APPENDIX M – UVIF/MIP NAPL INVESTIGATIONS

FINAL REMEDIAL INVESTIGATION REPORT
CASMALIA RESOURCES SUPERFUND SITE
CASMALIA, CALIFORNIA

Prepared by: ERM

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LIST OF ACRONYMS

bgs	Below ground surface
CNS	Casmalia Neutralization System
CPT	Cone Penetrometer Test
CSC	Casmalia Resources Site Steering Committee
DNAPL	Dense non-aqueous phase liquid
DQOs	Data Quality Objectives
ECD	Electron capture detector
ERM	ERM-West, Inc.
FID	Flame Ionization detector
FS	Feasibility Study
FSP	Field Sampling Plan
GC	Gas chromatograph
HSU	Hydrostratigraphic Unit
LNAPL	Light non-aqueous phase liquid
mg/kg	milligram per kilogram
MIP	Membrane Interface Probe
NAPL	Non-aqueous phase liquid
PID	Photoionization detector
PAHs	Polycyclic aromatic hydrocarbons
PSCT	Perimeter Source Control Trench
P/S	Pesticides/Solvents
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RCF	Runoff containment facility
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SVOCs	Semivolatile organic compounds
TI	Technical Impracticability
USEPA	United States Environmental Protection Agency
USTs	Underground Storage Tanks
UVIF	Ultraviolet Induced Fluorescence
VOCs	Volatile organic compounds
WAO	Wet air oxidation

1.0 UVIF/MIP NAPL SURVEY

The Casmalia Resources Site Steering Committee (CSC) completed an ultraviolet induced fluorescence (UVIF)/Membrane Interface Probe (MIP) nonaqueous-phase liquid (NAPL) investigation in accordance with the June 2004 *Remedial Investigation/Feasibility Study Work Plan* (RI/FS Work Plan), which was prepared by the CSC and submitted to the United States Environmental Protection Agency (USEPA). The following sections describe the nature and findings of the work completed as part of this investigation.

1.1 Purpose of the Investigation

The NAPL survey was completed to evaluate the potential for various types of NAPL to be present at the Casmalia Resources Superfund Site (Site), specifically in areas associated with historical burial trenches and wells, the former drainages, pads, and ponds south of the landfills, but north of the perimeter source control trench (PSCT), and in former drainages and oilfield-related ponds south of the PSCT. Identifying the nature and extent of potential NAPL is a necessary component of site characterization, and is required to complete both a technical impracticability (TI) evaluation and complete remedial alternatives evaluations within the Feasibility Study (FS).

The locations for the NAPL survey (Figure M-1) were chosen with USEPA's concurrence based on a review of historical Site operations and groundwater quality data from wells located within areas specifically identified as having potential or indirect indication of high NAPL presence. The CSC also considered other indirect evidence of NAPL presence, including observations made during Remedial Investigation (RI)/FS drilling activities and chemical partitioning based on soil concentration data.

The following types of NAPL are presently known to occur in the area from the toe of the Pesticides/Solvents (P/S) Landfill to extraction well PSCT-1:

- Residual Dense NAPL (DNAPL);
- Free-Phase Pooled DNAPL;
- Lower Hydrostratigraphic Unit (HSU) DNAPL; and
- Light NAPL (LNAPL).

These types of NAPL are described in the RI/FS Work Plan. Based on the CSC's review of historical Site operations, residual NAPLs are most likely found within the following areas:

- The Central Drainage Area – This is an area where contamination in former ponds and pads was in some cases left in place. These included some ponds and pads in this area that were recommended for closure as a landfill at the time of the pond closure activities. The pads collected runoff and other liquids from the landfills and may contain DNAPL constituents. DNAPL has been identified in two locations in the Central Drainage Area including RGPZ-7C and -7D. LNAPL is present in Sump 9B, piezometers around Sump 9B, Sump 9B-CW, RG-3B, and PSCT-1.
- The Capped Landfill Area – This study area may contain DNAPL constituents. DNAPL is present in the Gallery Well and LNAPL is present in the Gallery Well and certain Gallery Well road piezometers.

- The former Burial Trench Area – Wastes that may contain NAPLs were placed in trenches or were injected into the subsurface via wells.
- South of the PSCT near former Ponds 16, A, B, C, D, S, M, and V – These ponds were oilfield-related and may contain NAPL.
- At the toe of the P/S Landfill and in former drainage features leading from the P/S Landfill – The P/S Landfill is a known DNAPL source and the drainages may be a conduit for DNAPL migration.

Although the potential for NAPL presence is lower in other areas of the Site, additional NAPL survey efforts were also completed within portions of RCRA Canyon, the Liquids Treatment Area, the Maintenance Shed Area, and former drainages south of the PSCT.

1.2 Scope of the Investigation

The objectives of the scope of the NAPL investigation are as follows:

- To complete UVIF or MIP surveys of selected locations to provide preliminary information regarding the potential presence of NAPLs.
- Decide if residual NAPL is present at a particular location and depth interval where the UVIF or MIP profiles may indicate potential NAPL in the vadose zone or in the saturated zone, in order to collect soil samples for laboratory analysis.

Initially, as described in the RI/FS Work Plan, a UVIF response profile from near Sump 9B (RISBCD-09) and the Gallery Well (RISBCL-01) was completed. NAPL is known to be present in these two locations. Additionally, a UVIF response profile was collected in a non-source area from an off-site location (RISBOF-01) to aid in determining a “background” response profile for uncontaminated local soils. The UVIF response profiles from these locations were intended to “benchmark” the UVIF response profiles obtained at other locations where residual NAPL may be present. After a UVIF response profile was established at the benchmark locations, a UVIF response profile was acquired at 10 additional locations (four locations in the Central Drainage Area, five locations in the Burial Cell Area, and one location in the Former Pond M).

At the onset of the NAPL investigations, USEPA noted a concern regarding the UVIF technology; they believed that pure chlorinated solvents do not generally fluoresce unless accompanied by hydrocarbons or naturally occurring organic compounds, and they were concerned that the UVIF could produce false negative results for NAPL. To address this concern, the CSC revisited eight locations that were initially tested by the UVIF tool with an MIP to confirm the presence or absence of pure chlorinated solvents. The MIP will respond to both NAPLs and dissolved-phase volatile organic compounds (VOCs). Following discussions with USEPA after completion of this supplemental work, the CSC agreed to proceed with the NAPL investigation using MIP equipment for each Type 7 NAPL sampling location, and terminate the use of the UVIF equipment for the remainder of the NAPL investigation. Table M-1 provides final sampling coordinates and summarizes the type of survey tools that were used for each Type 7 sample.

It should be noted that, in addition to the UVIF/MIP survey work described in this appendix, other studies were completed during the RI fieldwork that relate to the overall NAPL assessment for the Site. Appendix L describes a geophysical investigation that was performed, in part, to identify potential depressions within the unweathered claystone bedrock, where DNAPLs could accumulate. Although the details of that investigation are not presented in this appendix, the

results of that investigation, where significant, are noted in the appropriate study areas within this appendix. Similarly, NAPL level data and groundwater chemistry data are presented in Appendices F and G, respectively. We have identified wells and piezometers that are proximal to the UVIF/MIP borings and have described whether or not these wells or piezometers have previously contained measurable quantities of LNAPLs or DNAPLs. Soil organic chemical data were also included in our analysis, but a more thorough description of the soil sampling program is described in Appendix B.

2.0 METHODOLOGY

The following section discusses the methodology of the Type 7 NAPL Investigation.

2.1 Detailed Approach

The CSC completed a NAPL investigation using UVIF and MIP technology to identify the nature and extent of NAPL present beneath the Site at 50 locations. The UVIF and MIP measurement techniques were combined with cone penetrometer test (CPT) equipment to obtain high-quality, subsurface exploration with detailed stratigraphic and hydrogeologic data.

Standard Operating Procedure (SOP) 4-1 in the June 2004 RI/FS Work Plan describes the methodology for conducting CPT, UVIF, and MIP measurement techniques.

2.1.1 Contractors and Subcontractors

Gregg In Situ performed the CPT/UVIF probing, which was completed between 2 and 9 August 2004. The CPT rig from Gregg In Situ was also subcontracted to advance the CPT rods during the subsequent MIP investigations. Vironex performed the initial MIP investigation, which was completed between 9 and 12 August 2004. Columbia Technologies performed the second phase of MIP investigation, which was completed between 20 September and 8 October 2004. ERM-West, Inc. (ERM) performed field oversight of all Type 7 sampling investigation activities.

2.1.2 Equipment and Tools

The tools used for the NAPL investigation include both a UVIF probe and two different sets of MIP equipment (operated by Vironex and Columbia Technologies), all of which were adapted to a CPT rig.

