PLAN

Interim Remedial Action Plan

Former American Beryllium
Company Site
1600 Tallevast Road
Tallevast, Florida

December 2005

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This Interim Remedial Action Plan for groundwater at the Former American Beryllium Company site located at 1600 Tallevast Road in Manatee County, Florida, dated December 2005, has been prepared in accordance with good scientific and engineering practices by individuals under my direct supervision and me. No other warranty is implied or intended.

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Abbreviations

ABC	American Beryllium Company
AF	Arcadia Formation
AMSL	Above Mean Sea Level
AOP	Advanced Oxidation Process
APT	Applied Process Technology, Inc.
BAP	Benzo(a)pyrene
BBL	Blasland, Bouck & Lee, Inc.
bgs	Below Ground Surface
BOD	Basis of Design
°C	Celsius
CAR	Contamination Assessment Report
CO_2	Carbon Dioxide
COC	Chemicals of Concern
CSM	Conceptual Site Model
DCA	1,1-Dichloroethane
DCE	1,1-Dichloroethene
IRAP	Interim Remedial Action Plan
FAC	Florida Administrative Code
FAS	Floridian Aquifer System
FDEP	Florida Department of Environmental Protection
ft^2/day	Square Feet per Day
ft/day	Feet per Day
GAC	Granular Activated Carbon
GCTLs	Groundwater Cleanup Target Levels
gpm	Gallons per Minute
HCU	HiPOx Cabinet Unit
H_2O	Water
H_2O_2	Hydrogen Peroxide
Hp	Horsepower
IAS	Intermediate Aquifer System
IRA	Interim Remedial Action
IRAP	Interim Remedial Action Plan
Lockheed Martin	Lockheed Martin Corporation
LSAS	Lower Surficial Aquifer System
MCUO	Manatee County Utility Operations
mg/L	Milligrams per Liter
NADCs	Natural Attenuation Default Concentrations
NAPL	Non-Aqueous Phase Liquid
O_3	Ozone
O&M	Operation & Maintenance
OMM	Operation, Maintenance, and Monitoring
PAT	Pump-and-Treat
PCE	Tetrachloroethene
Pd	Palladium
PLC	Programmable Logic Controller
POTW	Publicly Owned Treatment Works
PRF	Peace River Formation

Psi	Pounds per Square Inch
Pt	Platinum
Purifics	Purifics ES, Inc.
PVC	Polyvinyl Chloride
RAP	Remedial Action Plan
RAWP	Remedial Action Work Plan
SARA	Site Assessment Report Addendum
SAS	Surficial Aquifer System
Sch	Schedule
SWFWMD	Southwest Florida Water Management District
TCE	Trichloroethene
TetraTech	TetraTech, Inc.
TiO_2	Titanium Dioxide
TPH	Total Petroleum Hydrocarbons
USAS	Upper Surficial Aquifer System
USEPA	United States Environmental Protection Agency
UV	Ultraviolet
UVOx	Ultraviolet Oxidation
VOCs	Volatile Organic Compounds

1. Introduction

This document presents an Interim Remedial Action Plan (IRAP) for groundwater at the former American Beryllium Company (ABC) property located at 1600 Tallevast Road in Tallevast, Manatee County, Florida (Site). Lockheed Martin Corporation (Lockheed Martin) intends to implement this IRAP at the Site as an initial phase of active groundwater remediation while site assessment activities are being completed. After the site assessment is complete, a Final Remedial Action Plan (RAP) will be developed for full-scale rehabilitation of groundwater at the Site and surrounding areas.

This IRAP involves the installation, operation, and monitoring of a groundwater pump-and-treat (PAT) system around the source area of the Site. The purposes of the PAT system are to expedite mass removal and destruction of chemicals of concern (COC), and to provide hydraulic containment of the source area. Implementing this strategy is beneficial because it will significantly reduce the potential off-site migration of groundwater containing the highest COC concentrations. Moreover, operation of the PAT system will also improve groundwater quality in areas adjacent to the Site. A remedy that addresses the full extent of the groundwater plume will be provided in the Final RAP.

This report was prepared on behalf of Lockheed Martin by Blasland, Bouck & Lee, Inc. (BBL), and presents the design of the groundwater PAT system. The report also provides site assessment and pre-design investigation data that were relied on, as well as the design analyses performed during design activities. Included are plans to install, operate, and monitor the effectiveness of the PAT system. In addition, the PAT system will be monitored to determine its impact on the groundwater plume both on- and off-site.

1.1 Objectives

The objectives of this IRAP are as follows:

- Provide on-site hydraulic containment of groundwater containing the highest concentrations of COCs in the upper and lower surficial aquifer systems (USAS and LSAS) at the Site;
- Remove a significant amount of COC mass from the groundwater plume;
- Provide additional hydrogeologic information near the Site that will enable design of the full-scale groundwater remedy to be provided in the Final RAP; and
- Destroy COCs in extracted groundwater prior to discharge to the publicly owned treatment works (POTW) using technologies that will neither result in air emissions nor disrupt the aesthetic qualities of the neighborhood.

1.2 Regulatory Basis

This IRAP was developed in accordance with the Consent Order for the Site entered into voluntarily by Lockheed Martin and the Florida Department of Environmental Protection (FDEP). The File Number for the Consent Order is 04-1328 and the effective date is July 28, 2004. The Consent Order provides for the performance of site assessment and remediation activities by Lockheed Martin at the former ABC Site.

Lockheed Martin is currently implementing additional site assessment activities necessary to delineate the nature and extent of COCs in groundwater in accordance with the assessment requirements set forth in Chapter 62-780.600, Florida Administrative Code (F.A.C.). The results of these additional site assessment activities will be documented in the Site Assessment Report Addendum 3 (SARA 3) and submitted to FDEP. After FDEP approves the SARA 3, Lockheed Martin will submit a Final RAP also in accordance with applicable sections of Chapter 62-780, F.A.C. Contaminated Site Cleanup Criteria.

Since site assessment activities are not yet complete, this IRAP was prepared and will be implemented voluntarily by Lockheed Martin pending the receipt of comments from the FDEP. At the request of the FDEP, this IRAP was prepared in accordance with the requirements of a RAP as specified in Chapter 62-780.700, F.A.C. The primary difference between this IRAP and the Final RAP to be prepared for the Site is that this IRAP is limited in geographic scope to the Site and immediately surrounding areas. The Final RAP will address the entire area encompassed by the COC plume, including off-site soil. A RAP Summary Form for this IRAP is included in Appendix A.

1.3 Design Process

The overall design process for Site remediation, including the performance of remedial pilot studies, was established through FDEP approval of the Remedial Action Work Plan (RAWP) submitted in July 2005 by TetraTech, Inc. (TetraTech). The RAWP was developed to address both on-site and off-site contamination found at the Site, and it described pre-design activities necessary to support a comprehensive remedial design for both on- and off-site areas in the Final RAP. The pre-design activities included performing:

- Aquifer pumping tests in the upper and lower surficial aquifer systems;
- A pilot test of an ultraviolet oxidation (UVOx) advanced oxidation process (AOP) for destruction of COCs in groundwater;
- A bench-scale test of another AOP technology for destruction of COCs in groundwater; and
- A pilot test of bioremediation technologies for destruction of COCs in groundwater.

The first three pre-design activities listed above were completed by TetraTech, and the data are summarized herein. The bioremediation pilot testing has not yet been completed, but may be implemented in the future, if necessary.

2. Site Assessment Summary and Conceptual Site Model

This section summarizes the results of site assessment activities completed at the former ABC Site and provides a Conceptual Site Model (CSM). The purpose of this section is to summarize the Site-specific data and knowledge relied on to arrive at the basis of design (BOD) presented in Section 3. As such, this section focuses on data collected at the Site and in areas immediately surrounding the Site since this IRAP is focused on the Site source area. A comprehensive discussion of site assessment data collected at both on- and off-site areas will be provided in the Final RAP.

A description of the Site location, setting, geology, and hydrogeology is provided below followed by a discussion of additional site assessment activities completed since submittal of the SARA 2, and an evaluation of the potential for non-aqueous phase liquids (NAPLs) to exist in the subsurface at the site, with implications for implementation of the IRAP. The Site assessment summary also includes discussions of rationale for technology selection.

2.1 Site Location and Setting

The Site is located at 1600 Tellevast Road in Tallevast, Manatee County, Florida (Figure 1). As shown, the Site is located on a gently sloping plain at an elevation of approximately 30 feet above mean sea level (AMSL). The Site is approximately 1.5 miles east of Sarasota Bay and approximately 5.75 miles from the Gulf of Mexico. The ground surface immediately surrounding the Site has very low relief and slopes gently in a radial pattern. The ground surface elevation decreases from approximately 30 feet AMSL at the Site to 25 feet AMSL to the west near the intersection of Tallevast Road and 15th Street East. Further west, surface elevations decrease to approximately 15 feet AMSL just north of the Sarasota-Bradenton Airport. Several small surface water bodies are depicted on the Bradenton 7 ½ minute quadrangle within a one half mile radius of the site (Figure 1).

The Site encompasses approximately five acres and is bounded by Tallevast Road to the north; 17th Street Court East to the east; a golf course, undeveloped, and residential areas to the south; and an abandoned industrial facility to the west (Figure 2). Five primary buildings designated as Buildings 1 through 5, covering a total surface area of approximately 66,335 square feet, are located in the central portion of the property. Surface cover consists of: a landscaped storm water retention pond surrounded by grass on the west side of the Site; asphalt-paved parking areas south of the retention pond and south and east of the buildings; and a grass area in the southwestern portion of the Site adjoining the asphalt surface. A concrete swale is located in the driveway between the main buildings (Buildings 1 and 2) to the west and Buildings 3, 4, and 5 to the east. The swale is a pathway for storm water and slopes to a grass area at the southern end of the paved parking area. The pond located on the west side of the property was reportedly constructed in approximately 1960 and supports various wildlife, including fish and birds. During periods of heavy rainfall, this pond may serve as a groundwater recharge area.

2.2 Geology and Hydrogeology

2.2.1 Geology

In January 1995, the Southwest Florida Water Management District (SWFWMD) published a report entitled "ROMP TR-7 Oneco Monitor Well Site, Manatee County, Florida," describing drilling and testing of a well completed to a depth of 1,715 feet below ground surface (bgs) at a site located approximately 2 ½ miles north of the former ABC Site in southwestern Manatee County. Information presented in the following discussion was derived, in large part, from data provided in the SWFWMD report.

From the surface downward, sediments underlying southern Manatee County consist of:

- Undifferentiated surficial deposits (Pliocene to Recent);
- The Peace River Formation (PRF) and Arcadia Formation (AF) (undifferentiated) (Miocene);
- The Tampa Member of the AF and Suwannee Limestone (Oligocene); and
- A thick sequence of marine carbonates, including the Ocala Limestone and Avon Park Formation (Eocene).

The surficial deposits consist predominantly of quartz sand and are generally less than 40 feet thick in the region. They unconformably overlie deposits of the PRF, which, in the study area, consist of a clay layer known as the Venice Clay. The contact between the Venice Clay and the underlying undifferentiated AF was reported at a depth of 48 feet bgs by SWFWMD (1995). Undifferentiated Arcadia deposits consist predominantly of clayey calcilutites and phosphatic/quartz sand calcilutites and calcarenites with intercalated thin clay beds. These deposits extend to a depth of approximately 332 feet bgs (SWFWMD, 1995). The underlying Tampa Member of the AF consists primarily of quartz sandy limestone and dolomitic limestone, and is the uppermost unit of a thick sequence of marine carbonates comprising the Florida platform.

2.2.2 Hydrogeology

Three aquifer systems are present beneath the Site including, from top to bottom, the surficial aquifer system (SAS), the intermediate aquifer system (IAS), and the Floridian Aquifer System (FAS). These aquifer systems were described in detail in the SARA 1 and 2 (TetraTech, 2005) and other documents listed in the next subsection and Section 7. Since this IRAP specifically is focused on hydraulic containment of groundwater in the SAS, the remainder of this subsection discusses hydrogeology of the SAS. Readers are referred to other reports listed in Section 7 for thorough descriptions of the IAS and FAS. Groundwater remediation in the IAS and FAS, if necessary, will be addressed in the Final RAP.

The SAS is comprised of undifferentiated surficial deposits and has been subdivided into the USAS and LSAS. The USAS is present from ground surface to approximately 30 feet bgs. Groundwater in the USAS is first encountered approximately 3 to 5 feet bgs and, therefore, the saturated thickness of the USAS is approximately 25 feet. Groundwater in the USAS is under unconfined conditions and the USAS is water table aquifer. The most recent groundwater levels measured at USAS monitoring wells in May 2005 were contoured on a site map (Figure 3). As shown on Figure 3, the water-table contours suggest that the regional hydraulic gradient direction in the USAS is primarily toward the north with localized radial groundwater flow patterns away from the Site toward the northwest, north, and northeast.

The USAS and LSAS are separated by a thin (one- to two-feet thick), partially cemented layer known as the "hard streak" that appears to serve as a confining layer. A hydraulic head difference of approximately 5 to 7 feet has been measured across the hard streak with a downward component of hydraulic gradient exists between the USAS and LSAS.

The LSAS is approximately 35 to 45 feet bgs; however, groundwater levels in LSAS monitoring wells rise to within approximately 5 to 10 feet bgs indicating the presence of artesian conditions in the LSAS at the Site. Based on the presence of the hard streak and artesian conditions in the LSAS, the LSAS is considered to be a confined aquifer. The most recent groundwater levels measured at LSAS monitoring wells in May 2005 were contoured on a site map (Figure 4). As shown on Figure 4, groundwater elevations for the LSAS suggest that the regional hydraulic gradient direction in the LSAS is primarily toward the North.

The LSAS is underlain by the Venice Clay, which is approximately 30 to 40 feet thick at the Site and surrounding areas. The Venice Clay is considered to be confining with respect to vertical groundwater flow between the LSAS and the IAS due to its fine-grained nature and thickness. It is unlikely that Site-related COCs have migrated through the Venice Clay under natural groundwater flow conditions. Rather, the hydrogeologic information for the Site indicates that Site-related COCs probably entered the IAS via vertical downward migration along the casings of unpermitted water supply wells in the area near the Site. From a groundwater remediation standpoint, it is necessary to properly abandon and seal water supply wells in the area near the Site.

Published transmissivity values for the SAS in south-central Manatee County have been estimated at approximately 1,000 to 2,000 square feet per day (ft^2/day), although in western and coastal Manatee County, published transmissivity values were as high as 7,000 ft^2/day, which is a function of the coarser nature of the sand interbedded with shelly limestones and shell fragments (SWFWMD, 1995). Based on this information, and assuming the total thickness of the SAS is approximately 40 feet, this would equate to hydraulic conductivity values for the SAS ranging from approximately 25 to 175 feet per day (ft/day).

2.3 Previous Site Assessment Activities and Interim Remedial Actions

Site assessment activities and IRAs have occurred at the Site since February 1997. These activities are described in detail in the various reports listed in Section 7, and are summarized in the following table.

Activity	Timeframe	Results/Outcome
Lockheed Martin acquired the Site from Loral Corp.	November 1996	--
Phase I Environmental Site Assessment	February 1997	21 potential sources of COCs were identified at the former ABC Site.
Preliminary Site Investigation	August 1997 – January 2000	Beryllium, arsenic, and total petroleum hydrocarbons (TPH) concentrations in on-site soil samples were reported above criteria.
Soil excavation/sump removal	January 2000	Building 5 sumps and soil were removed to limit direct contact.
Phase I Environmental Site Assessment	December 1999 – January 2000	--

Activity	Timeframe	Results/Outcome
Contamination Discovery Report	July 2000	Tetrachloroethene (PCE), Trichloroethene (TCE), 1,1-Dichloroethene (DCE), beryllium, and chromium concentrations in on-site groundwater samples were reported above criteria.
Contamination Assessment Report (CAR)	April 2001	14 monitoring wells installed and sampled. Extent of beryllium and chromium in groundwater was limited to the area near the former sumps. Volatile organic compounds (VOCs) including PCE, TCE, DCE, 1,1-Dichloroethane (DCA), and vinyl chloride in on-site groundwater samples were reported above criteria.
Source Removal Action	September 2001	538 tons of soil removed near the Building 5 sump areas.
Supplemental Groundwater Assessment	December 2001 – January 2002	Additional temporary on- and off-site monitoring wells installed and sampled. Results presented in Interim Data Report.
Interim Data Report	September 2002	Further assessment required to delineate off-site groundwater COC plume.
Delineation Investigation	December 2002 – March 2003	Additional off-site monitoring wells installed and sampled. Results presented in Final CAR.
Final CAR	May 2003	Additional groundwater sampling and site assessment activities. Further assessment required to delineate off-site groundwater COC plume.
Post-CAR Monitoring	September 2003 – March 2004	Additional groundwater sampling of SAS monitoring wells both on- and off-site.
Residential Well Sampling and Geophysical Logging	May 2004 – July 2004	Groundwater samples collected at 29 private wells. Geophysical logging performed at 22 private wells. 17 of 29 wells had COCs above criteria. Many private wells were constructed with "open hole conditions" from 26 to 233 feet bgs. The well casings were in poor and deteriorated condition. Some wells were being fully or partially recharged through corrosion holes in well casings. The wells were constructed without bentonite or sanitary seals.
FDEP Site Investigation Section (SIS) Report	July 2004	Geophysical logging, groundwater sampling, and soil sampling. Downward hydraulic gradient from SAS to IAS.
Site Assessment Report	January 2005	Additional assessment activities required to delineate off-site groundwater COC plume.
Site Assessment Report Addendum 1 (SARA 1)	April 2005	Additional assessment activities required to delineate off-site groundwater COC plume.
Site Assessment Report Addendum 2 (SARA 2)	August 2005	Additional assessment activities required to delineate off-site groundwater COC plume. See below for additional details.

The SARA 2 summarized additional site assessment data collected between approximately April and August 2005, and includes much of the data relied upon to develop this IRAP. Additional site assessment data used to develop this IRAP, which have been collected since the completion of SARA 2, are described below. As noted, this IRAP is focused at the source area of the Site and therefore only includes data collected on the Site and areas immediately surrounding the Site. The reader is referred to the SARA 2 and other reports listed in Section 7 to access all of the Site data collected to date, including data collected at off-site locations that are beyond the scope of this IRAP. Furthermore, a SARA 3 report will be submitted to FDEP that includes all site assessment data for both on-site and off-site locations.

Results and conclusions of the SARA 2 are summarized below:

- Site-specific COCs in groundwater identified in the Consent Order include PCE, TCE, DCE, DCA, and Cis-1,2-DCE. Subsequent to issuance of the Consent Order, 1,4-Dioxane has been added as a site-specific COC in groundwater.

- Concentrations of one or more COCs were found to be above groundwater cleanup target levels (GCTLs) in the USAS and LSAS.

- The potential current and future exposure to contaminated groundwater is limited due to the use of the public water supply by the residents living in the vicinity of the groundwater plume.

- Private wells that previously provided water are no longer in use. Public water service has been extended to all private well users within the groundwater plume area.

- Groundwater in the upper 10 feet of the saturated zone (i.e., USAS) contains very low concentrations of COCs; however, groundwater deeper than 10 feet in the USAS was found to contain elevated COC concentrations.

Based on the site assessment data collected through August 2005, the SARA 2 recommended that a RAP be prepared for the Site to address COC exceedances in the USAS, LSAS, and IAS. Since additional site assessment activities are required to fully delineate the off-site extent of the groundwater COC plume, Lockheed Martin intends to implement this IRAP at the Site source area and to address the full extent of the off-site plume in the Final RAP after the SARA 3 has been submitted and approved by the FDEP.

2.4 Nature and Extent of COCs in Groundwater

As discussed above, this IRAP is focused on hydraulic containment of the source area at the former ABC Site. This section summarizes the nature and extent of COCs in groundwater in the USAS and LSAS at the Site and its immediately surrounding areas. The nature and extent of COCs in the deeper aquifers (i.e., the IAS and FAS) and at off-site areas are still being delineated by means of additional site assessment activities, and will be addressed in the SARA 3 and Final RAP, which are being submitted separately.

The most recent groundwater analytical results for USAS and LSAS monitoring wells at the Site were collected in June and July 2005 and are shown on Figures 5 and 6, respectively, and summarized below. As shown, COCs were detected in SAS groundwater at the Site as follows:

COC	USAS Samples (Summer 2005)		LSAS Samples (Summer 2005)	
	Concentrations (µg/L)	Location of Highest Concentration	Concentrations (µg/L)	Location of Highest Concentration
PCE	ND (<0.5) – 347	MW-38	ND (<0.5) – 63	MW-87
TCE	ND (<0.5) – 3,160	MW-42	ND (<0.5) – 2,310	MW-37
Cis-1,2-DCE	ND (<0.5) – 133	MW-42	ND (<0.5) – 420	MW-79
1,1-DCE	ND (<0.5) – 253	MW-38	ND (<0.5) – 485	MW-80
1,1-DCA	ND (<0.5) – 123	MW-38	ND (<0.5) – 382	MW-78
1,4-Dioxane	ND (<2) – 46	MW-42	ND (<2) – 418	MW-33

Note: ND = non detect at the detection limit indicated in parentheses.

As shown on Figure 5 and in the above table, the highest COC concentrations in USAS groundwater during summer 2005 were detected in samples collected at monitoring wells MW-38 and MW-42. These wells are located southeast of Building 5, which is consistent with the location of the former sumps and is considered to be indicative of the source area targeted in this IRAP.

As shown on Figure 6 and in the above table, the highest TCE concentration in LSAS groundwater during summer 2005 was detected in a sample collected at monitoring well MW-37. This well is also located near the former sumps associated with the southeast corner of Building 5.

The highest concentrations of other COCs in LSAS groundwater during summer 2005 were found in samples collected at various monitoring wells both on- and off-site, and did not appear to be correlated with the source area near the southeast corner of Building 5. For example, the highest PCE concentration in LSAS groundwater during summer 2005 was detected in a sample collected at monitoring well MW-87 located on the adjacent golf course. The highest cis-1,2-DCE concentration in LSAS groundwater during summer 2005 was detected in a sample collected at monitoring well MW-79 which is located east-northeast of the Site adjacent to the Seminole-Gulf Railway. The highest 1,1-DCE concentration in LSAS groundwater during summer 2005 was detected in a sample collected at monitoring well MW-80 which is located adjacent to the Site storm water retention pond. The highest 1,1-DCA concentration in LSAS groundwater during summer 2005 was detected in a sample collected at monitoring well MW-78 which is located off-Site to the south. The highest 1,4-dioxane concentration in LSAS groundwater during the summer 2005 was detected in a sample collected at monitoring well MW-33 which is located in the southern portion of the Site.

2.5 Additional Data Collected Since SARA 2

Pre-design data have been collected since August 2005 during the performance of pumping tests and the completion of remedial pilot studies. Results of these studies were used to prepare this IRAP, refine the BOD, and design the groundwater PAT system. These studies are described below.

In accordance with the RAWP, TetraTech conducted two pumping tests at the Site in September 2005. The first was a 48-hour pumping test in the USAS and the second was a 24-hour pumping test in the LSAS. The purpose of the pumping tests was to collect Site-specific pre-design hydrogeological data to support the preparation of the Final RAP for the area. The potential for PAT (i.e., groundwater extraction) to remove contaminant mass from the affected aquifer zones within the SAS, and to contain and mitigate plume migration was evaluated. Data collected during the pumping tests was used to support the BOD presented in Section 3 of this IRAP. Specifically, pumping test data were used to:

- Design the groundwater extraction wells and estimate groundwater extraction rates for the USAS and LSAS (Section 3.1.1);

- Provide a preliminary estimate of the extent of the capture zones in the USAS and LSAS that may be created during operation of this IRAP (Section 3.1.2); and

- Provide a basis for designing the water treatment system (Section 3.1.3).

During each pumping test, extracted groundwater was collected into a 6,000 gallon tank. Prior to treatment of groundwater within the on-site UVOx pilot system, periodic samples were collected and analyzed for COCs. Additionally, samples of the treated discharge from the UVOx unit were collected during its operational period and analyzed for COCs. A sample of extracted water was also sent off-site for a bench-scale test using an AOP.

The groundwater quality results, pumping test data, and associated design analyses are provided in Appendix B.

2.6 NAPL Evaluation

This section presents an evaluation of the potential for NAPL to be present in the subsurface at and near the Site. This is important because if subsurface NAPL enters the proposed groundwater PAT system it could potentially hinder the effectiveness of the pumping and treatment equipment. Therefore, an evaluation of the potential for NAPL is warranted.

Results indicate that even though NAPL has never been directly observed in any soil or groundwater samples collected during Site assessment or pre-design activities, NAPL potentially exists within a limited portion of the USAS near the source area associated with the southeast corner of Building 5. This conclusion is based on groundwater samples collected during site assessment and pre-design activities. The data suggest that if NAPL is present in the USAS near the source area, then it probably exists as small, disconnected ganglia that are no longer mobile under natural hydraulic gradients and will probably not enter the PAT system. Nonetheless, the IRAP includes provisions to monitor the groundwater PAT system for the presence of NAPL.

This NAPL evaluation considered two types of site assessment (or pre-design) data:

1. Observations of NAPL or sheens in soil and groundwater samples collected during site assessment activities or the absence thereof; and

2. Groundwater samples with concentrations of COCs in excess of 1% of associated solubility limits.

To supplement the first data type, TetraTech used a specialized NAPL-detection technology called the Flute™ method during completion of SARA 1 field activities. The Flute™ method involves the use of a proprietary Flute™ Liner that is placed in contact with soil in-situ during drilling. A NAPL-sensitive dye on the Flute™ Liner will visibly change color if NAPLs come in contact with the dye thereby indicating the presence of NAPL. As reported in the SARA 1, no NAPL was visually observed or detected by the Flute™ test during SARA 1 field activities.

Based on the first data type, NAPL has never been directly observed in any soil or groundwater samples collected during Site assessment activities. Therefore, there is no direct evidence that NAPL exists in the subsurface.

Using the second data type, there is some potential for NAPL to exist in a limited area within the USAS. The following table provides COC solubility limits and summarizes the highest COC concentrations detected in groundwater samples collected at and near the Site during the completion of SARA 2 and pre-design field activities:

COC	Solubility Limit[1] (mg/L)	1% of Solubility[2] (mg/L)	Highest Concentrations Detected in Site Samples (mg/L)	Result
PCE	150	1.5	0.35 (MW-38, USAS, June/July 2005) 0.06 (MW-87, LSAS, June/July 2005)	NAPL probably not present
TCE	1,100	11	11 (USAS Pumping test, Sept 2005) 2.3 (MW-37, LSAS, June/July 2005)	NAPL potentially present
Cis-1,2-DCE	3,500	3.5	0.13 (MW-42, USAS, June/July 2005) 0.42 (MW-79, LSAS, June/July 2005)	NAPL probably not present
1,1-DCE	250	2.5	0.25 (MW-38, USAS, June/July 2005) 0.49 (MW-80, LSAS, June/July 2005)	NAPL probably not present
1,1-DCA	5,060	5.1	0.12 (MW-38, USAS, June/July 2005) 0.38 (MW-78, LSAS, June/July 2005)	NAPL probably not present
1,4 Dioxane	Miscible	Not Applicable	0.05 (MW-42, USAS, June/July 2005) 0.99 (LSAS pumping test, Sept 2005)	Inconclusive

Notes: [1] Howard, 1991. [2] USEPA suggests that NAPL may be present if the chemical concentration exceeds 1% of its solubility (USEPA, 1992). mg/L = milligrams per liter.

As indicated in the table above, samples of un-treated USAS groundwater collected during the pumping test were found to contain TCE at concentrations that are approximately 1% of TCE's solubility limit. Additionally, some discrete-interval groundwater samples collected from the USAS in the source area during completion of SARA 1 field activities (TetraTech, 2005) and one groundwater sample collected from a USAS monitoring well in the source area during completion of the Preliminary Contamination Assessment Report (FDEP, 2004) also were found to contain some COCs at concentrations approaching or exceeding 1 % of their solubility limits. None of the groundwater samples collected from the LSAS have been found to contain COCs at concentrations exceeding 1 % of their solubility limits. Based on this information, it is concluded that NAPL is potentially present in the USAS within a limited area near the southeast corner of Building 5.

2.7 Rationale for Technology Selection

2.7.1 Evaluation of Remedial Alternatives

This section presents the evaluation of remedial technologies for the Interim Remedial Action (IRA) at the Site. This evaluation was also included in TetraTech's July 2005 RAWP. The technologies considered effective for the treatment of COCs present at the Site were considered further for the bench/pilot scale studies, as detailed in Section 2.7.2.

2.7.1.1 Air Stripping

Air stripping involves the mass transfer of VOCs from water to air. This process is typically conducted in packed towers or using lower-profile perforated trays. These units include a spray nozzle at the top, a fan to force air countercurrent to the water flow, and a sump at the bottom to collect treated water. Auxiliary equipment that can be added to the basic air stripper include a feed water heater and an air heater to improve removal efficiencies; automated control systems with sump level switches and safety features such as differential pressure monitors, high sump level switches and explosion proof components; and discharge air treatment systems such as activated carbon units, catalytic oxidizers, or thermal oxidizers. Air strippers are installed either as permanent installations on concrete pads, as temporary installations on skids, or on trailers.

The air stripping technology is effective for treating VOCs in groundwater; however, air stripping does not remove 1,4-dioxane from groundwater and there would be an air emission. Therefore, this technology was not evaluated further.

2.7.1.2 Liquid Phase Carbon Adsorption

Liquid-phase carbon adsorption is a technology in which groundwater is pumped through a series of vessels containing activated carbon to which dissolved organic compounds adsorb. When the concentration of compounds in the effluent from the bed exceeds a certain level, the carbon can be regenerated in place, removed and regenerated at an off-site facility, or removed and taken off-site for disposal. Adsorption by activated carbon has a long history of use in treating municipal, industrial, and hazardous wastes.

The liquid-phase carbon adsorption is effective for the treatment of highly substituted organic compounds with low aqueous solubility, including TCE and PCE. However, as the solubility of the organic compounds increases, carbon adsorbability decreases. The liquid-phase carbon adsorption will be used as a polishing step to a primary treatment technology (advanced oxidation) in the IRA.

2.7.1.3 In-Situ Reductive Dechlorination

In-situ reductive dechlorination (abiotic and biotic processes) of chlorinated aliphatic compounds can occur by several abiotic and biotic reductive pathways. Hydrogenolysis or reductive dehalogenation is the primary pathway where complete dechlorination occurs in a sequential manner where a hydrogen ion replaces a chloride ion and daughter products are formed. A second primary pathway is called reductive β-elimination process where chlorinated compounds form degradation products in the acetylene group. Other less significant pathways include degradation via hydrogenation and dehydrohalogenation.

Nanoscale Fe (0) particles (both with and without a noble metal catalyst) have been shown to effectively treat groundwater contaminated with numerous chlorinated VOCs under saturated conditions in both laboratory and field-based studies. Nanoscale iron particles are defined as Fe (0) particles that are within 50 to 300 nanometers (nm or 10^{-9} meter) in diameter. Smaller in diameter than colloids or bacteria, these particles are approximately the same size as viruses or large molecules. These laboratory-synthesized particles may or may not contain a trace coating of noble metal catalyst [generally palladium (Pd), platinum (Pt) or other metal]. With one of these catalysts, the particles are commonly referred to as bimetallic nanoparticles. Nanoscale particles provide a versatile remediation tool due to their extremely small particle size, which allows an iron-water suspension to be readily injected into the subsurface where contaminants are present. It has been shown that some particles flow with groundwater and remain in suspension for extended periods of time, while others are filtered out and adhere to the soil matrix to establish an in-situ treatment zone favorable for source remediation and emanating plumes. A substantial body of research on the Fe (0) abiotic destruction of chlorinated alkenes suggests that the reactions are surface-mediated. The high reactivity of the particles is directly related to their extremely high specific surface area. A benefit of Fe (0) is that the generation of strong reducing conditions and hydrogen gas foster anaerobic microbial growth and increase natural biological degradation in the field.

Pilot and full-scale demonstrations have revealed that the addition of biodegradable organic substrates can also stimulate the anaerobic biodegradation of VOCs in contaminated aquifers. The addition of soluble and slow release organic substrates to groundwater can accelerate the natural anaerobic biodegradation of the chlorinated hydrocarbons. Several vendors have developed edible oil (e.g., vegetable oil or soybean oil) products for injection into groundwater. Since the injected substrate is an oil, its biodegradation rate is limited by its slow dissolution into groundwater. In addition to their slow release properties, edible oils contain more energy per mass and sustain biodegradation reactions. Other electron donors that can be injected into the aquifer for anaerobic biodegradation of VOCs include lactate and molasses.

Numerous studies have shown that reductive dechlorination of PCE or TCE stalls with the production of cis-1,2-DCE in the absence of certain microbes (i.e., *Dehalococcoides ethenogenes*). In these cases, bioremediation of chlorinated VOCs may be enhanced by the addition of microbes in the groundwater to complete the reductive dechlorination pathway.

While in-situ reductive dechlorination may be part of the Final Remedy for the site, it will not be included as part of the IRA. Due to the need to effect groundwater cleanup as quickly as possible at the Site, in-situ reductive dechlorination was not selected for use during the IRA.

2.7.1.4 Enhanced Bioremediation

Although the available data indicate that 1,4-dioxane is not appreciably removed in conventional biological treatment systems, recent research suggests that high 1,4-dioxane removal efficiencies can be achieved in modified biological processes. The biodegradation of 1,4-dioxane was investigated by electrolytic respirometery using activated sludge with prior exposure to 1,4-dioxane to seed the reactor. After an adaptation period of 32 days, 150 mg/L of 1,4-dioxane was biodegraded to below detection. However, at higher initial concentrations, biodegradation was incomplete suggesting inhibition from byproducts.

In another study, a continuous flow attached-growth reactor was used to develop a mixed culture that could biodegrade 1,4-dioxane as the sole carbon and energy source. It was determined that the micro-organisms responsible for 1,4-dioxane biodegradation belonged to the genus Rhodococcus. The culture was enriched for approximately 6 months and had a maximum specific growth rate of 0.103 day^{-1} and a half-saturation constant of 180 mg/L as chemical oxygen demand. The 1,4-dioxane biodegradation rate was highly dependent on temperature, with the optimum growth rate occurring at 35 degrees Celsius (°C). In subsequent work, a fluidized bed reactor consistently treated an influent stream containing 100 mg/L of 1,4-dioxane to below 1 mg/L. Due to the slow growth rates, long residence times were required to achieve satisfactory removal. It was also found that the culture developed required high temperature (35 °C), long residence times, and high initial 1,4-dioxane concentrations to achieve significant removal.

Aerobic cometabolism is a promising technology for the in-situ remediation of chlorinated aliphatic hydrocarbons and 1,4-dioxane. This task is complicated by the complexity of the cometabolic process and the different cometabolic substrates (propane, butane, etc.) from which to choose. The target compounds and their concentrations are also important considerations, along with the transformation abilities of the indigenous microorganisms that are stimulated on a specific substrate.

While enhanced bioremediation may be part of the Final Remedy for the site, it will not be included as part of the IRA. Due to the need to effect groundwater cleanup as quickly as possible at the Site, enhanced bioremediation was not selected for use during the IRA.

2.7.1.5 Advanced Oxidation

Advanced Oxidation or AOP uses the hydroxyl radical as an oxidant and can achieve substantial reductions in 1,4-dioxane and VOCs. Ultraviolet (UV) light is also commonly used as an AOP. However, 1,4-dioxane is a relatively weak absorber of UV light and, thus, poorly degraded by direct photolysis. UV light can be used in combination with peroxide (H_2O_2) and/or ozone (O_3), however, to produce hydroxyl radicals that react with 1,4-dioxane. It has been determined that the degradation kinetics of 1,4-dioxane exposed to UV/H_2O_2 treatment followed first-order kinetics and achieved a 90% reduction in 1,4-dioxane in 5 minutes. The pH of the solution decreased from 5 to 3 during treatment due to the formation of organic acids.

In related work, it was found that sodium peroxydisulfate combined with UV light was more effective in degrading 1,4-dioxane than UV light with H_2O_2. 1,4-Dioxane was observed to degrade faster at higher pH values. UV, in combination with a titanium dioxide (TiO_2) catalyst, has also been demonstrated to degrade 1,4-dioxane. A 99% reduction in 1,4-dioxane was achieved using wavelengths greater than 300 nm.

Hydrogen peroxide can also be used in combination with ferrous ion (Fenton's reagent) to degrade 1,4-dioxane. A 97% reduction in 1,4-dioxane was observed in the experiments after 10 hours of incubation in Fenton's reagent with a 12:1 ratio of H_2O_2 to 1,4-dioxane.

There are several different AOPs that are commercially available for the treatment of 1,4-dioxane and VOCs that use combinations of H_2O_2, O_3, and UV light. Two AOPs for the treatment of 1,4-dioxane and chlorinated VOCs were further evaluated during pilot testing. These are discussed further in Section 2.7.2.

2.7.1.6 Monitored Natural Attenuation

Natural attenuation allows for biological processes and physical processes, such as dispersion, sorption, and dilution, to reduce chemical concentrations. Chlorinated compounds can be biologically degraded by anaerobic microorganisms. However, this process requires a carbon source. Often, naturally-occurring carbon is present in sufficient quantities to sustain the biological activity. In many cases, a coincidental fuel release contributes the carbon.

These natural processes may take many years. Groundwater modeling is often performed to estimate the time to reach cleanup goals throughout the plume. When natural attenuation is used as a remedial approach, long-term monitoring is required to track the changes in plume concentrations and to evaluate changes in geochemical conditions.

Off-site COC concentrations are all relatively low and the existing natural attenuation data suggests that biological reduction is occurring. Therefore, monitored natural attenuation may be a viable remedial alternative for off-site portions of the plume, and will be considered in the Final RAP. Typically, a monitored natural attenuation approach is used in conjunction with another source treatment technology such as PAT. Thus, monitored natural attenuation will not be included as part of the IRA but will be carefully considered in the Final RAP for off-site control.

2.7.2 Pilot Study Results

This section discusses the bench scale/pilot testing of treatment technologies selected in Section 2.7.1 for further evaluation for the treatment of site COCs. The bench scale/pilot test for the COCs in each aquifer zone are discussed below. To ensure security of the pilot test equipment and limit, to the extent practicable, potential impact to the surrounding community, the pilot tests were conducted within the boundaries of the former ABC Site. The property is completely fenced with locked gates so access to the pilot test locations was controlled.

The following two tests were conducted to determine the most efficient and cost-effective AOP technology for the treatment of contaminants present at the Site:

- Field pilot test conducted by Purifics ES, Inc. (Purifics); and

- Bench scale test conducted by Applied Process Technology, Inc. (APT).

These tests are described in the following subsections.

2.7.2.1 UVOx Pilot Test (Purifics)

To aid in the process design, a pilot test utilizing the UVOx treatment process was conducted on-site. The pilot test verified the effectiveness of the UVOx treatment process in treating 1,4-dioxane and VOCs in groundwater at the former ABC Site.

A mobile pilot test unit that utilizes UVOx treatment technology with a patented closed-loop TiO_2 slurry-based photocatalytic process was used for the pilot testing using site groundwater. The pilot test unit is a smaller scale version of the Photo-Cat system manufactured by Purifics.

Other organic and inorganic constituents in site groundwater were investigated as to assess whether they interfere with the UVOx process, reduce the treatment efficiency, or even prohibit its use. If these deteriorating conditions existed, modifications to the treatment process, such as adding pre- and/or post-treatment, would be considered. The pilot test provided baseline design and operating parameters for a full-scale treatment system.

To safeguard the environment, the mobile pilot test unit was equipped with influent/effluent storage tanks, a pre-treatment filtration unit, and a post-treatment carbon adsorption unit. The pilot treatment unit operated at various flow rates ranging from 2.6 to 5.0 gpm. Influent, effluent, and intermediate samples were collected at critical points of the pilot test system and analyzed throughout the pilot test period to verify the input and output conditions.

Adjustments of the pilot test unit, such as residence time, dosage, etc., were conducted by Purifics to optimize its performance. Design information and operating data were collected. A test report prepared by Purifics and an analytical data report from KB Labs, Inc. are presented in Appendix C.

