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April 27, 2012

VIA EMAIL

Galo Jackson
Remedial Project Manager
US EPA Region 4
61 Forsyth St. S.W.
Atlanta, Georgia 30303-8960

RE: Workplan for Flux Study Sampling and Site-wide Groundwater Sampling – 2012 Event
Workplan for LNAPL Assessment – 2012 Event
LCP Chemicals Site, Brunswick, Georgia

Dear Mr. Jackson:

Enclosed are two OU2-related workplans for sampling at the LCP Chemicals Site.

The first plan describes sampling related to the uplands-marsh groundwater flux and to evaluate present site-wide groundwater conditions, consistent with the work scope developed during our meeting with the EPA and EPD on April 17, 2012. As we discussed during that meeting, the goal is to obtain your team's review and approval of this document over the next 10 days so that we can begin field work on May 14, 2012 (note that the tides are favorable that week for site-wide groundwater level measurements).

The second workplan presents our proposed work scope and approach for a site-wide LNAPL assessment, to supplement the LNAPL assessment accomplished along the flux transect described in the first document. We would appreciate if possible that you could expedite the review of this workplan so that the sampling can be conducted at the same time as the sampling for the first workplan.

Please do not hesitate to call me at 678-336-8544 if you have any questions.

Sincerely,

Kirk J. Kessler, P.G.
Principal

Enclosures

cc: Jim McNamara, Georgia EPD
Prashant Gupta, Honeywell
Brett Mitchell, Georgia Power
Paul Taylor, Arco

Prepared for:

LCP SITE STEERING COMMITTEE

**WORK PLAN FOR COMPREHENSIVE
GROUNDWATER SAMPLING - 2012
(OPERABLE UNIT 2)**

**LCP CHEMICALS SITE
BRUNSWICK, GEORGIA**

Prepared by:



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April 2012

**WORKPLAN FOR COMPREHENSIVE
SITE-WIDE GROUNDWATER SAMPLING – 2012
(OPERABLE UNIT 2)**

**LCP CHEMICALS SITE OPERABLE UNIT TWO
BRUNSWICK, GEORGIA**

Prepared for:
LCP SITE STEERING COMMITTEE



Prepared by:
1050 Crown Pointe Parkway, Suite 550
Atlanta, GA 30338

A handwritten signature in blue ink that reads "Kirk Kessler".

Kirk Kessler, Principal

April 2012

**WORKPLAN FOR COMPREHENSIVE
SITE-WIDE GROUNDWATER SAMPLING – 2012
(OPERABLE UNIT 2)
LCP CHEMICALS SITE
BRUNSWICK, GEORGIA**

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1 INTRODUCTION

1.1 Overview

Honeywell International (formerly AlliedSignal, Inc.), the Atlantic Richfield Company (ARCO), and the Georgia Power Company are Responsible Parties (RPs) under an Administrative Order on Consent (AOC), to conduct Remedial Investigation and Feasibility Studies (RI/FS) for the LCP Chemicals Site (LCP Site) in Brunswick, Georgia. The LCP Site is being managed as three Operable Units (OUs). OU2 addresses groundwater beneath the LCP Site.

This document presents a plan to conduct a comprehensive sampling of groundwater from all wells in the site-wide monitoring well network. Furthermore there will be additional site assessment using direct-push (DP) methods. DP assessment is proposed along an upland marsh transect in support of both flux modeling and as an element of a petroleum hydrocarbon non-aqueous phase liquid (LNAPL) assessment. These activities are being performed at the request of the U.S. Environmental Protection Agency (EPA) and the Georgia Environmental Protection Division (EPD) of the Department of Natural Resources.

1.2 Background

The first groundwater sampling activity under the Superfund site characterization process occurred in 1994, involving DP sampling by EPA. Monitoring wells were installed and sampled as part of the Remedial Investigation (RI) over the period of 1995-1997 in accordance with methods and analytical testing programs approved by the EPA and EPD. An additional site characterization study involving installation of additional monitoring wells (including the “horizontal” monitoring wells) was performed in 2000. Selective monitoring was initiated by the RPs in 2001 and subsequent events have occurred in 2003, 2004, 2005, 2006, 2007, 2009, 2010 and 2011.

1.3 Study Objectives

One of the objectives of the proposed 2012 monitoring event is to obtain a comprehensive and synoptic measurement of groundwater quality and hydraulic head information from the entire network of on-site monitoring wells. This information will be used to inform decisions around each of the OUs.

A second objective is to provide information for evaluating the contaminant flux in groundwater as it flows across the uplands-marsh boundary.

A third objective is to assess for the presence of LNAPL along the marsh-upland border.

1.4 Document Organization

The remainder of this document is organized as described below:

- Section 2 presents an evaluation of past groundwater sampling data in support of the proposed scope for the comprehensive groundwater sampling;
- Section 3 describes the field methods;
- Section 4 describes laboratory tests and methods;
- Section 5 describes the decontamination procedures;
- Sections 6 and 7 address quality control and documentation protocols, respectively; and
- Section 8 provides a list of references.

2 SAMPLING SCOPE

2.1 Review of Previous Sampling Events to Determine Parameters List for 2012 Event

2.1.1 Approach and Summary of Evaluation

The early RI groundwater sampling events on the site tested for a broad suite of chemical constituents. These past sampling events have been evaluated to identify specific chemical groups that can be eliminated from the 2012 sampling event. There are 138 monitoring wells and 12 horizontal wells on the site (Figure 1). Eliminating unnecessary analytical groups from the program is consistent with EPA guidance.

All of the major analytical groups are represented in the database generated from the past groundwater sampling events. These analytical groups include Target Analyte List (TAL) metals and Target Compound List (TCL) organics – TCL organics include volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) including polycyclic aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs).

The analytical group scoping process involved comparing all of the groundwater data records from monitoring wells sampled from 1995 to present, taking maximum detections of each analyte and comparing that value to EPA's Regional Screening Level (RSL) value for groundwater (MCL where available, otherwise tap water). The results of this evaluation can be summarized as follows:

- A number of different metals exceed the RSL and therefore the full list of TAL metals is retained for the 2012 sampling program;
- A number of different VOCs exceed the RSL and therefore the VOC chemical group is retained for the 2012 sampling program;
- Only two of the non-PAH SVOC constituents exceed the RSL: 2,4,6-trichlorophenol and bis(2-ethylhexyl)phthalate. Detections are infrequent and slight in concentration and therefore non-PAH SVOCs are not a parameter group of interest (further details of this evaluation follow below). PAHs are retained as an analytical group for the 2012 sampling program.
- Three pesticides are detected above the RSL (aldrin, alpha-BHC, and dieldrin) but these detections are infrequent and slight in concentration and therefore this is not a parameter group of interest (further details of this evaluation follow below).
- PCB detections did occur in some of the early sampling events (1995, 1996) where on-site laboratories (TEG and later QAL) were being utilized. Detections were infrequent and generally qualified later with a non-detect result. It is proposed to conduct testing for PCBs for wells located within the footprint where soil conditions exceed the extraction-based soil screening level (ESSL) derived from the 2009 batch leaching study. More information on the PCB detections in groundwater and the ESSL comparison follows below.

2.1.2 Evaluation of SVOCs

Table 1 is a listing of non-PAH detections in groundwater with comparison to MCLs (or Tap Water RSLs where no MCL exists). The table highlights each instance where the groundwater criteria is exceeded – gray highlight is used to indicate that the parameter is also reported as part of the standard VOC analysis, and yellow highlight is used for parameters that are only reported under the standard SVOC analysis. VOCs are proposed for the 2012 program and thus the gray highlight cases will be part of the sampling event. That leaves only two SVOCs that exceed criteria: 2,4,6-trichlorophenol and bis(2-ethylhexyl)phthalate.

2,4,6-trichlorophenol

Three detections of 2,4,6-trichlorophenol occurred in past sampling events. All of these detections were above the RSL (detects range from 8 to 26 parts per billion (ppb) compared to the RSL of 6.1 ppb). Figure 2a shows the location and magnitude of the detections.

bis(2-ethylhexyl)phthalate

Nine detections of bis(2-ethylhexyl)phthalate occurred in past sampling events. Only one of these detections was above the RSL (detect of 7 ppb compared to the RSL of 6.1 ppb). Figure 2b shows the location and magnitude of the detections.

2.1.3 Evaluation of Pesticides

Table 2 is a listing of pesticide detections in groundwater with comparison to MCLs (or Tap Water RSLs where no MCL exists). The table highlights each instance where the groundwater criteria are exceeded. Three pesticides exceed criteria: aldrin, alpha-BHC, and dieldrin.

Aldrin

Two detections of aldrin occurred in past sampling events. One of these detections was above the RSL (0.071 ppb compared to the RSL of 0.004 ppb). Figure 3a shows the location and magnitude of the detections.

alpha-BHC

Five detections of alpha-BHC occurred in past sampling events. Two of these detections were above the RSL (detects of 0.088 and 0.027 ppb compared to the RSL of 0.011 ppb). Figure 3b shows the location and magnitude of the detections.

Dieldrin

Two detections of dieldrin occurred in past sampling events. Both of these detections were above the RSL (detects of 0.077 and 0.018 ppb compared to the RSL of 0.004 ppb). Figure 3c shows the location and magnitude of the detections.

2.1.4 Evaluation of PCBs

Table 3 is a listing of PCB detections in groundwater with comparison to Tap Water RSLs. Three different PCB Aroclors have been detected (all are above criteria): Aroclor 1016, Aroclor 1260, and Aroclor 1268.

Aroclor 1016

One detection of Aroclor 1016 occurred in past sampling events. This detection was above the RSL (40 ppb compared to the RSL of 0.96 ppb). Three other sampling events all showed non-detect result for Aroclor 1016 at this well location (MW-302).

Aroclor 1260

One detection of Aroclor 1260 occurred in past sampling events. This detection was above the RSL (detect of 0.52 ppb compared to the RSL of 0.034 ppb). Two other sampling events showed non-detect result for Aroclor 1260 at this well location (MW-359B).

Aroclor 1268

Eight detections (seven well locations) of Aroclor 1268 occurred in past sampling events. All of these detections were from on-site laboratory testing (either TEG or QAL). Six of the wells showed non-detect in a subsequent sampling event. One of the wells with Aroclor 1268 showed a detection in both the initial sampling and a subsequent sampling at well MW-356A (sampled on 04/22/96 analyzed by TEG (4.7 ppb) and sampled later on 06/26/96 analyzed by QAL (1.6 ppb)); this well has not been subsequently tested for Aroclor 1268.

Figure 4 shows the locations where PCBs have been detected in any of the past sampling events, along with soils data mapped in comparison to the soils ESSL criteria (5 ppb Aroclor 1268). Given the fact that nearly all of the past PCB detections were subsequently nullified by subsequent testing, it is proposed to apply the >ESSL footprint as the basis for selecting wells that will be tested for PCBs in the 2012 event. All wells shown within the “PCB ESSL Exceedence” polygon displayed on Figure 4 are proposed for PCB analysis.

2.2 Proposed Scope for the 2012 Sampling Event

2.2.1 Shoreline Transect for Flux Modeling

The table below indicates the proposed sampling locations for this program.

Monitoring Wells (south to north along transect)	Direct Push Points	DP Sampling Interval
MW-114A, B, C		
	DP-1	A – span water table B – 30 ft bgs
MW-113A, B, C		
	DP-2	A – span water table B – 30 ft bgs
MW-112A, B, C		
	DP-3	A – span water table B – 30 ft bgs
MW-358A, B		

MW-354 A, B		
MW-104 B, C (A well destroyed during past removal action)	DP-4	A – span water table
	DP-5	A – span water table B – 30 ft bgs
MW-110A, B, C		
	DP-6	A – span water table B – 30 ft bgs
MW-111 A, B, C		

Figure 5 shows the sampling transect that intersects the existing monitoring wells shown in the table above and also shows the proposed locations of the DP investigation along the transect; the DP locations span the distance between monitoring wells at critical locations along the transect (DP-4 will provide the equivalent of an “A” well at the MW-104 cluster location).

The DP program will involve two offset borings. The shallow DP boring (A) will involve collection of a soil core from the ground surface to approximately 5 ft below the water table, in order to allow visual observation of the soil across the zone of water table fluctuation for the presence of petroleum hydrocarbon LNAPL (i.e., the “smear zone”). After the core is extracted, a temporary well with a pre-packed well screen will be placed in the borehole to facilitate collection of a groundwater sample and to check for the presence of dissolved LNAPL. A ten-foot length screen interval is proposed for the shallow installation to ensure spanning of the water table while also ensuring adequate depth to obtain a representative groundwater sample. The offset DP boring (B) will be advanced using the same DP and temporary well installations methods to a depth consistent with the “B” well of the nearby monitoring wells along the transect, strictly for the collection of a groundwater sample. A 5-foot screen interval will be used for the deeper DP boring in order to be more consistent with existing monitoring well installations. Turbidity will be monitored during purging of the DP locations. If turbidity exceeds 10 NTUs, a standard metals container will be filled (pre-preserved with acid) along with a second metals container (without acid) to allow for both an unfiltered and filtered metals analysis.

The groundwater samples will be analyzed for the following constituents of interest:

- TAL Metals
- Mercury
- Volatile Organic Compounds
- Polynuclear Aromatic Hydrocarbons
- Polychlorinated Biphenyls
- pH – laboratory
- Total Dissolved Solids (TDS) – for use in equivalent fresh-water head adjustment

The DP temporary well points will also be sampled for geochemical parameters including:

- Silica
- Sulfate/Sulfide
- Chloride
- Total Organic Carbon

2.2.2 Site-wide Comprehensive Sampling

All of the monitoring wells present on the site (including the 12 horizontal wells) will be sampled for the 2012 event. Water levels and field parameters (pH, ORP, DO, temperature, turbidity) will be measured in all site wells in addition to the laboratory testing. Laboratory testing will be conducted as follows:

- TAL metals All wells
- Mercury All wells
- Hexavalent Chromium 5 - 10% of wells with past total chromium detects
- VOCs All wells
- PAHs All wells
- PCBs MW-104, -105, -106; MW-112, -113; MW-351 to -359; MW-501 to MW-519
- pH – laboratory All wells
- TDS All wells

Note that all wells within the “proximate” grouping of the caustic brine pool program will be analyzed for geochemical parameters in addition to the analytes listed above.

The selection of wells for chromium speciation analysis is based on the historical detection of dissolved chromium (total) in groundwater. All of the past results for total chromium were extracted from the database and the results were mapped in GIS to examine the concentration distribution. A total of 12 wells (8% of the total number of monitoring wells on the site) have been selected, on the basis of spanning the range of total chromium detections and also to provide spatial distribution across the monitoring well network (Figure 6). Wells selected for hexavalent chromium include:

- Upland wells north of B Street: MW-108A, MW-110A, and MW-111A
- Upland wells south of B Street: MW-112C, MW-115C, MW-353B, MW-358B, HWwest3
- Marsh wells: MW-101D, MW-307B, MW-312B, MW-313B

3 FIELD METHODS

3.1 Sequence of Field Activities

Field activities will occur in the following order:

1. Installation of DP temporary well points
2. Site wide groundwater level measurements
3. Groundwater sampling.

Installation of the DP well points will be completed as the first step of this work plan to support the characterization of the LCP Site potentiometric surface during the site wide groundwater level measurement task. Inclusion of the DP well points will increase the number of available water level measurement points along the marsh-upland border. Site wide groundwater level measurements will be completed with several teams to complete the task in the shortest period as feasible to minimize tidal or temporal influences on the dataset.

Groundwater sampling will first be complete along the marsh transect (DP well points and monitoring wells) following by all other site monitoring wells. Groundwater samples from the marsh transect will be analyzed on an expedited schedule to allow for potential follow-up work during the current field mobilization. All other samples will be analyzed with a standard turnaround time.

3.2 Direct Push Procedure

DP technology will be used to install temporary monitoring wells in general accordance with the procedures outlined in the USEPA Region IV Science and Ecosystem Support Division standard operating procedure for Design and Installation of Monitoring Wells (SESDGUID-101-R0 dated February 2008). The DP procedure will utilize dual-tube (DT) technology to set temporary well points at depths listed in Section 2.2.1. DT technology uses both an outer and inner rod. The outer rod is equipped with a cutting shoe that cuts a soil core which is collected inside of the outer casing sliding into the acetate liner held in place by the inside rod string. When at depth, the inside rod string and the soils retained in the acetate liner is removed from inside of the outer rods. The outer rods remain in the ground thereby providing a cased hole. A clean liner is then attached to the inner rods, sent back down within the outer rods and another outer rod is added to the drill string.

After reaching a desired depth the inner rod string (and soil core for “A” DP locations) will be withdrawn and a temporary well casing will be inserted inside the outer rod without collapse of the borehole. A 0.75” ID pre-pack screen will be placed at both “A” (spanning water table) and “B” (approximately 30’ below ground surface) DP locations.

3.3 Site Wide Water Level Measurement Procedure

Water level measurements will be conducted in every monitoring well on site after the DP temporary wells have been set. Sampling teams will make every attempt possible to obtain the water level measurement at slack low tide – wells within and bordering the marsh exhibit tidal fluctuation. Water level measurements will be made as follows:

- decontaminate water level meter probe that is graduated to 0.01 feet (for more details on decontamination procedures, see Section 5);
- lower tip of the probe into well until it touches the water surface (beeping sound begins);
- raise and lower tip and adjust length of cable to placement on the top of the casing (notched or otherwise marked reference point); water levels will be measured from the same point each time on the top of the casing;
- mark depth on cable with thumb nail and hold;
- read and record the water level measurement in increments to the nearest 0.01 foot in the logbook and/or on the water level form; and
- decontaminate prior to measuring next location.

3.4 Groundwater Sampling Procedure

Field sampling procedures are designed to ensure the collection of data that are representative of site conditions. Sampling will be conducted in general accordance with the procedures outlined in the USEPA Region IV Science and Ecosystem Support Division standard operating procedure for Groundwater Sampling (SESDPROC-301-R2 dated October 2011). General water quality parameters will be measured in purged groundwater using a flow-through cell monitor (e.g., Horiba U-22 or equivalent).

3.4.1 Purging and Sampling Procedure

3.4.1.1 Tubing-in-Screen-Interval Method

The “Tubing-in-Screen-Interval” (TSI) method will be applied to vertical monitoring wells consistent with past groundwater sampling events and work plans. TSI methodology is used primarily when calculated purge volumes for the traditional purging method are excessive and present issues related to timely completion of the project and/or management of investigation derived waste.