The CPT rig used an integrated electronic piezocone, which is pushed using a rig with a force capacity of 25 tons. The piezocone recorded measurements of cone bearing, sleeve friction, and dynamic pore water pressure at 5-centimeter intervals during penetration to provide a nearly continuous hydrogeologic log. Unless otherwise noted, a continuous, real-time data log was created each time the UVIF or Columbia Technologies MIP equipment was used. Vironex MIP borings were co-located with borings previously logged with CPT/UVIF; therefore, piezocones were not used with the CPT rig for the Vironex MIP borings. A split-spoon sampler attached to the CPT rig was used to collect several soil samples at USEPA request, as discussed in Section 2.2.

The UVIF module is located above the standard piezocone. The UVIF equipment works on the principle that organic compounds fluoresce when irradiated by ultraviolet light. Therefore, by measuring the UVIF intensity of the soil and groundwater, the lateral and vertical extent of organic compounds in the ground can be determined. This tool is used primarily to identify aromatic and aliphatic hydrocarbons. Pure chlorinated solvents do not generally fluoresce unless accompanied by hydrocarbons or naturally occurring organic compounds.

To confirm the absence of NAPLs including DNAPLs that may not have been detected using UVIF, the MIP tool was used for the majority of the NAPL investigation locations. The MIP system is a down-hole tool that heats the soils and groundwater adjacent to the probe to 120°C.

This increases the volatility of the organic contaminants, and the chemical vapors quickly diffuse across a chemical-permeable membrane into a closed, inert gas loop, which carries these vapors to a series of detectors, which are housed above the ground surface. Continuous chemical logs or profiles are generated from each location. It is important to note that unlike the UVIF, the MIP responds well to NAPLs, dissolved-phase VOCs, and vapor-phase VOCs (in the vadose zone); however, because this instrument is a diffusion-based system that uses a carrier gas, a response exceeding the instrument's scale would tend to mask lower responses from deeper intervals due to the time it would take to re-equilibrate the carrier gas.

At all Type 7 sampling locations, the CPT was advanced as far down through the Upper HSU as possible. Gregg In Situ operated the UVIF equipment, which was mounted directly above the CPT cone. Two subcontractors were used to complete the MIP investigation. The initial MIP instrument, operated by Vironex, consisted of a gas chromatograph (GC) with an electron capture detector (ECD) and a photoionization detector (PID). The second MIP instrument was operated by Columbia Technologies, which consisted of a GC with an ECD, PID, and flame ionization detector (FID). Columbia Technologies was used following the work performed by Vironex, and the change in service providers was based partly the added capabilities of Columbia's MIP equipment, because it included an FID. Both the Vironex and Columbia Technologies MIP equipment also collected temperature, soil conductivity, and advancement rate data.

It should be noted that the UVIF module was located 2.83 feet above the tip of the CPT cone, the Vironex MIP membrane was located 1.33 feet above the tip of the CPT cone, and the Columbia MIP membrane was located 2.55 feet above the tip of the cone. Every attempt was made to advance the CPT rods as deeply as possible to identify DNAPLs that might be pooled on the Lower HSU contact. Depths shown on the UVIF/MIP logs and presented in the UVIF/MIP Results sections of the text are the depths of the UVIF module or MIP membrane, as appropriate; as such, these depths do not represent the total completed depths of the borings themselves. Depths reported in the text are rounded to the nearest 0.1 foot, although more accurate data for some of the locations are presented in Table M-1.

2.2 Deviations from the RI/FS Work Plan

Changes made to the approved sampling program during the field efforts are discussed in the paragraphs that follow. These changes are documented in RICH-007.2.

As discussed above, the most significant change to the sampling program occurred following completion of the first eight Type 7 sampling locations. As described in SOP 4-1 (within Appendix A of the June 2004 RI/FS Work Plan), the MIP was initially used at eight locations that had the greatest potential to exhibit high concentrations of chlorinated solvents. These eight MIP signatures were then compared with the previously completed UVIF signatures to determine the instrumentation method that would best respond to the contaminants found at the Site. A comparison of the UVIF and MIP data at these high-priority sampling locations is described below in Section 3.0.

Following discussions with the USEPA regarding the initial results of both the UVIF and the MIP responses, the CSC and USEPA agreed that the MIP could provide more useful information for the NAPL investigation, specifically by addressing the potential presence of DNAPL. On 17 September 2004, the CSC submitted an RI Field Change Request (No. RICH-007.2), which proposed to modify the RI/FS Work Plan to change from the exclusive use of the UVIF tool to

the exclusive use of a MIP tool at all remaining Type 7 sampling locations, plus six sampling locations where either UVIF/MIP or UVIF (only) data were previously collected. At the request of the USEPA, the CSC agreed to continue the NAPL investigation program using three GC detectors (PID, FID, and an ECD). This change to a three-detector MIP setup required the CSC to change MIP subcontractors from Vironex, having the capacity to use only two detectors, to Columbia Technologies, which could utilize all three detectors.

Additionally, soil samples were collected during the Type 7 NAPL investigation by using a split-spoon soil sampler with the CPT rig. These samples were not initially scoped within the RI/FS Work Plan, but were collected at the request of USEPA to determine the presence of DNAPL at these specific locations. These samples include:

- On 4 August 2004, a soil sample was collected from the bottom of RISBCL-01A. The sample was collected from a depth of 76 to 77 feet below ground surface (bgs). The soil was placed in sample jars and bottled water was added to the jars in attempt to visually identify DNAPL or LNAPL. This sample was not retained for laboratory analysis.
- On 5 August 2004, the CSC collected soil samples in location RISBCD-09A at depths of 11.5 to 12.5 and 27 to 28 feet bgs. These samples were not retained for laboratory analysis by CSC, but were instead provided to USEPA.
- On 12 August 2004, the CSC collected a soil sample in location RISBCD-11A at a depth of 42 to 43 feet bgs.
- On 12 August 2004, the CSC also attempted to collect a soil sample in location RISBCL-01B at a depth of 74 to 75 feet bgs. This is the same general location of the previous “jar test” sample that was collected on 4 August 2004; however, the intent of this boring was to collect a sample for subsequent laboratory analysis. The initial attempt at sample collection failed at this location. The CPT rig stepped over several feet from the previous location and another sample was collected from this location (designated RISBCL-01C) at a depth of 74 to 75 feet bgs.

With the exception of the soil sample collected from location RISBCL-01A on 4 August 2004 (which was collected for field inspection purposes), all soil samples were collected in accordance with SOPs in the Sampling and Analysis Plan (SAP) and Field Sampling Plan (FSP) (Appendix A of the RI/FS Work Plan). All soil samples except those collected from RISBCD-09A on 5 August 2004 (which were provided to USEPA) and from RISBCL-01A were submitted to the laboratory for chemical analyses.

3.0 INVESTIGATION RESULTS

This section describes activities occurring during the UVIF and MIP investigations, the responses of these direct-sensing tools, and their correlation with adjacent soil sampling and nearby water quality data. Other appropriate lines of evidence for the NAPL investigation, such as field sampling observations and adjacent monitoring well data, are also presented. Results are grouped by study area, and are presented in the order they were originally presented in the RI/FS Work Plan.

Figure M-1 shows the Type 7 UVIF/MIP sampling locations as originally proposed in the RI/FS Work Plan, as well as the final boring locations. Location adjustments in several areas were necessary due to access restrictions with the CPT rig, but all location adjustments were made with USEPA concurrence prior to initiating the borehole. Table M-1 summarizes the CPT/UVIF/MIP and soil sampling locations completed during this investigation, and includes the sampling dates, types of instruments (and subcontractors) used, total depth of each boring, and location coordinates. Electronic copies of the Gregg In Situ CPT and UVIF logs are included as Attachment M-1. Electronic copies of the Vironex MIP logs are included as Attachment M-2, and the Columbia Technologies MIP logs are included as Attachment M-3.

At selected boring locations where the UVIF and/or MIP tools exhibited significant responses, analytical results for soil samples collected in adjacent boreholes were quantitatively evaluated to assess the possibility of residual NAPL contamination. Many Type 7 borings did not exhibit any significant UVIF or MIP responses. Samples that exhibited significant UVIF or MIP responses, or contained significant concentrations of VOCs or semivolatile organic compounds (SVOCs), were evaluated further for potential NAPL presence. Chemical partitioning calculations were completed using the method described by Feenstra et al. (1991) and modified by Mariner et al. (1997). This method is also described by Feenstra and Cherry (1996).

In general, organic chemical concentrations in soil (specifically, VOCs and SVOCs) were used to estimate the concentrations in groundwater and soil vapor (if the sample was collected above the capillary fringe) that would be in equilibrium with the chemically impacted soil. If the sorbed, soil vapor, and groundwater concentrations exceeded their respective solubility or sorptive capacity (using aqueous solubilities and distribution coefficients), then the sample would be considered to have the potential for NAPL presence. A more thorough description of the analytical method, the calculations performed, and assumptions used in this analysis are included in Attachment M-4. Calculation spreadsheets for each of the samples that were quantitatively evaluated are also included as Attachment M-4. These calculations are summarized on Table M-2.