2.7.2.2 Advanced Oxidation Process Bench Scale Test (APT)

APT's HiPOx™ technology is a continuous, in-line, at-pressure AOP for the destruction of waterborne VOCs and 1,4-dioxane. The process uses O_3 and H_2O_2 chemistry in a uniquely designed oxidation reactor. The reactants are injected directly into the water stream in precisely controlled ratios and locations, generating hydroxyl radicals, which are powerful oxidizers. These hydroxyl radicals attack the bonds in the organic molecules, progressively oxidizing these compounds and any resulting intermediate by-products until the basic atoms ultimately recombine into benign end-products of carbon dioxide (CO_2), water (H_2O), and salts.

This application is best served by a HiPOx Cabinet Unit (HCU) configured with an O_3 generator. The HCU includes a H_2O_2 storage and delivery system, oxygen delivery system, O_3 generation and delivery system, integrated control system, and process cooling system. The reactor skid included plug-flow reactors, O_3 and H_2O_2 injectors, and gas/liquid separation system.

To confirm efficacy and to design a full scale system for a particular application, a bench scale reactor was used to validate HiPOx performance. Approximately 2.5 gallons of representative groundwater were collected and shipped to the APT facility in California. Typically, two or three runs of a given sample were made at differing O_3 and H_2O_2 dosages. During the tests, analytical samples were drawn from the raw sample and at the end of each run. This method generated several destruction points that, when taken together, defined the HiPOx system's destruction characteristics. This data was used to model the design and performance of the full scale system. A test report prepared by APT, including analytical data from Accutest Laboratories, is presented in Appendix C.

2.7.3 Selected Remedial Alternative

Groundwater PAT utilizing an advanced oxidation water treatment process has been selected as the remedial approach for the IRA. This is based on site conditions, the CSM, the evaluation of remedial alternatives, and applicable bench-scale and pilot study testing as presented herein. Table 1 presents a summary of the required evaluation criteria for the selected remedial alternative as specified in Chapter 62-780.700(3)(d)(2) items a through g, F.A.C.

3. Basis of Design

This BOD describes the selected remedial alternative for the IRAP, which consists of a PAT system. The BOD was based on Site assessment data presented in SARA 2, other reports listed in Section 7, and pre-design data collected during remedial pilot studies. The BOD also includes discussions of target cleanup levels, disposition of treated effluent, performance objectives, and cessation criteria. This BOD is based on the conceptual BOD submitted to FDEP in December 2005 (BBL, 2005).

3.1 Description of the IRAP

The layout of the proposed IRA system is shown on Figure 7. A conceptual hydrogeologic cross section of the proposed IRA is shown on Figure 8. As shown, a total of eight groundwater extraction wells will be installed around the Site source area including four extraction wells in the USAS and four in the LSAS. Extracted groundwater will be conveyed to the treatment compound via underground piping. Treated water will be transferred to the POTW via underground piping.

3.1.1 Extraction Well Design

The locations of proposed extraction wells are shown on Figure 7. The rationale for these locations is as follows:

- Proposed Extraction Location A: This extraction well pair will provide hydraulic containment at the source area, remove COC mass from the USAS and LSAS, and limit the potential for groundwater with high COC concentrations to migrate off-site toward the north and northeast. These wells will be installed initially and tested during startup of the treatment system.

- Proposed Extraction Location B: This extraction well pair will provide hydraulic containment at the source area, remove COC mass from the USAS and LSAS, and limit the potential for groundwater with high COC concentrations to migrate off-site. These extraction wells will also be installed initially and tested during startup of the treatment system.

- Proposed Extraction Location C: This extraction well pair will provide hydraulic containment at the source area, remove COC mass from the USAS and LSAS, and limit the potential for groundwater with high COC concentrations to migrate off-site toward the east and southeast. These extraction wells will be installed after startup and testing of the treatment system. Extraction well locations are subject to change pending results obtained during startup and testing. For example, it may be beneficial to move one or both proposed extraction wells to the South in an effort to increase the capture zone in that direction.

- Proposed Extraction Location D: This extraction well pair will provide hydraulic containment at the source area, remove COC mass from the USAS and LSAS, and limit the potential for groundwater with high COC concentrations to migrate off-site toward the north and northwest. Similar to the Location C extraction well pair, the Location D extraction wells will be installed after startup and testing of the treatment system, and locations are subject to change pending results obtained during startup and testing. For example, it may be beneficial to move one or both proposed extraction wells to the west in an effort to increase the capture zone in that direction.

The extraction wells will consist of 5-inch-diameter Schedule 40 (Sch. 40) polyvinyl chloride (PVC) well materials designed to screen the USAS or LSAS. The extraction wells will include a five-foot section of blank casing below the target screened interval to house the pumps, allow for maximum drawdown in the well, and provide a sump to monitor for dense NAPL in case mobile NAPL enters the extraction well. The screen slot size will be determined based on grain size characteristics of aquifer samples collected during drilling.

Extraction well design parameters for the USAS extraction wells are as follows:

Design Parameters for Proposed Extraction Wells in the USAS		
Design Parameter	**Value**	**Basis/Comments**
Number of extraction wells	4	Rationale provided above. Locations shown on Figure 7.
Total depth (ft bgs)	35	Approximate depth of USAS. May be adjusted in the field based on geologic conditions encountered during drilling. Includes 5-feet of blank casing below screened interval.
Screened interval (ft bgs)	5 – 30	Entire saturated thickness of aquifer. May be adjusted in the field based on geologic conditions encountered during drilling.
Well materials	Sch. 40 PVC	Based on durability, strength, and compatibility with USAS geochemistry.
Groundwater extraction rate (gpm per well)	3 - 5	USAS pumping test was performed at 3 gpm with approximately 20 feet of drawdown.
Total extraction rate (gpm – all USAS wells)	12 – 20	--
Well diameter (inches)	5	Appropriate for pump size.
Borehole diameter (feet)	2	Increase well efficiency relative to smaller borehole diameter.
Screen slot width	TBD*	Aquifer soil samples will be collected during drilling and analyzed for grain size distribution (GSD). Screen slot width will be determined after receipt of GSD data.
Filter material	TBD	Will be selected in conjunction with screen slot width.
Blank casing below well screen (feet)	5	Blank casing will be installed below the screened interval to allow for maximum drawdown in the well, and also to allow for monitoring/removal of NAPL, if present. The hardstreak interval will be sealed with grout.

* To be determined.

Extraction well design parameters for the LSAS extraction wells are as follows:

Design Parameters for Proposed Extraction Wells in the LSAS		
Design Parameter	**Value**	**Basis/Comments**
Number of extraction wells	4	Rationale provided above. Locations shown on Figure 7.
Total depth (ft bgs)	45	Depth of LSAS. May be adjusted in the field based on geologic conditions encountered during drilling. Includes 5-feet of blank casing below screened interval.
Screened interval (ft bgs)	35 – 40	Entire saturated thickness of aquifer.
Well materials	Sch. 40 PVC	Based on durability, strength, and compatibility with LSAS geochemistry.
Groundwater extraction rate (gpm per well)	5 – 10	LSAS pumping test was performed at 5 gpm with approximately 15 feet of drawdown.
Total extraction rate (gpm for all 4 wells)	20 – 40	--
Well diameter (inches)	5	Appropriate for pump size.
Borehole diameter (feet)	1	Increase well efficiency relative to smaller borehole diameter.
Screen slot width	TBD*	Aquifer soil samples will be collected during drilling and analyzed for GSD. Screen slot width will be determined after receipt of GSD data.
Filter material	TBD	Will be selected in conjunction with screen slot width.
Blank casing below well screen (feet)	5	Blank casing will be installed below the screened interval to allow for maximum drawdown in the well, and also to allow for monitoring/removal of NAPL, if present. The blank casing below the screen will be encased in grout.

* To be determined.

3.1.2 Capture Zone Analysis

A preliminary estimate of the extent of the hydraulic containment zones (also known as "capture zones") associated with the operation of this IRAP is provided in Appendix B. As discussed in Appendix B, the estimate of the USAS capture zone was based on extrapolating aquifer pumping test data to 90 days for the USAS in which continued drawdown was observed during the later stages of the pumping test. No extrapolation of pumping test results was used in the analysis of the LSAS capture zone. Rather the LSAS capture zone analysis was based on the predicted capture zone created after approximately 1 day of pumping. It should be noted that these estimates were based on the best available information at the time this report was prepared, and that the actual shape of the capture zones under pumping conditions will likely change with time. Early-time capture zones (i.e., less than one day after pumping) will likely be somewhat smaller than estimated herein for the USAS, and late-time capture zones (i.e., more than three months after pumping) will likely be somewhat larger than estimated herein for both the USAS and LSAS.

As shown on Figure B-5 in Appendix B, the estimated extent of the capture zone within the USAS associated with this IRAP encompasses the source area at Building 5 (former sumps), the area of the USAS where NAPL may potentially be present based on COC concentrations (see Section 2.6), and the area of the USAS containing the highest COC concentrations near monitoring wells MW-38 and MW-42. Furthermore, the pumping test data suggest that the capture zone within the USAS will extend off-site to the north, south and east of the Site to some extent.

As shown on Figure B-6 in Appendix B, the estimated extent of the capture zone within the LSAS associated with this IRAP encompasses the source area at Building 5 and the area with the highest TCE concentrations in the LSAS near monitoring well MW-37. As with the USAS, it is anticipated that the capture zone within the LSAS associated with this IRAP will extend off-site north, south and east.

The actual capture zones developed in the USAS and LSAS under pumping conditions will be monitored on a regular basis during operation of the IRAP using groundwater level measurements obtained during effectiveness monitoring.

3.1.3 Influent Concentrations

The influent concentrations are estimated from the analytical results of groundwater samples collected during summer 2005 and pumping tests conducted in September 2005 by TetraTech. Separate pumping tests were conducted in the USAS and LSAS. Based on these analytical results, the key treatment system design constituents were identified to be TCE and 1,4-dioxane. While additional VOCs were present at lower concentrations in the sampled groundwater, TCE and 1,4-dioxane were identified as the key constituents based on concentrations and required treatment process.

During the pumping tests, USAS data reported a maximum TCE concentration of 11 mg/L and a maximum 1,4-dioxane concentration of 0.3 mg/L. LSAS data reported a maximum TCE concentration of 1 mg/L and a maximum 1,4-dioxane concentration of 1 mg/L. However, to account for relatively low levels (0.2 mg/L or less) of other VOCs and that it is improbable that there will be a 50-50 blend of water from the upper and lower surficial aquifers, the anticipated influent concentrations of the key parameters are presented below.

Parameter	Unit	Concentration
TCE	mg/L	10
1,4-Dioxane	mg/L	0.75

These concentrations are greater that the highest COC concentrations in USAS and LSAS groundwater during summer 2005 (see Section 2.4).

Data reported by FDEP in the Preliminary Contamination Assessment Report dated July 2004 indicated the presence of dissolved phase TCE in source area groundwater at concentrations above 1% of solubility, suggesting the potential presence of residual non-aqueous phase liquid. However, no direct observations of NAPL have been reported and NAPL is not expected to be encountered during groundwater treatment activities.

3.1.4 Groundwater Extraction and Treatment System

The groundwater extraction and treatment system is described in this section. Design data, including calculations and equipment literature, is presented in Appendix D. The proposed IRA process flow diagram and treatment compound layout are shown on Figures 9 and 10, respectively.

3.1.4.1 Extraction Well Pumps

Groundwater with dissolved VOCs will be extracted from eight on-site extraction wells, including four screened in the USAS and four screened in the LSAS. Groundwater will be extracted from each well in the USAS using a Grundfos Model 5S03-9-1/3 (1/3 horsepower [hp]) submersible pump. These pumps are designed to operate at a flowrate of approximately 5 gpm each. Groundwater will be extracted from each well in the LSAS using a Grundfos Model 10S03-6-1/3 (1/3 hp) submersible pump. These pumps are designed to pump a flowrate of approximately 10 gpm each. The total anticipated flowrate is up to 60 gpm.

Equipment

1. Submersible Well Pumps (USAS)

Manufacturer:	Grundfos, or equal
Model:	5S03-9-1/3
Type:	Submersible
Quantity:	4
Horsepower:	1/3
Flowrate:	5 gpm each

2. Submersible Well Pumps (LSAS)

Manufacturer:	Grundfos, or equal
Model:	10S03-6-1/3
Type:	Submersible
Quantity:	4
Horsepower:	1/3
Flowrate:	10 gpm each

3.1.4.2 Influent Tank

The extraction well pumps will pump to a baffled influent tank. The influent tank will not only provide storage capacity but it will also entrap NAPL in the unlikely even that it is encountered. The influent tank will be a baffled tank manufactured by Baker Tanks and have a storage capacity of 21,000 gallons. Transfer pump operation will be controlled from a level sensor in the influent tank. The tank will also be equipped with a high level alarm which will shut down the extraction well pumps upon activation and a low level alarm which will shut down the transfer pump to prevent it from running dry.

Equipment

1. Influent Tank

Manufacturer:	Baker Tanks, or equal
Model:	Frac Tank
Storage Capacity:	21,000 gallons
Materials of Construction:	Carbon Steel

3.1.4.3 Bag Filters

Following the influent tank, groundwater will be pumped through a bag filter skid for primary filtration. The bag filter skid will consist of two bag filter housings in parallel containing 25 micron bag filters, followed in series by two bag filter housings containing 10 micron bag filters. The bag filter skid will be a Carbonair Model 88 bag filter housing with differential pressure gauges to measure bag filter fouling.

Equipment

1. Bag Filters

Manufacturer:	Carbonair, or equal
Model:	88 Duplex
Surface Area:	8.8 cubic feet
Materials of Construction:	Carbon Steel

3.1.4.4 Advanced Oxidation

After primary filtration, the VOCs in the groundwater will be treated via an AOP. Based on performance during the field pilot test and other advantages discussed below, a Photo-Cat water treatment system manufactured by Purifics was selected. The VOCs in the groundwater are destroyed when the groundwater is mixed with a TiO_2 slurry and exposed to UV light in the reactor. This photocatalytic process purifies or detoxifies the groundwater resulting in benign end-products of CO_2, H_2O and salts. No daughter products of the COCs (e.g., vinyl chloride) are generated during this process.

The Photo-Cat is designed to operate continuously with minimal operator attention. The process is fully automated, sealed, and generates no waste stream, including air emissions. The Photo-Cat also contains a fully integrated programmable logic controller (PLC) based operating system. This operating system will control the entire treatment system controls and alarms.

Equipment

1. Advanced Oxidation

Manufacturer:	Purifics
Model:	Photo-Cat

3.1.4.5 Granular Activated Carbon Vessels

The treated groundwater will go through a granular activated carbon (GAC) vessel for tertiary treatment or polishing. The GAC vessel will be a Carbonair Model LPC 9 liquid-phase carbon adsorber with 1,500 pounds of virgin carbon. Following treatment, the groundwater will be discharged to the Manatee County POTW as discussed in Section 3.1.5.

Equipment

1. GAC Vessel

Manufacturer: Carbonair, or equal
Model: LPC 9
Carbon Capacity: 1,500 lbs
Carbon Type: Virgin
Max. Pressure: 15 pounds per square inch (psi)

3.1.4.6 Treatment System Enclosure

The groundwater treatment system equipment will be housed in a fixed canopy structure. The canopy structure will provide protection against rain and sun, and will be approximately 35 feet long by 15 feet wide. The structure will be designed in accordance with applicable local and State of Florida building codes.

3.1.5 Disposition of Effluent

Recovered groundwater will be treated on-site via primary filtration, advanced oxidation, and carbon polishing. Following treatment, the groundwater will be discharged to the Manatee County POTW through an on-site connection to the sanitary sewer. This option for discharge of treated groundwater was selected due to anticipated quicker timeframe to obtain approval compared to other potential alternatives.

Manatee County Utility Operations (MCUO) is currently in discussion with the FDEP to develop criteria for new industrial or remediation wastewaters that is accepted into the County's sanitary sewer system. Manatee County's current policy is that any new industrial or remediation wastewaters discharged to the County's sanitary sewer must be approved through a Manatee County Government Wastewater Discharge Permit Application (permit application).

Based on initial discussions with MCUO, any treated water discharged to the Manatee County POTW would be subject to the general chemistry and metals criteria outlined below.

Parameter	Unit	Effluent Concentration
General Chemistry		
pH	SU	6.5 – 8.5
Total Suspended Solids	mg/L	1,830
BOD (5-day)	mg/L	7,290
Metals		
Arsenic	mg/L	2.51
Chloride	mg/L	287
Cadmium	mg/L	0.73
Chromium (total)	mg/L	9.90
Copper	mg/L	28.48
Cyanide	mg/L	4.70
Lead	mg/L	1.87
Mercury	mg/L	0.38

Parameter	Unit	Effluent Concentration
Metals (Cont'd)		
Molybdenum	mg/L	1.26
Nickel	mg/L	11.08
Selenium	mg/L	2.11
Silver	mg/L	16.06
Zinc	mg/L	4.78

Currently, VOC discharge limits have not yet been established. These limits will be discussed and established during the permitting process. However, advanced oxidation and carbon polishing will be adequate to treat the impacted groundwater to VOC levels set forth by MCUO. This IRAP is being submitted in conjunction with the completion of the permit application process.

3.1.6 Process and Instrumentation

The groundwater extraction and treatment system will be designed to run continuously without any daily operator attention. The control system will be PLC based and monitor key treatment system parameters. These parameters will include influent tank level, process flowrate, differential pressure across the bag filters, Photo-Cat system alarms, and pump operation. The system parameters and alarms will be able to be remotely monitored via computer to computer software such as PCAnywhere. This will allow the operation of the treatment system to be monitored without an operator being onsite, remotely troubleshoot the treatment system, and remotely shutdown the treatment system. When operating parameters are out of the operating range, the treatment system will automatically shutdown.

The influent tank will be equipped with an ultrasonic level transmitter. This level transmitter will not only control the operation of the process pump but will also signal high and low level alarms to the PLC. The bag filter housings will be equipped with local pressure gauges before and after each unit. The bag filter housing will also have a differential pressure switch which will signal alarm to the PLC upon high differential pressure. The Photo-Cat system will be equipped by the manufacturer with applicable process instrumentation and alarms. The Photo-Cat parameters will be monitored via the PLC control system. The GAC vessel will have a local pressure gauge to monitor fouling of the carbon.

3.1.7 Air Emissions

Air emissions will not be generated by this treatment system.

3.2 Cleanup Target Levels

Cleanup target levels for COCs in Site groundwater are specified in Chapter 62-780.700, F.A.C. as follows:

Chemical of Concern	GCTL (mg/L)	Natural Attenuation Default Concentrations (NADCs) (mg/L)
PCE	0.003	0.3
TCE	0.003	0.3
Cis-1,2-DCE	0.07	0.7
1,1-DCE	0.007	0.07
1,1-DCA	0.07	0.7
1,4-Dioxane	0.0032	0.32

3.3 Performance Objectives

The performance objectives of the IRA are to:

1. Remove COC mass from the USAS and LSAS; and

2. Hydraulically contain the source area.

The first performance objective, COC mass removal, can be evaluated by periodically measuring groundwater extraction rates and COC concentrations in extracted groundwater prior to treatment. This information can be used to estimate and monitor COC mass removal rates of the PAT system. It is anticipated that initial COC mass removal rates in the PAT system will be relatively fast, and will decrease over time until concentrations in source area groundwater are low.

The second performance objective, hydraulic containment of the source area, can be evaluated by periodically measuring groundwater and surface water elevations at the Site (including water levels within the PAT system) and preparing potentiometric surface maps based on the field data. So long as hydraulic gradients are inward toward the PAT system, and the inward gradients encompass areas where COC concentrations in groundwater are highest, the PAT system can be considered to be achieving this performance objective.

3.4 Cessation Criteria

The groundwater PAT system will be operated until COC concentrations in groundwater are below cessation criteria. Cessation criteria for this IRAP will be either the GCTLs or NADCs for Site-related COCs specified in Chapter 62-777, F.A.C. This decision will be deferred to the Final RAP for the Site.

4. Operation and Maintenance

4.1 Activities

To promote proper operation of the IRA, operation and maintenance (O&M) activities described in this section will be conducted. Additional maintenance requirements/activities are described in the manufacturer's O&M manuals that will be stored at the treatment system.

The operator will be responsible for maintaining records throughout the operation of the treatment system in order to verify performance and document proper treatment system O&M. The operator will be responsible for performing and documenting preventative maintenance tasks on treatment system components. Maintenance performed on system components will be documented on a Facility Maintenance Log. For detailed instruction on performing preventative maintenance on system components, refer to the manufacturer's O&M manuals and vendor literature that will be stored at the treatment system.

Specific O&M activities are summarized below.

4.1.1 Routine O&M

Operating personnel will perform the following routine O&M activities:

- Observe piping/tanks for leaks and spills;
- Observe groundwater treatment system transfer pump during normal operation, and check for leaks, unusual noises, or general indications of poor performance;
- Record instantaneous and totalized system flow rates;
- Record influent tank operating levels;
- Record Photo-Cat operating data; and
- Record bag filter pressures and carbon vessel pressure.

The above described routine O&M will be conducted daily for the first five days of operation and then reduced to weekly.

4.1.2 Monthly O&M

Operating personnel will perform the following O&M activities at least once per month:

- Visually inspect all tanks/equipment, associated piping, and containment for leaks, cracks, chips, exterior corrosion, or other damage;

- As practical, visually verify proper operation of instrumentation (operational and free of obstruction). For the flow meters compare the local transmitter display to the flow displayed at the PLC operator interface; and

- Inspect/test eye wash/safety shower unit.

4.1.3 Equalization Tank Maintenance

During normal operation, the influent tank may contain sediment buildup. The tank should be checked monthly, at a minimum, for sediment buildup and cleaned as necessary. The frequency of tank cleaning will be determined by operational experience.

4.1.4 Filter Bag Maintenance

The pressure drop across the bag filters will increase as the bags collect solids. When indicated by the increased pressure drop, the filter in service should be changed with a new filter bag. The frequency of filter bag change outs will be determined by operational experience.

4.1.5 Photo-Cat Maintenance

The Photo-Cat unit requires very little maintenance. However, the unit will require replenishment of pH adjustment chemicals, monthly pH calibrations, and lamp replacement approximately every two years. The frequency of pH adjustment chemical replenishment will be determined by operational experience.

4.1.6 Liquid-Phase GAC Maintenance

The GAC unit is designed to adsorb VOCs that may remain after the Photo-Cat. As the number of available sites for adsorption decreases, breakthrough of VOCs can occur. The only effective means of detecting VOC breakthrough is through sampling. If effluent sampling indicates VOC concentrations approaching the permitted discharge limits, the GAC units should be changed out with a spare unit stored on-site.

There are several additional factors that can indicate a GAC change out is required prior to VOC breakthrough. An abnormal increase or decrease in the effluent pH can indicate a biological buildup (biofouling) in the GAC units. An increase in the pressure drop across the unit may indicate excessive solids loading or biofouling. When the pressure drop increases to a predetermined (based on operational experience) setpoint or the effluent pH is outside the normal operating range, the GAC units should be changed out.

4.1.7 Centrifugal Pumps

Grease motor bearings once every six months, or as recommended by the manufacturer.

4.1.8 System Alarms and Response

System operation set points for various process parameters will be settable by the system operator. The PLC will monitor these parameters and alert the operator of changes in the system operation. The following parameters will be monitored for both "informational" and "system shutdown" alarm conditions:

- High pressure before bag filter units;
- High pressure after bag filter units;
- High pressure before liquid-phase GAC unit; and
- High pressure after liquid-phase GAC units.

System shutdown alarms are also triggered under the following conditions:

- Photo-Cat shutdown;
- High-high level alarm in influent tank;
- Low level alarm in influent tank;
- High differential pressure across bag filter units; and
- Power loss.

All alarms and system operation will be accessible via remote telemetry utilizing the treatment system computer and PCAnywhere software. The PLC, computer, and PCAnywhere software will be used to remotely investigate, correct, reset, and document any alarm conditions that occur. System shutdown will result in activation of the autodialer. The system autodialer is used to alert pre-designated personnel via phone, fax, or e-mail in the case of treatment system critical alarms. For detailed treatment system alarm procedures involving the Photo-Cat, refer to the manufacturer's O&M manuals that will be stored at the treatment system.

4.1.9 Sampling and Analysis

Sampling and analysis of treated groundwater discharged to the Manatee County POTW will be conducted in accordance with the requirements established by the MCUO. Sewer discharge monitoring will consist of collecting for laboratory analysis, at a minimum, three water samples the first week of operation, weekly samples for the first month, monthly samples for the next two months, and quarterly samples thereafter. Samples will be collected from the sampling port on the discharge side of the liquid-phase GAC unit and submitted for laboratory analysis for parameters specified by MCUO. Sample frequency may be adjusted based on requirements established by MCUO and system performance. A request to alter the frequency or parameters will be made to FDEP and MCUO prior to modifying the sampling and analysis program.

Influent and mid-process monitoring will also be conducted. Influent samples will be collected from the discharge of the equalization tank, and the mid-process samples will be collected between the Photo-Cat and the liquid-phase GAC unit. Samples will initially be collected and submitted for laboratory analysis for the same parameters at the same frequency as the effluent samples. This may change based on operational experience.

4.2 Schedule

As indicated above, monitoring of the treatment system components will be conducted on a routine or monthly basis. In accordance with Chapter 62-780.700(3)(g)1 and (12)(d), F.A.C., influent, effluent, and mid-process sampling will be conducted, at a minimum, three times per week for the first week of operation, weekly for the first month, monthly for the next two months, and quarterly thereafter. The treatment system sampling schedule is outlined in Table 2. However, sampling frequency may be adjusted based on requirements established by the MCUO and system performance.

Within 120 days of initiating the active PAT, Lockheed Martin will provide the FDEP two signed and sealed sets of engineering drawings (As-Built Drawings). The engineering drawings will include all construction and equipment design specifications of the installed active remediation system(s) and any operational parameters different from those in the approved IRAP. A summary of the system(s) startup activities will be included with the engineering drawings.

5. Effectiveness Monitoring

5.1 Overview

In accordance with Chapter 62-780.700(3)(g)2, 3 and 4, F.A.C., effectiveness monitoring of the groundwater recovery system will consist of collecting monthly water levels for the first six months, quarterly groundwater samples and water levels for the first two years following start-up of the PAT system, and semi-annual groundwater samples and water levels beginning in year 3 until cessation of pumping. Groundwater samples will be collected using previously approved sampling methods and shipped to a certified laboratory for analysis of site specific COCs identified in Section 2.3 (VOCs via USEPA Method 8260 and 1,4-dioxane by USEPA Method 8270) to monitor the cleanup progress.

Operational monitoring of the treatment system will consist of collecting influent, effluent, and mid-process samples on three days during the first week, followed by weekly sampling for the first month, monthly sampling for the next two months, and quarterly sampling thereafter. As indicated in the previous section, sampling frequency and parameters may be adjusted at the request of the MCUO. The treatment process monitoring samples will be initially analyzed for parameters specified by the MCUO, but may change based on operational experience.

Table 2 summarizes the schedule for monitoring the groundwater PAT system per Chapter 62-780.700(3)(g), F.A.C.

5.2 Monthly Groundwater Monitoring

Monthly monitoring will occur during the first six months after the groundwater PAT system is started and will involve measurement of water levels at a specified subset of USAS, LSAS and IAS monitoring wells. The purpose of this portion of the monitoring program is to monitor the development of the groundwater capture zones in the USAS and LSAS and verify that the PAT system is providing hydraulic control of the source area. The data will be used to prepare potentiometric surface contour maps and delineate capture zones in the USAS and LSAS. Monthly monitoring reports will be submitted to FDEP showing the results. After the six-month monthly monitoring is finished, water levels will be collected on a quarterly basis as discussed in Section 5.3.

Groundwater levels will be measured at the following on- and off-site monitoring wells:

<u>USAS Monitoring Wells</u>

- All proposed USAS extraction wells
- MW-2
- MW-3
- MW-4
- MW-5
- MW-6
- MW-7S
- MW-7D
- MW-8S
- MW-8D

- MW-9S
- MW-9D
- MW-10
- MW-11
- MW-12
- MW-13D
- MW-14S
- MW-14D
- MW-15S
- MW-15D
- MW-17S
- MW-17D
- MW-30
- MW-32
- MW-35
- MW-36
- MW-38
- MW-40
- MW-42
- MW-70
- MW-71
- MW-72
- MW-76

<u>LSAS Monitoring Wells</u>

- All proposed LSAS extraction wells
- MW-33
- MW-37
- MW-39
- MW-41
- MW-43
- MW-48
- MW-77
- MW-78
- MW-79
- MW-80
- MW-81
- MW-84
- MW-87

<u>IAS Monitoring Wells</u>

- MW-127
- MW-128

5.3 Quarterly Groundwater Monitoring

In accordance with Chapter 62-780.700(3)(g)4, F.A.C., quarterly groundwater monitoring will occur during the first two years after the groundwater PAT system is started and will involve collecting groundwater samples from the monitoring well listed below and measuring water levels at the USAS, LSAS and IAS monitoring wells listed in Section 5.2. Additionally, during the last quarterly sampling event each calendar year (i.e., October), groundwater samples will be collected from the USAS, LSAS and IAS monitoring wells listed in Section 5.2. The purpose of this two-year monitoring program will be to monitor the COC mass removal rates of the IRAP, changes in COC concentrations over time during operation of the IRAP, and monitor the extent of the capture zones after the first six months of system operation. The data will be used to estimate COC mass removal rates, evaluate changes in COC concentrations over time, prepare potentiometric surface contour maps, and delineate capture zones in the USAS and LSAS. Quarterly monitoring reports will be submitted to FDEP summarizing the monitoring results. After one year of quarterly groundwater monitoring, quarterly monitoring locations and sample analyses will be re-evaluated, and modifications to the quarterly monitoring program may be suggested to the FDEP. After two years of quarterly monitoring, groundwater samples and water level measurements will be collected on a semi-annual basis as discussed in Section 5.4.

In accordance with Chapter 62-780.700(3)(g)2, F.A.C., groundwater samples will be collected quarterly from the following wells and analyzed for the COCs (VOCs via USEPA Method 8260 and 1,4-dioxane by USEPA Method 8270) to monitor the cleanup progress. A proposal to change sample locations, frequency, or analytical methods may be proposed in the quarterly monitoring reports for approval by FDEP, if warranted based on system performance.

Due to the dimension of the area of highest groundwater concentrations (source) and the radial nature of groundwater flow from the source area, several source area and down-gradient monitoring wells were selected from both the USAS and LSAS to evaluate the change in COC concentrations in groundwater over time. Mainly monitoring wells screened on top of the hard streak or at the base of the USAS were selected for quarterly monitoring because these wells exhibit greater impacts than the shallower USAS monitoring wells. Also, two IAS monitor wells below the SAS source area will be monitored to evaluate any vertical influence the PAT system may have on the IAS.

<u>USAS Monitoring Wells (screened on top of hard streak/base of the USAS)</u>

- MW-15D (down/cross gradient edge)
- MW-35 (up/cross gradient edge)
- MW-36 (source area)
- MW-38 (source area)
- MW-42 (source area)
- MW-70 (down gradient edge)
- MW-71 (down gradient edge)
- MW-72 (down/cross gradient edge)
- MW-76 (down/cross gradient edge)

<u>LSAS Monitoring Wells</u>

- MW-37 (source area)
- MW-39 (source area)
- MW-43 (source area)

- MW-77 (cross gradient edge)
- MW-78 (up gradient - impacted)
- MW-79 (cross/down gradient edge)
- MW-81 (down gradient edge)
- MW-84 (cross/down gradient edge)
- MW-87 (up gradient – impacted)

<u>IAS Monitoring Wells</u>

- MW-127 (vertically down gradient)
- MW-128 (vertically down gradient)

5.4 Semi-Annual Groundwater Monitoring

After the two-year quarterly monitoring program is complete, groundwater monitoring will occur on a semi-annual basis until cessation of pumping. As discussed in Section 3.4, cessation criteria will be presented in the Final RAP for the Site. The first semi-annual sampling event each calendar year (i.e., April) will be similar to quarterly monitoring and involve collecting groundwater samples and measuring water levels at the USAS, LSAS and IAS monitoring wells listed in Section 5.3. Additionally, during the second semi-annual sampling event each calendar year (i.e., October), groundwater samples will be collected from the USAS, LSAS and IAS monitoring wells listed in Section 5.2. The purpose of the semi-annual groundwater monitoring program will be to monitor COC mass removal rates, changes in COC concentrations over time during operation of the IRAP, and the extent of the capture zones. The data will be used to evaluate changes in COC concentrations over time, prepare potentiometric surface contour maps, and delineate capture zones in the USAS and LSAS. Semi-annual monitoring reports will be submitted to FDEP summarizing the monitoring results. After one year of semi-annual groundwater monitoring, monitoring locations and sample analyses will be re-evaluated, and modifications to the semi-annual monitoring program may be proposed to the FDEP for approval.

5.5 Water Treatment Process and Compliance Monitoring

As discussed in Section 4.1.9, influent samples will be collected from the discharge of the equalization tank. Effluent samples will be collected from the discharge of the liquid-phase GAC unit, and mid-process monitoring will be conducted between the Photo-Cat unit and the liquid-phase GAC unit.

Sampling frequency will be based on Manatee County POTW requirements. However, BBL anticipates that sampling activities will be conducted on three days during the first week, followed by weekly sample collection for the first month, monthly sample collection for the next two months, and quarterly sample collection thereafter.

Samples will be submitted for laboratory analysis for Manatee County POTW established requirements. Reporting for all collected process and compliance monitoring will be in accordance with Manatee County POTW requirements.

6. Implementation Schedule

The schedule shown on Figure 11 presents the anticipated major activities associated with the implementation of the IRAP. As indicated on Figure 11, detailed design activities associated with the IRA will be conducted in conjunction with FDEP review and approval of this IRAP. Following FDEP approval of the IRAP, which is estimated to occur in mid-January 2006, mobilization to the site and equipment procurement will begin. Equipment procurement will require approximately 12 weeks due to the anticipated delivery of the advanced oxidation system. During equipment procurement activities, extraction well installation activities will be completed and equipment installation activities will begin. Following receipt of the advanced oxidation system, final installation activities will be completed and system startup is anticipated for early-May 2006.

7. Bibliography

BBL, Inc., 2005. Draft Basis of Design, Interim Remedial Action, Former American Beryllium Company, 1600 Tallevast Road, Tallevast, Florida. Prepared for Lockheed Martin Corporation, Bethesda, Maryland. Submitted to FDEP December 2, 2005.

FDEP (Florida Department of Environmental Protection), 2004. Draft Rule, Contaminated Site Cleanup Criteria, Chapter 62-780, F.A.C., July 16, 2004.

FDEP Site Investigation Section, 2004. Preliminary Contamination Assessment Report, Tallevast Community, SIS Report No. 2004-01.

Howard, P.H. (Ed.). 1991. Handbook of Environmental Fate and Exposure Data for Organic Chemicals. Lewis Publishers, Inc.: Chelsea, Michigan.

State of Florida, 2004. Department of Environmental Protection Consent Order OGC File No. 04-1328. Executed July 28, 2004.

SWFMD (Southwest Florida Water Management District), 1995. Final Report, ROMP TR7-2 ONECO Monitor Well Site, Manatee County Florida, Drilling and Testing. January 1995.

Tetra Tech, Inc., 1997. Final Phase I Environmental Assessment, Former American Beryllium Company, 1600 Tallevast Road, Tallevast, Florida. Prepared for Lockheed Martin Corporation, Bethesda, Maryland. Submitted to FDEP February 7, 1997.

Tetra Tech, Inc., 2000. Contamination Discovery Report, Building #5, Former American Beryllium Company, 1600 Tallevast Road, Tallevast, Florida. Prepared for Lockheed Martin Corporation, Bethesda, Maryland. Submitted to FDEP July 7, 2000.

Tetra Tech, Inc., 2000. Contamination Assessment Plan, Former American Beryllium Company, 1600 Tallevast Road, Tallevast, Florida. Prepared for Lockheed Martin Corporation, Bethesda, Maryland. Submitted to FDEP September 25, 2000.

Tetra Tech, Inc., 2001. Contamination Assessment Report, Former American Beryllium Company, 1600 Tallevast Road, Tallevast, Florida. Prepared for Lockheed Martin Corporation, Bethesda, Maryland. Submitted to FDEP April 30, 2001.

Tetra Tech, Inc., 2001. Initial Remedial Action Report, Former American Beryllium Company, 1600 Tallevast Road, Tallevast, Florida. Prepared for Lockheed Martin Corporation, Bethesda, Maryland. Submitted to FDEP December 12, 2001.

Tetra Tech, Inc., 2002. Interim Data Report and Contamination Assessment Plan Addendum #2, Former American Beryllium Company, 1600 Tallevast Road, Tallevast, Florida. Prepared for Lockheed Martin Corporation, Bethesda, Maryland. Submitted to FDEP September 13, 2002.

Tetra Tech, Inc., 2003. Contamination Assessment Report, Former American Beryllium Company, 1600 Tallevast Road, Tallevast, Florida. Prepared for Lockheed Martin Corporation, Bethesda, Maryland. Submitted to FDEP May 2003.

Tetra Tech, Inc., 2005. Site Assessment Report (SAR), Former American Beryllium Company, 1600 Tallevast Road, Tallevast, Florida. Prepared for Lockheed Martin Corporation, Bethesda, Maryland. Submitted to FDEP January 31, 2005.

Tetra Tech, Inc., 2005. Site Assessment Report Addendum 1 (SARA 1), Former American Beryllium Company, 1600 Tallevast Road, Tallevast, Florida. Prepared for Lockheed Martin Corporation, Bethesda, Maryland. Submitted to FDEP April 2005.

Tetra Tech 2005. Remedial Action Work Plan (RAWP), Former American Beryllium Company, 1600 Tallevast Road, Tallevast, Florida. Prepared for Lockheed Martin Corporation, Bethesda, Maryland. Submitted to FDEP July 28, 2005.

Tetra Tech, Inc., 2005. Site Assessment Report Addendum 2 (SARA 2), Former American Beryllium Company, 1600 Tallevast Road, Tallevast, Florida. Prepared for Lockheed Martin Corporation, Bethesda, Maryland. Submitted to FDEP August 2005.

USEPA (United States Environmental Protection Agency), 1992. Estimating the Potential for Occurrence of DNAPL at Superfund Sites. Office of Solid Waste and Emergency Response. R.S. Kerr Environmental Research Laboratory. Publication 9355.4-07FS.

Tables

TABLE 1

FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA

EVALUATION OF SELECTED REMEDIAL ALTERNATIVE
(CHAPTER 62-780.700(3)(D)2 ITEMS A THROUGH G, F.A.C.)

Evaluation Criteria	Basis of Selection
Long-term and short-term human health and environmental effects	Groundwater PAT is protective of human health and the environment provided that the private wells within the plume area are closed and not used for consumption and/or irrigation. Moreover, the proposed groundwater PAT has no air emissions, and wastewater effluent will be directly discharged to the sanitary sewer in accordance with POTW standards.
Implementability	Groundwater PAT is a common, well-established remedial technology that uses conventional, modular equipment which will facilitate implementation. Further, implementation is largely non-invasive and will not cause major disruption or outage to WPI operations or other community resources.
Operation and maintenance requirements	Routine operation and maintenance includes automated, remote monitoring as well as periodic manual inspection and maintenance. This level of operation and maintenance is commensurate with comparable remedial technologies.
Reliability	The proposed system includes the use of proven and well established technology, and includes appropriate alarms and controls to ensure reliable operation.
Feasibility	Groundwater PAT is a feasible and well established technology.
Estimated time required to achieve cleanup	Not applicable for the IRAP – This PAT system is intended to provide short-term mass removal and hydraulic control in and around the source area, and is intended only as an interim measure. The future Remedial Action Plan will identify a long-term remedy, and will evaluate estimated time to cleanup once site assessment activities are complete.
Cost-effectiveness	Groundwater PAT is a cost effective technology, particularly as an interim measure.

