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February 18, 2003

Commander
U.S. Army Engineer District, Nashville
ATTN: CELRN-EC-R-M (Mrs. Linda Ingram)
110 Ninth Avenue South, Room 682
U.S. Court House Annex
Nashville, Tennessee 37203

Submittal of the Final - Fifth Quarterly Background Groundwater Report for Phase II Groundwater Remedial Investigation Former Plum Brook Ordnance Works, Sandusky, Ohio Contract Number DACA62-00-D-002; IT Project Number 833886

Dear Mrs. Ingram:

In accordance with the requirements of Delivery Order 0014 of Contract Number DACA62-00-D-002, IT Corporation is pleased to submit the Final - Fifth Quarterly Background Groundwater Report for the Phase II Groundwater Remedial Investigation of the TNT and Red Water Ponds Areas at the Former Plum Brook Ordnance Works in Sandusky, Ohio.

Please submit any external comments within 30 days or by **March 20, 2003** to Mrs. Linda Ingram at the U.SACE office in Nashville, Tennessee. The submittal address is as follows:

Department of the Army
Nashville District, Corps of Engineers
ATTN: CELRN-EC-R-M (Mrs. Linda Ingram)
P.O. Box 1070
Nashville, Tennessee 37202-1070

Any external comments received will be incorporated into next background groundwater report which will be titled "2003 Groundwater Data Summary and Evaluation Report".

Should you have any questions or require additional information regarding this submittal, please do not hesitate to call me at (865) 694-7496.

Sincerely,

Steven T. Downey, PE
Project Manager

Enclosures

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Client Name: U.S. Army Engineer District, Nashville; CELRN-EC-R-M

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NOTICE: By signature above, parties certify that the subject document has been prepared by and/or reviewed by them (as appropriate), that all review comments have been resolved, and that the document is ready for submittal.

RESPONSE TO COMMENTS
U.S. ARMY CORPS OF ENGINEERS (CELRN-EC-R-D)
FINAL - FIFTH QUARTERLY BACKGROUND GROUNDWATER REPORT
FORMER PLUM BROOK ORDNANCE WORKS, SANDUSKY, OHIO
(Report dated January 2003)

Reference: Pre-issue Comments from Jim Beaujon forwarded by Linda Ingram (dated 4 February 2003).

Comment 1: **Section 5.0: The first part of the paragraph is confusing as it refers to the "quarterly background" analytical data as "from non-background monitoring wells".**

Also we're not sure that the Groundwater RI will be the report corresponding to the "6th Quarterly" sampling. The Risk Assessors will probably need to be happy with the groundwater background data before we can present Volume I of the RI and that may not happen until after the "10th Quarterly" sampling.

Response 1: The paragraph in section 5.0 will be changed to "A sixth quarterly background groundwater report (2003 Groundwater Data Summary and Evaluation Report) representing groundwater analytical results of April 2003 in conjunction with wet and dry season analytical data from non-background monitoring wells, will be submitted following receipt and evaluation of April analytical data." Information in this paragraph suggesting the 6th Quarterly report will become Volume I of the RI will be omitted.

Comment 2: **Figure 2-1: The arrow indicating bedrock groundwater flow direction near PB-BED-MW24 indicates flow is away from PBOW to the northwest. Please confirm that is what the data actually indicates and whether it's only shown up in one set of data or has been consistently present. If flow direction at PB-BED-MW24 is truly away from PBOW then there is no reason to try to install a new background well off-site in that area and PB-BED-MW24 is not a valid background well. It would also explain why we're getting hits of explosives in PB-BED-MW24.**

Response 2: The groundwater flow direction at the extreme western corner of the PBOW site has been and is difficult to interpret based on the lack of available groundwater data to the west and north of this corner. February, May, August, and November 2002 groundwater flow maps use a similar interpretation of groundwater flowing away from well PB-BED-MW24. This interpretation is due to the low water level measured in the well compared with the other nearby monitoring wells to the north and west. Groundwater flow directions prior to the installation of well PB-BED-MW24 (November 1997, February and May 1998, and August and November 2001) showed similar groundwater flow directions to the

northeast in this area. Well PB-BED-MW24 is in the karst Delaware Limestone bedrock.

A monitoring well installed off-site (west) of PB-BED-MW-24 would be beneficial for several reasons. 1) If historic (November 1997 through November 2001) groundwater flow maps are correct, the well would be upgradient of PB-BED-MW24. 2) If current (February through November 2002) flow maps are correct, the well would be downgradient to assess groundwater leaving the PBOW facility. 3) A monitoring well in this area is needed to provide an accurate interpretation of the groundwater flow to determine the correct flow direction.

Comment 3: **Of a somewhat minor note: "Quarterly" is misspelled on the cover and "Groundwater" isn't included in the title.**

Response 3: The covers and spines of the report will be replaced prior to the full distribution.

Response to Pacific Environmental Services Comments on the Final - Fifth Quarterly Background Groundwater Report Former Plum Brook Ordnance Works, Sandusky, Ohio
(Report dated February 2003)

Comments Received from Mike Gunderson:

Comment 1: **Section 1.0, page 1-1, second paragraph, penultimate sentence; The negotiation date for the contract is irrelevant and should be removed.**

Response: Agreed. Entire sentence has been removed.

Comment 2: **Section 1.0, page 1-2, first complete paragraph, first sentence; Suggest changing the sentence to read ". . . . to stop possible toxic hydrogen sulfide gas emanating . . . "**

Response: Agreed. Sentence will be reworded.

Comment 3: **Section 1.1, general comment; The report uses the term "residuum" throughout. Historically, this unit has been referred to as the "overburden". May want to keep this consistent to avoid potential confusion for other reviewers (i.e., the public and RAB).**

Response: Agreed. "Residuum" will be replaced with "overburden" throughout the report.

Comment 4: **Section 1.1, page 1-2, item #7; Suggest changing to "Determine if the locations of background monitoring wells are adequate to establish background groundwater quality."**

Response: Agreed. Sentence will be reworded.

Comment 5: **Section 1.1, page 1-2, item #8; Suggest changing to " . . . for use in the future groundwater risk assessment.".**

Response: Agreed. Sentence will be reworded.

Comment 6: **Section 2.2, page 2-1, second sentence; Suggest changing to ". . . included four bedrock wells (PB-BED-MW20, PB-BED-MW24, BG8-BEDGW-001, AND PB-BED-MW25) and one overburden well ((IT-MW01).". The reason for this is that I went to Table 2-1 as reference in the fifth sentence and the well list there did not match this text.**

Response: Agreed. Paragraph will be reworded.

Comment 7: Section 2.2, page 2-1, last sentence; Depending on the resolution of comment #6 above, this sentence may need to be deleted.

Response: Agreed. Sentence will be deleted.

Comment 8: Table 2-1; Well PB-BED-MW27 is not listed in Table 2-1.

Response: Monitoring well PB-BED-MW27 was sampled in October 2002, however, the analytical results, etc. will be presented in the Second Annual Data Summary and Evaluation Report. For simplicity, results for this well in its entirety was omitted from the Fifth Quarterly Background Report and will be included in the Second Annual Data Summary and Evaluation Report, including Table 2-1.

Comment 9: Section 2.2, page 2-2, last paragraph, last sentence; Please extrapolate on how the equipment would be "damaged".

Response: Agreed. Both the petroleum hydrocarbon and black hydrogen sulfide substance have the potential to stain and/or contaminate the low-flow sampling equipment. This will be explained in the sentence.

Comment 10: Section 2.4, page 2-3, last sentence; Per recent USACE comments on the Groundwater RI, change "U.S. Liquids office" to "U.S. Liquids facility".

Response: Agreed. Sentence will be changed.

Comment 11: Section 4.2, page 4-1, penultimate sentence; Suggest changing to "With the exception of nitroaromatic compounds, all analytes detected below preliminary screening levels are not discussed in detail but are presented in the referenced data table.

Response: Agreed. Sentence will be revised.

Response to Internal IT Review Comments on the
Final - Fifth Quarterly Background Groundwater Report
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Report dated February 2003)

Comments Received from Bill Hedberg:

Comment 1: **Section 2.2, page 2-2, first paragraph; Suggest changing the first sentence to: "Based upon present drought conditions and sampling during the PBOW dry season time period, groundwater recharge rates permitted only wells PB-BED-MW25 and BG8-BEDGW-001 to be sampled with the minimal drawdown (low-flow) sampling methodology." Recommend removing the second sentence and moving it to the beginning of the third paragraph on this page.**

Response: Agreed. The rewording will be made.

Comment 2: **Section 2.2, page 2-2, last paragraph; Grammatically rephrase the last two sentences in the paragraph to: "Low-flow sampling was not attempted in monitoring well PB-BED-MW27 due to 0.50 feet of weathered, petroleum hydrocarbon present in the well and a black hydrogen sulfide substance on the well casing. Both of these factors were considered to potentially damage the low-flow sampling equipment."**

Response: Agreed. The grammatical change will be made.

Comment 3: **Section 4.2.3, 2001 First Quarterly Dry Season Sampling Event (October), second sentence; include ethylbenzene in the analytical data that was detected above preliminary screening levels(PB-BED-MW24).**

Response: Agreed. Ethylbenzene will be added.

Comment 4: **Section 4.2.3, 2002 Second Quarterly Wet Season Sampling Event (January), second sentence; include ethylbenzene in the analytical data that was detected above preliminary screening levels(PB-BED-MW24).**

Response: Agreed. Ethylbenzene will be added.

Comment 5: **Section 4.2.3, 2002 Third Quarterly Wet Season Sampling Event (April), fourth sentence; include ethylbenzene and total xylenes in the analytical data that was detected above preliminary screening levels (PB-BED-MW24).**

Response: Agreed. Ethylbenzene and total xylenes will be added.

Comment 6: **Section 4.2.3, 2002 Fourth Quarterly Dry Season Sampling Event (July), second sentence; include ethylbenzene in the analytical data that was detected above preliminary screening levels (PB-BED-MW24).**

Response: Agreed. Ethylbenzene will be added.

Comment 7: **Section 4.2.4, Insert the following sentence after the fourth sentence in paragraph; "In addition, the VOCs ethylbenzene, methylene chloride, and total xylenes were detected in monitoring well PB-BED-MW24 above screening levels."**

Response: Agreed. Sentence will be added.

Comments Received from Mary Hall:

Comment 1: Section 1.0, page 1-1, second paragraph; Refer to Shaw as Shaw Environmental, Inc. instead of Shaw Environmental and Infrastructure, Inc..

Response: Agreed. "and Infrastructure" will be removed.

Comment 2: Section 2.2, page 2-1, first paragraph, fourth sentence; add "for PB-BED-MW27" after Analytical results.

Response: Agreed. Change will be made.

Comment 3: Section 3.0, page 3-1, first paragraph; Add reference (EPA, 2002) after (PRG).

Response: Agreed. Change will be made.

Comment 4: Section 3.1, page 3-1, first paragraph; Reference Method for Chemical Analysis of Water and Wastes needs to be added to Section 6.0 of report.

Response: Agreed. Reference section will be updated.

Comment 5: Table 2-2; gallon (gal) and oxygen (O2) need to be added to references underneath table.

Response: Agreed. They will be added.

Comment 6: Table 4-1; NS (Not sampled) and NE (Not established) were not used on table, so they can be removed from references underneath table. (VQ) needs to be added next to Validation Qualifiers.

Response: Agreed. Changes will be made.

Comment 7: Appendix B, general comment; Several places throughout appendix

have acronyms that are not spelled out. Several tables have undefined symbols or acronyms.

Response: Agreed. Changes will be made.

Comment 8: Appendix E; table of contents and acronyms needs to be updated.

Response: Agreed. Changes will be made.

Comment 9: Appendix E, general comment; Several places throughout appendix have acronyms that are not spelled out.

Response: Agreed. Changes will be made.

Comment 10: Appendix E, general comment; Appendix needs to have a reference section.

Response: Agreed. Reference section will be added.

Comment 11: Appendix E, page E-4, section before E3.0, Field Split Samples; This section should be E2.3 instead of E2.5. This needs to be updated on the table of contents.

Response: Agreed. Section number will be changed, and table of contents will be updated.

Comments Received from Steve Downey:

Comment 1: Section 1.0, page 1-1, second paragraph; delete last two sentences of paragraph.

Response: Agreed. Sentences will be deleted.

Comment 2: Section 1.0, page 1-2, first complete paragraph; reword first sentence to "Also, during the September 11, 2002 quarterly background investigation meeting between the USACE, OEPA, IT, and PES, a decision was made to abandon monitoring well PB-BED-MW27 and stop emanating odors from causing a nuisance to local residents." Change "should be" to "was" in last sentence.

Response: Agreed. Sentences will be reworded.

Fifth Quarterly Background Groundwater Report
Former Plum Brook Ordnance Works
Sandusky, Ohio

Prepared for:

U.S. Army Corps of Engineers, Nashville District
P. O. Box 1070
Nashville, Tennessee 37202-1070

Prepared by:

IT Corporation
312 Directors Drive
Knoxville, Tennessee 37923

IT Project No. 833886

Revision 1

February 2003

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List of Acronyms

DNT	dinitrotoluene
DOD	U.S. Department of Defense
DQO	data quality objective
Eh	oxidation-reduction potential
EPA	U.S. Environmental Protection Agency
FUDS	Formerly Used Defense Sites
GSA	General Services Administration
IDW	investigation-derived waste
IT	IT Corporation
NASA	National Aeronautics and Space Administration
OEPA	Ohio Environmental Protection Agency
PBOW	Plum Brook Ordnance Works
PBS	Plum Brook Station
PES	Pacific Environmental Services
pH	hydrogen ion concentration
ppm	parts per million
PRG	preliminary remediation goal
PRRWP	Pentolite Road Red Water Ponds
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
QAPP	quality assurance project plan
RDX	research department explosive (cyclotrimethylenetrinitramine)
RI	remedial investigation
SAP	sampling and analysis plan
SSAP	site-specific sampling and analysis plan
SSHP	site-specific health and safety plan
SVOC	semivolatile organic compound
TNT	trinitrotoluene
TNTA	TNT Area A
TNTB	TNT Area B
TNTC	TNT Area C
VOC	volatile organic compound
USACE	U.S. Army Corps of Engineers
WARWP	West Area Red Water Ponds

1.0 Introduction

The U.S. Army is conducting studies of the environmental impact of suspected hazardous waste sites at properties previously owned by the U.S. Department of Defense (DOD). The former Plum Brook Ordnance Works (PBOW), located in Sandusky, Ohio, is currently being investigated under the Defense Environmental Restoration Program for Formerly Used Defense Sites (FUDS). Figure 1-1 shows the geographical location of the former PBOW site. This 9,000-acre facility was used for the manufacture of explosives during World War II. The site is currently owned by the National Aeronautics and Space Administration (NASA) and is operated as the Plum Brook Station (PBS) of the John Glenn Research Center with headquarters based out of Lewis Field in Cleveland, Ohio.

The investigation is being managed and technically overseen by the Nashville, Tennessee and Huntington, West Virginia District Offices of the U.S. Army Corps of Engineers (USACE). Shaw Environmental, Inc. (Shaw), formerly IT Corporation (IT) was contracted by the USACE, Nashville District to continue a groundwater remedial investigation (RI) at two red water pond areas and three former trinitrotoluene (TNT) manufacturing areas at PBOW. The two red water pond areas are the West Area Red Water Ponds (WARWP) and the Pentolite Road Red Water Ponds (PRRWP). The three former TNT manufacturing areas are TNT Area A (TNTA), TNT Area B (TNTB), and TNT Area C (TNTC) (Figure 1-2).

Fifth quarter groundwater sampling activities were conducted pursuant to the following documents: the final site-specific safety and health plan (SSHP) (IT, 2001a), final site-specific sampling and analysis plan (SSAP) (IT, 2001b), the March 2002 letter amendment to the SSAP (IT, 2002), the site-wide sampling and analysis plan (SAP) (IT, 1996a), the quality assurance project plan (QAPP) (IT, 1996b), and the site-wide safety and health plan (IT, 1996c).

The purpose of the quarterly background sampling is to provide four seasonal collection events to evaluate groundwater quality and determine if a trending pattern is present in the groundwater of the background monitoring wells. Since minor concentrations of nitroaromatics (<0.5 parts per million [ppm]) were detected in three background wells during the month of April 2002 (3rd quarter), a joint decision was made by the USACE, Ohio Environmental and Protection Agency (OEPA), IT, and Pacific Environmental Services (PES) to continue background groundwater

sampling for two additional events. One event was scheduled during the dry season of October 2002 and one event is scheduled to take place during the wet season of April 2003.

Also, during the September 11, 2002 quarterly background investigation meeting between the USACE, OEPA, IT, and PES, a decision was made to abandon monitoring well PB-BED-MW27 and stop possible toxic hydrogen sulfide gas odors from emanating and causing a nuisance to local residents. A final groundwater sample was collected from PB-BED-MW27 during the October 2002 quarterly sampling event. Groundwater analytical results will be presented in the next upcoming background report with the other downgradient monitoring wells.

1.1 Objectives

The objectives, as scoped (USACE, 2001), for the quarterly background sampling were as follows:

1. Determine the quality of bedrock groundwater entering the PBOW site.
2. Determine the quality of overburden groundwater upgradient of selected sites at PBOW.
3. Determine the range of background concentrations for inorganics in both overburden and bedrock groundwater.
4. Perform trend analysis to determine if any change in the concentration of inorganics is seasonally dependent.
5. Establish background concentrations of inorganics in overburden and bedrock groundwater.

Additional background sampling objectives:

6. Determine if nitroaromatic occurrence in the background monitoring wells during the month of April 2002 was field error, laboratory error, or natural.
7. Determine if the locations of background monitoring wells are adequate to establish background groundwater quality.
8. Provide additional groundwater quality data for use in the future groundwater risk assessment.

It should be noted that due to drought conditions, establishing background concentrations of inorganics overburden groundwater was eliminated from the objectives.

After collection and analysis of the April 2003 groundwater data, a second full evaluation will be prepared and the trend analysis reviewed.

This report presents:

- Groundwater sampling procedures
- Results of the first, second, third, fourth, and fifth quarterly groundwater sampling events
- Laboratory analytical data of the October 2002 (fifth quarter) sampling (first quarter results were presented in the 2001 Groundwater Remedial Investigation report, second and third quarter results were presented in the Second and Third Quarterly Background Reports, respectively, and fourth quarter results presented in the First Annual Data Summary and Evaluation Report)
- Handling and disposal of investigation-derived waste (IDW).

1.2 Facility Location and Description

As mentioned above, the former PBOW site is currently owned by NASA. Most of the aerospace testing facilities at PBOW were constructed in the 1960s and are presently in a standby or inactive status. The site is located approximately 4 miles south of Sandusky, Ohio, and 59 miles west of Cleveland. Although primarily in Perkins and Oxford Townships, the eastern edge of the site extends into Huron and Milan Townships. PBOW is bounded on the north by Bogart Road, on the south by Mason Road, on the west by County Road 43, and on the east by U.S Highway 250. The immediate area surrounding PBOW is mostly agricultural. Along the northern and northeast perimeter residential sections are present. Public access at PBOW is restricted except during the annual deer hunting season.

1.3 Site History and Potential for Contamination

The PBOW site was built in early 1941 as a manufacturing plant for 2,4,6-TNT, dinitrotoluene (DNT), and pentolite. Production of explosives began on December 16, 1941 and continued until 1945. It is estimated that more than one billion pounds of explosives were manufactured during the 4-year operating period.

After the plant was shut down, decontamination of TNT, acid, pentolite, and DNT processing lines began. Decontamination was completed during the last quarter of 1945. The property was initially transferred to the Ordnance Department and then to the War Assets Administration after it was certified by the U.S. Army to be decontaminated. In 1949, PBOW was transferred to the General Services Administration (GSA).

NASA acquired PBOW on March 15, 1963 and is presently utilizing the site. On April 18, 1978, NASA declared approximately 2,152 acres of land as excess. The Perkins Township Board of Education acquired 46 acres of the excess for use as a bus transportation center. The GSA retains the remaining acreage and currently has a use agreement with the Ohio National Guard for 604 acres of the land. NASA presently controls about 6,400 acres and is using the site to conduct space research as a satellite operation of its John Glenn Research Center. The details of these land transactions are listed in the site management plan and can be found at the NASA PBS.

Based on review of historical use of the site and findings of previous investigations, potential chemicals in the groundwater at PBOW may include nitroaromatic compounds (nitroaromatics), volatile organic compounds (VOC), semivolatile organic compounds (SVOC), cyanide, and inorganics.

2.0 Field Activities

2.1 Investigative Methods

Fifth quarter groundwater sampling of background monitoring wells was conducted following the same procedures used during the first, second, third, and fourth quarter groundwater sampling events. Specific sampling procedures are detailed in the approved 2001 SSAP/SSHP and include minimal drawdown (low-flow) purging and sample collection or bailing.

2.2 Groundwater Sampling

Fifth quarter groundwater sampling was conducted from October 15 through 19, 2002. Sampled background wells included four bedrock wells (PB-BED-MW20, PB-BED-MW24, BG8-BEDGW-001, and PB-BED-MW25) and one overburden well (IT-MW01). Although not a background well, monitoring well PB-BED-MW27 was also sampled in October 2002, prior to scheduled abandonment. Analytical results for PB-BED-MW27 will be presented in the Second Annual Data Summary and Evaluation Report with an expected submittal date of June 2003. Table 2-1 shows a list of the groundwater samples collected. The background monitoring wells sampled are located on the extreme west and southwest portion of PBOW and were selected by the USACE based on the groundwater investigation conducted in 1997 (USACE, 2001) (Figure 2-1). Bedrock well PB-BED-MW26 was scheduled for sampling; however, the well was dry and no groundwater sample could be collected.

Groundwater samples were analyzed for nitroaromatics, metals (filtered and unfiltered), VOCs, SVOCs, and water quality parameters (alkalinity, chloride, cyanide, hardness, nitrate, sulfate, total dissolved solids, total organic carbon, total suspended solids, and turbidity). Final field measurements of groundwater samples are presented in Table 2-2. Well locations are shown on Figure 2-1. Sample collection logs are provided in Appendix A.

Two procedures were used for purging and sampling wells. Minimal drawdown (low-flow) was the preferred purging and sampling method in wells where adequate recharge was present. If a well did not recharge adequately to use minimal drawdown (low-flow) sampling (i.e., water level dropped 6 inches or more), removal of 3 to 5 volumes of groundwater was performed and samples collected with a bailer.

Based upon present drought conditions and sampling during the PBOW dry season time period, groundwater recharge rates permitted only wells PB-BED-MW25 and BG8-BEDGW-001 to be sampled with the minimal drawdown (low-flow) sampling methodology. A bladder pump was used for the low-flow minimal drawdown sampling. The pump was inserted into the screened portion of the monitoring well, and the well was pumped at a rate that minimized drawdown. Typically, purging rates were on the order of 200 to 500 milliliters per minute. The purge rate was set such that drawdown in the well was never greater than 0.5 foot. Water chemistry parameters (hydrogen ion concentration [pH], oxidation-reduction potential [Eh], conductivity, temperature, dissolved oxygen, and turbidity) were monitored for stability.

Samples collected for metals analysis were filtered in the field through a 0.45-micrometer high-capacity filter attached to the discharge line of the bladder pump. If the well was sampled with a disposable bailer and not with the bladder pump, a hand-operated 0.45-micrometer filter was used. Sample filtration, preservation, packing, and shipment were performed in accordance with Section 5.4 of the QAPP (IT, 1996b).

Low-flow sample collection was not attempted on monitoring wells IT-MW01, PB-BED-MW26, and PB-BED-MW27. Monitoring well IT-MW01 was not sampled using low-flow due to indentation in the riser at 2 feet below the top of casing that prohibited entry of a pump. During initial static water level measurements on October 16, 2002, very little groundwater was present in monitoring well PB-BED-MW26 (0.62 feet). Based upon groundwater level measurements from previous events, the calculation of the smaller water column (compared to former events), and knowing the lack of water recharge in the well, groundwater from monitoring well PB-BED-MW26 was not bailed or sampled. Low-flow sampling was not attempted in monitoring well PB-BED-MW27 due to 0.50 feet of weathered, petroleum hydrocarbon present in the well and a black hydrogen sulfide substance on the well casing. Both of these factors were considered to potentially stain and/or excessively contaminate the low-flow sampling equipment.

2.3 Decontamination Procedures

Decontamination of all sampling equipment was performed in accordance with Section 4.3 of the SSAP (IT, 2001). Specifically, the water level indicator and low-flow pump were the only instruments that needed the complete decontamination procedures. Decontamination was performed in sequence by wash and rinse with soapy water, deionized water, isopropyl alcohol, and a final wash and rinse with deionized water. The bladder pump was decontaminated by

running the decontamination fluids through the pump head. Equipment was then air dried before use. The bladder pump was wrapped in aluminum foil (shiny side out) after decontamination. Bailers, if needed, and tubing were not decontaminated because new items were used for each well. To prevent damage to sensitive membranes, the water quality instrument (Horiba) was thoroughly rinsed only with deionized water.

2.4 IDW Management

Investigation-derived waste (IDW) generated during the October 2002 groundwater sampling event included groundwater, decontamination water, and personnel protective equipment. All IDW was managed and handled in accordance with procedures described in the SAP (IT, 1996a).

An estimated total of 55 gallons of decontamination and purge water were generated from the background monitoring wells (including overburden well IT-MW01), as well as 60 gallons of decontamination and purge water from downgradient monitoring well PB-BED-MW27. All liquid was contained in labeled 55-gallon drums that were stored in an igloo to protect from possible freezing temperatures. Soiled personal protective gear and disposable field equipment generated during the project was double-bagged and placed in an on-site industrial dumpster.

IDW drums were removed from the PBOW facility December 11, 2002, by U.S. Liquids of Detroit, Inc., following proper IDW disposal procedures. All water was transported to the U.S. Liquids facility in Detroit, Michigan, treated, and disposed of at the facility, as was done for the previous four events.

3.0 Analytical Program

Primary and field duplicate project samples were analyzed by Severn Trent Laboratories, Inc. of Knoxville, Tennessee. Analyses for water quality data parameters were provided by Severn Trent's Canton, Ohio laboratory. Quality assurance samples and field splits were analyzed by Accutest Laboratory of Orlando, Florida. IT performed data validation. The validation summary is provided in Appendix B. The analytical results are summarized in Appendix C. Tables of detected hits that exclude "B" qualified data (data that were not detected significantly above method blank or field blank levels) are included in Appendix D. A data quality evaluation is located in Appendix E. U.S. Environmental Protection Agency (EPA) Region 9 Preliminary Remediation Goals (PRG) (EPA, 2002) are being used as preliminary screening levels for comparison to groundwater analytical results. These comparisons are not intended to imply remediation or clean-up levels, but to provide a screening perspective of the data.