3.1 Capped Landfills

Location ID RISBCL-01 is adjacent to the Gallery Well at the toe of the P/S Landfill. This is one of the “benchmark locations” because DNAPL and LNAPL are known to exist in the Gallery Well and LNAPL is known to exist in certain nearby piezometers [GW-P (W), GW-P(E2), and GW-P(E3)]. An initial CPT/UVIF boring was completed to a depth of 75.6 feet on 3 August 2004; an additional CPT/UVIF boring (RISBCL-01A) was completed to a depth of 78.6 feet on 4 August. On 11 August, RISBCL-01-MIP was advanced using the Vironex MIP equipment to a total depth of 75.4 feet. Additionally, as mentioned in Section 2.2, the following soil samples were collected at this location:

- On 4 August 2004, a soil sample was collected from the bottom of RISBCL-01A from a depth of 76 to 77 feet bgs. The soil was placed in sample jars and bottled water was added to the jars to visually identify DNAPL or LNAPL. No NAPL was observed.
- On 12 August, the CSC attempted to collect a soil sample at location RISBCL-01B at a depth of 74 to 75 feet bgs. This is the same location of the previous "jar test" sample collected on 4 August, but the intent of this boring was to collect a sample for subsequent laboratory analysis. The initial attempt at collecting a sample failed at this location. The CPT rig stepped over several feet from the previous location and a complete sample was collected from this location (designated RISBCL-01C) at 74 to 75 feet bgs.

3.1.1 UVIF/MIP Results

A comparison of the UVIF and MIP responses for boring RISBCL-01 is shown on Figure M-2. As shown, the UVIF tool responded with three primary peaks that were centered at depths of approximately 43, 48, and 55 feet bgs. The UVIF did not exhibit significant response above 40 feet or below 60 feet bgs. The MIP ECD, however, began responding at a depth of approximately 5 feet bgs, and increased rapidly at 23 feet bgs, going off scale at 33 feet bgs. The PID began responding at approximately 33 feet bgs, with the most significant peak near the bottom of the boring, between approximately 69 and 74.1 feet bgs. The sharp increased CPT tip resistance shown on Figure M-2 indicates that the Lower HSU contact was encountered at a depth of approximately 70 feet bgs.

3.1.2 Comparison of UVIF/MIP Results with Soil Sampling Data

Chemical partitioning calculations were performed on one soil sample within this study area. A summary of the selected sampling location and its associated total VOC and total SVOC concentrations is provided below.

Location ID	Depth interval, ft bgs	Total VOCs, mg/kg	Total SVOCs, mg/kg
RISBCL-01C	74-75	622	75.5

As shown above, the soil sample collected at RISBCL-01 contained numerous VOC and SVOC detections at relatively high concentrations. As shown in Table M-2 and the calculation sheets provided in Attachment M-4, the soil sample collected here exhibited concentrations of organic chemicals that would indicate potential NAPL presence. Although many chemicals were detected in this sample, bis(2-ethyhexyl) phthalate is the only chemical that exceeds its effective solubility.

3.1.3 Comparison of UVIF/MIP Results with Groundwater Sampling Data

LNAPL and DNAPL are known to exist in the adjacent Gallery Well and LNAPL is known to exist at certain nearby piezometers. The responses of the MIP ECD (which exceeded the detector's capable range) beginning at the water table (approximately 33 feet bgs) and the response of the PID (near maximum range at the bottom of the borehole) are consistent with the potential for NAPLs at this location.

During the RI fieldwork, two additional piezometers (RIPZ-23 and -24) were installed here. As described in Appendix E, LNAPL was observed during development at RIPZ-23 (screened within the Upper HSU). Recent liquid level measurements have confirmed the presence of LNAPL in piezometer RIPZ-23 and have additionally identified the presence of LNAPL in RIPZ-24 (screened in the Upper HSU). Relative to the Type 7 sampling work, RIPZ-23 and -24 are approximately 45 feet west and 50 feet east of RISBCL-01, respectively.

3.2 RCRA Canyon Area

Five NAPL investigation borings were advanced within the RCRA Canyon Area. The five borings were completed on 6 October 2004 using Gregg In Situ's CPT rig with the Columbia MIP equipment. The work completed at each location is described as follows:

- Two borings (RISBRC-01 and RISBRC-02) were drilled at the location of the former waste burial area portion of the former RCRA Landfill. These locations were selected to be within the former landfill boundary and near the former drainage. RISBRC-01 was completed to a depth of 25.1 feet bgs, and RISBRC-02 was completed to a depth of 21.5 feet bgs. Note that the former RCRA Landfill was also investigated by trenching methods, as described in Appendix B.
- One boring (RISBRC-03) was drilled along the canyon bottom downgradient of the former landfill area. RISBRC-03 was completed to a depth of 7.6 feet bgs.
- One boring (RISBRC-04) was drilled within the former West Canyon Catch Basin (WCCB, or Pond 43), where liquids previously accumulated throughout this area. The expected depth of the contact for this boring was estimated to be between 5 and 10 feet bgs. RISBRC-04 was completed to a depth of 27.0 feet bgs.
- One boring (RISBRC-06) was drilled at the head of the canyon, where elevated VOC concentrations were previously found, to evaluate the potential impacts from spreading oilfield wastes. RISBRC-06 was completed to a depth of 51.3 feet bgs.

3.2.1 UVIF/MIP Results

As shown in the MIP logs provided in Attachment M-3, no significant responses were observed within any of these five borings. Very minor FID responses were observed at RISBRC-01, -02, and -06, and very minor PID responses were observed at RISBRC-06. No ECD responses were observed at any location. Based on the MIP responses, NAPL is not expected at these locations.

3.2.2 Comparison of UVIF/MIP Results with Soil Sampling Data

Because no significant MIP responses or elevated VOC or SVOC concentrations in soil were observed within the RCRA Canyon Type 7 borings, a detailed analysis of soil chemistry data for the purposes of evaluating the potential presence of NAPL was not performed.

3.2.3 Comparison of UVIF/MIP Results with Groundwater Sampling Data

Because no significant MIP responses were observed within the RCRA Canyon Type 7 borings, a detailed analysis of groundwater quality data for the purposes of evaluating the potential presence of NAPL has not been performed. It should be noted that several monitoring wells are present within the RCRA Canyon Area near the Type 7 boreholes. RG-10B and RP-29D are

immediately south of the former RCRA Landfill, and are therefore just south of RISBRC-01 and RISBRC-02. Well SW-46 is north of RISBRC-04, near the former West Canyon Catch Basin. No NAPL has been observed in any of these three RCRA Canyon monitoring wells.

3.3 Burial Trench Area

Five Type 7 NAPL investigation borings were advanced within the Burial Trench Area. Four of the borings (RISBBC-02 through RISBBC-05) were advanced within/between the burial trenches (the actual locations of these cells were estimated using a combination of historical Site maps and aerial photography), and one boring (RISBBC-01) was completed along the southern margin of the Burial Trench Area, downgradient of the trenches. Initially, between 4 and 6 August 2004, CPT/UVIF borings were completed for each of the five locations within the Burial Trench Area. MIP probing was subsequently completed using the Vironex PID and ECD between 9 and 12 August 2004 at locations RISBBC-03 through RISBBC-05. The MIP probing extended to approximately the same depth reached by the UVIF probe. Later, in September and October 2004, each of the five locations in the Burial Trench Area was probed again using the Columbia Technologies MIP equipment. The work completed at each location is described as follows.

- Boring location RISBBC-01 was initially advanced using CPT/UVIF equipment on 5 August 2004. After reaching a total depth of 47.2 feet bgs, the CPT log was analyzed, and it was determined that, because of the low pore pressure, tip resistance, and sleeve friction on the CPT log from 16 to 43 feet bgs, the boring was most likely advanced through the fill material of the PSCT. On 8 October 2004, RISBBC-01-MIP was relocated slightly north of the initial boring location (and yet still downgradient of the Burial Trenches) and was completed using the Columbia Technologies MIP equipment to a total depth of 9.5 feet bgs, where the CPT rig met refusal.
- Boring location RISBBC-02 was initially advanced to a total depth of approximately 22.5 feet bgs on 6 August 2004 with the CPT/UVIF instrument. On 7 October 2004, RISBBC-02-MIP was advanced using the Columbia MIP equipment to a total depth of approximately 22.1 feet bgs.
- Boring location RISBBC-03 was initially advanced to a total depth of 52.7 feet bgs on 6 August 2004 with the CPT/UVIF instrument. On 10 August 2004, RISBBC-03-MIP was advanced using the Vironex MIP equipment to a total depth of 52.6 feet bgs. On 21 September 2004, RISBBC-03A-MIP was advanced using the Columbia Technologies MIP equipment to a total depth of approximately 54.0 feet bgs.
- Boring location RISBBC-04 was initially advanced to a total depth of 39.2 feet bgs on 4 August 2004 with the CPT/UVIF instrument. On 9 August 2004, RISBBC-04-MIP was advanced using the Vironex MIP equipment to a total depth of 39.0 feet bgs. On 8 October 2004, RISBBC-04A-MIP was advanced using the Columbia Technologies MIP equipment to a total depth of 52.3 feet bgs.
- Boring location RISBBC-05 was initially advanced to a total depth of 29.4 feet bgs on 6 August 2004 with the CPT/UVIF instrument. On 12 August 2004, RISBBC-05-MIP was advanced using the Vironex MIP equipment to a total depth of 28.0 feet bgs. On 23 September 2004, RISBBC-05A-MIP was advanced using the Columbia Technologies MIP equipment to a total depth of 47.9 feet bgs.