TABLE 2

FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA

SUMMARY OF MONITORING SCHEDULE

Monitoring Task & Location(s)[2]	Year 1 (2006)[1]															Year 2 (2007)												Year 3 through cessation of pumping											
Month >	M				J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
Week >	1	2	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Treatment System Monitoring - Weekly/Quarterly																																							
System Effluent - Treated Groundwater to POTW	X[3]	X	X	X	X	X			X			X			X			X			X			X			X			X			X			X			X
System Influent - Discharge from Equalization Tank	X[3]	X	X	X	X	X			X			X			X			X			X			X			X			X			X			X			X
System Mid-Process - Effluent from Photo-Cat System	X[3]	X	X	X	X	X			X			X			X			X			X			X			X			X			X			X			X
Groundwater Sampling - Quarterly/Semi-Annually[4]																																							
USAS Monitoring Wells (8 Locations)						X			X[5]			X			X			X			X[5]			X			X						X[5]						X
LSAS Monitoring Wells (4 Locations)						X			X[5]			X			X			X			X[5]			X			X						X[5]						X
IAS Monitoring Wells (2 Locations)						X			X[5]			X			X			X			X[5]			X			X						X[5]						X
Water Levels - Monthly/Quarterly/Semi-Annually																																							
USAS Monitoring Wells (36 Locations)	X				X	X	X	X	X			X			X			X			X			X			X						X						X
LSAS Monitoring Wells (17 Locations)	X				X	X	X	X	X			X			X			X			X			X			X						X						X
IAS Monitoring Wells (2 Locations)	X				X	X	X	X	X			X			X			X			X			X			X						X						X
Reports[6]																																							
1=Monthly, 2=Quarterly, 3=Semi-Annually	1				1	1	1	1	1			2			2			2			2			2			2						3						3

Notes:

[1] The schedule is based on the implementation schedule presented on Figure 11.

[2] A request to modify sample locations, analytical parameters and frequency may be submitted to FDEP based on the results.

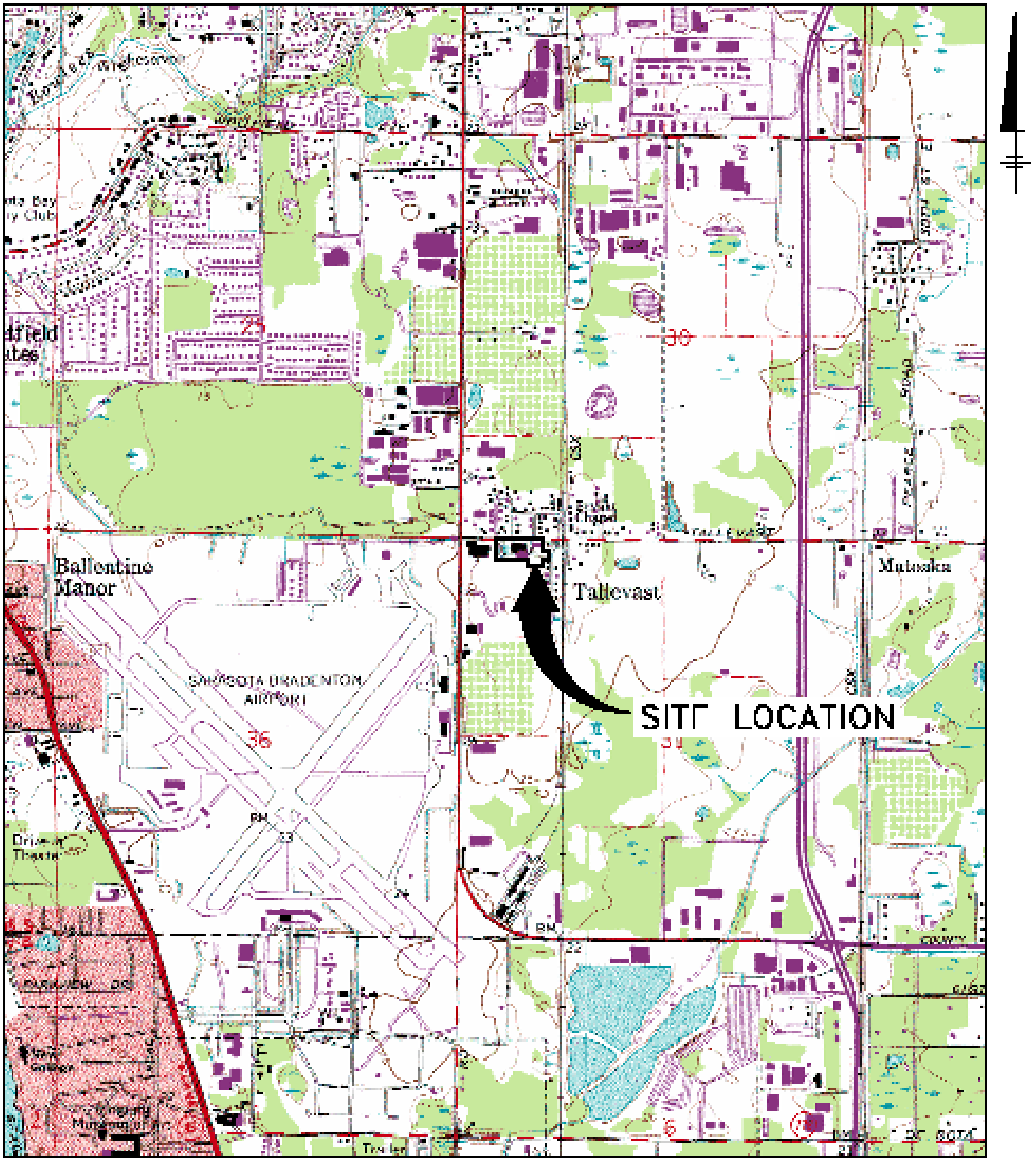
[3] Samples will be collected 3 times during the first week of system operations.

[4] Groundwater samples will be analyzed for VOCs by USEPA Method 8260 and 1,4-Dioxane by USEPA Method 8270.

[5] The October groundwater sampling event each calendar year will include 36 USAS, 17 LSAS and 2 IAS monitoring well locations.

[6] In accordance with Table A of Chapter 62-780, F.A.C., reports will be provided to FDEP within 60 days of sample collection.

Figures



REFERENCE: BASE MAP SOURCE USGS 7.5 MINUTE QUADS. SERIES BRADENTON, FLORIDA, 1964, PHOTOREVISED 1987.

AREA LOCATION

FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA
INTERIM REMEDIAL ACTION PLAN

SITE LOCATION MAP

BBL

FIGURE
1

X: [illegible].TIF
L: ON=*, OFF=REF
P: PAGESET/[illegible]
12/13/06 SYR-[illegible]
[illegible]/3007T01.DWG

LEGEND:

-·-·- SITE BOUNDARY

┼┼┼┼ RAILROAD TRACKS

—x—x— FENCE

◐ MW-79 MONITORING WELL

NOTE:

1. BASE MAP INFORMATION OBTAINED FROM A TETRA TECH, INC. FIGURE 2-8 ENTITLED "TCE IN SURFICIAL AQUIFER SYSTEM BASED ON SCREEN POINT SAMPLING AT THE BASE OF THE SURFICIAL AQUIFER" DATED 10/5/04, AT A SCALE OF 1"=280'.

0 50' 100'
GRAPHIC SCALE

FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA

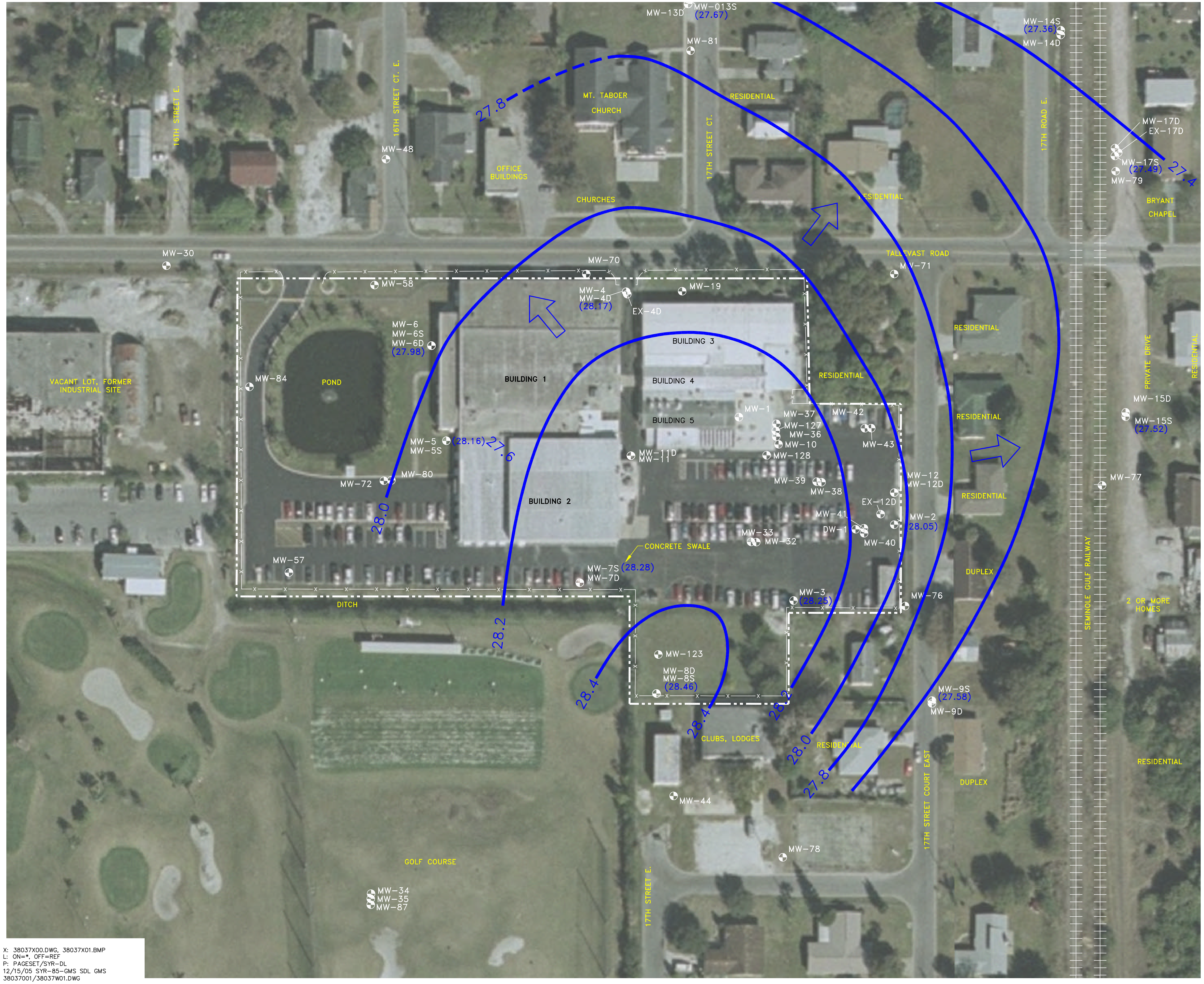
INTERIM REMEDIAL ACTION PLAN

SITE PLAN

BBL
BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

FIGURE
2

X: 38037X00.DWG, 38037X01.BMP
L: ON=*, OFF=REF
P: PAGESET/SYR-DL
12/9/05 SYR-85-GMS
38037001/38037B02.DWG



X: 38037X00.DWG, 38037X01.BMP
L: ON=*, OFF=REF
P: PAGESET/SYR-DL
12/15/05 SYR-85-GMS SDL GMS
38037001/38037W01.DWG

LEGEND:

—·—·—	SITE BOUNDARY
┼┼┼┼┼┼┼	RAILROAD TRACKS
—x—x—	FENCE
◐ MW-79	MONITORING WELL
——	WATERTABLE ELEVATION CONTOUR IN FEET (AMSL) (DASHED WHERE INFERRED)
(27.49)	GROUNDWATER ELEVATION IN FEET (AMSL)
⇨	DIRECTION OF HYDRAULIC GRADIENT

NOTES:

1. BASE MAP INFORMATION OBTAINED FROM A TETRA TECH, INC. FIGURE 2-8 ENTITLED "TCE IN SURFICIAL AQUIFER SYSTEM BASED ON SCREEN POINT SAMPLING AT THE BASE OF THE SURFICIAL AQUIFER" DATED 10/5/04, AT A SCALE OF 1"=280'.
2. WATER LEVEL DATA COLLECTED ON 5/10/05 AND 5/11/05.

0 50' 100'
GRAPHIC SCALE

FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA

INTERIM REMEDIAL ACTION PLAN

WATER TABLE ELEVATIONS AND CONTOURS IN THE USAS - MAY 2005

BBL®
BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

FIGURE
3

LEGEND:

-·-·-·-	SITE BOUNDARY
┼┼┼┼┼┼┼	RAILROAD TRACKS
—x—x—	FENCE
MW-79	MONITORING WELL
━━━	GROUNDWATER POTENTIOMETRIC ELEVATION CONTOUR IN FEET (AMSL) (DASHED WHERE INFERRED)
(21.78)	GROUNDWATER ELEVATION IN FEET
⇨	DIRECTION OF HYDRAULIC GRADIENT

NOTES:

1. BASE MAP INFORMATION OBTAINED FROM A TETRA TECH, INC. FIGURE 2-8 ENTITLED "TCE IN SURFICIAL AQUIFER SYSTEM BASED ON SCREEN POINT SAMPLING AT THE BASE OF THE SURFICIAL AQUIFER" DATED 10/5/04, AT A SCALE OF 1"=280'.
2. WATER LEVEL DATA COLLECTED ON 5/10/05 AND 5/11/05.

0 50' 100'
GRAPHIC SCALE

FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA
INTERIM REMEDIAL ACTION PLAN

GROUNDWATER POTENTIOMETRIC SURFACE ELEVATIONS AND CONTOURS IN THE LSAS - MAY 2005

BBL
BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

FIGURE
4

X: 38037X00.DWG, 38037X01.BMP
L: ON=*, OFF=REF
P: PAGESET/SYR-DL
12/15/05 SYR-85-GMS SDL GMS
38037001/38037W02.DWG

MW-13D	
USAS	(15 – 20')
1,4-Dioxane	2.1 U
1,1-DCA	0.5 U
1,1-DCE	1.1
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-14S	
USAS	(4 – 10')
1,4-Dioxane	2 U
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-14D	
USAS	(15 – 20')
1,4-Dioxane	2 U
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-11	
USAS	(15 – 20')
1,4-Dioxane	**3.5 I**
1,1-DCA	**92.8**
1,1-DCE	**49.3**
Cis-1,2-DCE	68.4
PCE	**14.4**
TCE	**937**

MW-70	
USAS	(23 – 29')
1,4-Dioxane	2.1 U
1,1-DCA	0.94 I
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-4	
USAS	(4 – 19')
1,4-Dioxane	2 U
1,1-DCA	1.1
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-36	
USAS	(23 – 28')
1,4-Dioxane	**18.9**
1,1-DCA	**113**
1,1-DCE	**242**
Cis-1,2-DCE	**115**
PCE	25 U
TCE	**1,400**

MW-71	
USAS	(24 – 29')
1,4-Dioxane	**5.3**
1,1-DCA	7.1
1,1-DCE	5
Cis-1,2-DCE	36.1
PCE	1 U
TCE	**192**

MW-17D	
USAS	(15 – 20')
1,4-Dioxane	2 U
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-17S	
USAS	(4 – 10')
1,4-Dioxane	2 U
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-30	
USAS	(23.5 – 28.5')
1,4-Dioxane	2.1 U
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-10	
USAS	(15 – 20')
1,4-Dioxane	1.9 U
1,1-DCA	0.84 I
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	**5.5**
TCE	**3.9**

MW-15D	
USAS	(15 – 20')
1,4-Dioxane	2.2 I
1,1-DCA	2.4
1,1-DCE	1.1
Cis-1,2-DCE	0.77 I
PCE	0.5 U
TCE	0.62 I

MW-6	
USAS	(4 – 10')
1,4-Dioxane	2 U
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-42	
USAS	(23 – 28')
1,4-Dioxane	**45.7**
1,1-DCA	50 U
1,1-DCE	**50.4 I**
Cis-1,2-DCE	**133**
PCE	50 U
TCE	**3,160**

MW-5	
USAS	(4 – 10')
1,4-Dioxane	1.9 U
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-38	
USAS	(23 – 28')
1,4-Dioxane	**30.9**
1,1-DCA	**123**
1,1-DCE	**253**
Cis-1,2-DCE	10.7 I
PCE	**347**
TCE	**1,160**

MW-72	
USAS	(23.5 – 28.5')
1,4-Dioxane	2 U
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	**3.3**
TCE	**3.7**

MW-12	
USAS	(15 – 20')
1,4-Dioxane	**14.3**
1,1-DCA	12.6
1,1-DCE	**15.8**
Cis-1,2-DCE	5.6
PCE	**199**
TCE	**364**

MW-15S	
USAS	(4 – 10')
1,4-Dioxane	2 U
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-7S	
USAS	(4 – 10')
1,4-Dioxane	1.9 U
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-2	
USAS	(10 – 20')
1,4-Dioxane	2 U
1,1-DCA	1.6
1,1-DCE	0.98 I
Cis-1,2-DCE	9.4
PCE	**45.2**
TCE	**32.4**

MW-40	
USAS	(23 – 28')
1,4-Dioxane	**9.8**
1,1-DCA	20.2
1,1-DCE	**23.1**
Cis-1,2-DCE	2.6 I
PCE	**70.1**
TCE	**137**

MW-76	
USAS	(23 – 28')
1,4-Dioxane	**9**
1,1-DCA	10.7
1,1-DCE	**7.9**
Cis-1,2-DCE	4.2 I
PCE	**5.8**
TCE	**232**

MW-7D	
USAS	(15 – 20')
1,4-Dioxane	2 U
1,1-DCA	0.52 I
1,1-DCE	1.3
Cis-1,2-DCE	0.5 U
PCE	**4**
TCE	**3.1**

MW-32	
USAS	(24.5 – 29.5')
1,4-Dioxane	3.1 I
1,1-DCA	**76.6**
1,1-DCE	**87.6**
Cis-1,2-DCE	3.8
PCE	**8.1**
TCE	**71.4**

MW-8D	
USAS	(15 – 20')
1,4-Dioxane	1.9 U
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-8S	
USAS	(4 – 10')
1,4-Dioxane	1.9 U
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-3	
USAS	(10 – 20')
1,4-Dioxane	1.9 U
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-9S	
USAS	(4 – 10')
1,4-Dioxane	2 U
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.62 I
TCE	0.5 U

MW-9D	
USAS	(15 – 20')
1,4-Dioxane	1.9 U
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-35	
USAS	(25 – 30')
1,4-Dioxane	1.9 U
1,1-DCA	0.99 I
1,1-DCE	2.1
Cis-1,2-DCE	0.5 U
PCE	**13**
TCE	**6.3**

X: 38037X00.DWG, 38037X01.BMP
L: ON=*, OFF=REF
P: PAGESET/SYR-DL
12/15/05 SYR-85-GMS
38037001/38037C01.DWG

LEGEND:

- SITE BOUNDARY
- RAILROAD TRACKS
- FENCE
- MW-71 USAS MONITORING WELL

RESULTS COMPARED TO GROUNDWATER TARGET CLEANUP LEVELS (GTCLs):

MW-10		
USAS	(15 – 20')	← MONITORING WELL SCREEN INTERVAL (FEET BELOW GROUND SURFACE)
1,4-Dioxane	1.9 U	
1,1-DCA	0.84 I	
1,1-DCE	0.5 U	← RESULT < GTCL
Cis-1,2-DCE	0.5 U	
PCE	**5.5**	← RESULT > GTCL (BOLD)
TCE	**3.9**	

MW-10 ← MONITORING WELL ID

I= REPORTED VALUE IS BETWEEN THE LABORATORY DETECTION LIMIT AND THE LABORATORY PRACTICAL QUANTITATION LIMIT

U= CONCENTRATION WAS BELOW LABORATORY DETECTION LIMIT

NOTES:

1. GTCLs FOR EACH COC ARE LISTED IN SECTION 3.2 OF THE IRAP.
2. ALL CONCENTRATIONS REPORTED IN ug/L.
3. ALL RESULTS ARE PROVIDED IN TABLE 3.9 OF THE SARA II.
4. BASE MAP INFORMATION OBTAINED FROM A TETRA TECH, INC. FIGURE 2–8 ENTITLED "TCE IN SURFICIAL AQUIFER SYSTEM BASED ON SCREEN POINT SAMPLING AT THE BASE OF THE SURFICIAL AQUIFER" DATED 10/5/04, AT A SCALE OF 1"=280'.

0 50' 100'
GRAPHIC SCALE

FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA
INTERIM REMEDIAL ACTION PLAN

GROUNDWATER ANALYTICAL RESULTS FOR USAS - JUNE/JULY 2005

BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

FIGURE
5

MW-48	
LSAS	(33.5 – 38.5')
1,4-Dioxane	2.3 I
1,1-DCA	0.5 U
1,1-DCE	0.5 U
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	0.5 U

MW-81	
LSAS	(36 – 41')
1,4-Dioxane	**30.1**
1,1-DCA	2.1
1,1-DCE	2.3
Cis-1,2-DCE	0.5 U
PCE	0.5 U
TCE	2.1

MW-37	
LSAS	(35.5 – 40.5')
1,4-Dioxane	**232**
1,1-DCA	25 U
1,1-DCE	**51.6**
Cis-1,2-DCE	**217**
PCE	25 U
TCE	**2,310**

MW-79	
LSAS	(36 – 41')
1,4-Dioxane	**44.6**
1,1-DCA	5 U
1,1-DCE	**13.4**
Cis-1,2-DCE	**420**
PCE	5 U
TCE	**827**

MW-84	
LSAS	(35.5 – 40.5')
1,4-Dioxane	**42.9**
1,1-DCA	3.8
1,1-DCE	**20.7**
Cis-1,2-DCE	9.7
PCE	1 U
TCE	**109**

MW-43	
LSAS	(35.5 – 40.5')
1,4-Dioxane	**169**
1,1-DCA	12
1,1-DCE	**67.8**
Cis-1,2-DCE	17.1
PCE	1 U
TCE	**69.6**

MW-77	
LSAS	(36 – 41')
1,4-Dioxane	**65.3**
1,1-DCA	50.2
1,1-DCE	**28.5**
Cis-1,2-DCE	2.3
PCE	1.7
TCE	**9**

MW-39	
LSAS	(35.5 – 40.5')
1,4-Dioxane	**179**
1,1-DCA	10 U
1,1-DCE	**34.2**
Cis-1,2-DCE	**94.5**
PCE	**15.7 I**
TCE	**526**

MW-41	
LSAS	(35.5 – 40.5')
1,4-Dioxane	**185**
1,1-DCA	7.9
1,1-DCE	**43.4**
Cis-1,2-DCE	69.9
PCE	0.5 U
TCE	**71.8**

MW-80	
LSAS	(36 – 41')
1,4-Dioxane	**4.5 I**
1,1-DCA	51.8
1,1-DCE	**485**
Cis-1,2-DCE	10.5
PCE	**10.8**
TCE	**44.7**

MW-33	
LSAS	(35.5 – 40.5')
1,4-Dioxane	**418**
1,1-DCA	60.4
1,1-DCE	**163**
Cis-1,2-DCE	17.4
PCE	**9.1**
TCE	**106**

MW-87	
LSAS	(36 – 41')
1,4-Dioxane	**184**
1,1-DCA	**142**
1,1-DCE	**443**
Cis-1,2-DCE	10.4
PCE	**62.9**
TCE	**381**

MW-78	
LSAS	(36 – 41')
1,4-Dioxane	**86.5**
1,1-DCA	**382**
1,1-DCE	**199**
Cis-1,2-DCE	**93.5**
PCE	2.5 U
TCE	**29.9**

X: 38037X00.DWG, 38037X01.BMP
L: ON=*, OFF=REF
P: PAGESET/SYR-DL
12/15/05 SYR-85-GMS
38037001/38037C02.DWG

LEGEND:

—·—··—·—	SITE BOUNDARY
┼┼┼┼┼┼┼┼	RAILROAD TRACKS
—x——x—	FENCE
◐ MW-79	LSAS MONITORING WELL

RESULTS COMPARED TO GROUNDWATER TARGET CLEANUP LEVELS (GTCLs):

MW-77	
LSAS	(36 – 41')
1,4-Dioxane	**65.3**
1,1-DCA	50.2
1,1-DCE	**28.5**
Cis-1,2-DCE	2.3
PCE	1.7
TCE	**9**

MONITORING WELL ID
MONITORING WELL SCREEN INTERVAL (FEET BELOW GROUND SURFACE)
RESULT < GTCL
RESULT > GTCL (BOLD)

I= REPORTED VALUE IS BETWEEN THE LABORATORY DETECTION LIMIT AND THE LABORATORY PRACTICAL QUANTITATION LIMIT

U= CONCENTRATION WAS BELOW LABORATORY DETECTION LIMIT

NOTES:

1. GTCLs FOR EACH COC ARE LISTED IN SECTION 3.2 OF THE IRAP.
2. ALL CONCENTRATIONS REPORTED IN ug/L.
3. ALL RESULTS ARE PROVIDED IN TABLE 3.9 OF THE SARA II.
4. BASE MAP INFORMATION OBTAINED FROM A TETRA TECH, INC. FIGURE 2-8 ENTITLED "TCE IN SURFICIAL AQUIFER SYSTEM BASED ON SCREEN POINT SAMPLING AT THE BASE OF THE SURFICIAL AQUIFER" DATED 10/5/04, AT A SCALE OF 1"=280'.

0 50' 100'
GRAPHIC SCALE

FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA
INTERIM REMEDIAL ACTION PLAN

GROUNDWATER ANALYTICAL RESULTS FOR LSAS - JUNE/JULY 2005

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FIGURE
6

X: 38037X00.DWG, 38037X01.BMP
L: ON=*, OFF=REF
P: PAGESET/SYR-DL
12/13/05 SYR-85-GMS SDL
38037001/38037B03.DWG

LEGEND:

—·—·—	SITE BOUNDARY
┼┼┼┼┼┼	RAILROAD TRACKS
—x—x—	FENCE
MW-79	MONITORING WELL
A	CONCEPTUAL GROUNDWATER EXTRACTION WELL LOCATION IN UPPER AND LOWER SURFICAL AQUIFER
A A'	LOCATION OF CONCEPTUAL HYDROGEOLOGIC CROSS SECTION OF PROPOSED IRA

NOTE:

1. BASE MAP INFORMATION OBTAINED FROM A TETRA TECH, INC. FIGURE 2-8 ENTITLED "TCE IN SURFICIAL AQUIFER SYSTEM BASED ON SCREEN POINT SAMPLING AT THE BASE OF THE SURFICIAL AQUIFER" DATED 10/5/04, AT A SCALE OF 1"=280'.

0 50' 100'
GRAPHIC SCALE

FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA
INTERIM REMEDIAL ACTION PLAN

PROPOSED IRA SITE PLAN

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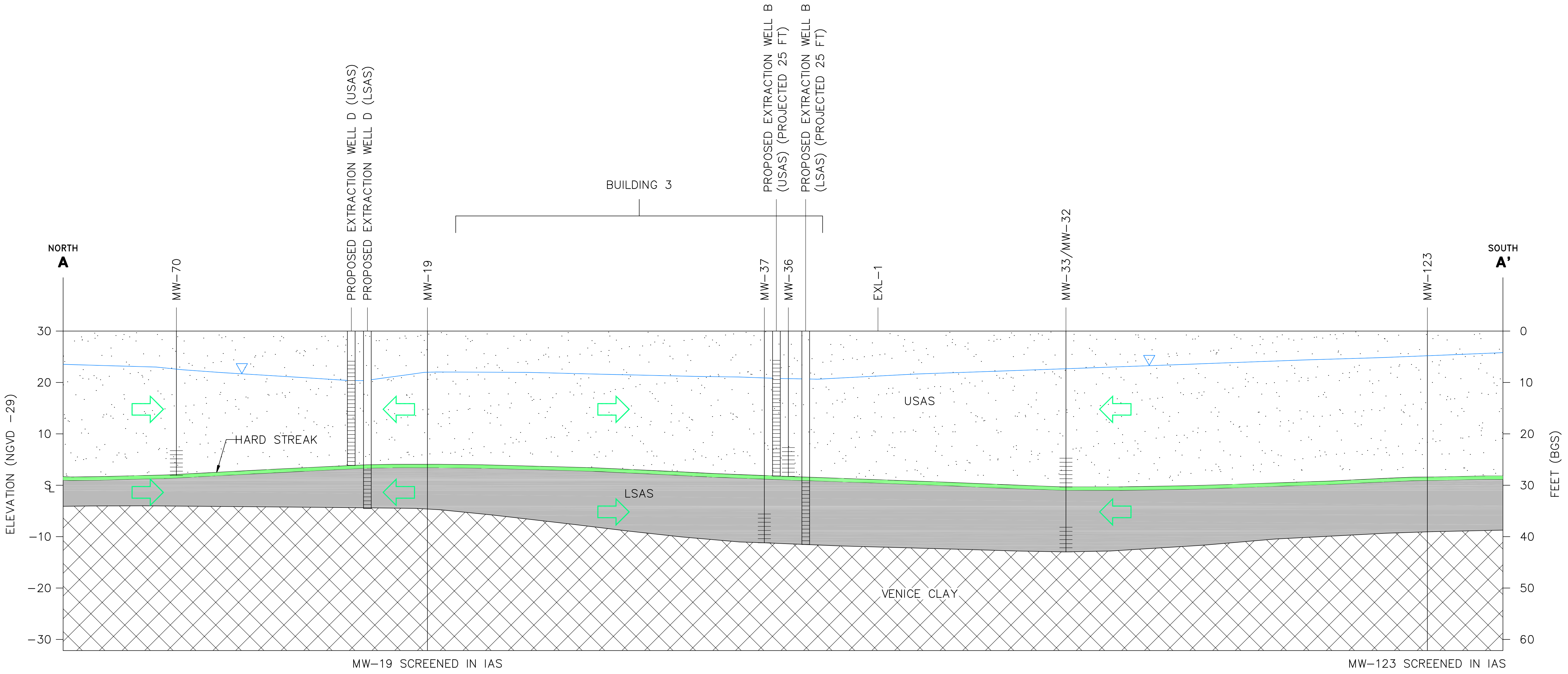
FIGURE
7



0 20' 40'
APPROXIMATE HORIZONTAL SCALE

0 10' 20'
APPROXIMATE VERTICAL SCALE

LEGEND:

▽	CONCEPTUAL POTENTIOMETRIC SURFACE IN USAS DURING IRA OPERATION
⇨	ANTICIPATED GROUNDWATER FLOW DIRECTION
≡	EXISTING MONITORING WELL
‖	PROPOSED EXTRACTION WELL (LOCATION SUBJECT TO CHANGE PENDING RECEIPT OF ADDITIONAL INFORMATION)

FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA
INTERIM REMEDIAL ACTION PLAN

CONCEPTUAL HYDROGEOLOGIC CROSS SECTION OF PROPOSED IRA

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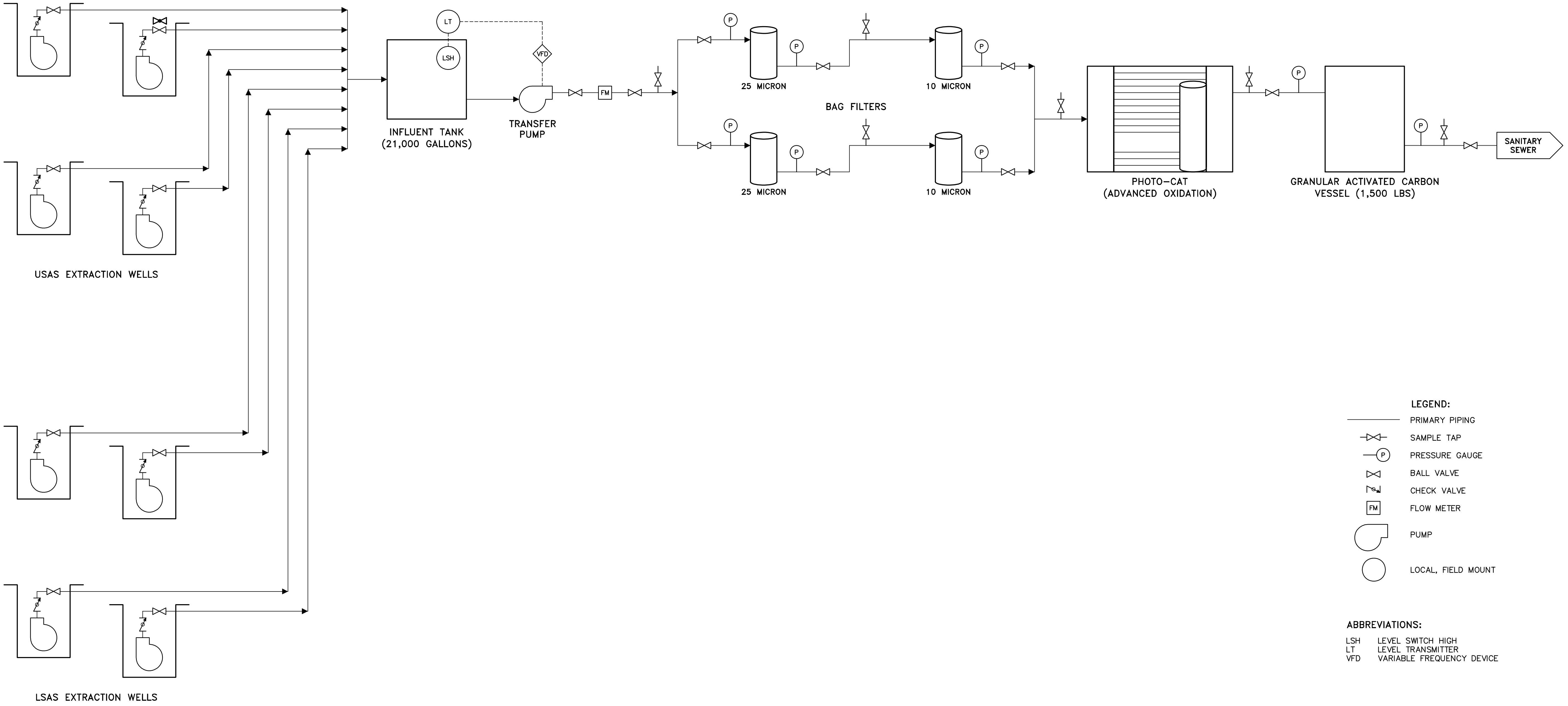
FIGURE
8

X: 38037X00.DWG
L: ON=*, OFF=REF
P: PAGESET/SYR–DL
12/15/05 SYR–85–GMS
38037001/38037V01.DWG



ABBREVIATIONS:

LSH	LEVEL SWITCH HIGH
LT	LEVEL TRANSMITTER
VFD	VARIABLE FREQUENCY DEVICE

X: 38037X00.DWG
L: ON=*, OFF=REF*
P: PAGESET/PLT-DL
12/13/05 SYR-85-DJP SDL
38037001/38037D02.DWG

FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA
INTERIM REMEDIAL ACTION PLAN

PROPOSED IRA PROCESS FLOW DIAGRAM

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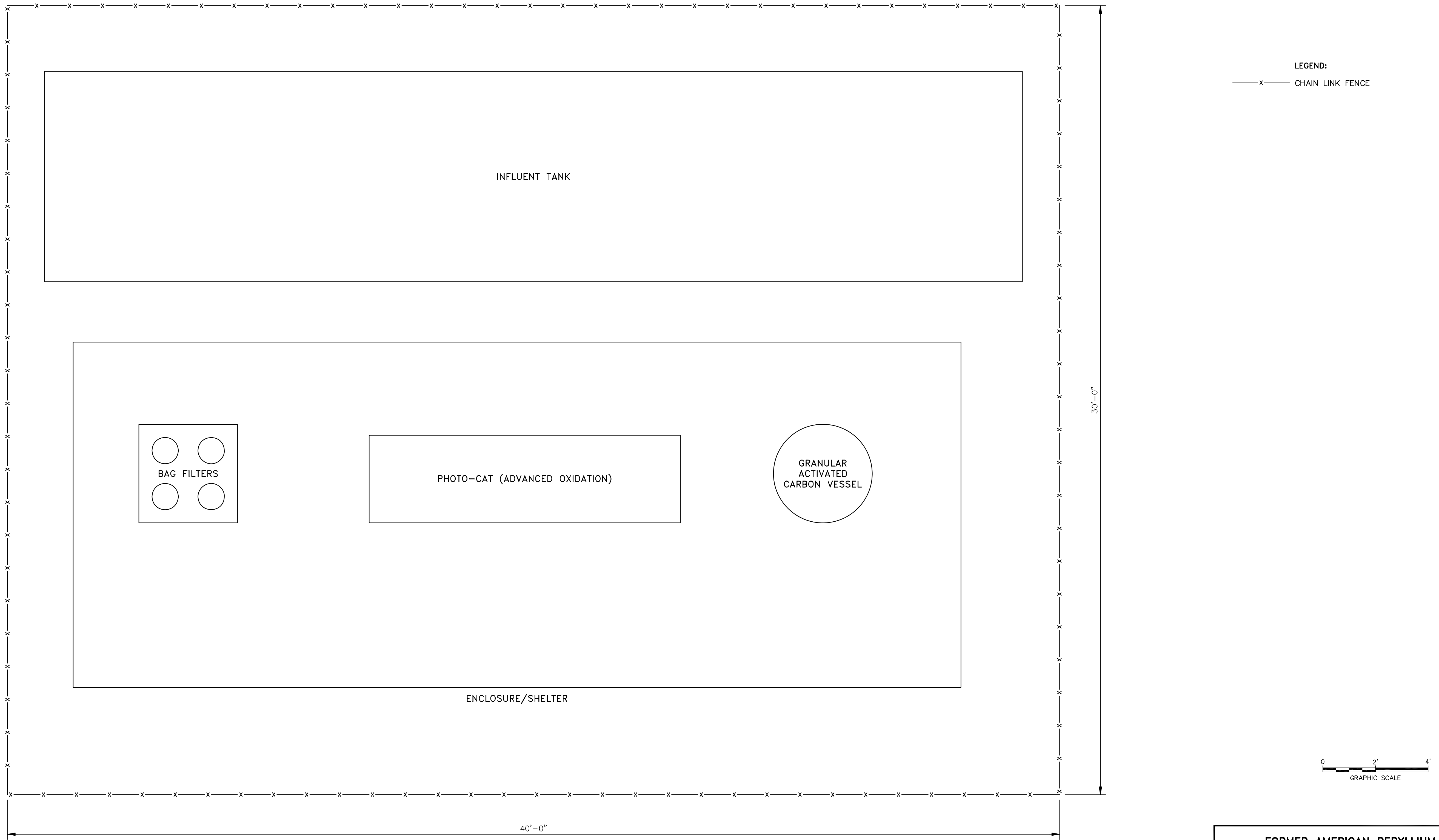
FIGURE
9



FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA

INTERIM REMEDIAL ACTION PLAN

TREATMENT COMPOUND LAYOUT

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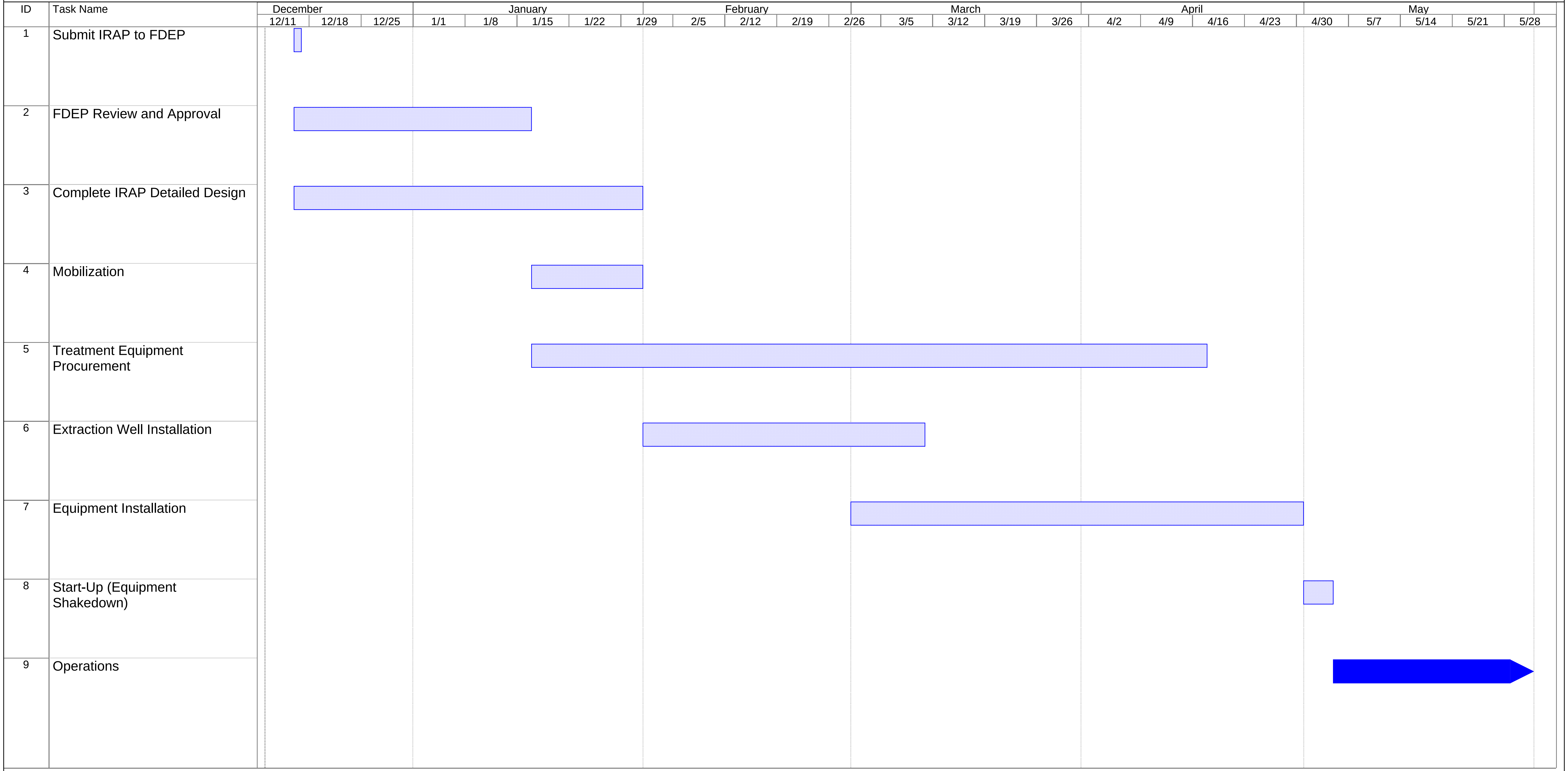
FIGURE
10

X: 38037X00.DWG
L: ON=*, OFF=REF*
P: PAGESET/PLT–DL
12/13/05 SYR–85–TJR DJP SDL
38037001/38037G01.DWG

FIGURE 11 - IMPLEMENTATION SCHEDULE
FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA

INTERIM REMEDIAL ACTION PLAN (IRAP) IMPLEMENTATION



Appendix A

Remedial Action Plan Summary Form

DEP Form # 62-780.900(4)
Form Title: Remedial Action Plan Summary
Effective Date: 4-17-05

Interim
Remedial Action Plan Summary

Site Name: Former American Beryllium Company Site
DEP Site ID No. OGC #04-1328
Location: Tallevast, Manatee County, Florida
Current Date: 12/15/2005
Date of Last GW Analysis: 07/25/2005

CHECK ALL THAT APPLY:

Media Contaminated: ☑ Groundwater ☐ Sediment ☐ Soil ☐ Air

Type(s) of Product(s) Discharged:

☐ Gasoline / Kerosene Analytical Group
☐ Listed Hazardous Waste
☑ Other types of contaminants (solvents, etc.)
List: TCE & 1,4-dioxane

Plume Characteristics:

- Estimated Mass (lbs):
  Groundwater TBD* Soil ___
- Area of Plume 960,000.0000000000 (ft^2)
- Depth of Plume 45.0000000000 (ft)

Groundwater Recovery and Specifications:

- No. of Recovery Wells 8
  ☑ Vertical ☐ Horizontal
- Design Flow Rate/Well 7.5000000000 (gpm)
- Total Flow Rate 60.0000000000 (gpm)
- Hydraulic Conductivity 4.2500000000 (ft/day)
- Recovery Well Screen Interval 40.0000000000 (ft)
- Depth to Water 4.0000000000 (ft)

Method of Groundwater Remediation:

☑ Pump-and-Treat:
  ☐ Air Stripper
    ☐ Low Profile ☐ Packed Tower
  ☐ Diffused Aerator
  ☑ Activated Carbon
    ☐ Primary Treatment ☑ Polishing
☐ In Situ Air Sparging - Pressure: ___ (psi)
- No. of Sparge Points ___
  ☐ Vertical ☐ Horizontal
- Design Air Flow Rate/Well ___ (cfm)
- Total Air Flow Rate ___ (cfm)

☐ Biosparging:
- No. of Sparge Points ___
  ☐ Vertical ☐ Horizontal
- Design Air Flow Rate/Well ___ (cfm)

☐ Bioremediation:
  ☐ In Situ ☐ Ex Situ
☑ Other UV oxidation with titanium dioxide catalyst

Free Product Present: ☐ Yes ☑ No
- Estimated Volume ___ (gal)
- Maximum Thickness ___ (in)
- Method of Recovery wells have sumps & baffled influent tank as precaution

Method of Groundwater Disposal:

☐ Infiltration Gallery ☑ Sanitary Sewer
☐ Surface Discharge/NPDES ☐ Injection Well
☐ Other ___

Method of Soil Remediation: NA for this IRAP

☐ Excavation:
  Volume to be excavated ___ (yds^3)
  ☐ Thermal Treatment ☐ Land Farming On Site
  ☐ Landfill ☐ Bioremediation
  ☐ Other ___
☐ Vapor Extraction System (VES):
- No. of Venting Wells ___
  ☐ Vertical ☐ Horizontal
- VES - Applied Vacuum ___ (wg)
- Design Air Flow Rate ___ (cfm)
- Design Radius of Influence ___ (ft)
- Air Emissions Treatment
  ☐ Thermal Oxidizer ☐ Catalytic Converter
  ☐ Carbon ☐ Other ___

☐ Soil Bioventing:
- No. of Venting Wells ___
  ☐ Vertical ☐ Horizontal
- Design Air Flow Rate ___ (cfm)

☐ In Situ Bioremediation
☐ Other ___

Natural Attenuation:

☐ Groundwater ☐ Soil
- Method of Evaluation:
  ☐ Historical Trends
  ☐ Site-Specific Parameters

Estimated Time of Cleanup: TBD* (days)
- Method of Estimation:
  ☐ Pore Volumes (no. of pore vols. = ___)
  ☐ Exponential Decay (Decay Rate) ___ (day^{-1})
  ☐ Groundwater Transport Model ___
  ☐ Other ___

* = To be determined as part of the Remedial Action Plan for the entire Site.

Appendix B

Pumping Test and Capture Zone Evaluation

BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

REPORT

Pumping Test & Capture Zone Analyses

Former American Beryllium Company Site
1600 Tallevast Road
Tallevast, Florida

December 2005

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Table of Contents

Tables

Figures

Attachments

1. Introduction

1.1 Purpose and Objectives

In accordance with the Remedial Action Work Plan (RAWP, TetraTech, Inc. [TetraTech, 2005]), TetraTech conducted one 48-hour and one 24-hour pumping test in the Surficial Aquifer System (SAS) at the Former American Beryllium Company Site (Site) located in Tallevast, Florida. The 48-hour pumping test was conducted in the Upper Surficial Aquifer System (USAS) which extends from 2 to 5 feet below ground surface (bgs) to a depth of approximately 30 feet bgs. The USAS 6-inch-diameter pumping well was screened from 15 to 30 feet bgs, and installed on-site just east of Building 5. The 24-hour pumping test was conducted in the Lower Surficial Aquifer System (LSAS) which extends approximately between 35 and 40 feet bgs. The 6-inch-diameter, fully penetrating pumping well was screened between 35.5 and 40.5 feet bgs, and installed on-site just south of Building 5.

The purpose and objectives of the pumping test as described in the RAWP were to:

- Obtain information of the sustainable yield of the target aquifer zones;
- Observe the area of influence that can be achieved by pumping;
- Estimate aquifer parameters (hydraulic conductivity and storage coefficients);
- Identify hydraulic connectivity and interference between aquifer zones;
- Measure the concentration of the contaminants of concern (COCs) in the extracted groundwater; and
- Evaluate the effectiveness and efficiency of advanced oxidation technologies for treatment of extracted groundwater.

In addition, the pumping test data from TetraTech provided relevant information to support the development of the Basis of Design for the Interim Remedial Action Plan (IRAP). Specifically, Blasland, Bouck & Lee, Inc. (BBL) has used the pumping test data to:

- Estimate the number, location, and pumping rate of wells that may be required to capture on-site groundwater where highly concentrated COCs are present;
- Perform an evaluation of the distance-drawdown data produced from the tests to estimate the potential shape and size of the capture zone that may result by operating a system of extraction wells at the same per-well rates used during the pumping tests; and
- Measure the concentration of the COCs in the extracted groundwater.

1.2 Hydrogeologic Characteristics

The hydrogeology of the site was also characterized in Section 2 of the IRAP. This portion of Manatee County is relatively flat and generally within 30 feet of mean sea level. A local topographic high point is near the southwest portion of the Site. Groundwater in the SAS is encountered at approximately three to five feet bgs. The SAS is further subdivided into the USAS composed of fine to medium grained sands (approximately 30 feet in thickness), and the LSAS consisting of a thin layer of fossiliferous carbonate and clayey gravel (approximately 5 feet in thickness). The SAS is separated from the Floridan Aquifer by the Venice Clay and carbonate units of the upper Arcadia Formation that form the intermediate aquifer system (IAS), approximately 300 feet in thickness. The Venice Clay forms the upper confining unit of the IAS and is between 30 to 40 feet in thickness. Strong downward hydraulic gradients exist between the USAS and the LSAS, with an approximately 5 to 7 foot head drop across the approximately 1- to 1.4-foot thick, partially cemented layer know as the "hard streak" that separates the two units. Similarly, the vertical component of the hydraulic gradient is downward between the LSAS and the IAS, with an approximately 5 foot head drop across Venice Clay and the clayey confining units in the upper 100 to 200 feet of the IAS.

The Site is adjacent to the northeastern corner of the Sarasota/Bradenton airport. The surrounding area is primarily mixed commercial/residential, with an abandoned industrial facility, a golf course and undeveloped land to the west and south and private residences mixed with undeveloped land in the other directions surrounding the site. The golf course is reportedly the site of a former automotive salvage yard. Multiple residential water supply wells are in close proximity to the Site. Previous surveys conducted by Lockheed Martin indicate over 50 residential water supply wells within a quarter-mile radius of the site. These wells are typically completed into the IAS. The presence of these wells is significant in that they provide a direct hydraulic connection between discrete water bearing units.

Site-specific water level measurements obtained in May 2005 indicate that, in plan view, groundwater flow mirrors the topography of the area, and may also be influenced by irrigation on the adjacent golf course. The regional hydraulic gradient direction in the USAS is primarily toward the north, and that there are localized radial groundwater flow patterns away from the Site toward the northwest, north, and northeast. In the LSAS, a potentiometric mound is observed at the golf course, with a generally northward hydraulic gradient at the Site. Site-specific flow in the IAS is predominantly to the west, consistent with regional conditions; however, there also appears to be some radial impact to flow in this system.

2. Pumping Test Procedures

2.1 Pumping Test Layout

The layout for the USAS pumping test consisted of one pumping well and eleven monitoring wells ranging in radial distance of approximately 18 feet to 422 feet from the pumping well (see Table B-1 and Figure B-1). The USAS pumping test monitoring wells consisted of USAS, LSAS, and IAS wells as follows:

- Seven USAS monitoring wells screened in the bottom 5 feet of the aquifer between approximately 23 feet and 28 feet bgs;
- Two LSAS monitoring wells screened between approximately 35 feet and 40 feet bgs; and
- Two IAS monitoring wells (one IAS monitoring well screened between 100 feet and 110 feet in the Upper Acadian Formation Gravels, and one IAS monitoring well screened between 140 feet and 150 feet in the Upper Acadian Formation Salt and Pepper Sands).

The layout for the LSAS pumping test consisted of one pumping well and eleven monitoring wells ranging in radial distance of approximately 12 feet to 422 feet from the pumping well (see Table B-2 and Figure B-2). The LSAS pumping test monitoring wells consisted of USAS, LSAS, and IAS wells as follows:

- Four USAS monitoring wells screened in the bottom 5 feet of the aquifer between approximately 23 feet and 28 feet bgs;
- Five LSAS monitoring wells screened between approximately 35 feet and 40 feet bgs; and
- Two IAS monitoring wells (one IAS monitoring well screened between 100 feet and 110 feet in the Upper Acadian Formation Gravels, and one IAS monitoring well screened between 140 feet and 150 feet in the Upper Acadian Formation Salt and Pepper Sands).

The purpose of these layouts was to allow for the collection of time- and distance-drawdown water level measurements during performance of 48-hour and 24-hour pumping tests in the USAS and LSAS, respectively.

2.2 Pumping and Observation Well Installation

To accomplish the objectives of the pumping tests, two 6-inch-diameter pumping wells and two additional monitoring wells were installed at the locations shown on Figures B-1 and B-2.

The USAS and LSAS pumping wells (EXU-1 and EXL-1, respectively) were constructed of 6-inch-diameter PVC well materials and were screened from approximately 15 to 30 feet bgs for EXU-1 and 35.5 feet to 40.5 feet bgs for EXL-1. The intake portion of the pumping wells had 0.020-inch width slots.

Two monitoring wells were installed using as follows:

- One IAS monitoring well (MW-127) was installed approximately 18 feet from EXU-1 and 39 feet from EXL-1 in the Upper Acadian Formation Gravel Sands and was screened between 100 feet and 110 feet bgs; and

- One IAS monitoring well (MW-128) was installed approximately 34 feet from EXU-1 and 12 feet from EXL-1 in the Upper Acadian Formation Salt and Pepper Sands and was screened between 140 feet and 150 feet bgs.

2.3 Surface Water and Barometric Pressure Monitoring Stations

One surface water monitoring station was established in the small pond located on-site west of Buildings 1 and 2. Water levels in the pond were monitored throughout the duration of the pumping tests. Tidal data was obtained from the NOAA/NO/CO-OPS Station #8726384 in Port Manatee, Florida, approximately 20 miles north of the Site. Hourly barometric pressure data was obtained from a weather station in Sarasota, Florida. Precipitation data was obtained both on-site during the test and from the NOAA weather station at the Sarasota/Bradenton International Airport.

2.4 Time Drawdown Data Collection

The USAS pumping test was performed by extracting groundwater from pumping well EXU-1 at a nearly constant rate of 3 gallons per minute (gpm) (variable during this first 30 minutes of the test) and measuring water levels at the monitoring wells and in the on-site pond. Water levels were measured using data-logging pressure transducers installed in the pumping well and four of the USAS monitoring wells and manually using hand-held water level meters at all monitoring wells. The data-logging pressure transducers were programmed to record water level measurements at 5-second (0.08-minute) increments throughout the pumping test.

The 48-hour USAS pumping test was conducted between September 21, 2005 at 6:50 am and September 23, 2005 at 7:02 am, when the pump was turned off. The data-logger and manual gauged water level measurements recorded water-level recovery data for up to 12 hours. After sufficient water-level recovery data were collected, the data loggers were stopped and data were downloaded from the transducers. The data is summarized in Table B-3. All recovered groundwater was containerized, treated, and discharged to the publicly owned treatment works (POTW).

The LSAS pumping test was performed by extracting groundwater from pumping well EXL-1 at a nearly constant rate of 5 gallons per minute (gpm) (variable during this first 50 minutes of the test) and measuring water levels at the monitoring wells and in the on-site pond. Water levels were measured using data-logging pressure transducers installed in the pumping well, three LSAS monitoring well and one background USAS monitoring well (MW-72) and manually using hand-held water level meters at all monitoring wells. The data-logging pressure transducers were programmed to record water level measurements at 5-second (0.08-minute) increments throughout the pumping test.

The 24-hour LSAS pumping test was conducted between September 23, 2005 at 8:05 pm and September 24, 2005 at 8:05 pm, when the pump was turned off. The data-logger and manual gauged water level measurements recorded water-level recovery data for up to 34 hours. After sufficient water-level recovery data were collected, the data loggers were stopped and data were downloaded from the transducers. The data is summarized in Table B-4. All recovered groundwater was containerized, treated, and discharged to the POTW.

2.5 Groundwater Quality Sampling

On-site testing of extracted groundwater was completed during both the USAS and LSAS pumping tests. All extracted groundwater during the pumping tests was collected into a 6,000 gallon tank. Water was pumped from this collection tank to a Purifics ES Inc., on-site Photo-Cat system. Prior to treatment of groundwater within the Photo-Cat system, groundwater was filtered using a 10 um cartridge filter and influent samples were analyzed for key organic concentration, 1,4-dioxane, and other VOC concentrations.

Extracted groundwater during the USAS test was collected for analysis prior to entering the Photo-Cat treatment system. Influent samples into the Photo-Cat system where analyzed on September 21, 2005 at 7:35 am (45 minutes after the start of pumping) and 1:15 pm (6 hours and 25 minutes after the start of pumping); on September 22, 2005 at 12:15 pm (approximately 29.5 hours after the start of pumping) and 5:00 pm (approximately 34 hours after the start of pumping); on September 23, 2005 at 10:30 am (approximately 3.5 hours after the cessation of pumping) and 2:00 pm (approximately 7 hours after the cessation of pumping). Since water was held in the collection tank prior to sampling, the time that each sample was extracted from the aquifer is unknown. Results from the on-site water quality analysis of USAS extracted groundwater are presented in Table B-5.

Prior to extracting groundwater from the LSAS, all USAS groundwater remaining in the collection tank was pumped out. Only one influent sample was analyzed for water quality parameters on September 24, 2005 at 10:00 am, approximately 14 hours after the start of pumping during the LSAS test. Results from the on-site water quality analysis of LSAS extracted groundwater are presented in Table B-5.

3. Preliminary Estimate of Capture Zone

3.1 Introduction

The capture zone analysis presented below is based on the design parameters described in Section 3 (Basis of Design) of the IRAP Report. This analysis utilizes a distance-drawdown evaluation based on the per-well pumping rates demonstrated during the USAS and LSAS pumping tests to predict the drawdown and capture zone that may potentially be achieved by four proposed pumping wells in the USAS and two proposed pumping wells in the LSAS.

3.2 Observed Pumping Rate and Drawdown

The USAS pumping test was completed between September 21 and 23, 2005. Following the first 30 minutes of pumping, during which pumping-rate adjustments were made, the pumping rate was held constant at 3 gpm. Pumping rates were measured by recording elapsed time and flow meter readings as the test progressed. The pumping rate was checked every 2 to 10 minutes during the first 30 minutes and every 10 to 60 minutes for the remainder of the test. Figures summarizing time-drawdown and pumping rate data from the USAS pumping test are included in the Attachment B-1.

Manually gauged and level-logger water level measurements were converted to drawdown values which were used to create a distance-drawdown graph for the USAS pumping test (Figure B-3). The distance-drawdown data used to create Figure B-3 are listed in Table B-3. Figure B-3 illustrates the resulting drawdown after approximately 1.94 days of pumping (just prior to the cessation of pumping) as observed using manual measurements for the monitoring wells screened in the USAS and level-logger data for the pumping well (EXU-1). Theoretically, when drawdown data are plotted versus to log of distance (from observation well to pumping well), a straight line can be fit through the distance-drawdown data to predict the effect of pumping at any distance from the pumped well. The slope of the straight line can be used to estimate values of transmissivity and storativity for the aquifer (Driscoll, 1986).

The LSAS pumping test was completed between September 23 and 24, 2005. Following the first 50 minutes of pumping, during which pumping-rate adjustments were made, a constant pumping rate of 5 gpm was maintained. The pumping rate was checked every 5 minutes during the first 75 minutes and every 10 to 60 minutes for the remainder of the test. Figures summarizing time-drawdown and pumping rate data from the LSAS pumping test are included in the Attachment B-1.

Similar to the USAS pumping test, manually gauged and level-logger water level measurements were converted to drawdown and used to create a distance-drawdown graph for the LSAS pumping test (Figure B-4). The distance-drawdown data used to create Figure B-4 is listed in Table B-4. Figure B-4 illustrates the resulting drawdown after approximately 0.96 days of pumping (just prior to the cessation of pumping) as observed using manual measurements for the monitoring wells screened in the LSAS and level-logger data for the pumping well (EXL-1). To be conservative, it was assumed that the drawdown immediately outside of the pumping well was approximately half of the measured in-well drawdown.

3.3 Capture Zone Estimation

3.3.1 USAS Capture Zone

The distance-drawdown relationship for the USAS was used to estimate values of transmissivity and storativity as mentioned above. These values were then used, in conjunction with the pumping rate applied during the test, to estimate the drawdown distribution for a longer period of pumping. The non-equilibrium equation developed by Theis (Theis, 1935) was used to predict the effect of pumping from each of four conceptual extraction wells after 90 days of pumping. The drawdown created by one extraction well after 90 days as predicted by the Theis solution is also shown on Figure B-3. Since the September 2005 USAS pumping test data indicate that drawdown observed at the monitoring wells was less than 20% of the initial saturated thickness of the aquifer, a correction to the Theis solution was not required to account for the unconfined nature of the aquifer.

A straight-line fit to the Theis solution on the semilog plot was the used to predict the drawdown that would be expected at each USAS monitoring well in the existing on- and off-site monitoring network. By superimposing the predicted drawdown from each of the four conceptual extraction wells, the resulting drawdown at each of the network monitoring wells was calculated. Where May 2005 water table elevation data was available, the predicted drawdown was subtracted from the static water table elevation at each monitoring well resulting in an estimate of the predicted water table elevation after 90 days of pumping from four conceptual extraction wells pumping at a rate of 3 gpm each.

The resulting predicted groundwater elevation across the USAS was used to estimate the capture zone that would be created from the four conceptual extraction wells. For the USAS, these extraction wells were designated as USAS wells A, B, C, and D. The approximate location of the extraction wells relative to USAS network monitoring wells and a preliminary estimate of the capture zone created are presented in Figure B-5. Results of the capture zone analysis suggest the potential for capture of on-site groundwater east of the pond (where COC concentrations are shown to be highest) as well as possibly a limited amount of groundwater in the USAS located north, east, and south of the site.

3.3.2 LSAS Capture Zone

The distance-drawdown relationship obtained from the LSAS pumping test indicates that the effects of pumping extended well beyond the furthest LSAS monitoring well (MW-41) during the 24-hour test. A straight line on the semilog plot of distance-drawdown data (Figure B-4) was fit through the monitoring well data and extended back to where the drawdown predicted immediately adjacent to the pumping well was equal to half of the observed drawdown in the pumping well. This created a straight line that predicts a drawdown of approximately 6.75 feet just outside the well bore and a drawdown of approximately 4.25 feet at a radial distance of 100 feet from the pumping well.

The equation of this curve was then used to predict the drawdown that would be expected at each LSAS monitoring well in the existing on- and off-site monitoring network after 0.96 days of pumping from one conceptual well at 5 gpm. For this analysis, only two conceptual extraction wells (designated as LSAS wells A and B) were used to estimate the resulting capture zone. By superimposing the predicted drawdown from each of the two conceptual extraction wells, the resulting drawdown at each of the network monitoring wells was calculated. Where May 2005 water table elevation data was available, the predicted drawdown was subtracted from the static water table elevation at each monitoring well resulting in an estimate of the predicted water table elevation after 0.96 days of pumping from two conceptual extraction wells pumping at a rate of 5 gpm each.

The resulting predicted groundwater elevation across the LSAS was used to estimate the capture zone that would be created from the two conceptual extraction wells. The approximate location of the extraction wells relative to LSAS network monitoring wells and a preliminary estimate of the capture zone created are presented in Figure B-6. Results of the capture zone analysis suggest the potential for capture of nearly all onsite groundwater as well as possibly a limited amount of groundwater in the LSAS located north, east, and south of the site. The most appropriate onsite location for additional extraction wells in the LSAS (conceptual wells C and D) will be selected, if necessary, after several months of monitoring the performance of proposed extraction wells A and B.

3.4 Quality of Extracted Groundwater

On-site analytical results for samples of extracted groundwater collected during the pumping tests are summarized in Table B-5. Purifics reported that four samples were sent to an off-site laboratory for confirmation of the results. Laboratory results were found to agree reasonably well with on-site results (Purifics, 2005). On-site analytical testing revealed the following regarding the quality of extracted groundwater during the pumping test:

- Alkalinity is 3 times greater in the LSAS (220 parts per million [ppm]) than in the USAS (60 – 80 ppm);
- The concentration of chlorides in the LSAS (100 – 120 ppm) is approximately 1.5 times greater than in the USAS (60 – 80 ppm);
- 1,1-Dichloroethene concentration were similar for the USAS and LSAS reaching a maximum of 190 micrograms per liter (µg/L) in the USAS and 160 µg/L in the LSAS;
- cis-1,2-dichoroethene concentration were over 4 times greater in the USAS (reaching 280 µg/L) than in the LSAS (60 µg/L);
- Tricholorethene concentrations in extracted groundwater increased from 540 µg/L to 11,000 µg/L during the USAS pumping test while in the LSAS was reported at a concentration of 920 µg/L;
- Tetrachloroethene in both the USAS and LSAS was below 10 µg/L where detected. Several USAS samples were below detection (< 200 µg/L); and
- 1,4-Dioxane concentrations in the USAS extracted groundwater remained between 200 and 300 µg/L for the duration of the test. Concentrations of 1,4-dioxane were over 3 times greater in the LSAS (990 µg/L).

4. Conclusions

The 48-hour USAS pumping test and 24-hour LSAS pumping test performed at the Site in September 2005 accomplished the objectives outlined in Section 1.1. Additionally, the USAS pumping test data were used to estimate aquifer parameters such as transmissivity and storativity for the USAS. The pumping test results were used to provide hydrogeologic and groundwater quality data to support design analyses presented in Section 3 of the IRAP. In summary, the pumping test results indicate the following:

- The distance-drawdown data suggest that the effects of pumping at distances beyond approximately 120 feet from the pumping well are negligible after 2 days of pumping from one well at 3 gpm within the USAS;
- The distance-drawdown data suggest that the effects of pumping at approximately 120 feet from the pumping well result in over 4 feet of drawdown after nearly 1 day of pumping from one well at 5 gpm within the LSAS;
- The transmissivity value for the USAS was estimated from distance-drawdown data to be approximately 106 ft^2/day;
- The storativity value for the USAS was estimated from distance-drawdown data to be approximately 0.0295 (dimensionless);
- Four extraction wells in the USAS (wells A, B, C, and D), pumping at a rate of at least 3 gpm each, may be capable of capturing on-site groundwater with highly concentrated COCs in the USAS;
- Two extraction wells (wells A and B) in the LSAS, pumping at a rate of at least 5 gpm each, may be capable of capturing on-site groundwater with highly concentrated COCs in the LSAS;
- The preliminary estimate of the USAS capture zone suggests that groundwater may be contained on-site east of the pond and to some extend off-site to the north, east and south, after 90 days of pumping at four wells (approximately 3 gpm each) - groundwater elevation monitoring during operation of the first four wells will be used to verify the USAS capture zone and determine the need for system adjustments, if any,
- The preliminary estimate of the LSAS capture zone suggest that groundwater can be contained on-site and to some extent off-site to the north, east and south after a shorter period of pumping at two wells (approximately 5 gpm each) - groundwater elevation monitoring during operation of the first two wells will be used to verify the LSAS capture zone and determine the need for system adjustments, if any;
- Alkalinity and chlorides concentration were reported several times greater in the LSAS than the USAS;
- Trichloroethene was reported as the highest concentration COC in the USAS (11,000 µg/L) and second highest concentration COC in the LSAS (920 µg/L);
- 1,4-Dioxane was reported as the highest concentration COC in the LSAS (990 µg/L) and the second highest concentration COC in the USAS (300 µg/L); and
- Concentrations of most COCs analyzed during the 48-hour USAS pumping test increased as pumping progressed and reached nearly steady concentrations during the second day of pumping.

5. References

Driscoll, F.G. 1986. *Groundwater and Wells*. Johnson Screens, St. Paul, Minnesota, pp. 236-238.

Purifics, 2005. *Test Report, Photo-Cat Treatment of Groundwater at the Former ABC Site – Sarasota*, Submitted to Tetra Tech November 4, 2005.

Tetra Tech, 2005, *Remedial Action Work Plan, Former American Beryllium Company*, Submitted July 2005.

Theis, C. V. 1935. *The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage*. Trans. Amer. Geophys. Union, 2, pp. 519-524.

Tables

TABLE B-1
SUMMARY OF WELLS MONITORED DURING USAS PUMPING TEST

INTERIM REMEDIATION ACTION PLAN
FORMER AMERICAN BERYLLIUM PHOSPHATE SITE
TALLEVAST, FLORIDA

Pumping or Monitoring Well	Groundwater Zone	Distance to EXU-1 (ft)	Screened Interval (ft bgs)	Water Level Gauging Method
EXU-1	USAS	0	15 - 30	level logger
MW-36	USAS	18	23 - 28	manual; level logger
MW-127	IAS	19	100 - 110	manual
MW-37	LSAS	22	35.5 - 40.5	manual
MW-128	IAS	34	140 - 150	manual
MW-38	USAS	55	23 - 28	manual; level logger
MW-32	USAS	115	24.5 - 29.5	manual; level logger
MW-33	LSAS	117	35.5 - 40.5	manual
MW-71	USAS	195	24 - 29	manual
MW-76	USAS	208	23 - 28	manual
MW-70	USAS	270	23 - 29	manual
MW-72	USAS	422	23.5 - 28.5	level logger

TABLE B-2
SUMMARY OF WELLS MONITORED DURING LSAS PUMPING TEST

INTERIM REMEDIATION ACTION PLAN
FORMER AMERICAN BERYLLIUM PHOSPHATE SITE
TALLEVAST, FLORIDA

Pumping or Monitoring Well	Groundwater Zone	Distance to EXL-1 (ft)	Screened Interval (ft bgs)	Water Level Gauging Method
EXL-1	LSAS	0	35.5 - 40.5	level logger
MW-128	IAS	13	140 - 150	manual
MW-36	USAS	34	23 - 28	manual
MW-127	IAS	39	100 - 110	manual
MW-37	LSAS	47	35.5 - 40.5	manual; level logger
MW-39	LSAS	54	23 - 28	manual; level logger
MW-32	USAS	76	24.5 - 29.5	manual
MW-33	LSAS	77	35.5 - 40.5	manual; level logger
MW-42	USAS	109	23 - 28	manual
MW-43	LSAS	115	35.5 - 40.5	manual
MW-41	LSAS	118	35.5 - 40.5	manual
MW-72	USAS	422	23.5 - 28.5	level logger

TABLE B-3
DATA USED IN DISTANCE-DRAWDOWN EVALUATION
USAS PUMPING TEST

INTERIM REMEDIATION ACTION PLAN
FORMER AMERICAN BERYLLIUM PHOSPHATE SITE
TALLEVAST, FLORIDA

Pumping or Monitoring Well	Groundwater Zone	Distance to EXU-1 (ft)	Elapsed Time[1] (min)	Elapsed Time (days)	Observed Drawdown (ft)	Source of Data
EXU-1	USAS	0	2790	1.94	20.1[2]	Level Logger
MW-36	USAS	18	2784	1.93	1.81	Manually Gauged
MW-127	IAS	19	*N/A*	*N/A*	*N/A*	*N/A*
MW-37	LSAS	22	*N/A*	*N/A*	*N/A*	*N/A*
MW-128	IAS	34	*N/A*	*N/A*	*N/A*	*N/A*
MW-38	USAS	55	2791	1.94	0.82	Manually Gauged
MW-32	USAS	115	2789	1.94	0.08	Manually Gauged
MW-33	LSAS	117	*N/A*	*N/A*	*N/A*	*N/A*
MW-71	USAS	195	2795	1.94	0.01	Manually Gauged
MW-76	USAS	208	2793	1.94	0[3]	Manually Gauged
MW-70	USAS	270	2798	1.94	0.01	Manually Gauged
MW-72	USAS	422	2790	1.94	0.1	Level Logger

Notes:

N/A: Distance-drawdown data not used. Well is not screened in the USAS.

[1] Water levels were manually gauged approximately 100 minutes prior to the cessation of pumping.

[2] Cessation of pumping occurred after 2895 minutes. Drawdown observed in the pumping well was also 20.1 feet after 2896 minutes.

[3] Negative observed drawdown. Drawdown value set to zero.

TABLE B-4
DATA USED IN DISTANCE-DRAWDOWN EVALUATION
LSAS PUMPING TEST

INTERIM REMEDIATION ACTION PLAN
FORMER AMERICAN BERYLLIUM PHOSPHATE SITE
TALLEVAST, FLORIDA

Pumping or Monitoring Well	Groundwater Zone	Distance to EXL-1 (ft)	Elapsed Time^1 (min)	Elapsed Time (days)	Observed Drawdown (ft)	Source of Data
EXL-1	LSAS	0	1378	0.96	13.5	Level Logger
MW-128	IAS	13	*N/A*	*N/A*	*N/A*	*N/A*
MW-36	USAS	34	*N/A*	*N/A*	*N/A*	*N/A*
MW-127	IAS	39	*N/A*	*N/A*	*N/A*	*N/A*
MW-37	LSAS	47	1387	0.96	4.39	Manually Gauged
MW-39	LSAS	54	1357	0.94	3.08	Manually Gauged
MW-32	USAS	76	*N/A*	*N/A*	*N/A*	*N/A*
MW-33	LSAS	77	1379	0.96	4.32	Manually Gauged
MW-42	USAS	109	*N/A*	*N/A*	*N/A*	*N/A*
MW-43	LSAS	115	1386	0.96	4.25	Manually Gauged
MW-41	LSAS	118	1384	0.96	4.24	Manually Gauged
MW-72	USAS	422	*N/A*	*N/A*	*N/A*	*N/A*

<u>Notes:</u>

N/A: Distance-drawdown data not used. Well is not screened in the LSAS.

[1] Water levels were manually gauged approximately 60 minutes prior to the cessation of pumping.

TABLE B-5
SUMMARY OF GROUNDWATER QUALITY RESULTS

INTERIM REMEDIATION ACTION PLAN
FORMER AMERICAN BERYLLIUM PHOSPHATE SITE
TALLEVAST, FLORIDA

Parameter	Units	USAS						LSAS
		9/21/2005 7:35 AM	9/21/2005 1:15 PM	9/22/2005 12:15 PM	9/22/2005 5:00 PM	9/23/2005 10:30 AM	9/23/05 2:00 PM	9/24/05 10:00 AM
Alkalinity[1]	ppm	60 - 80						220
Iron[1]	ppm	7 - 8						2
Chlorides[1]	ppm	60 - 80						100 - 120
Vinyl Chloride	µg/L	< 1.0	1.2	< 100	< 100	110	< 200	2.1
1,1-Dichloroethylene	µg/L	12.8	25.1	190	120	< 100	< 200	160
c-1,2-dichloroethylene	µg/L	36.6	95.1	< 100	280	270	270	60
Trichloroethylene	µg/L	540	2,800	7,500	10,000	10,000	11,000	920
Tetrachloroethylene	µg/L	3.7	4.8	< 100	< 100	< 100	< 200	1
1,4-Dioxane	µg/L	300	300	200	250	250	250	990

Notes:

ppm parts per million

µg/L micrograms per liter

[1] Inorganic concentrations reported as a range over duration of pumping test.

Figures

LEGEND:

— · · — · · —	SITE BOUNDARY
┼┼┼┼┼┼┼┼	RAILROAD TRACKS
—x—x—	FENCE
EXU-1 ◒	PUMPING WELL INSTALLED BY TETRA TECH
MW-37 ◉	MONITORING WELL INSTALLED BY TETRA TECH

NOTE:

1. BASE MAP INFORMATION OBTAINED FROM A TETRA TECH, INC. FIGURE 2-8 ENTITLED "TCE IN SURFICIAL AQUIFER SYSTEM BASED ON SCREEN POINT SAMPLING AT THE BASE OF THE SURFICIAL AQUIFER" DATED 10/5/04, AT A SCALE OF 1"=280'.

0 50' 100'
GRAPHIC SCALE

FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA
INTERIM REMEDIAL ACTION PLAN

USAS PUMPING TEST LAYOUT
SEPTEMBER 2005

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engineers, scientists, economists

FIGURE
B-1

X: 38037X00.DWG, 38037X01.BMP
L: ON=*, OFF=REF
P: PAGESET/SYR-DL
12/9/05 SYR-85-GMS
38037001/38037B04.DWG

LEGEND:

—·—·—	SITE BOUNDARY
┼┼┼┼┼┼	RAILROAD TRACKS
—x—x—	FENCE
EXL-1 ◓	PUMPING WELL INSTALLED BY TETRA TECH
MW-37 ◉	MONITORING WELL INSTALLED BY TETRA TECH

NOTE:

1. BASE MAP INFORMATION OBTAINED FROM A TETRA TECH, INC. FIGURE 2-8 ENTITLED "TCE IN SURFICIAL AQUIFER SYSTEM BASED ON SCREEN POINT SAMPLING AT THE BASE OF THE SURFICIAL AQUIFER" DATED 10/5/04, AT A SCALE OF 1"=280'.