3.4.1.2 Purge and Sample Collection Criteria

Purging of the monitoring well will be completed by first setting the peristaltic pump tubing or intake point of the submersible pump at the approximate mid-portion of the screened interval of the well. The well screen interval is available from well construction diagrams.

The following steps will be taken during well purging and sampling:

- **Water Level Measurements:** Static water levels will be measured before any fluids are withdrawn and before any equipment enters the well prior to purging. Water level measurements will be conducted immediately prior to well purging with a “clean”

electronic sounder. If the casing cap is air-tight, time will be allowed prior to measurement for the equilibration of pressures after the cap is removed.

- **Purging Requirements:** TSI purge methods using peristaltic pumps will be used. Purge water is passed into a flow-through cell. The purge water samples shall be measured for pH, Eh, DO, temperature, conductivity, and turbidity every 10 minutes for a minimum of 30 minutes of purging. At that time measurements will be taken on a 5-minute cycle until parameters stabilize indicating the well is sufficiently purged.
- **Measurements:** The temperature, pH, Eh, DO, conductivity, and turbidity will be measured and recorded during purging. The sample may be collected when pH and conductivity have stabilized and turbidity is below 10 NTU. Stabilization is defined as follows: pH \pm 0.1 units and conductivity \pm 5% for three consecutive measurements. If these parameters do not stabilize, the sample will be taken after five well volumes have been removed. The total number of well volumes removed will be recorded in the field forms.
- **Collection Period:** Groundwater samples will be collected immediately after the completion of purging. Sample containers appropriate for the analyte group are provided by the laboratory.

If the purge water exceeds a pH of 9.0 standard units, the site protocol requires the water to be containerized as an investigative-derived waste (otherwise, the site protocol allows for the purge water to be directed away from the active work area and discharged to the ground surface to allow it to seep through the permeable sands).

3.4.2 Sampling Sequence

The preferred order of sample collection according to the major analytical groups is:

1. Target Analyte List (TAL) metals;
2. Inorganics/geochemical indicator parameters;
3. PAHs;
4. PCBs;
5. pH for lab analysis; amd
6. VOCs.

3.4.3 Sampling of Horizontal Wells

3.4.3.1 Purging Procedure

Horizontal wells contain a large volume of standing water within the casing owing to their excessive length (approximately 2200 ft), thus requiring a unique purging and sampling approach. The south side of each duct will be connected to a diaphragm pump, or a dedicated submersible centrifugal pump capable of pumping in the 1-3 gpm range will be used in each well duct. The entire volume of stored water in the well duct will be evacuated and the purge water will be monitored for pH, conductivity and temperature. A pH criterion has been established that will trigger more frequent monitoring if the pH exceeds 8.0. If the purge water exceeds a pH of 9.0 standard units, the site protocol requires the water to be containerized as an investigative-derived waste (otherwise, the site protocol allows for the purge water to be directed away from the active work area and discharged to the ground surface to allow it to seep through the

permeable sands). Purge volumes will be recorded on field forms. After this primary purge is complete, the ½-inch sampling tubes on the north side of each well duct will be connected to a peristaltic pump and one volume of the stagnant water in the tubes will be evacuated. After this purging, a water quality meter (e.g., Horiba U-22 or equivalent) connected to a flow-through cell will be used to monitor the stability of field parameters (i.e., temperature, pH, Eh, conductivity, DO, and turbidity). A pH meter will be used to record the pH readings. Stabilization is defined as follows: pH \pm 0.1 standard units and conductivity \pm 5%. After these parameters have stabilized, the groundwater will be sampled for chemical analyses as outlined in Section 3.4.2.

3.5 Equipment Calibration

Calibration of field instruments will be performed each day prior to sampling and at the intervals specified by the manufacturer or more frequently as conditions dictate. In the event that an internally calibrated field instrument fails to meet calibration/checkout procedures, it will be returned to the manufacturer for service.

3.6 Sample Documentation

3.6.1 Overview

Documents for recording sampling events will include a daily field activity log, field measurement logs, and photographs as appropriate. Sample information to be included on sample labels, custody seals, and chain-of-custody forms is described below.

3.6.2 Sample Identification and Documentation

After sample collection, all sample containers will be labeled with an identification number that uniquely identifies the sample. The samples will be identified with a unique alpha-numeric identification that follows the format “YYDDD-Z” where:

- YY is the year the sample was taken;
- DDD is the Julian date of sample collection;
- X is the Decision Unit designation; and
- Z is the Sampling Unit designation.

Each sample container will have a sample label. The sample identification number will be logged in the field notes sheet, along with the following information about the sampling event:

- Sampling personnel;
- Date and time of collection;
- Observations on ambient conditions;
- Decision Unit / Sampling Unit designations;
- Method of sampling; and
- Intended sample processing methods and analyses.

3.6.3 Sample Labels

Each sample container will be labeled with the following information: unique sample number, date, time, project name and/or number, sampler's initials, and requested analytical parameters/methods. Indelible ink will be used to record information on the sample label.

3.6.4 Custody Seals

Custody seals will be used when a sample shipment is picked up by the laboratory or sent to the laboratory by overnight courier. Signed and dated custody seals will be attached to the top of the shipping container in such a way that it is necessary to break the seal to open the container. Custody seals ensure that any tampering during transportation will be detected by the receiving laboratory.

3.6.5 Chain-of-Custody Forms

Chain-of-custody forms provide the documentation to trace sample possession from the time of sample collection until receipt by the laboratory. One chain-of-custody form will be filled out for each cooler or shipping container and will list all the samples contained in the cooler or container. One copy of the completed form will be placed in a plastic bag and taped to the inside lid of the shipping container and one copy will be kept with the project files.

3.7 Field Activity Logs

3.7.1 Introduction

A field logbook will be maintained to record the details of field investigation activities and field data. This logbook will be bound and will have sequentially numbered pages. Entries will be written in indelible ink and will be initialed and dated by the field personnel recording the information. Several types of field activity logs will be maintained, including site health and safety logs, equipment calibration logs, and field sampling logs.

3.7.2 Field Sampling Logs

In addition to the descriptions of field investigation activities and field data recorded in the field log book, details of sampling information may be provided on field sampling logs. Field sampling logs will generally include the following information:

- date and weather;
- personnel;
- time and description of investigative activities;
- sample medium and type;
- sample collection technique(s);
- sample containers, analyses, and preservatives;
- sample number, location, and depth;
- sampling times; and
- pertinent field observations.

3.7.3 Corrections to Documentation

All documents will be completed in permanent, waterproof ink. None of the field documents are to be destroyed or thrown away, even if they are damaged or contain inaccuracies that require a replacement document. Corrections will be made by crossing out mistakes with a single line and then dating and initialing the correction. The use of correction fluid is not permissible. The documents used during the field investigation will remain on-site in the field office during the field effort.

4 ANALYTICAL METHODS

Groundwater samples will be analyzed for VOCs, PAHs, PCBs, metals, and geochemical parameters using USEPA approved methods. Note that low-level methods will be employed for PAHs. Specific test methods are indicated below:

VOCs	8260C
PAHs	8270D
PCBs	8082A
Metals	6010C (for high concentration metals) or 200.8 (for low concentration metals)
Chromium	IC-ICP-MS
Mercury	7470A (or 1613E for low level methods where concentration is known to be low)
pH	SM 4500-H+B
TDS	SM 160.1

Geochemical parameters include the following:

Sulfide	SM 4500-S2-D
Chloride	SM 4500-Cl-C
Sulfate	300.0
Silica	SM 4500-SiO2
TOC	SM-4500

5 DECONTAMINATION AND WASTE HANDLING

5.1 Sample Equipment Decontamination

Field sampling equipment will be decontaminated on-site according to the procedures outlined in USEPA Region IV Science and Ecosystem Support Division standard operating procedure for Field Equipment Cleaning and Decontamination at the FEC(SEDPROC-206-R2). The general procedures for decontaminating the equipment are listed below.

- Wash equipment thoroughly with Liquinox® (or other phosphate-free detergent) and water using a brush or scrub pad to remove any particulate matter of surface film.
- Rinse equipment thoroughly with tap water.
- Rinse equipment thoroughly with deionized water and allow to air dry.
- Wrap equipment in one layer of aluminum foil.

Tap water from any municipal water treatment system or distilled/deionized water may be used for initial equipment rinses. The use of an untreated potable water supply is not an acceptable substitute for tap water.

5.2 Investigation-Derived Waste Management

Investigation-derived waste (IDW) that will be generated during the sampling event includes:

- personal protective equipment (PPE) and disposables (e.g., gloves);
- decontamination liquids; and
- purge water from monitoring wells.

PPE and other disposables will be discarded like regular waste. Decontamination liquids and solids will be containerized in plastic buckets and then consolidated in open-top drums. Purge water from monitoring wells will either be discharged to the ground surface or containerized and consolidated into onsite holding tanks for pH neutralization with the onsite treatment system (and discharged into the infiltration galleries). For vertical and horizontal wells, a pH criterion of <9.0 standard units has previously been established with the agency as a threshold for discharging purge water back onto the ground surface (this is done in the area of the cell building cap where the caustic brine pool underlies the area).

6 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

6.1 Field QC Samples

Two types of field QC samples will be collected, trip blank and field duplicate samples.

Trip Blank

A trip blank sample is designed to detect contamination of environmental samples during transport from the field to the laboratory. A trip blank (VOC sample bottle filled in the laboratory with analyte-free water) is transported to the site, handled like a sample, and returned to the laboratory for analysis. Trip blanks shall not be opened in the field. One trip blank shall accompany every cooler of water samples sent to the laboratory for the analysis of VOCs. This blank shall be analyzed for VOCs only.

Field Duplicate

A field duplicate is collected at the same sampling location in a manner similar to other environmental samples, so the laboratory cannot distinguish them. The field duplicate is designed to check variability arising from sampling activities or lack of sample homogeneity. The duplicate will be identified in a manner similar to other environmental samples so the laboratory cannot distinguish them. Five percent (i.e., 1 in 20) of all environmental water samples shall be field duplicates. Both duplicates (e.g., the sample and the duplicate) shall be analyzed for the same parameters in the laboratory.

6.2 Field Operations

Control of field operations and sampling methods will be established through by ensuring that each field team member is familiar with the provisions of the Workplan and Health & Safety Plan (HASP). Also, the EPS Project Manager will ensure that each field team member is familiar with the Workplan prior to implementation of field activities. The EPS Project Manager will also provide a QA review of field activities at the beginning of the sampling event to ensure that all procedures are followed and at least one additional time during the execution of this project for each sampling team through on-site monitoring of representative field activities. The Project Manager will regularly check field notebooks and forms.

7 DATA QUALITY EVALUATION AND REPORTING

7.1 Data Quality Evaluation

EPS will store the data in an MS Access normalized relational database. A database is defined as a large collection of data organized especially for rapid search and retrieval. Data are organized into standardized, structured tables that are specifically related to one another. MS Access is an industry-standard relational application for small to medium databases.

Before data is added to the database, it undergoes a validation process. In the case of hand written notes and hard copies, records are manually entered into an electronic spreadsheet, checked twice by two different people. Electronic records are then imported into a separate database (Build database) where several queries are used to perform additional data validation. In order to maintain internal consistency, each parameter is spell checked to ensure proper encoding, each Sample ID and date pair is evaluated to prevent duplicate entries, and all data are checked for proper units, methods, and matrix types.

The database is designed for use by two classes of users: the Database Manager (DM) and the End-User. A DM designs and maintains the structure of the database, appropriately prepares data for entry (outside of Access), correctly executes validation tests within Access during data entry, and informs end-users of any limitations to the dataset. An End-User queries data for day-to-day work (analysis, reports, thought experiments, etc.) and links data to outside applications (GIS, outside databases). There is one DM and any number of End-Users.

The database is not simply one database, but rather a collection of three separate databases: Build, Master, and Main. The Build database links directly to the Master database and is used exclusively by the DM to validate, format, and finally enter data into the Master database. The Master database stores all the data and is managed only by the DM. The Main database is an exact replicate of the Master database that is linked to by End-Users for day-to-day work. When changes are made to the Master database it is copied over to the Main database. This procedure, known as "compacting", ensures that the Main database always has the most up to date records, and that there is separation between the original records and those used on a daily basis.

The work necessary to validate raw data is performed in queries. A query in its basic form allows the user to select fields for a table or multiple tables. Queries can also perform statistical calculations, replace values, add and remove records, create and delete tables. Because of the heterogeneity of the raw data, DMs modify queries and update key fields in order to maintain proper encoding. The following is a step by step process used to "clean" raw data:

- Raw data are imported into a temporary table that has the same structure as the Master database's Data table.
- Each set of raw data is assigned a batch number in order to track its addition.
- Raw data are checked for duplicate records. If duplicate records exist, they are assigned the proper Dup code. The database is designed to store all duplicate records that often are the result of multiple analysis methods and lab replicates. Original values are given a

Dup code of 0. Duplicate records are given values that are the sum their duplicate characteristics. Characteristic codes are listed below:

- 1 - Duplicate sample sent to the same lab (often with a different Sample ID)
 - 2 - Split sample sent to different lab; generally with the same Sample ID
 - 4 - A duplicate analysis by the same lab generally by another method
 - 8 - A duplicate due to reporting both the diluted and undiluted result
 - 16 - Miscellaneous
- The analyte names are checked for spelling to ensure proper encoding.
 - Units and Methods are checked to ensure proper encoding.
 - Missing values are checked in order to prevent errors of omission.
 - Sample ID / Date pairs are checked.
 - Sample IDs in the raw data are cross-checked with existing locations. New locations are added when necessary.
 - All raw records are checked against the Master database's Data table to prevent duplicate entries.
 - "Clean" data are added to the Master database.
 - All temporary tables are deleted.

Note that all data are actually entered into the database. "Clean" data are to be used without qualification, whereas other data flagged during the data review process are to be used with appropriate professional judgment. Instead of being thrown out, all data is categorized to allow database End-Users flexibility in analyzing data: Records are given Dup codes, data quality flags, matrix codes, area designations, etc. Because the database is a living database, DMs often have to modify table structures and add keys to key tables to input new sources of data in order to categorize additional records. These modifications do not change existing records, but instead build upon them.

7.2 Data Reporting

Data deliverables from the analytical laboratory will consist of the following items:

- Case Narrative;
- Laboratory Final Reports;
- Surrogate Recovery Summary;
- Matrix Spike/Matrix Spike Duplicate Recovery Summary;
- Method Blank Summary;
- Laboratory Control Sample (LCS) Recovery Summary;
- Initial Calibration Summary Gas Chromatograph (GC) Method Printout;
- Continuing Calibration Summary;
- Analytical Sequence Printout;
- Chromatographs and Quantification Reports for all Samples, Standards, and QC Samples;
- Copies of Extraction Log Pages; and
- Copies of Chain-of-Custody Document.

For consistency and ease of review, the data deliverables will be organized in the same manner. The arrangement will be as follows:

- Sample Narrative;
- Final Reports;
- QC Summary Information;
- Analytical Sequence Printout(s);
- Sample Raw Data (arranged by sample number);
- Instrument Calibration Data (in chronological order);
- Raw QC Data;
- Blanks;
- LCS;
- Matrix Spike/ Matrix Spike Duplicate (MS/MSD);
- Extraction Logbook Pages; and
- Chain-of-Custody Documents.

8 REFERENCES

GeoSyntec Consultants, “Health and Safety Plan for Removal Response Activities, LCP Chemicals – Brunswick Site”, June 1996 and subsequent addenda.

GeoSyntec Consultants, “Work Plan for Additional Site Characterization, LCP Chemicals Superfund Site – Groundwater Operable Unit Two (OU2) – Brunswick, Georgia”, June 2001.

GeoSyntec Consultants, “Groundwater RI Addendum Report, Revision 0, LCP Chemicals – Brunswick, Georgia”, January 2002.

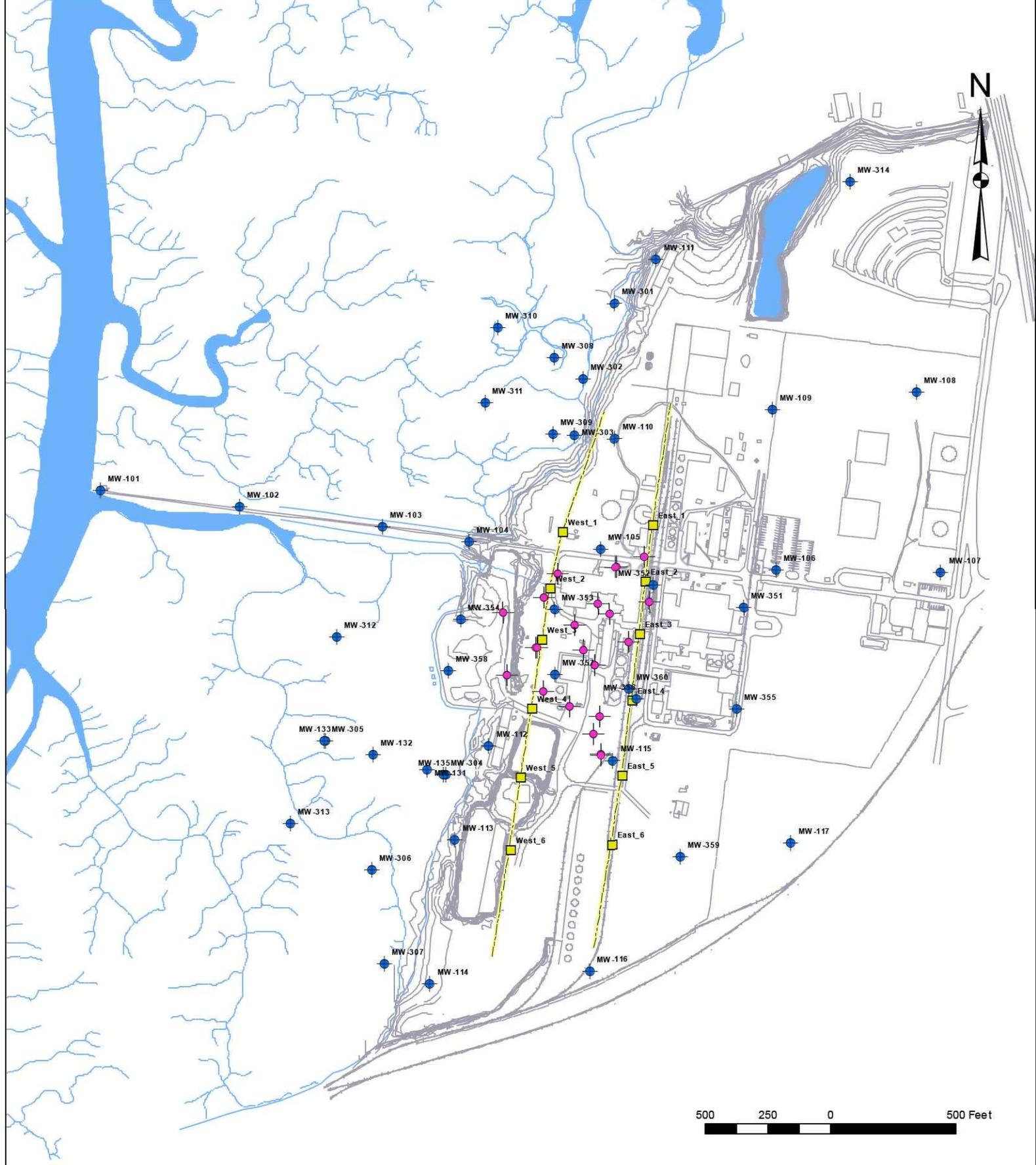
GeoSyntec Consultants, “Compilation of Agency Review Comments on the Groundwater Remedial Investigation and Feasibility Study Deliverables and Response to Comments, LCP Chemicals Superfund Site – Brunswick, Georgia”, October 2002.