In addition to the UVIF and MIP survey completed in this area, the geophysical investigation identified a bedrock depression (identified as LOW-2) that could provide an accumulation point for DNAPLs, if present. The results of that investigation are presented in Appendix L.

3.3.1 UVIF/MIP Results

As shown in the UVIF and MIP logs provided in Attachments M-1 and M-3, no significant UVIF or MIP responses were observed in RISBBC-01 or -02. Based on these responses, it is highly unlikely that NAPLs exist at these locations. The UVIF and MIP responses for boring locations RISBBC-03, -04, and -05 are compared shown on Figure M-2. The UVIF tool showed little to no response in RISBBC-03, -04, and -05, with the only notable responses occurring in very thin spikes at RISBBC-04 at depths of approximately 17 and 21 feet bgs. The MIP logs, however, did show notable ECD and FID responses in all three of these borings, although none of the detectors reached saturation and exceeded the range of the instrument as in several other sampling locations at the Site.

3.3.2 Comparison of UVIF/MIP Results with Soil Sampling Data

Based on the UVIF/MIP results, chemical partitioning calculations were performed on four samples from the three borings with elevated MIP responses in this study area. The selected sampling locations and their associated total VOC and total SVOC concentrations are summarized below.

Location ID	Depth interval, ft bgs	Total VOCs, mg/kg	Total SVOCs, mg/kg
RISBBC-03	37-38.5	30.8	25.7
RISBBC-04	27-29	0.57	1.6
RISBBC-04	49-50.5	0.006	0.37
RISBBC-05	35-36.5	311.20	0.98

As shown above, samples collected adjacent to UVIF/MIP borings RISBBC-03 and RISBBC-04 contained relatively low VOC and SVOC concentrations. As shown in Table M-2 and the calculation sheets provided in Attachment M-4, none of the above-listed samples exhibited concentrations of organic chemicals that would indicate potential NAPL presence.

3.3.3 Comparison of UVIF/MIP Results with Groundwater Sampling Data

In addition to the UVIF, MIP, and soil sampling results, other investigation tools and field observations must be considered to evaluate the potential presence of NAPLs within this study area. For example, tar seeps have been observed immediately northeast of RISBBC-05. Samples of the tar were collected during the RI fieldwork, and the results of that sampling are described in Appendix B.

Monitoring well and piezometer installation within this study area have also identified NAPL presence. Prior to the RI fieldwork, three monitoring wells (EPA-2, SW-17, and SW-44) were installed within the Burial Trench Area. No NAPLs have been observed in these wells. During the recent RI fieldwork, three additional water quality monitoring wells (RIMW-6, -7, and -8) and two piezometers (RIPZ-15 and -16) were installed here. As described in Appendix E, NAPLs (primarily in the form of small droplets or product sheens) were observed during drilling at

RIMW-7 (screened within the Upper HSU) and RIPZ-15 (screened within the Lower HSU). Relative to the Type 7 sampling work, RIMW-7 is approximately 150 feet east of RISBBC-03, and RIPZ-15 is approximately 75 feet northeast of RISBBC-04. No LNAPLS were found at these locations during subsequent liquid level measurements. Future monitoring of these wells will allow us to observe any presence of NAPL in this study area.

Based on the estimated locations of the individual burial cells (as shown in Figure 4-2 of the RI/FS Work Plan), RISBBC-03 and RISBBC-04 are likely located between the burial trenches, whereas RIPZ-15 was likely advanced through the middle of Trench #4. RIMW-7 appears to be located south (and downgradient) of Trench #7.

3.4 Central Drainage Area

There is direct evidence of LNAPLs and DNAPLs within the Central Drainage Area. LNAPLs have been observed in Sump 9B, Sump 9B-CW, Sump 9B-PB, Sump 9B-PC, RG-3B, and PSCT-1. DNAPLs have been observed in RGPZ-7C and RGPZ-7D.

There are 10 Type 7 NAPL investigation boring locations within the Central Drainage Area (RISBCD-04 through RISBCD-13), as shown on Figure M-3. Four borings are located along the former P/S Landfill drainage: (from north to south) RISBCD-11 is located immediately south of the P/S Landfill, RISBCD-07 and RISBCD-06 are located one each in former Pads 9B and 9A, respectively, and RISBCD-10 is located near well PSCT-1. Three borings are located along the former Metals Landfill drainage: (from north to south) RISBCD-04, RISBCD-05, and RISBCD-12 are located within former Ponds 19 and 6. Boring RISBCD-13 is located at the former Loading Dock, boring RISBCD-08 is located within Pond R, and boring RISBCD-09 is located near Sump 9B.

Type 7 boring RISBCD-09 is one of the two “benchmark locations” where NAPL (in this case, LNAPL) is known to exist. This initial boring was completed to a depth of 33.3 feet bgs on 3 August 2004 to evaluate the response of the UVIF equipment. On 11 August 2004, two borings (RISBCD-09-MIP and RISBCD-09A-MIP) were advanced using the Vironex MIP equipment. Boring RISBCD-09-MIP was advanced to a depth of 22.0 feet bgs. However, the CPT rig was positioned at an angle on the side of the buttress, and was not able to reach the total depth of 33.3 feet bgs initially reached when using the UVIF instrument. The CPT rig was repositioned, and boring RISBCD-09A-MIP was advanced to a depth of 33.0 feet bgs. Additionally, as mentioned in Section 2.2, soil samples were collected from RISBCD-09A on 5 August 2004. The samples were collected from 11.5 to 12.5 feet bgs and 27 to 28 feet bgs and submitted to USEPA. On 23 September 2004, RISBCD-09B-MIP was advanced to a depth of 47.4 feet bgs using the Columbia Technologies MIP equipment.

The work completed at the remaining locations is described as follows:

- Boring location RISBCD-04 – Completed on 4 October 2004 using the Columbia Technologies MIP equipment to a depth of 52.0 feet bgs.
- Boring location RISBCD-05 – Completed on 4 October 2004 to a total depth of 13.0 feet bgs using the Columbia Technologies MIP equipment. However, before the advancement of RISBCD-05, the MIP membrane was replaced. Therefore, an additional boring was advanced to 12.5 feet bgs at RISBCD-05A to obtain MIP results after the MIP equipment had been desensitized in RISBCD-05.

- Boring location RISBCD-06 – Initially advanced on 4 August 2004 with the CPT/UVIF equipment to a depth of 24.9 feet bgs. On 11 August 2004, this location was evaluated again (RISBCD-06-MIP) using the Vironex MIP equipment to a depth of 25.0 feet bgs. Finally, this location (RISBCD-06A-MIP) was reevaluated on 7 October 2004 using the Columbia Technologies MIP equipment to a depth of 26.6 feet bgs.
- Boring location RISBCD-07 – Completed on 24 September 2004 using the Columbia Technologies MIP equipment to a depth of 28.5 feet bgs.
- Boring location RISBCD-08 – Initially advanced on 9 August 2004 with the CPT/UVIF equipment to a total depth of 27.1 feet bgs. This location (RISBCD-08-MIP) was reevaluated on 23 September 2004 using the Columbia Technologies MIP equipment to a total depth of 27.1 feet bgs.
- Boring location RSBCD-10 – Completed on 24 September 2004 using the Columbia Technologies MIP equipment to a total depth of approximately 30.7 feet bgs.
- Boring location RISBCD-11 – Initially advanced on 6 August 2004 with the CPT/UVIF equipment to a depth of approximately 45.6 feet bgs. This location was evaluated again (RISBCD-11-MIP) on 10 August 2004 using the Vironex MIP equipment to a depth of 45.6 feet bgs. Additionally, as mentioned in Section 2.2, soil samples were collected from RISBCD-11A on 12 August 2004. The samples were collected from 42 to 43 feet bgs and submitted to the laboratory for chemical analyses. Finally, this location (RISBCD-11A-MIP) was re-evaluated on 22 September 2004 using the Columbia Technologies MIP equipment to a depth of 46.8 feet bgs.
- Boring location RSBCD-12 – Completed on 27 September 2004 using the Columbia Technologies MIP equipment to a depth of 26.1 feet bgs.
- Boring location RISBCD-13 – Initially advanced on 9 August 2004 with the CPT/UVIF equipment to a total depth of 37.6 feet bgs. On 7 October 2004, location RISBCD-13-MIP was advanced using the Columbia Technologies MIP equipment to a depth of 43.1 feet bgs.

In addition to the UVIF and MIP survey completed in this area, the geophysical investigation identified a potential bedrock depression (identified as LOW-1) near PSCT-1 that could provide an accumulation point for DNAPLs, if present. Subsequent CPT borings in this area indicated that the potential low area did not actually exist. The geophysical results may have been skewed by the presence of lower density soils found within the PSCT trench. The results of that investigation are presented in Appendix L.

