin aldehyde	7421-93-4	(r)	1.1E+00	NC
Endrin Ketone	53494-70-5	(r)	1.1E+00	NC
Heptachlor	76-44-8		1.5E-03	C
Heptachlor epoxide	1024-57-3		7.4E-04	C
Hexachlorobenzene	118-74-1		4.2E-03	C
Hexachlorocyclopentadiene	77-47-4		7.3E-02	NC
Isodrin	465-73-6		NA	-
Methoxychlor	72-43-5		1.8E+01	NC
Toxaphene	8001-35-2		6.0E-03	C
Herbicides				
2,4-D	94-75-7		3.7E+01	NC
2,4-DB	94-82-6		2.9E+01	NC

TABLE 4
DATA QUALITY LEVELS (DQLs) FOR AIR
SAUGET AREA 2 - REMEDIAL INVESTIGATION
SAUGET AND CAHOKIA, ILLINOIS
SAUGET AREA 2 SITE GROUP

CONSTITUENT	CAS NO.	DQL (a) (ug/m^3)	
2,4,5-TP	93-72-1	2.9E+01	NC
2,4,5-T	93-76-5	3.7E+01	NC
Dalapon	75-99-0	1.1E+02	NC
Dicamba	1918-00-9	1.1E+02	NC
Dichloroprop	120-36-5	NA	-
Dinoseb	88-85-7	3.7E+00	NC
MCPA	94-74-6	1.8E+00	NC
MCPP	93-65-2	3.7E+00	NC

Notes:
CAS = Chemical Abstracts Service.
CDD = Chlorodibenzodioxin.
CDF = Chlorodibenzofuran.
DQL = Data Quality Level.
NA = Not available.
PCB = Polychlorinated Biphenyl.
PRG = Preliminary Remedial Goal.
TAL = Target Analyte List.
TCL = Target Compound List.
(a) Air DQLs are based on USEPA Region IX PRG Table. (USEPA, 2000b)
(b) Synonym of Bis(2-Chloroisopropyl ether)
(c) Value for cis-1,2-Dichloroethylene used.
(d) Due to structural similarities, the value for 4-Methyl-2-Pentanone was used.
(e) Value for 1,3-Dichloropropene.
(f) Due to structural similarities, the value for Naphthalene was used.
(g) Due to structural similarities, the value for 4-Nitrophenol was used.
(h) Due to structural similarities, the value for 2-Nitroaniline was used.
(i) Due to structural similarities, the value for Acenaphthene was used.
(j) Due to structural similarities, the value for Pyrene was used.
(k) Due to structural similarities, the value for Anthracene was used.
(l) Value for Chromium VI.
(m) Value for Nickel Refinery Dust.
(n) Value for 2,3,7,8-TCDD.
(o) Due to structural similarities, the value for Beta-BHC was used.
(p) Due to structural similarities, the value for Chlordane was used.
(q) Due to structural similarities, the value for Endosulfan was used.
(r) Due to structural similarities, the value for Endrin was used.
C = Value Based on potential carcinogenic effects.
NC = Value based on noncancer effects.