3.1 Analytical Program and Methodologies

Chemical analyses for the investigation were performed in accordance with guidelines detailed in the EPA's *Test Methods for Evaluating Solid Waste (SW-846), Physical/Chemical Methods,* Third Edition, September (EPA, 1986) and subsequent revisions and EPA 600/4-79-020, *Method for Chemical Analysis of Water and Wastes.* The groundwater samples and associated quality assurance/quality control (QA/QC) samples were analyzed for VOCs, SVOCs, metals, and several water quality parameters. Methods used for analysis are summarized in Table 3-1.

All data analyzed were reviewed for accuracy and completeness. One hundred percent of the data analyzed were subjected to data validation following guidelines in the *EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, October (EPA, 1999) and *EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, February (EPA, 1994a). Data were evaluated against specific criteria to verify the achievement of precision, accuracy, representativeness, completeness, and comparability goals established to meet the project data quality objectives (DQO). The criteria for blank evaluation were based on those detailed in *Region III Modifications to National Functional Guidelines for Organic Data Review,* September (EPA, 1994b) and *Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses* (EPA, 1993). The procedure is outlined in Section 3.3.

3.2 Data Quality Evaluation

The reliability of the sampling and analytical procedures used during the investigation was demonstrated by implementing the project-specific QA procedures specified in the site-wide SAP (IT, 1996a) and QAPP (IT, 1996b) and its site-specific attachments. Successful execution of these procedures provides supporting evidence that the data is representative of the background area under investigation.

The DQOs for this project were to produce scientifically valid data of known accuracy and precision that were complete with respect to identified critical samples, comparable with similar data types, and representative of the media sampled so as to be useful for the cited purposes. Evaluation of the data using the DQOs and the data validation process resulted in the determination that most of the data set is valid and of sufficient quality to meet the objectives of the investigation. Cyanide results were rejected in samples because of poor recovery of the matrix spike and matrix spike duplicate. All cyanide results were nondetects.

The laboratory did not meet requirements for completion. Samples were sent to the lab for analysis for nitroaromatics by SW-846 8330. Upon completion of analysis and subsequent review, it appeared that the project samples and laboratory QC samples were not spiked with surrogates or spike compounds. The data was not submitted.

A complete evaluation of the analytical results is given in the data quality evaluation found in Appendix E.

3.3 Blank Evaluation

The purpose of blank analysis is to detect contamination resulting from laboratory and field activities. Blank evaluation involves qualification of data based on the results of associated field blanks, trip blanks, equipment rinsates, and laboratory method blanks. The criteria for blank evaluation are as follows:

- If a parameter is found in a blank, but not detected in the sample, no action is taken.
- For organics, if the sample result is greater than the contract-required quantitation limit, but is less than 5X or 10X of the blank result, the sample result is qualified "B."

- For organics, if the sample result is less than the contract-required quantitation limit and less than 5X or 10X of the blank result, the sample result is qualified "B." The "J" qualifier is not used.

- For inorganics, if the sample result is greater than the instrument detection limit, but less than 5X of the blank result, the sample result is qualified "B."

- If the sample result is greater than 5X or 10X of the blank result, the sample result is not qualified.

In instances where more than one blank is associated with a given sample, qualification is based upon a comparison with the associated blank having the highest concentration of a chemical. Blank results are not subtracted from sample concentrations.

3.4 Screening Criteria

To provide a better perspective of the data but without inferring a regulatory limit or mandated cleanup level, the analytical data were screened against preliminary screening values for tap water (EPA, 2002). These values, with a few exceptions, correspond to a one-in-a-million (1E-6) cancer risk or a hazard quotient of 1, whichever would result in a lower value. Further evaluation may be appropriate if site concentrations exceed these screening values.

No attempt was made to develop preliminary screening levels for ubiquitous, nutritionally essential elements unlikely to be toxic at concentrations ordinarily found in environmental media and for which toxicity values are unavailable (e.g., calcium, magnesium, potassium, and sodium). PRGs used in the screening of groundwater investigation data are presented in Chapter 4.0, Table 4-1. Chemicals detected in groundwater were compared to PRGs for tap-water. It was assumed that household use of groundwater results in the most restrictive contamination level.

4.0 Analytical Results

4.1 Groundwater Sampling Events

In October 2002, background groundwater samples representative of low groundwater levels (or dry season) conditions were collected. The background samples were collected from the same monitoring wells as sampled in November 1997 and May 1998, as well as from two of the three wells installed in 2001. A quarterly sampling schedule was chosen for these wells to obtain background bedrock groundwater data to determine if similar patterns or trends of chemical constituents are present and thus establish background groundwater constituent concentrations for the bedrock groundwater. Monitoring well PB-BED-MW27 was also sampled during the fifth quarterly sampling event, prior to scheduled abandonment. Analytical results for PB-BED-MW27 will be presented in the Second Annual Data Summary and Evaluation Report.

4.2 Analytical Results

The following sections present the blank-corrected results of the first, second, third, fourth, and fifth quarterly sampling events. October 2002 PRGs have been used to evaluate the detected constituents. As a comparison tool, the November 1997, May 1998, fall 2001, and January through July 2002 results, compared to the preliminary screening levels, are shown on Figure 2-1 with the October 2002 data. Analytical detections for the first through fifth quarters are presented in Table 4-1. With the exception of nitroaromatic compounds, all analytes detected below preliminary screening levels are not discussed in detail but are presented in the referenced data table. All fifth quarter analytical data is presented in Appendices C and D.

4.2.1 Background Monitoring Wells

Five bedrock wells were selected to be sampled on a quarterly basis to determine background bedrock groundwater values. These background bedrock monitoring wells include PB-BED-MW20, PB-BED-MW24, PB-BED-MW25, and BG8-BEDGW-001, and PB-BED-MW26 (Figure 2-1). Overburden well IT-MW01 is included to be sampled as part of the quarterly sampling events and, due to its location, has previously been considered as providing information relative to possible background overburden groundwater values. Groundwater from these wells was analyzed for VOCs, SVOCs, nitroaromatics, metals (total and dissolved), cyanide, and water quality parameters.

4.2.2 Overburden

2001 First Quarterly Dry Season Sampling Event (September/October). Due to an indentation of the polyvinyl chloride (PVC) riser, monitoring well IT-MW01 could not be sampled.

2002 Second Quarterly Wet Season Sampling Event (January). On January 16, 2002, an attempt was made to repair IT-MW01. As with the September/October 2001 sampling, an indentation of the PVC riser (2 feet below the top of the casing) prevented sampling equipment (pump and bailer) from reaching groundwater in the well. Review of IT-MW01 well construction diagram showed that the bottom of the only riser joint (3.2 feet stickup to 4 feet below ground surface) is located within the filter pack. This, therefore, precluded removal of the riser for replacement. Sampling personnel attempted to remove or push back the indentation in the riser, but did not succeed.

2002 Third Quarterly Wet Season Sampling Event (April). Due to an indentation of the PVC riser, monitoring well IT-MW01 could not be sampled.

2002 Fourth Quarterly Dry Season Sampling Event (July). No nitroaromatics, VOCs, SVOCs, filtered, or unfiltered metal samples were detected above preliminary screening levels in the overburden background well (Table 4-1).

2002 Fifth Quarterly Dry Season Sampling Event (October). No nitroaromatics, VOCs, or SVOCs were detected above preliminary screening levels. Overburden monitoring well IT-MW01 showed the metals arsenic, iron, lead, and thallium above preliminary screening levels in the unfiltered metal sample. There were no metals detected above preliminary screening levels in the filtered metal sample (Table 4-1).

4.2.3 Bedrock

2001 First Quarterly Dry Season Sampling Event (October). No nitroaromatic compounds were detected in any of the background monitoring wells. VOCs (benzene, ethylbenzene, and methylene chloride) were detected above preliminary screening levels in well

PB-BED-MW24, and benzene and chloroform were detected above limits in well PB-BED-MW25. No SVOCs were detected in any of the wells above preliminary screening levels. Only groundwater from well PB-BED-MW20 showed metals above the preliminary screening level. Barium was detected in both the unfiltered and filtered metal samples, while arsenic was found above its screening limit in only the filtered sample (Table 4-1).

2002 Second Quarterly Wet Season Sampling Event (January). No nitroaromatic compounds were detected in any of the background bedrock monitoring wells. Only the VOCs benzene and ethylbenzene and the SVOC (naphthalene) were detected above preliminary screening levels in monitoring well PB-BED-MW24. Groundwater from all five background wells showed metals above preliminary screening levels. Thallium was detected above its preliminary screening level in both the unfiltered and filtered metal samples from wells BG8-BEDGW-001, PB-BED-MW20, and PB-BED-MW24, and in the unfiltered sample in well PB-BED-MW25. All of the thallium detections were noted with a "B" qualifier. Barium was detected above its preliminary screening level in both the unfiltered and filtered metals samples from well PB-BED-MW20. Due to a low water column present, only unfiltered metals were sampled in well PB-BED-MW26. Analytes in well PB-BED-MW26 above preliminary screening levels included aluminum, arsenic, chromium, iron, lead, and manganese (Table 4-1).

2002 Third Quarterly Wet Season Sampling Event (April). Three nitroaromatic compounds were detected (2,6-DNT, nitrobenzene, and research department explosive [RDX]) in the background bedrock monitoring wells. Monitoring well PB-BED-MW24 exhibited 2,6-DNT above the preliminary screening level and detections of nitrobenzene and RDX below the respective screening level. Nitrobenzene was also present in monitoring wells PB-BED-MW20 and PB-BED-MW25 but below screening levels. Benzene, ethylbenzene, and total xylenes were the VOCs detected above the preliminary screening level (PB-BED-MW24) during the third quarterly groundwater sampling event. No SVOCs were detected above preliminary screening levels during the third quarterly sampling event. The only metal detected above screening levels was barium in filtered and unfiltered samples collected from PB-BED-MW20 (Table 4-1).

2002 Fourth Quarterly Dry Season Sampling Event (July). No nitroaromatic compounds were detected in any of the background bedrock monitoring wells. Benzene, ethylbenzene, and naphthalene were detected above screening levels in well PB-BED-MW24. Benzene was detected above limits in well PB-BED-MW20. Unfiltered metals above the

screening limit were arsenic and iron in well PB-BED-MW24 and barium in well PB-BED-MW20. Barium was also detected above the preliminary screening level as a filtered metal in well PB-BED-MW20 (Table 4-1).

2002 Fifth Quarterly Dry Season Sampling Event (October). Nitrobenzene was detected in monitoring well PB-BED-MW25 below the preliminary screening level. No nitroaromatics or SVOCs were detected above preliminary screening levels in any of the background bedrock monitoring wells. Benzene was detected above the preliminary screening level in wells PB-BED-MW20 and PB-BED-MW24, and ethylbenzene was detected above the preliminary screening level in well PB-BED-MW24. Barium was detected above the preliminary screening level in both the unfiltered and filtered metal samples from well PB-BED-MW20. Thallium was also detected above the preliminary screening level in the unfiltered metal sample from well PB-BED-MW20 (Table 4-1).

4.2.4 Summary of Sampling Events

At least one of three nitroaromatic compounds (2,6-DNT, nitrobenzene, and RDX) were detected in three of the five background wells (PB-BED-MW20, PB-BED-MW24, and PB-BED-MW25) during the background sampling events November 1997 to October 2002. Nitroaromatic 2,6-DNT was the only compound above the preliminary screening level, and it was from well PB-BED-MW24. It should be noted that explosive compound RDX, as detected in well PB-BED-MW24, was not manufactured at PBOW. Benzene, above preliminary screening level, was a common contaminant in groundwater in wells PB-BED-MW20 and PB-BED-MW24 and also was detected once (October 2001) in PB-BED-MW25. In addition, VOCs ethylbenzene, methylene chloride, and total xylenes were detected in monitoring well PB-BED-MW24 above screening levels. SVOCs infrequently detected above preliminary screening levels were bis(2-ethylhexyl)phthalate in well PB-BED-MW20 (May 1998) and naphthalene in PB-BED-MW24 (January and July 2002). Fifteen different unfiltered and filtered metals were detected in the background wells. Barium was the only metal (PB-BED-MW20) frequently detected in the unfiltered and filtered samples to be above the preliminary screening level.

5.0 Planned Activities

The following activities are scheduled:

- A sixth quarterly background groundwater report (2003 Groundwater Data Summary and Evaluation Report) representing analytical results of April 2003 in conjunction with wet and dry season analytical data from non-background monitoring wells, will be submitted following receipt and evaluation of April analytical data.

6.0 References

IT Corporation (IT), 2002, ***Letter Amendment to Site-Specific Sampling and Analysis Plan, Groundwater Remedial Investigation, TNT and Red Water Ponds Areas, Plum Brook Ordnance Works, Sandusky, Ohio,*** March.

IT Corporation (IT), 2001a, ***Site-Specific Safety and Health Plan, Plum Brook Ordnance Works, Sandusky, Ohio***, July.

IT Corporation (IT), 2001b, ***Site-Specific Sampling and Analysis Plan, Groundwater Remedial Investigation, TNT and Red Water Ponds Areas, Plum Brook Ordnance Works, Sandusky, Ohio,*** July.

IT Corporation (IT), 1996a, ***Site-Wide Sampling and Analysis Plan in Site Investigations and Groundwater Investigation, Plum Brook Ordnance Works, Sandusky, Ohio,*** September.

IT Corporation (IT), 1996b, ***Quality Assurance Project Plan, Plum Brook Ordnance Works, Sandusky, Ohio.***

IT Corporation (IT), 1996c, ***Site-Wide Safety and Health Plan, Plum Brook Ordnance Works, Sandusky, Ohio.***

U.S. Army Corps of Engineers (USACE), 2001, ***Scope of Work; Groundwater Remedial Investigation of TNT and Red Water Ponds Areas, Former Plum Brook Ordnance Works, Sandusky, Ohio,*** Nashville, Tennessee, Revised 19, March.

U.S. Environmental Protection Agency (EPA), 2002, ***Region 9 Preliminary Remediation Goals (PRGs) 2002 Update***, online, October 3.

U.S. Environmental Protection Agency (EPA), 1999, ***Contract Laboratory Program National Functional Guidelines of Organic Data Review***, October.

U.S. Environmental Protection Agency (EPA), 1994a, ***Contract Laboratory Program National Functional Guidelines for Inorganic Data Review***, February.

U.S. Environmental Protection Agency (EPA), 1994b, ***Region III Modifications to National Functional Guidelines for Organic Data Review***, September.

U.S. Environmental Protection Agency (EPA), 1993, ***Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses***, April.

U.S. Environmental Protection Agency (EPA), 1986, ***Test Methods for Evaluating Solid Waste (SW-846), Physical/Chemical Methods***, Third Edition, September.

U.S. Environmental Protection Agency (EPA), 1983, ***Method for Chemical Analysis of Water and Wastes***, March.

Tables

TABLES

Table 2-1

Summary of Groundwater Samples Collected
Fifth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Sample Identification	Sample Date	Sample Number
IT-BG8-BEDGW-001	PBOW-02-GW-IT-BG8-BEDGW-001-CD3001	10/18/02	CD3001
IT-MW01	PBOW-02-GW-IT-MW01-CD3002	10/16/02	CD3002
PB-BED-MW20	PBOW-02-GW-PB-BED-MW20-CD3003	10/17/02	CD3003
PB-BED-MW24	PBOW-02-GW-PB-BED-MW24-CD3004	10/19/02	CD3004
PB-BED-MW25	PBOW-02-GW-PB-BED-MW25-CD3005	10/17/02	CD3005
PB-BED-MW25	PBOW-02-GW-PB-BED-MW25-CD3006	10/17/02	CD3006[1]
PB-BED-MW25	PBOW-02-GW-PB-BED-MW25-CD3007	10/17/02	CD3007[2]

[1] Field duplicate.
[2] Field split.

Table 2-2

Final Field Measurements of Groundwater Samples
Fifth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Date	Time	Low-Flow Sampled	PID (ppm)	H_2S (ppm)	Eh (mV)	pH	Conductivity (µmhos/cm)	Turbidity (NTU)	Dissolved O_2 (ppm)	Temperature (°C)	Volume Purged (gal)
Overburden Well (1997 through Fifth Quarterly Sampling Event)												
IT-MW01	10/16/02	0925	NA	0.0	0.0	-28	6.22	0.765	3.6	3.41	14.4	3.09
	7/10/02	0900	No	0	0	-8	6.28	0.590	3.7	5.08	17.76	4
	4/2/02	NA	NA	NM	NM	Not sampled. Riser section dented and prohibited bailer from entering well.						
	1/16/02	NA	NA	NM	NM	Not sampled. Riser section dented and prohibited bailer from entering well.						
	9/27/01	1040	NA	NM	NM	Not sampled. Riser section dented and prohibited bailer from entering well.						
	5/16/98	NA	No	0	NM	57.3	6.23	0.447	0	13.13	14.2	8
	11/19/97	NA	No	0	NM	-58.2	6.7	0.512	1	10.57	9.6	6.5
Bedrock Wells (1997 through Fifth Quarterly Sampling Event)												
BG8-BEDGW-001	10/18/02	1050	Yes	0.0	0.0	-307	5.97	3.88	16.5	1.73	14.2	4.0
	7/12/02	0920	Yes	0	0	-258	7.21	3.68	10.3	0.41	13.45	5
	4/3/02	1127	Yes	0.0	0.0	220	7.25	0.43	4.7	NM	6.7	3
	1/16/02	1450	Yes	0.0	0.0	-79	7.38	0.856	2.8	0.00	10.69	2.22
	9/27/01	1220	Yes	0.0	NM	-339	13.03	3.75	0.0	0.00	12.65	2.97
	5/15/98	NA	No	0.1	NM	-36.2	7.80	151	10	8.00	13.0	27.73
	11/17/97	NA	No	0	NM	-245.3	7.21	3.31	321	6.83	10.5	30
PB-BED-MW20	10/17/02	1510	No	0.0	0.0	-32	5.69	56.3	10.8	3.38	11.60	24
	7/10/02	1600	Yes	0	0	-57	6.73	52.9	NR	0	13.85	3.5
	4/4/02	1013	Yes	0.0	NM	51	7.07	53	0.0	0.00	10.37	1.9
	1/15/02	1415	Yes	1.6	0.00	-55	6.83	52.60	15.0	0.00	7.22	1
	9/26/01	1415	No	0.0	NM	-73	8.95	53.60	53.5	0.00	10.54	10.33
	5/28/98	NA	No	0.1	NM	NM	6.65	38.1	999	12.80	13.0	58
	11/17/97	NA	No	0	NM	-24.7	6.74	48.5	563	4.14	9.4	27
PB-BED-MW24	10/19/02	1110	No	58.2	>50	-297	6.30	1.85	22.3	5.52	12.20	4.5
	7/12/02	1405	Yes	84.1	>500	-358	6.66	1.88	350	0	12.93	4.5
	4/3/02	1730	Yes	76.0	0.0	-318	7.06	1.98	0.0	NM	10.71	1.8
	1/17/02	1005	Yes	114	0.0	-333	6.82	1.99	2.5	0.00	9.69	2.11
	10/9/01	0935	Yes	NM	NM	-144	9.38	1.81	73.3	5.32	11.20	2.99

Table 2-2

Final Field Measurements of Groundwater Samples
Fifth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Well Identification	Date	Time	Low-Flow Sampled	PID (ppm)	H_2S (ppm)	Eh (mV)	pH	Conductivity (µmhos/cm)	Turbidity (NTU)	Dissolved O_2 (ppm)	Temperature (°C)	Volume Purged (gal)
Bedrock Wells (1997 through Fifth Quarterly Sampling Event), continued												
PB-BED-MW25	10/17/02	1035	Yes	0.0	0.0	-290	6.56	2.96	2.1	1.69	12.00	6.0
	7/11/02	1115	Yes	0	0	-302	7.19	1.86	1.9	0	12.92	8
	4/3/02	1120	Yes	NM	NM	-333	8.46	2.62	2.7	0.01	10.90	8
	1/16/02	1030	Yes	0.0	0.0	-291	7.23	2.42	5.8	0.00	10.54	4.44
	10/5/01	0920	Yes	0.0	0.01	-237	10.58	1.89	5.7	2.41	11.90	3.67
PB-BED-MW26	10/16/02	NA	NA	6.0	0.0	No sample collected due to insufficient water volume.						
	7/12/02	NA	NA	3.1	0	No sample collected due to insufficient water volume.						
	4/9/02	NA	NA	NM	NM	No sample collected due to insufficient water volume.						
	1/15/02[a]	1030	No	2.2	0.21	-59	6.87	31.0	999	8.04	8.69	0.5
	10/10/01	NA	NA	3.6	NM	No sample collected due to insufficient water volume.						

Water quality measurements recorded at time of sample collection. PID and H_2S readings taken as monitoring well lid removed.

PID - Photoionization detector.
H_2S - Hydrogen sulfide
Eh - Oxidation-reduction potential.
ppm - Parts per million.
mV - Millivolts.
µmhos/cm - Micromhos per centimeter.
NTU - Nephelometric turbidity unit.
°C - Degrees Celsius.
NA - Not applicable.
NM - Not measured.
NR - Not recorded.
gal - Gallon.
O_2 - Oxygen.

[a]Final water quality reading collected from last purged groundwater due to a very limited water volume. Well was purged on 1/15/02, sample was collected on 1/17/02 at 0820.

Table 3-1

Summary of Analytical Parameters and Methods
Fifth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Matrix	Analytical Parameters[a]	Analytical Method[b]
Groundwater (Monitoring Well)	TCL Volatile Organic Compounds	SW-846 5030/8260B
	TCL Semivolatile Organic Compounds	SW-846 3510C/8270C
	TAL Metals (T/D)	SW-846 3005A/6010B/7470A
	Turbidity	EPA 180.1
	Alkalinity	EPA 310.1
	Hardness	EPA 200.7
	Total Organic Carbon	EPA 415.1
	Total Dissolved Solids	EPA 160.1
	Total Suspended Solids	EPA 160.2
	Chloride	EPA 325.2
	Cyanide, total	SW-846 9012A
	Nitrate	EPA 353.2
	Sulfate	EPA 375.4

[a]Target analyte list (TAL) and target compound list (TCL) are used to designate parameter lists with no requirements for Contract Laboratory Program (CLP) method quality control or data reporting packages.
[b] Analyses found in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* Third Edition and *Methods for Chemical Analysis of Water and Wastes*, March 1983 and their subsequent revisions.

T/D - Total/Dissolved.

Table 4-1

Detected Constituents in Bedrock Monitoring Wells
Fifth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Area	Background Wells									
		Location Code:	IT-BG8-BEDGW-001									
		Sample No:	5410		5415		BD3007		CA3006		CB3007	
		Sample Date:	17-NOV-97		15-MAY-98		27-SEP-01		16-JAN-02		03-APR-02	
Parameter	**Units**	**PRG**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**
Explosives												
Dinitrotoluene, 2,4-	ug/L	0.099										
Dinitrotoluene, 2,6-	ug/L	0.099										
Nitrobenzene	ug/L	3.4										
RDX	ug/L	0.61										
Volatiles												
Acetone	ug/L	610									3.5	J
Benzene	ug/L	0.34										
Bromomethane	ug/L	8.7										
Butanone, 2-	ug/L	1900										
Carbon disulfide	ug/L	1000	0.65	J								
Chloroform	ug/L	6.2										
Chloromethane	ug/L	1.5										
Ethylbenzene	ug/L	2.9										
Methyl-2-pentanone, 4-	ug/L	160										
Methylene chloride	ug/L	4.3	0.37	B								
Toluene	ug/L	720										
Xylenes, total	ug/L	210	0.38	B							1.0	
Semivolatiles												
Bis(2-ethylhexyl)phthalate	ug/L	4.8	1.7	J	4.0	B						
Dimethylphenol, 2,4-	ug/L	730										
Methylnaphthalene, 2-	ug/L											
Methylphenol, 2-	ug/L	1800										
Methylphenol, 4-	ug/L	180										
Naphthalene	ug/L	6.2										
Phenanthrene	ug/L											
Phenol	ug/L	22000										
Metals - Unfiltered												
Aluminum	ug/L	36000	9020		307		51.6	B	78.7	B	31.5	J
Antimony	ug/L	150										
Arsenic	ug/L	0.045	17.6									
Barium	ug/L	2600	520				285		68	J	29.9	J
Beryllium	ug/L	73							1.2	B		
Cadmium	ug/L	18										
Chromium	ug/L	110	18.2				1.4	B				
Cobalt	ug/L	730										
Copper	ug/L	1500	59.5								3.3	J
Iron	ug/L	11000	22600		1230	J	204		118	B	38.2	J
Lead	ug/L	15	26.3		6.8							
Manganese	ug/L	880	2240		130		71.6		107		29.0	
Mercury	ug/L	11										
Nickel	ug/L	730									6.8	J
Selenium	ug/L	180										
Thallium	ug/L	2.4							3.3	B		
Vanadium	ug/L	260										
Zinc	ug/L	11000	126		49.7	B			12.6	J	15.6	J
Metals - Filtered												
Aluminum	ug/L	36000					56.6	B	83.6	B	52.0	B
Arsenic	ug/L	0.045										
Barium	ug/L	2600	366				279		83.6	J	30.6	J
Beryllium	ug/L	73							1.5	B		
Chromium	ug/L	110										
Cobalt	ug/L	730										
Copper	ug/L	1500										
Iron	ug/L	11000	563				169		216			
Manganese	ug/L	880	1300		658		73.5		117		23.6	
Mercury	ug/L	11										
Nickel	ug/L	730									7.0	J
Thallium	ug/L	2.4							4.6	B		
Zinc	ug/L	11000			44.9	B			13.5	J	17.3	J
Water Quality Parameters												
Alkalinity	ug/L		350000		180000		357000	J	200000		157000	
Chloride	ug/L		780000		34000		932000		78000		63200	J
Hardness	ug/L		1000000		340000		719000		380000		314000	
Nitrate	ug/L	10000	200		7300				22000		10400	
Sulfate	ug/L		70000		45000		28300		68000		63300	
Total dissolved solids	ug/L		1800000		300000		1990000		500000		458000	
Total organic carbon	ug/L				1000							
Total suspended solids	ug/L		10000		280000		4000				3000	J
Turbidity	NTU						104	J			0.61	