3.4.1 UVIF/MIP Results

Of all the study areas at the Site, the most widespread and significant responses from the UVIF or MIP detectors were found within the Central Drainage Area. As shown in the UVIF and MIP logs provided in Attachments M-1, M-2, and M-3, significant responses were observed in borings RISBCD-04, -06, -07, -08, -09, -10, -11, and -13. No significant MIP responses were observed in RISBCD-05 or RISBCD-12; the UVIF tool was not used at these two locations. Brief descriptions of the significant responses are provided below. Please note that at RISBCD-08 and RISBCD-13, two different detectors were used (Gregg's UVIF and Columbia's MIP). At borings RISBCD-06, -09, and -11, three different sets of detectors were used (Gregg's UVIF, Vironex's MIP, and Columbia's MIP). The UVIF and MIP responses for these three borings are compared on Figure M-2. In all other Type 7 borings within this study area, only the Columbia Technologies MIP equipment was used.

- RISBCD-04 – The FID responded with low to moderate peaks between depths of approximately 12 and 20 feet bgs. No PID or ECD responses were noted at this depth interval, perhaps due to the presence of heavy-end hydrocarbons or natural organic matter. The ECD began responding at approximately 23 feet bgs, and ultimately exceeded the detector's range at approximately 29 feet bgs. The PID similarly began responding at approximately 23 feet bgs, and showed sharp individual peaks at approximately 38, 43, and 45.5 feet bgs. These latter peaks on the PID were also recorded by the FID at these depths.
- RISBCD-06 – Three different sets of instruments were used at this boring location. The UVIF tool showed little to no response. The Vironex PID and ECD also showed very little to no response throughout this boring. The Columbia Technologies FID responded between approximately 9 and 17 feet bgs, in the absence of any PID or ECD response within this depth interval. Significant FID and ECD responses on the Columbia equipment were observed near the base of this boring at approximately 24.0 feet bgs. A graphical comparison of the three instruments used on this boring (Gregg's UVIF, Vironex's MIP, and Columbia's MIP) is provided in Figure M-2.
- RISBCD-07 – The ECD began responding significantly at a depth of approximately 14 feet bgs, and exceeded the detector's range by 16 feet bgs. The PID and FID both responded similarly to each other, with initial responses at approximately 17 feet bgs that generally increased to the bottom of the boring at 26 feet bgs.
- RISBCD-08 – The UVIF tool showed no significant responses throughout the boring. The ECD and FID began responding at depths of approximately 7 to 9 feet bgs, with the most significant responses observed between depths of approximately 12.5 to 14 feet bgs (for the FID) and 14.5 to 17.0 feet bgs (for the ECD). Other sharp individual peaks were observed on the ECD log at depths of approximately 18.5, 19.5, and 20.5 feet bgs. The PID began responding at approximately 14 feet bgs, with the most significant peak centered on approximately 15.5 feet bgs.
- RISBCD-09 – Three different sets of instruments were used at this boring location. The UVIF tool showed significant responses between approximately 11 and 29 feet bgs. The Vironex ECD exceeded the upper range of the instrument at approximately 6 feet bgs, and the Vironex PID showed significant peaks between 6 feet and the bottom of the boring at approximately 20.7 feet bgs. A duplicate Vironex MIP boring was completed to 33 feet bgs at this location (labeled RISBCD-09A), which showed similar responses on the ECD, but slightly different peaks on the PID. The Columbia Technologies ECD responded sharply at 8 feet bgs (this is the depth to water in nearby piezometer Sump 9B-PA) to 10.5 feet bgs, with similar, but lower magnitude responses at this depth on the PID and FID. The Columbia ECD also responded with significant peaks between approximately 24 and 38 feet bgs. Sharp single peaks on all three detectors registered at the very bottom of the boring, at 44.9 feet bgs. A graphical comparison of the three instruments used on this boring (Gregg's UVIF, Vironex's MIP, and Columbia's MIP) is provided in Figure M-2.
- RISBCD-10 – Only very low ECD responses were recorded between approximately 9 and 27 feet bgs, with the most significant peaks found at depths of approximately 13, 19, and 21.5 ft bgs.
- RISBCD-11 – Three different sets of instruments were used at this boring location. The UVIF tool responded with one significant peak between 29 and 31 feet bgs. The Vironex MIP ECD showed increasing responses between approximately 5 and 25 feet bgs, where the instrument went over range for the remainder of the borehole, with the exception of a sharp negative deflection between 29 and 30 feet bgs. The Vironex PID began increasing at 30 feet bgs, and exhibited the most significant response between

approximately 42 and 44 feet bgs. The Columbia Technologies MIP equipment showed only low ECD responses within the top 35 feet in this boring. At approximately 35 feet bgs, all three detectors began to rise significantly to the bottom of the boring at 44.2 feet bgs. The ECD showed the greatest response, exceeding the instrument's scale at approximately 37 feet bgs. A graphical comparison of the three instruments used on this boring (Gregg's UVIF, Vironex's MIP, and Columbia's MIP) is provided in Figure M-2.

- RISBCD-13 – The UVIF tool showed no significant responses throughout the boring. Significant ECD and FID responses were observed beginning at approximately 6 feet bgs at this boring. The ECD quickly exceeded the maximum instrument range, and remained high for most of the remainder of the boring. The most significant PID and FID peaks were located between 18 and 24 feet bgs and 30 to 32 feet bgs.

3.4.2 Comparison of UVIF/MIP Results with Soil Sampling Data

Based on the UVIF/MIP results, chemical partitioning calculations were performed on 18 samples from nine borings in this study area. The selected sampling locations and their associated total VOC and total SVOC concentrations are summarized below.

Location ID	Depth interval, ft bgs	Total VOCs, mg/kg	Total SVOCs, mg/kg
RISBCD-04	14-17.5	0.28	Not Detected
RISBCD-04 (dup)	14-17.5	0.19	Not Detected
RISBCD-04	36-37.5	0.095	Not Detected
RISBCD-06	10-14.5	22.56	0.34
RISBCD-06	24-25.5	534	0.65
RISBCD-07	22-24	646	507
RISBCD-08	12-14	175.00	20.9
RISBCD-08	24-26	12.1	Not Detected
RISBCD-09	8-10.5	169	Not Detected
RISBCD-09	33-35	65.9	40.3
RISBCD-10	12-15.5	2.3	Not Detected
RISBCD-11	29-30.5	4.6	Not Detected
RISBCD-11	42-43.5	310	86.7
RISBCD-11A	41-42	611	148
RISBCD-13	8-10	98.1	Not Detected
RISBCD-13	20-22	149	Not Detected
RISBCD-13	30-31.5	280	41.5

The concentrations of VOCs and SVOCs in samples collected from RISBCD-04 and RISBCD-10 are very low to non-detectable. As shown in Table M-2 and the calculation sheets provided in Attachment M-4, NAPLs are unlikely to be found at these two locations. Soil VOC and SVOC concentrations at locations RISBCD-06, -07, -08, -09, -11, and -13 are generally higher and, based on the partitioning calculations shown in Attachment M-4, may be indicative of NAPL presence.

3.4.3 Comparison of UVIF/MIP Results with Groundwater Sampling Data

As described above, LNAPLs have been observed in Sump 9B, Sump 9B-CW, Sump 9B-PB, Sump 9B-PC, RG-3B, and PSCT-1. DNAPLs have been observed in RGPZ-7C and RGPZ-7D. The following table identifies the Type 7 borings where NAPL is predicted and the proximity to nearby groundwater monitoring wells or piezometers.

Type 7 Sample ID	Soil Sample Depth	Proximal Well	Screen Interval	NAPL Present in Well?
RISBCD-06	10-14.5	RIPZ-26	5-15	None
RISBCD-06	24-25.5	RG-3B	21.4-36.4	LNAPL
RISBCD-07	22-24	Sump 9B-CW	21-31	LNAPL
RISBCD-08	12-14	RIPZ-8	12-32	None
RISBCD-08	15-16.5	RIPZ-8	12-32	None
RISBCD-09	8-10.5	Sump 9B	8.4-27.4	LNAPL
RISBCD-11	42-43.5	RGPZ-5B	29.5-39.5	None
RISBCD-13	30-31.5	RIPZ-8	12-32	None

Geographically, RISBCD-06, -07, -08, -09, -11, and -13 (the borings that may contain NAPLs based on soil concentrations) are all located either along the toe of the P/S Landfill buttress or along the former drainage channel that once drained the P/S Landfill canyon, as shown on Figure M-3. NAPL presence based on soil partitioning calculations was not predicted for the eastern capped landfill drainage channel between former Pond 19 and Pond 6.