0 50' 100'
GRAPHIC SCALE

X: 38037X00.DWG, 38037X01.BMP
L: ON=*, OFF=REF
P: PAGESET/SYR-DL
12/9/05 SYR-85-GMS
38037001/38037B05.DWG

FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA
INTERIM REMEDIAL ACTION PLAN

LSAS PUMPING TEST LAYOUT
SEPTEMBER 2005

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engineers, scientists, economists

FIGURE
B-2

FIGURE B-3
DISTANCE-DRAWDOWN DATA: USAS PUMPING TEST

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA

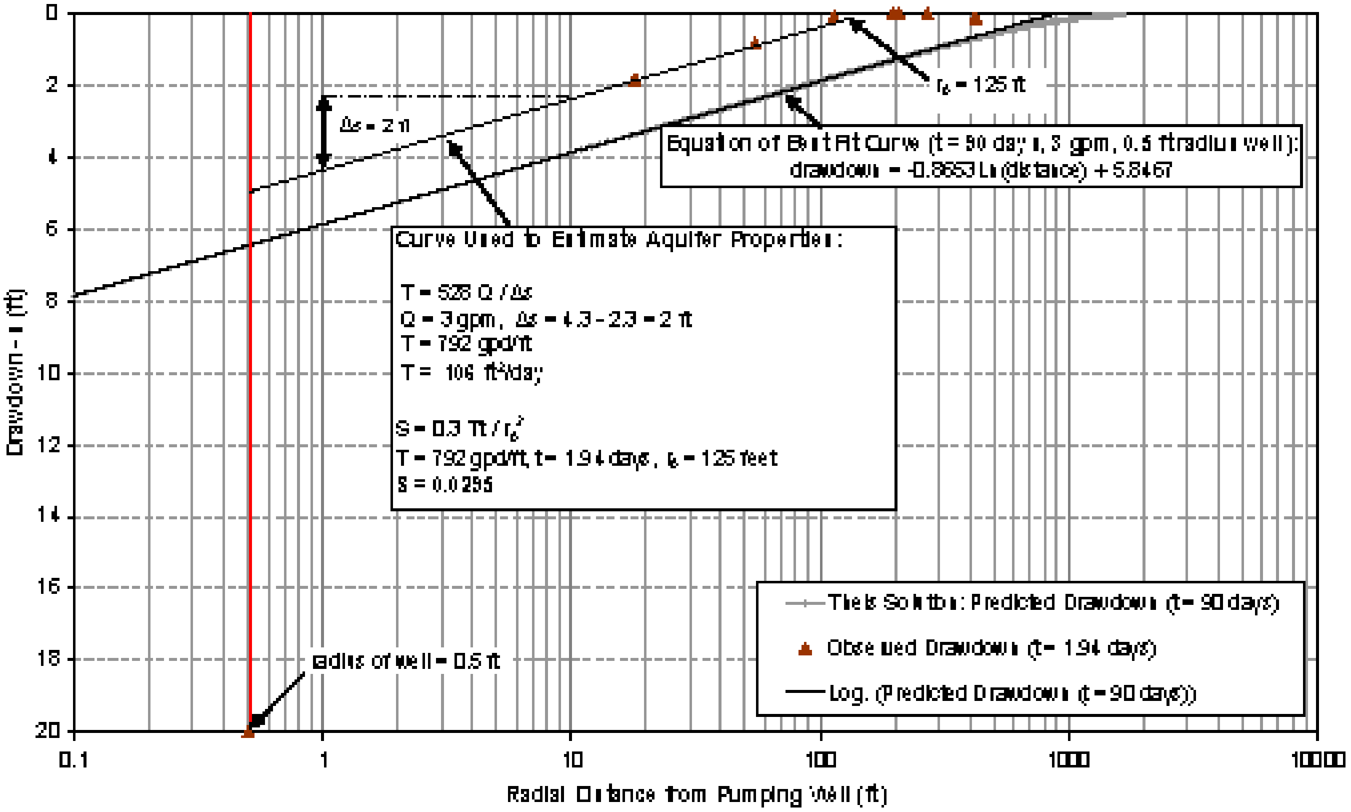
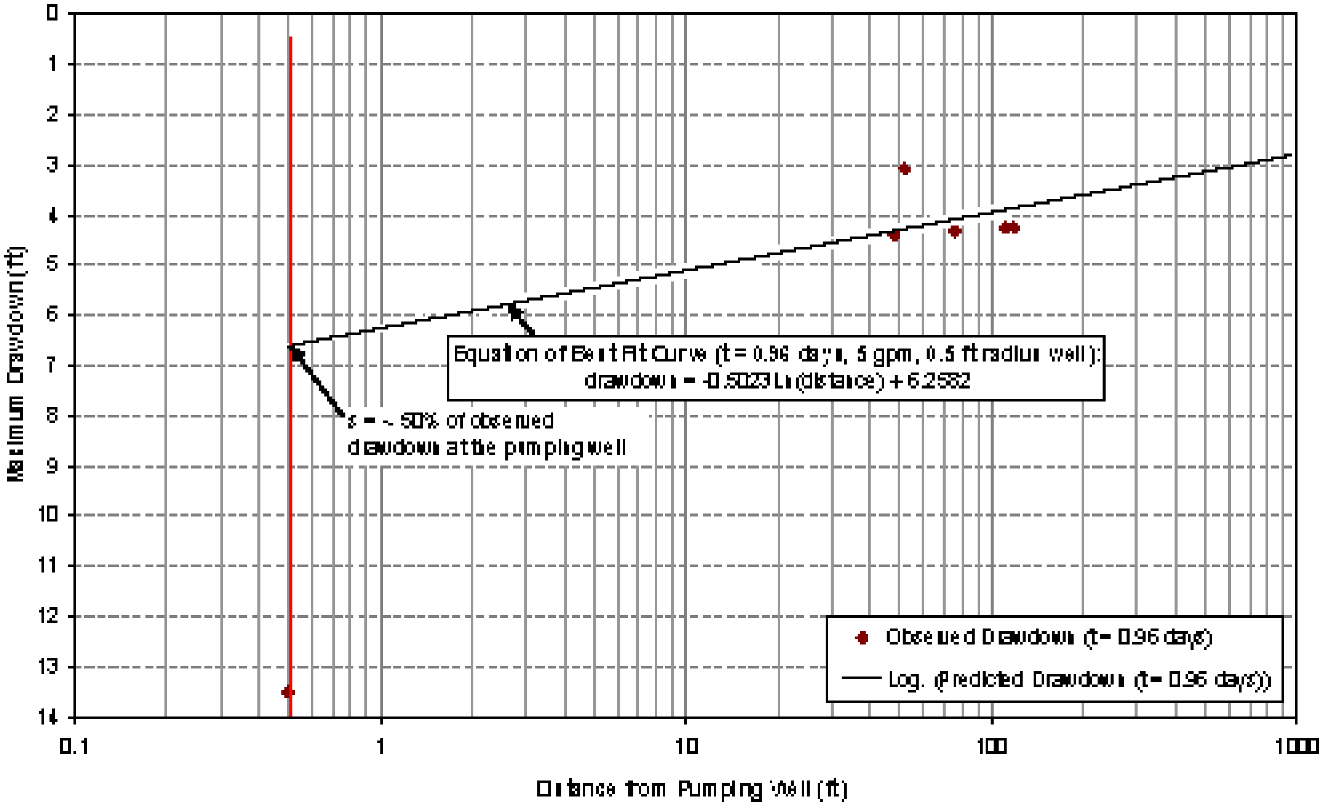


FIGURE B-4
DISTANCE-DRAWDOWN DATA: LSAS PUMPING TEST

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



LEGEND:

-·-·-·- SITE BOUNDARY
┼┼┼┼┼┼┼ RAILROAD TRACKS
—x—x— FENCE
MW-79 ⊕ MONITORING WELL
⊕ B CONCEPTUAL GROUNDWATER EXTRACTION WELL LOCATION IN UPPER SURFICAL AQUIFER
– – – PRELIMINARY ESTIMATE OF CAPTURE ZONE (PUMPING RATE ASSUMED TO BE 3gpm PER EXTRACTION WELL; TOTAL Q=12gpm)

NOTE:

1. CAPTURE ZONE SHOWN HERE IS A PRELIMINARY ESTIMATE BASED ON THE EXTRAPOLATION OF THE USAS PUMPING TEST DATA OUT TO 90 DAYS.
2. BASE MAP INFORMATION OBTAINED FROM A TETRA TECH, INC. FIGURE 2–8 ENTITLED "TCE IN SURFICIAL AQUIFER SYSTEM BASED ON SCREEN POINT SAMPLING AT THE BASE OF THE SURFICIAL AQUIFER" DATED 10/5/04, AT A SCALE OF 1"=280'.

0 50' 100'
GRAPHIC SCALE

FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA
INTERIM REMEDIAL ACTION PLAN

USAS ESTIMATED CAPTURE ZONE

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FIGURE
B-5

X: 38037X00.DWG, 38037X01.BMP
L: ON=*, OFF=REF
P: PAGESET/SYR-DL
12/13/05 SYR-85-GMS
38037001/38037B06.DWG

LEGEND:

-·-·-·- SITE BOUNDARY
┼┼┼┼┼┼ RAILROAD TRACKS
—x—x— FENCE
MW-79⊕ MONITORING WELL
⊕B CONCEPTUAL GROUNDWATER EXTRACTION WELL LOCATION IN LOWER SURFICAL AQUIFER
– – – PRELIMINARY ESTIMATE OF CAPTURE ZONE (PUMPING RATE ASSUMED TO BE 5gpm PER EXTRACTION WELL; TOTAL Q=10gpm)

NOTE:

1. ACTUAL CAPTURE ZONE IS ANTICIPATED TO BE LARGER THAN SHOWN HERE SINCE THE INTERIM RAP WILL INCLUDE PUMPING FROM 4 WELLS (LOCATIONS OF C AND D TO BE DETERMINED UPON RECEIPT OF ADDITIONAL INFORMATION).
2. BASE MAP INFORMATION OBTAINED FROM A TETRA TECH, INC. FIGURE 2-8 ENTITLED "TCE IN SURFICIAL AQUIFER SYSTEM BASED ON SCREEN POINT SAMPLING AT THE BASE OF THE SURFICIAL AQUIFER" DATED 10/5/04, AT A SCALE OF 1"=280'.

0 50' 100'
GRAPHIC SCALE

FORMER AMERICAN BERYLLIUM COMPANY SITE
TALLEVAST, FLORIDA
INTERIM REMEDIAL ACTION PLAN

LSAS ESTIMATED CAPTURE ZONE

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FIGURE
B-6

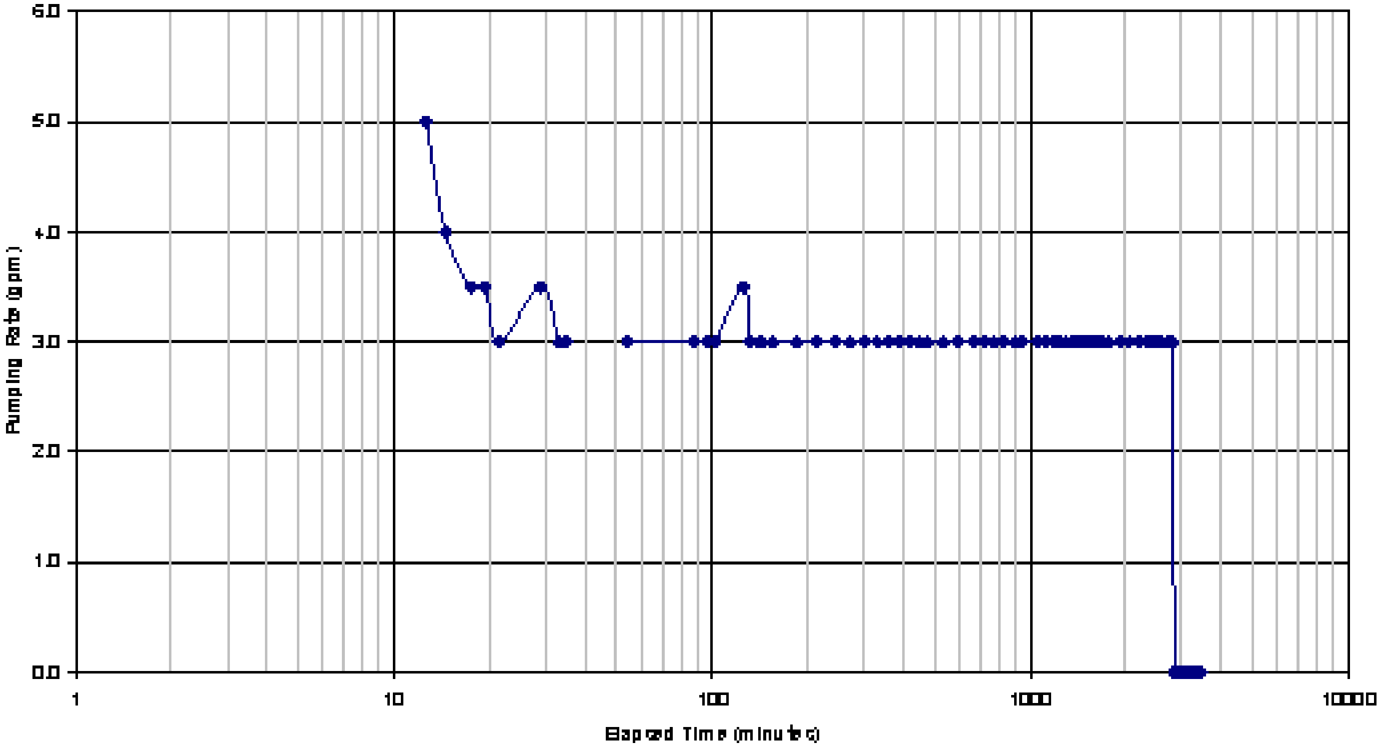
X: 38037X00.DWG, 38037X01.BMP
L: ON=*, OFF=REF
P: PAGESET/SYR-DL
12/13/05 SYR-85-GMS
38037001/38037B07.DWG

Attachment

Pumping Test Data

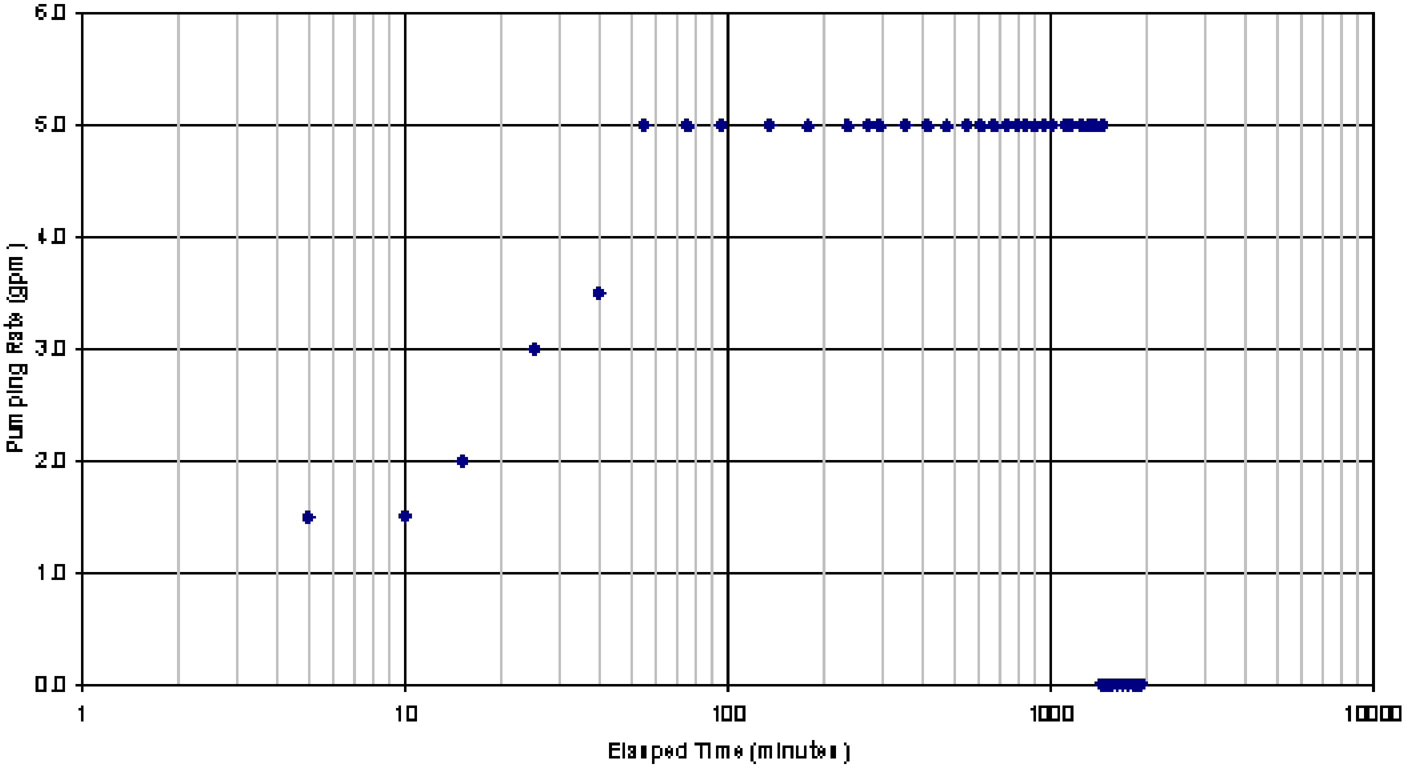
USAS PUMPING TEST: PUMPING RATE

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



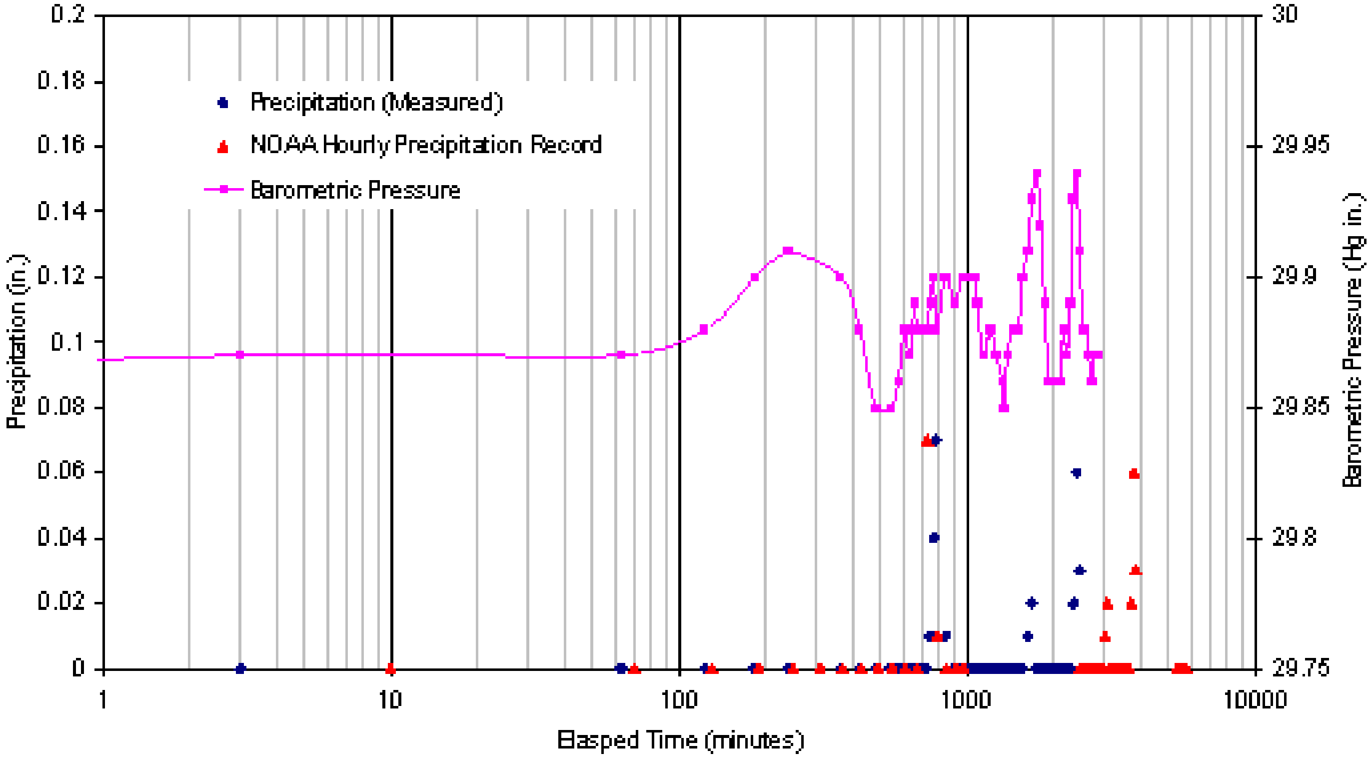
LSAS PUMPING TEST: PUMPING RATE

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



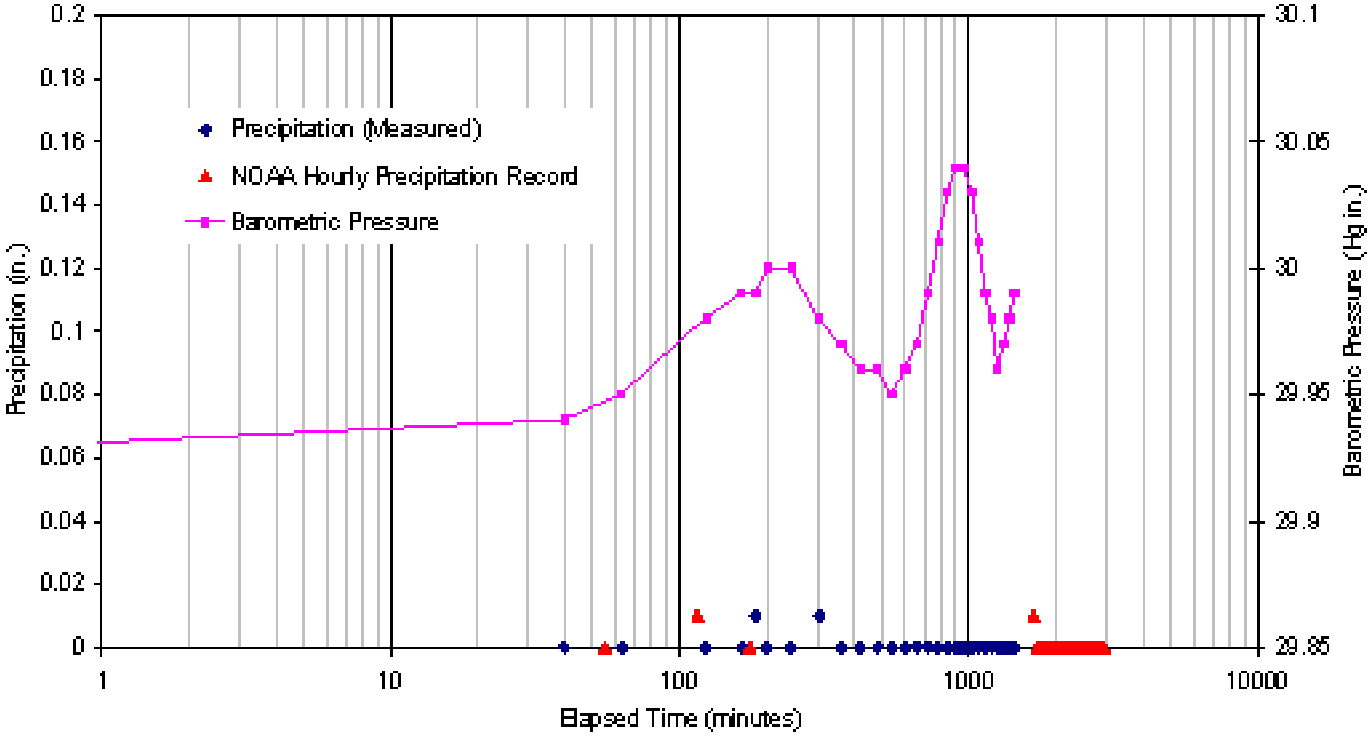
USAS PUMPING TEST
BAROMETRIC PRESSURE AND PRECIPITATION

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



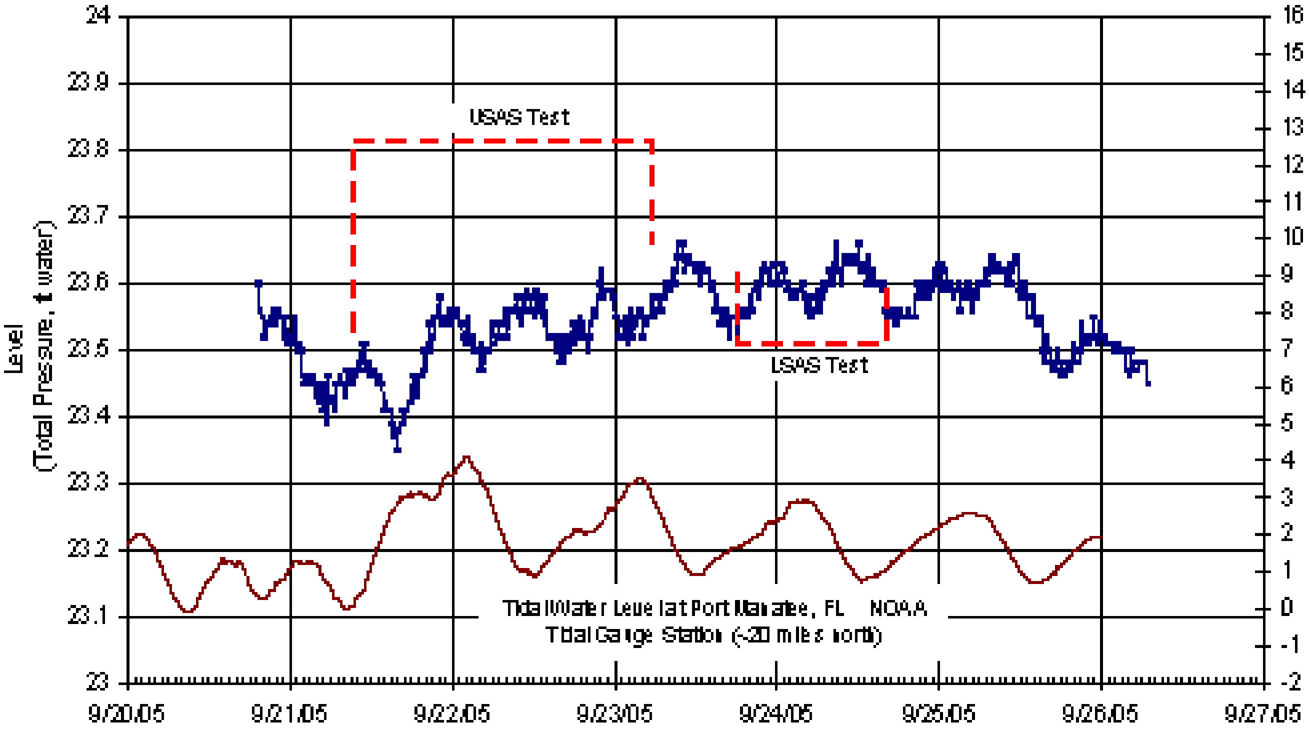
LSAS PUMPING TEST
BAROMETRIC PRESSURE AND PRECIPITATION

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



USAS AND LSAS PUMPING TESTS
USAS MW-72 (BACKGROUND WELL): LEVEL LOGGER DATA

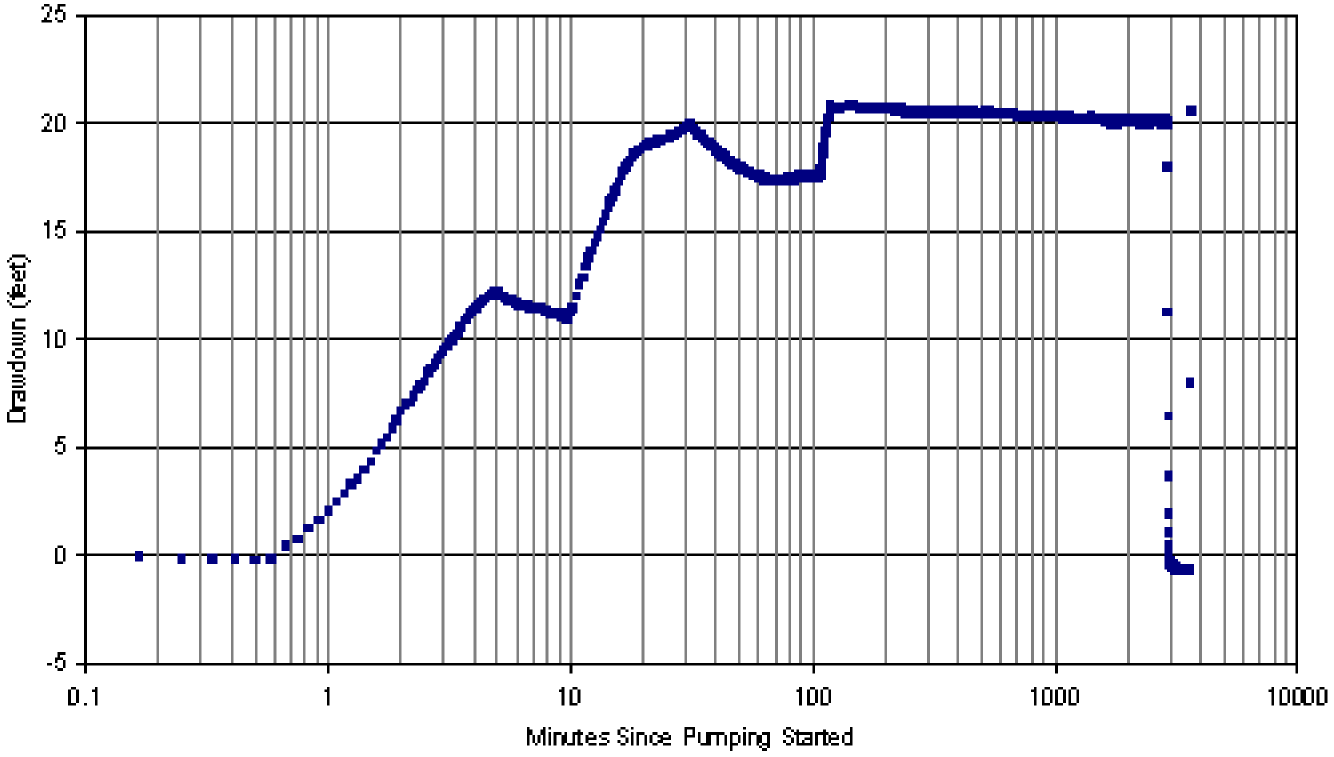
INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



F:\USERS\TRUSSO\2005\100451838.doc

USAS PUMPING TEST
PUMPING WELL (EXU-1): LEVEL LOGGER DATA

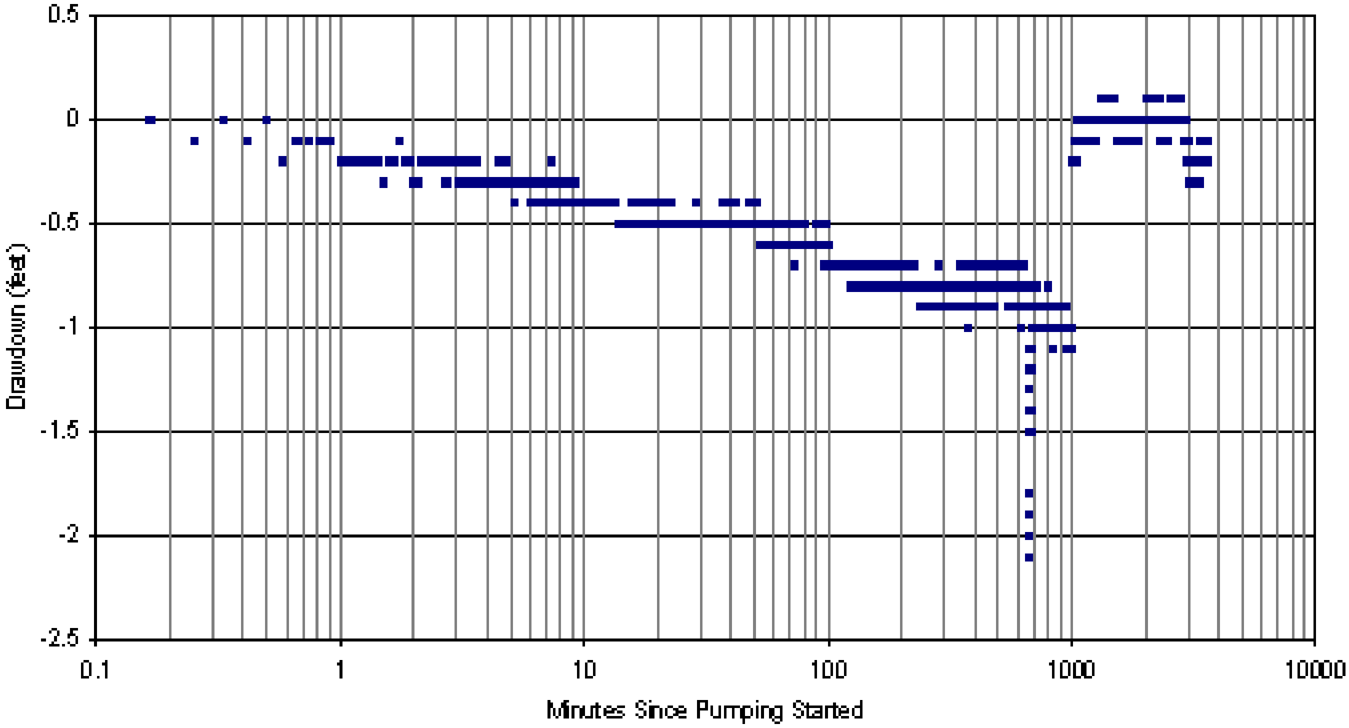
INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