Table 4-1

Detected Constituents in Bedrock Monitoring Wells
Fifth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Area	Background Wells									
		Location Code:	IT-BG8-BEDGW-001				IT-MW01					
		Sample No:	CC3001		CD3001		5530		5535		5535R	
		Sample Date:	12-JUL-02		18-OCT-02		19-NOV-97		16-MAY-98		18-MAY-98	
Parameter	**Units**	**PRG**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**
Explosives												
Dinitrotoluene, 2,4-	ug/L	0.099										
Dinitrotoluene, 2,6-	ug/L	0.099										
Nitrobenzene	ug/L	3.4										
RDX	ug/L	0.61										
Volatiles												
Acetone	ug/L	610	2.6	B	3.4	J						
Benzene	ug/L	0.34										
Bromomethane	ug/L	8.7										
Butanone, 2-	ug/L	1900	3.2	B								
Carbon disulfide	ug/L	1000			0.43	J						
Chloroform	ug/L	6.2										
Chloromethane	ug/L	1.5										
Ethylbenzene	ug/L	2.9										
Methyl-2-pentanone, 4-	ug/L	160										
Methylene chloride	ug/L	4.3					0.33	B			0.58	B
Toluene	ug/L	720									22	
Xylenes, total	ug/L	210					0.31	B				
Semivolatiles												
Bis(2-ethylhexyl)phthalate	ug/L	4.8	4.3	B								
Dimethylphenol, 2,4-	ug/L	730										
Methylnaphthalene, 2-	ug/L											
Methylphenol, 2-	ug/L	1800										
Methylphenol, 4-	ug/L	180										
Naphthalene	ug/L	6.2										
Phenanthrene	ug/L											
Phenol	ug/L	22000										
Metals - Unfiltered												
Aluminum	ug/L	36000	65.2	B	83.6	B						
Antimony	ug/L	150										
Arsenic	ug/L	0.045	3.6	J								
Barium	ug/L	2600	229		279							
Beryllium	ug/L	73										
Cadmium	ug/L	18										
Chromium	ug/L	110										
Cobalt	ug/L	730	12.1	J								
Copper	ug/L	1500										
Iron	ug/L	11000	1490		74.5	J	1320		2200	J		
Lead	ug/L	15										
Manganese	ug/L	880	688		51.1		323		348			
Mercury	ug/L	11					0.45					
Nickel	ug/L	730	8.6	J								
Selenium	ug/L	180										
Thallium	ug/L	2.4										
Vanadium	ug/L	260										
Zinc	ug/L	11000	10.0		0.83	J	51.6		149			
Metals - Filtered												
Aluminum	ug/L	36000	113	B	86.7	B			276			
Arsenic	ug/L	0.045										
Barium	ug/L	2600	236		285							
Beryllium	ug/L	73										
Chromium	ug/L	110										
Cobalt	ug/L	730	8.2	J								
Copper	ug/L	1500										
Iron	ug/L	11000	1160		53.4	J	1090		1970			
Manganese	ug/L	880	728		52.2		331		395			
Mercury	ug/L	11										
Nickel	ug/L	730	8.5	J								
Thallium	ug/L	2.4										
Zinc	ug/L	11000	7.3	J	1.2	B	46.9		47.5	B		
Water Quality Parameters												
Alkalinity	ug/L		367000		332000		360000		110000			
Chloride	ug/L		896000		999000		4000		3000			
Hardness	ug/L		647000		687000		420000		200000			
Nitrate	ug/L	10000										
Sulfate	ug/L		9200		11200		79000		140000			
Total dissolved solids	ug/L		2040000		1870000		310000		400000			
Total organic carbon	ug/L		1900		1300		8600		7000			
Total suspended solids	ug/L		21000				84000		5000			
Turbidity	NTU		39.0		44.2							

Table 4-1

Detected Constituents in Bedrock Monitoring Wells
Fifth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Area	Background Wells											
		Location Code:	IT-MW01				PB-BED-MW20							
		Sample No:	CC3009		CD3002		5960		5965		BD3026		CA3005	
		Sample Date:	10-JUL-02		16-OCT-02		17-NOV-97		28-MAY-98		26-SEP-01		15-JAN-02	
Parameter	**Units**	**PRG**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**
Explosives														
Dinitrotoluene, 2,4-	ug/L	0.099												
Dinitrotoluene, 2,6-	ug/L	0.099												
Nitrobenzene	ug/L	3.4												
RDX	ug/L	0.61												
Volatiles														
Acetone	ug/L	610	3.5	B							1.2	J		
Benzene	ug/L	0.34					0.93	J	1.6		0.25	J		
Bromomethane	ug/L	8.7												
Butanone, 2-	ug/L	1900			0.7	B								
Carbon disulfide	ug/L	1000							0.17	J				
Chloroform	ug/L	6.2												
Chloromethane	ug/L	1.5												
Ethylbenzene	ug/L	2.9					0.15	J						
Methyl-2-pentanone, 4-	ug/L	160												
Methylene chloride	ug/L	4.3	0.19	B			0.30	B	0.49	B				
Toluene	ug/L	720					0.73	B	0.95	B			2.4	B
Xylenes, total	ug/L	210					2.6		0.91	J				
Semivolatiles														
Bis(2-ethylhexyl)phthalate	ug/L	4.8							5.4	B	2.9	J		
Dimethylphenol, 2,4-	ug/L	730												
Methylnaphthalene, 2-	ug/L						1.1	J						
Methylphenol, 2-	ug/L	1800												
Methylphenol, 4-	ug/L	180												
Naphthalene	ug/L	6.2												
Phenanthrene	ug/L													
Phenol	ug/L	22000												
Metals - Unfiltered														
Aluminum	ug/L	36000	117	J	10200	J	3290		678	J	207	J		
Antimony	ug/L	150			8	J								
Arsenic	ug/L	0.045			52.6									
Barium	ug/L	2600	75.9	J	139	J	19000		16400		23900		22500	
Beryllium	ug/L	73			4.6	J								
Cadmium	ug/L	18												
Chromium	ug/L	110			14.1						7.6	B		
Cobalt	ug/L	730	7.5	J	14	J					7.1	J		
Copper	ug/L	1500	9.1	J	72.2		32.8				15.8	B	32.8	
Iron	ug/L	11000	563		52100		13200		6770		5920	J	6480	
Lead	ug/L	15			101									
Manganese	ug/L	880	292		490		180		153		189	J	128	
Mercury	ug/L	11												
Nickel	ug/L	730	15.0	J	35	J					3.5	J		
Selenium	ug/L	180			5									
Thallium	ug/L	2.4			5.7	J							7.1	B
Vanadium	ug/L	260			35.9	J								
Zinc	ug/L	11000	34.3		124		41.6		42.1	B	5.3		23.4	
Metals - Filtered														
Aluminum	ug/L	36000	62.2	B	71.6	B					40.9	B		
Arsenic	ug/L	0.045									2.8	J		
Barium	ug/L	2600	82.5	J	89.1	J	21000		4950		24400		21300	
Beryllium	ug/L	73												
Chromium	ug/L	110												
Cobalt	ug/L	730	10.3	J	4.9	J					6.4	J		
Copper	ug/L	1500	2.8	J	3.7	J					2.0	B	5.7	J
Iron	ug/L	11000	745		1840		2310		1320		5350		6180	
Manganese	ug/L	880	326		424		162		47.0		188		129	
Mercury	ug/L	11							0.24					
Nickel	ug/L	730	26.2	J	10.5	J					2.9	J		
Thallium	ug/L	2.4											7.3	B
Zinc	ug/L	11000	124		13.1	J					3.3	J	21.6	
Water Quality Parameters														
Alkalinity	ug/L		90000		209000		240000		260000		255000	J	280000	
Chloride	ug/L		3400		9900		19000000		21000000		22400000		18000000	
Hardness	ug/L		144000		263000		20000000		10000000		9360000		8200000	
Nitrate	ug/L	10000	190											
Sulfate	ug/L		118000		67300								3200	
Total dissolved solids	ug/L		279000		342000		32000000		24000000		27400000	J	26000000	
Total organic carbon	ug/L		7100		9900						500	J	1100	J
Total suspended solids	ug/L		4000		5000		74000		90000		125000		13000	
Turbidity	NTU		1.7		10.6						48.4	J	8.8	

Table 4-1

Detected Constituents in Bedrock Monitoring Wells
Fifth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Area	Background Wells									
		Location Code:	PB-BED-MW20						PB-BED-MW24			
		Sample No:	CB3001		CC3003		CD3003		BD3029		CA3001	
		Sample Date:	04-APR-02		10-JUL-02		17-OCT-02		09-OCT-01		17-JAN-02	
Parameter	**Units**	**PRG**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**
Explosives												
Dinitrotoluene, 2,4-	ug/L	0.099										
Dinitrotoluene, 2,6-	ug/L	0.099										
Nitrobenzene	ug/L	3.4	0.088	J								
RDX	ug/L	0.61										
Volatiles												
Acetone	ug/L	610	5.3	J	10	B			120	J		
Benzene	ug/L	0.34			3.2		1.3	J	60		91	
Bromomethane	ug/L	8.7			0.27	J						
Butanone, 2-	ug/L	1900			9.8						8.1	
Carbon disulfide	ug/L	1000					1.1	J			1.2	
Chloroform	ug/L	6.2										
Chloromethane	ug/L	1.5									1.3	J
Ethylbenzene	ug/L	2.9							19	J	32	
Methyl-2-pentanone, 4-	ug/L	160										
Methylene chloride	ug/L	4.3							21	J		
Toluene	ug/L	720			0.76	B	0.35	J	58		90	
Xylenes, total	ug/L	210	0.67	J					110		180	
Semivolatiles												
Bis(2-ethylhexyl)phthalate	ug/L	4.8										
Dimethylphenol, 2,4-	ug/L	730							1.1	J		
Methylnaphthalene, 2-	ug/L								3.6	J	5.6	
Methylphenol, 2-	ug/L	1800										
Methylphenol, 4-	ug/L	180										
Naphthalene	ug/L	6.2							2.9	J	7	
Phenanthrene	ug/L											
Phenol	ug/L	22000							1.4	J		
Metals - Unfiltered												
Aluminum	ug/L	36000	48.6	J	83.4	B	155	J	37.8	J	77.7	B
Antimony	ug/L	150										
Arsenic	ug/L	0.045										
Barium	ug/L	2600	23700		24000		25700		932		938	
Beryllium	ug/L	73					0.51	B			1.2	B
Cadmium	ug/L	18										
Chromium	ug/L	110	1.7	J								
Cobalt	ug/L	730	6.1	J	8.0	J	8.1	J				
Copper	ug/L	1500	30.5									
Iron	ug/L	11000	853		4970		5310		48.3	J	72.7	B
Lead	ug/L	15										
Manganese	ug/L	880	156		190		185		24.8		19.2	
Mercury	ug/L	11										
Nickel	ug/L	730	3.4	J								
Selenium	ug/L	180										
Thallium	ug/L	2.4					4.1	B			4.2	B
Vanadium	ug/L	260										
Zinc	ug/L	11000	64.9		9.7	J	15.6	J				
Metals - Filtered												
Aluminum	ug/L	36000	55.9	B	63.1	B	69.8	B	55.1	B	89.6	B
Arsenic	ug/L	0.045										
Barium	ug/L	2600	23800		23900		24500		942		962	
Beryllium	ug/L	73					0.24	B			1.5	B
Chromium	ug/L	110										
Cobalt	ug/L	730	5.9	J	8.0	J	7.5	J				
Copper	ug/L	1500	26.5									
Iron	ug/L	11000	1130		5100		4940				40.7	B
Manganese	ug/L	880	156		193		182		22.1		18.7	
Mercury	ug/L	11										
Nickel	ug/L	730	3.2	J								
Thallium	ug/L	2.4									4.1	B
Zinc	ug/L	11000	59.2	J	3.2	J	78.3					
Water Quality Parameters												
Alkalinity	ug/L		229000		293000		259000		697000	J	810000	
Chloride	ug/L		17300000	J	19000000		21100000		149000		140000	
Hardness	ug/L		8850000		8140000		9390000		566000		710000	
Nitrate	ug/L	10000										
Sulfate	ug/L								21400		150000	
Total dissolved solids	ug/L		27800000		35500000		43800000		948000		1000000	
Total organic carbon	ug/L		740	J					3000		1800	
Total suspended solids	ug/L		13000		33000		19000					
Turbidity	NTU		10.5		7.4		19.2		266		61	

Table 4-1

Detected Constituents in Bedrock Monitoring Wells
Fifth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Sample Area	Background Wells									
		Location Code:	PB-BED-MW24						PB-BED-MW25			
		Sample No:	CB3008		CC3004		CD3004		BD3030		CA3002	
		Sample Date:	03-APR-02		12-JUL-02		19-OCT-02		05-OCT-01		16-JAN-02	
Parameter	**Units**	**PRG**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**
Explosives												
Dinitrotoluene, 2,4-	ug/L	0.099										
Dinitrotoluene, 2,6-	ug/L	0.099	0.43									
Nitrobenzene	ug/L	3.4	0.33									
RDX	ug/L	0.61	0.22	J								
Volatiles												
Acetone	ug/L	610	170	J	60				1.7	B		
Benzene	ug/L	0.34	110		14	J	9.3	J	0.37	J		
Bromomethane	ug/L	8.7										
Butanone, 2-	ug/L	1900	17	J	12	B						
Carbon disulfide	ug/L	1000	0.59	J			29		0.48	J	1.5	
Chloroform	ug/L	6.2							1.1			
Chloromethane	ug/L	1.5										
Ethylbenzene	ug/L	2.9	38		8.0	J	4.8	J	0.22	J		
Methyl-2-pentanone, 4-	ug/L	160							0.30	J		
Methylene chloride	ug/L	4.3							0.30	B		
Toluene	ug/L	720	100		17	J	14		0.80	J		
Xylenes, total	ug/L	210	210		55		23		1.5			
Semivolatiles												
Bis(2-ethylhexyl)phthalate	ug/L	4.8			4.6	B			0.86	J		
Dimethylphenol, 2,4-	ug/L	730			0.76	J						
Methylnaphthalene, 2-	ug/L		4.6	J	10	J	1.4	J				
Methylphenol, 2-	ug/L	1800										
Methylphenol, 4-	ug/L	180										
Naphthalene	ug/L	6.2	4.0	J	8.7	J						
Phenanthrene	ug/L											
Phenol	ug/L	22000										
Metals - Unfiltered												
Aluminum	ug/L	36000	35.7	J	1150		115	J	78.2	B	79.8	B
Antimony	ug/L	150										
Arsenic	ug/L	0.045			4.3							
Barium	ug/L	2600	1160		680		1080		226		247	
Beryllium	ug/L	73									1.2	B
Cadmium	ug/L	18										
Chromium	ug/L	110			9.4							
Cobalt	ug/L	730			2.9							
Copper	ug/L	1500			8.6							
Iron	ug/L	11000			13400		403		795		357	
Lead	ug/L	15			5.2	B						
Manganese	ug/L	880	14.8	J	420		23.6		89.0		56.2	
Mercury	ug/L	11										
Nickel	ug/L	730			7.9							
Selenium	ug/L	180										
Thallium	ug/L	2.4									4.7	B
Vanadium	ug/L	260			6.1							
Zinc	ug/L	11000			28.4		3.9	J	7.7	J		
Metals - Filtered												
Aluminum	ug/L	36000	74.0	B	110	B	87.0	B	68.7	B		
Arsenic	ug/L	0.045										
Barium	ug/L	2600	1170		670		1140		224		234	
Beryllium	ug/L	73										
Chromium	ug/L	110										
Cobalt	ug/L	730					1.4	J				
Copper	ug/L	1500										
Iron	ug/L	11000							713		337	
Manganese	ug/L	880	16.6		44.2		15.5		87.0		52.2	
Mercury	ug/L	11										
Nickel	ug/L	730										
Thallium	ug/L	2.4										
Zinc	ug/L	11000	3.4	J			5.7	B	3.0	J		
Water Quality Parameters												
Alkalinity	ug/L		157000		979000		757000		278000	J	320000	
Chloride	ug/L		175000	J	155000		126000		404000		460000	
Hardness	ug/L		715000		1370000		808000		627000		720000	
Nitrate	ug/L	10000										
Sulfate	ug/L		23600		32300				121000		79000	
Total dissolved solids	ug/L		2200000		1020000		990000		1000000		1100000	
Total organic carbon	ug/L		2400		3700		3700		4000	B	2000	
Total suspended solids	ug/L		14000		124000		62000		4000			
Turbidity	NTU		116		742		49.6		21.7	J	21	

Table 4-1

Detected Constituents in Bedrock Monitoring Wells
Fifth Quarterly Background Report
Former Plum Brook Ordnance Works, Sandusky, Ohio

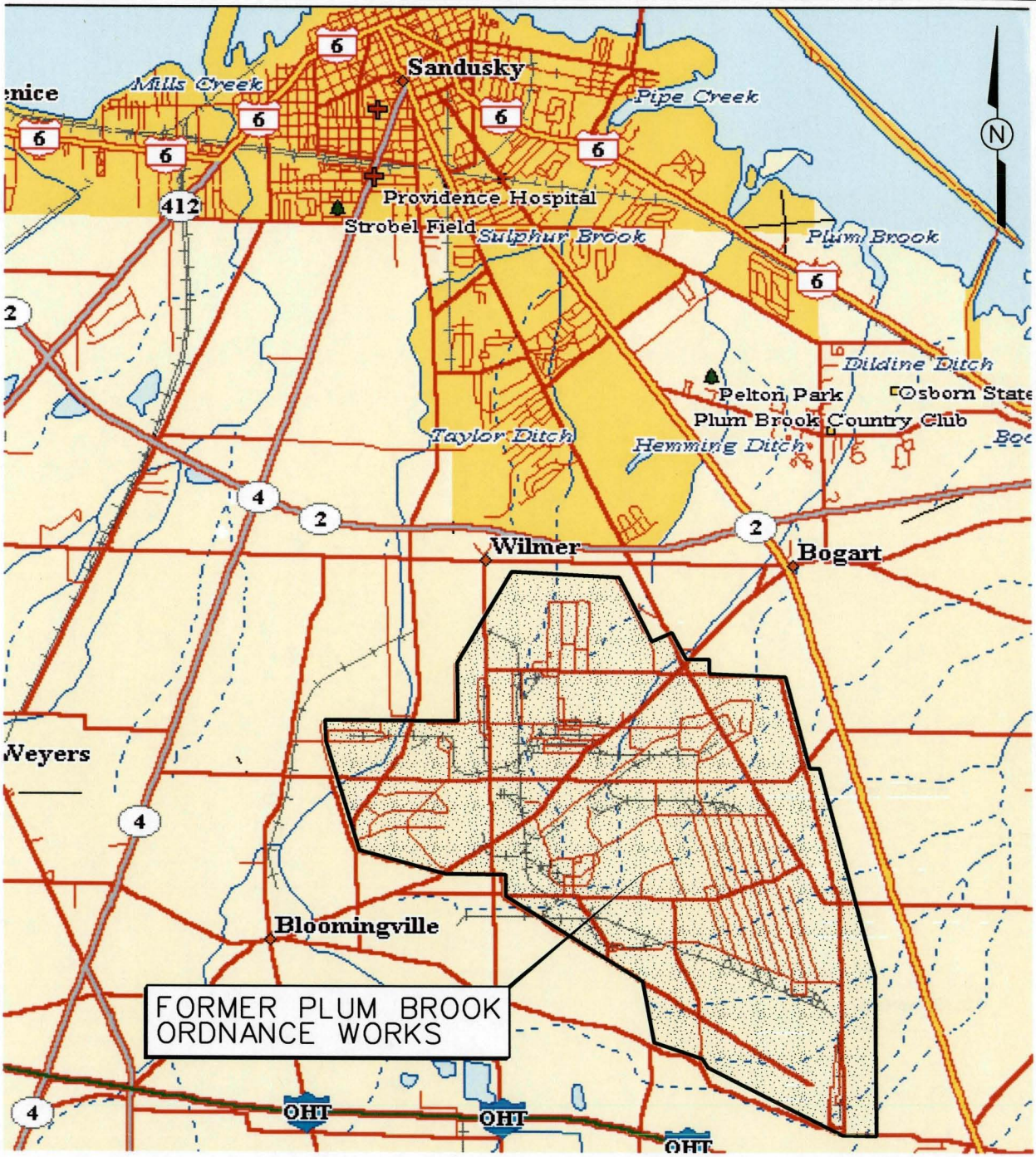
		Sample Area	Background Wells							
		Location Code:	PB-BED-MW25						PB-BED-MW26	
		Sample No:	CB3004		CC3005		CD3005		CA3004	
		Sample Date:	03-APR-02		11-JUL-02		17-OCT-02		17-JAN-02	
Parameter	**Units**	**PRG**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**	**Result**	**VQ**
Explosives										
Dinitrotoluene, 2,4-	ug/L	0.099								
Dinitrotoluene, 2,6-	ug/L	0.099								
Nitrobenzene	ug/L	3.4	0.076	J			0.12	J		
RDX	ug/L	0.61								
Volatiles										
Acetone	ug/L	610			1.4	B	1.6	J		
Benzene	ug/L	0.34					0.15	J		
Bromomethane	ug/L	8.7								
Butanone, 2-	ug/L	1900								
Carbon disulfide	ug/L	1000	0.36	J	0.17	J	1.3			
Chloroform	ug/L	6.2								
Chloromethane	ug/L	1.5								
Ethylbenzene	ug/L	2.9								
Methyl-2-pentanone, 4-	ug/L	160								
Methylene chloride	ug/L	4.3	0.21	B						
Toluene	ug/L	720	0.25	J						
Xylenes, total	ug/L	210					0.37	J		
Semivolatiles										
Bis(2-ethylhexyl)phthalate	ug/L	4.8			3.0	B				
Dimethylphenol, 2,4-	ug/L	730								
Methylnaphthalene, 2-	ug/L									
Methylphenol, 2-	ug/L	1800								
Methylphenol, 4-	ug/L	180								
Naphthalene	ug/L	6.2								
Phenanthrene	ug/L									
Phenol	ug/L	22000								
Metals - Unfiltered										
Aluminum	ug/L	36000	41.3	J	44.6	J	79.7	J	93200	
Antimony	ug/L	150								
Arsenic	ug/L	0.045							56.6	
Barium	ug/L	2600	434		164	J	277		1970	
Beryllium	ug/L	73							5.2	
Cadmium	ug/L	18							3.3	J
Chromium	ug/L	110							454	
Cobalt	ug/L	730							82.8	
Copper	ug/L	1500							293	
Iron	ug/L	11000	91.1	J	103		207		232000	
Lead	ug/L	15							79.2	
Manganese	ug/L	880	68.8		95.6		86.5		7470	
Mercury	ug/L	11							0.14	J
Nickel	ug/L	730							457	
Selenium	ug/L	180								
Thallium	ug/L	2.4								
Vanadium	ug/L	260							142	
Zinc	ug/L	11000	79.5				1.7	J	789	
Metals - Filtered										
Aluminum	ug/L	36000	52.7	B	97.8	B	69.8	B		
Arsenic	ug/L	0.045								
Barium	ug/L	2600	452		160	J	270			
Beryllium	ug/L	73								
Chromium	ug/L	110								
Cobalt	ug/L	730								
Copper	ug/L	1500								
Iron	ug/L	11000			59.8	J	157			
Manganese	ug/L	880	65.6		94.0		84.2			
Mercury	ug/L	11								
Nickel	ug/L	730								
Thallium	ug/L	2.4			6.4	J				
Zinc	ug/L	11000	19.9	J			1.5	B		
Water Quality Parameters										
Alkalinity	ug/L		337000		329000		314000			
Chloride	ug/L		558000	J	219000		631000			
Hardness	ug/L		611000		772000		848000			
Nitrate	ug/L	10000								
Sulfate	ug/L		36200		416000		79500			
Total dissolved solids	ug/L		1330000		1180000		1440000			
Total organic carbon	ug/L		3000		2700		2700			
Total suspended solids	ug/L		9000		5000					
Turbidity	NTU		112		23.6		35.8			

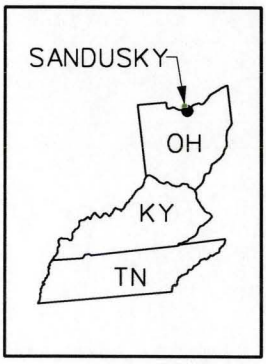
µg/L - Micrograms per liter.
PRG - Preliminary remedial goal.
NTU - Nephelometric turbidity unit.
Shaded cell indicates value is above preliminary screening level (EPA, 2002).

Validation Qualifiers (VQ)
B - The analyte was not detected significantly above the level found in the associated blank or field blanks.
J - The compound/analyte was positively identified; the reported value is an estimated concentration.

Figures

FIGURES





NOT TO SCALE

FIGURE 1-1
VICINITY MAP

FORMER PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

STARTING DATE: 12/16/97	DATE LAST REV.: JAN 2003	DRAFT. CHCK. BY:	INITIATOR: D. KESSLER	DWG. NO.: \773701ES.001
DRAWN BY: D. BILLINGSLEY	DRAWN BY: lstout	ENGR. CHCK. BY: D. KESSLER	PROJ. MGR.: S. DOWNEY	PROJ. NO.: 773701

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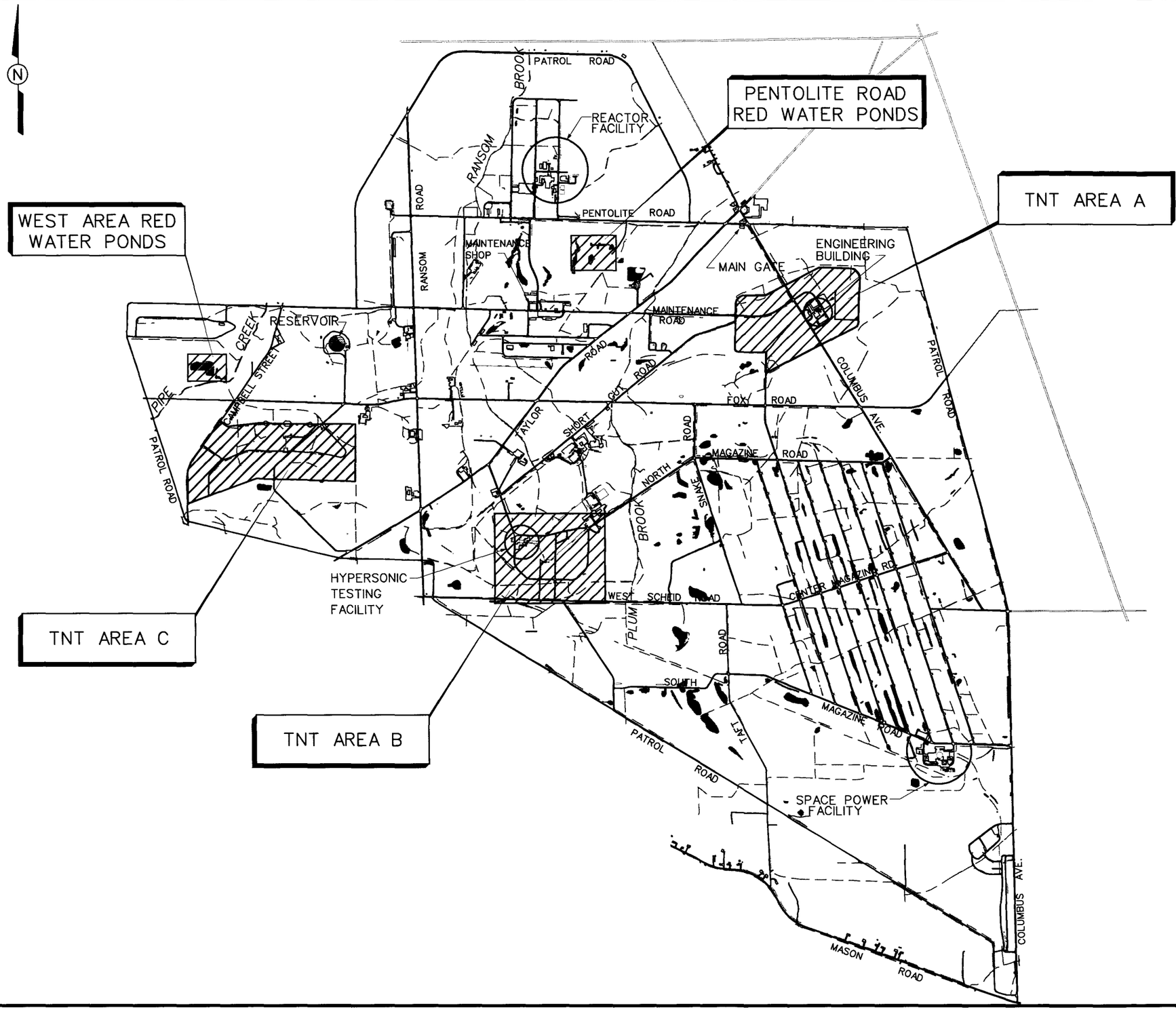

LEGEND:

- BUILDINGS
- STREAMS OR DITCHES
- ROAD
- SURFACE WATER
- AREAS OF CONCERN

NOTES:

BACKGROUND MONITORING WELLS ARE LOCATED ALONG THE WEST AND SOUTHWEST SIDE OF THE FACILITY.