Numerous water quality wells and piezometers are located along the former P/S Landfill drainage between the Gallery Well and PSCT-1. During the RI fieldwork, one additional water quality monitoring well (RIMW-3) and three piezometers (RIPZ-8, -25, and -26) were installed here. As described in Appendix E, NAPLs (primarily in the form of floating product, a sheen, or product saturation) were observed during drilling at RIMW-3 and RIPZ-25 (screened within the Upper HSU) and RIPZ-8 (screened within the Lower HSU). Liquid level measurements have confirmed the presence of LNAPL in piezometer RIPZ-25. Relative to the Type 7 sampling work, RIPZ-25 is approximately 50 feet east of RISBCD-09. LNAPLs have not been observed in RIMW-3, RIPZ-8, or RIPZ-26 in recent measurement events. Relative to the Type 7 sampling work, RIMW-3 is approximately 40 feet southeast of RISBCD-07, RIPZ-8 is approximately 70 feet north of RISBCD-08, and RIPZ-26 is approximately 60 feet northeast of RISBCD-06. Future monitoring of these wells will allow us to observe any presence of NAPL in this study area.

3.5 Liquids Treatment Area

Four NAPL investigation borings are located within the Liquids Treatment Area. The four borings were advanced on 5 October 2004 with the Columbia Technologies MIP equipment. The work completed is described as follows.

- Three borings (RISBLT-05, RISBLT-07, and RISBLT-08) were completed surrounding the eastern, northern, and western boundaries of the 6-pack containment berm, respectively. Location RISBLT-05 was completed to a depth of 47.2 feet bgs, location RISBLT-07 was completed to a depth of 50.7 feet bgs, and location RISBLT-08 was completed to a depth of 51.3 feet bgs.
- One boring (RISBLT-09) was completed south of the Operations Building adjacent to the cement pond. RISBLT-09 was completed to a depth of 45.1 feet bgs.

3.5.1 UVIF/MIP Results

As shown in Attachment M-3, each of the four borings completed in the Liquids Treatment Area exhibited low to moderate MIP responses. The MIP responses for locations RISBLT-05 and RISBLT-07 were sharp single peaks at approximately 43 feet bgs, near the bottom of these borings. The MIP response for location RISBLT-08 was a sharp single peak at approximately 32 feet bgs, with the MIP PID response rising at the bottom of the boring at approximately 49 feet bgs. A moderate MIP ECD response in Boring RISBLT-09 was centered around 36.5 feet bgs. Given the magnitude of the MIP responses, it is highly unlikely that NAPLs exist at these locations.

3.5.2 Comparison of UVIF/MIP Results with Soil Sampling Data

Based on the UVIF/MIP results, chemical partitioning calculations were performed on eight samples (two of which represented field duplicate samples) from four borings in this study area. A summary of the selected sampling locations and their associated total VOC and total SVOC concentrations are provided below.

Location ID	Depth interval, ft bgs	Total VOCs, mg/kg	Total SVOCs, mg/kg
RISBLT-05	43-44.5	2.5	Not Detected
RISBLT-07	42-45.5	4.68	Not Detected
RISBLT-07 (duplicate)	42-45.5	4.18	Not Detected
RISBLT-08	42.5-44	0.37	Not Detected
RISBLT-08	48-49.5	3.89	Not Detected
RISBLT-09	19-23	0.006	Not Detected
RISBLT-09 (duplicate)	19-23	0.008	Not Detected
RISBLT-09	36-37.5	0.26	Not Detected

The total VOC concentrations for each of these samples are very low, and SVOCs were not detected. As expected, Table M-2 and the calculation sheets provided in Attachment M-4 show that none of these samples exhibited concentrations of VOCs or SVOCs that would be indicative of NAPL presence. These data are consistent with drilling logs completed in adjacent boreholes. No NAPLs or chemical sheens were observed during the soil sampling program.

3.5.3 Comparison of UVIF/MIP Results with Groundwater Sampling Data

Only one monitoring well (RIMW-5; screened in the Lower HSU) is located in the Liquids Treatment Area. This well is near the former Casmalia Neutralization System (CNS) in the northern portion of the study area. No monitoring wells are present in the vicinity of the Type 7 NAPL investigation samples completed in this area (i.e., near the 6-pack containment berm or south of the Operations Building near the “cement pond”).

Although groundwater quality data are not specifically available for this area, the MIP and soil data collected during this investigation do not suggest the presence of NAPL in the Liquids Treatment Area.

3.6 Maintenance Shed Area

Four NAPL investigation borings were advanced within the Maintenance Shed Area: one boring east of the Maintenance Building (RISBMS-02), one boring beneath the former decontamination tank (RISBMS-03), one boring adjacent to the septic tank (RISBMS-08), and one boring immediately south of the diesel/gasoline underground storage tanks (USTs) (RISBMS-09). Each of these locations was completed between 6 and 7 October 2004 using the Columbia Technologies MIP equipment.

3.6.1 UVIF/MIP Results

As shown in Attachment M-3, with the exception of a single PID, FID, and ECD peak at the bottom of the RISBMS-02 boring (approximately 21 feet bgs), no significant MIP responses were observed in any of these Maintenance Shed borings.

3.6.2 Comparison of UVIF/MIP Results with Soil Sampling Data

Based on the UVIF/MIP results, chemical partitioning calculations were performed on the one sample collected at the base of RISBMS-02. The sample depth and its associated total VOC and total SVOC concentrations are summarized below.

Location ID	Depth interval, ft bgs	Total VOCs, mg/kg	Total SVOCs, mg/kg
RISBMS-02	21-23	0.07	0.11

The total VOC and SVOC concentrations for this sample are very low. As expected, Table M-2 and the calculation sheets provided in Attachment M-4 show that this sample does not exhibit concentrations of VOCs or SVOCs that would be indicative of NAPL presence.

These data are consistent with drilling logs completed in adjacent boreholes. No NAPLs or chemical sheens were observed during the soil sampling program.

3.6.3 Comparison of UVIF/MIP Results with Groundwater Sampling Data

No monitoring wells are located within the vicinity of the Type 7 NAPL investigation samples completed in this area.

Although groundwater quality data are not specifically available for this area, the MIP and soil data collected during this investigation do not suggest the presence of NAPL in the Maintenance Shed Area.

3.7 Administration Building Area

Two NAPL investigation borings are located at the Administration Building Area. The two borings were completed on 5 October 2004. One boring (RISBAB-01) is adjacent to the septic tank near the Administration Building and the other (RISBAB-04) is near the former laboratory piping that historically discharged to Pond 12. Each of these locations was completed using the Columbia Technologies MIP equipment to total depths of 36.1 and 34.0 feet bgs, respectively.

3.7.1 UVIF/MIP Results

As shown in Attachment M-3, both of these borings exhibited low to moderate MIP responses. Boring RISBAB-01 responded with low-level peaks on the PID, FID, and ECD between approximately 13 and 15 feet bgs. Boring RISBAB-04 responded with thin single peaks on the PID and FID at a depth of approximately 22.5 feet bgs.

3.7.2 Comparison of UVIF/MIP Results with Soil Sampling Data

Based on the UVIF/MIP results, chemical partitioning calculations were performed on two soil samples in this study area. The selected sampling locations and their associated total VOC and total SVOC concentrations are summarized below.

Location ID	Depth interval, ft bgs	Total VOCs, mg/kg	Total SVOCs, mg/kg
RISBAB-01	14-17.5	0.01	0.79
RISBAB-04	22-23.5	0.005	Not Detected

The total VOC and SVOC concentrations for these samples are very low to non-detect. As expected, Table M-2 and the calculation sheets provided in Attachment M-4 show that these samples do not exhibit concentrations of VOCs or SVOCs that would be indicative of NAPL presence. These data are consistent with drilling logs completed in adjacent boreholes. No NAPLs or chemical sheens were observed during the soil sampling program.

3.7.3 Comparison of UVIF/MIP Results with Groundwater Sampling Data

One monitoring well (RP-64B, an Upper HSU well) is located within the Administration Building Area, just north of RISBAB-01. No NAPLs have been observed in this monitoring well.

The data collected during this investigation do not suggest the presence of NAPL in the Administration Building Area.

3.8 Remaining On-Site Area

Eighteen NAPL investigation locations are found in the Remaining On-Site Area, 13 of which are within the former ponds and pads, and five within historical drainage channels in the western and eastern portions of the Remaining On-Site Area. With the exception of RISBON-67, each of the NAPL investigation locations in the Remaining On-Site Area was completed using the Columbia Technologies MIP equipment. RISBON-67 was completed using only the Gregg In Situ CPT/UVIF instrument. The work completed at each of the former pond locations is described as follows:

- Two borings (RISBON-66 and RISBON-70) were completed within former Pond C (oilfield wastes) on 28 September 2004 to total depths of 7.4 and 8.0 feet bgs, respectively.
- Two borings (RISBON-68 on 28 September 2004 and RISBON-69 on 20 September 2004) were completed within former Pond D (Wet Air Oxidation [WAO] effluent/RCRA liquids/truck washout) to total depths of 25.10 and 17.72 feet bgs, respectively.
- Two borings (RISBON-67 and RISBON-71) were completed within former Pond M (oilfield wastes). As mentioned above, RISBON-67 was completed on 8 August 2004 to a total depth of 20.5 feet bgs with the CPT/UVIF instrument. RISBON-71 was completed on 28 September 2004 to a total depth of 18.7 feet bgs.
- Two borings (RISBON-64 and RISBON-65) were completed within former Pond S (oilfield wastes) on 27 September 2004 to total depths of 9.5 and 7.1 feet bgs, respectively.
- One boring (RISBON-63) was completed within former Pond A on 28 September 2004 to a total depth of 4.4 feet bgs.
- One boring (RISBON-74) was completed within former Pond B on 28 September 2004 to a total depth of 15.6.
- One boring (RISBON-72) was completed within former Pond V (oilfield wastes) on 27 September 2004 to a total depth of 50.9 feet bgs.
- One boring (RISBON-73) was completed within former Pond 16 (WAO effluent/RCRA liquids/truck washout) on 28 September 2004 to a total depth of 19.4 feet bgs.
- One boring (RISBON-75) was completed just south and between former Ponds P and 14 (acid/alkaline wastes) on 28 September 2004 to a total depth of 19.7 feet bgs.