US EPA Region IV Science and Ecosystem Support Division standard operating procedure for Design and Installation of Monitoring Wells (SESDGUID-101-R0) February 2008.

US EPA Region IV Science and Ecosystem Support Division standard operating procedure for Groundwater Sampling (SESDPROC-301-R2) October 2011.

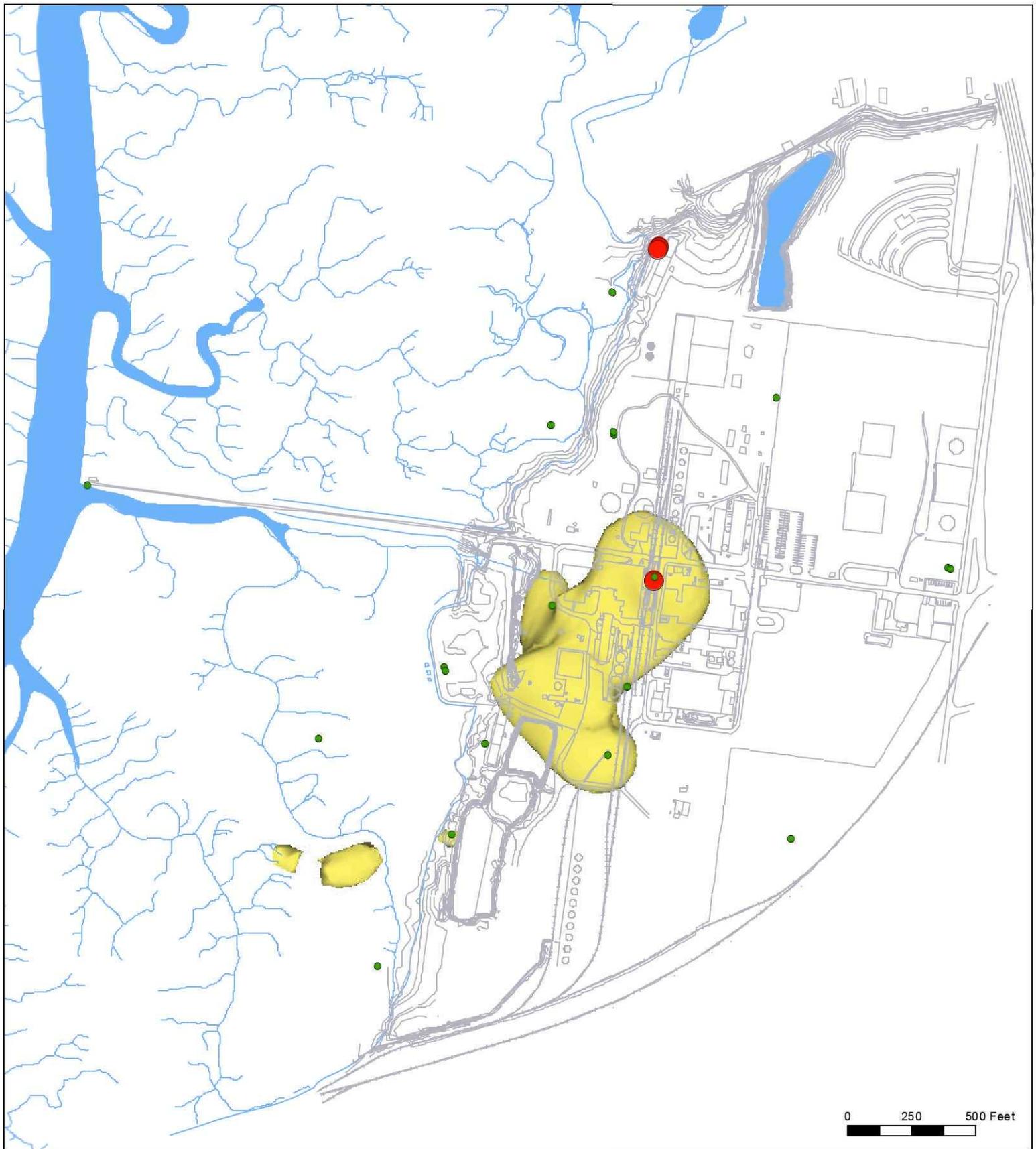
US EPA Region IV Science and Ecosystem Support Division standard operating procedure for Field Equipment Cleaning and Decontamination at the FEC (SESDPROC-206-R2) December 2011.

Figures



- ◆ Monitoring Well Cluster Location
- Horizontal Well Screen Location
- Horizontal Well Alignment
- ★ CBP Performance Monitoring Wells

Figure No. 1
Existing Monitoring Well Locations



2,4,6-trichlorophenol

RESULTPPB

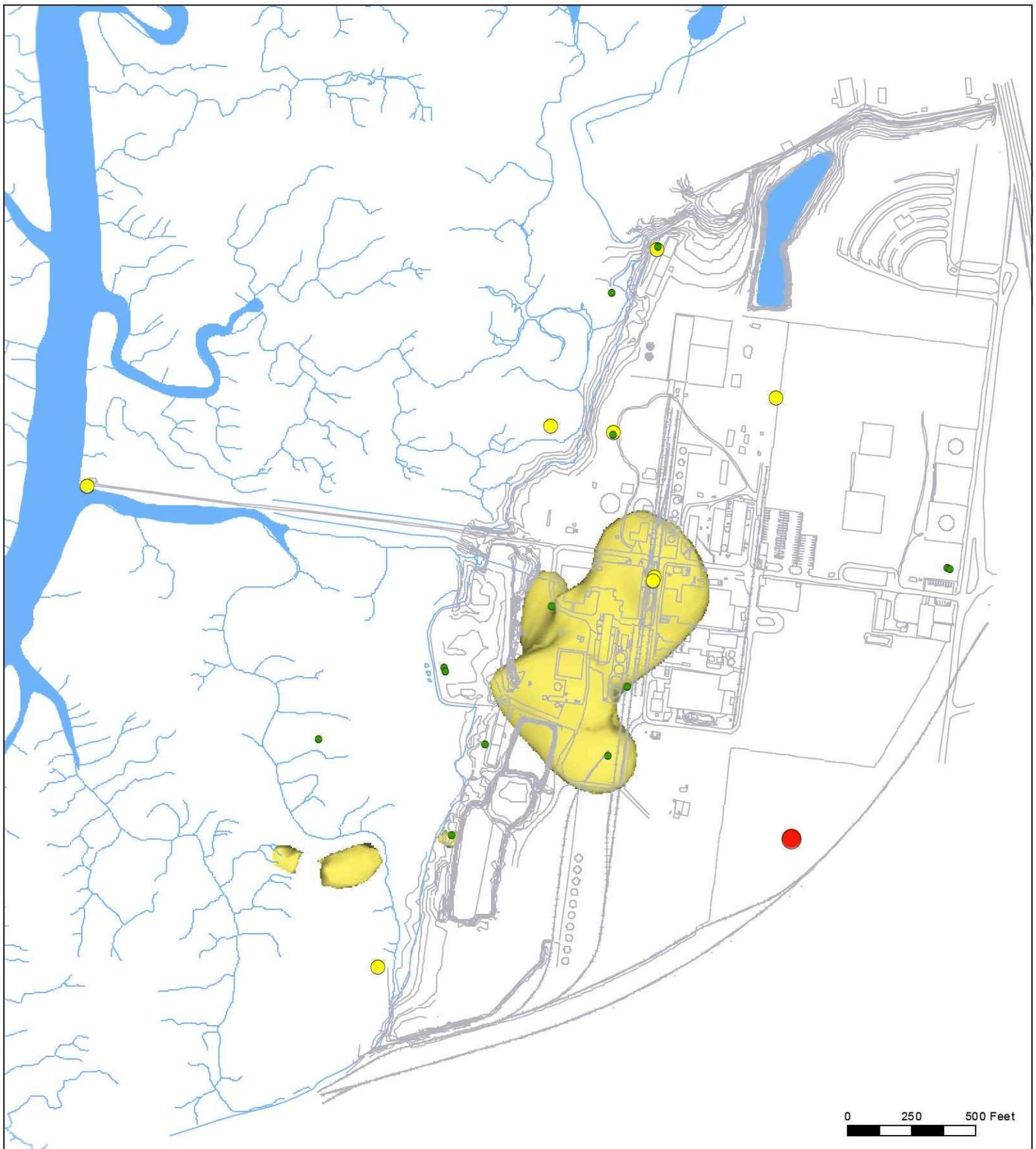
- ND
- < 6.1 ppb
- > 6.1 ppb [>RSL]

CBP May 2010 Extent

RGB

- Red: Band_1
- Green: Band_2
- Blue: Band_3

Figure 2a
2,4,6-Trichlorophenol



bis(2-Ethylhexyl)phthalate

RESULTPPB

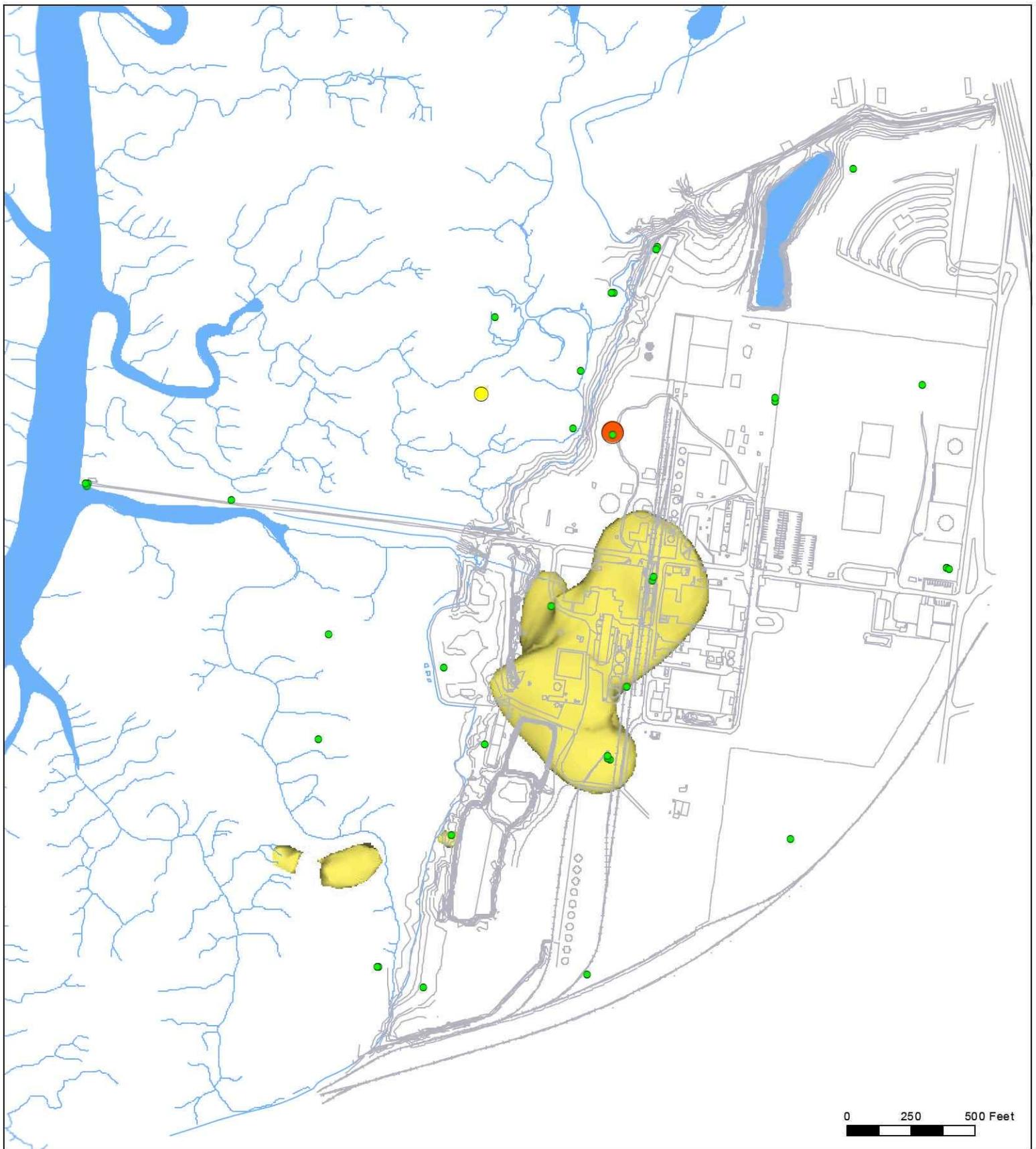
- ND
- < 6.1 ppb
- > 6.1 ppb [>RSL]

CBP May 2010 Extent

RGB

- Red: Band_1
- Green: Band_2
- Blue: Band_3

Figure 2b
bis(2-ethylhexyl)phthalate



Aldrin
RESULTPPB

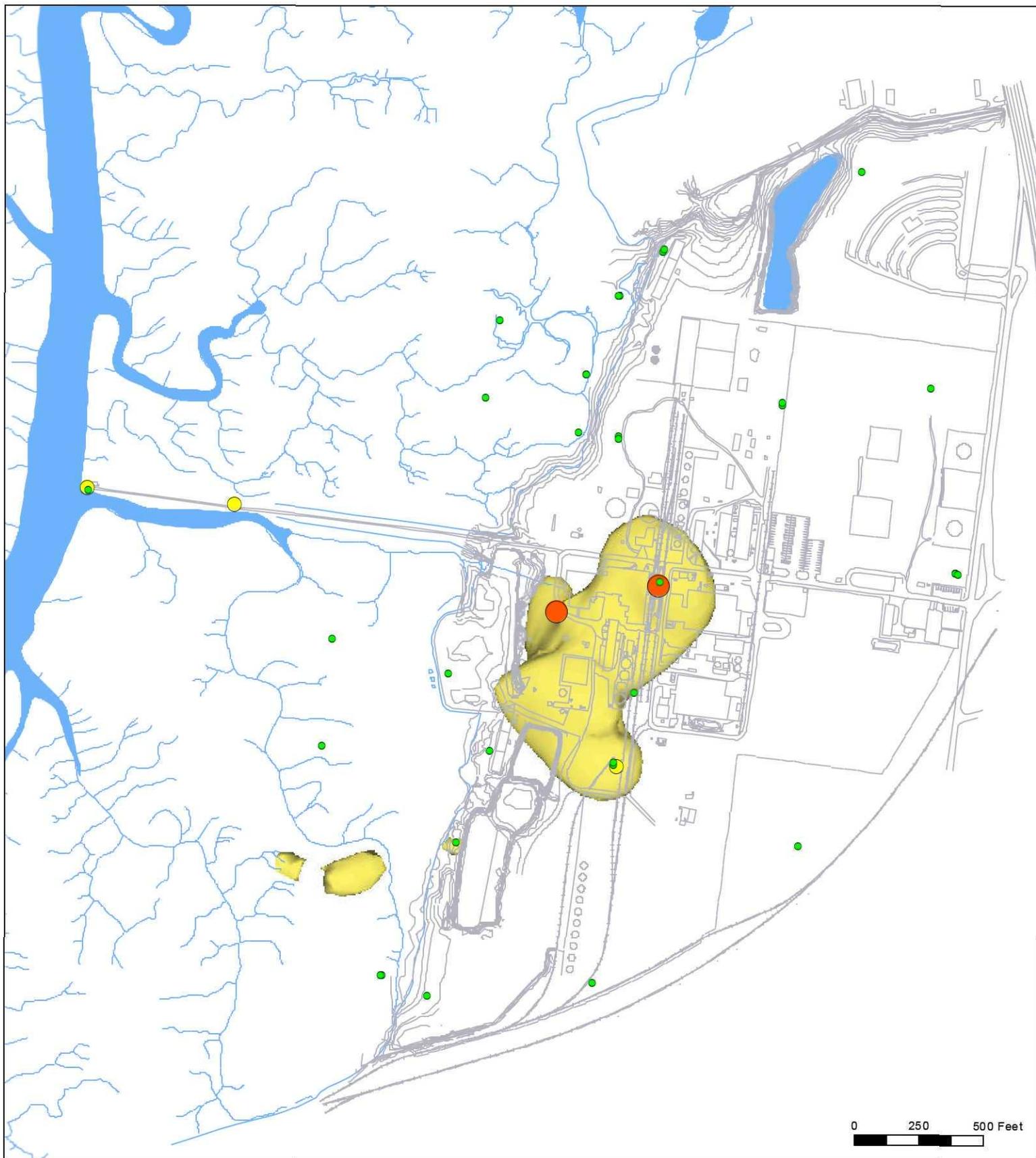
- ND
- < 0.004 ppb
- > 0.004 ppb [> RSL]