SCALE

0 2400 4800 FEET

FIGURE 1-2
SITE MAP WITH AREAS OF CONCERN

FORMER PLUM BROOK ORDNANCE WORKS
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

STARTING DATE: 05/06/02	DATE LAST REV.:	DRAFT. CHCK. BY:	INITIATOR: D. KESSLER
DRAWN BY: B. VANDERGRIFF	DRAWN BY:	ENGR. CHCK. BY: D. KESSLER	PROJ. MGR: S. DOWNEY
15 JAN 2003	15:50:39		DWG. NO.: ...\825635es.027
			PROJ. NO.: 825635

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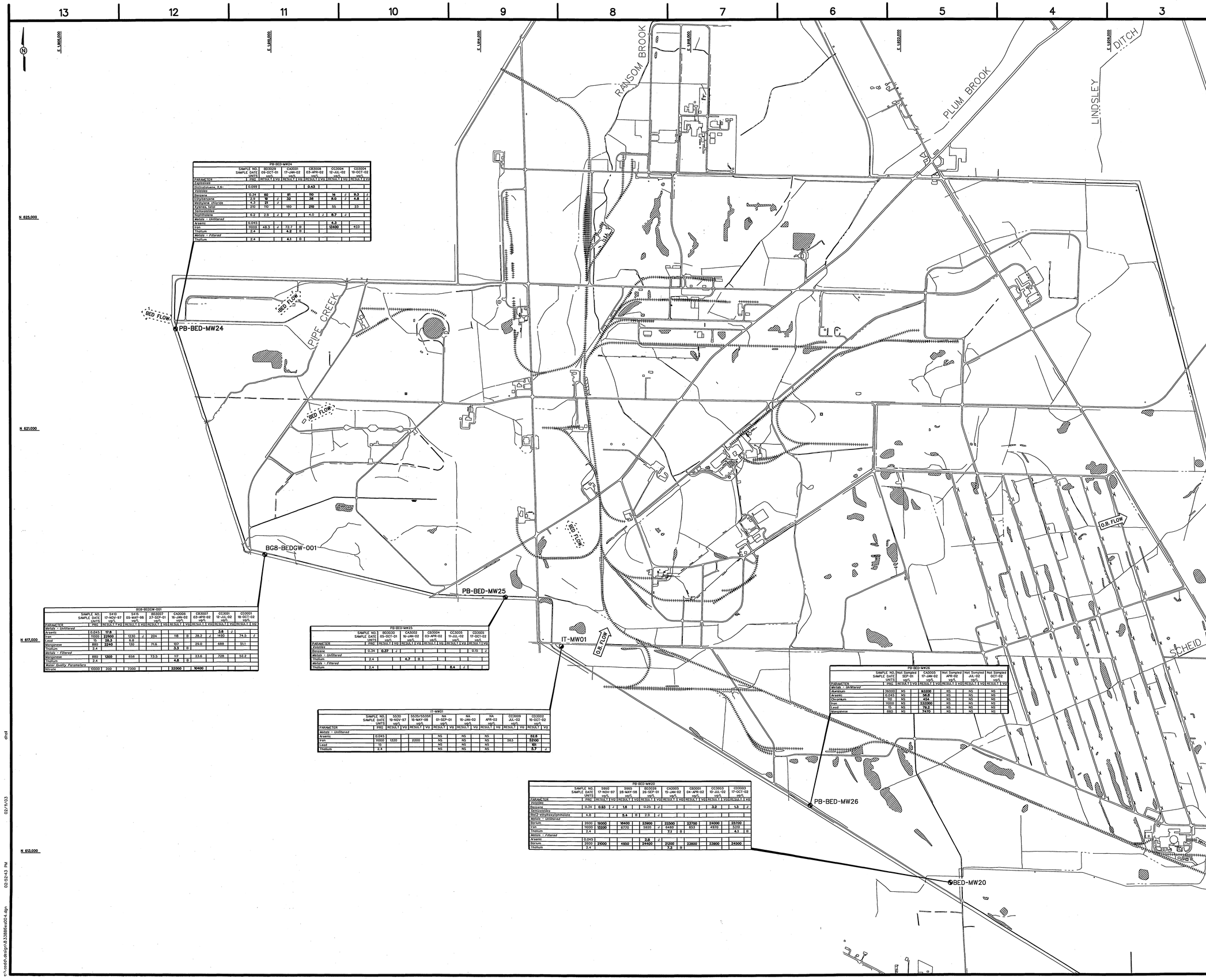
c:\cadd\design\825635es.027



PB-BED-MW24

PARAMETER	SAMPLE NO. / SAMPLE DATE / UNITS	PRG	B03029 09-OCT-01 ug/L RESULT	VQ	CA3001 17-JAN-02 ug/L RESULT	VQ	CB3008 03-APR-02 ug/L RESULT	VQ	CC3004 12-JUL-02 ug/L RESULT	VQ	CD3004 18-OCT-02 ug/L RESULT	VQ
Explosives												
Octahydrotetra, 2,6-		0.099					0.43					
Volatiles												
Benzene		0.34	60	J	81		110		14	J	9.3	J
Ethylbenzene		2.3	12	J	32		38		8.0	J	4.8	J
Methylene chloride		4.3	21	J								
Xylenes, total		210	110		180		210		55		23	
Semivolatiles												
Naphthalene		6.2	2.9	J	7		4.0	J	8.7	J		
Metals - Unfiltered												
Arsenic		0.045							4.3			
Iron		11000	48.3	J	72.7	B			12400		403	
Thallium		2.4			4.2	B						
Metals - Filtered												
Thallium		2.4			4.1	B						

BG8-BEDGW-001

PARAMETER	SAMPLE NO. / SAMPLE DATE / UNITS	PRG	5410 17-NOV-97 ug/L RESULT	VQ	5415 05-MAY-98 ug/L RESULT	VQ	B03027 27-SEP-01 ug/L RESULT	VQ	CA3005 16-JAN-02 ug/L RESULT	VQ	CB3007 03-APR-02 ug/L RESULT	VQ	CC3011 12-JUL-02 ug/L RESULT	VQ	CD3001 18-OCT-02 ug/L RESULT	VQ
Metals - Unfiltered																
Arsenic		0.045	17.6										3.8	J		
Iron		11000	22600		1230	J	204		118	B	38.2	J	1490		74.5	J
Lead		15	28.3		6.8											
Manganese		880	2240		130		71.6		107		29.0		688		51.1	
Thallium		2.4							3.3	B						
Metals - Filtered																
Manganese		880	1300		658		73.5		117		23.6		728		52.2	
Thallium		2.4							5.8	B						
Water Quality Parameters																
Nitrate		10000	200		7300				22000		10400					

PB-BED-MW25

PARAMETER	SAMPLE NO. / SAMPLE DATE / UNITS	PRG	B03030 09-OCT-01 ug/L RESULT	VQ	CA3002 16-JAN-02 ug/L RESULT	VQ	CB3004 03-APR-02 ug/L RESULT	VQ	CC3005 16-JUL-02 ug/L RESULT	VQ	CD3002 17-OCT-02 ug/L RESULT	VQ
Volatiles												
Benzene		0.34	0.37	J							0.15	J
Metals - Unfiltered												
Thallium		2.4			4.7	B						
Metals - Filtered												
Thallium		2.4							8.4	J		

IT-MW01

PARAMETER	SAMPLE NO. / SAMPLE DATE / UNITS	PRG	5530 19-NOV-97 ug/L RESULT	VQ	5535/55330 16-MAY-98 ug/L RESULT	VQ	NA 01-SEP-01 ug/L RESULT	VQ	NA 16-JAN-02 ug/L RESULT	VQ	NA APR-02 ug/L RESULT	VQ	CC3009 JUL-02 ug/L RESULT	VQ	CD3002 18-OCT-02 ug/L RESULT	VQ
Metals - Unfiltered																
Arsenic		0.045					NS		NS		NS				52.8	
Iron		11000	1320		2200		NS		NS		NS		563		52100	
Lead		15					NS		NS		NS				101	
Thallium		2.4					NS		NS		NS				5.7	J

PB-BED-MW26

PARAMETER	SAMPLE NO. / SAMPLE DATE / UNITS	PRG	Not Sampled SEP-01 ug/L RESULT	VQ	CA3003 17-JAN-02 ug/L RESULT	VQ	Not Sampled APR-02 ug/L RESULT	VQ	Not Sampled JUL-02 ug/L RESULT	VQ	Not Sampled OCT-02 ug/L RESULT	VQ
Metals - Unfiltered												
Aluminum		36000	NS		83200		NS		NS		NS	
Arsenic		0.045	NS		56.8		NS		NS		NS	
Chromium		110	NS		454		NS		NS		NS	
Iron		11000	NS		332000		NS		NS		NS	
Lead		15	NS		79.2		NS		NS		NS	
Manganese		880	NS		7470		NS		NS		NS	

PB-BED-MW20

PARAMETER	SAMPLE NO. / SAMPLE DATE / UNITS	PRG	5910 17-NOV-97 ug/L RESULT	VQ	5965 28-MAY-98 ug/L RESULT	VQ	B03028 26-SEP-01 ug/L RESULT	VQ	CA3005 15-JAN-02 ug/L RESULT	VQ	CB3001 04-APR-02 ug/L RESULT	VQ	CC3003 10-JUL-02 ug/L RESULT	VQ	CD3003 17-OCT-02 ug/L RESULT	VQ
Volatiles																
Benzene		0.34	0.93	J	1.6		0.25	J					3.2		1.3	J
Semivolatiles																
Bis(2-ethylhexyl)phthalate		4.8			5.4	B	2.3	J								
Metals - Unfiltered																
Barium		2600	15000		14400		23900		23500		22700		24000		25700	
Iron		11000	13200		6770		5920	J	4480		653		4970		5370	
Thallium		2.4							7.1	B					4.3	B
Metals - Filtered																
Arsenic		0.045			2.8		4	J								
Barium		2600	21000		4950		24400		23200		23800		23900		24500	
Thallium		2.4							7.3	B						

LEGEND:

- IT-MW01 — OVERBURDEN MONITORING WELL LOCATION
- BED-MW20 — BEDROCK MONITORING WELL LOCATION
- BUILDINGS
- RAILROAD
- SURFACE WATER
- DITCH
- FENCE
- O.B. FLOW — OVERBURDEN GROUNDWATER FLOW DIRECTION
- BED FLOW — BEDROCK GROUNDWATER FLOW DIRECTION

NOTES:

1. GROUNDWATER FLOW DIRECTION ON MAY 4, 2002.
2. UNABLE TO SAMPLE IT-MW01 IN SEPTEMBER 2001, JANUARY OR APRIL 2002. PVC CASING WAS DAMAGED AND PREVENTED ACCESS.
3. BOLDED VALUES ABOVE OCTOBER 2002 PRELIMINARY SCREENING LIMITS.
4. IF ANALYTE DETECTED ABOVE PRELIMINARY SCREENING LIMIT, ALL ANALYTICAL RESULTS FOR THAT ANALYTE ARE SHOWN.

NE - NOT ESTABLISHED

SCALE
0 800 1600 FEET

NO	DATE	REVISION	BY	CHKD	DSGN ENGR	ENGR	PROJ MGR	APPR

STARTING DATE	INITIATOR / CHKD	DRAWN / CHKD	PROJECT MNGR
07/21/02	D. KESSLER	VANDERGRIFF/ C. TUMLIN	S. DOWNEY

IT CORPORATION
A Member of The IT Group
KNOXVILLE, TENNESSEE

FIFTH QUARTERLY BACKGROUND GROUNDWATER REPORT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

FIGURE 2-1
DETECTED CONSTITUENTS IN OVERBURDEN/BEDROCK BACKGROUND MONITORING WELLS
(NOVEMBER 1997, MAY 1998, SEPTEMBER-OCTOBER 2001, JANUARY, APRIL, JULY, AND OCTOBER 2002)

AREA	JOB NO.	DRAWING NO.	REV
	833886	833886ES004.DGN	

c:\cadd\design\833886es004.dgn 02:52:43 PM 02/11/03 dnd

Appendix A

APPENDIX A

SAMPLE COLLECTION LOGS

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 PLUM BROOK ORDNANCE WK

Manager: Steve Downey

PB 101802STLN

RFA / COC Number: PB101802STLK

Location Code: IT-BG8-BEDGW-001

Sample Number: CD3001

Sample Name: PBOW-02-GW-IT-BG8-BEDGW-001-CD3001

Sampling Method: LF

Sample Type: GW *Sample Purpose:* REG

Collection Date: 10/18/02

Collection Time: 1050

Start Depth: 6.05

End Depth: 6.10

Sample Matrix: WATER

Sample Team: DK/JH

QC Partners:

(TB) CD5006 (ER) — (FB) —

ERPIMS Values:

Sacode:

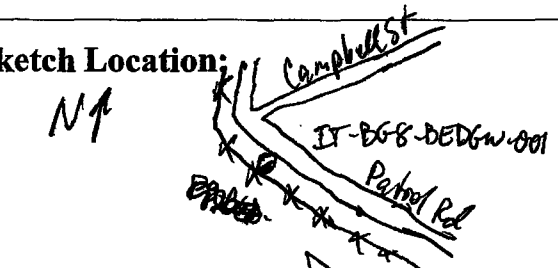
Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
METALS3-W-F	Y	A	1	250/500	mL	HDPE
METALS3-W	N	B	1	250/500	mL	HDPE
EXPLOSIVES	N	C	1	1	L	Amb. Glass
VOLATILES3	N	D	3	40	mL	GVIAL,SEP
SEMIVOLATILES3	N	E	2	1	L	Amb. Glass
TOC	N	F	2	40	mL	GVIAL,SEP
CYANIDE	N	G	1	1,000/500	mL	HDPE
ALKALINITY	N	H	1	1	L	HDPE
CHLORIDE	N	H	1	1	L	HDPE
NITRATE-W	N	H	1	1	L	HDPE
SULFATE	N	H	1	1	L	HDPE
TDS	N	H	1	1	L	HDPE
TSS	N	H	1	1	L	HDPE
TURB180.1	N	H	1	1	L	HDPE
HARDNESS	N	I	1	250/500	mL	HDPE

Comments: Collected via low-flow sampling

Sketch Location:



Logged BY / Date: David Kresch 10/18/02 *Reviewed BY / Date:* David Kresch 10/18/02

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 PLUM BROOK ORDNANCE WK

Manager: Steve Downey

Location Code: IT-BG8-BEDGW-001

Sample Number: CD3901

10/18/01 Depth to water = 5.82, TD = 20 ft, water column = 14.18 ft, pump placed at 14 ft

Settings: CPM4 Refill: 8.0
7.0 Throttle 10 psi, 20 ft. Purge rate 280-300 ml/min

PURGE RECORD:

Initial	Time(24hr)	DepthtoWater (ft)	Eh (mV)	pH (SU)	Conductivity (mS/cm)	Turbidity (NTU)	DissOxygen (ppm)	Temperature (C)	Purge Volume (gal)
	1000	5.82							
	1005	6.04	-51	5.23	3.78	66.2	2.48	14.5	
	1010	6.10	-160	5.56	3.79	44.9	2.10	14.1	1.0
	1015	6.08	-250	5.97	3.92	52.6	2.01	14.0	
	1020	6.08	-258	5.99	3.99	16.3	1.95	13.9	
	1025	6.03	-263	5.96	3.97	31.2	1.88	13.8	2.0
	1030	6.05	-277	5.98	4.01	10.7	1.89	13.9	
	1035	6.03	-279	5.98	4.07	9.3	1.88	13.8	
	1040	6.08	-286	6.00	4.07	17.0	1.87	13.9	
	1045	6.09	-291	5.99	4.05	15.1	1.86	13.7	3.5 x 280-300 ml/min
Sample:	1050	5.98	-307	5.97	3.88	16.5	1.73	14.2	4.0

- Appears to be biofouling on screen, small black particulates.
- Slight sulfur odor

Removed 3.5 gal

Logged BY / Date: David Kesch 10/18/02 *Reviewed BY / Date:* David Kesch 10/18

GROUNDWATER SAMPLING FORM

IT CORPORATION
A Member of The IT Group

Project Number: 825635
Project Name: PBOW Groundwater
Investigation Site: Background
RFA/COC Number: PD10802STLK+N

Collection Date: 10/18/02
Collection Time: 1050
Sample Filtered (Yes / No): yes
Weather/Temp: partly cloudy, cool

Form Completed By: D. Kessler
Sampler(s): D. Kessler, J. Hofer
Reviewed By: David Kessler

Sample Number: P B O W - 0 2 - G W

MONITORING WELL INFORMATION [use top of casing (TOC) for all measurements]

Well Number: IT-~~BED~~ BG8-BEDGW-001
Well Secure (Yes / No): yes
Well Labeled (Yes / No): yes
Well Condition: Good
Screen Height: 15 ft
Casing Type: PVC

Outside Casing Dia. (in): 2
Depth to Product (ft): None
Total Well Depth (ft): 20
Depth to Water (ft): 5.82
Water Column (ft): 14.18
Elev. Ref. for Water Level:

Odor: None
Vapor Monitor Type: PID / VRAE
- Vapor Monitor S/N: H842641 / H845141 - Firdlay
- Reading (ppm): 0 / LEL-57% H_2S=0 CO=0 O_2=20.0
Remarks:

MONITORING WELL PURGE CALCULATIONS AND PURGE RECORD

Volume of Water in Casing: Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (_____)^2) = _____ gal/ft
Well Volume (gallons) = Water Column (ft) x Gal/ft = _____ ft x _____ Gal/ft = _____ gallons

Volume of Water in Filter Pack: Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. in inches & d is casing dia. in inches = 0.041 x ((_____)^2 - (_____)^2) = _____ gal/ft
Filter Pack Volume (gal) = ((Screen Height + lesser of 2 ft or water column) x gal/ft) x porosity (0.3) = ((Screen Height _____ ft + _____ ft) x _____ gal/ft) x 0.3 = _____ gallons

Purge Well Volume: Purge Well Volume = Filter Pack Volume + Well Volume = _____ gal + _____ gal = _____ gal

1 x Purge Well Volume (gal.)	2 x Purge Well Volume (gal.)	3 x Purge Well Volume (gal.)	4 x Purge Well Volume (gal.)	5 x Purge Well Volume (gal.)

Purge Cycle	Time (24 hr)	Depth to Water	Conductivity	pH	Eh	Temperature	Turbidity	Diss. O_2	Purge Volume
Units:		Feet	µmho/cm	Standard Units	ppm	°F	NTU	ppm	gallons
Purge Vol 1									
Purge Vol 2									
Purge Vol 3									
Purge Vol 4									
Purge Vol 5									
SAMPLE									

Low Flow

SAMPLE ANALYTICAL INFORMATION

Requested Analysis	Method	Sample Container(s)	Requested Analysis	Method	Sample Container(s)	Requested Analysis	Method	Sample Container(s)
Nitroaromatics	Mod. 8330	2 - 1 Liter Amber Glass	Dissolved TAL Metals	3005A/6010B / 7470A	1 - 500 mL HDPE	Chloride	325.3	1 - 1 Liter HDPE See Note A
TCL Volatile Organics	5030 / 8260B	3 - 40 mL Glass Vials	Total Cyanide	9010A/9012	1 - 1 Liter HDPE	Sulfate	375.3	A. Sample for alkalinity, chloride, sulfate, TSS. TDS, and turbidity combined in one 1-liter HDPE container.
TCL SVOCs	3510C / 8270C	2 - 1 Liter Amber Glass	Total Organic Carbon	9060	1 - 250 mL Amber Glass	Tot. Suspended Solids	160.2	
Total TAL Metals	3005A/6010B / 7470A	1 - 500 mL HDPE	Nitrate	353.2		Total Dissolved Solids	160.1	
Hardness	130.2		Alkalinity	310.1	1 - 1 Liter HDPE See Note A	Turbidity	180.1	

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 PLUM BROOK ORDNANCE WK

Manager: Steve Downey

RFA / COC Number: PB101602STLK / PB101602STLN

Location Code: IT-MW01

Sample Number: CD3002

Sample Name: PBOW-02-GW-IT-MW01-CD3002

Sampling Method: LF

Sample Type: GW

Sample Purpose: REG

Collection Date: 10/16/02

Collection Time: 0925

Start Depth: 9

End Depth: 11

Sample Matrix: WATER

Sample Team: DK/JA

QC Partners:
(TB) CD5003 (ER) — (FB) —

ERPIMS Values:
Sacode:
Lot Control#:

Containers

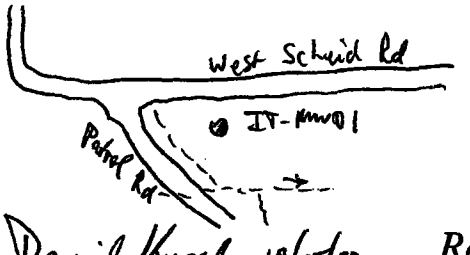
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
METALS3-W-F	Y	A	1	~~500~~ 250	mL	HDPE
METALS3-W	N	B	1	~~500~~ 250	mL	HDPE
EXPLOSIVES	N	C	1	1	L	Amb. Glass
VOLATILES3	N	D	3	40	mL	GVIAL,SEP
SEMIVOLATILES3	N	E	2	1	L	Amb. Glass
TOC	N	F	2	40	mL	GVIAL,SEP
CYANIDE	N	G	1	1000	mL	HDPE
ALKALINITY	N	H	1	1	L	HDPE
CHLORIDE	N	H	1	1	L	HDPE
NITRATE-W	N	H	1	1	L	HDPE
SULFATE	N	H	1	1	L	HDPE
TDS	N	H	1	1	L	HDPE
TSS	N	H	1	1	L	HDPE
TURB 180.1	N	H	1	1	L	HDPE
HARDNESS	N	I	1	~~500~~ 250	mL	HDPE

- Pumped w/ peristaltic pump pump at 300 rpm 10/15/02
- Pumped dry.

Comments: Dept is given 2 ft below TOC. Overburden well. Purging time 11:00-12:05 = 1 hr 5 min. Removed 3.0 gal.