F:\USERS\YR\USS\DC\2005\L00451638.doc

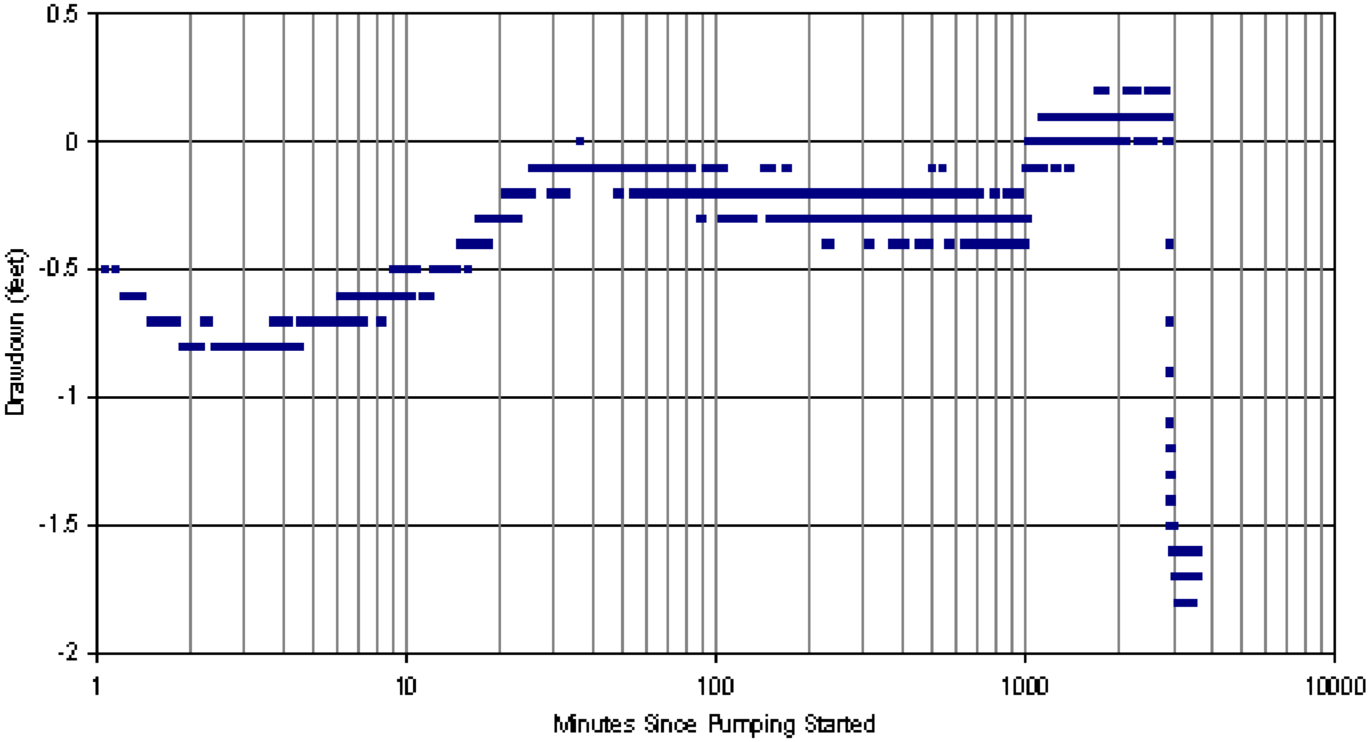
USAS PUMPING TEST
USAS MW-32: LEVEL LOGGER DATA

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



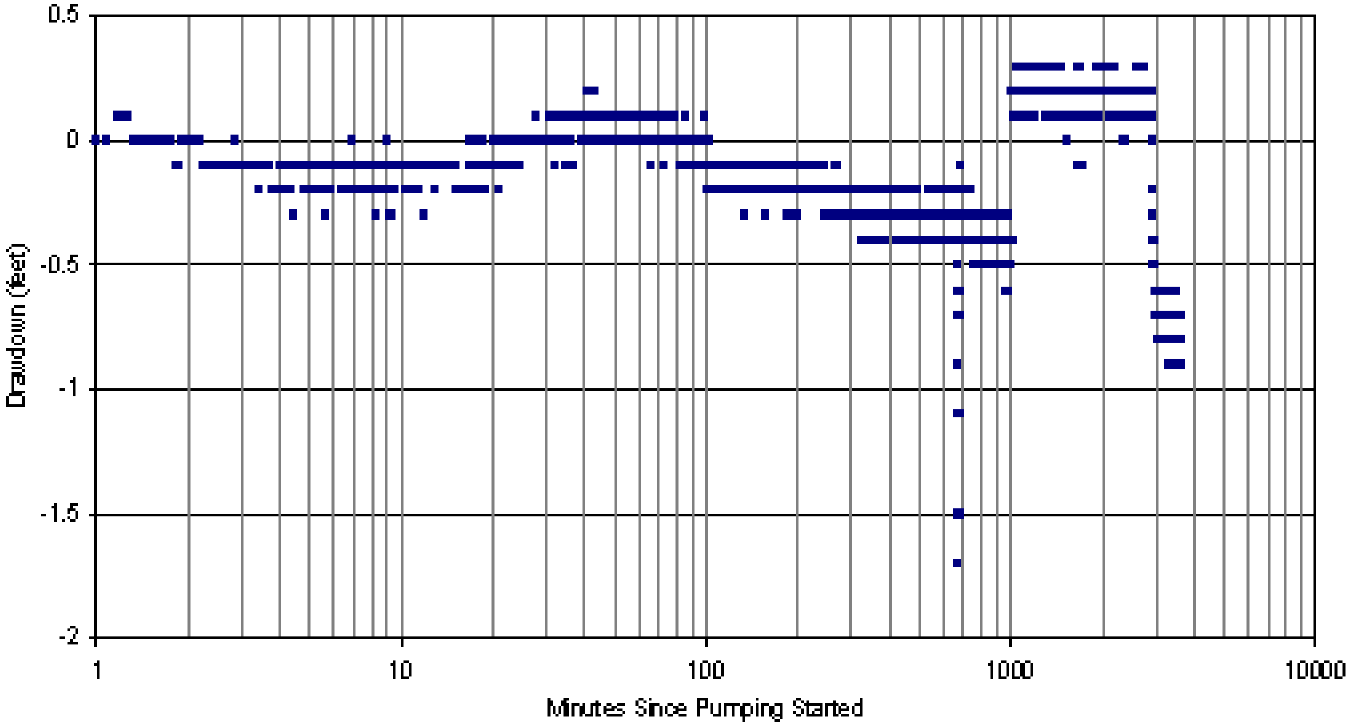
USAS PUMPING TEST
USAS MW-36: LEVEL LOGGER DATA

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



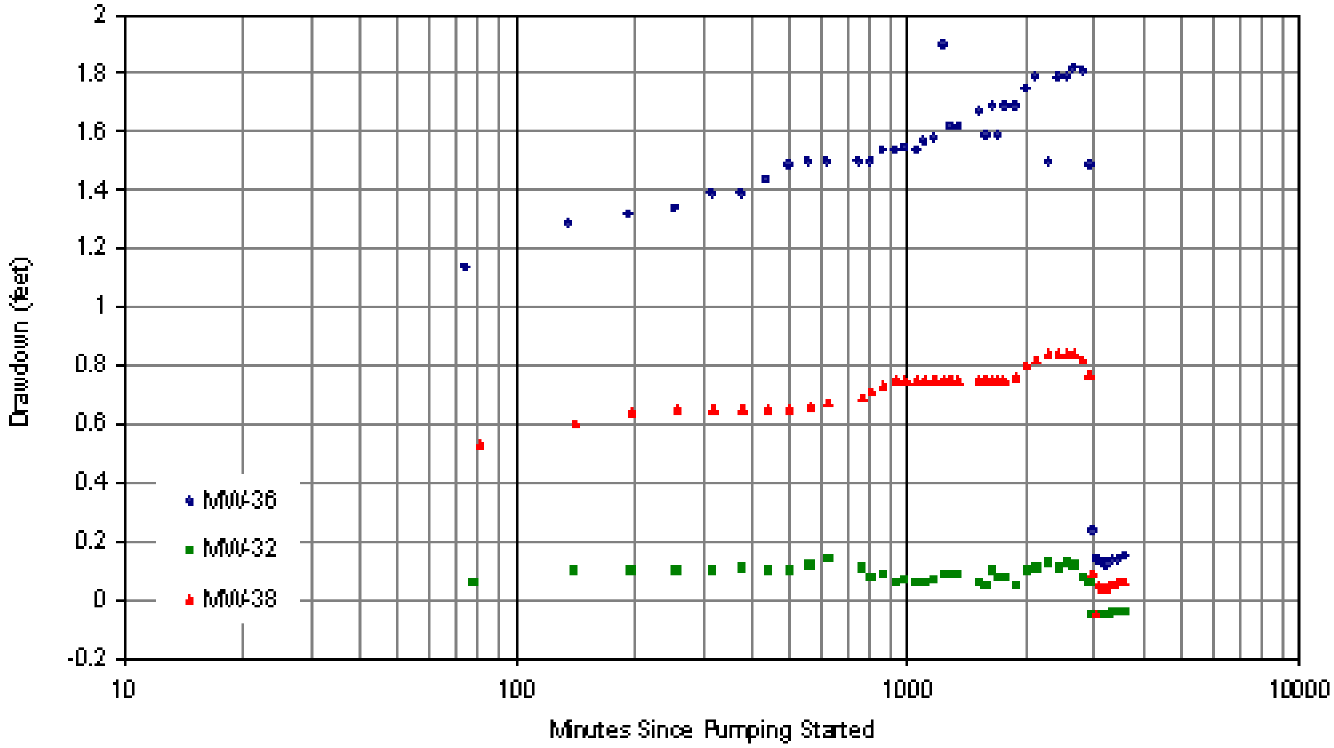
USAS PUMPING TEST
USAS MW-38: LEVEL LOGGER DATA

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



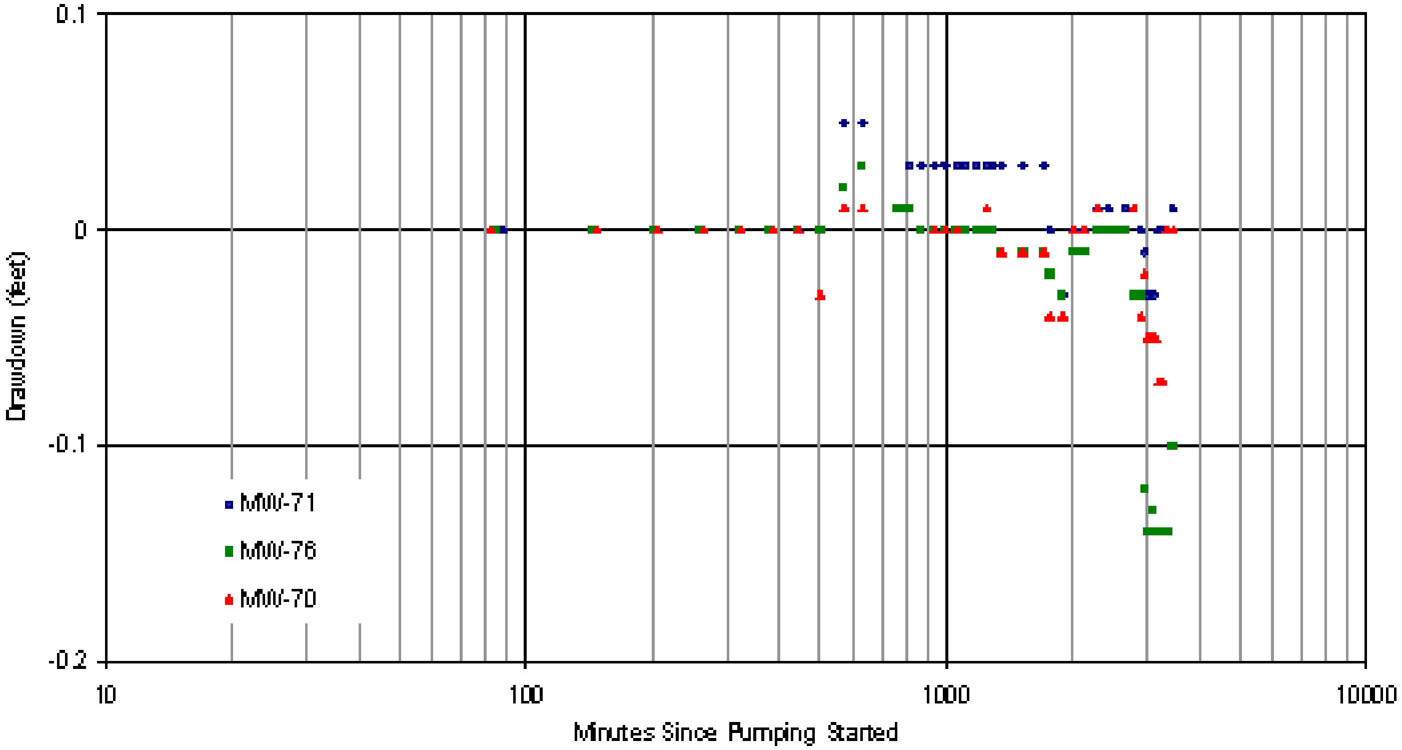
USAS PUMPING TEST
USAS WELLS (CLOSE): MANUALLY GAUGED LEVELS

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



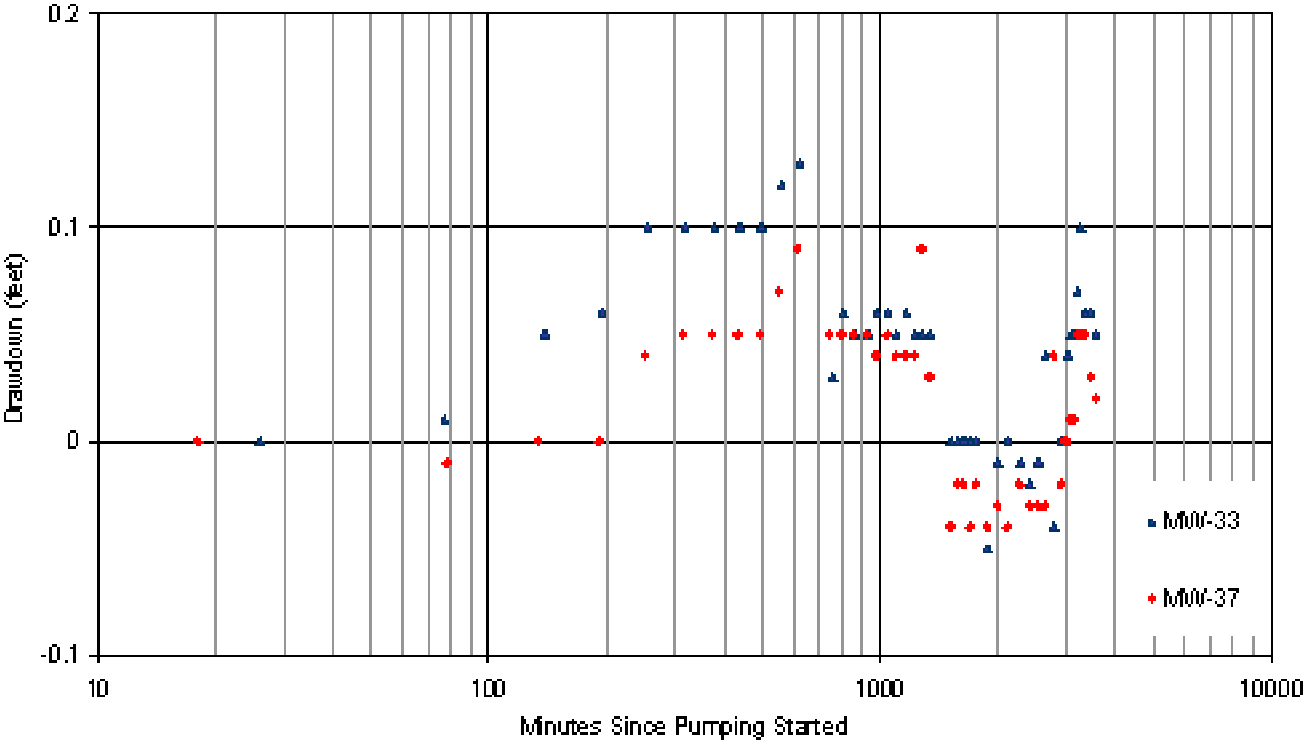
USAS PUMPING TEST
USAS WELLS (DISTANT): MANUALLY GAUGED LEVELS

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



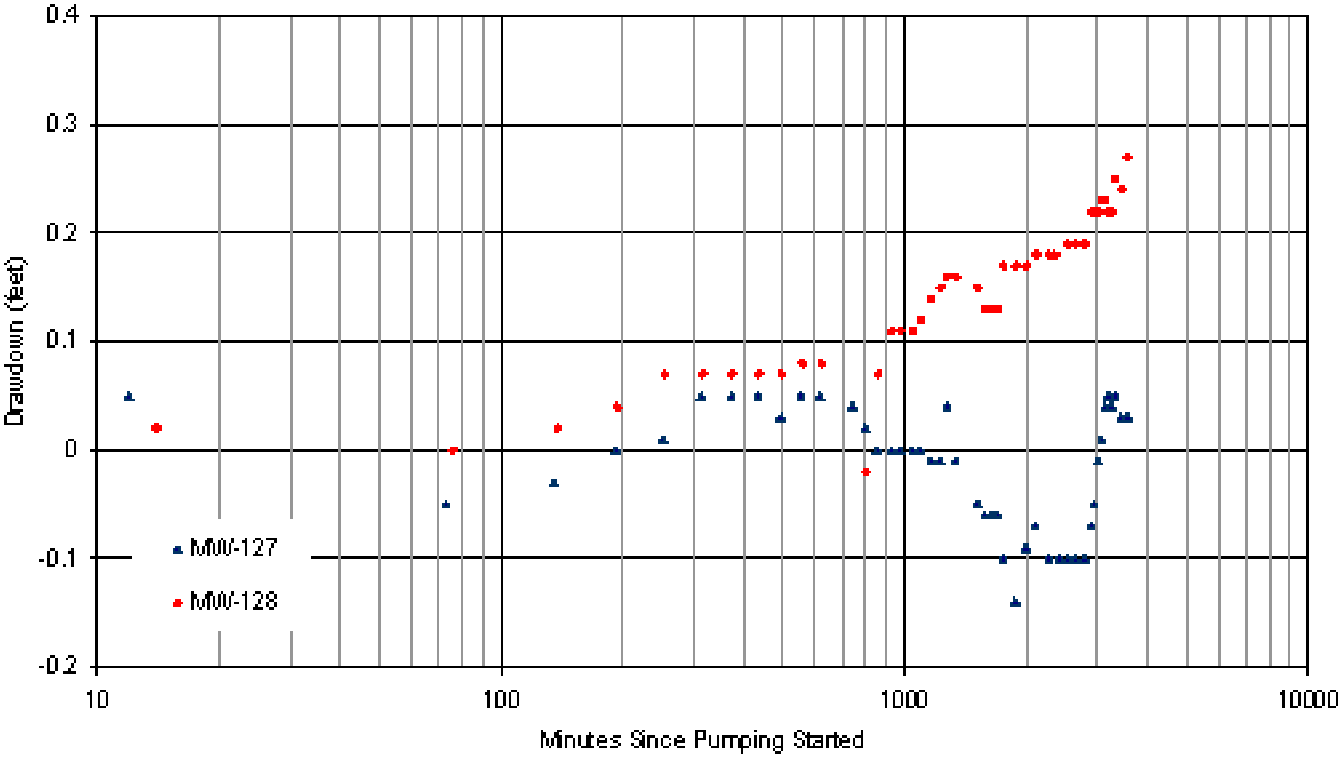
USAS PUMPING TEST
LSAS WELLS: MANUALLY GAUGED LEVELS

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



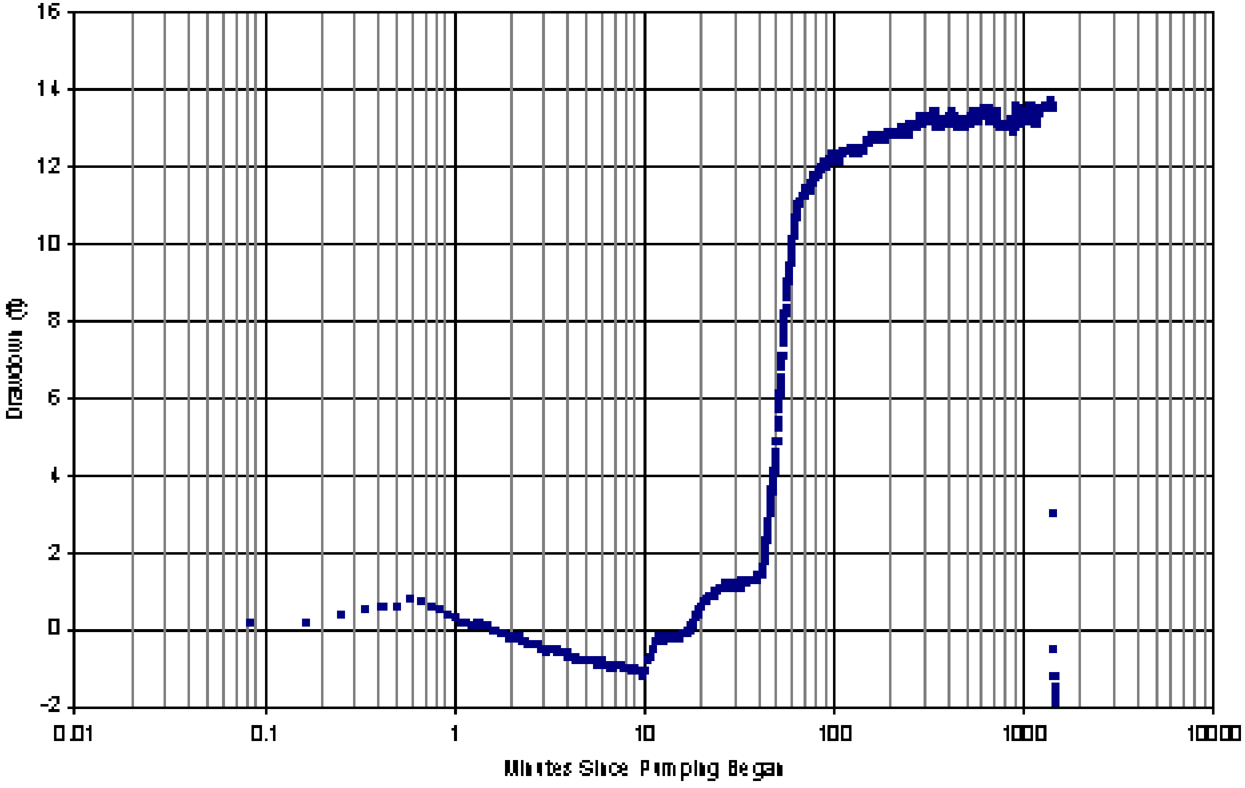
USAS PUMPING TEST
IAS WELLS: MANUALLY GAUGED LEVELS

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



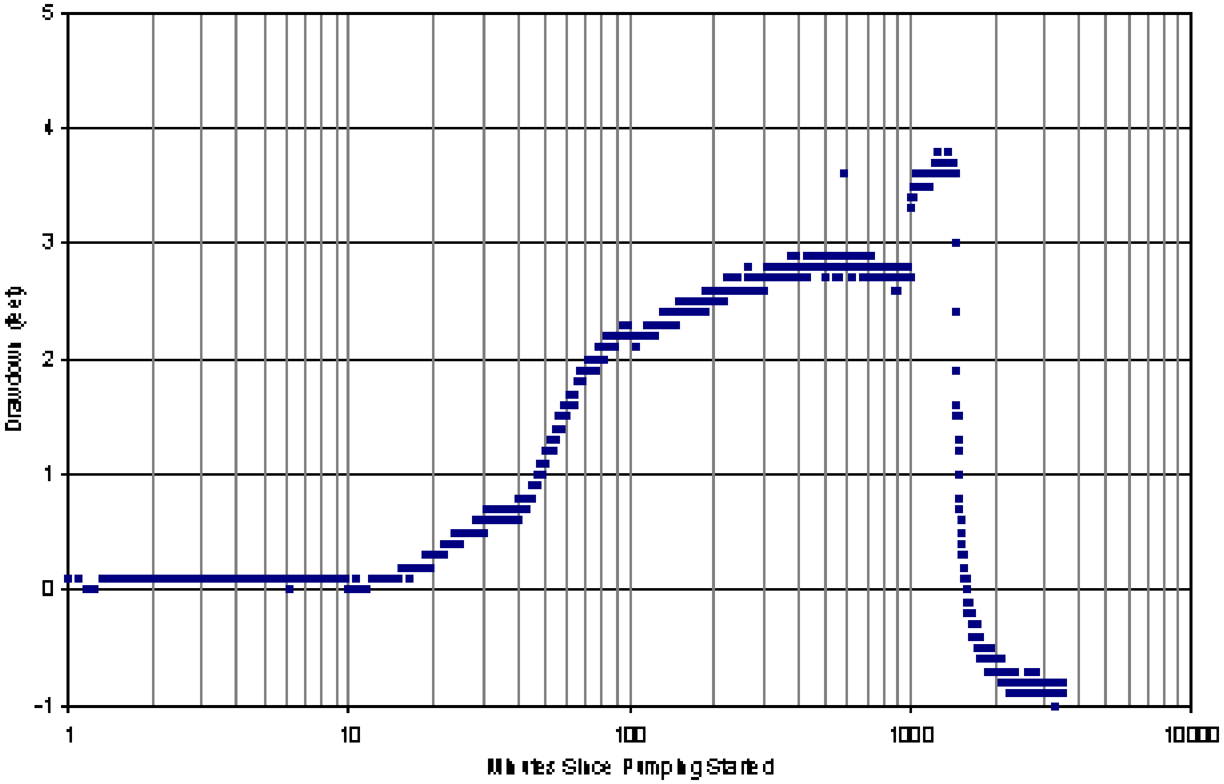
LSAS PUMPING TEST
PUMPING WELL (EXL-1): LEVEL LOGGER DATA

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



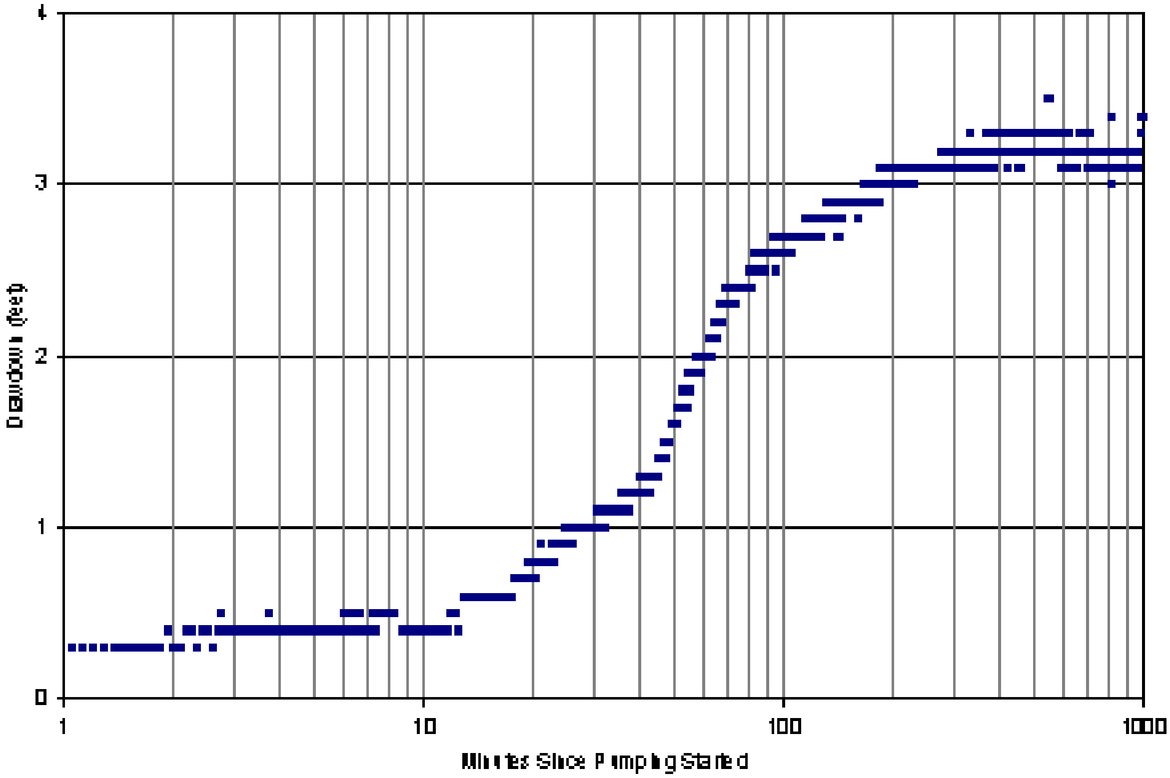
LSAS PUMPING TEST
LSAS MW-33: LEVEL LOGGER DATA

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



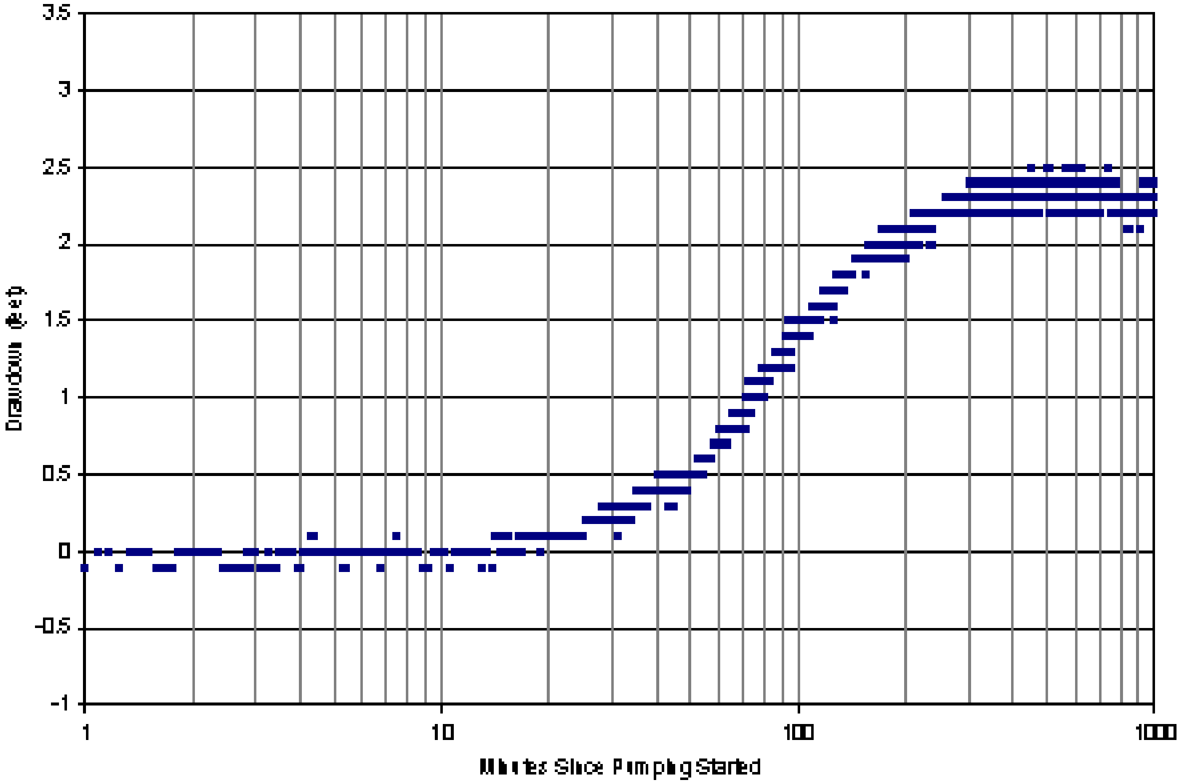
LSAS PUMPING TEST
LSAS MW-37 : LEVEL LOGGER DATA

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



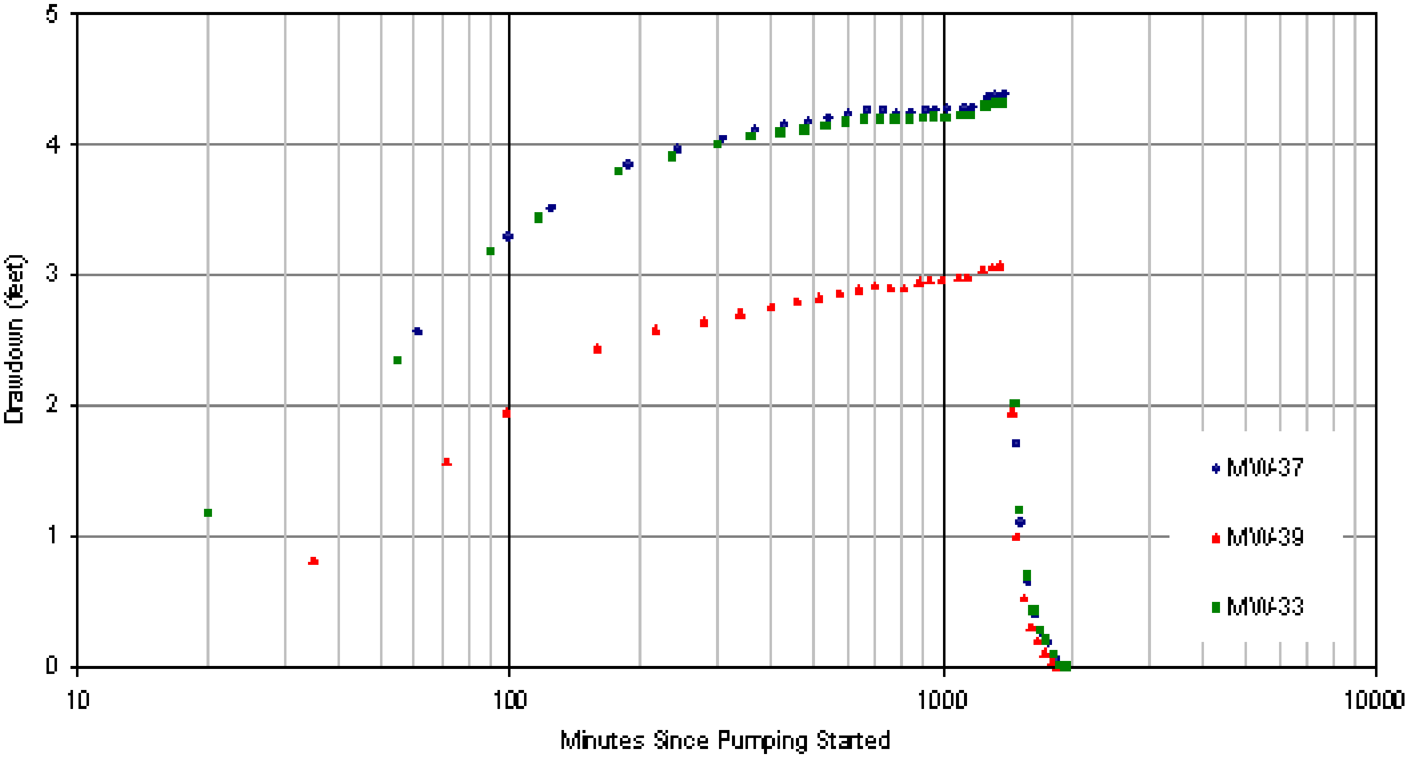
LSAS PUMPING TEST
LSAS MW-39 : LEVEL LOGGER DATA

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



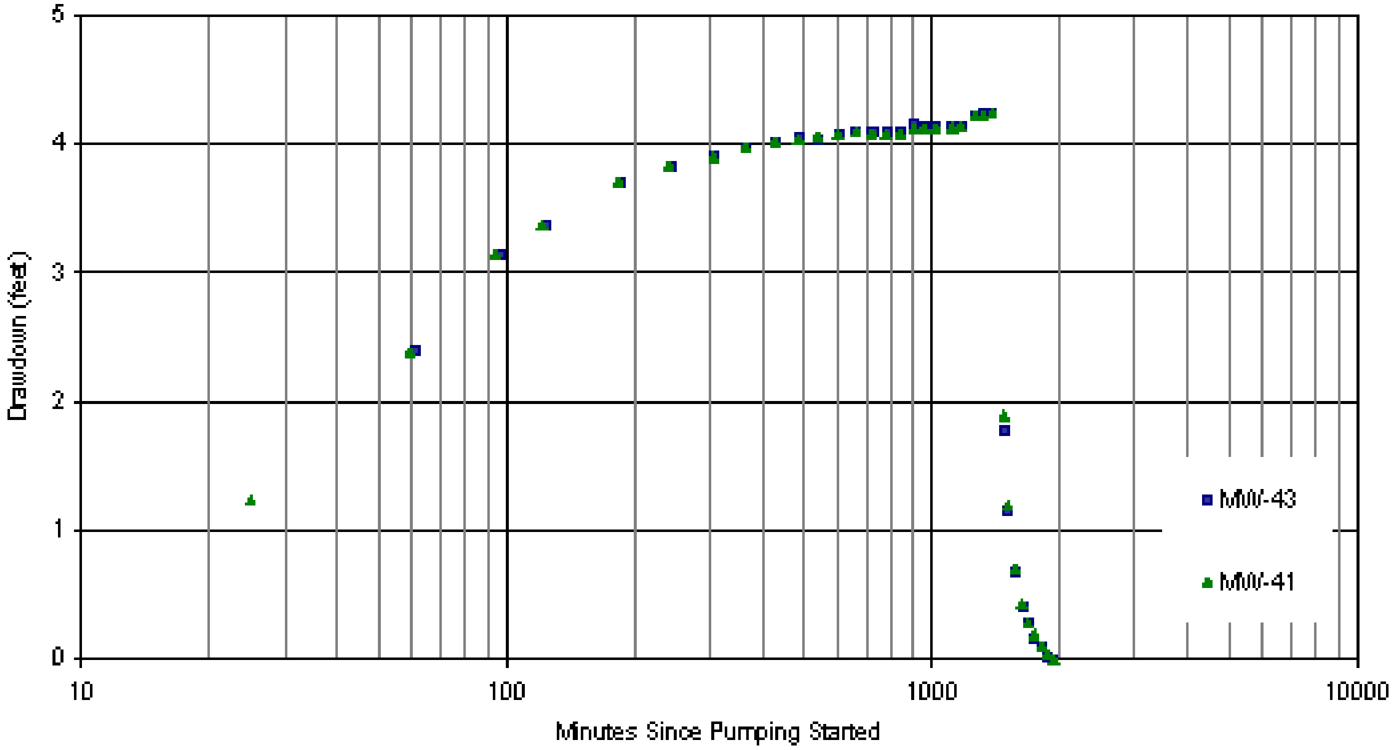
LSAS PUMPING TEST
LSAS WELLS (CLOSE): MANUALLY GAUGED LEVELS

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



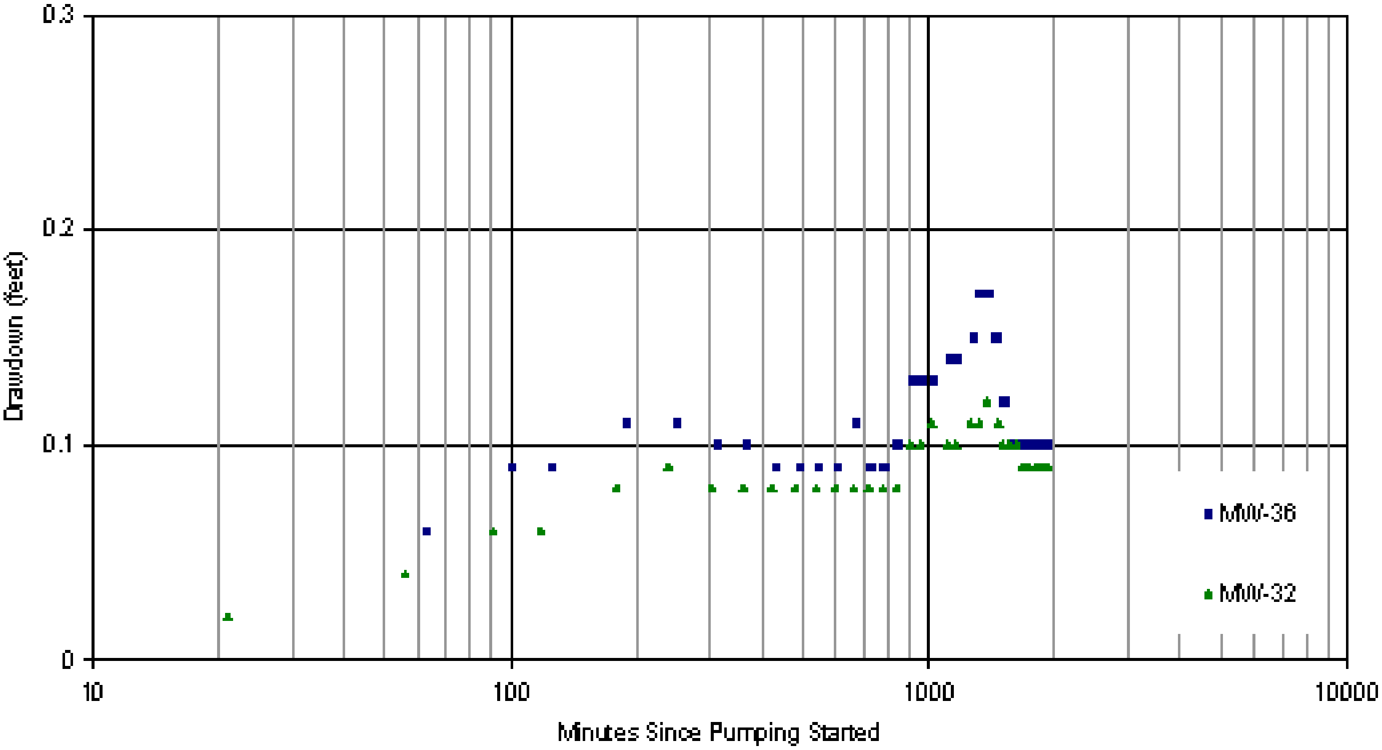
LSAS PUMPING TEST
LSAS WELLS (DISTANT): MANUALLY GAUGED LEVELS

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



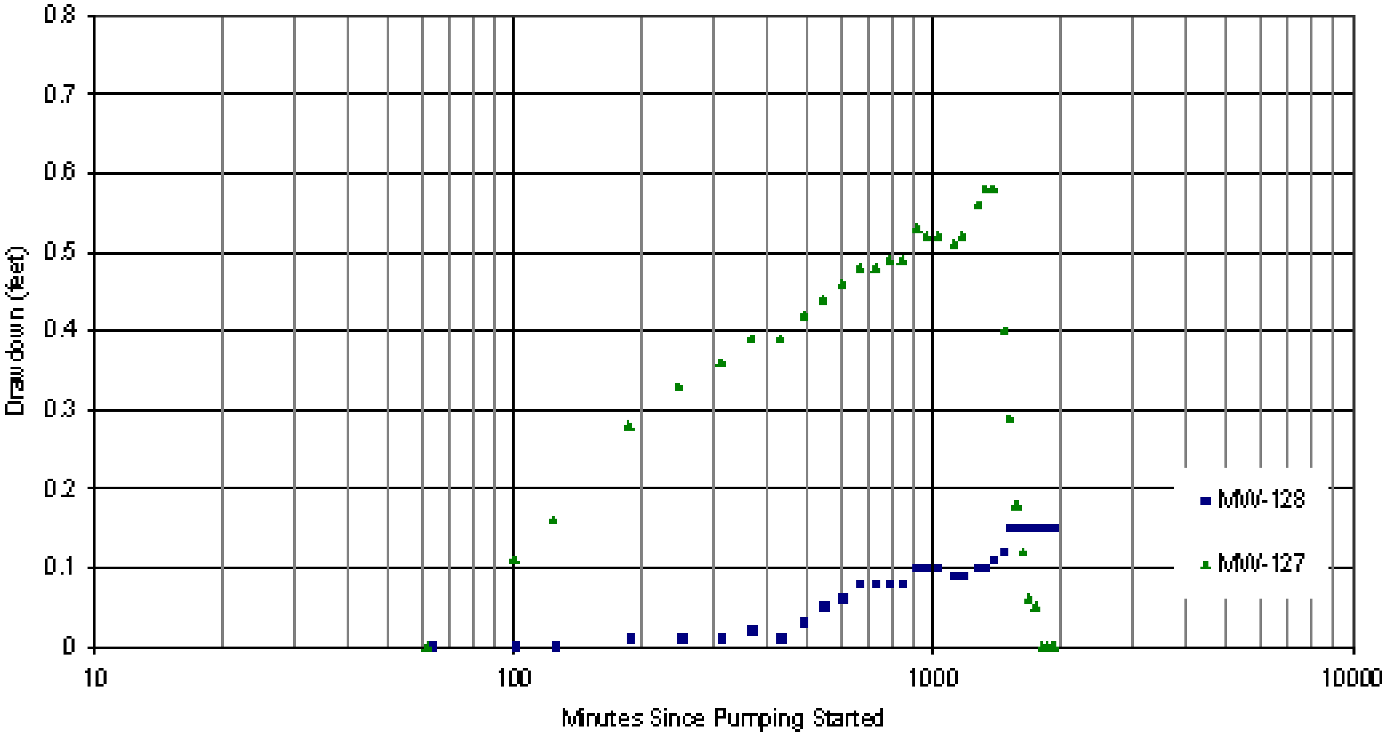
LSAS PUMPING TEST
USAS WELLS: MANUALLY GAUGED LEVELS

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



LSAS PUMPING TEST
IAS WELLS: MANUALLY GAUGED LEVELS

INTERIM REMEDIAL ACTION PLAN
FORMER AMERICAN BERYLLIUM COMPANY
TALLEVAST, FLORIDA



Appendix C

Pilot Test Data

KB LABS, INC.
6821 Southwest Archer Road
Gainesville, Florida 32608
Telephone (352) 367-0073
Fax (352) 367-0074
Email: info@kbmobilelabs.com

October 10, 2005

Paul Calligan
TtNUS
5421 Beaumont Center Blvd, Suite 660
Tampa, FL 33634

RE: Former American Beryllium, Tallevast, FL - Final Data Report
KB Labs Project # 05-227

Dear Mr. Calligan:

Enclosed is the final report of the on-site analysis performed by KB Labs, Inc. at the above referenced site. Samples were collected and analyzed from September 21 to 24, 2005. Included are a brief project narrative, data report narrative, tables listing quality control results, final analytical results, and sample chain-of-custody form. This information will also be sent electronically.

KB Labs' mobile laboratories have been inspected by the FDOH Bureau of Laboratories and are NELAP Certified as of April 1, 2003. Our personnel, methodology, proficiency testing, and quality assurance requirements comply with the guidelines of Chapter 62-160 of the Florida Administrative Code and with the consensus standards adopted at the National Environmental Laboratory Accreditation Conference (NELAC). Data for the site referenced above were determined in accordance with published procedures under Test Methods for Evaluating Solid Waste (EPA SW-846, Update III Revised May 1997). Unless otherwise indicated on the quality control narrative accompanying the data report, the quality assurance and quality control procedures performed in conjunction with analysis of groundwater samples demonstrated that the reported data met our requirements for accuracy and precision under NELAC Standards.

If you have any questions, please do not hesitate to call me or Kelly Bergdoll, President of KB Labs, at (352) 367-0073.

Sincerely,

KB Labs, Inc.

Todd Romero

Todd Romero
Director of Operations

"KB Labs is a small, woman-owned business enterprise."

KB Labs, Inc.
6921 SW Archer Road
Gainesville, FL 32608
Phone: 352-367-0073
Fax: 352-367-0073
Email: info@kbmobilelabs.com

PROJECT NARRATIVE

Project Scope

From September 21 to 24, 2005, a total of 23 samples (23 water) were analyzed for TtNUS at Former American Beryllium, Tallevast, FL. The samples were analyzed for vinyl chloride, 1,1-dichloroethene, cis- and trans-1, 2-dichloroethene, trichloroethene, tetrachloroethene, benzene, toluene, ethylbenzene, xylenes, and 1,4-dioxane.

NELAP Certification

KB Mobile Labs Unit KB1: FDOH NELAP Certification Number E82815

Analytical Procedure

All samples were analyzed using SW846 Method 5030/8260 for waters. Ten (10) milliliters (mL) of water or air (air samples) were purged with helium and the volatile organic compounds (VOCs) were collected on a solid-phase adsorption trap. The adsorption trap was heated and back-purged with helium. The components were then separated by capillary column gas chromatography and measured with a mass spectrometer (GC/MS) operated in the electron impact full-scan mode. The individual VOCs in the samples were measured against corresponding VOC standards.

Analytical Results

Laboratory results were provided to the client on an as-completed or next-day basis. Final results of the on-site analyses are provided in a hardcopy report. The data produced and reported in the field has been reviewed and approved for this final report by the Director of Operations for KB Labs.

Quality Control (QC) Data

Surrogate Recoveries – Table 1 lists the daily analytical sequence and percent recovery results for surrogate compounds, which were added to all analyses. Four (4) surrogate compounds were added to each analysis in order to continually monitor general method performance.