CBP May 2010 Extent

RGB

- Red: Band_1
- Green: Band_2
- Blue: Band_3

Figure 3a
Aldrin



alpha-BHC
RESULTPPB

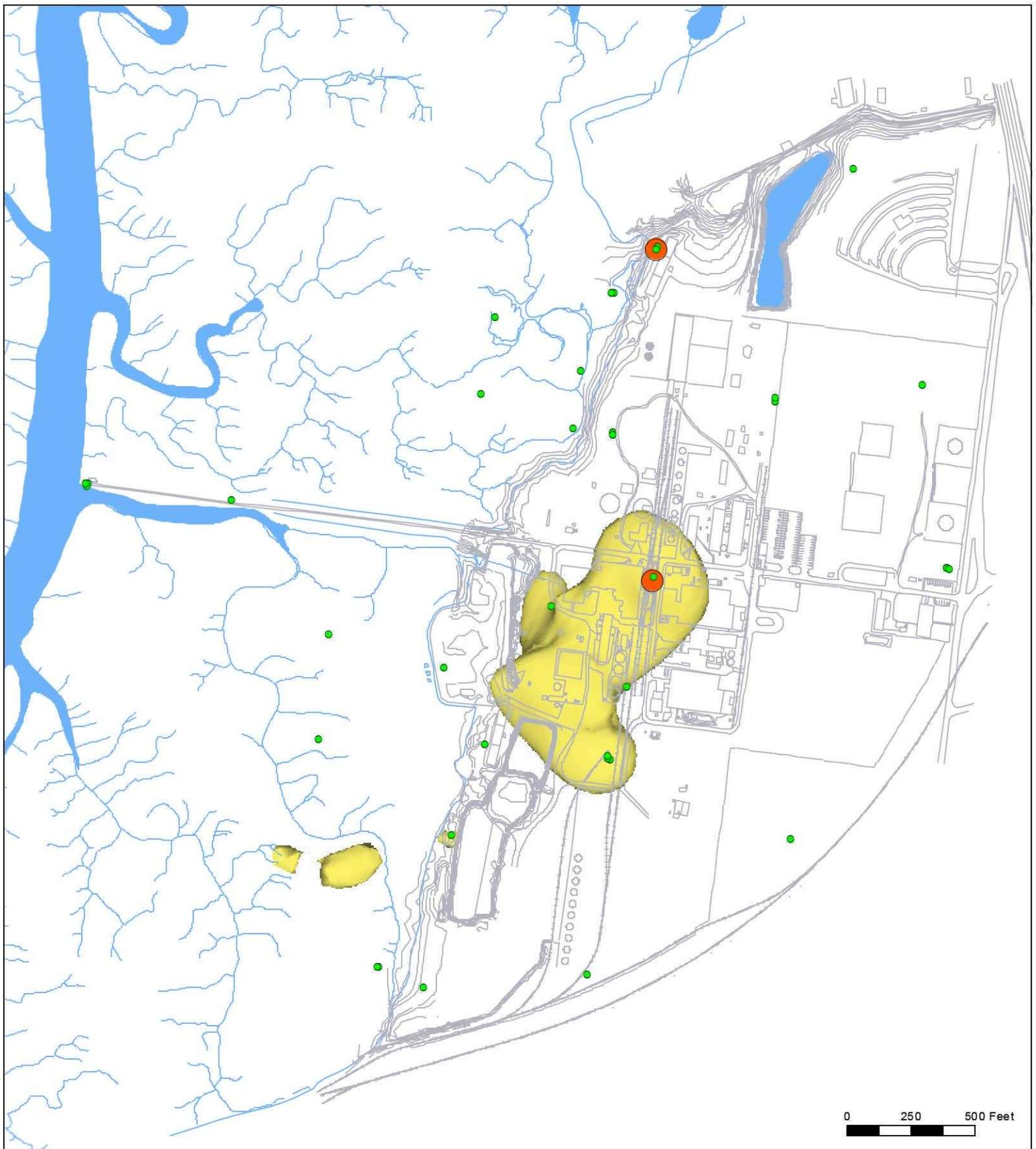
- ND
- < 0.011 ppb
- > 0.011 ppb [$>$ RSL]

CBP May 2010 Extent

RGB

- Red: Band_1
- Green: Band_2
- Blue: Band_3

Figure 3b
alpha-BHC



Dieldrin
RESULTPPB

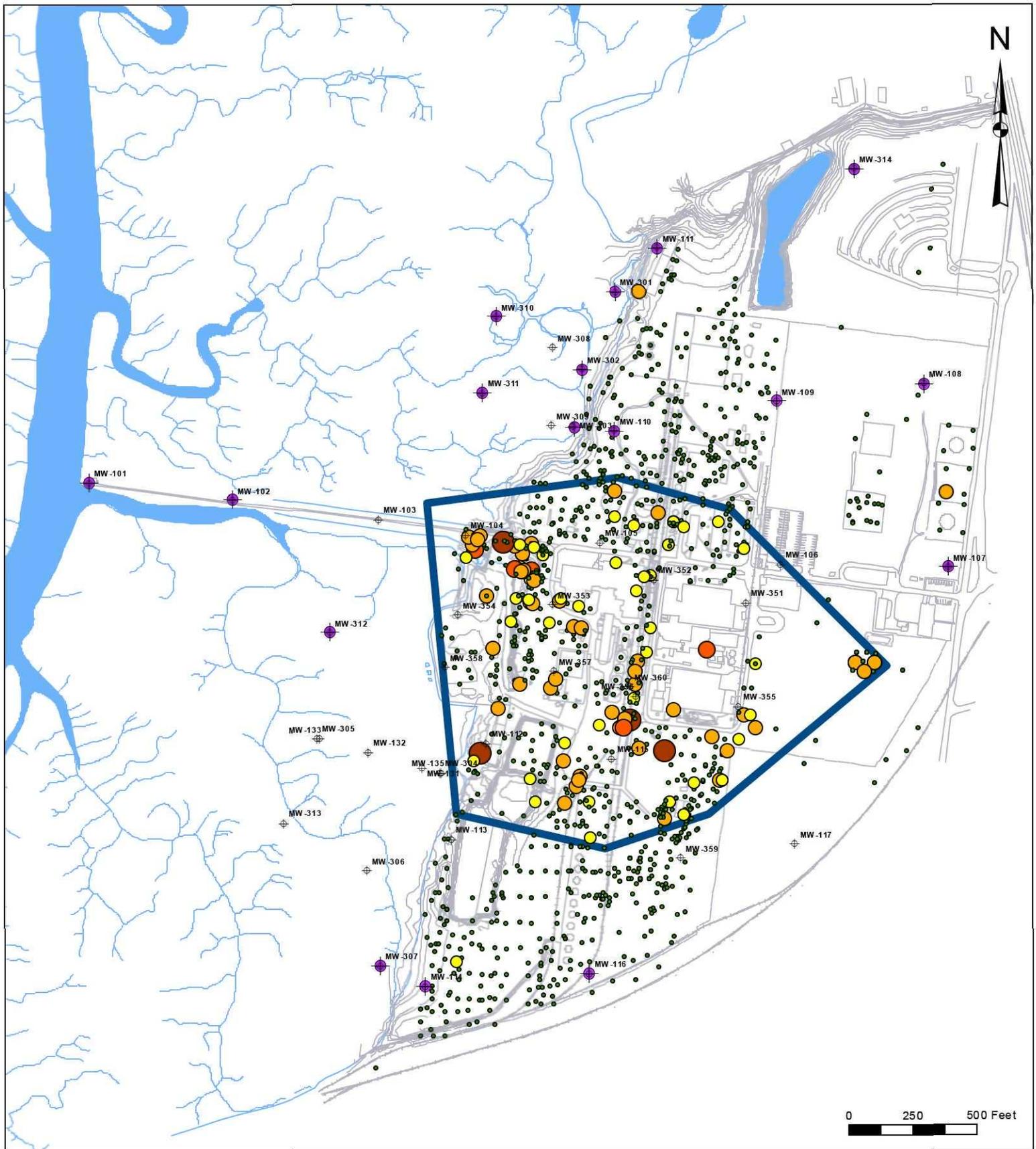
- ND
- < 0.004 ppb
- > 0.004 ppb [> RSL]

CBP May 2010 Extent

RGB

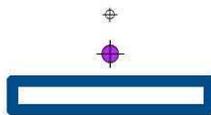
- Red: Band_1
- Green: Band_2
- Blue: Band_3

Figure 3c
Dieldrin



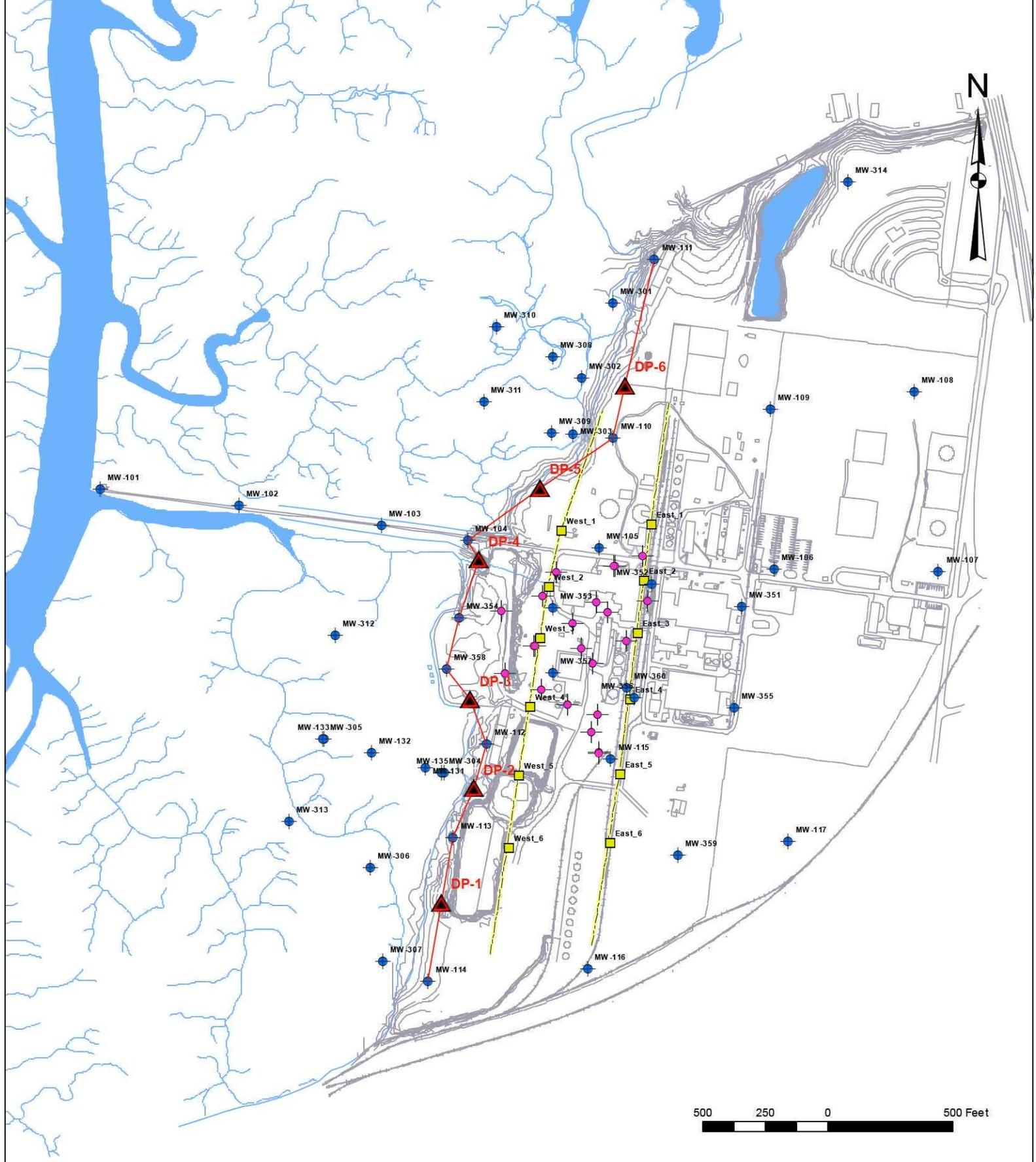
A1268 Distribution in Soil

- < 5 ppm
- 5 - 10 ppm [>ESSL]
- 10 - 50 ppm
- 50 - 100 ppm
- > 100 ppm



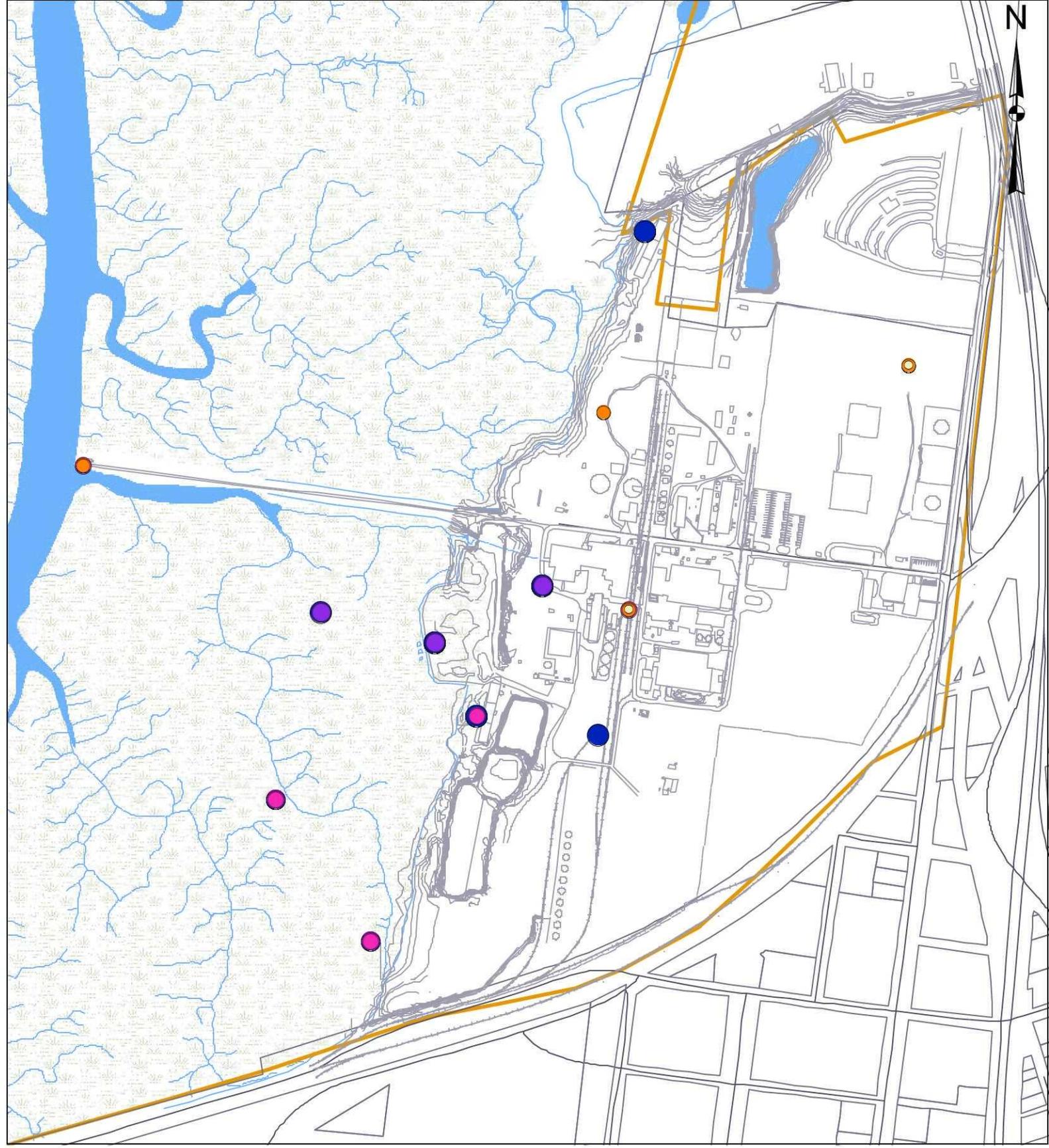
- ⊕ Monitoring Well Cluster Location
- Well Sampled for PCBs in 2009 (leaching)
- ▭ PCB ESSL Exceedence

Figure 4
Aroclor 1268 Distribution in Soil



- ◆ Monitoring Well Cluster Location
- Horizontal Well Screen Location
- Horizontal Well Alignment
- ◆ CBP Performance Monitoring Wells
- DPT Transect
- ▲ Proposed Shoreline DP Wellpoint

Figure No. 5
Proposed Sampling Locations



RESULTPPM

- ND
- < 0.001
- 0.001 - 0.01
- 0.01 - 0.1
- 0.1 - 1
- > 1

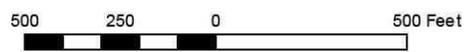


Figure No. 6
Total Chromium (past sampling) in Wells
Selected for Hexavalent Chromium Testing