Sketch Location:

N↑



Logged BY / Date: David Kusch 10/15/02 *Reviewed BY / Date:* David Kusch 10/16/02

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 PLUM BROOK ORDNANCE WK

Manager: Steve Downey

Location Code: CD 3002

Sample Number: ~~ST~~ - MW01

pumped w/ peristaltic pump

1100 10/15/02 DTW = 8.13 ft TD = 11.95 (From well const. diagram), water column = 3.82 ft
pumped dry. 11:00-12:05

0915 10/16/02 DTW = 9.23 ft

PURGE RECORD:

	Initial	Time(24hr)	DepthtoWater (ft)	Eh (mV)	pH (SU)	Conductivity (mS/cm)	Turbidity (NTU)	DissOxygen (ppm)	Temperature (C)	Purge Volume (gal)
10/15/02	1100	Began	8.13							
	1105		8.60	-34	5.93	0.928	4.1	4.69	16.6	0.24 180 ml/min
	1110		8.90	-80	6.13	0.857	5.0	3.04	16.9	0.48
	1115		9.14	-78	6.09	0.832	3.6	2.74	17.2	0.71
	1120		9.44	-74	6.06	0.803	2.0	2.73	17.3	0.95
	1125		9.73	-70	6.03	0.785	1.2	2.68	17.2	1.20
	1130		10.08	-68	6.03	0.772	1.1	2.55	17.1	1.43
	1140		10.61	-70	6.06	0.719	1.1	2.44	17.1	1.90
	~~1150~~ 1145		~~11.14~~ 10.89	-69	6.06	0.807	1.2	2.41	16.9	
	1150		11.14	-67	6.06	0.818	1.2	2.37	17.0	
	1155		11.42	-65	6.06	0.877	1.7	2.36	17.0	
	1200		11.65	-61	6.04	0.889	1.9	2.37	16.8	
	1205	Dry	—	—	—	—	—	—	—	3.09
10/16/02	Sample:	0925	9.23	-28	6.22	0.765	3.6	3.41	14.4	

~~DTW~~

Removed 3 gal

Logged BY / Date: David Kessler 10/15/02 *Reviewed BY / Date:* David Kessler 10/16/02

GROUNDWATER SAMPLING FORM

IT CORPORATION
A Member of The IT Group

Project Number: 833886 ~~825635~~
Project Name: PBOW Groundwater
Investigation Site: Background
RFA/COC Number: PB101602STL KIN

Collection Date: 10/16/02
Collection Time: 0925
Sample Filtered (Yes / No): yes
Weather/Temp: cloudy, cool (48°), windy

Form Completed By: D. Kessler
Sampler(s): D. Kessler / J. Hofer
Reviewed By: D. Kessler

Sample Number: P B O W 0 2 G W

MONITORING WELL INFORMATION [use top of casing (TOC) for all measurements]

Well Number: IT-MW01
Well Secure (Yes / No): yes
Well Labeled (Yes / No): yes
Well Condition: ~~fair~~ riser bent (at 2 ft from TOC)
Screen Height:
Casing Type: PVC

Outside Casing Dia. (in): 2"
Depth to Product (ft): None
Total Well Depth (ft): 11.95
Depth to Water (ft): 8.13
Water Column (ft): 3.82
Elev. Ref. for Water Level:

Odor: None
Vapor Monitor Type: PID / VRAE
- Vapor Monitor S/N: H842641 / H845141
- Reading (ppm): 0.0 / LEL=0, H2S=0.0, CO=0, O2=20.8
Remarks: Pumped gw w/peristaltic pump

MONITORING WELL PURGE CALCULATIONS AND PURGE RECORD

Volume of Water in Casing: Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (2)^2) = 0.163 gal/ft
Well Volume (gallons) = Water Column (ft) x Gal/ft = 3.82 ft x 0.163 Gal/ft = 0.623 gallons

Volume of Water in Filter Pack: Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. in inches & d is casing dia. in inches = 0.041 x ((8)^2 - (2)^2) = 2.46 gal/ft
Filter Pack Volume (gal) = ((Screen Height + lesser of 2 ft or water column) x gal/ft) x porosity (0.3) = ((Screen Height ____ ft + 3.82 ft) x 2.46 gal/ft) x 0.3 = 2.82 gallons

Purge Well Volume: Purge Well Volume = Filter Pack Volume + Well Volume = 2.82 gal + 0.62 gal = 3.44 gal

1 x Purge Well Volume (gal.)	2 x Purge Well Volume (gal.)	3 x Purge Well Volume (gal.)	4 x Purge Well Volume (gal.)	5 x Purge Well Volume (gal.)
3.44	6.88	10.32	13.76	17.2

Purge Cycle	Time (24 hr)	Depth to Water	Conductivity	pH	Eh	Temperature	Turbidity	Diss. O_2	Purge Volume
Units:		Feet	umhos/cm	Standard Units	ppm	°F	NTU	ppm	gallons
Purge Vol 1									
Purge Vol 2									
Purge Vol 3									
Purge Vol 4									
Purge Vol 5									
SAMPLE									

see page 2 for readings

SAMPLE ANALYTICAL INFORMATION

Requested Analysis	Method	Sample Container(s)	Requested Analysis	Method	Sample Container(s)	Requested Analysis	Method	Sample Container(s)
Nitroaromatics	Mod. 8330	1 - 1 Liter Amber Glass	Dissolved TAL Metals	3005A/6010B / 7470A	1 - 500 mL HDPE	Chloride	325.3	1 - 1 Liter HDPE See Note A
TCL Volatile Organics	5030 / 8260B	3 - 40 mL Glass Vials	Total Cyanide	9010A/9012	1 - 1 Liter HDPE	Sulfate	375.3	A. Sample for alkalinity, chloride, sulfate, TSS. TDS, and turbidity combined in one 1-liter HDPE container.
TCL SVOCs	3510C / 8270C	2 - 1 Liter Amber Glass	Total Organic Carbon	9060	1 - 250 mL Amber Glass	Tot. Suspended Solids	160.2	
Total TAL Metals	3005A/6010B / 7470A	1 - 500 mL HDPE	Nitrate	353.2		Total Dissolved Solids	160.1	
Hardness	130.2		Alkalinity	310.1	1 - 1 Liter HDPE See Note A	Turbidity	180.1	

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 PLUM BROOK ORDNANCE WK

Manager: Steve Downey

RFA / COC Number: PB101702STLK PB101702STLN

Location Code: PB-BED-MW20

Sample Number: CD3003

Sample Name: PBOW-02-GW-PB-BED-MW20-CD3003

Sampling Method: LF

Sample Type: GW *Sample Purpose:* REG

Collection Date: 10/17/02

Collection Time: 1510

Start Depth: 17.0

End Depth: 17.5

Sample Matrix: WATER

Sample Team: DK/JH

QC Partners:
(TB) CD5004 (ER) — (FB) —

ERPIMS Values:
Sacode:
Lot Control#:

Containers

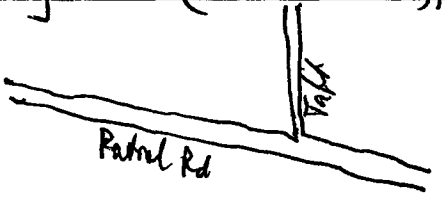
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
METALS3-W-F	Y	A	1	250~~500~~	mL	HDPE
METALS3-W	N	B	1	250~~500~~	mL	HDPE
EXPLOSIVES	N	C	1	1	L	Amb. Glass
VOLATILES3	N	D	3	40	mL	GVIAL,SEP
SEMIVOLATILES3	N	E	2	1	L	Amb. Glass
TOC	N	F	2	40	mL	GVIAL,SEP
CYANIDE	N	G	1	1000~~500~~	mL	HDPE
ALKALINITY	N	H	1	1	L	HDPE
CHLORIDE	N	H	1	1	L	HDPE
NITRATE-W	N	H	1	1	L	HDPE
SULFATE	N	H	1	1	L	HDPE
TDS	N	H	1	1	L	HDPE
TSS	N	H	1	1	L	HDPE
TURB 180.1	N	H	1	1	L	HDPE
HARDNESS	N	I	1	250~~500~~	mL	HDPE

10/16/02 - DTW 14.01 RK
10/17/02 - DTW = 12.17 RK

* Could not low-flow

Comments: Collected sample/purged well w/ bailer. Filtered sample w/ 0.45 micro filter hand pump.
- Gurgling/bubbling in well (Shook 2" well), No strong H_2S odor but occassional sulfur odor (very slight). (Natural Gas?) LEL meter >50ppm

Sketch Location:



Logged BY / Date: David Kusch 10/16/02 *Reviewed BY / Date:* David Kusch 10/16/02

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 **PLUM BROOK ORDNANCE WK**

Manager: Steve Downey

Location Code: PB-BED-MW20

Sample Number: CD3003

DKK 10/16/02 DTW = 14.01, TD = 45.50, water column = 31.49. Pump set at 32 Ft

pump rate = / settings of bladder pump: CPM 4

Refill: 10.0

5.0

throttle: ·

10/17/02 - DTW = 17.17 Ft

PURGE RECORD:

Initial	Time(24hr)	DepthtoWater (ft)	Eh (mV)	pH (SU)	Conductivity (mS/cm)	Turbidity (NTU)	DissOxygen (ppm)	Temperature (C)	Purge Volume (gal)	
10/16/02	1335	14.01	Adjusting							
	1350	14.12	5	6.75	60.3	28.6	3.17	11.7	0.4	= 250ml/min
turned back	1355	14.36	-7	6.82	60.1	33.4	2.34	11.7		
	1400	14.46	-11	6.85	59.8	65.2	2.13	11.5		= 110ml/
	1405	14.62	-14	6.87	60.5	100	1.99	11.6		= 100ml/min
	1410	14.81	-18	6.80	58.5	43.1	2.01	11.7		
	1415	14.88	-18	6.83	58.5	57.2	2.00	11.6		= 100/min
	1425	14.97	-18	6.86	58.8	72.6	Bubbles 1.94	11.6		
	1430	14.99	-20	6.89	59.5	31.9	1.87	11.7		
	1435	15.01	-20	6.90	59.5	32.1	2.11	11.6	2	= 80ml/min
	1500	16.69	-26	6.96	54.4	37.9	1.58	11.6	4	= 300ml
Bubbling (Not Gas?)	1525	~21	-20	6.96	59.7	16.2	3.15	11.4	9	
	1540	~25.3	-7	6.96	59.9	16.8	3.21	11.3	14	
	1405	~30	-17	6.97	60.3	16.1	4.00	11.1	19	
Sample:	10/17/02 1510	17.49	-32	5.69	56.3	10.8	3.38	11.6		
	1425	~33.5	-23	7.02	60.5	20.4	2.85	11.2	24	

Gurgling/bubbling in well, Did not/could not low-flow.

Removed ~~18~~ gal 24 gal

Logged BY / Date: David Kresch 10/16/02 *Reviewed BY / Date:* David Kresch 10/16

page 3

GROUNDWATER SAMPLING FORM

IT CORPORATION
A Member of The IT Group

Project Number: 833886 ~~825635~~
Project Name: PBOW Groundwater
Investigation Site: Background
RFA/COC Number: PB10 & 02 STLC K

Collection Date: 10/17/02
Collection Time: 1510
Sample Filtered (Yes / No): yes
Weather/Temp: cloudy, cold (48°)

Form Completed By: D. Kesslu
Sampler(s): D. Kesslu / J. Hofer
Reviewed By: D. Kesslu

Sample Number: P B O W - 0 2 - G W

MONITORING WELL INFORMATION [use top of casing (TOC) for all measurements]

Well Number: PB-BED-MW20
Well Secure (Yes / No): yes
Well Labeled (Yes / No): yes
Well Condition: good
Screen Height: 20 ft
Casing Type: PVC

Outside Casing Dia. (in): 2
Depth to Product (ft): None
Total Well Depth (ft): 48.6
Depth to Water (ft): 14.01
Water Column (ft): ~~34~~ 34.59
Elev. Ref. for Water Level:

Odor: None
Vapor Monitor Type: PID / VRAE
- Vapor Monitor S/N: H842641 / H845141
- Reading (ppm): 0.0 / LEL->50, H_2S=0, CO=0, O_2=19.6
Remarks:

MONITORING WELL PURGE CALCULATIONS AND PURGE RECORD

Volume of Water in Casing: Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (2)^2) = 0.164 gal/ft
Well Volume (gallons) = Water Column (ft) x Gal/ft = 34.59 ft x 0.164 Gal/ft = 5.67 gallons

Volume of Water in Filter Pack: Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. in inches & d is casing dia. in inches = 0.041 x ((3)^2 - (2)^2) = 0.25 gal/ft
Filter Pack Volume (gal) = ((Screen Height + lesser of 2 ft or water column) x gal/ft) x porosity (0.3) = ((Screen Height 20 ft + 2 ft) x 0.25 gal/ft) x 0.3 = 1.65 gallons

Purge Well Volume: Purge Well Volume = Filter Pack Volume + Well Volume = 1.65 gal + 5.67 gal = 7.32 gal

1 x Purge Well Volume (gal.)	2 x Purge Well Volume (gal.)	3 x Purge Well Volume (gal.)	4 x Purge Well Volume (gal.)	5 x Purge Well Volume (gal.)
7.32	14.64	21.96	29.28	36.60

Purge Cycle	Time (24 hr)	Depth to Water	Conductivity	pH	Eh	Temperature	Turbidity	Diss. O_2	Purge Volume
Units:		Feet	umhos/cm	Standard Units	ppm	°F	NTU	ppm	gallons
Purge Vol 1									
Purge Vol 2									
Purge Vol 3									
Purge Vol 4									
Purge Vol 5									
SAMPLE									

Did not Low-Flow. See Page 2 for readings

SAMPLE ANALYTICAL INFORMATION

Requested Analysis	Method	Sample Container(s)	Requested Analysis	Method	Sample Container(s)	Requested Analysis	Method	Sample Container(s)
Nitroaromatics	Mod. 8330	2 - 1 Liter Amber Glass	Dissolved TAL Metals	3005A/6010B / 7470A	1 - 500 mL HDPE	Chloride	325.3	1 - 1 Liter HDPE See Note A
TCL Volatile Organics	5030 / 8260B	3 - 40 mL Glass Vials	Total Cyanide	9010A/9012	1 - 1 Liter HDPE	Sulfate	375.3	A. Sample for alkalinity, chloride, sulfate, TSS. TDS, and turbidity combined in one 1-liter HDPE container.
TCL SVOCs	3510C / 8270C	2 - 1 Liter Amber Glass	Total Organic Carbon	9060	1 - 250 mL Amber Glass	Tot. Suspended Solids	160.2	
Total TAL Metals	3005A/6010B / 7470A	1 - 500 mL HDPE	Nitrate	353.2		Total Dissolved Solids	160.1	
Hardness	130.2		Alkalinity	310.1	1 - 1 Liter HDPE See Note A	Turbidity	180.1	

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 PLUM BROOK ORDNANCE WK

Manager: Steve Downey

PB 10 19 02STLN - Water Quad

RFA / COC Number: PB1021 19 02STLK

Location Code: PB-BED-MW24

Sample Number: CD3004

Sample Name: PBOW-02-GW-PB-BED-MW24-CD3004

Sampling Method: LF

Sample Type: GW *Sample Purpose:* REG

Collection Date: 10/18/02

Collection Time: 1110

Start Depth: 30.50

End Depth: 31

Sample Matrix: WATER

Sample Team: DK/JH

QC Partners:

(TB) CD 500 7 (ER) — (FB) —

ERPIMS Values:

Sacode:

Lot Control#:

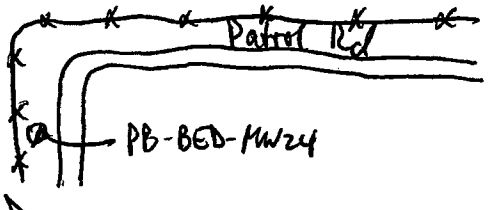
Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
METALS3-W-F	N	A	1 250 500		mL	HDPE
METALS3-W	Y	B	1 250 500		mL	HDPE
EXPLOSIVES	N	C	1	1	L	Amb. Glass
VOLATILES3	N	D	3	40	mL	GVIAL,SEP
SEMIVOLATILES3	N	E	2	1	L	Amb. Glass
TOC	N	F	2	40	mL	GVIAL,SEP
CYANIDE	N	G	1 100 500		mL	HDPE
ALKALINITY	N	H	1	1	L	HDPE
CHLORIDE	N	H	1	1	L	HDPE
NITRATE-W	N	H	1	1	L	HDPE
SULFATE	N	H	1	1	L	HDPE
TDS	N	H	1	1	L	HDPE
TSS	N	H	1	1	L	HDPE
TURB 180.1	N	H	1	1	L	HDPE
HARDNESS	N	I	1 250 500		mL	HDPE

Comments: Did not purge/collect sample via low-flow. Bailed dry. Filtered groundwater w/ 0.045 µg filter in hand held pump.

Sketch Location:

N ↑



Logged BY / Date: David Kesler 10/18/02 *Reviewed BY / Date:* David Kesler 10/18/02

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 PLUM BROOK ORDNANCE WK

Manager: Steve Downey

Location Code: PB-BED-MW24

Sample Number: CD3004

10/18/02 DTW = 29.81 TD = 42.78 Ft, water column = 12.97 Ft. *bottom of pump at ~~30~~ 36.5 Ft DLE

10/19/02 DTW = 30.49 lowered to bottom 42 Ft

Settings: CPM 4 Refill 10.0 5.0 Throttle 20 Ft ~12 psi Air pushing water to 21.5 Ft.

PURGE RECORD:

Initial	Time(24hr)	DepthtoWater (ft)	Eh (mV)	pH (SU)	Conductivity (mS/cm)	Turbidity (NTU)	DissOxygen (ppm)	Temperature (C)	Purge Volume (gal)	
Began	1340	28.34								
Gassing	1345		-309	6.16	1.75	101	2.90	13.3		200 ml/min
	1350		-323	6.10	1.78	>1000	2.05	13.8	~0.5	
	1420	? water on top at 25.5	-327	6.04	1.80	>1000	1.82	14.1	1 gal	
	1425	24.7 "	-326	6.03	1.81	>1000	1.85	13.6		~80 ml/min
	1430	24.7 "	-325	6.01	1.81	>1000	1.84	13.3	1.75 gal	
	1450	29.5 *	-322	5.97	1.82	>1000	1.93	12.1	2 gal	200 ml/min pump on bottom
	1500	30.25	-322	5.98	1.83	>1000	2.08	12.2		
	1505	32.9	-322	5.97	1.83	>1000	2.21	12.1		
	1510	33.9	-322	5.98	1.83	>1000	2.34	11.9		
	1515	34.45	-322	5.98	1.83	707	2.44	12.2	~3	* increased to 525 ml/min
	1520	>40.0 Ft	-318	6.21	1.85	750	2.95	11.7	4	
	1525	>40	-318	6.05	1.84					
Dry →	1529								4.5	
Sample:	1110	30.49	-297	6.30	1.85	22.3	5.52	12.2		

*Gurgling/bubbling in well stopped at ~33 Ft. (Gas/Fracture at 33 Ft) Removed 4.5 gal.

Logged BY / Date: David Kessler 10/18/02 *Reviewed BY / Date:* David Kessler 10/18

pr 3 of 3

GROUNDWATER SAMPLING FORM

IT CORPORATION
A Member of The IT Group

Project Number: 825635
Project Name: PBOW Groundwater
Investigation Site: Background
RFA/COC Number: PB 102182 STL K+N

Collection Date: 10/19/02
Collection Time: 1110
Sample Filtered (Yes / No): yes
Weather/Temp: partly cloudy, warm (55), windy

Form Completed By: D. Kessler
Sampler(s): D. Kessler / J. Hofer
Reviewed By: D. Kessler

Sample Number: P B O W 0 2 G W

MONITORING WELL INFORMATION [use top of casing (TOC) for all measurements]

Well Number: PB-BED-MW24
Well Secure (Yes / No): yes
Well Labeled (Yes / No): yes
Well Condition: Excellent
Screen Height: 15 ft
Casing Type: PVC

Outside Casing Dia. (in): 2
Depth to Product (ft): None
Total Well Depth (ft): 42.78
Depth to Water (ft): 29.81
Water Column (ft): 12.97
Elev. Ref. for Water Level:

Odor: hydrogen sulfide
Vapor Monitor Type: PID / VRAE
- Vapor Monitor S/N: H842641 / H845141 - Findlay
- Reading (ppm): 58.2 / LEL=566 H_2S=>50 CO=0 O_2=18.3
Remarks:

MONITORING WELL PURGE CALCULATIONS AND PURGE RECORD

Volume of Water in Casing: Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (2)^2) = 0.164 gal/ft
Well Volume (gallons) = Water Column (ft) x Gal/ft = 12.97 ft x 0.164 Gal/ft = 2.13 gallons

Volume of Water in Filter Pack: Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. in inches & d is casing dia. in inches = 0.041 x ((6)^2 - (2)^2) = 1.31 gal/ft
Filter Pack Volume (gal) = ((Screen Height + lesser of 2 ft or water column) x gal/ft) x porosity (0.3) = ((Screen Height 12.97 ft + — ft) x 1.31 gal/ft) x 0.3 = 5.10 gallons

Purge Well Volume: Purge Well Volume = Filter Pack Volume + Well Volume = 2.13 gal + 5.10 gal = 7.23 gal

1 x Purge Well Volume (gal.)	2 x Purge Well Volume (gal.)	3 x Purge Well Volume (gal.)	4 x Purge Well Volume (gal.)	5 x Purge Well Volume (gal.)
7.23	14.46	21.69	28.92	36.15

Purge Cycle	Time (24 hr)	Depth to Water	Conductivity	pH	Eh	Temperature	Turbidity	Diss. O_2	Purge Volume
Units:		Feet	umhos/cm	Standard Units	ppm	°F	NTU	ppm	gallons
Purge Vol 1									
Purge Vol 2									
Purge Vol 3		Pumped well Dry. See page 2 for readings.							
Purge Vol 4							DKK		
Purge Vol 5									
SAMPLE									

SAMPLE ANALYTICAL INFORMATION

Requested Analysis	Method	Sample Container(s)	Requested Analysis	Method	Sample Container(s)	Requested Analysis	Method	Sample Container(s)
Nitroaromatics	Mod. 8330	2 - 1 Liter Amber Glass	Dissolved TAL Metals	3005A/6010B / 7470A	1 - 500 mL HDPE	Chloride	325.3	1 - 1 Liter HDPE See Note A
TCL Volatile Organics	5030 / 8260B	3 - 40 mL Glass Vials	Total Cyanide	9010A/9012	1 - 1 Liter HDPE	Sulfate	375.3	A. Sample for alkalinity, chloride, sulfate, TSS. TDS, and turbidity combined in one 1-liter HDPE container.
TCL SVOCs	3510C / 8270C	2 - 1 Liter Amber Glass	Total Organic Carbon	9060	1 - 250 mL Amber Glass	Tot. Suspended Solids	160.2	
Total TAL Metals	3005A/6010B / 7470A	1 - 500 mL HDPE	Nitrate	353.2		Total Dissolved Solids	160.1	
Hardness	130.2		Alkalinity	310.1	1 - 1 Liter HDPE See Note A	Turbidity	180.1	

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 PLUM BROOK ORDNANCE WK

Manager: Steve Downey

PB101702STLN

RFA / COC Number: PB101702STLK

Location Code: PB-BED-MW25

Sample Number: CD3005

Sample Name: PBOW-02-GW-PB-BED-MW25-CD3005

Sampling Method: LF

Sample Type: GW *Sample Purpose:* REG

Collection Date: 10/17/02

Collection Time: 1035

Start Depth: 16.75

End Depth: 16.84

Sample Matrix: WATER

Sample Team: DK/TW

QC Partners:
(TB) CD5004 (ER) — (FB) —

ERPIMS Values:

Sacode:

Lot Control#:

Containers

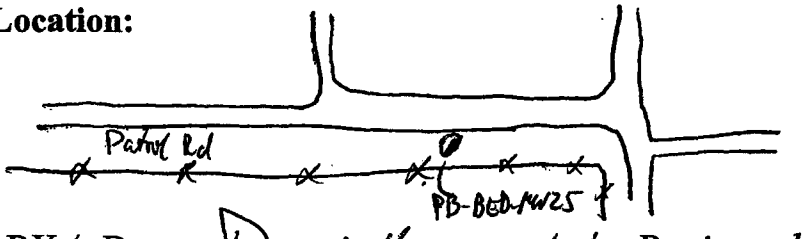
Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
METALS3-W-F	Y	A	1 ~~250~~	~~500~~	mL	HDPE ✓
METALS3-W	N	B	1 ~~250~~	500	mL	HDPE ✓
EXPLOSIVES	N	C	1	1	L	Amb. Glass ✓
VOLATILES3	N	D	3	40	mL	GVIAL,SEP
SEMIVOLATILES3	N	E	2	1	L	Amb. Glass ✓
TOC	N	F	2	40	mL	GVIAL,SEP
CYANIDE	N	G	1 ~~1000~~	~~500~~	mL	HDPE
ALKALINITY	N	H	1	1	L	HDPE
CHLORIDE	N	H	1	1	L	HDPE
NITRATE-W	N	H	1	1	L	HDPE
SULFATE	N	H	1	1	L	HDPE
TDS	N	H	1	1	L	HDPE
TSS	N	H	1	1	L	HDPE
TURB 180.1	N	H	1	1	L	HDPE
HARDNESS	N	I	1 ~~250~~	~~500~~	mL	HDPE ✓

Flow rate 400-425 ml/min

Comments: Static = 16.62 Ft, Total Depth = 40.60 Ft, water column = 23.98

Sample Collection Time 1035-

Sketch Location:



Logged BY / Date: David Kessler 10/17/02 *Reviewed BY / Date:* David Kessler 10/17/02

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 **PLUM BROOK ORDNANCE WK**

Manager: Steve Downey

Location Code: PB-BED-MW25

Sample Number: CD3005

Slight sulfur odor while pumping.
- Water initially black w/particles

10/17/02 DTW = 16.62, TD = 40.60, water column = 23.98. Pump set at 35 ft

Pump settings: CPM 4 Refill: 10.0 / 5.0

Flow rate 400-425 ml/min

Throttle 20-25 psi

water level fluctuates 16.73-16.84 ft

PURGE RECORD:

Initial	Time(24hr)	DepthtoWater (ft)	Eh (mV)	pH (SU)	Conductivity (mS/cm)	Turbidity (NTU)	DissOxygen (ppm)	Temperature (C)	Purge Volume (gal)	
0945	0945	16.83	-9	5.41	3.29	13.4	6.81	12.0	0.5	
	0950	16.75	-46	5.60	3.05	19.9	5.29	12.0	1 gal	~425 ml/min
	0955	16.78	-144	5.93	2.87	12.1	2.62	12.0	1.5	~450 ml/min
	1000	16.82	-206	6.35	2.91	32.6	2.13	12.0	2 gal	
	1005	16.75	-250	6.51	3.09	46.5	1.95	12.0	2.5	
	1010	16.81	-266	6.52	3.10	47.7	1.84	12.0	3 gals	~450 ml/min
	1015	16.76	-273	6.53	3.09	47.6	1.82	12.0	3.5	
	1020	16.82	-271	6.51	3.04	2.0	1.83	12.0	4.0	~425 ml/min
	1025	16.84	-282	6.54	3.02	2.1	1.87	12.0	4.5	
	1030	16.77	-285	6.55	2.98	2.2	1.76	12.0	5.0	
Sample:	1035	16.80	-290	6.56	2.96	2.1	1.69	12.0	6.0 gal	

1210 Finished collection. Water level 16.77 ft

1035-1210 Sample collection (95 min)

0910-1230 Time at well (3 Hr 20 min)

Removed 6 gal

Logged BY / Date: David Kessler 10/17/02 *Reviewed BY / Date:* David Kessler 10/17/0

3 of 3

GROUNDWATER SAMPLING FORM

IT CORPORATION
A Member of The IT Group

Project Number: 825635
Project Name: PBOW Groundwater
Investigation Site: Background
RFA/COC Number: PB10T02STL-N

Collection Date: 10/17/02
Collection Time: 1035
Sample Filtered (Yes / No): yes
Weather/Temp: Cloudy, cold (40°), windy

Form Completed By: D. Kessler
Sampler(s): D. Kessler / J. Hofer
Reviewed By: D. Kessler

Sample Number: P B O W – 0 2 – G W

MONITORING WELL INFORMATION [use top of casing (TOC) for all measurements]

Well Number: PB-BED-MW25
Well Secure (Yes / No): yes
Well Labeled (Yes / No): yes
Well Condition: Excellent
Screen Height: 10 Ft
Casing Type: PVC

Outside Casing Dia. (in): 2
Depth to Product (ft): None
Total Well Depth (ft): 40.60
Depth to Water (ft): 16.62
Water Column (ft): 23.98
Elev. Ref. for Water Level:

Odor: None, slight sulfur odor during pumping
Vapor Monitor Type: PID / VRAE
- Vapor Monitor S/N: #842641 / #845141
- Reading (ppm): 0.0 / LEL = 51%, H_2S = 0.0, CO = 0, O_2 = 20.9
Remarks:

MONITORING WELL PURGE CALCULATIONS AND PURGE RECORD

Volume of Water In Casing: Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (_____)^2) = _____ gal/ft

Well Volume (gallons) = Water Column (ft) x Gal/ft = _____ ft x _____ Gal/ft = _____ gallons

Volume of Water In Filter Pack: Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. in inches & d is casing dia. in inches = 0.041 x ((_____)^2 - (_____)^2) = _____ gal/ft

Filter Pack Volume (gal) = ((Screen Height + lesser of 2 ft or water column) x gal/ft) x porosity (0.3) = ((Screen Height _____ ft + _____ ft) x _____ gal/ft) x 0.3 = _____ gallons

Purge Well Volume: Purge Well Volume = Filter Pack Volume + Well Volume = _____ gal + _____ gal = _____ gal

1 x Purge Well Volume (gal.)	2 x Purge Well Volume (gal.)	3 x Purge Well Volume (gal.)	4 x Purge Well Volume (gal.)	5 x Purge Well Volume (gal.)