VOC Spike Recoveries – Table 2 lists the percent recovery results for matrix spike and laboratory control samples. A known amount of each target compound was added to selected field samples and to laboratory reagent water in order to monitor the performance of each of the target compounds in the actual matrix and in laboratory reagent water.

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Method Blanks – Daily analysis of laboratory reagent water samples was performed in order to monitor the cleanliness of the analytical system.

DATA REPORT NARRATIVE

1. All sample data has been reviewed and, if required, updated in the Final Data Report for rounding and significant figures.

2. The trichloroethene result for sample **EXU-1-No.Tank –1700** was updated from 17000 ug/L to 12000 ug/L.

3. The 1,4-Dioxane results were masked for samples collected from 9/21/05 to 9/23/05 that contained high concentrations of trichloroethene. Results were estimated by comparing compound area counts with the initial calibration curve. Data was flagged with FDEP Data Qualifier "J".

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KB LABS, INC.

Table 1: Analytical Run Sequence/Surrogate Percent Recoveries

Client: TINUS	**Driller/Sampler:** Purifics	**Analyst:** Enoch
Site: Former American Beryllium	**KB Labs Project Manager:** Kelly Bergdoll	**KB Labs Project No:** 05-227
On-site Dates: 09/21/05-09/24/05	**Client Project Manager:** Paul Calligan	**Matrix:** Water

Sample ID	Date of Analysis	Surrogate % Recovery				Surrogate Control Limits			
		S1*	S2*	S3*	S4*	S1*	S2*	S3*	S4*
BLANK WATER DIOX	09/21/05	NA	NA	NA	NA	NA	NA	NA	NA
DIOX 2	09/21/05	NA	NA	NA	NA	NA	NA	NA	NA
DIOX 10	09/21/05	NA	NA	NA	NA	NA	NA	NA	NA
DIOX 20	09/21/05	NA	NA	NA	NA	NA	NA	NA	NA
DIOX 40	09/21/05	NA	NA	NA	NA	NA	NA	NA	NA
DIOX 10	09/21/05	NA	NA	NA	NA	NA	NA	NA	NA
DIOX 200	09/21/05	NA	NA	NA	NA	NA	NA	NA	NA
BLANK WATER DIOX	09/21/05	NA	NA	NA	NA	NA	NA	NA	NA
BLANK WATER	09/21/05	102	97	100	98	Pass	Pass	Pass	Pass
DIOX 40	09/21/05	NA	NA	NA	NA	> UCL	> UCL	> UCL	> UCL
VSTD 20	09/21/05	110	93	102	101	Pass	Pass	Pass	Pass
RSTD 20	09/21/05	121	104	98	97	Pass	Pass	Pass	Pass
EXU-1-INF-735	09/21/05	116	104	96	104	Pass	Pass	Pass	Pass
EXU-1-INF-735 DIOX	09/21/05	NA	NA	NA	NA	> UCL	> UCL	> UCL	> UCL
EXU-1-INF-735 1:10	09/21/05	119	105	94	106	Pass	Pass	Pass	Pass
EXU-1-INF-1315	09/21/05	131	110	93	109	Pass	Pass	Pass	Pass
BLANK WATER DIOX	09/21/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-EFF-1435	09/21/05	132	110	95	108	Pass	Pass	Pass	Pass
EXU-1-INF-1315 1:100	09/21/05	126	105	94	102	Pass	Pass	Pass	Pass
EXU-1-EFF-1435 DIOX	09/21/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-EFF-1635 DIOX	09/21/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-EFF-1635	09/21/05	118	105	107	106	Pass	Pass	Pass	Pass
VSTD 10	09/21/05	127	107	98	106	Pass	Pass	Pass	Pass
DIOX 20	09/21/05	NA	NA	NA	NA	NA	NA	NA	NA
BLANK WATER	09/22/05	103	100	103	109	Pass	Pass	Pass	Pass
VSTD 20	09/22/05	105	104	93	98	Pass	Pass	Pass	Pass
RSTD 20	09/22/05	112	102	103	100	Pass	Pass	Pass	Pass
BLANK WATER DIOX	09/22/05	NA	NA	NA	NA	NA	NA	NA	NA
DIOX 40	09/22/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-EFF-1015 DIOX	09/22/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-EFF-1215 DIOX	09/22/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-EFF-1215 DIOX	09/22/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-EFF 1215	09/22/05	114	102	101	100	Pass	Pass	Pass	Pass
EXU-1-INF-1215 1:100	09/22/05	112	105	97	104	Pass	Pass	Pass	Pass
EXU-1-No Tank-1700 1:1000	09/22/05	68	85	98	99	Pass	< LCL	Pass	Pass
EXU-1-INF-1702 1:100	09/22/05	114	102	95	109	Pass	Pass	Pass	Pass
EXU-1-EFF-1704	09/22/05	119	106	98	107	Pass	Pass	Pass	Pass
EXU-1-EFF-1704MS	09/22/05	125	108	83	104	Pass	Pass	< LCL	Pass

<u>*Surrogate Compounds:</u>

S1 = 1,2- Dichloroethane-D4 (73% - 146%)
S2 = 1,2-Difluorobenzene (79% - 120%)
S3 = Toluene-D8 (84% - 116%)
S4 = 4-Bromofluorobenzene (79% - 127%)

KB LABS, INC.

Table 1: Analytical Run Sequence/Surrogate Percent Recoveries

Client: TtNUS	**Driller/Sampler:** Purifics	**Analyst:** Enoch
Site: Former American Beryllium	**KB Labs Project Manager:** Kelly Bergdoll	**KB Labs Project No:** 05-227
On-site Dates: 09/21/05-09/24/05	**Client Project Manager:** Paul Calligan	**Matrix:** Water

Sample ID	Date of Analysis	Surrogate % Recovery				Surrogate Control Limits			
		S1*	S2*	S3*	S4*	S1*	S2*	S3*	S4*
EXU-1-EFF-1704MSD	09/22/05	91	107	99	97	Pass	Pass	Pass	Pass
EXU-1-NO TANK-1700 DIOX	09/22/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-INF-1702 1:100 DIOX	09/22/05	NA	NA	NA	NA	NA	NA	NA	NA
BLANK WATER DIOX	09/22/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-EFF-1704 DIOX	09/22/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-EFF-1704MS DIOX	09/22/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-EFF-1704MSD DIOX	09/22/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-NO TANK-1700 1:200	09/22/05	123	106	99	104	Pass	Pass	Pass	Pass
VSTD 10	09/22/05	125	105	95	109	Pass	Pass	Pass	Pass
DIOX 20	09/22/05	NA	NA	NA	NA	NA	NA	NA	NA
BLANK WATER	09/23/05	105	100	104	129	Pass	Pass	Pass	> UCL
VSTD 20	09/23/05	109	86	97	105	Pass	Pass	Pass	Pass
RSTD 20	09/23/05	113	101	102	101	Pass	Pass	Pass	Pass
BLANK WATER DIOX	09/23/05	NA	NA	NA	NA	NA	NA	NA	NA
DIOX 40	09/23/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-NO TANK 0650 1:100	09/23/05	91	97	94	105	Pass	Pass	Pass	Pass
EXU-1-EFF 1030	09/23/05	121	104	96	107	Pass	Pass	Pass	Pass
EXU-1-INF-1030 1:100	09/23/05	118	100	97	101	Pass	Pass	Pass	Pass
EXU-1-NO TANK 0650 DIOX	09/23/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-EFF-1030 DIOX	09/23/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-INF-1030 DIOX	09/23/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-NO TSNK 0650 1:200	09/23/05	112	108	92	106	Pass	Pass	Pass	Pass
Exu-1-No Tank 0650 1:10 Dio	09/23/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-INF-1400 1:200	09/23/05	122	100	94	104	Pass	Pass	Pass	Pass
EXU-1-EFF-1402	09/23/05	122	104	90	106	Pass	Pass	Pass	Pass
EXU-1-EFF-1402 DIOX	09/23/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-INF-1400 DIOX	09/23/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-EFF=1540 DIOX	09/23/05	NA	NA	NA	NA	NA	NA	NA	NA
EXU-1-EFF-1540	09/23/05	126	108	91	105	Pass	Pass	Pass	Pass
VSTD 10	09/23/05	125	104	93	102	Pass	Pass	Pass	Pass
DIOX 20	09/23/05	NA	NA	NA	NA	NA	NA	NA	NA
BLANK WATER	09/24/05	105	98	103	107	Pass	Pass	Pass	Pass
VSTD 20	09/24/05	109	104	98	100	Pass	Pass	Pass	Pass
BLANK WATER DIOX	09/24/05	NA	NA	NA	NA	NA	NA	NA	NA
DIOX 40	09/24/05	NA	NA	NA	NA	NA	NA	NA	NA
EXL-1-No Tank-0700 DIOX	09/24/05	NA	NA	NA	NA	NA	NA	NA	NA
EXL-1 TANK-0700 DIOX	09/24/05	NA	NA	NA	NA	NA	NA	NA	NA
EXL-1-NO TANK 0700	09/24/05	124	111	91	103	Pass	Pass	Pass	Pass

*<u>Surrogate Compounds:</u>

S1 = 1,2- Dichloroethane-D4 (63% - 146%)
S2 = 1,2-Difluorobenzene (78% - 120%)
S3 = Toluene-D8 (84% - 117%)
S4 = 4-Bromofluorobenzene (73% - 127%)

KB LABS, INC.

Table 1: Analytical Run Sequence/Surrogate Percent Recoveries

Client: TINUS	**Driller/Sampler:** Purifics	**Analyst:** Enoch
Site: Former American Beryllium	**KB Labs Project Manager:** Kelly Bergdoll	**KB Labs Project No:** 05-227
On-site Dates: 09/21/05-09/24/05	**Client Project Manager:** Paul Calligan	**Matrix:** Water

Sample ID	**Date of Analysis**	**Surrogate % Recovery**				**Surrogate Control Limits**			
		S1*	**S2***	**S3***	**S4***	**S1***	**S2***	**S3***	**S4***
EXL-1-TANK-0700 1:100	09/24/05	123	106	90	100	Pass	Pass	Pass	Pass
Exl-1-No Tank-0700 1:50 Diox	09/24/05	NA	NA	NA	NA	NA	NA	NA	NA
EXL-1-INF-1000	09/24/05	124	109	94	104	Pass	Pass	Pass	Pass
EXL-1-INF-1000 DIOX	09/24/05	NA	NA	NA	NA	NA	NA	NA	NA
EXL-1-EFF-1000 DIOX	09/24/05	NA	NA	NA	NA	NA	NA	NA	NA
EXL-1-NO TANK-0700 1:10	09/24/05	128	109	92	104	Pass	Pass	Pass	Pass
EXL-1-TANK-0700 1:20 DIOX	09/24/05	NA	NA	NA	NA	NA	NA	NA	NA
WXL-1-EFF 1125 DIOX	09/24/05	NA	NA	NA	NA	NA	NA	NA	NA
EXL-1-EFF-1125	09/24/05	128	106	91	105	Pass	Pass	Pass	Pass
EXL-1-EFF-1000	09/24/05	127	106	92	102	Pass	Pass	Pass	Pass
EXL-1-EFF-1000 DIOX	09/24/05	NA	NA	NA	NA	NA	NA	NA	NA
EXL-1-EFF-1400 DIOX	09/24/05	NA	NA	NA	NA	NA	NA	NA	NA
EXL-1-EFF-1400	09/24/05	134	109	90	105	Pass	Pass	Pass	Pass
EXL-1-EFF-1400	09/24/05	134	109	90	105	Pass	Pass	Pass	Pass
EXL-1-INF-1000 1:20 DIOX	09/24/05	NA	NA	NA	NA	NA	NA	NA	NA
EXL-1-INF-1000 1:20	09/24/05	140	106	88	104	Pass	Pass	Pass	Pass
EXL-1-EFF-1600	09/24/05	137	109	95	109	Pass	Pass	Pass	Pass
EXL-1-EFF-1600 DIOX	09/24/05	NA	NA	NA	NA	NA	NA	NA	NA
RSTD 20	09/24/05	139	110	94	101	Pass	Pass	Pass	Pass
VSTD 10	09/24/05	137	110	97	100	Pass	Pass	Pass	Pass
DIOX 20	09/24/05	NA	NA	NA	NA	NA	NA	NA	NA
Comments:	Although some surrogates may be out of the control percent recovery range, other supporting QC, such as matrix spikes, matrix spike duplicates, method blanks, and laboratory control samples, are performed by KB Labs to further validate reported data. 14-Dioxane samples are calculated off internal standard and no surrogates are added.								

*Surrogate Compounds:
S1 = 1,2- Dichloroethane-D4 (63% - 146%)
S2 = 1,2-Difluorobenzene (79% - 120%)
S3 = Toluene-D8 (84% - 117%)
S4 = 4-Bromofluorobenzene (78% - 127%)

KB LABS, INC.

Table 2: VOC Spike Compound Percent Recoveries

Client: TtNUS	**Driller/Sampler:** Purifics	**Analyst:** Enoch
Site: Former American Beryllium	**KB Labs Project Manager:** Kelly Bergdoll	**KB Labs Project No.:** 05-227
Onsite Dates: 09/21/05-09/24/05	**Client Project Manager:** Paul Calligan	**Matrix:** Water

Matrix Spike/Matrix Spike Duplicate (MS/MSD):

Samples: EXU-1-EFF-1704MS
EXU-1-EFF-1704MSD **Date of Analysis:** 9/22/2005

Matrix Spike Compounds	**Control Limits**			**Percent Recoveries**			**Control Limit Checks**		
	Lower	**Upper**	**RPD**	**MS**	**MSD**	**RPD**	**MS**	**MSD**	**RPD**
Vinyl Chloride	20	187	20	112	93	19	Pass	Pass	Pass
1,1-Dichloroethene	52	144	20	134	67	67	Pass	Pass	> RPDL
Trans-1,2-Dichloroethene	41	157	20	113	73	43	Pass	Pass	> RPDL
Cis-1,2-Dichloroethene	59	143	20	115	108	6	Pass	Pass	Pass
Benzene	51	149	20	112	108	3	Pass	Pass	Pass
Trichloroethene	50	147	20	118	103	14	Pass	Pass	Pass
Toluene	60	136	20	83	104	23	Pass	Pass	> RPDL
Tetrachloroethene	56	138	20	92	105	13	Pass	Pass	Pass
Ethylbenzene	60	143	20	102	90	13	Pass	Pass	Pass
m,p-Xylene	58	142	20	99	92	7	Pass	Pass	Pass
o-Xylene	57	145	20	101	98	3	Pass	Pass	Pass

Note: Control Limits are based on a semi-annual historical evaluation of mobile unit and method guidelines.

Samples: EXU-1-EFF-1704MS
EXU-1-EFF-1704MSD **Date of Analysis:** 9/22/2005

Matrix Spike Compounds	**Control Limits**			**Percent Recoveries**			**Control Limit Checks**		
	Lower	**Upper**	**RPD**	**MS**	**MSD**	**RPD**	**MS**	**MSD**	**RPD**
1,4-Dioxane	70	130	20	91	103	12	Pass	Pass	Pass

Note: Control Limits are based on a semi-annual historical evaluation of mobile unit and method guidelines.

Laboratory Control Spikes (LCS):

Samples: LCS 1
LCS 2
LCS 3 **Date of Analysis:** 9/21/2005
9/22/2005
9/23/2005

Spike Compounds	**Control Limits**			**Percent Recoveries**			**Control Limit Checks**		
	Lower		**Upper**	**LCS#1**	**LCS#2**	**LCS#3**	**LCS#1**	**LCS#2**	**LCS#3**
Vinyl Chloride	15	to	194	109	110	104	Pass	Pass	Pass
1,1-Dichloroethene	41	to	151	132	130	78	Pass	Pass	Pass
Trans-1,2-Dichloroethene	38	to	159	118	111	108	Pass	Pass	Pass
Cis-1,2-Dichloroethene	59	to	138	113	114	104	Pass	Pass	Pass
Benzene	55	to	141	108	106	104	Pass	Pass	Pass
Trichloroethene	57	to	137	104	108	104	Pass	Pass	Pass
Toluene	59	to	138	98	105	102	Pass	Pass	Pass
Tetrachloroethene	57	to	137	99	101	101	Pass	Pass	Pass
Ethylbenzene	66	to	136	91	97	95	Pass	Pass	Pass
m,p-Xylene	57	to	141	95	26	99	Pass	< LCL	Pass
o-Xylene	59	to	144	98	111	97	Pass	Pass	Pass

Note: Control Limits are based on a semi-annual historical evaluation of mobile unit and method guidelines.

KB LABS, INC.

Table 2: VOC Spike Compound Percent Recoveries

Client: TtNUS	**Driller/Sampler:** Purfics	**Analyst:** Enoch
Site: Former American Beryllium	**KB Labs Project Manager:** Kelly Bergdoll	**KB Labs Project No.:** 05-227
Onsite Dates: 09/21/05-09/24/05	**Client Project Manager:** Paul Calligan	**Matrix:** Water

Samples: LCS 4 **Date of Analysis:** 9/24/2005

Spike Compounds	**Control Limits**			**Percent Recoveries**			**Control Limit Checks**		
	Lower		Upper	LCS# 4			LCS# 4		
Vinyl Chloride	15	to	194	88			Pass		
1,1-Dichloroethene	41	to	161	61			Pass		
Trans-1,2-Dichloroethene	36	to	159	95			Pass		
Cis-1,2-Dichloroethene	59	to	138	109			Pass		
Benzene	55	to	141	106			Pass		
Trichloroethene	57	to	137	127			Pass		
Toluene	59	to	138	90			Pass		
Tetrachloroethene	57	to	137	86			Pass		
Ethylbenzene	66	to	138	80			Pass		
m,p-Xylene	57	to	141	85			Pass		
o-Xylene	59	to	144	88			Pass		

Note: Control Limits are based on a semi-annual historical evaluation of mobile unit and method guidelines.

KB LABS, INC.
Final Data Report
Former American Beryllium
Tallevast, FL
September 21-24, 2005

Prepared for: TtNUS

	Sample ID EXU-1-INF-0735	Sample ID EXU-1-INF-1315	Sample ID EXU-1-EFF-1435	Sample ID EXU-1-EFF-1535	Sample ID EXU-1-EFF-1015	Sample ID EXU-1-INF-1215	Sample ID EXU-1-EFF-1215	Sample ID EXU-1-No Tank-1730	Sample ID EXU-1-INF-1702	Sample ID EXU-1-EFF-1704	Sample ID EXU-1-No Tank-0830
Date of Analysis	9/21/2005	9/21/2005	9/21/2005	9/21/2005	9/22/2005	9/22/2005	9/22/2005	9/22/2005	9/22/2005	9/22/2005	9/23/2005
Matrix:	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
Dilution Factor	1, 10	1, 100	1	1	1	100	1	200	100	1	100,200
Vinyl chloride	< 1.0	**1.2**	< 1.0	< 1.0	< 1.0	< 100	< 1.0	< 200	< 100	< 1.0	< 100
1,1-Dichloroethene	**12.8**	**25.1**	< 1.0	< 1.0	< 1.0	< 100	< 1.0	< 200	**120**	< 1.0	**140**
trans-1,2-Dichloroethene	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 100	< 1.0	< 200	< 100	< 1.0	< 100
cis-1,2-Dichloroethene	**36.6**	**66.1**	< 1.0	< 1.0	< 1.0	**190**	< 1.0	**310**	**260**	< 1.0	**230**
Benzene	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 100	< 1.0	< 200	< 100	< 1.0	< 100
Trichloroethene	**540**	**2000**	**1.3**	< 1.0	< 1.0	**7500**	< 1.0	**12000**	**10000**	< 1.0	**15000**
Toluene	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 100	< 1.0	< 200	< 100	< 1.0	< 100
Tetrachloroethene	**3.7**	**4.6**	< 1.0	< 1.0	< 1.0	< 100	< 1.0	< 200	< 100	< 1.0	< 100
Ethylbenzene	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 100	< 1.0	< 200	< 100	< 1.0	< 100
m,p-Xylene	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 100	< 1.0	< 200	< 100	< 1.0	< 100
o-Xylene	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 100	< 1.0	< 200	< 100	< 1.0	< 100
1,4-Dioxane	**300 J**	**300 J**	< 3.2	< 3.2	< 3.2	**200 J**	< 3.2	**300 J**	**250 J**	< 3.2	**250 J**

Units in water are µg/L and for solids are mg/Kg.

FDEP Data Qualifier "J": Values are estimated.

KB LABS, INC.

Final Data Report

Former American Beryllium

Tallevast, FL

September 21-24, 2005

Prepared for: TtNUS

	Sample ID EXU-1-EFF-1030	Sample ID EXU-1-INF-1030	Sample ID EXU-1-INF-1400	Sample ID EXU-1-EFF-1402	Sample ID EXU-1-EFF-1540	Sample ID EXL-1-No Tank-0700	Sample ID EXL-1-Tank-0700	Sample ID EXL-1-INF-1000	Sample ID EXL-1-EFF-1000	Sample ID EXL-1-EFF-1158	Sample ID EXL-1-EFF-1400
Date of Analysis:	9/23/2005	9/23/2005	9/23/2005	9/23/2005	9/23/2005	9/24/2005	9/24/2005	9/24/2005	9/24/2005	9/24/2005	9/24/2005
Matrix:	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
Dilution Factor:	1	100	200	1	1	1, 10, 50	100	1, 20	1	1	1
Vinyl chloride	< 1.0	< 100	< 200	< 1.0	< 1.0	2.9	< 100	2.4	< 1.0	< 1.0	< 1.0
1,1-Dichloroethene	< 1.0	110	< 200	< 1.0	< 1.0	320	< 100	160	< 1.0	< 1.0	< 1.0
trans-1,2-Dichloroethene	< 1.0	< 100	< 200	< 1.0	< 1.0	< 1.0	< 100	< 1.0	< 1.0	< 1.0	< 1.0
cis-1,2-Dichloroethene	< 1.0	270	270	< 1.0	< 1.0	48.1	210	86.0	< 1.0	< 1.0	< 1.0
Benzene	< 1.0	< 100	< 200	< 1.0	< 1.0	< 1.0	< 100	< 1.0	< 1.0	< 1.0	< 1.0
Trichloroethene	< 1.0	10000	11000	12.5	31.9	630	7300	920	6.8	1.4	22.0
Toluene	< 1.0	< 100	< 200	< 1.0	< 1.0	< 1.0	< 100	< 1.0	< 1.0	< 1.0	< 1.0
Tetrachloroethene	< 1.0	< 100	< 200	< 1.0	< 1.0	< 1.0	< 100	1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	< 1.0	< 100	< 200	< 1.0	< 1.0	< 1.0	< 100	< 1.0	< 1.0	< 1.0	< 1.0
m,p-Xylene	< 1.0	< 100	< 200	< 1.0	< 1.0	< 1.0	< 100	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	< 1.0	< 100	< 200	< 1.0	< 1.0	< 1.0	< 100	< 1.0	< 1.0	< 1.0	< 1.0
1,4-Dioxane	< 3.2	250 J	250 J	5.1	43.5	1400	690	990	< 3.2	9.0	21.5

Units for waters are ug/L and for soils are mg/Kg.

FDEP Data Qualifier "J": Values are estimated.

KB LABS, INC.

Final Data Report

Former American Beryllium

Tallevast, FL

September 21-24, 2005

Prepared for: TtNUS

	Sample ID EXL-1-EFF-1600	Sample ID	Sample ID	Sample ID	Sample ID	Sample ID	Sample ID	Sample ID	Sample ID	Sample ID	Sample ID
Date of Analysis:	9/24/2005										
Matrix:	Water										
Dilution Factor:	1										
Vinyl chloride	< 1.0										
1,1-Dichloroethene	< 1.0										
trans-1,2 Dichloroethene	< 1.0										
cis-1,2-Dichloroethene	< 1.0										
Benzene	< 1.0										
Trichloroethene	< 1.0										
Toluene	< 1.0										
Tetrachloroethene	< 1.0										
Ethylbenzene	< 1.0										
m,p-Xylene	< 1.0										
o-Xylene	< 1.0										
1,4-Dioxane	< 3.2										

Units for waters are ug/L and for soils are mg/kg

FDEP Data Qualifier 'J': Values are estimated.

KB LABS
Mobile Laboratory Services

6321 SW Archer Road
Gainesville, FL 32608
TEL (352) 367-0073
FAX (352) 367-0074

CHAIN-OF-CUSTODY RECORD

MOBILE UNIT # KB-2

CLIENT NAME	TTNUS
PROJECT NAME & ADDRESS	05-227 AMERICAN BERYLLIUM FL
SAMPLERS	PARIFICS
CONTACT PERSON	STEVE RASH
BATCH # (Lab Use Only)	

SPECIFY PARAMETERS NEEDED AND NO. OF CONTAINERS

PRESERVATION
C Chilled
H HCl
O Other (see Remarks)

SAMPLE FIELD ID NUMBER	DATE SAMPLED	TIME SAMPLED	COMP	GRAB	DATE REC'D	TIME REC'D	STATION LOCATION / No.	SAMPLE MATRIX	NUMBER OF CONTAINERS	VOLATILES				COMMENT
EXU-1-INF-735	092105	0735		/	092105	1057		6/	2	✓				
EXU-1-INF-1315	|			|	|	1318		|	2	|				
EXU-1-EFF-1435	|			|	|	1440		|	|	|				
~~ ~~	|			|	|	~~1440~~		|	|	|				
EXU-1-EFF-1635	|			|	|	1637		|	|	|				

Preserved Containers Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
	|		|
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
	9-21 | 1655		092105

Remarks and Observations

Matrix Types S Soil SW Surface Water GW Ground Water SG Soil Gas

Mobile Laboratory Services

5821 SW Archer Road
Gainesville, FL 32608
TEL (352) 367-0073
FAX (352) 367-0074

CHAIN-OF-CUSTODY RECORD

MOBILE UNIT #: KB-2

2

CLIENT NAME: TETRA TECH	PROJECT NAME & ADDRESS: 05-227 FORMER AMERICAN BERYLLIUM FL	
SAMPLERS: PURIFICS	CONTACT PERSON: STEVE RASH	BATCH # (Lab Use Only)

IDENTIFY PARAMETERS DESIRED AND NO. OF CONTAINERS

PRESERVATION
C Chilled
H HCl
Ot Other (see Remarks)

SAMPLE FIELD ID / NUMBER	DATE SAMPLED	TIME SAMPLED	COMP.	GRAB	DATE REC'D	TIME REC'D	STATION LOCATION / No.	SAMPLE MATRIX	NUMBER OF CONTAINERS	VOLATILES				COMMENT
EXU-1-EFF-1015	092205	1015		✓	092205	1212		W	2	✓				
EXU-1-INF-1215	〃			〃	〃	1222		〃	〃	〃				
EXU-1-EFF-1215	〃			〃	〃	1222		〃	〃	〃				
EXU-1-NOTANK-1700	〃			〃	〃	1703		〃	〃	〃				
EXU-1-INF-1702	〃			〃	〃	1709		〃	〃	〃				
EXU-1-EFF-1704	〃			〃	〃	1712		〃	〃	〃				

Preferred Containers Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time	Remarks and Observations
Relinquished by: (Signature)	Date / Time: 9-24 1655	Received by: (Signature)	Date / Time: 092205	

Matrix Types S Soil SW Surface Water GW Ground Water SG Soil Gas

3

6621 SW Archer Road
Gainesville, FL 32608
TEL (352) 367-0073
FAX (352) 367-0074

Mobile Laboratory Services

CHAIN-OF-CUSTODY RECORD

MOBILE UNIT # KB-2

CLIENT NAME: TETRATECH

PROJECT NAME & ADDRESS: 05-227 FORMER AMERICAN BERYLLIUM FL

SAMPLERS: PUREFICS

CONTACT PERSON: STEVE RASH

BATCH # (Lab Use Only)

ANALYSIS PARAMETERS EXPECTED AND NO. OF CONTAINERS

PRESERVATION
C Chilled
H HCL
Dr Chlorine Removal

SAMPLE FIELD ID/NUMBER	DATE SAMPLED	TIME SAMPLED	COMP.	GRAB	DATE REC'D	TIME REC'D	STATION/LOCATION/No.	SAMPLE MATRIX	NUMBER OF CONTAINERS	VOLATILES				COMMENT
EXU-1-NOTANK-0850	092305			✓	092305	1027		W	2	✓				
EXU-1-EFF-1030	〃			〃	〃	1029		〃	〃	〃				
EXU-1-INF-1030	〃			〃	〃	1034		〃	〃	〃				
EXU-1-INF-1400	〃			〃	〃	1403		〃	〃	〃				
EXU-1-EFF-1402	〃			〃	〃	1408		〃	〃	〃				
EXU-1-EFF-1540	〃			〃	〃	1546		〃	〃	〃				

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time
	9-23 1655		092305

Remarks and Observations

Matrix Types S Soil SW Surface Water GW Ground Water SG Soil Gas

Mobile Laboratory Services

5921 SW Archer Road
Gainesville, FL 32608
TEL (352) 367-0073
FAX (352) 367-0074

CHAIN-OF-CUSTODY RECORD

4

MOBILE UNIT # KB-2

CLIENT NAME: TETRA TECH	PROJECT NAME & ADDRESS: 05-227 FORMER AMERICAN BERYLIUM
SAMPLERS: PURIFICS	CONTACT PERSON: BATCH # (Lab Use Only)

IDENTIFY PARAMETERS ANALYSES AND NO. OF CONTAINERS

PRESERVATION
C Chilled
H HCl
O Other (see Remarks)

SAMPLE FIELD ID / NUMBER	DATE SAMPLED	TIME SAMPLED	COMP.	GRAB	DATE REC'D	TIME REC'D	STATION LOCATION / No.	SAMPLE MATRIX	NUMBER OF CONTAINERS	VOLATILES				COMMENT
EXL-1-INFTANK-0700	092405			✓	092405	0728		W	2	✓				
EXL-1-~~[illegible]~~ TANK-0700						0728								
EXL-1-INF-1000						0958								
EXL-1-EFF-1000						0958								
EXL-1-EFF-1125						1120								
EXL-1-EFF-1400						1410								
EXL-1-EFF-1600						1554								

Preserved Containers Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Date / Time	Remarks and Observations
Relinquished by: (Signature)	Date / Time 9-24-05 1455	Received by: (Signature)	Date / Time 092405	

Matrix Types S Soil SW Surface Water GW Ground Water SG Soil Gas

TEST REPORT – REV. 1

PHOTO-CAT TREATMENT OF GROUNDWATER AT THE FORMER ABC SITE - SARASOTA

PREPARED FOR

Lockheed Martin Corporation
6801 Rockledge Drive
Bethedsa, MD 20817

Attn: Dr. Tina Armstrong

December 12, 2005

Submitted by:

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1 PHOTO-CAT IN-HOUSE TEST PROGRAM OBJECTIVES

The purpose of the on-site test program was to quantify rates of Photo-Cat destruction of 1,4-dioxane and chlorinated solvents in 2 separate groundwater aquifers, and to verify destruction of all targeted contaminants below detectable limits.

2 TEST DESCRIPTION

Two separate pumping tests were performed by the client in which groundwater from 2 aquifers were pumped continuously for 48 hours (upper aquifer) and 24 hours (lower aquifer) respectively. In each pumping test, the groundwater was collected in a 6,000 gallon tank (ie. Collection Tank). Purifics pumped the groundwater from the collection tank using a variable speed driven centrifugal pump into its mobile Photo-Cat system. All treated water was discharged into a 20,000 gallon holding tank.

The groundwater was pumped at various flow rates, ranging from 10 – 19 Lpm (2.6 – 5.0gpm). The groundwater was filtered upstream of the Photo-Cat system using a 10um cartridge filter. The pH was then lowered to remove alkalinity (which is a scavenger of the hydroxyl radical) and to maintain iron in solution. A diaphragm metering pump controlled by the PLC was used to provide precise pH control. A variable frequency drive was used to maintain a constant flow rate. The frequency is adjusted by the PLC as the pressure drop increased across the cartridge filter.

All tests were performed with 1 modular photocatalytic rack. The nominal power of the rack was 2.4 kW. Ambient air was added to the reactor by a compressor and flow meter, at a rate of nominally 100mL/min in all tests, to provide stoichiometric oxygen requirements.

The 2 main parameters that were adjusted throughout the test program were operating pH and system flow rate. Samples were taken throughout the test program and analysed for 1,4-dioxane and other VOCs utilizing an on-site mobile laboratory.

3 RESULTS

All Photo-Cat testing was performed over a 4 day period during business hours. Over the 4 days, 21,266L (5,618 gallons) of groundwater was treated. The groundwater tests were performed on two sources, upper and lower aquifer groundwater.

3.1 Upper Aquifer Testing

Table 1 lists the key inorganic concentrations analyzed by Purifics on-site using field test kits.

Table 1: Key Inorganic Concentrations – Upper Aquifer

Parameter	Concentration
Alkalinity	60 – 80 ppm
Iron	7 – 8 ppm
Chlorides	60 – 80 ppm

Alkalinity, which is a measure of the bicarbonate ion, is important as it is a scavenger of the hydroxyl radical. Sulfuric acid is added to the groundwater to remove the bicarbonate ion. Although the pH buffer at which the bicarbonate ion evolves to CO_2 is nominally 4.6, the pH setpoint at which the Photo-Cat system is operated is typically a function of the iron concentration. The greater the iron concentration, the lower the pH setpoint will be to ensure that the iron remains soluble. The optimal operating pH for the upper aquifer groundwater was 3.0.

Tables 2 – 4 show the Photo-Cat performance data for the tests on the upper aquifer groundwater.

Table 2: Day 1 Testing – Upper Aquifer:

Date	Wednesday, Sept. 21/05			
Time	07:35	13:15	14:35	16:35
Sample Description	Influent	Influent	Effluent	Effluent
Flow Rate (Lpm)	---	---	12	12
pH	---	---	3.8	3.4
Parameter (ug/L)				
Vinyl Chloride	< 1.0	1.2	< 1.0	< 1.0
1,1-Dichloroethylene	12.8	25.1	< 1.0	< 1.0
c-1,2-dichloroethylene	36.6	95.1	< 1.0	< 1.0
Trichloroethylene	540	2800	1.3	< 1.0
Tetrachloroethylene	3.7	4.8	< 1.0	< 1.0
1,4 Dioxane	300	300	< 3.2	< 3.2

The primary purpose of day 1 was to determine the required operating pH to keep iron in solution, and to quantify preliminary treatment rates. As shown in the two tests above, the only parameter altered was operating pH.

Operating at a pH of 3.4 did provide destruction of all targeted parameters below detection limits. There was a slight brown colour on the TiO_2 catalyst at pH 3.4 operation, thus the pH was reduced to 3.0 for all tests on Day 2.

Table 3: Day 2 Testing – Upper Aquifer:

Date	Thursday, Sept. 22/05				
Time	10:15	12:15	12:15	17:00	17:00
Sample Description	Effluent	Influent	Effluent	Influent	Effluent
Flow Rate (Lpm)	12	---	12	---	12
pH	3	---	3	---	3
Parameter (ug/L)					
Vinyl Chloride	< 1.0	< 100	< 1.0	< 100	< 1.0
1,1-Dichloroethylene	< 1.0	190	< 1.0	120	< 1.0
c-1,2- dichloroethylene	< 1.0	< 100	< 1.0	280	< 1.0
Trichloroethylene	< 1.0	7500	< 1.0	10,000	< 1.0
Tetrachloroethylene	< 1.0	< 100	< 1.0	< 100	< 1.0
1,4-Dioxane	< 3.2	200	< 3.2	250	< 3.2

It was found in Day 2 that operating at a pH of 3 kept all iron completely dissolved, consequently, pH 3 was maintained for all subsequent tests with the upper aquifer groundwater.

As shown in Tables 2 and 3, the influent TCE concentrations increased dramatically (540ppb up to 10,000ppb). Consequently, the test conditions were unchanged for all effluent samples taken on this day in order to quantify the TCE removal rates versus increasing TCE concentration. All effluent samples were below detectable limits.

Table 4: Day 3 Testing – Upper Aquifer:

Date	Friday, Sept. 23/05				
Time	10:30	10:30	14:00	14:00	15:40
Sample Description	Influent	Effluent	Influent	Effluent	Effluent
Flow Rate (Lpm)	---	12	---	16	19
pH	---	3	---	3	3
Parameter (ug/L)					
Vinyl Chloride	110	< 1.0	< 200	< 1.0	< 1.0
1,1-Dichloroethylene	< 100	< 1.0	< 200	< 1.0	< 1.0
c-1,2- dichloroethylene	270	< 1.0	270	< 1.0	< 1.0
Trichloroethylene	10000	< 1.0	11000	12.5	31.9
Tetrachloroethylene	< 100	< 1.0	< 200	< 1.0	< 1.0
1,4-Dioxane	250	< 3.2	250	5.1	43.5

These data show that the influent TCE concentration of the tank had leveled off at nominally 10,000 – 11,000ppb. At these test conditions, all targeted parameters were destroyed below detection limits. In order to get an actual rate of contaminant destruction, it is required that the Photo-Cat system operate in a mode such that breakthrough of targeted parameters is maintained. Consequently, the Photo-Cat system was operated at increased flow rates of 16 and 19 Lpm to accomplish this. Accordingly, low detections of both TCE and 1,4-dioxane were obtained at increased flow rate operating conditions, and rates of contaminant removal were calculated.

3.2 Lower Aquifer Testing

After Day3, all of the upper aquifer groundwater remaining in the collection tank was pumped out, and the 24 hour pump test for the lower aquifer water was started and ran all night. All Photo-Cat operations on Day4 were on the lower aquifer water.

Table 5 shows the key inorganic concentrations as measured by field test kits. The Photo-Cat performance data obtained on Day 4 for the lower aquifer is shown in Table 6.

Table 5: Key Inorganic Concentrations – Lower Aquifer

Parameter	Concentration
Alkalinity	220 ppm
Iron	2 ppm
Chlorides	100 – 120 ppm

Comparing tables 1 and 5 show that the inorganic concentrations of the 2 aquifers differ significantly. The iron is significantly lower but the chlorides and alkalinity are greater.

Table 6: Day 4 Testing – Lower Aquifer:

Date	Saturday, Sept. 24/05				
Time	10:00	10:00	11:25	14:00	16:00
Sample Description	Influent	Effluent	Effluent	Effluent	Effluent
Flow Rate (Lpm)	---	12	12	16	10
pH	---	3	3.5	3.5	3.5
Parameter (ug/L)					
Vinyl Chloride	2.1	< 1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethylene	160	< 1.0	< 1.0	< 1.0	< 1.0
c-1,2- dichloroethylene	60	< 1.0	< 1.0	< 1.0	< 1.0
Trichloroethylene	920	6.8	1.4	22.9	< 1.0
Tetrachloroethylene	1	< 1.0	< 1.0	< 1.0	< 1.0
1,4-Dioxane	990	< 3.2	9	21.5	< 3.2

The concentrations of the 1,4-dioxane in the lower aquifer were greater than the upper aquifer, however, the TCE concentrations were lower.

3.3 DATA VALIDATION

Four samples were sent to an off-site contract laboratory for confirmation. The data from the off-site lab compares reasonably well with on-site mobile lab.

4 CONCLUSIONS

It is difficult to compare the results of varying tests when the parameters are different, thus a first order rate constant is used. The rate constant normalizes all key operating parameters to provide an 'apples to apples' comparison. As with normal rate constants, as the rate constant increases the treatment efficiency increases. The rates of contaminant destruction follow first order kinetics as shown in Equation 1.

$$\mathbf{k = 1/t * \ln (Co/C)} \qquad \mathbf{1/}$$

Where:
Co = Initial concentration
C = Final concentration
t = Time
k = First order rate constant

The time (t) in Equation 1 is directly proportional to the Photo-Cat power (kW) divided by the flow rate (L/min). Substituting the kW/Lpm ratio for 't' in Equation 1 above gives units of 'L/min / kW' for the rate constant 'k' as shown in Equation 2.

$$\mathbf{k = Flow\ Rate / Power * \ln (Co/C)} \qquad \mathbf{2/}$$

Once the rate constant has been obtained, it is used to calculate full-scale treatment requirements by substituting the rate constant, the design flow rate, and the design influent and effluent concentrations into equation 2 and then solve for the power (kW).