Tables

Table 1
Detections of SVOCs in Groundwater, 1995-Present

Well ID	Date Sampled	Parameter	Result (ppb)	MCL (ppb)	RSL-oral (ppb)	Exceeds Criteria?
MW-301B	3/23/1996	1,2,3-Trichlorobenzene	265.0		29	Y
MW-301B	3/23/1996	1,2,3-Trichlorobenzene	192.0		29	Y
MW-301B	3/23/1996	1,2,3-Trichlorobenzene	146.0		29	Y
MW-359B	5/13/1996	1,2,3-Trichlorobenzene	43.7		29	Y
MW-104B	1/27/2000	1,2,3-Trichlorobenzene	38.0		29	Y
MW-359B	5/13/1996	1,2,3-Trichlorobenzene	35.4		29	Y
MW-359B	5/13/1996	1,2,3-Trichlorobenzene	32.8		29	Y
MW-104B	12/5/1995	1,2,3-Trichlorobenzene	18.0		29	
MW-104C	12/5/1995	1,2,3-Trichlorobenzene	17.8		29	
MW-104C	1/31/2000	1,2,3-Trichlorobenzene	9.2		29	
MW-354A	4/15/1996	1,2,3-Trichlorobenzene	5.2		29	
MW-104B	1/27/2000	1,2,4-Trichlorobenzene	360.0	70	70	Y
MW-104C	1/31/2000	1,2,4-Trichlorobenzene	280.0	70	70	Y
MW-359B	5/13/1996	1,2,4-Trichlorobenzene	152.0	70	70	Y
MW-359B	5/13/1996	1,2,4-Trichlorobenzene	119.0	70	70	Y
MW-359B	5/13/1996	1,2,4-Trichlorobenzene	109.0	70	70	Y
MW-104B	12/5/1995	1,2,4-Trichlorobenzene	108.0	70	70	Y
MW-104C	12/5/1995	1,2,4-Trichlorobenzene	76.0	70	70	Y
MW-356A	1/28/2000	1,2,4-Trichlorobenzene	5.2	70	70	
MW-357A	4/18/1996	1,2,4-Trichlorobenzene	2.3	70	70	
MW-357A	4/18/1996	1,2,4-Trichlorobenzene	2.2	70	70	
MW-357A	7/16/1996	1,2-Dichlorobenzene	200.0	600	600	
MW-357A	4/18/1996	1,2-Dichlorobenzene	183.0	600	600	
MW-357A	4/18/1996	1,2-Dichlorobenzene	148.0	600	600	
MW-357A	4/18/1996	1,2-Dichlorobenzene	146.0	600	600	
MW-353A	4/24/1996	1,2-Dichlorobenzene	101.0	600	600	
MW-358B	2/2/2000	1,2-Dichlorobenzene	98.0	600	600	
MW-353A	4/24/1996	1,2-Dichlorobenzene	65.0	600	600	
MW-354A	7/15/1996	1,2-Dichlorobenzene	64.0	600	600	
MW-354A	4/15/1996	1,2-Dichlorobenzene	49.6	600	600	
MW-358B	7/10/1996	1,2-Dichlorobenzene	43.0	600	600	
MW-358B	4/16/1996	1,2-Dichlorobenzene	26.8	600	600	
MW-357B	4/19/1996	1,2-Dichlorobenzene	18.0	600	600	
MW-357B	4/19/1996	1,2-Dichlorobenzene	17.6	600	600	
MW-358B	4/16/1996	1,2-Dichlorobenzene	15.2	600	600	
MW-112B	12/4/1995	1,2-Dichlorobenzene	14.4	600	600	
MW-112B	7/16/1996	1,2-Dichlorobenzene	11.0	600	600	
MW-112B	12/4/1995	1,2-Dichlorobenzene	10.5	600	600	
MW-131	2/1/2000	1,2-Dichlorobenzene	6.7	600	600	
MW-135	7/9/1996	1,2-Dichlorobenzene	6.4	600	600	
MW-359B	7/10/1996	1,2-Dichlorobenzene	5.4	600	600	
MW-359B	5/13/1996	1,2-Dichlorobenzene	4.0	600	600	
MW-359B	5/13/1996	1,2-Dichlorobenzene	3.4	600	600	
MW-359B	5/13/1996	1,2-Dichlorobenzene	3.1	600	600	
MW-312A	5/9/2009	1,2-Dichlorobenzene	0.5	600	600	

Shading indicates where parameter detection exceeds criteria:
 -Gray shaded parameters also are reported as VOCs
 -Yellow shaded parameters are reported only as SVOCs

Table 1
Detections of SVOCs in Groundwater, 1995-Present

Well ID	Date Sampled	Parameter	Result (ppb)	MCL (ppb)	RSL-oral (ppb)	Exceeds Criteria?
MW-104C	1/31/2000	1,3-Dichlorobenzene	120.0	600	600	
MW-104B	1/27/2000	1,3-Dichlorobenzene	110.0	600	600	
MW-104C	7/23/1996	1,3-Dichlorobenzene	87.0	600	600	
MW-105A	7/16/1996	1,3-Dichlorobenzene	42.0	600	600	
MW-359B	5/13/1996	1,3-Dichlorobenzene	8.0	600	600	
MW-359B	5/13/1996	1,3-Dichlorobenzene	6.3	600	600	
MW-359B	7/10/1996	1,3-Dichlorobenzene	6.1	600	600	
MW-359B	5/13/1996	1,3-Dichlorobenzene	5.9	600	600	
MW-105A	7/16/1996	1,4-Dichlorobenzene	120.0	75	75	Y
MW-104C	1/31/2000	1,4-Dichlorobenzene	54.0	75	75	
MW-104B	1/27/2000	1,4-Dichlorobenzene	33.0	75	75	
MW-104C	7/23/1996	1,4-Dichlorobenzene	26.0	75	75	
MW-357A	4/18/1996	1,4-Dichlorobenzene	20.4	75	75	
MW-357A	4/18/1996	1,4-Dichlorobenzene	16.4	75	75	
MW-357A	4/18/1996	1,4-Dichlorobenzene	16.2	75	75	
MW-358B	2/2/2000	1,4-Dichlorobenzene	16.0	75	75	
MW-353A	4/24/1996	1,4-Dichlorobenzene	11.9	75	75	
MW-353A	4/24/1996	1,4-Dichlorobenzene	10.0	75	75	
MW-359B	7/10/1996	1,4-Dichlorobenzene	9.9	75	75	
MW-359B	5/13/1996	1,4-Dichlorobenzene	8.6	75	75	
MW-359B	5/13/1996	1,4-Dichlorobenzene	6.6	75	75	
MW-359B	5/13/1996	1,4-Dichlorobenzene	6.1	75	75	
MW-358B	7/10/1996	1,4-Dichlorobenzene	5.0	75	75	
MW-312A	5/9/2009	1,4-Dichlorobenzene	3.4	75	75	
MW-358B	4/16/1996	1,4-Dichlorobenzene	3.3	75	75	
MW-358B	4/16/1996	1,4-Dichlorobenzene	2.7	75	75	
MW-358B	4/16/1996	1,4-Dichlorobenzene	2.6	75	75	
MW-357B	4/19/1996	1,4-Dichlorobenzene	1.8	75	75	
MW-357B	4/19/1996	1,4-Dichlorobenzene	1.8	75	75	
MW-358A	4/16/1996	1,4-Dichlorobenzene	1.0	75	75	
MW-111A	5/8/2009	1,4-Dichlorobenzene	0.1	75	75	
MW-307B	4/4/1996	2,4,5-Trichlorophenol	1.0		3700	
MW-352A	4/23/1996	2,4,6-Trichlorophenol	26.0		6.1	Y
MW-111A	6/21/1996	2,4,6-Trichlorophenol	15.0		6.1	Y
MW-111B	11/30/1995	2,4,6-Trichlorophenol	8.0		6.1	Y
MW-111B	11/30/1995	2,4-Dichlorophenol	10.0		110	
MW-358D	7/10/1996	2,4-Dichlorophenol	0.3		110	
MW-115D	6/26/1996	2,4-Dichlorophenol	0.1		110	
MW-353A	4/24/1996	2,4-Dimethylphenol	2.0		730	
MW-115D	6/26/1996	2,4-Dimethylphenol	0.1		730	
MW-111B	11/30/1995	2-Chlorophenol	14.0		180	
MW-352A	4/23/1996	2-Chlorophenol	3.0		180	
MW-309	7/19/1996	2-Methylphenol	0.9		1800	
MW-115D	6/26/1996	2-Methylphenol	0.2		1800	
MW-111A	6/21/1996	3/4-Methylphenol	37.0		180	
MW-309	7/19/1996	3/4-Methylphenol	0.6		180	
MW-115D	6/26/1996	3/4-Methylphenol	0.1		180	
MW-352A	4/23/1996	4-Methylphenol	91.0		180	
MW-111B	11/30/1995	4-Methylphenol	66.0		180	
MW-110B	11/30/1995	4-Methylphenol	27.0		180	
MW-117D	3/15/1996	bis(2-Ethylhexyl) phthalate	7.0	6	6	Y
MW-101D	3/19/1996	bis(2-Ethylhexyl) phthalate	4.0	6	6	

Shading indicates where parameter detection exceeds criteria:
 -Gray shaded parameters also are reported as VOCs
 -Yellow shaded parameters are reported only as SVOCs

Table 1
Detections of SVOCs in Groundwater, 1995-Present

Well ID	Date Sampled	Parameter	Result (ppb)	MCL (ppb)	RSL-oral (ppb)	Exceeds Criteria?
MW-352D	6/26/1996	bis(2-Ethylhexyl) phthalate	4.0	6	6	
MW-110A	7/19/1996	bis(2-Ethylhexyl) phthalate	1.0	6	6	
MW-307B	4/4/1996	bis(2-Ethylhexyl) phthalate	1.0	6	6	
MW-309	7/19/1996	bis(2-Ethylhexyl) phthalate	1.0	6	6	
MW-352A	4/23/1996	bis(2-Ethylhexyl) phthalate	1.0	6	6	
MW-109B	6/20/1996	bis(2-Ethylhexyl) phthalate	0.9	6	6	
MW-111A	6/21/1996	bis(2-Ethylhexyl) phthalate	0.5	6	6	
MW-307B	4/4/1996	Butylbenzylphthalate	20.0	NV	NV	
MW-352A	4/23/1996	Carbazole	2.0	NV	NV	
MW-352A	4/23/1996	Dibenzofuran	6.0			37
MW-110A	5/8/2009	Dibenzofuran	0.6			37
MW-114A	5/9/2009	Dibenzofuran	0.2			37
MW-314A	5/10/2009	Dibenzofuran	0.2			37
MW-303	5/8/2009	Dibenzofuran	0.1			37
MW-307A	5/9/2009	Dibenzofuran	0.1			37
MW-116A	5/10/2009	Dibenzofuran	0.0			37
MW-117D	3/15/1996	Di-n-octylphthalate	8.0	NV	NV	
MW-352A	4/23/1996	Pentachlorophenol	1.0	1		1
MW-358D	7/10/1996	Pentachlorophenol	0.2	1		1
MW-352A	4/23/1996	Phenol	100.0			11000
MW-111A	6/21/1996	Phenol	79.0			11000
MW-301B	6/21/1996	Phenol	44.0			11000

Shading indicates where parameter detection exceeds criteria:
 -Gray shaded parameters also are reported as VOCs
 -Yellow shaded parameters are reported only as SVOCs

Table 2
Detections of Pesticides in Groundwater, 1995-Present

Well ID	Date Sampled	Parameter	Result (ppb)	MCL (ppb)	RSL-oral (ppb)	Exceeds Criteria?
MW-302	5/10/2009	4,4'-DDD	0.017		0.280	
MW-302	5/10/2009	4,4'-DDD	0.009		0.280	
MW-312A	5/9/2009	4,4'-DDE	0.001		0.200	
MW-109A	5/8/2009	4,4'-DDE	0.001		0.200	
MW-302	5/10/2009	4,4'-DDT	0.013		0.200	
MW-307A	5/9/2009	4,4'-DDT	0.007		0.200	
MW-312A	5/9/2009	4,4'-DDT	0.002		0.200	
MW-301A	5/8/2009	4,4'-DDT	0.001		0.200	
MW-311A	5/9/2009	4,4'-DDT	0.001		0.200	
MW-101A	5/9/2009	4,4'-DDT	0.001		0.200	
MW-110A	5/8/2009	Aldrin	0.071		0.004	Y
MW-311A	5/9/2009	Aldrin	0.001		0.004	
MW-352A	4/23/1996	alpha-BHC	0.088		0.011	Y
MW-353A	4/24/1996	alpha-BHC	0.027		0.011	Y
MW-102A	5/9/2009	alpha-BHC	0.003		0.011	
MW-115A	6/26/1996	alpha-BHC	0.003		0.011	
MW-101C	6/25/1996	alpha-BHC	0.002		0.011	
MW-115D	6/26/1996	beta-BHC	0.006		0.037	
MW-114A	5/9/2009	beta-BHC	0.005		0.037	
MW-310A	5/9/2009	beta-BHC	0.002		0.037	
MW-352A	4/23/1996	Dieldrin	0.077		0.004	Y
MW-111A	5/8/2009	Dieldrin	0.018		0.004	Y
MW-111A	6/21/1996	Endosulfan I	0.180		220.000	
MW-302	5/10/2009	Endosulfan II	0.021		220.000	
MW-111A	5/8/2009	Endosulfan II	0.020		220.000	
MW-114A	5/9/2009	Endosulfan II	0.007		220.000	
MW-108A	5/8/2009	Endosulfan II	0.001		220.000	
MW-302	5/10/2009	Endosulfan sulfate	0.007		220.000	
MW-111A	6/21/1996	Endrin	0.065	2.0	2.000	
MW-307A	5/9/2009	Endrin ketone	0.018	2.0	2.000	
MW-114A	5/9/2009	Endrin ketone	0.011	2.0	2.000	
MW-101A	5/9/2009	Endrin ketone	0.002	2.0	2.000	
MW-110A	5/8/2009	gamma-BHC (Lindane)	0.057	0.2	0.200	
MW-114A	5/9/2009	gamma-BHC (Lindane)	0.002	0.2	0.200	
MW-311A	5/9/2009	gamma-BHC (Lindane)	0.001	0.2	0.200	
MW-110A	5/8/2009	gamma-Chlordane	0.004	2.0	2.000	
MW-302	5/10/2009	Heptachlor	0.031	0.4	0.400	
MW-110A	5/8/2009	Heptachlor	0.010	0.4	0.400	
MW-303	5/8/2009	Heptachlor	0.004	0.4	0.400	
MW-307A	5/9/2009	Heptachlor	0.002	0.4	0.400	
MW-303	5/8/2009	Heptachlor epoxide	0.006	0.2	0.200	
MW-109B	6/20/1996	Heptachlor epoxide	0.003	0.2	0.200	
MW-101A	5/9/2009	Heptachlor epoxide	0.001	0.2	0.200	

Table 3
Detections of PCBs in Groundwater, 1995-Present

Well ID	Date Sampled	Result (ppb)	Parameter	Lab	Comment
MW-106A	11/28/95	3.00	Aroclor-1268	TEG	Non detect July 1996 event
MW-106B	11/28/95	2.90	Aroclor-1268	TEG	Non detect July 1996 event
MW-106C	11/28/95	3.00	Aroclor-1268	TEG	Non detect July 1996 event
MW-107B	11/28/95	2.90	Aroclor-1268	TEG	Non detect July 1996 event
MW-101C	11/29/95	3.80	Aroclor-1268	TEG	Non detect July 1996 event
MW-356A	04/22/96	4.70	Aroclor-1268	TEG	Well sampled again in Jun with QAL
MW-356A	06/26/96	1.60	Aroclor-1268	QAL	Well not subsequently sampled
MW-356B	06/26/96	0.62	Aroclor-1268	QAL	Non detect April 1996 event
MW-302	06/28/96	40.00	Aroclor-1016	QAL	Non detect Mar 1996, Feb 2002 and May 2009 events
MW-359B	07/10/96	0.52	Aroclor-1260	QAL	Non detect Feb 1996 and May 2009 events

Prepared for:

LCP SITE STEERING COMMITTEE

**WORK PLAN FOR SITE-WIDE
ASSESSMENT FOR PETROLEUM
PRODUCT
(OPERABLE UNIT 2)**

**LCP CHEMICALS SITE
BRUNSWICK, GEORGIA**

Prepared by:



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April 2012

**WORKPLAN FOR SITE-WIDE ASSESSMENT OF
PETROLEUM PRODUCT
(OPERABLE UNIT 2)**

**LCP CHEMICALS SITE OPERABLE UNIT TWO
BRUNSWICK, GEORGIA**

Prepared for:

LCP SITE STEERING COMMITTEE



Prepared by:

1050 Crown Pointe Parkway, Suite 550
Atlanta, GA 30338

A handwritten signature in blue ink that reads "Kirk Kessler".

Kirk Kessler, Principal

April 2012

**WORKPLAN FOR SITE-WIDE ASSESSMENT OF PETROLEUM PRODUCT
(OPERABLE UNIT 2)
LCP CHEMICALS SITE
BRUNSWICK, GEORGIA**

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1 INTRODUCTION

1.1 Terms of Reference

Honeywell International (formerly AlliedSignal, Inc.), the Atlantic Richfield Company (Arco), and the Georgia Power Company are Responsible Parties (RPs) under an Administrative Order on Consent (AOC), to conduct Remedial Investigation and Feasibility Studies (RI/FS) for the LCP Chemicals Site (LCP Site) in Brunswick, Georgia. The LCP Site is being managed as three Operable Units (OUs). OU2 addresses groundwater beneath the LCP Site.

This document presents a plan to conduct a site-wide assessment for the presence of light non-aqueous phase liquid (LNAPL) petroleum product potentially present on the LCP Site. The assessment will be initially targeted in areas that based on past soil borings are believed to have the greatest potential for LNAPL, and if found to be present, further delineation will be performed during the same mobilization event. The assessment will utilize direct-push (DP) methods allowing collection of a continuous soil core, and placement of temporary well points as needed where LNAPL is judged to potentially be present. Results of this assessment will be integrated with a separate phase of work being performed along the uplands/marsh shoreline.

1.2 Background

Numerous soil borings have been drilled during past assessments on the LCP Site, and detailed boring logs are available for review to identify the LNAPL potential across the site. The borings vary in depth but generally extended to the depth of the groundwater table, thus they are useful in identifying the LNAPL potential. An operational diagram of the former Arco refinery is also available to aid in this review. Furthermore, the past episodes of soil sampling and groundwater monitoring across the site offer another line of evidence used in this review of LNAPL potential.

1.3 Study Objectives

The objective of this assessment is to delineate the extent, if any, of LNAPL on the LCP Site.

2 BASIS FOR PROPOSED LNAPL ASSESSMENT SCOPE

2.1 Process of Evaluation Applied to Boring Logs Review

A library of soil boring and monitoring well installation logs from past removal and remedial action assessment events was reviewed for descriptors of LNAPL presence – comments such as “staining”, “odor”, “oil” were logged into a spreadsheet file for use in mapping (in GIS). Three qualitative categories were established for this review:

- “no” where there was no indication of LNAPL;
- “maybe” where notations on the boring logs describe discoloration or possible petroleum hydrocarbon presence; and
- “yes” where notation on the boring logs describe definitive evidence of petroleum hydrocarbon staining such as staining or presence of free oil.

Table 1 provides this review compilation. Figure 1 provides the spatial distribution of the boring logs that were reviewed along with the LNAPL review designation.

2.2 Review of Past Groundwater Monitoring Data

Multiple episodes of past groundwater monitoring are available in the database for wells across the Site that have been tested for chemicals associated with petroleum hydrocarbons. Typical and appropriate indicators of petroleum hydrocarbons include:

- BTEX (benzene, toluene, ethylbenzene, xylenes); and
- Naphthalene.

These constituents have been mapped in GIS in a manner that identifies the highest concentration detected for a given constituent across the time series of past monitoring. Figures 2a through 2e provide the results of this mapping protocol.