Purge Cycle	Time (24 hr)	Depth to Water	Conductivity	pH	Eh	Temperature	Turbidity	Diss. O_2	Purge Volume
Units:		Feet	umhos/cm	Standard Units	ppm	°F	NTU	ppm	gallons
Purge Vol 1									
Purge Vol 2									
Purge Vol 3									
Purge Vol 4									
Purge Vol 5									
SAMPLE									

Low Flow

SAMPLE ANALYTICAL INFORMATION

Requested Analysis	Method	Sample Container(s)	Requested Analysis	Method	Sample Container(s)	Requested Analysis	Method	Sample Container(s)
Nitroaromatics	Mod. 8330	2 - 1 Liter Amber Glass	Dissolved TAL Metals	3005A/6010B / 7470A	1 - 500 mL HDPE	Chloride	325.3	1 - 1 Liter HDPE See Note A
TCL Volatile Organics	5030 / 8260B	3 - 40 mL Glass Vials	Total Cyanide	9010A/9012	1 - 1 Liter HDPE	Sulfate	375.3	A. Sample for alkalinity, chloride, sulfate, TSS. TDS, and turbidity combined in one 1-liter HDPE container.
TCL SVOCs	3510C / 8270C	2 - 1 Liter Amber Glass	Total Organic Carbon	9060	1 - 250 mL Amber Glass	Tot. Suspended Solids	160.2	
Total TAL Metals	3005A/6010B / 7470A	1 - 500 mL HDPE	Nitrate	353.2		Total Dissolved Solids	160.1	
Hardness	130.2		Alkalinity	310.1	1 - 1 Liter HDPE See Note A	Turbidity	180.1	

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 **PLUM BROOK ORDNANCE WK**

Manager: Steve Downey

PB101702STLN

RFA / COC Number: PB101702STLK

Location Code: **PB-BED-MW25**

Sample Number: **CD3005-MS**

Sample Name: **PBOW-02-GW-PB-BED-MW25-CD3005-MS**

Sampling Method: **LF**

Sample Type: **GW** *Sample Purpose:* **MS**

Collection Date: 10/17/02

Collection Time: 1035

Start Depth: 16.75

End Depth: 16.84

Sample Matrix: **WATER**

Sample Team: DK/TH

QC Partners:

(TB) CD5004 (ER) — (FB) —

ERPIMS Values:

Sacode:

Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
METALS3-W-F	Y	A	1250	~~500~~	mL	HDPE
METALS3-W	N	B	1250	~~500~~	mL	HDPE
EXPLOSIVES	N	C	1	1	L	Amb. Glass
VOLATILES3	N	D	3	40	mL	GVIAL,SEP
SEMIVOLATILES3	N	E	2	1	L	Amb. Glass
TOC	N	F	2	40	mL	GVIAL,SEP
CYANIDE	N	G	1	~~500~~	mL	HDPE
ALKALINITY	N	H	1	1	L	HDPE
CHLORIDE	N	H	1	1	L	HDPE
NITRATE-W	N	H	1	1	L	HDPE
SULFATE	N	H	1	1	L	HDPE
TDS	N	H	1	1	L	HDPE
TSS	N	H	1	1	L	HDPE
TURB 180.1	N	H	1	1	L	HDPE
HARDNESS	N	I	1250	~~500~~	mL	HDPE

Comments:

See page 2 of CD3005 Reg

Sketch Location:

See CD3005 Reg

Logged BY / Date: David Kresh 10/17/02 *Reviewed BY / Date:* David Kresh 10/17/02

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 PLUM BROOK ORDNANCE WK

Manager: Steve Downey

RFA / COC Number: PB101702STLN / PB101702STLK

Location Code: PB-BED-MW25

Sample Number: CD3005-MSD

Sample Name: PBOW-02-GW-PB-BED-MW25-CD3005-MSI

Sampling Method: LF

Sample Type: GW *Sample Purpose:* MSD

Collection Date: 10/17/02

Collection Time: 10:35

Start Depth: 16.75

End Depth: 16.84

Sample Matrix: WATER

Sample Team: DK/JH

QC Partners:

(TB) CD5004 (ER) — (FB) —

ERPIMS Values:

Sacode:

Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
METALS3-W-F	Y	A	1	250 500	mL	HDPE
METALS3-W	N	B	1	250 500	mL	HDPE
EXPLOSIVES	N	C	1	1	L	Amb. Glass
VOLATILES3	N	D	3	40	mL	GVIAL,SEP
SEMIVOLATILES3	N	E	2	1	L	Amb. Glass
TOC	N	F	2	40	mL	GVIAL,SEP
CYANIDE	N	G	1	100 500	mL	HDPE
ALKALINITY	N	H	1	1	L	HDPE
CHLORIDE	N	H	1	1	L	HDPE
NITRATE-W	N	H	1	1	L	HDPE
SULFATE	N	H	1	1	L	HDPE
TDS	N	H	1	1	L	HDPE
TSS	N	H	1	1	L	HDPE
TURB 180.1	N	H	1	1	L	HDPE
HARDNESS	N	I	1	250 500	mL	HDPE

Comments:

See CD3005 Reg. page 2

Sketch Location:

Logged BY / Date: David Kresch 10/17/02 *Reviewed BY / Date:* David Kresch 10/17/02

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 PLUM BROOK ORDNANCE WK

Manager: Steve Downey

RFA / COC Number: PB101702STLK

Location Code: PB-BED-MW25

Sample Number: CD3006

Sample Name: PBOW-02-GW-PB-BED-MW25-CD3006

Sampling Method: LF

Sample Type: GW *Sample Purpose:* FD

Collection Date: 10/17/02

Collection Time: 1035

Start Depth: 16.75

End Depth: 16.84

Sample Matrix: WATER

Sample Team: DK/JH

QC Partners:

(TB) CD5004 (ER) — (FB) —

ERPIMS Values:

Sacode:

Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
METALS3-W-F	Y	A	1 ~~250~~	~~500~~	mL	HDPE
METALS3-W	N	B	1 ~~250~~	~~500~~	mL	HDPE
EXPLOSIVES	N	C	1	1	L	Amb. Glass
VOLATILES3	N	D	3	40	mL	GVIAL,SEP
SEMIVOLATILES3	N	E	2	1	L	Amb. Glass

Comments:

See CD3005 Reg, page 2

Sketch Location:

Logged BY / Date: David Kessler 10/17/02 *Reviewed BY / Date:* David Kessler 10/17/02

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 **PLUM BROOK ORDNANCE WK**

Manager: Steve Downey

RFA / COC Number: PB101702ACC

Location Code: **PB-BED-MW25**

Sample Number: **CD3007**

Sample Name: **PBOW-02-GW-PB-BED-MW25-CD3007**

Sampling Method: **LF**

Sample Type: **GW** *Sample Purpose:* **FS**

Collection Date: 10/17/02

Collection Time: 1035

Start Depth: 16.75

End Depth: 16.84

Sample Matrix: **WATER**

Sample Team: DK/JH

QC Partners:

(TB) CD5005 (ER) — (FB) —

ERPIMS Values:

Sacode:

Lot Control#:

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
METALS3-W-F	Y	A	1	250~~500~~	mL	HDPE
METALS3-W	N	B	1	250~~500~~	mL	HDPE
EXPLOSIVES	N	C	1	1	L	Amb. Glass
VOLATILES3	N	D	3	40	mL	GVIAL,SEP
SEMIVOLATILES3	N	E	2	1	L	Amb. Glass

Comments:

See CD3005 Reg, page 2

Sketch Location:

Logged BY / Date: David Kessler 10/17/02 *Reviewed BY / Date:* David Kessler 10/17/02

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 PLUM BROOK ORDNANCE WK

Manager: Steve Downey

RFA / COC Number: _____

Location Code: PB-BED-MW26

Sample Number: CD3008

Sample Name: PBOW-02-GW-PB-BED-MW26-CD3008

Sampling Method: LF

Sample Type: GW *Sample Purpose:* REG

Collection Date: _____

Collection Time: _____

Start Depth: _____

End Depth: _____

Sample Matrix: WATER

Sample Team: _____

QC Partners:

(TB) _____ (ER) _____ (FB) _____

ERPIMS Values:

Sacode: _____

Lot Control#: _____

Containers

Analytical Suite	Flt	Frtn	Qty	Size	Units	Type
METALS3-W-F	Y	A	1 ~~250~~	~~500~~	mL	HDPE
METALS3-W	N	B	1 ~~250~~	~~500~~	mL	HDPE
EXPLOSIVES	N	C	1	1	L	Amb. Glass
VOLATILES3	N	D	3	40	mL	GVIAL,SEP
SEMIVOLATILES3	N	E	2	1	L	Amb. Glass
TOC	N	F	2	40	mL	GVIAL,SEP
CYANIDE	N	G	1 ~~1000~~	~~500~~	mL	HDPE
ALKALINITY	N	H	1	1	L	HDPE
CHLORIDE	N	H	1	1	L	HDPE
NITRATE-W	N	H	1	1	L	HDPE
SULFATE	N	H	1	1	L	HDPE
TDS	N	H	1	1	L	HDPE
TSS	N	H	1	1	L	HDPE
TURB-180.1	N	H	1	1	L	HDPE
HARDNESS	N	I	1 ~~250~~	~~500~~	mL	HDPE

Not sampled.
DTW 10/16/02 = 59.73
TD = 60.35
0.62 ft water

Comments:

Not Sampled

Sketch Location:

Logged BY / Date: David Kesch 10/16/02 *Reviewed BY / Date:* David Kesch 10/16/02

INTERNATIONAL TECHNOLOGY CORPORATION

Sample Collection Log

Project: 833886 **PLUM BROOK ORDNANCE WK**

Manager: Steve Downey

Location Code: PB-BED-MW26

Sample Number: CD3008

10/16/02 Depth to water = 59.73 ft

PID = 6.0 ppm

~~LEL = 0%~~ LEL = >

CO = 0

PURGE RECORD:

Initial	Time(24hr)	DepthtoWater (ft)	Eh (mV)	pH (SU)	Conductivity (mS/cm)	Turbidity (NTU)	DissOxygen (ppm)	Temperature (C)	Purge Volume (gal)
		59.73							
Sample:									

Not Sampled (0.62 ft water)

Logged BY / Date: David Kozak 10/16/02 *Reviewed BY / Date:* David Kozak 10/16/02

GROUNDWATER SAMPLING FORM

IT CORPORATION
A Member of The IT Group

Project Number: 833886 ~~825035~~
Project Name: PBOW Groundwater
Investigation Site: Background
RFA/COC Number: —

Collection Date: Not Sampled
Collection Time:
Sample Filtered (Yes / No):
Weather/Temp:

Form Completed By: D. Kessler
Sampler(s): Not Sampled
Reviewed By:

Sample Number: P B O W 0 2 G W

MONITORING WELL INFORMATION [use top of casing (TOC) for all measurements]

Well Number: PB-BED-MW26
Well Secure (Yes / No): yes
Well Labeled (Yes / No): yes
Well Condition: good
Screen Height: 15 Ft
Casing Type: PVC

Outside Casing Dia. (in): 2
Depth to Product (ft): None
Total Well Depth (ft): 60.35
Depth to Water (ft): 59.73
Water Column (ft): 0.62
Elev. Ref. for Water Level:

Odor: slight petroleum
Vapor Monitor Type: PID / VRAE
- Vapor Monitor S/N: H842641 / H845141
- Reading (ppm): 6.0 / LEL = 60, H_2S = 0, CO = 0, O = 16.4
Remarks:

MONITORING WELL PURGE CALCULATIONS AND PURGE RECORD

Volume of Water in Casing: Gallons/foot = 0.041 x d^2, where d is casing diameter in inches = (0.041 x (_____)^2) = _____ gal/ft

Well Volume (gallons) = Water Column (ft) x Gal/ft = _____ ft x _____ Gal/ft = _____ gallons

Volume of Water in Filter Pack: Gallons/foot = 0.041 x (D^2 - d^2), where D is total borehole dia. in inches & d is casing dia. in inches = 0.041 x ((_____)^2 - (_____)^2) = _____ gal/ft

Filter Pack Volume (gal) = ((Screen Height + lesser of 2 ft or water column) x gal/ft) x porosity (0.3) = ((Screen Height _____ ft + _____ ft) x _____ gal/ft) x 0.3 = _____ gallons

Purge Well Volume: Purge Well Volume = Filter Pack Volume + Well Volume = _____ gal + _____ gal = _____ gal

1 x Purge Well Volume (gal.)	2 x Purge Well Volume (gal.)	3 x Purge Well Volume (gal.)	4 x Purge Well Volume (gal.)	5 x Purge Well Volume (gal.)

Not Sampled

Purge Cycle	Time (24 hr)	Depth to Water	Conductivity	pH	Eh	Temperature	Turbidity	Diss. O_2	Purge Volume
Units:		Feet	umhos/cm	Standard Units	ppm	°F	NTU	ppm	gallons
Purge Vol 1									
Purge Vol 2									
Purge Vol 3									
Purge Vol 4									
Purge Vol 5									
SAMPLE									

SAMPLE ANALYTICAL INFORMATION

Requested Analysis	Method	Sample Container(s)	Requested Analysis	Method	Sample Container(s)	Requested Analysis	Method	Sample Container(s)
Nitroaromatics	Mod. 8330	2 - 1 Liter Amber Glass	Dissolved TAL Metals	3005A/6010B / 7470A	1 - 500 mL HDPE	Chloride	325.3	1 - 1 Liter HDPE See Note A
TCL Volatile Organics	5030 / 8260B	3 - 40 mL Glass Vials	Total Cyanide	9010A/9012	1 - 1 Liter HDPE	Sulfate	375.3	A. Sample for alkalinity, chloride, sulfate, TSS. TDS, and turbidity combined in one 1-liter HDPE container.
TCL SVOCs	3510C / 8270C	2 - 1 Liter Amber Glass	Total Organic Carbon	9060	1 - 250 mL Amber Glass	Tot. Suspended Solids	160.2	
Total TAL Metals	3005A/6010B / 7470A	1 - 500 mL HDPE	Nitrate	353.2		Total Dissolved Solids	160.1	
Hardness	130.2		Alkalinity	310.1	1 - 1 Liter HDPE See Note A	Turbidity	180.1	

Appendix B

APPENDIX B

DATA VALIDATION SUMMARY

Data Validation Summary Report
Fifth Quarterly Site Investigation Performed for
Plum Brook Ordinance Works

1.0 Introduction

Level III data validation was performed on environmental samples collected from Plum Brook Ordinance Works fifth quarterly sampling event. The analytical data consisted of five sample delivery groups (SDG), F15100, (field split sample), which was analyzed by Accutest Laboratories, and SDGs H2J170128, H2J180210, H2J190106, and H2J210108 (regular and field duplicate samples), which were analyzed by Severn Trent Laboratories.

Location	Sample Number	Lot Number
IT-BG8-BEDGW-001	CD3001	H2J190106
IT-MW01	CD3002	H2J170128
PB-BED-MW20	CD3003	H2J180210
PB-BED-MW24	CD3004	H2J210108
PB-BED-MW25	CD3005	H2J180210
PB-BED-MW25	CD3006	H2J180210
PB-BED-MW25	CD3007	F15100
PB-BED-MW27	CD3009	H2J190106

The parameters for which the data were analyzed and validated are identified below:

Parameter (Method)
Volatile Organic Compounds by SW-846 5030/8260B
Semivolatile Organic Compounds by SW-846 3520/8270C
Total/Dissolved Metals by SW-846 3005A/6010B/7471A
Nitroaromatic and Nitramine Explosives by SW-846 8330
Wet Chemistry by various methods

2.0 Procedures

The sample data were validated following the logic identified in the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, October 1999 (EPA, 1999) and *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, February 1994. The criteria for blank evaluation were based on those detailed in *Region III Modifications to National Functional Guidelines for Organic Data Review* (September 1994) and *Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses,* (April 1993). Specific quality control (QC) criteria, as identified in the Quality Assurance Plan (QAP), analytical methods, and laboratory Standard Operating Procedures (SOPs) were applied to all sample results. As the result of the use of Update III SW846 test methods for the analytical data and the application of the CLP guidelines during the validation process, there were instances where specific QC requirements for all target compounds were not defined. This primarily occurred in the organic, Gas Chromatograph (GC) and Gas Chromatograph/Mass Spectra (GC/MS) calibration areas and is due to the fact that the analytical methods are "performance-based", and allows the use of average calibration responses in lieu of individual responses, which are defined by CLP protocol. In light of applying CLP guidelines to SW846 methods and evaluating the usability of the data during the validation process, specific QC criteria were determined to address all target compounds and are identified in this report for each parameter, as well as in the validation checklists, which function as worksheets. All completed validation checklists are included in Attachment A. For those analytical methods not addressed by the CLP and Region III guidelines, the validation was based on the method requirements and technical judgement, following the logic of the CLP validation guidelines.

3.0 Summary of Data Validation Findings

The overall quality of the data was determined to be acceptable with minimal qualification. The only rejected data ("R" qualified) was due to "poor performing" volatile compounds (Ketones, some halogenated hydrocarbons, etc.), which experienced poor calibration responses in the associated calibration data and explosive compound (tetryl), results which experienced no (zero percent) recoveries in the matrix spike analysis associated with the project samples.

Individual validation reports have been prepared for each parameter in each SDG and the overall results of the validation findings are summarized in this report. The following section highlights the key findings of the data validation for each analysis.

4.0 Analysis-Specific Data Validation Summaries

4.1 Volatile Organics by GC/MS SW-846 5030/8260B

Overall, the data are of good quality and are usable as reported by the laboratory, with the noted exceptions. Data were reviewed for the following:

Holding Times. Technical holding time criteria were met for all samples.

Initial Calibration (ICAL) and Continuing Calibration (CCAL). All initial and continuing calibrations associated with the project samples met QC criteria, with the exceptions of the following:

- The following exhibited ICAL/CCAL relative response factor (RRF) < 0.05 and/or individual ICAL percent relative standard deviation (%RSD) > 30% or CCAL percent difference (%D) > 25%.

SDG	Samples Affected	Compound(s)	Validation Qualifier
H2J180210	CD3003, CD3005, CD3006	2-Butanone, Bromomethane	R/UJ
H2J190106	CD3001, CD3009	2-Butanone, Bromomethane	R/UJ
H2J210108	CD3004	2-Butanone, Bromomethane	R/UJ
F15100	CD3007	Acetone, Bromoform	J/UJ
H2J170128	CD3002	2-Butanone*, Bromomethane, Styrene	B/UJ

B - blank contamination; J - estimated; R - rejected; U - nondetect

2-Butanone results for CD3002 were qualified "B" due to method blank contamination.

Blanks. The 5X/10X rule for contaminants found in the associated trip and method blanks was applied to all sample results. All were found to be acceptable, with the exception of the following:

SDG	Samples Affected	Analyte	Blank Containment	Validation Qualifier
H2J170128	CD3002	2-Butanone	Method	B
H2J180210	CD3006	Methylene Chloride	Trip	B

B - blank contamination

Surrogate Recoveries. All surrogate recoveries were within acceptable QC limits with the following exception(s):

SDG	Samples Affected	Compound(s)	Validation Qualifier
H2J180210	CD3003	Benzene, Carbon Disulfide, Toluene	J

J - estimated

Matrix Spike/Matrix Spike Duplicate (MS/MSD). MS/MSD was performed and all QC criteria were met.

Laboratory Control Sample (LCS). LCS was performed for the project samples and all QC criteria were met.

Internal Standards. All internal standards met QC criteria.

Field Duplicates (FD). Original and field duplicate results were reviewed to evaluate the precision and accuracy of field activities. All QC criteria (30%) for analytes detected in both samples were met with the following exception(s):

SDG	Samples Affected	Compound(s)	Validation Qualifier
H2J180210	CD3005 (Original), CD3006 (FD)	Acetone, Carbon disulfide	J

J - estimated

Quantitation. Results quantified between the method detection limit (MDL) and the reporting limit (RL), which the lab qualified as "J," were qualified as estimated "J" unless blank contamination was present or the results were rejected.

4.2 Semivolatiles by SW846 3520/8270C

Overall, the data are of good quality and are usable as reported by the laboratory with the noted exceptions. Data were reviewed for the following:

Holding Times. Technical holding time criteria were met for all samples.

Initial Calibration and Continuing Calibration. All initial and continuing calibrations associated with the project samples met QC criteria, with the exception of the following:

- The following exhibited individual ICAL %RSD > 30% and/or CCAL %D > 25%.

SDG	Samples Affected	Compound(s)	Validation Qualifier
H2J170128	CD3002	2,4-Dinitrophenol	UJ

J - estimated; U - nondetect

Blanks. The 5X/10X rule for contaminants found in the associated equipment rinses, and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries. All surrogate recoveries met QC criteria.

Matrix Spike/Matrix Spike Duplicate. MS/MSD was performed for the project samples and all QC criteria were met

Laboratory Control Sample/Laboratory Control Sample Duplicate. LCS was performed for the project samples and all QC criteria were met.

Internal Standards. All internal standards met QC criteria.

Field Duplicates. Original and field duplicate results were reviewed to evaluate the precision and accuracy of field activities and all QC criteria were met.

Quantitation. Results quantified between the MDL and the RL, which the lab qualified as "J," were qualified as estimated "J" unless blank contamination was present or the results were rejected.

4.3 Total/Dissolved Metals by SW846 3005A/6010B/7471A

Overall, the data are of good quality and are usable as reported by the laboratory, with the noted exceptions. Data were reviewed for the following:

Holding Times. Technical holding time criteria were met for all samples.

Initial and Continuing Calibrations. All initial and continuing calibrations associated with the project samples met QC criteria.

Blanks. The 5X rule for contaminants found in the associated equipment rinse, initial calibration blank (ICB), continuing calibration blank (CCB) and method blanks was applied to all sample results. All were acceptable, with the noted exceptions:

SDG	Samples Affected	Analyte	Blank	Validation Qualifier
H2J180210	CD3003T, CD3006T/D	Thallium	Method/ICB	B
	CD3003D, CD3005D, CD3006T/D	Aluminum	ICB/CCB	B
	CD3003T/D	Beryllium	ICB/CCB	B
	CD3005D, CD3006D	Zinc	Method	B
H2J190106	CD3001T/D, CD3009D	Aluminum	ICB/CCB	B
	CD3001D, CD3009D	Zinc	Method	B
H2J210108	CD3004D	Aluminum, Zinc	Method/ICB/CCB	B
H2J170128	CD3002D	Aluminum	ICB/CCB	B

B - blank contamination

- T = Total / D = Dissolved

Matrix Spike/Matrix Spike Duplicate. MS/MSD was performed for the project samples and all QC criteria were met.

Laboratory Control Sample/Laboratory Control Sample Duplicate. LCS was performed for the project samples and all QC criteria were met.

Interference Check Sample (ICS). All ICS % recoveries were within QC limits.

Inductively Coupled Plasma (ICP) Serial Dilutions. Serial dilution 10% D criteria were met with the following exception(s):

SDG	Samples Affected	Compound(s)	Validation Qualifier
H2J180210, H2J190106, H2J210108, H2J170128	All Samples (Total/Dissolved except CD3002T)	Potassium	J
H2J170128	CD3002T	Aluminum, Zinc	J

J - estimated

Field Duplicates. Original and field duplicate results were evaluated and all QC criteria were met.

Quantitation. Results quantified between the MDL and the RL (flagged by the laboratory as "B") were qualified as estimated "J", unless blank contamination was present or results were rejected.

4.4 Nitroaromatic and Nitramine Explosives by SW-846 8330

Overall, the data are of good quality and are usable as reported by the laboratory, with the noted exceptions. Data were reviewed for the following:

Holding Times. Technical holding time criteria were met for all samples.

Initial and Continuing Calibration. All initial and continuing calibrations associated with the project samples met QC criteria.

Blanks. The 5X/10X rule for contaminants found in the associated trip and method blanks was applied to all sample results. All were found to be acceptable.

Surrogate Recoveries. All surrogate recoveries were within acceptable QC limits.

Matrix Spike/Matrix Spike Duplicate. MS/MSD was performed and all QC criteria were met with the following exception(s):

SDG	Samples Affected	Compound(s)	Validation Qualifier
H2J180210, H2J190106, H2J210108, H2J170128	All Samples	Tetryl	R

R - rejected

- All tetryl results were rejected due to zero percent recovery.

Laboratory Control Sample. LCS was performed for the project samples and all QC criteria were met.

Field Duplicates. Original and field duplicate results were reviewed to evaluate the precision and accuracy of field activities. All QC criteria were met (30% water).

Quantitation. Results quantified between the MDL and the RL, which the lab qualified as "J," were qualified as estimated "J" unless blank contamination was present or the results were rejected.

4.5 Wet Chemistry

Overall, the data are of good quality and are usable as reported by the laboratory, with the noted exceptions. Data were reviewed for the following:

Holding Times. Technical holding time criteria were met for all samples.

Initial and Continuing Calibration. All initial and continuing calibrations associated with the project samples met QC criteria with the following exception(s):

SDG	Samples	Compound(s)	Validation Qualifier
H2J180210	CD3003, CD3005	Nitrate	UJ

J - estimated; U - nondetect

Blanks. The 5X rule for contaminants found in the associated blanks was applied to all sample results. All were found to be acceptable.

Matrix Spike/Matrix Spike Duplicate. MS/MSD was performed for the project samples and all QC criteria were met.

Laboratory Control Sample. LCS was performed for the project samples and all QC criteria were met.

Field Duplicates. Original and field duplicate results were evaluated and all QC criteria were met.

Quantitation. Results quantified between the MDL and the RL, which the lab qualified as "B," were qualified as estimated "J" unless blank contamination was present or the results were rejected.

ATTACHMENT A

DATA VALIDATION CHECKLIST

Validation Qualifiers

U Not detected. The compound/analyte was analyzed for, but not detected above the associated reporting limit.

J The compound/analyte was positively identified; the reported value is the estimated concentration of the constituent detected in the sample analyzed.

B The concentration reported was detected significantly above the levels reported in the associated equipment rinse samples and/or laboratory method and trip blanks. (5X/10X Rule was applied).

R The reported sample results are rejected due to the following:

1. Severe deficiencies in the supporting quality control data.
2. Anomalies noted in the sampling and/or analysis process which could affect the validity of the reported data.
3. The presence or absence of the constituent cannot be verified based on the data provided.
4. To indicate not to use a particular result in the event of a reanalysis.

UJ The compound/analyte was analyzed for, but not detected above the established reporting limit. However, review and evaluation of supporting QC data and/or sampling and analysis process have indicated that the "nondetect" may be inaccurate or imprecise. The nondetect result should be estimated.