The work completed at each of the historical drainage channels is described as follows:

- Two borings were completed along the western drainage. RISBON-58 was originally positioned in former Pad 4A, downstream of the confluence of two former drainages. This boring was moved approximately 160 feet north along the western former drainage line (fed from the Liquids Treatment Area) due to access restrictions of the CPT rig. RISBON-59 is located further south along the drainage where it crosses NTU Road. These two locations were completed on 23 and 24 September 2004 to total depths of 25.8 and 60.0 feet bgs, respectively.
- Three borings were completed along the eastern drainage. RISBON-60 and -61 are located at the confluence and south of the confluence of the P/S and Metals Landfill drainages (in former Pond 8), respectively. RISBON-62 is located further south along

the drainage where it crosses NTU Road. Two locations (RISBON-60 and -61 were completed on 23 September 2004 to total depths of 12.5 and 12.3 feet bgs, respectively. The other location (RISBON-62) was completed on 24 September 2004 to a total depth of 37.7 feet bgs.

3.8.1 UVIF/MIP Results

As shown in Attachment M-3, of the 17 Type 7 borings completed within these former ponds, pads, and historical drainages using the MIP tool, only three borings exhibited any significant responses to the MIP detectors. RISBON-59, located along the former western drainage where it crosses NTU Road, showed no responses within the PID or ECD, but did exhibit low to moderate peaks on the FID between approximately 25 to 44 feet bgs. This response correlates with soil sampling observations at this depth, which noted “black, oily, with moderate-strong petroleum-like odor” at a depth of 29 feet bgs. RISBON-68, located within former Pond D (just south of the Liquids Treatment Area), responded with low to moderate peaks on the FID and ECD between approximately 13 and 16 feet bgs, but had no response on the PID. RISBON-73, located within former Pond 16 (also just south of the Liquids Treatment Area), produced notable peaks on the PID, FID, and ECD over a fairly short interval centered on approximately 5.25 feet bgs.

A shown in Attachment M-2, RISBON-67, located within former Pond M, showed little to no response on the UVIF.

3.8.2 Comparison of UVIF/MIP Results with Soil Sampling Data

Based on the UVIF/MIP results, chemical partitioning calculations were performed on three soil samples in this study area. A summary of the selected sampling locations and their associated total VOC and total SVOC concentrations are provided below.

Location ID	Depth interval, ft bgs	Total VOCs, mg/kg	Total SVOCs, mg/kg
RISBON-59	29-32.5	52.8	3.4
RISBON-68	14-16	0.02	Not Detected
RISBON-73	5-7	0.003	Not Detected

The total VOC and SVOC concentrations for samples RISBON-68 and RISBON-73 are very low to non-detect. Table M-2 and the calculation sheets provided in Attachment M-4 show that none of the samples exhibit concentrations of VOCs or SVOCs that may be indicative of NAPL presence. Although no NAPLs or chemical sheens were observed at RISBON-59 during the soil sampling program, the soil that was described as “oily” with a petroleum-like odor was found at the water table (29 feet bgs). That field observation, combined with the elevated MIP response at the water table, suggested potential LNAPL presence at this location. The absence of any ECD response on the MIP suggests that the chemicals observed at this depth do not contain any chlorinated solvents, and the absence of any PID response at this depth suggests that the lower ionization-potential hydrocarbons (such as benzene) that are commonly associated with gasoline are not present.

The CSC completed Phase II RI investigations during July 2006 in the vicinity of RISBON-59 to further assess the nature and extent of soil impacts in this area, and evaluate whether NAPL may be present. The Phase II RI investigations included installation of Piezometer RIPZ-37 at the location of Phase I soil boring RISBON-59, and completion of three additional Type 6 soil borings to the west, east, and south of the piezometer (locations RISBON-83, -84, and -85, respectively). The piezometer was installed to a depth of 50 feet bgs, with a screened interval extending from 30 to 50 feet bgs, spanning the groundwater table in this area. To date, no NAPL has been observed in this piezometer.

Borings RISBON-83, -84, and -85 were completed to depths of 58, 60, and 52.5 feet bgs respectively. Five soil samples were collected at selected depths from each of the three soil borings for analysis of the modified Appendix IX list of constituents. While analytical results of all samples collected from the three step-out borings detected a variety of organic constituents, only four of the 15 samples tested were reported to contain poor-purging compounds/alcohols and polycyclic aromatic hydrocarbons (PAHs) at concentrations in excess of available screening levels. Available data, including analytical laboratory results, MIP measurements and field observations, indicate that maximum contaminant concentrations in this area are present at depths of between approximately 27 to 36 feet bgs in RISBON-59, and diminish both laterally and vertically away from this location. Additional Phase III step-out borings were also completed in this area, and the results of that supplemental investigation are provided in Section 5.0 of Appendix B.

3.8.3 Comparison of UVIF/MIP Results with Groundwater Sampling Data

The Remaining On-Site Area represents the single largest study area of the Site, and as such, dozens of wells have been completed here. In general, monitoring wells and piezometers that have historically contained NAPLs are located within the Central Drainage Area and in the Capped Landfills Area. DNAPLs have been observed in the Gallery Well, RGPZ-7C, and RGPZ-7D. LNAPLs have been observed in the Gallery Well, GW-P(W), GW-P(E2), GW-P(E3), Sump 9B-CW, Sump 9B-PB, Sump 9B-PC, RG-3B, and PSCT-1. No NAPLs have been observed in monitoring wells south of the PSCT.

The Phase II RI investigations included installation of piezometer RIPZ-37 at the location of Phase I soil boring RISBON-59. The piezometer was installed to a depth of 50 feet bgs, with a screened interval extending from 30 to 50 feet bgs, spanning the groundwater table in this area. To date, no NAPL has been observed in this piezometer.

With respect to other wells located near RISBON-59, where LNAPL was suspected, three groundwater monitoring wells (TP-3, an Upper HSU monitoring well, and RP-92C and MW-11D, both Lower HSU monitoring wells) are approximately 100 to 150 feet south, between the western margin of the runoff containment facility (RCF) pond and Pond 13. NAPLs have not been observed in any of these nearby wells. Available data, including analytical laboratory results, MIP measurements, and field observations, indicate that maximum contaminant concentrations in this area are present in soils at depths of between approximately 27 to 36 feet bgs in RISBON-59, and diminish both laterally and vertically away from this location.

The background, nature and findings of the Phase II and III investigations conducted in the RISBON-59 area are summarized in Section 5.0 of this RI Report. While the CSC initially attributed the impacts in the area of RISBON-59 to remnant contamination left in-place during cleanup of former Pond 2 during (approximately 1988-1990), EPA noted a previously unidentified pond on historical aerial photos from 1974 and 1975. This feature was the subject

of a focused Phase III investigation conducted during 2007 in proximity to RISBON-59. These investigations concluded that contamination detected in the RISBON-59 area is coincident with the southern margin of former waste management Pond 2 as well as with a preceding former waste impoundment visible on historical aerial photographs from 1974 and 1975.

3.9 Off-Site Areas

RISBOF-01 is located off site, west of Pond A-5. Probing at this location was intended to provide a UVIF response profile that represents a non-NAPL or non-contaminated area of the Site. The profile obtained from this location and from two known NAPL locations (near Sump 9B and near the Gallery Well) was used to benchmark the UVIF technology.

The initial CPT/UVIF boring was completed on 2 August 2004 to a depth of 56.3 feet bgs. On 10 August 2004, RISBOF-01-MIP was advanced using the Vironex MIP equipment to a total depth of 51.8 feet bgs.

3.9.1 UVIF/MIP Results

No significant responses to the UVIF probe were observed within borehole RISBOF-01. Small but noticeable responses on the PID and ECD were observed at the bottom of the MIP boring (RISBOF-01-MIP). Although the cause for these responses remains unknown, the overall magnitude of the responses was low relative to other samples on Site, and do not suggest the presence of NAPLs at this location.