The distribution of BTEX (Figures 2a through 2d) show two areas of note: (1) the more significant concentrations are present in a region near the uplands/marsh shoreline in the western portion of “Quadrant 3”, and (2) an area of generally lesser concentrations is present from B Street south to MW-113 and from the cell building area west to the shoreline. The naphthalene distribution in groundwater is similar to BTEX with generally higher concentrations exhibited and a somewhat broader areal distribution across “Quadrant 3”.

2.3 Review of Subsurface Soils (smear zone) Data

Soil samples previously characterized for BTEX and naphthalene that span the zone of water-table fluctuation (i.e., the LNAPL “smear zone”) were used as another line of evidence in the work scope development for the LNAPL assessment. Data were selected from the database from

a depth interval of 5-10 feet (queried by “ $D1 \geq 5$ and $D1 \leq 10$ ”), regardless of whether the area had been remediated or not (i.e., “Removed” flag of both 0 and 1 were used) in order the best understand the original conditions of the smear zone soils. Figures 3a through 3e present the distribution of BTEX and naphthalene in the soils of the smear zone depth interval.

Three distinct areas of interest develop from this exercise. One area of interest is in “Quadrant 3” centered in the northwest portion of that quadrant. Two areas of interest occur in “Quadrant 4”, one in what perhaps was formerly a railcar loading area in the southwestern portion of that quadrant and the other to the east, in the area referred to as the “Old South Tank Farm”. The patterns are quite similar for each of the BTEX constituents and naphthalene.

2.4 Proposed Locations for LNAPL Assessment in 2012

Figure 4 shows the locations proposed for the LNAPL assessment. Six locations are already planned (and approved by EPA/EPD) along the uplands/marsh transect used in the groundwater flux modeling (DP-1 through DP-6 on Figure 4). Several of these locations are ideally situated in areas of interest developed during the reviews described above. Five additional locations are proposed as shown in Figure 4 in more upland-based locations where the LNAPL potential is suspected to be greatest, based primarily on the boring logs review.

Additional LNAPL assessment borings will be performed as needed to delineate LNAPL if found, whether identified from the shoreline flux program or this site-wide assessment program.

3 FIELD METHODS

3.1 Direct Push Procedure

DP technology will be used for the LNAPL assessment. The DP procedure will utilize dual-tube (DT) technology. DT technology uses both an outer and inner rod. The outer rod is equipped with a cutting shoe that cuts a soil core which is collected inside of the outer casing sliding into the acetate liner held in place by the inside rod string. When at depth, the inside rod string and the soils retained in the acetate liner is removed from inside of the outer rods. The outer rods remain in the ground thereby providing a cased hole. A clean liner is then attached to the inner rods, sent back down within the outer rods and another outer rod is added to the drill string. DP borings will be advanced to a depth of 15 feet below ground surface at each location. This depth of penetration will ensure that the borings area advanced the full thickness of the smear zone and slightly beyond. Soil cores will be examined for the indicators of LNAPL – this will include: (1) visual observation for discoloration, staining or free oil, (2) identification of odor, and (3) “shake tests” of subsamples from stained sections of the core to see if NAPL is mobilized (shake testing simply involves placement of a small volume of soil into a water-containing glass jar and vigorously shaking to displace free oil, then visually examining the jar for the presence of NAPL).

Temporary monitoring wells will be installed in the DP borings, where LNAPL is suspected based upon the screening process identified above. The temporary monitoring wells will be installed in general accordance with the procedures outlined in the USEPA Region IV Science and Ecosystem Support Division standard operating procedure for Design and Installation of Monitoring Wells (SESDGUID-101-R0 dated February 2008).

3.2 LNAPL Thickness Measurements

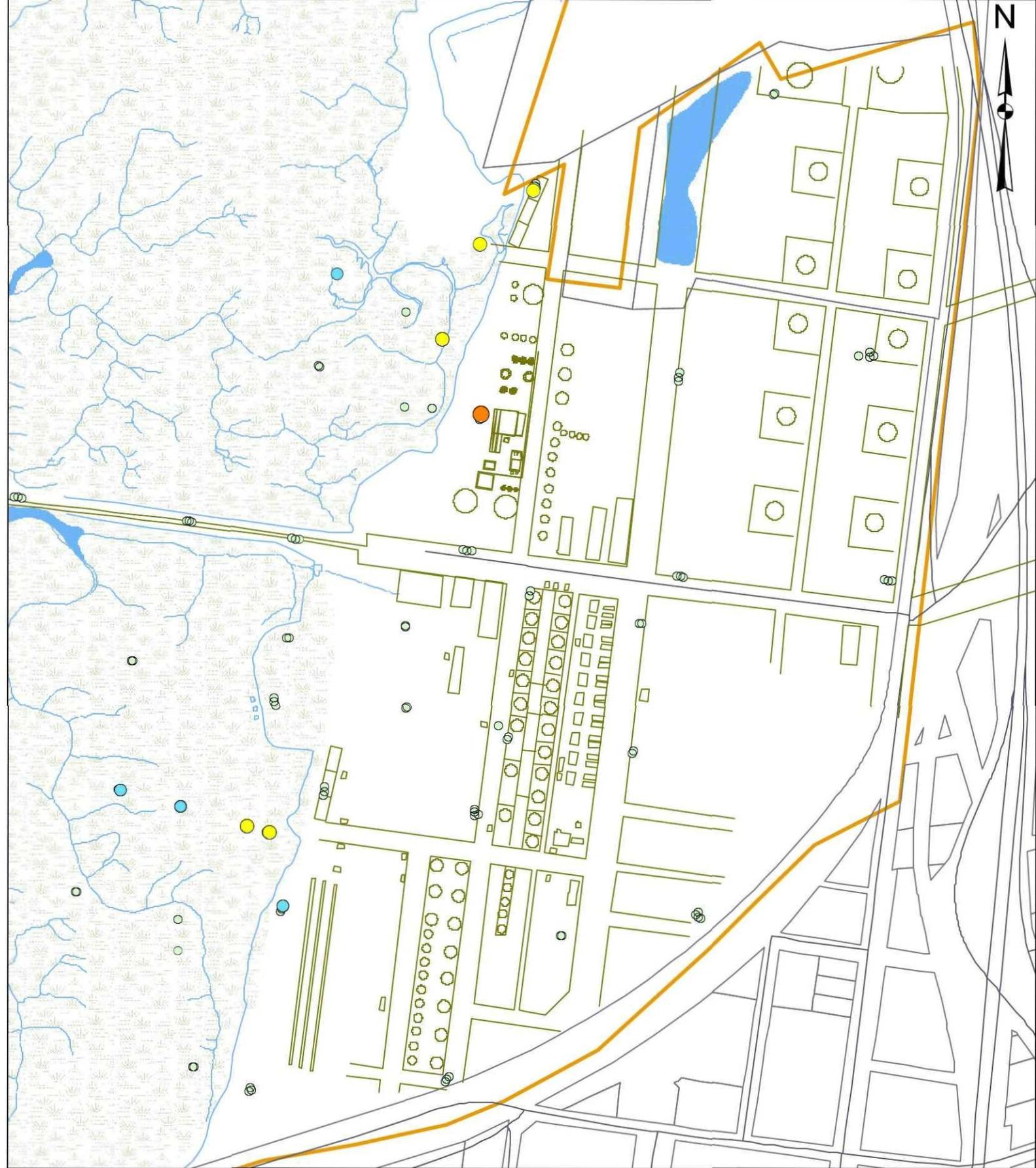
Temporary wells that are installed as part of the flux study and the site-wide assessment, will be tested for the presence of LNAPL during the field mobilization event and on an “opportunistic” basis (i.e., when field personnel are on Site for other purposes) for a period of time beyond. LNAPL thickness measurements will be accomplished with either the use of an interface probe, or with the use of Kolor Kut paste or similar products.

Table 1. Summary of Review of Boring Log Records

Soil Boring ID	Date	LNAPL Review	Depth Interval Noted		Comment	State Plane Coordinates	
			Top (ft)	Bottom (ft)		X	Y
MW-131	10/16/1994	No				860997.60000	431459.60000
B-1	12/9/1994	Yes	0.00000	22.00000		862063.50000	431544.40000
B-2	12/13/1994	Yes	0.00000	5.00000		861914.40000	431243.60000
B-3	12/13/1994	No				861886.30000	430986.90000
B-4	12/14/1994	No				861873.10000	430801.00000
B-5	12/14/1994	No				862122.40000	431261.80000
B-6	12/14/1994	Yes	1.00000	1.70000		861738.50000	430916.70000
B-7	12/15/1994	Yes	0.00000	45.00000		861945.80000	432011.60000
B-8	12/15/1994	Yes	0.00000	45.00000		862244.60000	432185.10000
MW-132	10/16/1995	No				860785.60000	431521.20000
MW-133	10/17/1995	No				860594.80000	431572.80000
MW-135	11/14/1995	No				861071.60000	431438.60000
MGB-2	1/15/1997	No				860738.10000	431950.00000
MGB-3	1/15/1997	No				860725.10000	432056.00000
MGB-4	1/16/1997	No				860977.10000	431854.00000
MGB-5	1/16/1997	No				861008.10000	431620.00000
MGB-6	1/20/1997	No				861113.10000	432136.90000
MGB-7	1/20/1997	No				860939.10000	432156.00000
MGB-8	1/20/1997	No				861105.10000	432286.90000
MGB-9	1/20/1997	Yes	5.00000	6.50000		860905.10000	432299.00000
MGB-10	1/21/1997	No				860527.10000	432000.00000
MGB-11	1/21/1997	No				860791.10000	431602.00000
MGB-12	1/21/1997	No				860874.10000	431494.00000
MGB-13	1/22/1997	No				860731.10000	431782.00000
MGB-14	1/22/1997	No				860730.10000	432210.00000
MW-101	9/15/1995	No				859696.80000	432574.80000
MW-101D	2/27/1996	No				859693.30000	432566.30000
MW-102	10/24/1995	No				860256.10000	432508.40000
MW-103	10/25/1995	No				860824.20000	432431.10000
MW-104	10/26/1995	No				861166.90000	432372.30000
MW-105	10/12/1995	Yes	2.00000	8.00000		861692.00000	432340.60000
MW-106	10/10/1995	Yes	2.50000	15.00000	Fee product	862395.50000	432255.20000
MW-107	9/21/1995	No				863051.40000	432243.40000
MW-108	9/19/1995	Maybe	5.00000	12.00000	Oil or humate	862954.60000	432961.80000
MW-108D	2/9/1996	Maybe	5.00000	10.00000	Oil or humate	862990.60000	432973.90000
MW-109	9/12/1995	No				862380.90000	432894.10000
MW-110	10/26/1995	Yes	0.00000	8.00000		861748.50000	432777.20000
MW-111	9/29/1995	Yes	28.00000	34.00000		861916.10000	433491.50000
MW-112	10/17/1995	Yes	0.00000	37.00000		861244.60000	431555.70000
MW-113	10/19/1995	Yes	0.00000	9.50000		861109.20000	431181.00000
MW-114	10/4/1995	Yes	6.00000	15.50000		861008.10000	430604.50000
MW-115	10/30/1995	Yes	11.00000	13.00000		861739.10000	431495.30000
MW-115D	6/4/1996	Yes	11.00000	13.00000		861728.60000	431511.00000
MW-116	10/6/1995	No				861646.70000	430655.30000
MW-117	11/1/1995	Yes	7.50000	15.50000		862451.20000	431162.70000
MW-117D	2/19/1996	Yes	7.50000	15.50000		862441.50000	431183.30000

Table 1. Summary of Review of Boring Log Records

Soil Boring ID	Date	LNAPL Review	Depth Interval Noted		Comment	State Plane Coordinates	
			Top (ft)	Bottom (ft)		X	Y
MW-301	3/19/1996	No				861750.10000	433321.40000
MW-302	3/14/1996	Yes	8.00000	14.50000	Petroleum odor	861622.10000	433017.30000
MW-303	3/19/1996	No				861589.60000	432792.40000
MW-304	3/21/1996	No				861066.50000	431439.60000
MW-305	3/27/1996	No				860589.10000	431574.00000
MW-306	3/26/1996	No				860779.10000	431058.00000
MW-307	3/26/1996	No				860831.10000	430685.00000
MW-308	3/27/1996	No				861508.10000	433101.90000
MW-309	3/27/1996	No				861503.10000	432798.90000
MW-310	5/2/1996	No				861285.70000	433224.40000
MW-311	5/2/1996	No				861231.90000	432925.30000
MW-312	5/30/1996	No				860637.10000	431987.40000
MW-313	5/28/1996	No				860455.00000	431244.50000
MW-314	6/4/1996	No				862689.10000	433802.60000
MW-351	4/22/1996	No				862263.50000	432104.00000
MW-352	4/17/1996	Maybe	13.00000	14.50000		861903.50000	432194.80000
MW-352D	5/15/1996	Maybe	13.00000	14.50000		861907.30000	432209.90000
MW-353	4/4/1996	Yes	23.00000	23.00000		861507.20000	432096.80000
MW-354	4/3/1996	No				861135.60000	432058.20000
MW-355	4/24/1996	Yes	3.00000	4.00000		862234.30000	431698.80000
MW-356	4/15/1996	Yes	8.00000	8.50000		861833.50000	431741.00000
MW-357	4/8/1996	Yes	5.00000	11.00000		861510.20000	431838.90000
MW-358	4/3/1996	No				861086.20000	431853.00000
MW-358D	5/7/1996	No				861089.60000	431840.00000
MW-359	5/1/1996	No				862007.60000	431107.00000
MW-360D	12/13/1996	No				861804.40000	431777.90000
SB-477	1/15/1997	No				862017.60000	432075.80000
SB-478	1/16/1997	Yes	2.00000	9.00000		862001.90000	432055.50000
SB-479	1/21/1997	Yes	3.00000	10.00000		862056.60000	432048.80000
SB-480	1/15/1997	No				862043.30000	432109.50000
SB-481	1/16/1997	No				862003.10000	432077.90000
SB-482	1/22/1997	Yes	5.00000	12.00000		862042.30000	432032.90000
SB-483	1/22/1997	No				862087.00000	432039.40000

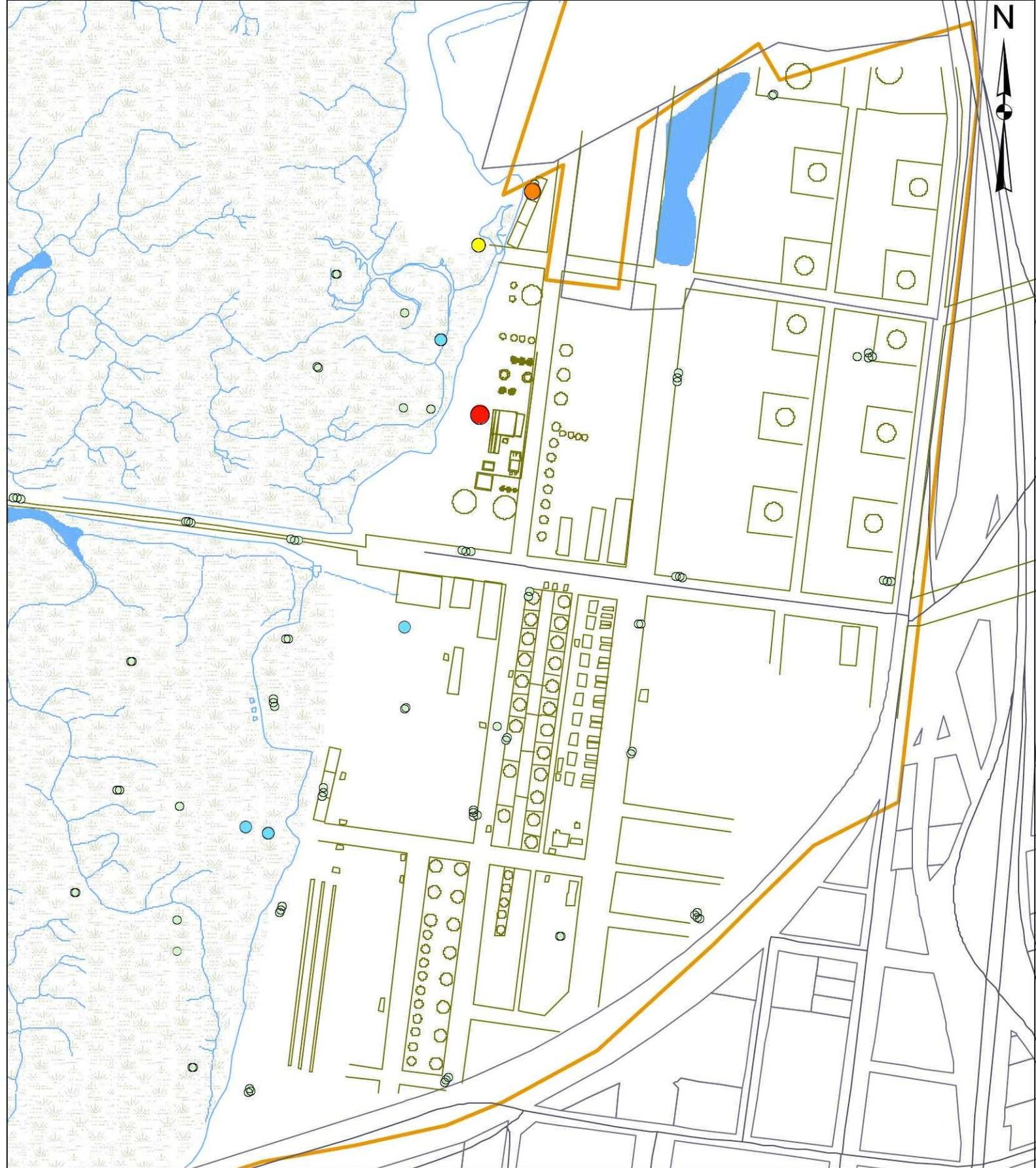


Benzene in Groundwater (max detect over time) — Arco Refinery Layout
 RESULTPPM LCP Site Property Boundary

- <math>< 0.01</math>
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.5
- > 0.5