Validation Reason Code Definitions

Reason Code	Definition
01	Sample received outside of 4+/-2 degrees Celsius
01A	Improper sample preservation
02	Holding time exceeded
02A	Extraction
02B	Analysis
03	Instrument performance – outside criteria
03A	BFB
03B	DFTPP
03C	DDT and/or Endrin % breakdown exceeds criteria
03D	Retention time windows
03E	Resolution
04	Initial calibration results outside specified criteria
04A	Compound mean RRF QC criteria not met
04B	Individual % RSD criteria not met
04C	Correlation coefficient >0.995
05	Continuing calibration results outside specified criteria
05A	Compound mean RRF QC criteria not met
05B	Compound % D QC criteria not met
06	Result qualified as a result of the 5x/10x blank correction
06A	Method or preparation blank
06B	ICB or CCB
06C	ER
06D	TB
06E	FB
07	Surrogate recoveries outside control limits
07A	Sample
07B	Associated method blank or LCS
08	MS/MSD/Duplicate results outside criteria
08A	MS and/or MSD recovery not within control limits (accuracy)
08B	% RPD outside acceptance criteria (precision)
09	Post digestion spike outside criteria (GFAA)
10	Internal standards outside specified control limits
10A	Recovery
10B	Retention time
11	Laboratory control sample recoveries outside specified limits
11A	Recovery
11B	% RPD (if run in duplicate)
12	Interference check standard
13	Serial dilution
14	Tentatively identified compounds
15	Quantitation
16	Multiple results available; alternate analysis preferred
17	Field duplicate RPD criteria is exceeded
18	Percent difference between original and second column exceeds QC criteria
19	Professional judgement was used to qualify the data
20	Pesticide clean-up checks
21	Target compound identification
22	Radiological calibration
23	Radiological quantitation
24	Reported result and/or lab qualifier revised to reflect validation findings

APPENDIX C

CHEMICAL ANALYTICAL DATA SUMMARY

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Data Summary

Report Date: 01/16/03

	Location Code:		IT-BG8-BEDGW-001			IT-MW01			PB-BED-MW20			PB-BED-MW24		
	Associated Site:		BCG			BCG			BCG			BCG		
	Sample No:		CD3001			CD3002			CD3003			CD3004		
	Sample Date:		18-OCT-02			16-OCT-02			17-OCT-02			19-OCT-02		
Jser Test Group	*Purpose:*		REG			REG			REG			REG		
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
EXPLOSIVES														
Amino-2,6-dinitrotoluene, 4-		ug/L	0.20	U	U	0.20	U	U	0.20	U	U	0.20	U	U
Amino-4,6-dinitrotoluene, 2-		ug/L	0.20	U	U	0.20	U	U	0.20	U	U	0.20	U	U
Dinitrobenzene, 1,3-		ug/L	0.20	U	U	0.20	U	U	0.20	U	U	0.20	U	U
Dinitrotoluene, 2,4-		ug/L	0.20	U	U	0.20	U	U	0.20	U	U	0.20	U	U
Dinitrotoluene, 2,6-		ug/L	0.20	U	U	0.20	U	U	0.20	U	U	0.20	IU	U
HMX		ug/L	0.50	U	U	0.50	U	U	0.50	U	U	0.50	U	U
Nitrobenzene		ug/L	0.20	U	U	0.20	U	U	0.20	U	U	0.20	IU	U
Nitrotoluene, 2-		ug/L	0.20	U	U	0.20	U	U	0.20	U	U	0.36	GU	U
Nitrotoluene, 3-		ug/L	0.20	U	U	0.20	U	U	0.29	GU	U	0.20	IU	U
Nitrotoluene, 4-		ug/L	0.20	U	U	0.20	U	U	0.20	U	U	0.20	U	U
RDX		ug/L	0.50	U	U	0.50	U	U	0.50	U	U	0.50	U	U
Tetryl		ug/L	0.20	U	R	0.20	U	R	0.20	U	R	0.20	U	R
Trinitrobenzene, 1,3,5-		ug/L	0.20	U	U	0.20	U	U	0.20	U	U	0.20	U	U
Trinitrotoluene, 2,4,6-		ug/L	0.20	U	U	0.20	U	U	0.20	U	U	0.20	U	U
EN CHEMISTRY														
Alkalinity		ug/L	332000			209000			259000			757000		
Chloride		ug/L	999000			9900			21100000			126000		
Cyanide, total		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Hardness		ug/L	687000			263000			9390000			808000		
Nitrate		ug/L	100	U	U	100	U	U	100	U	UJ	100	U	U
Sulfate		ug/L	11200			67300			5000	U	U	5000	U	U
Total dissolved solids		ug/L	1870000			342000			43800000			990000		
Total organic carbon		ug/L	1300			9900			1000	U	U	3700		
Total suspended solids		ug/L	4000	U	U	5000			19000			62000		
Turbidity		NTU	44.2			10.6			19.2			49.6		
IETALS														
Aluminum		ug/L				10200		J	155	B	J	115	B	J
Antimony	Y	ug/L	60.0	U	U	60.0	U	U	60.0	U	U	60.0	U	U

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Data Summary

Report Date: 01/16/03

		Location Code:	PB-BED-MW25			PB-BED-MW25		
		Associated Site:	BCG			BCG		
		Sample No:	CD3006			CD3005		
		Sample Date:	17-OCT-02			17-OCT-02		
User Test Group		*Purpose:*	FD			REG		
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
EXPLOSIVES								
Amino-2,6-dinitrotoluene, 4-		ug/L	0.20	U	U	0.20	U	U
Amino-4,6-dinitrotoluene, 2-		ug/L	0.20	U	U	0.20	U	U
Dinitrobenzene, 1,3-		ug/L	0.20	U	U	0.20	U	U
Dinitrotoluene, 2,4-		ug/L	0.20	U	U	0.20	U	U
Dinitrotoluene, 2,6-		ug/L	0.20	U	U	0.20	U	U
HMX		ug/L	0.50	U	U	0.50	U	U
Nitrobenzene		ug/L	0.14	J	J	0.12	J	J
Nitrotoluene, 2-		ug/L	0.20	U	U	0.20	U	U
Nitrotoluene, 3-		ug/L	0.20	U	U	0.20	U	U
Nitrotoluene, 4-		ug/L	0.20	U	U	0.20	U	U
RDX		ug/L	0.50	U	U	0.50	U	U
Tetryl		ug/L	0.20	U	R	0.20	U	R
Trinitrobenzene, 1,3,5-		ug/L	0.20	U	U	0.20	U	U
Trinitrotoluene, 2,4,6-		ug/L	0.20	U	U	0.20	U	U
GEN CHEMISTRY								
Alkalinity		ug/L				314000		
Chloride		ug/L				631000		
Cyanide, total		ug/L				10	U	U
Hardness		ug/L				848000		
Nitrate		ug/L				100	U	UJ
Sulfate		ug/L				79500		
Total dissolved solids		ug/L				1440000		
Total organic carbon		ug/L				2700		
Total suspended solids		ug/L				4000	U	U
Turbidity		NTU				35.8		
METALS								
Aluminum		ug/L				79.7	B	J
Antimony	Y	ug/L	60.0	U	U	60.0	U	U

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Data Summary

		Location Code:	IT-BG8-BEDGW-001			IT-MW01			PB-BED-MW20			PB-BED-MW24		
		Associated Site:	BCG			BCG			BCG			BCG		
		Sample No:	CD3001			CD3002			CD3003			CD3004		
		Sample Date:	18-OCT-02			16-OCT-02			17-OCT-02			19-OCT-02		
		Purpose:	REG			REG			REG			REG		
User Test Group														
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
METALS														
Antimony		ug/L	60.0	U	U	8.0	B	J	60.0	U	U	60.0	U	U
Arsenic	Y	ug/L	10.0	U	U	10.0	U	U	10.0	U	U	10.0	U	U
Arsenic		ug/L	10.0	U	U	52.6			10.0	U	U	10.0	U	U
Barium	Y	ug/L	285			89.1	B	J	24500			1140		
Barium		ug/L	279			139	B	J	25700			1080		
Beryllium	Y	ug/L	5.0	U	U	5.0	U	U				5.0	U	U
Beryllium		ug/L	5.0	U	U	4.6	B	J				5.0	U	U
Cadmium	Y	ug/L	5.0	U	U	5.0	U	U	5.0	U	U	5.0	U	U
Cadmium		ug/L	5.0	U	U	1.5	B	J	5.0	U	U	5.0	U	U
Calcium	Y	ug/L	127000			57700			1990000			160000		
Calcium		ug/L	122000	J		56300	J		2050000	J		159000	J	
Chromium	Y	ug/L	10.0	U	U	10.0	U	U	10.0	U	U	10.0	U	U
Chromium		ug/L	10.0	U	U	14.1			10.0	U	U	10.0	U	U
Cobalt	Y	ug/L	50.0	U	U	4.9	B	J	7.5	B	J	1.4	B	J
Cobalt		ug/L	50.0	U	U	14.0	B	J	8.1	B	J	50.0	U	U
Copper	Y	ug/L	25.0	U	U	3.7	B	J	25.0	U	U	25.0	U	U
Copper		ug/L	25.0	U	U	72.2			25.0	U	U	25.0	U	U
Iron	Y	ug/L	53.4	B	J	1840			4940			100	U	U
Iron		ug/L	74.5	B	J	52100			5310			403		
Lead	Y	ug/L	3.0	U	U	3.0	U	U	6.0	G U	U	3.0	U	U
Lead		ug/L	3.0	U	U	101			6.0	G U	U	3.0	U	U
Magnesium	Y	ug/L	79800			20300			911000			77600		
Magnesium		ug/L	77000			19500	J		941000			75400		
Manganese	Y	ug/L	52.2			424			182			15.5		
Manganese		ug/L	51.1			490			185			23.6		
Mercury	Y	ug/L	0.20	U	U	0.20	U	U	0.20	U	U	0.20	U	U
Mercury		ug/L	0.20	U	U	0.20	U	U	0.20	U	U	0.20	U	U
Nickel	Y	ug/L	40.0	U	U	10.5	B	J	40.0	U	U	40.0	U	U
Nickel		ug/L	40.0	U	U	35.0	B	J	40.0	U	U	40.0	U	U
Potassium	Y	ug/L	43200	J	J	6400	J	J	88400	B J	J	24000	J	J

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Data Summary

Report Date: 01/16/03

	Location Code:		PB-BED-MW25			PB-BED-MW25		
	Associated Site:		BCG			BCG		
	Sample No:		CD3006			CD3005		
	Sample Date:		17-OCT-02			17-OCT-02		
	Purpose:		FD			REG		
User Test Group								
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
METALS								
Antimony		ug/L	60.0	U	U	60.0	U	U
Arsenic	Y	ug/L	10.0	U	U	10.0	U	U
Arsenic		ug/L	10.0	U	U	10.0	U	U
Barium	Y	ug/L	279			270		
Barium		ug/L	275			277		
Beryllium	Y	ug/L	5.0	U	U	5.0	U	U
Beryllium		ug/L	5.0	U	U	5.0	U	U
Cadmium	Y	ug/L	5.0	U	U	5.0	U	U
Cadmium		ug/L	5.0	U	U	5.0	U	U
Calcium	Y	ug/L	202000			198000		
Calcium		ug/L	198000	J		200000	J	
Chromium	Y	ug/L	10.0	U	U	10.0	U	U
Chromium		ug/L	10.0	U	U	10.0	U	U
Cobalt	Y	ug/L	50.0	U	U	50.0	U	U
Cobalt		ug/L	50.0	U	U	50.0	U	U
Copper	Y	ug/L	25.0	U	U	25.0	U	U
Copper		ug/L	25.0	U	U	25.0	U	U
Iron	Y	ug/L	147			157		
Iron		ug/L	203			207		
Lead	Y	ug/L	3.0	U	U	3.0	U	U
Lead		ug/L	3.0	U	U	3.0	U	U
Magnesium	Y	ug/L	80500			78600		
Magnesium		ug/L	79500			80200		
Manganese	Y	ug/L	85.6			84.2		
Manganese		ug/L	85.2			86.5		
Mercury	Y	ug/L	0.20	U	U	0.20	U	U
Mercury		ug/L	0.20	U	U	0.20	U	U
Nickel	Y	ug/L	40.0	U	U	40.0	U	U
Nickel		ug/L	40.0	U	U	40.0	U	U
Potassium	Y	ug/L	16200	J	J	900	J	J

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Data Summary

Report Date: 01/16/03

		Location Code:	IT-BG8-BEDGW-001			IT-MW01			PB-BED-MW20			PB-BED-MW24		
		Associated Site:	BCG			BCG			BCG			BCG		
		Sample No:	CD3001			CD3002			CD3003			CD3004		
		Sample Date:	18-OCT-02			16-OCT-02			17-OCT-02			19-OCT-02		
		Purpose:	REG			REG			REG			REG		
User Test Group														
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
METALS														
Potassium		ug/L	41200	J	J	6480	J		91700	B J	J	22900	J	J
Selenium	Y	ug/L	5.0	U	U	5.0	U	U	5.0	U	U	5.0	U	U
Selenium		ug/L	5.0	U	U	5.0			5.0	U	U	5.0	U	U
Silver	Y	ug/L	10.0	U	U	10.0	U	U	10.0	U	U	10.0	U	U
Silver		ug/L	10.0	U	U	10.0	U	U	10.0	U	U	10.0	U	U
Sodium	Y	ug/L	472000			19400			7750000			92500		
Sodium		ug/L	462000			17800			8190000			91800		
Thallium	Y	ug/L	10.0	U	U	10.0	U	U	10.0	U	U	10.0	U	U
Thallium		ug/L	10.0	U	U	5.7	B	J				10.0	U	U
Vanadium	Y	ug/L	50.0	U	U	50.0	U	U	50.0	U	U	50.0	U	U
Vanadium		ug/L	50.0	U	U	35.9	B	J	50.0	U	U	50.0	U	U
Zinc	Y	ug/L				13.1	B J	J	78.3	J				
Zinc		ug/L	0.83	B	J	124		J	15.6	B	J	3.9	B	J
SEMIVOLATILES														
Acenaphthene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Acenaphthylene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Anthracene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Benzo(a)anthracene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Benzo(a)pyrene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Benzo(b)fluoranthene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Benzo(ghi)perylene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Benzo(k)fluoranthene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Bis(2-chloroethoxy)methane		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Bis(2-chloroethyl)ether		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Bis(2-chloroisopropyl)ether		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Bis(2-ethylhexyl)phthalate		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Bromophenyl phenyl ether, 4-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Butyl benzyl phthalate		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Carbazole		ug/L	10	U	U	10	U	U	10	U	U	10	U	U

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Data Summary

Report Date: 01/16/03

		Location Code:	PB-BED-MW25			PB-BED-MW25		
		Associated Site:	BCG			BCG		
		Sample No:	CD3006			CD3005		
		Sample Date:	17-OCT-02			17-OCT-02		
User Test Group		*Purpose:*	FD			REG		
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
METALS								
Potassium		ug/L	15900	J	J	16200	J	J
Selenium	Y	ug/L	5.0	U	U	5.0	U	U
Selenium		ug/L	5.0	U	U	5.0	U	U
Silver	Y	ug/L	10.0	U	U	10.0	U	U
Silver		ug/L	10.0	U	U	10.0	U	U
Sodium	Y	ug/L	183000			180000		
Sodium		ug/L	183000			187000		
Thallium	Y	ug/L				10.0	U	U
Thallium		ug/L				10.0	U	U
Vanadium	Y	ug/L	50.0	U	U	50.0	U	U
Vanadium		ug/L	50.0	U	U	50.0	U	U
Zinc	Y	ug/L						
Zinc		ug/L	1.9	B	J	1.7	B	J
SEMIVOLATILES								
Acenaphthene		ug/L	10	U	U	10	U	U
Acenaphthylene		ug/L	10	U	U	10	U	U
Anthracene		ug/L	10	U	U	10	U	U
Benzo(a)anthracene		ug/L	10	U	U	10	U	U
Benzo(a)pyrene		ug/L	10	U	U	10	U	U
Benzo(b)fluoranthene		ug/L	10	U	U	10	U	U
Benzo(ghi)perylene		ug/L	10	U	U	10	U	U
Benzo(k)fluoranthene		ug/L	10	U	U	10	U	U
Bis(2-chloroethoxy)methane		ug/L	10	U	U	10	U	U
Bis(2-chloroethyl)ether		ug/L	10	U	U	10	U	U
Bis(2-chloroisopropyl)ether		ug/L	10	U	U	10	U	U
Bis(2-ethylhexyl)phthalate		ug/L	10	U	U	10	U	U
Bromophenyl phenyl ether, 4-		ug/L	10	U	U	10	U	U
Butyl benzyl phthalate		ug/L	10	U	U	10	U	U
Carbazole		ug/L	10	U	U	10	U	U

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Data Summary

Report Date: 01/16/03

	Location Code:		IT-BG8-BEDGW-001			IT-MW01			PB-BED-MW20			PB-BED-MW24		
	Associated Site:		BCG			BCG			BCG			BCG		
	Sample No:		CD3001			CD3002			CD3003			CD3004		
	Sample Date:		18-OCT-02			16-OCT-02			17-OCT-02			19-OCT-02		
User Test Group	*Purpose:*		REG			REG			REG			REG		
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
SEMIVOLATILES														
Chloro-3-methylphenol, 4-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Chloroaniline, 4-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Chloronaphthalene, 2-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Chlorophenol, 2-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Chlorophenyl phenyl ether, 4-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Chrysene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Di-n-butyl phthalate		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Di-n-octyl phthalate		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Dibenz(a,h)anthracene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Dibenzofuran		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Dichlorobenzene, 1,2-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Dichlorobenzene, 1,3-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Dichlorobenzene, 1,4-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Dichlorobenzidine, 3,3'-		ug/L	50	U	U	50	U	U	50	U	U	50	U	U
Dichlorophenol, 2,4-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Diethyl phthalate		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Dimethyl phthalate		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Dimethylphenol, 2,4-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Dinitro-2-methylphenol, 4,6-		ug/L	50	U	U	50	U	U	50	U	U	50	U	U
Dinitrophenol, 2,4-		ug/L	50	U	U	50	U	UJ	50	U	U	50	U	U
Dinitrotoluene, 2,4-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Dinitrotoluene, 2,6-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Fluoranthene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Fluorene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Hexachlorobenzene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Hexachlorobutadiene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Hexachlorocyclopentadiene		ug/L	50	U	U	50	U	U	50	U	U	50	U	U
Hexachloroethane		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Indeno(1,2,3-cd)pyrene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Isophorone		ug/L	10	U	U	10	U	U	10	U	U	10	U	U

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Data Summary

Report Date: 01/16/03

	Location Code:		PB-BED-MW25			PB-BED-MW25		
	Associated Site:		BCG			BCG		
	Sample No:		CD3006			CD3005		
	Sample Date:		17-OCT-02			17-OCT-02		
User Test Group	*Purpose:*		FD			REG		
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
SEMIVOLATILES								
Chloro-3-methylphenol, 4-		ug/L	10	U	U	10	U	U
Chloroaniline, 4-		ug/L	10	U	U	10	U	U
Chloronaphthalene, 2-		ug/L	10	U	U	10	U	U
Chlorophenol, 2-		ug/L	10	U	U	10	U	U
Chlorophenyl phenyl ether, 4-		ug/L	10	U	U	10	U	U
Chrysene		ug/L	10	U	U	10	U	U
Di-n-butyl phthalate		ug/L	10	U	U	10	U	U
Di-n-octyl phthalate		ug/L	10	U	U	10	U	U
Dibenz(a,h)anthracene		ug/L	10	U	U	10	U	U
Dibenzofuran		ug/L	10	U	U	10	U	U
Dichlorobenzene, 1,2-		ug/L	10	U	U	10	U	U
Dichlorobenzene, 1,3-		ug/L	10	U	U	10	U	U
Dichlorobenzene, 1,4-		ug/L	10	U	U	10	U	U
Dichlorobenzidine, 3,3'-		ug/L	50	U	U	50	U	U
Dichlorophenol, 2,4-		ug/L	10	U	U	10	U	U
Diethyl phthalate		ug/L	10	U	U	10	U	U
Dimethyl phthalate		ug/L	10	U	U	10	U	U
Dimethylphenol, 2,4-		ug/L	10	U	U	10	U	U
Dinitro-2-methylphenol, 4,6-		ug/L	50	U	U	50	U	U
Dinitrophenol, 2,4-		ug/L	50	U	U	50	U	U
Dinitrotoluene, 2,4-		ug/L	10	U	U	10	U	U
Dinitrotoluene, 2,6-		ug/L	10	U	U	10	U	U
Fluoranthene		ug/L	10	U	U	10	U	U
Fluorene		ug/L	10	U	U	10	U	U
Hexachlorobenzene		ug/L	10	U	U	10	U	U
Hexachlorobutadiene		ug/L	10	U	U	10	U	U
Hexachlorocyclopentadiene		ug/L	50	U	U	50	U	U
Hexachloroethane		ug/L	10	U	U	10	U	U
Indeno(1,2,3-cd)pyrene		ug/L	10	U	U	10	U	U
Isophorone		ug/L	10	U	U	10	U	U

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Data Summary

Report Date: 01/16/03

	Location Code:		IT-BG8-BEDGW-001			IT-MW01			PB-BED-MW20			PB-BED-MW24		
	Associated Site:		BCG			BCG			BCG			BCG		
	Sample No:		CD3001			CD3002			CD3003			CD3004		
	Sample Date:		18-OCT-02			16-OCT-02			17-OCT-02			19-OCT-02		
User Test Group	*Purpose:*		REG			REG			REG			REG		
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
SEMIVOLATILES														
Methylnaphthalene, 2-		ug/L	10	U	U	10	U	U	10	U	U	1.4	J	J
Methylphenol, 2-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Methylphenol, 4-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Naphthalene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Nitroaniline, 2-		ug/L	50	U	U	50	U	U	50	U	U	50	U	U
Nitroaniline, 3-		ug/L	50	U	U	50	U	U	50	U	U	50	U	U
Nitroaniline, 4-		ug/L	50	U	U	50	U	U	50	U	U	50	U	U
Nitrobenzene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Nitrophenol, 2-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Nitrophenol, 4-		ug/L	50	U	U	50	U	U	50	U	U	50	U	U
Pentachlorophenol		ug/L	50	U	U	50	U	U	50	U	U	50	U	U
Phenanthrene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Phenol		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Pyrene		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Trichlorobenzene, 1,2,4-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Trichlorophenol, 2,4,5-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
Trichlorophenol, 2,4,6-		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
n-Nitroso-di-n-propylamine		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
n-Nitrosodiphenylamine		ug/L	10	U	U	10	U	U	10	U	U	10	U	U
VOLATILES														
Acetone		ug/L	3.4	J	J	10	U	U	10	U	U	100	U	U
Benzene		ug/L	1.0	U	U	1.0	U	U	1.3		J	9.3	J	J
Bromodichloromethane		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Bromoform		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Bromomethane		ug/L	2.0	U	UJ	2.0	U	UJ	2.0	U	UJ	20	U	UJ
Butanone, 2-		ug/L	5.0	U	R				5.0	U	R	50	U	R
Carbon disulfide		ug/L	0.43	J	J	1.0	U	U	1.1		J	29		
Carbon tetrachloride		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Chlorobenzene		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Data Summary

	Location Code:		PB-BED-MW25			PB-BED-MW25		
	Associated Site:		BCG			BCG		
	Sample No:		CD3006			CD3005		
	Sample Date:		17-OCT-02			17-OCT-02		
User Test Group	*Purpose:*		FD			REG		
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
SEMIVOLATILES								
Methylnaphthalene, 2-		ug/L	10	U	U	10	U	U
Methylphenol, 2-		ug/L	10	U	U	10	U	U
Methylphenol, 4-		ug/L	10	U	U	10	U	U
Naphthalene		ug/L	10	U	U	10	U	U
Nitroaniline, 2-		ug/L	50	U	U	50	U	U
Nitroaniline, 3-		ug/L	50	U	U	50	U	U
Nitroaniline, 4-		ug/L	50	U	U	50	U	U
Nitrobenzene		ug/L	10	U	U	10	U	U
Nitrophenol, 2-		ug/L	10	U	U	10	U	U
Nitrophenol, 4-		ug/L	50	U	U	50	U	U
Pentachlorophenol		ug/L	50	U	U	50	U	U
Phenanthrene		ug/L	10	U	U	10	U	U
Phenol		ug/L	10	U	U	10	U	U
Pyrene		ug/L	10	U	U	10	U	U
Trichlorobenzene, 1,2,4-		ug/L	10	U	U	10	U	U
Trichlorophenol, 2,4,5-		ug/L	10	U	U	10	U	U
Trichlorophenol, 2,4,6-		ug/L	10	U	U	10	U	U
n-Nitroso-di-n-propylamine		ug/L	10	U	U	10	U	U
n-Nitrosodiphenylamine		ug/L	10	U	U	10	U	U
VOLATILES								
Acetone		ug/L	2.6	J	J	1.6	J	J
Benzene		ug/L	0.14	J	J	0.15	J	J
Bromodichloromethane		ug/L	1.0	U	U	1.0	U	U
Bromoform		ug/L	1.0	U	U	1.0	U	U
Bromomethane		ug/L	2.0	U	UJ	2.0	U	UJ
Butanone, 2-		ug/L	5.0	U	R	5.0	U	R
Carbon disulfide		ug/L	0.49	J	J	1.3		J
Carbon tetrachloride		ug/L	1.0	U	U	1.0	U	U
Chlorobenzene		ug/L	1.0	U	U	1.0	U	U

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Data Summary

Location Code:			IT-BG8-BEDGW-001			IT-MW01			PB-BED-MW20			PB-BED-MW24		
Associated Site:			BCG			BCG			BCG			BCG		
Sample No:			CD3001			CD3002			CD3003			CD3004		
Sample Date:			18-OCT-02			16-OCT-02			17-OCT-02			19-OCT-02		
Purpose:			REG			REG			REG			REG		
User Test Group														
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
VOLATILES														
Chloroethane		ug/L	2.0	U	U	2.0	U	U	2.0	U	U	20	U	U
Chloroform		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Chloromethane		ug/L	2.0	U	U	2.0	U	U	2.0	U	U	20	U	U
Dibromochloromethane		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Dichloroethane, 1,1-		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Dichloroethane, 1,2-		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Dichloroethene, 1,1-		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Dichloroethene, 1,2-		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Dichloropropane, 1,2-		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Dichloropropene, cis-1,3-		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Dichloropropene, trans-1,3-		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Ethylbenzene		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	4.8	J	J
Hexanone, 2-		ug/L	5.0	U	U	5.0	U	U	5.0	U	U	50	U	U
Methyl-2-pentanone, 4-		ug/L	5.0	U	U	5.0	U	U	5.0	U	U	50	U	U
Methylene chloride		ug/L	2.0	U	U	2.0	U	U	2.0	U	U	20	U	U
Styrene		ug/L	1.0	U	U	1.0	U	UJ	1.0	U	U	10	U	U
Tetrachloroethane, 1,1,2,2-		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Tetrachloroethene		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Toluene		ug/L	1.0	U	U	1.0	U	U	0.35	J	J	14		
Trichloroethane, 1,1,1-		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Trichloroethane, 1,1,2-		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Trichloroethene		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Vinyl chloride		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	10	U	U
Xylenes, total		ug/L	1.0	U	U	1.0	U	U	1.0	U	U	23		