3.9.2 Comparison of UVIF/MIP Results with Soil Sampling Data

Because this was a background sample from a presumed uncontaminated area, no soil samples were collected at RISBOF-01.

3.9.3 Comparison of UVIF/MIP Results with Groundwater Sampling Data

No groundwater monitoring wells are located adjacent to the RISBOF-01 location. The UVIF and MIP responses are generally consistent with a sample collected from a non-chemically impacted area.

3.10 Additional Chemical Partitioning Calculations

Following their review of the *Interim Progress Report* (CSC, 2005), USEPA noted that most of the soil borings identified as having the potential for NAPLs, based on UVIF/MIP responses and associated chemical partitioning calculations, contained elevated concentrations of total VOCs and total SVOCs. USEPA also noted that several additional soil samples were collected during the Phase I RI field sampling program that similarly contained elevated concentrations of total VOCs and total SVOCs, but were not included in the CSC's previous partitioning evaluation, as they were not associated with the Type 7 NAPL investigation program. Following discussions with USEPA, the CSC agreed to expand the NAPL analysis and complete additional chemical partitioning calculations for all soil samples that contain total VOC concentrations greater than 10 milligrams per kilogram (mg/kg) or total SVOC concentrations greater than 10 mg/kg (excluding tentatively identified compounds).

The 32 samples that meet these criteria are listed in Table M-3. As noted in this table, half of these samples (16 of 32) were already evaluated for NAPL potential because of their associated elevated UVIF or MIP responses (i.e., included in Table M-2). Table M-3 and the calculation sheets provided in Attachment M-4 show that the following 11 samples have the potential for NAPLs based on chemical partitioning calculations:

- RISBCD-06* 24-25.5 ft
- RISBCD-07* 22-24 ft
- RISBCD-08* 12-14 ft
- RISBCD-09* 33-35 ft
- RISBCD-11A* 41-42 ft
- RISBCD-11* 42-43.5 ft
- RISBCD-13* 30-31.5 ft
- RISSCD-01 0-0.5 ft
- RISBON-37 5-7 ft
- RISBON-37 10-13.5 ft
- RISBCL-01C* 74-75 ft

* = Denotes location also exhibits elevated UVIF or MIP response.

Figure M-4 shows these sample locations as well as field NAPL observations. Based on the calculations completed:

- Eight of these 11 samples were included in the Type 7 NAPL investigation program, and exhibited elevated UVIF or MIP responses (as noted with an asterisk above), and are discussed above (Sections 3.1 through 3.9).
- The 11 samples were collected from nine borings at the Site, and seven of those nine borings were within the Central Drainage Area, an area known to have NAPLs.
- Two samples collected from boring RISBON-37 contained VOC concentrations that suggest the potential for NAPL presence. RISBON-37 is located within former Pond B. The elevated concentrations of organic compounds are consistent with observations made during the time of sample collection. The boring log for RISBON-37 indicates strong odors beginning at approximately 5 feet bgs, and headspace PID concentrations above 1,000 parts per million at approximately 10 feet bgs. No UVIF or MIP sampling was completed at RISBON-37, but an MIP probe was completed at RISBON-74, less than 100 feet away within the same former pond area. The MIP sampling at RISBON-74 did not indicate the need for further investigation.
- The other sample with potential NAPL presence based on soil concentrations and MIP results (RISBCL-01C) was collected from the Capped Landfill Area, immediately adjacent to the Gallery Well, which is known to contain NAPLs.

4.0 EVALUATION OF ADDITIONAL DATA NEEDS

The necessity for collecting additional NAPL data from the Site has been evaluated relative to the data quality objectives (DQOs) presented in Section 4 of the RI/FS Work Plan. The DQO process is a series of planning steps completed by all members of the project team that is based on scientific method to ensure that the type, quantity, and quality of environmental data used in decision-making are appropriate for the intended application. DQOs also serve as performance criteria for assessing ongoing or completed environmental investigations and for allowing key decisions to be made with a defined level of confidence (USEPA, 2000). For these reasons, it is appropriate to review the DQOs following the collection of field data to determine if additional data will be necessary to complete the RI and FS.

The NAPL survey data obtained during this RI investigation, along with historical data, were evaluated with respect to the DQOs identified in the RI/FS Work Plan. Work Plan Sections 4.3 through 4.6 identify specific decisions and decision rules for issues related to this Task, including those related to contaminant extent, fate and transport, and TI and FS evaluations, all of which will need to consider the nature and extent of NAPLs present at the Site. Note some of the NAPL-related DQO decisions described below are also addressed in Appendix B (Soil and Sediment Sample Summary), Appendix E (Well and Piezometer Installation), and Appendix G (Groundwater Chemistry).

4.1 DQO Decisions Related to NAPL Surveys

The specific decisions and decision rules for issues related to the NAPL surveys are as follows:

- What is the nature and extent of NAPL in the Capped Landfills Area? Are there NAPLs present in other areas of the Site and what is the character of these NAPLs?
- What is the nature and extent of groundwater contamination? Is DNAPL or LNAPL present or likely to be present?
- If significant groundwater contamination is evident, the presence of NAPL will also be assessed in that area.
- If NAPL is identified in a Site area, the nature of the NAPL will be assessed.
- To assess potential off-site contaminant transport, the investigation will be focused on drainages (and other similar preferential pathways) because contaminants would be expected to concentrate there.

NAPLs were historically known to occur within the Capped Landfills Area (e.g., the Gallery Well) and the Central Drainage Area (e.g., Sump 9B). Newly installed monitoring wells and piezometers in the Central Drainage Area also encountered NAPLs during development. The elevated UVIF and MIP responses, in combination with high concentrations of organic compounds found in soil samples within the Gallery Well and the Central Drainage Area, are consistent with the known presence of NAPLs in these two study areas.

The NAPL survey within the Burial Trench Area also exhibited significant UVIF and MIP responses that are consistent with elevated concentrations of organic compounds found in soil and groundwater in this area. Soil partitioning calculations indicate the potential presence of LNAPLs in the Burial Trench Area. LNAPLs have also been identified in two of the new wells installed in this area.

One sample within the Remaining On-Site Area (RISBON-59) contained visibly stained soil that had an “oily” appearance. This sample was collected at the water table, and may represent an isolated presence of LNAPL near the southeastern corner of the RCF pond. This sample location does not appear to be associated with any particular historical release, and should be investigated to confirm LNAPL presence. Two additional phases of soil and groundwater sampling were completed in the area surrounding RISBON-59 and, based on the results of that sampling, any potential NAPL that might be present at this location does not appear to be widespread.

Based on chemical partitioning calculations performed on soil samples with elevated VOC and SVOC concentrations, two samples collected from boring RISBON-37 contained VOC concentrations that suggest the potential for NAPL presence. RISBON-37 is located within former Pond B. The elevated concentrations of organic compounds are consistent with observations made during the time of sample collection. The boring log for RISBON-37 indicates strong odors beginning at approximately 5 feet bgs, and headspace PID concentrations above 1,000 parts per million at approximately 10 feet bgs. No UVIF or MIP sampling was completed at RISBON-37, but an MIP probe was completed at RISBON-74, less than 100 feet away within the same former pond area. The MIP sampling at RISBON-74 did not indicate the need for further investigation.

Other than the Capped Landfills Area, the Central Drainage Area, the Burial Trench Area, a single sample collected near the southwestern extent of the RCF pond, and a single boring within former Pond B, no other study areas at the Site appear to contain significant quantities of NAPL in the subsurface. This includes the Liquids Treatment Area, RCRA Canyon, the Administration Building Area, and the Maintenance Shed Area. In addition, none of the Type 7 NAPL survey borings completed along the historical drainage channels detected DNAPLs.

In summary, the UVIF and MIP tools responded significantly to the presence of organic compounds in Site soils and groundwater. In general, these areas have been adequately characterized using direct measurement techniques (i.e., monitoring well liquid levels and chemical analyses). We do not recommend any further UVIF or MIP sampling at the Site.

5.0 CONCLUSIONS

The NAPL survey was completed to evaluate the potential for various types of NAPL to be present at the Site, specifically in areas associated with historical burial trenches and wells, the former drainages, pads, and ponds south of the landfills, but north of the PSCT, and in former drainages and oilfield-related ponds south of the PSCT.

The locations for the NAPL survey were chosen with USEPA's concurrence based on a review of historical Site operations and groundwater quality data from wells located within areas specifically identified as having potential or indirect indication of high NAPL presence. The CSC also considered other indirect evidence of NAPL presence, including observations made during RI/FS drilling activities and chemical partitioning based on soil concentration data.

The results of the survey show that NAPL presence appears to be limited to areas upgradient of the PSCT, where NAPL has been previously observed in monitoring wells or piezometers (i.e., the Burial Cell Area, the Capped Landfill Area, and the Central Drainage Area). Isolated findings of residual soil contamination south of the PSCT (e.g., at RISBON-37 in former Pond B, and oily soils found at RISBON-59 near the former Pond 2) have been identified, but no significant groundwater impacts have been observed at these locations.

6.0 REFERENCES

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