400 200 0 400 Feet

Figure No. 2a
Benzene Distribution in Groundwater

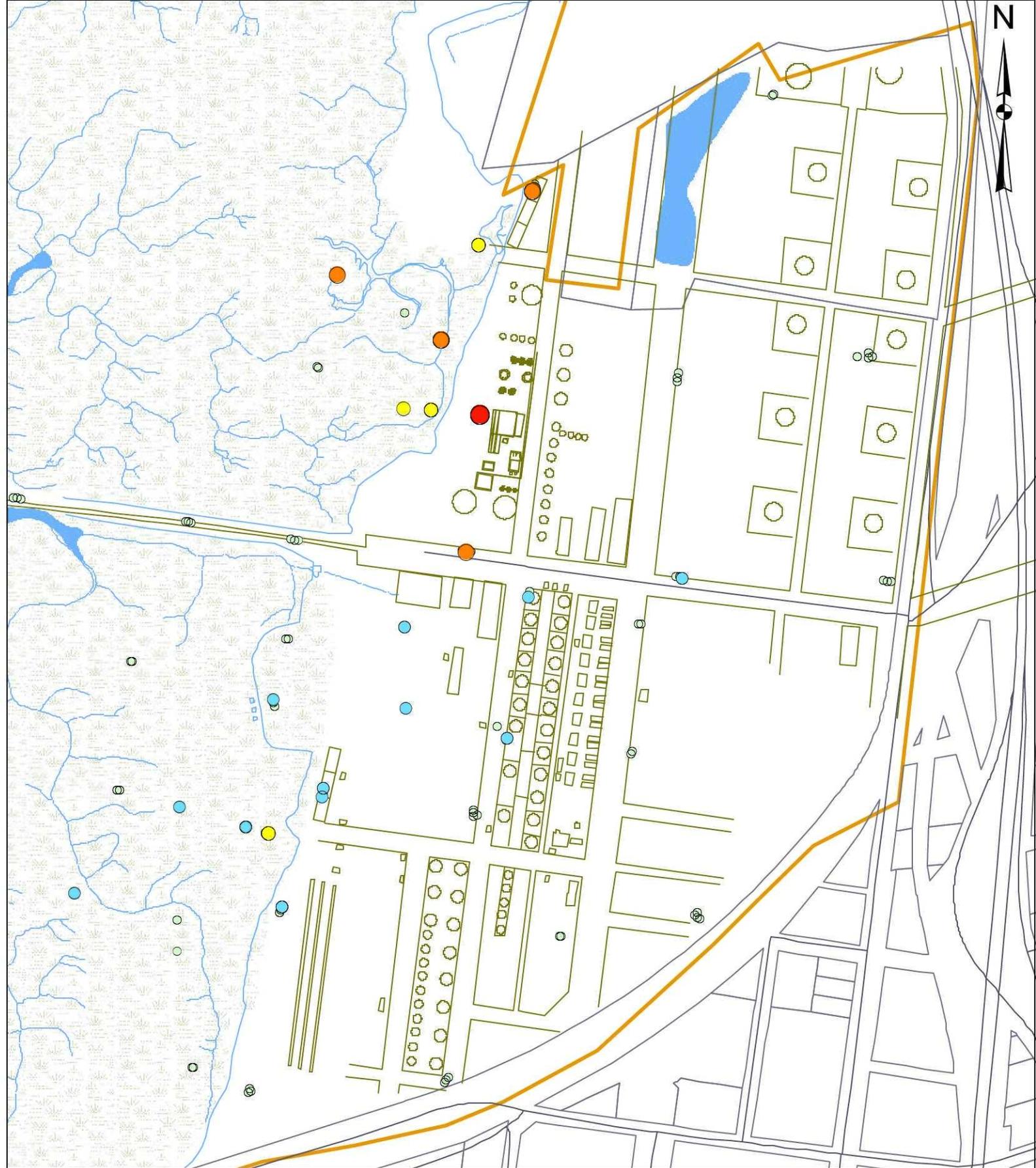


Toluene in Groundwater (max detect over time) — Arco Refinery Layout
RESULTPPM LCP Site Property Boundary

- < 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.5
- > 0.5

400 200 0 400 Feet

Figure No. 2b
Toluene Distribution in Groundwater

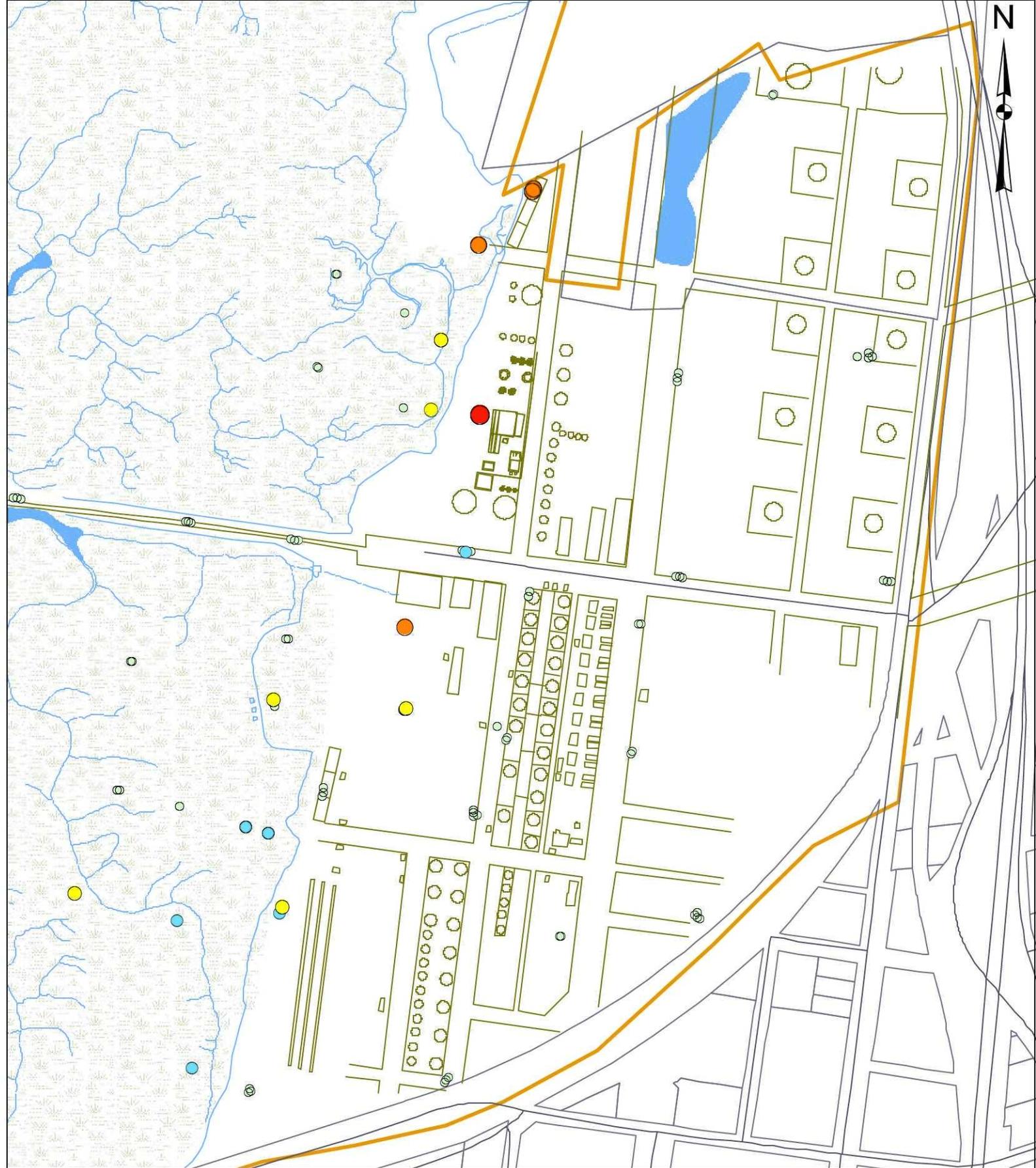


Ethylbenzene in Groundwater (max detect over time) — Arco Refinery Layout
RESULTPPM — LCP Site Property Boundary

- < 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.5
- > 0.5

400 200 0 400 Feet

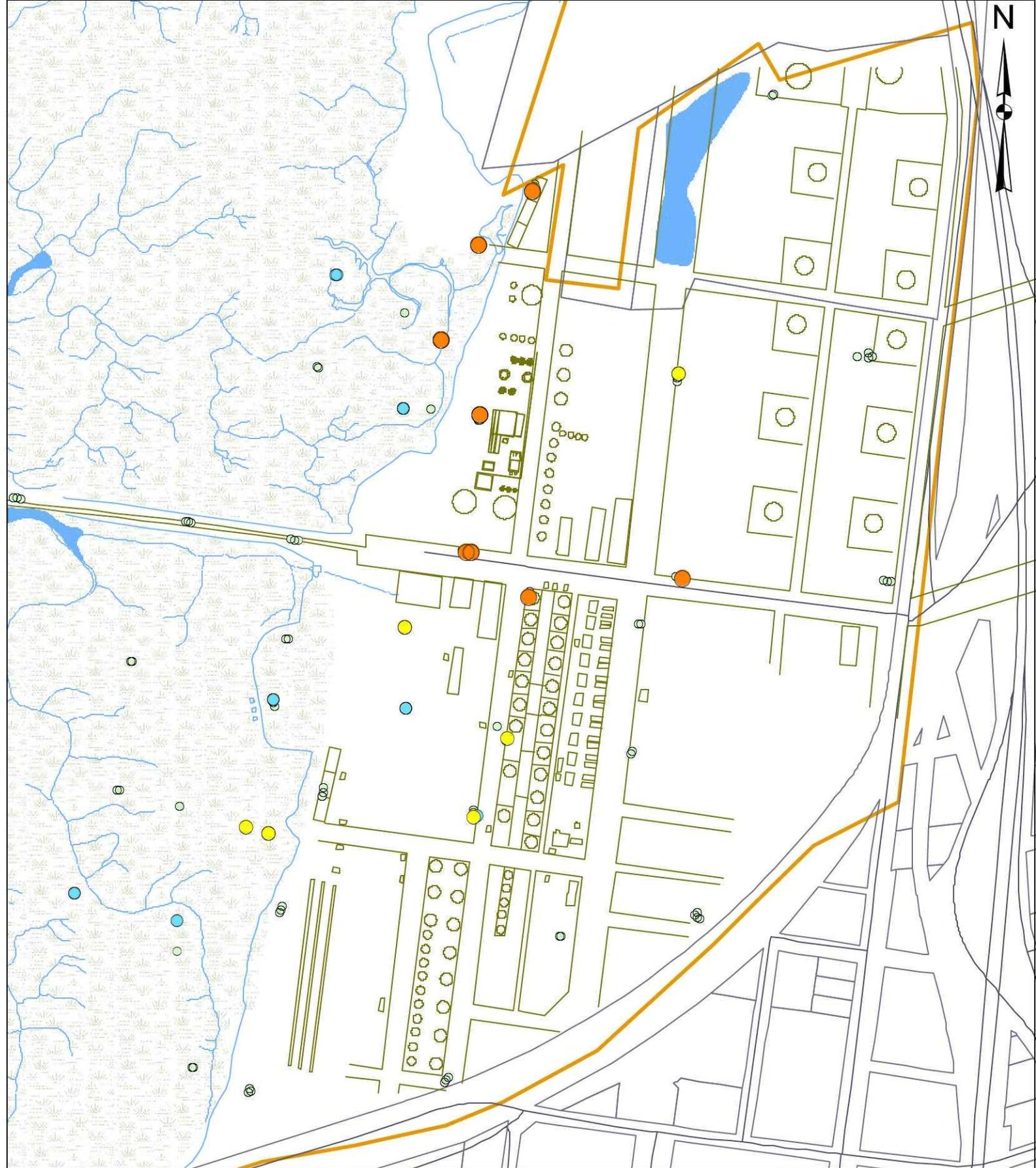
Figure No. 2c
Ethylbenzene Distribution in Groundwater



Xylenes in Groundwater (max detect over time) — Arco Refinery Layout
RESULTPPM — LCP Site Property Boundary

- < 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.5
- > 0.5

Figure No. 2d
Xylenes Distribution in Groundwater



Naphthalene in Groundwater (max detect over time)

RESULTPPM

- < 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.5
- > 0.5

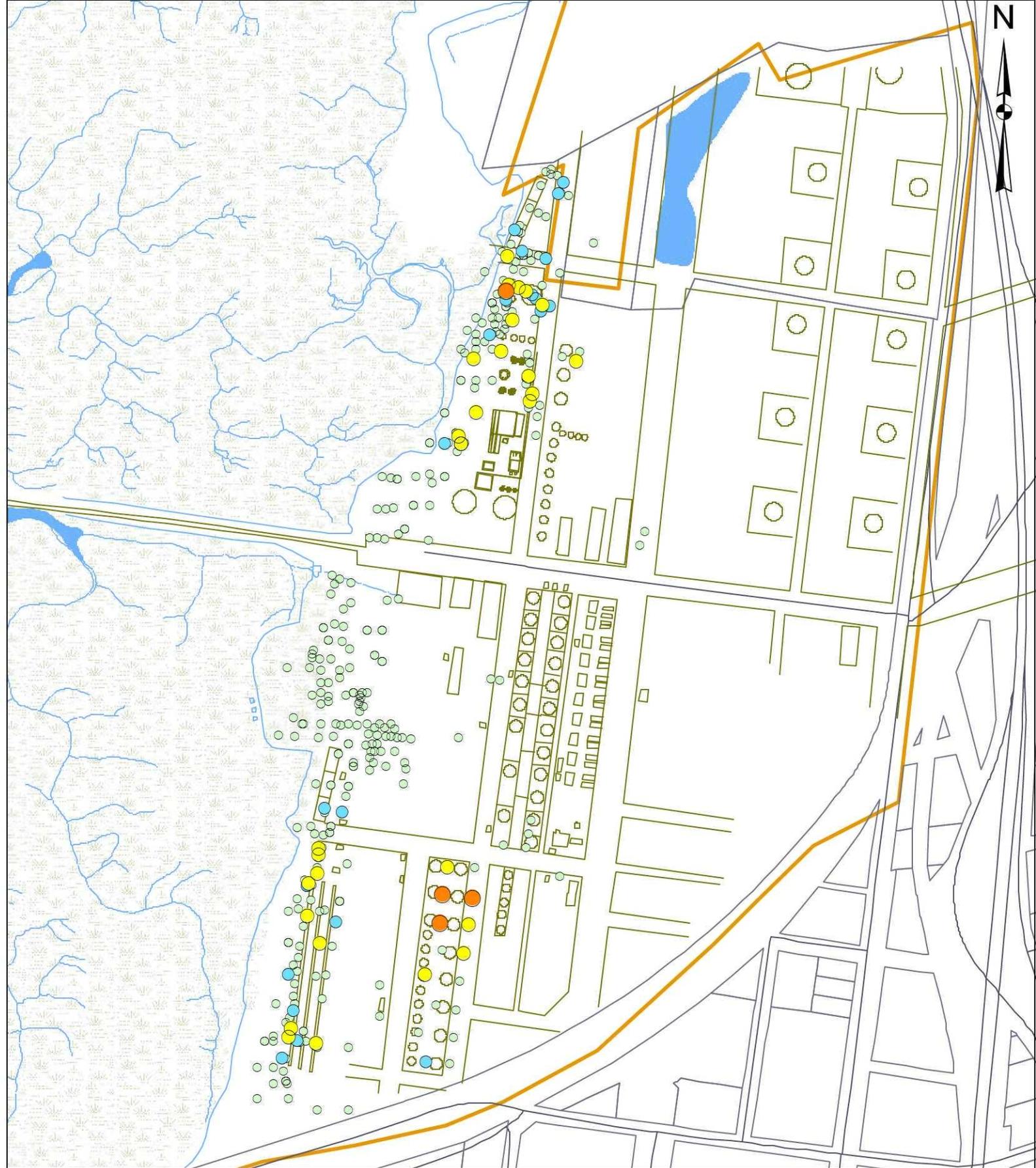
— Arco Refinery Layout

▭ LCP Site Property Boundary

400 200 0 400 Feet



Figure No. 2e
Naphthalene Distribution in Groundwater



Soil Benzene 5-10ft — Arco Refinery Layout
 RESULTPPM — LCP Site Property Boundary