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Data Summary

Report Date: 01/16/03

	Location Code:		PB-BED-MW25			PB-BED-MW25		
	Associated Site:		BCG			BCG		
	Sample No:		CD3006			CD3005		
	Sample Date:		17-OCT-02			17-OCT-02		
	Purpose:		FD			REG		
User Test Group								
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
VOLATILES								
Chloroethane		ug/L	2.0	U	U	2.0	U	U
Chloroform		ug/L	1.0	U	U	1.0	U	U
Chloromethane		ug/L	2.0	U	U	2.0	U	U
Dibromochloromethane		ug/L	1.0	U	U	1.0	U	U
Dichloroethane, 1,1-		ug/L	1.0	U	U	1.0	U	U
Dichloroethane, 1,2-		ug/L	1.0	U	U	1.0	U	U
Dichloroethene, 1,1-		ug/L	1.0	U	U	1.0	U	U
Dichloroethene, 1,2-		ug/L	1.0	U	U	1.0	U	U
Dichloropropane, 1,2-		ug/L	1.0	U	U	1.0	U	U
Dichloropropene, cis-1,3-		ug/L	1.0	U	U	1.0	U	U
Dichloropropene, trans-1,3-		ug/L	1.0	U	U	1.0	U	U
Ethylbenzene		ug/L	1.0	U	U	1.0	U	U
Hexanone, 2-		ug/L	5.0	U	U	5.0	U	U
Methyl-2-pentanone, 4-		ug/L	5.0	U	U	5.0	U	U
Methylene chloride		ug/L				2.0	U	U
Styrene		ug/L	1.0	U	U	1.0	U	U
Tetrachloroethane, 1,1,2,2-		ug/L	1.0	U	U	1.0	U	U
Tetrachloroethene		ug/L	1.0	U	U	1.0	U	U
Toluene		ug/L	1.0	U	U	1.0	U	U
Trichloroethane, 1,1,1-		ug/L	1.0	U	U	1.0	U	U
Trichloroethane, 1,1,2-		ug/L	1.0	U	U	1.0	U	U
Trichloroethene		ug/L	1.0	U	U	1.0	U	U
Vinyl chloride		ug/L	1.0	U	U	1.0	U	U
Xylenes, total		ug/L	0.35	J	J	0.37	J	J

Appendix D

APPENDIX D

DETECTED HITS SUMMARY EXCLUDING "B" QUALIFIERS

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Detected Hits Summary

Report Date: 01/14/03

		Location Code:	IT-BG8-BEDGW-001			IT-MW01			PB-BED-MW20			PB-BED-MW24		
		Associated Site:	BCG			BCG			BCG			BCG		
		Sample No:	CD3001			CD3002			CD3003			CD3004		
		Sample Date:	18-OCT-02			16-OCT-02			17-OCT-02			19-OCT-02		
User Test Group		*Purpose:*	REG			REG			REG			REG		
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
EXPLOSIVES														
Nitrobenzene		ug/L												
GEN CHEMISTRY														
Alkalinity		ug/L	332000			209000			259000			757000		
Chloride		ug/L	999000			9900			21100000			126000		
Hardness		ug/L	687000			263000			9390000			808000		
Sulfate		ug/L	11200			67300								
Total dissolved solids		ug/L	1870000			342000			43800000			990000		
Total organic carbon		ug/L	1300			9900						3700		
Total suspended solids		ug/L				5000			19000			62000		
Turbidity		NTU	44.2			10.6			19.2			49.6		
METALS														
Aluminum		ug/L				10200		J	155	B	J	115	B	J
Antimony		ug/L				8.0	B	J						
Arsenic		ug/L				52.6								
Barium	Y	ug/L	285			89.1	B	J	24500			1140		
Barium		ug/L	279			139	B	J	25700			1080		
Beryllium		ug/L				4.6	B	J						
Cadmium		ug/L				1.5	B	J						
Calcium	Y	ug/L	127000			57700			1990000			160000		
Calcium		ug/L	122000	J		56300	J		2050000	J		159000	J	
Chromium		ug/L				14.1								
Cobalt	Y	ug/L				4.9	B	J	7.5	B	J	1.4	B	J
Cobalt		ug/L				14.0	B	J	8.1	B	J			
Copper	Y	ug/L				3.7	B	J						
Copper		ug/L				72.2								
Iron	-Y	ug/L	53.4	B	J	1840			4940					
Iron		ug/L	74.5	B	J	52100			5310			403		
Lead		ug/L				101								

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Detected Hits Summary

Report Date: 01/14/03

		Location Code:	PB-BED-MW25			PB-BED-MW25		
		Associated Site:	BCG			BCG		
		Sample No:	CD3006			CD3005		
		Sample Date:	17-OCT-02			17-OCT-02		
User Test Group		*Purpose:*	FD			REG		
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
EXPLOSIVES								
Nitrobenzene		ug/L	0.14	J	J	0.12	J	J
GEN CHEMISTRY								
Alkalinity		ug/L				314000		
Chloride		ug/L				631000		
Hardness		ug/L				848000		
Sulfate		ug/L				79500		
Total dissolved solids		ug/L				1440000		
Total organic carbon		ug/L				2700		
Total suspended solids		ug/L						
Turbidity		NTU				35.8		
METALS								
Aluminum		ug/L				79.7	B	J
Antimony		ug/L						
Arsenic		ug/L						
Barium	Y	ug/L	279			270		
Barium		ug/L	275			277		
Beryllium		ug/L						
Cadmium		ug/L						
Calcium	Y	ug/L	202000			198000		
Calcium		ug/L	198000	J		200000	J	
Chromium		ug/L						
Cobalt	Y	ug/L						
Cobalt		ug/L						
Copper	Y	ug/L						
Copper		ug/L						
Iron	Y	ug/L	147			157		
Iron		ug/L	203			207		
Lead		ug/L						

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Detected Hits Summary

Report Date: 01/14/03

		Location Code:	IT-BG8-BEDGW-001			IT-MW01			PB-BED-MW20			PB-BED-MW24		
		Associated Site:	BCG			BCG			BCG			BCG		
		Sample No:	CD3001			CD3002			CD3003			CD3004		
		Sample Date:	18-OCT-02			16-OCT-02			17-OCT-02			19-OCT-02		
User Test Group		*Purpose:*	REG			REG			REG			REG		
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
METALS														
Magnesium	Y	ug/L	79800			20300			911000			77600		
Magnesium		ug/L	77000			19500	J		941000			75400		
Manganese	Y	ug/L	52.2			424			182			15.5		
Manganese		ug/L	51.1			490			185			23.6		
Nickel	Y	ug/L				10.5	B	J						
Nickel		ug/L				35.0	B	J						
Potassium	Y	ug/L	43200	J	J	6400	J	J	88400	B J	J	24000	J	J
Potassium		ug/L	41200	J	J	6480	J		91700	B J	J	22900	J	J
Selenium		ug/L				5.0								
Sodium	Y	ug/L	472000			19400			7750000			92500		
Sodium		ug/L	462000			17800			8190000			91800		
Thallium		ug/L				5.7	B	J						
Vanadium		ug/L				35.9	B	J						
Zinc	Y	ug/L				13.1	B J	J	78.3	J				
Zinc		ug/L	0.83	B	J	124		J	15.6	B	J	3.9	B	J
SEMIVOLATILES														
Methylnaphthalene, 2-		ug/L										1.4	J	J
VOLATILES														
Acetone		ug/L	3.4	J	J									
Benzene		ug/L							1.3		J	9.3	J	J
Carbon disulfide		ug/L	0.43	J	J				1.1		J	29		
Ethylbenzene		ug/L										4.8	J	J
Toluene		ug/L							0.35	J	J	14		
Xylenes, total		ug/L										23		

Plum Brook Ordnance Works
Quarterly Groundwater Monitoring
Detected Hits Summary

Report Date: 01/14/03

	Location Code:		PB-BED-MW25			PB-BED-MW25		
	Associated Site:		BCG			BCG		
	Sample No:		CD3006			CD3005		
	Sample Date:		17-OCT-02			17-OCT-02		
User Test Group	*Purpose:*		FD			REG		
Parameter	*Flt*	*Units*	*Result*	*Qual*	*VQ*	*Result*	*Qual*	*VQ*
METALS								
Magnesium	Y	ug/L	80500			78600		
Magnesium		ug/L	79500			80200		
Manganese	Y	ug/L	85.6			84.2		
Manganese		ug/L	85.2			86.5		
Nickel	Y	ug/L						
Nickel		ug/L						
Potassium	Y	ug/L	16200	J	J	15900	J	J
Potassium		ug/L	15900	J	J	16200	J	J
Selenium		ug/L						
Sodium	Y	ug/L	183000			180000		
Sodium		ug/L	183000			187000		
Thallium		ug/L						
Vanadium		ug/L						
Zinc	Y	ug/L						
Zinc		ug/L	1.9	B	J	1.7	B	J
SEMIVOLATILES								
Methylnaphthalene, 2-		ug/L						
VOLATILES								
Acetone		ug/L	2.6	J	J	1.6	J	J
Benzene		ug/L	0.14	J	J	0.15	J	J
Carbon disulfide		ug/L	0.49	J	J	1.3		J
Ethylbenzene		ug/L						
Toluene		ug/L						
Xylenes, total		ug/L	0.35	J	J	0.37	J	J

Appendix E

APPENDIX E

DATA QUALITY EVALUATION

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List of Acronyms

AR/COC	analysis request/chain of custody
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
DI	deionized
DQE	data quality evaluation
DQO	data quality objectives
USEPA	U.S. Environmental Protection Agency
LCS	laboratory control sample
MB	material blank or method blank
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
PQL	practical quanitation limit
PBOW	Plum Brook Ordnance Works
QA/QC	quality assurance/quality control
SAP	sampling and analysis plan
RL	reporting limit
RPD	relative percent difference
RRF	relative response factor
SOP	standard operating procedures
STL	Severn Trent Laboratory
TDS	total dissolved solids
TOC	total organic compounds
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compounds

E.1.0 Introduction

This appendix of the Fifth Quarterly Background Report presents results of the quality assurance/quality control (QA/QC) measures implemented for the sampling and analysis activities at the Plum Brook Ordnance Works (PBOW) – Sandusky, Ohio. The quality indicators from every aspect of the data collection have been reviewed, and an assessment of the data with regard to project-specific objectives is presented. Successful execution of project-specific objectives and procedures provides strong support for the acceptance of the data generated as adequate for the purpose of evaluating the analytical results from this assessment at PBOW.

IT Corporation conducted field-sampling activities at PBOW in October 2002. Severn Trent Laboratories (STL) in Knoxville, Tennessee and Canton, Ohio analyzed the project samples. Accutest Laboratories of Orlando, Florida analyzed the field split samples. All data analyzed were reviewed for accuracy and completeness. One hundred percent of the data analyzed were subjected to data validation following Unites States Environmental Protection Agency (USEPA) guidelines in the *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, (EPA, 1999) and *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, (EPA, 1994a). The criteria for blank evaluation were based on those detailed in *Region III Modifications to National Functional Guidelines for Organic Data Review* (EPA, 1994b) and *Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses* (EPA, 1993). Data were evaluated against specific criteria to verify the achievement of precision, accuracy, representativeness, completeness and comparability goals established to meet the project data quality objectives (DQO). To verify that these DQOs were met, field measurements, sampling and handling procedures, laboratory analysis and reporting, and all nonconformances and discrepancies in the data were examined to determine compliance with the appropriate and applicable procedures defined in the site-wide sampling and analysis plan (SAP). The results of this review are presented in the following sections, with all analytical outliers or nonconformances discussed where they occurred.

This report is divided into three subsections. Section E.2.0 discusses the field investigation and QC procedures used during the sampling effort. Section E.3.0 outlines the analytical program and the associated QC activities performed. The final part of this document, Section E.4.0, summarizes the data findings and their overall impact on the usability of the analytical data.

E.2.0 Field Sampling and QC Activities

IT was retained by the U. S. Army Corps of Engineers (USACE), Nashville District to conduct investigation and sampling activities at PBOW. Field activities at this site included collection of the background groundwater samples. The collection of these samples along with their associated QA and QC samples are discussed in this section of the Data Quality Evaluation (DQE).

All project and field duplicate samples collected were submitted to STL. Sample shipments from the field were performed under custody and documented using standard IT Analysis Request/Chain of Custody (AR/COC) forms. These forms provided project-specific analytical specifications and QC instructions to the laboratory. A formal COC transfer record was prepared and included with these forms to document custody during sample transportation, storage, and disposition by the laboratory. Table E-1 summarizes the field sample number, location, sample type, date of collection, and sample delivery group for each sample collected. Table E-2 summarizes the detected compounds in the method blanks associated with the PBOW samples.

E.2.1 Trip Blanks

Aqueous samples designated for volatile organic compound (VOC) analysis may be susceptible to contamination by diffusion of organic compounds into the sample container. Trip blanks are analyzed in order to assess the potential for contamination to be introduced to an aqueous volatile sample during transport and handling procedures. A trip blank is a sample of analyte-free deionized (DI) water that is prepared at the laboratory, shipped to the field with sample containers, and returned to the laboratory with the water matrix samples receiving VOC analysis. A trip blank is then analyzed for volatile organics using the same sample preparation and analysis procedures used for the actual field samples. Five trip blank samples were collected. Three trip blanks contained target analytes, however only one associated sample was affected.

The data validator applied the 5X-10X rule to the samples for the analytes detected. The following samples were qualified "B" by the data validator indicating that sample results are indicative of blank contamination:

Lot Number	Sample Affected	Blank Contaminant	Validation Qualifier
H2J180210	CD3006	Methylene Chloride	B

E.2.2 Field Duplicates

Field duplicate samples are collected and submitted to the laboratory for analysis along with their corresponding original samples. The data generated from the analysis of field duplicate samples are used to evaluate the precision of the sample collection and analysis procedures. It is difficult to collect and analyze soil samples in duplicate due to the heterogeneous nature of a soil. High relative percent difference (RPD) between an original sample and its field duplicate may indicate a difference in sample matrix or sample collection rather than true problems with precision of sample analysis. Also, when estimated "J" or nondetected "U" results are reported, there is a potential for increased variability between the primary and duplicate sample results

Field duplicate samples were collected at a frequency of approximately one for every ten samples collected (10 percent). One field duplicate sample was collected during this sampling event. Table E-3 compares the original and field duplicate results and shows the RPDs calculated for those detected compounds. Compounds not presented in the table were not detected in either the original or field duplicate samples. In cases where duplicates were performed and one result is less than the reporting limit, but greater than the method detection limit (MDL), the RPD is reported, but should be considered an estimated value.

The acceptance criterion of 30 percent RPD was used to evaluate these sample results. Acetone and carbon disulfide were qualified "J". In 21 cases out of 26, original and field duplicate data compared well as demonstrated by the RPDs calculated. The instances where they do not compare well involve estimated or blank contaminated data. RPD is calculated by using the following formula:

$$RPD = \left| \frac{A - B}{(A + B)/2} \right| \quad x \quad 100$$

where:

RPD	=	relative percent difference
A	=	original result
B	=	field duplicate result.

E.2.3 Field Split Samples

Split samples were collected in conjunction with field duplicate samples and sent to Accutest Laboratories. The split samples were submitted to the laboratory for the same analysis as their corresponding field duplicates and original field samples. The split samples are used to determine if data results are reproducible when analyzed by two different laboratories. Results are also evaluated to determine if a contracted laboratory's preparation and analysis procedures are in control and meet the approved method criteria.

Field split samples were collected at a frequency of approximately one for every ten regular samples. One split sample was collected during this sampling event.

Table E-3 compares the original and field split results and shows the RPDs calculated for those detected compounds. Compounds not presented in the table were not detected in either the original or field split samples. The analytes compare well when both labs reported above their reporting limits and there was no blank contamination.

E.3.0 Analytical Program and QC Activities

The project QA/QC program described in the SAP was followed for the collection and laboratory analysis of samples. Each of the analytical methods used require that method-specific QA/QC protocols be followed during sample analysis. These protocols are a critical part of the methods employed and were followed by the laboratory during sample analysis. Specific measures included detailed record keeping procedures, instrument calibrations, and analysis of method blanks, blank spikes, matrix spikes/matrix spike duplicates (MS/MSD), surrogates, and internal standards. The following SW-846 and USEPA Methods were used to analyze PBOW samples:

Parameter	Method
Volatiles	SW-846 5030/8260B
Semivolatiles	SW-846 3520/8270C
Nitroaromatic Compounds	SW-846 8330
Metals	SW-846 3005A/6010B/7470A
Gasoline Range Organics	SW-846 5030/8015B
Diesel Range Organics	SW-846 8015B
Turbidity	EPA 180.1
Alkalinity	EPA 310.1
Total Organic Carbon (TOC)	SW-846 9060

Hardness	EPA 130.2
Total Dissolved Solids (TDS)	EPA 160.1
Total Suspended Solids (TSS)	EPA 160.2
Chloride	EPA 325.2
Total Cyanide	SW-846 9012A
Nitrate	EPA 353.2
Sulfate	EPA 375.4

Appendix C contains validated analytical data summaries for the samples collected during this field investigation. The validator used the QA/QC criteria defined in the SAP to evaluate the data for all parameters for which criteria were provided. If acceptance criteria were not provided in the SAP, the validator used the laboratory-derived acceptance criteria or analytical method criteria to qualify data. Any qualifiers added to these data by the data validator are included in the summaries.

E.3.1 Laboratory QA/QC Procedures

The following sections discuss specific QA/QC protocols required and performed by the laboratory during this investigation.

E.3.1.1 Method/Calibration Blanks

Method blanks are analyzed with each analytical "batch" processed on a per matrix (i.e., soil and water) basis. Method blanks are carried step-wise through the same analytical procedure as their associated field samples including the addition of solvents, surrogate and standard spikes, and reagents as required in the analysis process. The purpose of a method blank is to identify any possible contaminants that may be introduced to the sample as a result of any part of the analytical process. Table E-2 summarizes the compounds detected in associated blanks by lot number. The data validator evaluated all blank data associated with each sample. When estimated or positive concentrations of compounds/analytes were reported in the corresponding field samples, associated samples were evaluated and qualified using the 5X-10X rule.

For some analyses, an initial and continuing calibration blank are performed throughout the run sequence. These blanks verify the presence of carry over contamination for the analytes of interest.

Qualifiers applied to samples based on detects in the method or calibration blanks are summarized below:

Lot Number	Sample Number Affected	Blank Contaminant	Blank	Validation Qualifier
Volatiles				
H2J170128	CD3002	2-Butanone	Method	B
Metals				
H2J170128	CD3002	Aluminum (total)	Calibration	B
H2J180210	CD3006	Aluminum (total)	Calibration	B
	CD3003, CD3005, CD3006	Aluminum (dissolved)	Calibration	B
	CD3003	Beryllium (total)	Calibration	B
	CD3003	Beryllium (dissolved)	Calibration	B
	CD3003, CD3006	Thallium (total)	Method/Calibration	B
	CD3006	Thallium (dissolved)	Method/Calibration	B
	CD3005, CD3006	Zinc (dissolved)	Method	B
H2J190106	CD3001	Aluminum (total)	Calibration	B
	CD3001, CD3009	Aluminum (dissolved)	Calibration	B
	CD3001, CD3009	Zinc (dissolved)	Method	B
H2J210108	CD3004	Aluminum (dissolved)	Calibration	B
	CD3004	Zinc (dissolved)	Method	B

B - blank contamination

E.3.1.2 Matrix Spikes and Laboratory Control Spikes

Two types of spikes were generally performed for all analyses: MS and laboratory control samples (LCS). MS compounds are spiked into an aliquot of a field sample. LCS compounds are spiked into a blank matrix. The spiked compounds are representative compounds that are quantified during performance of the method. Recovery of the spiked compound is used as an assessment of analytical accuracy for the sample matrix analyzed. These results are useful in distinguishing sample matrix interferences from analysis interferences through a comparison of MS and LCS recovery data. Often, spikes are performed in duplicate (as an MSD or LCS duplicate). In this manner, the precision of the assessment can be quantified as the RPD of the original and duplicate spike.

Matrix spikes were assigned at a frequency of 1 for every 20 field samples collected. An MS and MSD were assigned in the field to sample CD3005. This sample corresponds to location PB-BED-MW25. Additional sample volume was provided to the laboratory for the MS/MSD analyses. This sampling frequency meets the collection criteria for this program as specified in the SAP. In addition to the overall collection frequency, the analytical method requires that the laboratory analyze 1 set of spikes per analytical batch. To comply with this method requirement, the laboratory may have to analyze "batch" QC with a work order. The validator evaluated the

"batch" QC. The laboratory statistically determined target acceptance limits were used to assess the spike recovery and RPD.

The MS/MSD criteria were met with the exception of the following, which exhibited zero % recovery:

Lot Number	Sample Number Affected	Compound(s)	Validation Qualifier
Explosives			
H2J170128, H2J180210, H2J190106, H2J210108	All samples	Tetryl	R

R - rejected

LCS results are used to evaluate lab method performance in the same manner as the MS/MSD results except the LCS is not performed on an actual field sample matrix. A LCS is prepared for each analytical "batch" for each parameter and matrix analyzed. All LCS recoveries met the established QC criteria.

E.3.1.3 Calibration

Several analytes were qualified because of unacceptable performance in the calibration standards. 2-Butanone was rejected in 6 samples because its relative response factors (RRF) did not meet Contract Laboratory Program (CLP) criteria. It was not detected in the samples. Acetone was qualified "J" in one sample for low RRF. Several analytes were qualified "UJ" because of % difference between the initial and continuing calibrations. For specific examples refer to the validation report in Appendix B and Table E-5.

E.3.2 Reporting Limits

Practical quantitation limits (PQL) or RLs, used for this project are those statistically determined by the laboratories. The analytical program executed for this project required the use of SW-846 methods, which specify the procedure for calculating the PQLs presented. Each laboratory is required to demonstrate method performance through MDL studies for every method employed. These studies are required to be laboratory-specific so that individual laboratory variables such as equipment brands, reagent suppliers, and chemist technique are factored into the performance study. MDLs are established using controlled matrices (i.e., DI water). The PQL calculation adjusts the limit by a predetermined mathematical factor for the analysis of actual environmental sample matrices (i.e. soil, groundwater, etc.). For purposes of clarity and consistency with respect to terminology, the term "reporting limit" has been substituted for PQL when referencing

the limit of detection reported by the laboratory for each individual sample and parameter. The actual values reported have been corrected for all necessary dilutions, dryness, and interference factors as applicable based on the resulting analytical data for a sample.

Standard operating procedures (SOP) address MDLs, PQLs, and RLs when dealing with low concentrations of analytes in samples. These limits are generally defined as follows:

- ***MDL.*** The minimum concentration of an analyte that can be determined with 99 percent confidence that the true value is greater than zero.
- ***PQL.*** The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.
- ***RL.*** This number is equivalent to the PQL.

An MDL is the lower limit at which the laboratory can differentiate a measurement from background. The MDL is determined in accordance with the procedures in the Code of Federal Regulations (CFR). Procedures can be found in 40 CFR Part 136. A PQL, or RL, is the lower limit at which a measurement becomes meaningful. This measurement (the PQL or the RL) is generally a multiple of three to five times the MDL.

Most samples were handled and analyzed as expected without significant changes to the anticipated project RLs. The following samples had dilution factors of at least 10.

Sample Number	Location	Analysis	Dilution Factor	Lot Number
CD3001	IT-BG8-BEDGW-001	Chloride	20	H2J190106
CD3003	PB-BED-MW20	TDS	10	H2J180210
CD3003	PB-BED-MW20	Chloride	1000	H2J180210
CD3003	PB-BED-MW20	Hardness	50	H2J180210
CD3004	PB-BED-MW24	Volatiles	10	H2J210108
CD3005	PB-BED-MW25	Chloride	20	H2J180210
CD3009	PB-BED-MW27	Hardness	10	H2J190106
CD3009	PB-BED-MW27	Volatiles	100	H2J190106
CD3009	PB-BED-MW27	Sulfate	50	H2J190106

E.3.3 Holding Times/Preservation

All laboratory results submitted for this investigation have been reviewed with respect to laboratory adherence to extraction and analysis holding times. Maximum sample extraction and analysis hold times were those specified in USACE document EM200-1-3.
All holding time criteria were acceptable for the samples collected.

E.4.0 Data Evaluation and Usability

The analytical data review process identified a few analytical nonconformance issues that were noted during this analytical program. These anomalies have been discussed in the previous sections of this appendix. Table E-4 summarizes all compounds requiring qualifier application due to anomalies discovered during data validation. Table E-5 defines the reason codes for qualification and Table E-6 defines the data validation qualifiers.

The following definitions are used for defining precision, accuracy, representativeness, completeness, and comparability as they have been applied to this evaluation.

Precision. Precision is a measurement of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision data were obtained through the analysis and evaluation of duplicate QA samples. Accuracy was determined through the analysis and evaluation of method blanks, LCSs, trip blanks, equipment rinsates, and MS samples.

Accuracy. Accuracy is a measurement of bias in a system and is expressed as a percent recovery. These QA samples were collected and/or analyzed at the frequency established in the SAP, verifying the completeness element of the DQOs along with the evaluation of holding times and reporting limits. Percent recovery is calculated as follows:

$$Percent\ \text{Recov}ery = \left(\frac{(x-s)}{T}\right) * 100$$

Where:

X = the lab determined concentration of a spiked sample
S = the sample native concentration prior to spike
T = the true concentration of the spike

Relative Percent Difference is calculated as follows:

$$Relative\ Percent\ Difference = \left[\frac{|D1 - D2|}{\frac{D1 + D2}{2}} \right] * 100$$

Where:

D1 and D2 = the results of duplicate measurements

Representativeness. Representativeness is a qualitative parameter that expresses the degree to which sample data actually represent the matrix and site conditions. For example, in conducting ground water monitoring, representativeness requires proper location of wells and the collection of samples under consistent, documented procedures. Wells are located based upon the results of the hydrological study in progress and are designed to provide maximum coverage of the flow conditions. Requirements and procedures for sample collection and handling are designed to maximize sample representativeness. Representativeness also can be monitored by reviewing field documentation and by performing field audits.

The samples were collected using IT SOPs and were fully documented through the use of standard IT field forms. Samples are representative of the matrix and site sampled.

Completeness. Completeness is a measure of the amount of valid data that are obtained during a sampling event as compared to the amount of data expected under optimum conditions. A total of 13 data points were qualified as rejected in the validation process due to various QC criteria as described in the previous sections of this report. Completeness is calculated as follows:

$$Completeness\ \% = \left(\frac{D_r}{D_c} \right) X\ 100$$

Where:

D_r = the number of data points for which valid results are reported

D_c = the number of valid samples/data points that are collected and reach the laboratory for analysis.

During this task, 6 monitoring wells were sampled resulting in approximately 1319 targeted analytical records, including duplicate and split records. One percent of the data points was rejected due to anomalies discovered during the validation process. Using the above calculation, 99% completeness is achieved for the task.

Comparability. Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Comparability ensures that results for the sampling event can be compared with data from other past and/or future sampling programs. Comparability for this sampling event was achieved through the use of established and recognized techniques and accepted standard USEPA methods. All samples collected and analyzed were subjected to the same sampling, handling, preparation, analysis, reporting, and validation criteria for the purpose of achieving comparability goals within the data set.

E.4.1 Statement of Data Usability

The overall results of the analyses, as discussed in this evaluation, suggest that representative samples were collected and analyzed, and the results are indicative of the media analyzed, with the exception of the few anomalies noted. The data do reflect expected site conditions and are usable for their intended purpose.

Tables E-1 through E-6 summarize the analytical program and the results for the data validation effort for all samples collected by IT at PBOW.

E.5.0 References

U.S Environmental Protection Agency (USEPA), 1999, ***USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review***, October

U.S Environmental Protection Agency (USEPA), 1994, ***USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review***, February

U.S Environmental Protection Agency (USEPA), 1994, ***Region III Modifications to National Functional Guidelines for Organic Data Review***, September

U.S Environmental Protection Agency (USEPA), 1993, ***Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses***, April