- < 0.1
- 0.1 - 1
- 1 - 10
- 10 - 100
- > 100

Figure No. 3a
Distribution of Benzene in Soils at 5-10ft

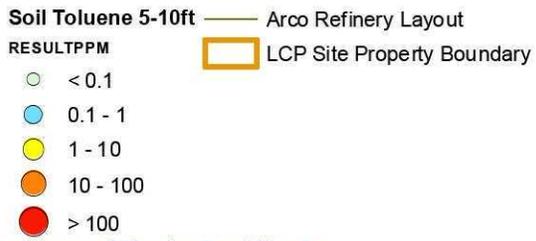
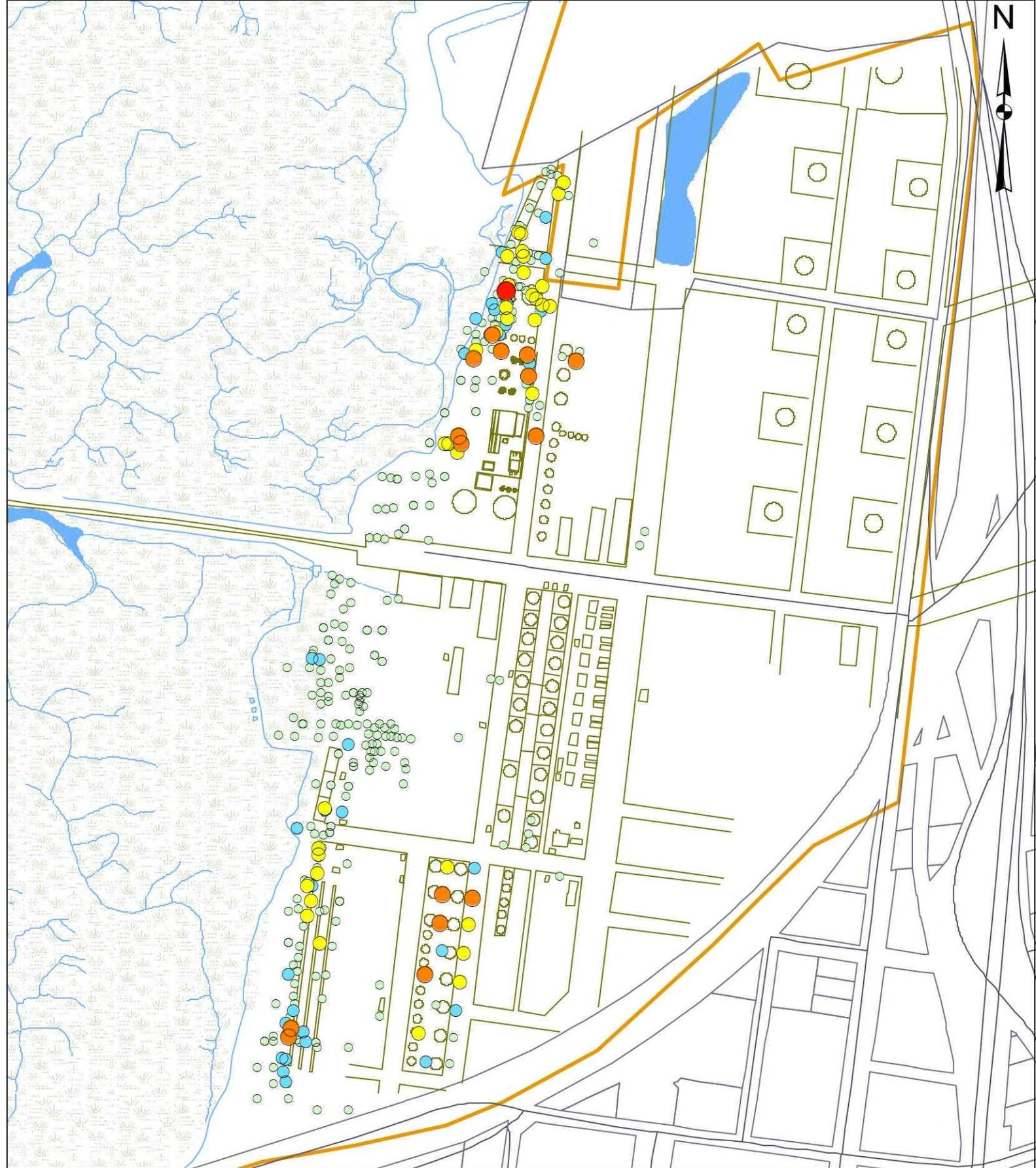
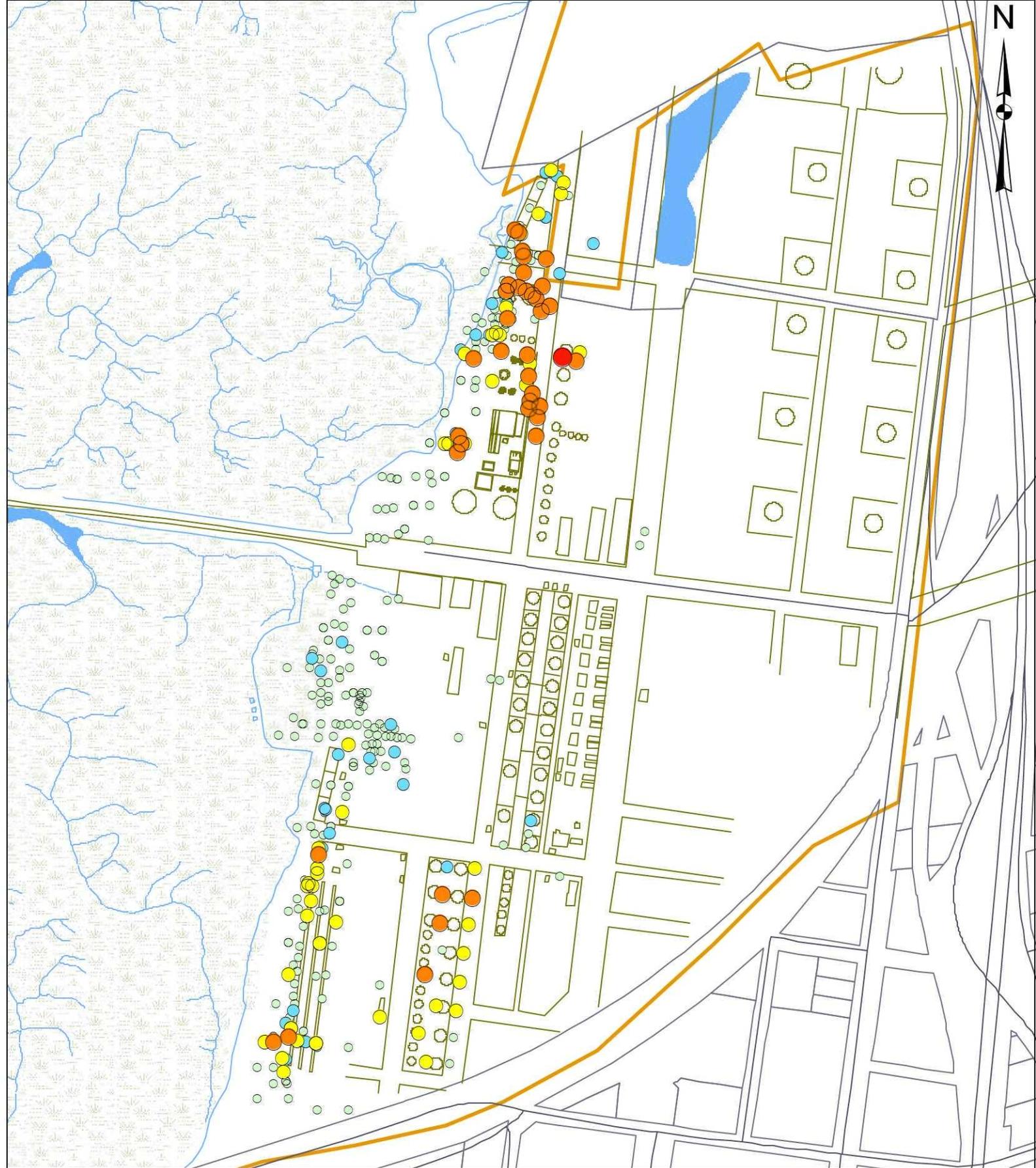


Figure No. 3b
Distribution of Toluene in Soils at 5-10ft

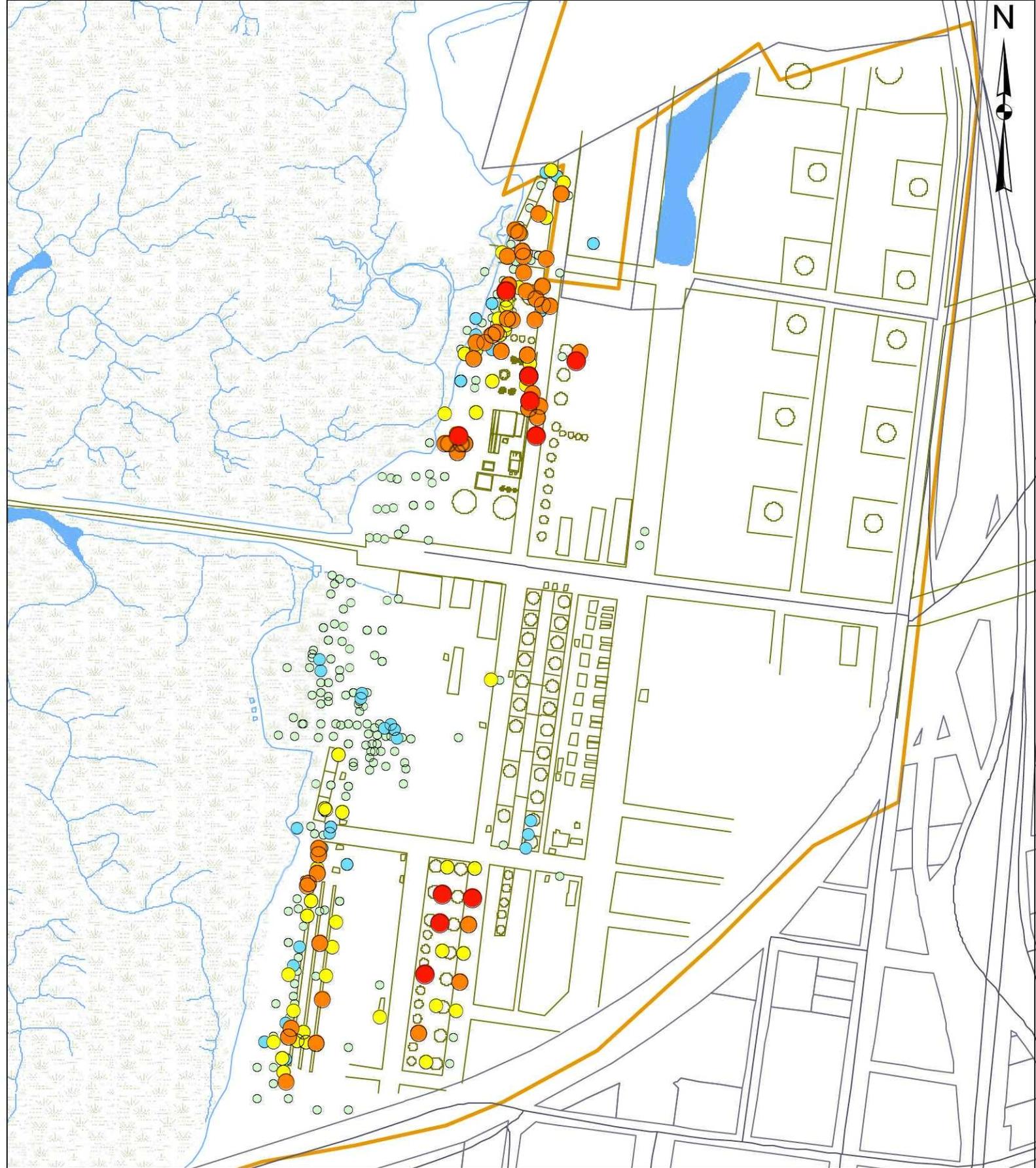


Soil Ethylbenzene 5-10ft — Arco Refinery Layout
 RESULTPPM — LCP Site Property Boundary

- < 0.1
- 0.1 - 1
- 1 - 10
- 10 - 100
- > 100

400 200 0 400 Feet

Figure No. 3c
Distribution of Ethylbenzene in Soils at 5-10ft

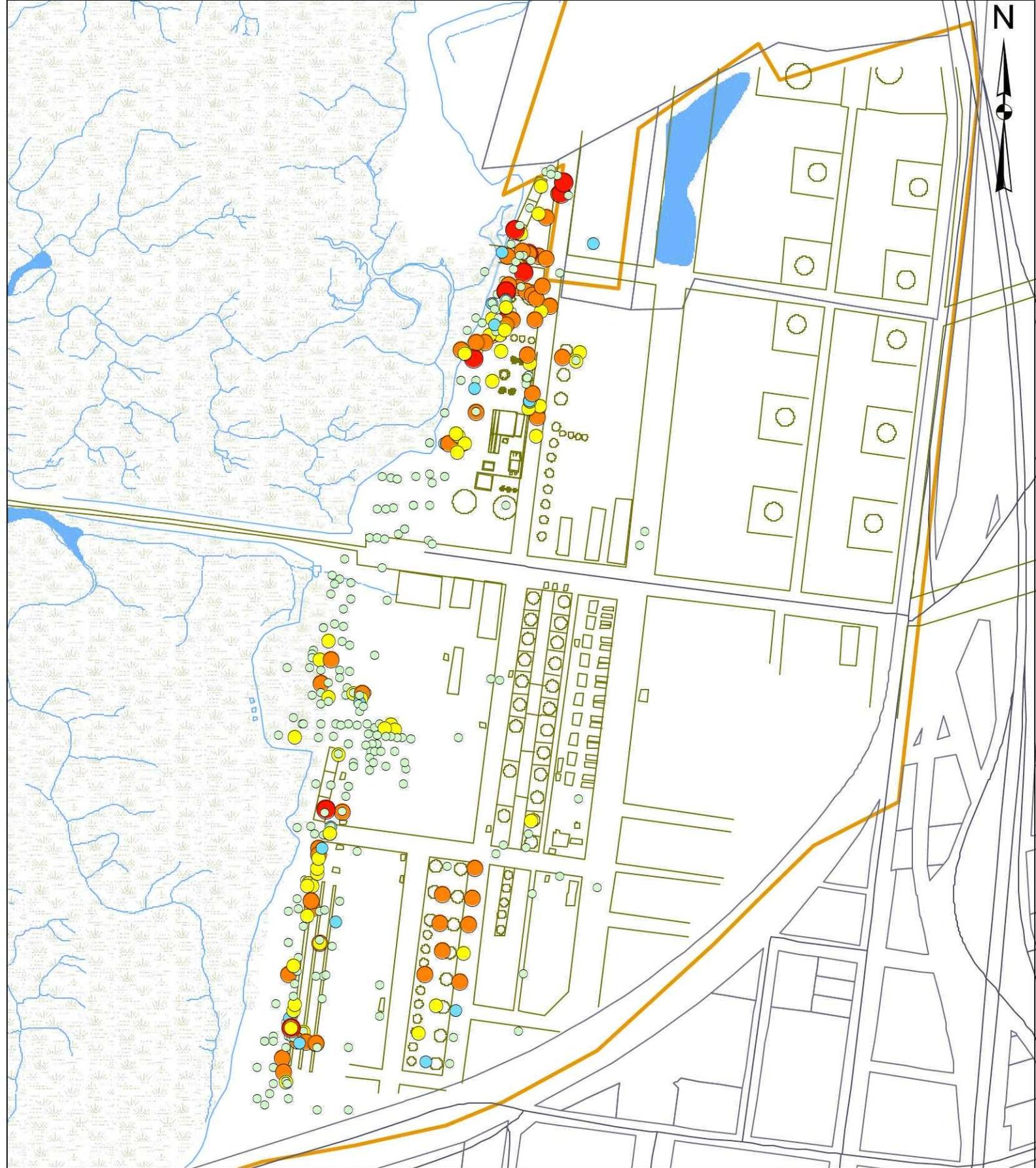


Soil Xylenes 5-10ft — Arco Refinery Layout
 RESULTPPM — LCP Site Property Boundary

- < 0.1
- 0.1 - 1
- 1 - 10
- 10 - 100
- > 100

400 200 0 400 Feet

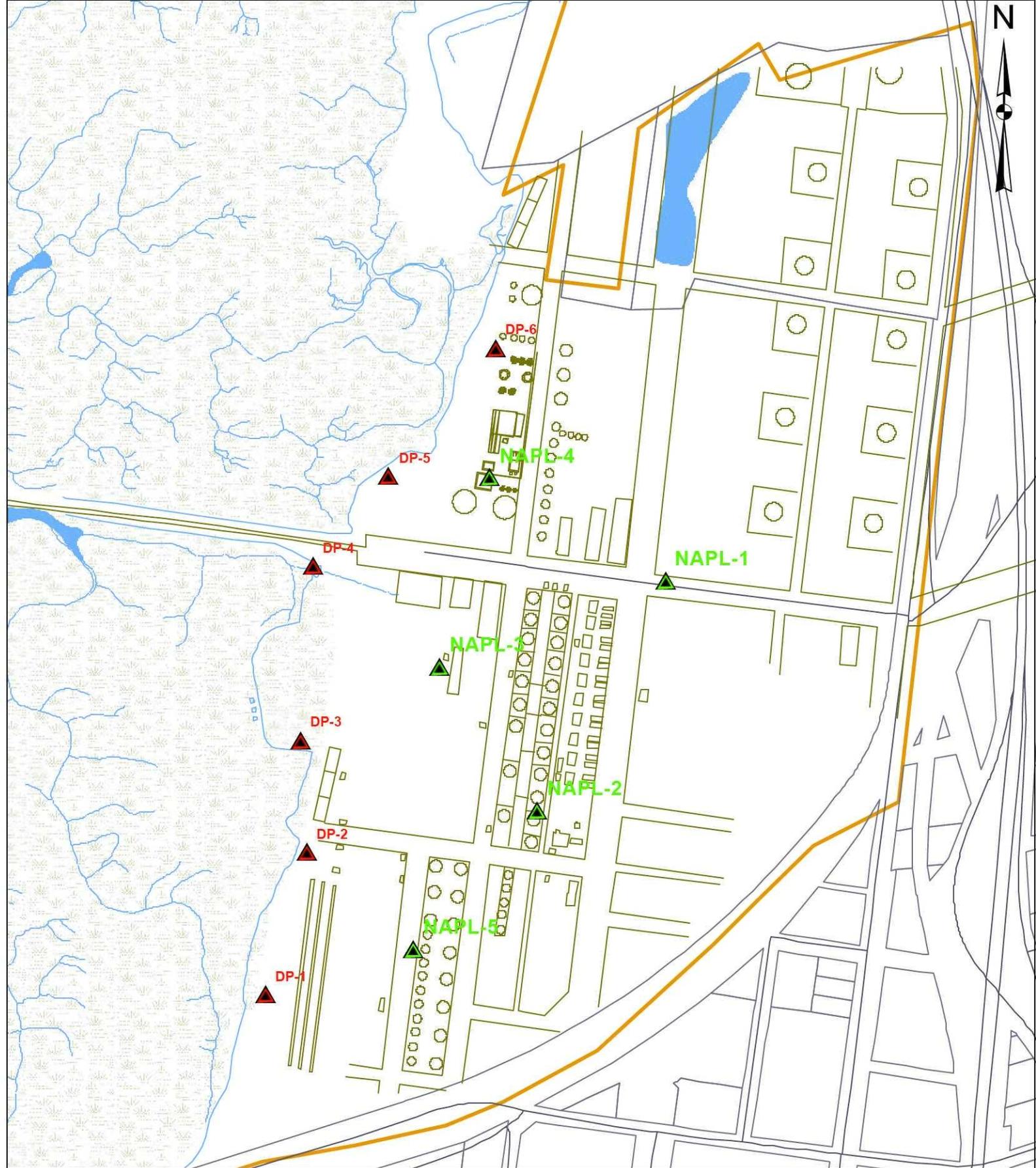
Figure No. 3d
Distribution of Xylenes in Soils at 5-10ft



Soil Naphthalene 5-10ft — Arco Refinery Layout
 RESULTPPM LCP Site Property Boundary

- < 0.1
- 0.1 - 1
- 1 - 10
- 10 - 100
- > 100

Figure No. 3e
Distribution of Naphthalene in Soils at 5-10ft



- ▲ Proposed NAPL Investigation 2012
- ▲ Proposed Shoreline DP Wellpoint
- Arco Refinery Layout
- LCP Site Property Boundary

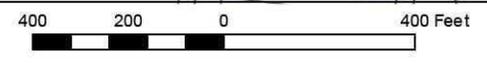


Figure No. 4
Proposed Locations for LNAPL Assessment