Based on the data obtained from on-site testing, the following are the demonstrated rate constants for TCE and 1,4-dioxane.

Table 7: Demonstrated Photo-Cat Rate Constants

Water Source	k – TCE (Lpm/kW)	k – 1,4-Dioxane
Upper Aquifer	45.2	25.9
Lower Aquifer	28.4	23.9
Average	36.8	24.9

The reason why the TCE rates of destruction reduced in the treatment of the lower aquifer water was due to the increase in chloride concentration, which is a scavenger of the hydroxyl radical. The increase in chlorides had a lower impact on 1,4-dioxane destruction.

Applied Project Number P-1638

HiPOx™ Technology Lab Testing:

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Tallevast, FL

Prepared for

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1.0 Background Information

1.1 HiPOx Technology

The HiPOx™ process developed by Applied Process Technology, Inc. (Applied) is an Advanced Oxidation Process (AOP) that uses ozone (O_3) and hydrogen peroxide (H_2O_2) to destroy organic compounds. Ozone dissociates as well as reacts with hydrogen peroxide to produce an intermediate, hydroxyl radical (•OH). Hydroxyl radicals are the second most powerful oxidizing agent found in nature. These hydroxyl radicals react very rapidly to oxidize organic contaminants to non-hazardous compounds, carbon dioxide, and water.[1] The oxidation of the organic contaminants does not increase the temperature or pressure of the treated water because of the low ppm or sub-ppm concentration of contaminants.

Advanced oxidation chemistry using ozone and hydrogen peroxide to create hydroxyl radicals is well known. The overall balanced reaction for ozone and hydrogen peroxide to yield hydroxyl radical is:

$$2O_3 + H_2O_2 \rightarrow 2\bullet OH + 3O_2$$

1.2 Objective of Evaluation

The objective of this laboratory trial was to determine the efficiency of the HiPOx technology utilizing ozone and hydrogen peroxide to reduce the concentration of 1,4-dioxane to < 3 ppb and to reduce the concentration of trichloroethylene (TCE) to <5.

1.3 Process Water Information

The tests were conducted on water supplied by Tetra Tech. Two samples of water were received on September 9, 2005: EXU-1Lab and EXL-1Lab. All samples, once received, were logged in and stored in a refrigerator until they were tested.

2.0 Test Equipment and Procedures

2.1 Test Equipment Description

The HiPOx reactor is constructed of PVC. All ozone piping is constructed of either 316 Stainless Steel or Teflon. The hydrogen peroxide piping is constructed of either 316 Stainless Steel or polyethylene. The ozone generator utilized was an ASTeX Model 8200. The ozone is injected under pressure into the water to be treated. Mixing of the ozone into the water is accomplished with an in-line static mixer. The vent from the system is passed through an ozone destruct unit manufactured by Pacific Ozone.

2.2 Test Procedures

Test Conditions

All water samples received were tested for pH, alkalinity and turbidity. The HiPOx tests conducted on both samples, EXU-1Lab and EXL-1Lab, occurred on October 7, 2005.

The test procedures for EXU-1Lab and EXL-1Lab were identical. Sample designations reflect sample and treatment levels: as an example, SP-5-1638-EXU represents water sample EXU-1Lab treated with 5 ppm of ozone. The test procedure was as follows: A sample (2.0 liters) was treated with hydrogen peroxide (1.00 mls, 0.5% by wt, 2.5 ppm). This mixture was then treated with ozone (151 mls, 5.0% by wt in oxygen, 5.0 ppm). A sample (SP-5-1638) was taken for 1,4-dioxane and VOC analysis. A total of 6 runs were

---

[1] W. Glaze and J. Kang, *J. Amer. Water Works Assoc.*, **80**, 51, (1988).

conducted. The amounts of ozone and hydrogen peroxide applied during each run is summarized in Table 1.

Table 1. Summary of Experimental Conditions for Samples EXU-1Lab and EXL-1Lab

		Experimental Conditions						
Sample Log #	Run #	Ozone Dose (ppm)	Ozone Conc. (wt%)	Volume of Ozone Added (mls)	H2O2 Conc (wt%)	H2O2 (ppm)	Volume H2O2 (mls)	Reactor Volume (L)
SP-5-1638-EXU	1	5.0	4.95	91	0.50	2.5	1.00	2
SP-10-1638-EXU	2	10.0	4.97	181	0.50	4.9	2.00	2
SP-15-1638-EXU	3	14.9	4.97	271	0.50	7.4	3.00	2
SP-8-1638-EXL	4	8.0	4.90	145	0.50	4.0	1.60	2
SP-16-1638-EXL	5	16.0	4.99	289	0.50	7.9	3.20	2
SP-24-1638-EXL	6	24.0	4.99	434	0.50	11.9	4.80	2

Analytical Testing
All samples from the HiPOx test conducted on October 7, 2005 were sent for analysis to Accutest, 4405 Vineland, Suite 15-C, Orlando, Florida 32811, Telephone: (407) 425-6700.

The turbidity meter was an Orbeco-Hellige Model 965-10 Serial # 2222.

3.0 Discussion

1,4-Dioxane and VOC Treatment

The results for the EXU-1Lab samples are shown in Table 2. The results for the EXL-1Lab are presented in Table 3.

Table 2. Summary of Results and Conditions for EXU-1Lab

Lab Analytical Run Sheet 1-1638EXU																				
Conditions									Results (ppb)											
Run #	O_3 Dose (ppm)	H_2O_2 Dose (ppm)	Mole Ratio	pH	Alk. (ppm)	Turbidity (NTU)	Residual H_2O_2 (ppm)	Residual O_3 (ppm)	Sample ID	1,4-Dioxane	TCE	DCE	Methyl Ethyl Ketone	Freon 113	Acetone	1,1-DCE	1,2-cis-DCE	1,1-DCA	Bromodichloromethane	Chloroform
0	0	0	0	–	–	–	–	–	EXU-1Lab	21	138	15.6	<2.5	114	10	6.8	6.5	20.1	1.7	11.3
1	5.0	2.5	0.70	6.42	140	19	2	1.6	SP-5-1638-EXU	<1.9	37.9	1.4	9.1	60.3	21.5	<0.5	1	22.6	0.93	6.4
2	10.0	4.9	0.70	6.45	140	27.5	2	1.5	SP-10-1638-EXU	<1.9	7.7	0.82	2.9	38.8	26.4	<0.5	<0.5	22.8	0.98	6.6
3	14.9	7.4	0.70	6.40	130	29.9	5	1.6	SP-15-1638-EXU	<1.9	<0.5	<0.5	2.6	31.1	34.7	<0.5	<0.5	19.5	0.95	6.3

Table 3. Summary of Results and Conditions for EXL-1Lab

Lab Analytical Run Sheet 1-1632EXL																						
Run #	O₃ Dose (ppm)	H₂O₂ Dose (ppm)	pH	Alk. (ppm)	Turbidity (NTU)	Residual H₂O₂ (ppm)	Residual O₃ (ppm)	Sample ID	1,4-Dioxane	TCE	PCE	Methyl Ethyl Ketone	1,2-Dichlorotetrafluoroethane	Freon 113	Acetone	1,2-trans-DCE	1,2-cis-DCE	1,1-DCE	1,1-DCA	Vinyl Chloride	Bromodichloromethane	Chloroform
0	0	0	--	--	--	--	--	EXL-1LAB	166	2750	0.93	<25	48.9	0.62	68	0.78	16.3	92.7	12.3	1.8	3.4	9.3
4	8.0	4.0	6.62	180	67.5	2	2.1	SP-8-1632-EXL	9.9	11.7	<2.5	<25	NR	<0.6	<25	<2.5	<2.5	<0.5	8.6	<2.5	<25	<2.5
5	16.0	7.9	6.67	180	80.2	3	1.1	SP-16-1632-EXL	<1.9	<0.5	<0.5	<25	NR	<0.6	20.4	<0.5	<0.5	<0.5	6.2	<0.5	0.59	1.7
6	24.0	11.9	6.71	160	87.7	2	0.5	SP-24-1632-EXL	<1.9	<0.5	<0.5	<25	NR	<0.6	18.5	<0.5	<0.5	<0.5	3.6	<0.5	<0.5	1.5

EXU

The influent concentrations of 1,4-dioxane and TCE in sample EXU-1Lab were < 3 ppb and 138 ppb, respectively. The data in Table 2 can be used to develop empirical models by plotting the TCE concentration as a function of applied ozone. This plot is then used to create a destruction curve for TCE (see Figure 1). The TCE empirical model can be used to estimate the amount of ozone required to treat TCE from an influent concentration of 138 to an effluent concentration of 3 ppb. This is shown Table 4. In addition, other potential influent TCE concentrations are shown along with the amount of ozone required to reduce each TCE concentration to an effluent of 3 ppb. Effluent concentrations of all the other chlorinated ethylenes (PCE and DCEs) were less than 0.5 ppb, and the effluent 1,4-dioxane was less than 1.9 ppb in HiPOx treated samples.

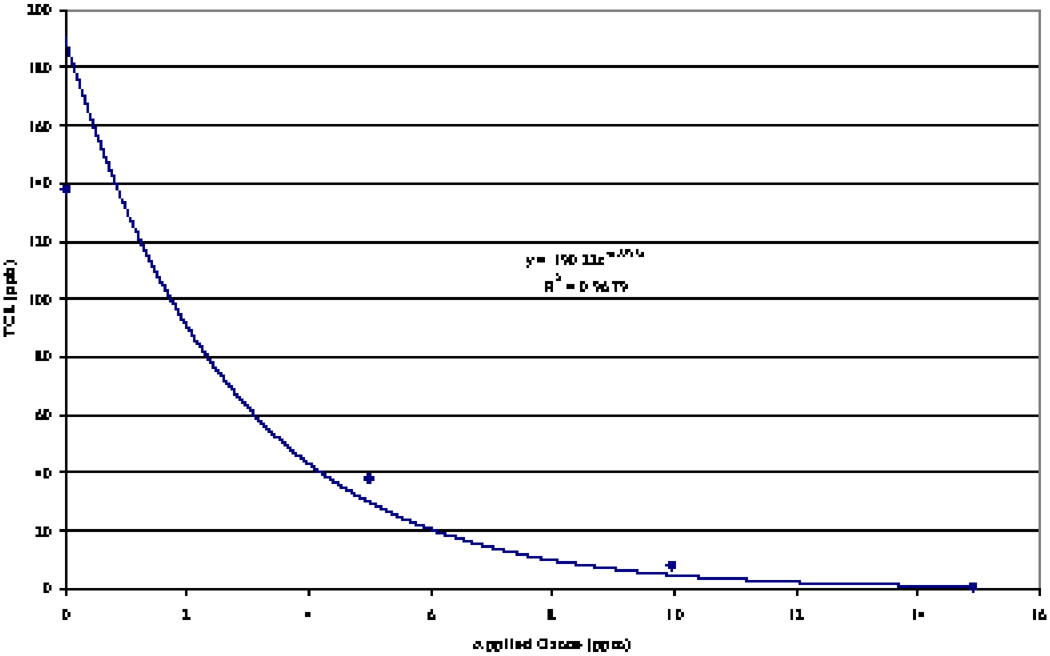


Figure 1. TCE Destruction Curve for EXU-1Lab

Table 4. EXU- TCE Modeling of Ozone Demand at Various TCE Influent Concentrations

Applied O3 (ppm)	TCE Influent (ppb)	TCE Effluent (ppb)
10.3	*138*	*3.0*
9.4	100	3.0
11.3	200	3.0
17.5	2000	3.0

EXL

The influent concentrations of 1,4-dioxane and TCE in sample EXL-1Lab were 166 and 2,700 ppb, respectively. The data in Table 3 can be used to develop empirical models for both TCE and 1,4-Dioxane by plotting their concentrations as a function of applied ozone. These plots are then used to create destruction curves for TCE and 1,4-dioxane (see Figures 2 and 3). These empirical models can be used to estimate the ozone required to treat various influent concentrations of the contaminants, TCE and 1,4-dioxane, to the required discharge concentrations. This is shown Table 5. In EXL-1Lab there are two compounds of concern, TCE and 1,4-dioxane. The concentrations of each of these contaminants will determine which contaminant controls the ozone dose required. For example, when the 1,4-dioxane concentration is high, >500 ppb, the amount of ozone required is determined by the 1,4-dioxane concentration (assuming a constant TCE concentration). However, at lower 1,4-dioxane concentrations, <300 ppb, the amount of ozone required is determined by the influent TCE concentration.

Effluent concentrations of all the other chlorinated ethylenes (PCE, DCEs, vinyl chloride) were less than 0.5 ppb after HiPOx treatment.

Table 5. EXL-TCE and 1,4-Dioxane Modeling of Ozone Demand at Various Influent Concentrations

Entry	Applied O3 (ppm)	Influent TCE (ppb)	Effluent TCE (ppb)	1,4-Dioxane Influent (ppb)	1,4-Dioxane Effluent (ppb)
1	15.2	2700	2.05	500	3.20
2	13.6	2700	4.23	300	3.20
3	14.3	2700	3.00	300	2.51

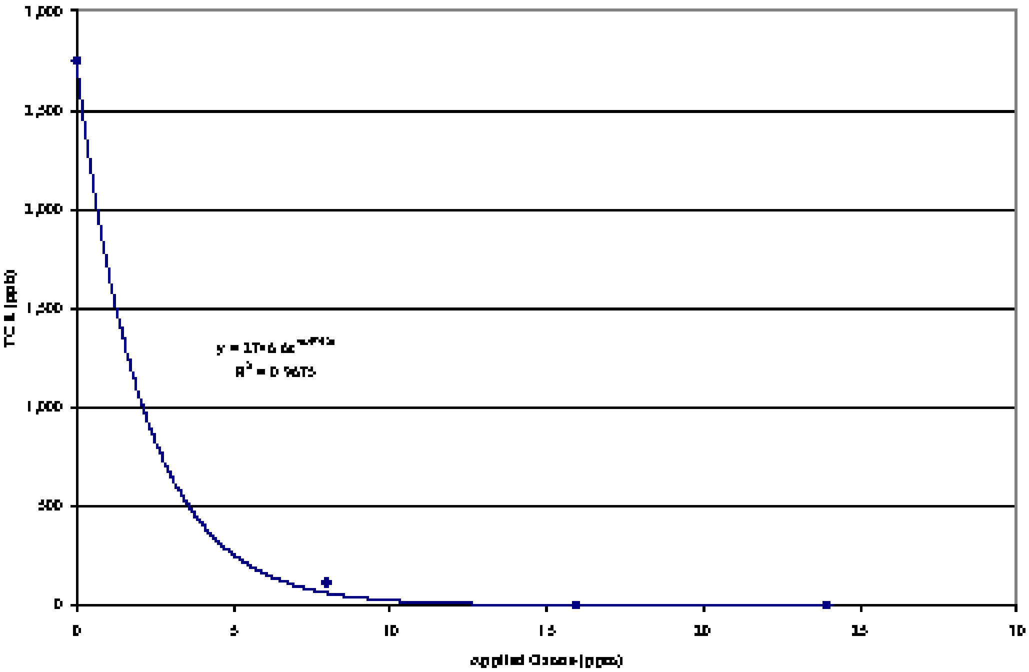


Figure 2. TCE Destruction Curve for EXL-1Lab

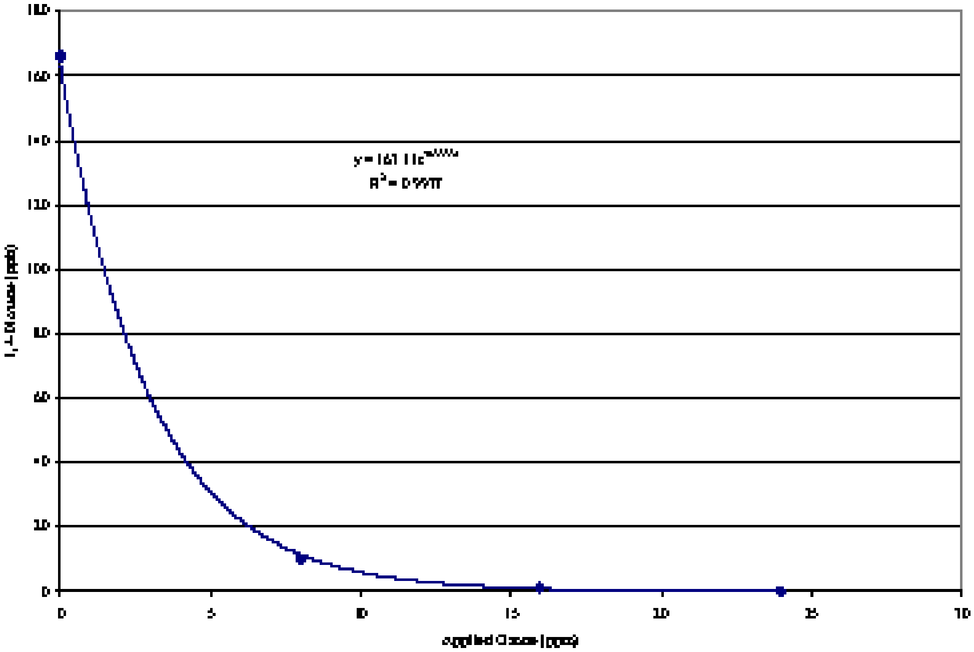


Figure 3. 1,4-Dioxane Destruction curve for EXL-1Lab

4.0 Conclusion

HiPOx technology, which uses ozone and hydrogen peroxide, is a very effective process for destroying 1,4-dioxane, TCE and other chlorinated ethylenes in groundwater at the Tallevast site. This was accomplished in both water samples provided EXU-1lab and EXL-1lab.

An empirical predictive model was developed to estimate applied ozone requirements. The model was used to estimate the ozone dose required to reduce concentrations of 1,4-dioxane and TCE to less than 3.2 and 3 ppb, respectively. This model could be used to estimate the ozone dose required for varying influent concentrations of 1,4-dioxane and TCE.

In order to treat water from the Tallevast site with and influent concentrations of 500 ppb 1,4-dioxane and 2,000 ppb TCE to effluent concentrations of <3.2 ppb and <3 ppb, respectively, an ozone dose of 15.2 would be required based on the empirical model developed for EXL-lab.

Appendix:
Analytical Reports

Note: Key data has been extracted from the full raw water analytical report for inclusion in this appendix. The complete report is available upon request.

e-Hardcopy 2.0
Automated Report

Southeast
ACCUTEST
Laboratories

09/20/05

Technical Report for

Tetra Tech NUS

Former American Beryllium, Sarasota, FL

N1075

Accutest Job Number: F34701

Sampling Date: 09/07/05

Report to:

Total number of pages in report: 91

Test results contained within this data package meet the requirements of the National Environmental Laboratory Accreditation Conference and/or state specific certification programs as applicable.

Harry Behzadi, Ph.D.
Laboratory Director

Certifications: FL (DOH E83510), NC (573), NJ (FL002), MA (FL946), IA (366), LA (03051), KS (E-10327), SC, AK
This report shall not be reproduced, except in its entirety, without the written approval of Accutest Laboratories.

Accutest Laboratories

Report of Analysis

Client Sample ID:	EX0-1LAB		
Lab Sample ID:	F34701-1	**Date Sampled:**	09/07/05
Matrix:	AQ - Ground Water	**Date Received:**	09/09/05
Method:	SW846 8260B	**Percent Solids:**	n/a
Project:	Former American Beryllium, Sarasota, FL		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	C0035287.D	1	09/13/05	KW	n/a	n/a	VC1431
Run #2	D003241.D	2	09/15/05	KW	n/a	n/a	VD1405

	Purge Volume
Run #1	5.0 ml
Run #2	5.0 ml

VOA TCL 4.2 List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone ª	10	25	5.0	ug/l	J
71-43-2	Benzene	0.50 U	1.0	0.50	ug/l	
75-27-4	Bromodichloromethane	1.7	1.0	0.50	ug/l	
75-25-2	Bromoform	0.50 U	1.0	0.50	ug/l	
108-90-7	Chlorobenzene	0.50 U	1.0	0.50	ug/l	
75-00-3	Chloroethane	1.0 U	2.0	1.0	ug/l	
67-66-3	Chloroform	11.3	1.0	0.50	ug/l	
75-15-0	Carbon disulfide	1.0	2.0	1.0	ug/l	J
56-23-5	Carbon tetrachloride	0.50 U	1.0	0.50	ug/l	
110-82-7	Cyclohexane	0.50 U	1.0	0.50	ug/l	
75-34-3	1,1-Dichloroethane	20.1	1.0	0.50	ug/l	
75-35-4	1,1-Dichloroethylene	6.8	1.0	0.50	ug/l	
96-12-8	1,2-Dibromo-3-chloropropane	1.0 U	2.0	1.0	ug/l	
106-93-4	1,2-Dibromoethane	0.50 U	1.0	0.50	ug/l	
107-06-2	1,2-Dichloroethane	0.50 U	1.0	0.50	ug/l	
78-87-5	1,2-Dichloropropane	0.50 U	1.0	0.50	ug/l	
354-23-4	1,2-Dichlorotrifluoroethane	9.5	2.0	0.70	ug/l	
124-48-1	Dibromochloromethane	0.40 U	1.0	0.40	ug/l	
75-71-8	Dichlorodifluoromethane	0.50 U	1.0	0.50	ug/l	
156-59-2	cis-1,2-Dichloroethylene	6.5	1.0	0.50	ug/l	
10061-01-5	cis-1,3-Dichloropropene	0.30 U	1.0	0.30	ug/l	
541-73-1	m-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
95-50-1	o-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
106-46-7	p-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
156-60-5	trans-1,2-Dichloroethylene	0.50 U	1.0	0.50	ug/l	
10061-02-6	trans-1,3-Dichloropropene	0.30 U	1.0	0.30	ug/l	
100-41-4	Ethylbenzene	0.50 U	1.0	0.50	ug/l	
76-13-1	Freon 113	114 ᵇ	2.0	1.2	ug/l	
591-78-6	2-Hexanone	2.5 U	5.0	2.5	ug/l	
98-82-8	Isopropylbenzene	0.50 U	1.0	0.50	ug/l	
108-10-1	4-Methyl-2-pentanone	2.5 U	5.0	2.5	ug/l	
79-20-9	Methyl Acetate	5.0 U	10	5.0	ug/l	

U = Not detected   MDL - Method Detection Limit

RL = Reporting Limit

E = Indicates value exceeds calibration range

I = Result >= MDL but < RL   J = Estimated value

V = Indicates analyte found in associated method blank

N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	EXJ-IIAB		
Lab Sample ID:	F34701-1	**Date Sampled:**	09/27/05
Matrix:	AQ - Ground Water	**Date Received:**	09/29/05
Method:	SW846 8260B	**Percent Solids:**	n/a
Project:	Former American Beryllium, Sarasota, FL		

VOA TCL 4.2 List

CAS No.	Compound	Result	RL	MDL	Units	Q
74-83-9	Methyl bromide	1.0 U	2.0	1.0	ug/l	
74-87-3	Methyl chloride	1.0 U	2.0	1.0	ug/l	
108-87-2	Methylcyclohexane	0.50 U	1.0	0.50	ug/l	
75-09-2	Methylene chloride	1.0 U	5.0	1.0	ug/l	
78-93-3	Methyl ethyl ketone	2.5 U	5.0	2.5	ug/l	
1634-04-4	Methyl Tert Butyl Ether	0.50 U	1.0	0.50	ug/l	
100-42-5	Styrene	0.50 U	1.0	0.50	ug/l	
71-55-6	1,1,1-Trichloroethane	0.50 U	1.0	0.50	ug/l	
79-34-5	1,1,2,2-Tetrachloroethane	0.40 U	1.0	0.40	ug/l	
79-00-5	1,1,2-Trichloroethane	0.50 U	1.0	0.50	ug/l	
120-82-1	1,2,4-Trichlorobenzene	0.50 U	1.0	0.50	ug/l	
127-18-4	Tetrachloroethylene	15.6	1.0	0.50	ug/l	
108-88-3	Toluene	0.50 U	1.0	0.50	ug/l	
79-01-6	Trichloroethylene	138	2.0	1.0	ug/l	b
75-69-4	Trichlorofluoromethane	0.50 U	2.0	0.50	ug/l	
75-01-4	Vinyl chloride	0.50 U	1.0	0.50	ug/l	
1330-20-7	Xylene (total)	1.0 U	3.0	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	111%	99%	86-115%
17060-07-0	1,2-Dichloroethane-D4	113%	93%	73-126%
2037-26-5	Toluene-D8	95%	108%	86-112%
460-00-4	4-Bromofluorobenzene	103%	114%	83-119%

(a) Associated BS recovery outside control limits

(b) Result is from Run# 2

U = Not detected MDL - Method Detection Limit J = Result >= MDL but < RL J = Estimated value

RL = Reporting Limit B = Indicates analyte found in associated method blank

E = Indicates value exceeds calibration range N = Indicates presumptive evidence of a compound

Accutest Laboratories

Report of Analysis

Client Sample ID:	EX33-1LAB		
Lab Sample ID:	F34701-1	**Date Sampled:**	09/07/05
Matrix:	AQ - Ground Water	**Date Received:**	09/08/05
Method:	SW846 8270C SW846 3510C	**Percent Solids:**	n/a
Project:	Former American Beryllium, Sarasota, FL		

	File ID	**DF**	**Analyzed**	**By**	**Prep Date**	**Prep Batch**	**Analytical Batch**
Run #1	F011475.D		09/13/05	NJ	09/12/05	OP14386	SF631
Run #2							

	Initial Volume	**Final Volume**
Run #1	1000 ml	1.0 ml
Run #2		

CAS No.	**Compound**	**Result**	**RL**	**MDL**	**Units**	**Q**
123-91-1	1,4-Dioxane	2.1	5.0	2.0	ug/l	J

CAS No.	**Surrogate Recoveries**	**Run# 1**	**Run# 2**	**Limits**
367-12-4	2-Fluorophenol	32%		19-90%
4165-62-2	Phenol-d5	22%		10-68%
118-79-6	2,4,6-Tribromophenol	89%		36-137%
4165-60-0	Nitrobenzene-d5	82%		49-119%
321-60-8	2-Fluorobiphenyl	79%		45-128%
1718-51-0	Terphenyl-d14	82%		45-135%

U = Not detected   MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

I = Result >= MDL but < RL   J = Estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	EXL-1LA9		
Lab Sample ID:	F34701-2	**Date Sampled:**	09/07/05
Matrix:	AQ - Ground Water	**Date Received:**	09/09/05
Method:	SW846 8260B	**Percent Solids:**	n/a
Project:	Former American Beryllium, Sarasota, FL		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	CC035288.D	1	09/13/05	KW	n/a	n/a	VC1431
Run #2 a	B033210.D	50	09/15/05	KW	n/a	n/a	VB1403

	Purge Volume
Run #1	5.0 ml
Run #2	5.0 ml

VOA TCL 4.2 List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone b	6.8	25	5.0	ug/l	I
71-43-2	Benzene	0.50 U	1.0	0.50	ug/l	
75-27-4	Bromodichloromethane	3.4	1.0	0.50	ug/l	
75-25-2	Bromoform	0.50 U	1.0	0.50	ug/l	
108-90-7	Chlorobenzene	0.50 U	1.0	0.50	ug/l	
75-00-3	Chloroethane	1.0 U	2.0	1.0	ug/l	
67-66-3	Chloroform	9.3	1.0	0.50	ug/l	
75-15-0	Carbon disulfide	1.0 U	2.0	1.0	ug/l	
56-23-5	Carbon tetrachloride	0.50 U	1.0	0.50	ug/l	
110-82-7	Cyclohexane	0.50 U	1.0	0.50	ug/l	
75-34-3	1,1-Dichloroethane	12.5	1.0	0.50	ug/l	
75-35-4	1,1-Dichloroethylene	927 a	50	25	ug/l	
96-12-8	1,2-Dibromo-3-chloropropane	1.0 U	2.0	1.0	ug/l	
106-93-4	1,2-Dibromoethane	0.50 U	1.0	0.50	ug/l	
107-06-2	1,2-Dichloroethane	0.50 U	1.0	0.50	ug/l	
78-87-5	1,2-Dichloropropane	0.50 U	1.0	0.50	ug/l	
354-23-4	1,2-Dichlorotrifluoroethane	48.9	2.0	0.70	ug/l	
124-48-1	Dibromochloromethane	0.82	1.0	0.40	ug/l	I
75-71-8	Dichlorodifluoromethane	0.50 U	1.0	0.50	ug/l	
156-59-2	cis-1,2-Dichloroethylene	150 a	50	25	ug/l	
10061-01-5	cis-1,3-Dichloropropene	0.20 U	1.0	0.20	ug/l	
541-73-1	m-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
95-50-1	o-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
106-46-7	p-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
156-60-5	trans-1,2-Dichloroethylene	0.78	1.0	0.50	ug/l	I
10061-02-6	trans-1,3-Dichloropropene	0.20 U	1.0	0.20	ug/l	
100-41-4	Ethylbenzene	0.50 U	1.0	0.50	ug/l	
76-13-1	Freon 113	0.67	1.0	0.60	ug/l	I
591-78-6	2-Hexanone	2.5 U	5.0	2.5	ug/l	
98-82-8	Isopropylbenzene	0.50 U	1.0	0.50	ug/l	
108-10-1	4-Methyl-2-pentanone	2.5 U	5.0	2.5	ug/l	
79-20-9	Methyl Acetate	5.0 U	10	5.0	ug/l	

U = Not detected MDL - Method Detection Limit I = Result >= MDL but < RL J = Estimated value
RL = Reporting Limit V = Indicates analyte found in associated method blank
E = Indicates value exceeds calibration range N = Indicates presumptive evidence of a compound

Accutest Laboratories

Report of Analysis

Client Sample ID:	EXL-[illegible]AB		
Lab Sample ID:	F34761-2	**Date Sampled:**	09/07/05
Matrix:	AQ - Ground Water	**Date Received:**	09/10/05
Method:	SW846 8260B	**Percent Solids:**	n/a
Project:	Former American Beryllium, Sarasota, FL		

VOA TCL 4.2 List

CAS No.	Compound	Result	RL	MDL	Units	Q
74-83-9	Methyl bromide	1.0 U	2.0	1.0	ug/l	
74-87-3	Methyl chloride	1.0 U	2.0	1.0	ug/l	
108-87-2	Methylcyclohexane	0.50 U	1.0	0.50	ug/l	
75-09-2	Methylene chloride	1.0 U	5.0	1.0	ug/l	
78-93-3	Methyl ethyl ketone	2.5 U	5.0	2.5	ug/l	
1634-04-4	Methyl Tert Butyl Ether	0.50 U	1.0	0.50	ug/l	
100-42-5	Styrene	0.50 U	1.0	0.50	ug/l	
71-55-6	1,1,1-Trichloroethane	0.50 U	1.0	0.50	ug/l	
79-34-5	1,1,2,2-Tetrachloroethane	0.40 U	1.0	0.40	ug/l	
79-00-5	1,1,2-Trichloroethane	0.50 U	1.0	0.50	ug/l	
120-82-1	1,2,4-Trichlorobenzene	0.50 U	1.0	0.50	ug/l	
127-18-4	Tetrachloroethylene	0.93	1.0	0.50	ug/l	J
108-88-3	Toluene	0.50 U	1.0	0.50	ug/l	
79-01-6	Trichloroethylene	3750 ᶜ	50	25	ug/l	
75-69-4	Trichlorofluoromethane	0.50 U	2.0	0.50	ug/l	
75-01-4	Vinyl chloride	1.8	1.0	0.50	ug/l	
1330-20-7	Xylene (total)	1.0 U	3.0	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	112%	100%	86-118%
17060-07-0	1,2-Dichloroethane-D4	117%	93%	73-126%
2037-26-5	Toluene-D8	93%	105%	80-112%
460-00-4	4-Bromofluorobenzene	103%	109%	83-119%

CAS No.	Tentatively Identified Compounds [d]	R.T.	Est. Conc.	Units	Q
	Total TIC, Volatile		0	ug/l	

(a) Sample was not preserved to a pH < 2.
(b) Associated BS recovery outside control limits.
(c) Result is from Run# 2
(d) No TICs detected.

U = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range
J = Result > = MDL but < RL J = Estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Accutest Laboratories

Report of Analysis

Page 1 of 1

Client Sample ID:	EXL-1LAB		
Lab Sample ID:	F34201-2	**Date Sampled:**	09/07/05
Matrix:	AQ - Ground Water	**Date Received:**	09/09/05
Method:	SW846 8270C SW846 3510C	**Percent Solids:**	n/a
Project:	Former American Beryllium, Sarasota, FL		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	F0114840.D	2	09/13/05	N.	09/12/05	OP14386	SF521
Run #2							

	Initial Volume	Final Volume
Run #1	900 ml	1.0 ml
Run #2		

CAS No.	Compound	Result	RL	MDL	Units	Q
123-91-1	1,4-Dioxane	156	11	4.4	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
367-12-4	2-Fluorophenol	21%		19-90%
4165-62-2	Phenol-d5	13%		10-68%
118-79-6	2,4,6-Tribromophenol	91%		36-137%
4165-60-0	Nitrobenzene-d5	84%		49-119%
321-60-8	2-Fluorobiphenyl	80%		45-118%
1718-51-0	Terphenyl-d14	86%		46-125%

U = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Result >= MDL but < RL J = Estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Sample Summary

Tetra Tech NUS

Job No: F35479

Former American Beryllium, Sarasota, FL
Project No: N1075, Order Number 1004773

Sample Number	Collected Date	Time	By	Received	Matrix Code	Type	Client Sample ID
F35479-1	10/03/05	07:10	DDS	10/04/05	AQ	Water	SP-5-1638-EXD
F35479-2	10/03/05	07:30	DDS	10/04/05	AQ	Water	SP-10-1638-EXL
F35479-3	10/03/05	07:45	DDS	10/04/05	AQ	Water	SP-15-1638-EXL
F35479-4	10/03/05	08:15	DDS	10/04/05	AQ	Water	SP-8-1638-EXL
F35479-5	10/03/05	08:30	DDS	10/04/05	AQ	Water	SP-16-1638-EXL
F35479-6	10/03/05	09:00	DDS	10/04/05	AQ	Water	SP-24-1638-EXL

Report of Analysis

Client Sample ID: SP-5-1638 EXU
Lab Sample ID: F35479-1
Matrix: AQ - Water
Method: SW846 8260B
Project: Former American Beryllium, Sarasota, FL
Date Sampled: 10/03/05
Date Received: 10/04/05
Percent Solids: n/a

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	N0007390.D	1	10/13/05	KK	n/a	n/a	VN310
Run #2							

	Purge Volume
Run #1	5.0 ml
Run #2	

VOA TCL 4.2 List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone	21.6	25	5.0	ug/l	J
71-43-2	Benzene	0.50 U	1.0	0.50	ug/l	
75-27-4	Bromodichloromethane	0.93	1.0	0.50	ug/l	J
75-25-2	Bromoform	0.50 U	1.0	0.50	ug/l	
108-90-7	Chlorobenzene	0.50 U	1.0	0.50	ug/l	
75-00-3	Chloroethane	1.0 U	2.0	1.0	ug/l	
67-66-3	Chloroform	6.4	1.0	0.50	ug/l	
75-15-0	Carbon disulfide	1.0 U	2.0	1.0	ug/l	
56-23-5	Carbon tetrachloride	0.50 U	1.0	0.50	ug/l	
110-82-7	Cyclohexane	0.50 U	1.0	0.50	ug/l	
75-34-3	1,1-Dichloroethane	22.6	1.0	0.50	ug/l	
75-35-4	1,1-Dichloroethylene	0.50 U	1.0	0.50	ug/l	
96-12-8	1,2-Dibromo-3-chloropropane	1.0 U	2.0	1.0	ug/l	
106-93-4	1,2-Dibromoethane	0.50 U	1.0	0.50	ug/l	
107-06-2	1,2-Dichloroethane	0.50 U	1.0	0.50	ug/l	
78-87-5	1,2-Dichloropropane	0.50 U	1.0	0.50	ug/l	
124-48-1	Dibromochloromethane	0.40 U	1.0	0.40	ug/l	
75-71-8	Dichlorodifluoromethane	0.50 U	1.0	0.50	ug/l	
156-59-2	cis-1,2-Dichloroethylene	1.0	1.0	0.50	ug/l	
10061-01-5	cis-1,3-Dichloropropene	0.30 U	1.0	0.30	ug/l	
541-73-1	m-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
95-50-1	o-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
106-46-7	p-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
156-60-5	trans-1,2-Dichloroethylene	0.50 U	1.0	0.50	ug/l	
10061-02-6	trans-1,3-Dichloropropene	0.30 U	1.0	0.30	ug/l	
100-41-4	Ethylbenzene	0.50 U	1.0	0.50	ug/l	
76-13-1	Freon 113	60.3	1.0	0.60	ug/l	
591-78-6	2-Hexanone	2.5 U	5.0	2.5	ug/l	
98-82-8	Isopropylbenzene	0.50 U	1.0	0.50	ug/l	
108-10-1	4-Methyl-2-pentanone	2.5 U	5.0	2.5	ug/l	
79-20-9	Methyl Acetate	5.0 U	10	5.0	ug/l	
74-83-9	Methyl bromide	1.0 U	2.0	1.0	ug/l	

U = Not detected   MDL - Method Detection Limit   I = Result >= MDL but < RL   J = Estimated value
RL = Reporting Limit   B = Indicates analyte found in associated method blank
E = Indicates value exceeds calibration range   N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	SP-5 1838 EXU		
Lab Sample ID:	F35479-1	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8260B	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, FL		

VOA TCL 4.2 List

CAS No.	Compound	Result	RL	MDL	Units	Q
74-87-3	Methyl chloride	1.0 U	2.0	1.0	ug/l	
108-87-2	Methylcyclohexane	0.50 U	1.0	0.50	ug/l	
75-09-2	Methylene chloride	1.0 U	5.0	1.0	ug/l	
78-93-3	Methyl ethyl ketone	9.1	5.0	2.5	ug/l	
1634-04-4	Methyl Tert Butyl Ether	0.50 U	1.0	0.50	ug/l	
100-42-5	Styrene	0.50 U	1.0	0.50	ug/l	
71-55-6	1,1,1-Trichloroethane	0.50 U	1.0	0.50	ug/l	
79-34-5	1,1,2,2-Tetrachloroethane	0.40 U	1.0	0.40	ug/l	
79-00-5	1,1,2-Trichloroethane	0.50 U	1.0	0.50	ug/l	
120-82-1	1,2,4-Trichlorobenzene	0.50 U	1.0	0.50	ug/l	
127-18-4	Tetrachloroethylene	1.4	1.0	0.50	ug/l	
108-88-3	Toluene	0.50 U	1.0	0.50	ug/l	
79-01-6	Trichloroethylene	37.9	1.0	0.50	ug/l	
75-69-4	Trichlorofluoromethane	0.50 U	2.0	0.50	ug/l	
75-01-4	Vinyl chloride	0.50 U	1.0	0.50	ug/l	
1330-20-7	Xylene (total)	1.0 U	3.0	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	100%		86-118%
17060-07-0	1,2-Dichloroethane-D4	98%		73-120%
2037-26-5	Toluene-D8	107%		86-112%
460-00-4	4-Bromofluorobenzene	99%		83-119%

U = Not detected   MDL - Method Detection Limit   I = Result >= MDL but < RL   J = Estimated value
RL = Reporting Limit   V = Indicates analyte found in associated method blank
E = Indicates value exceeds calibration range   N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	SP-5-1638 KXU		
Lab Sample ID:	F35479-1	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8270C SW846 3510C	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, FL		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	T011934.D	1	10/10/05	NJ	10/07/05	OP14630	SF650
Run #2							

	Initial Volume	Final Volume
Run #1	1040 ml	1.0 ml
Run #2		

CAS No.	Compound	Result	RL	MDL	Units	Q
123-91-1	1,4-Dioxane	1.0 U	4.8	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
4165-60-0	Nitrobenzene-d5	63%		49-119%
321-60-8	2-Fluorobiphenyl	68%		45-118%
1718-51-0	Terphenyl-d14	59%		46-135%

U = Not detected   MDL - Method Detection Limit   J = Result >= MDL but < RL   J = Estimated value
RL = Reporting Limit   V = Indicates analyte found in associated method blank
E = Indicates value exceeds calibration range   N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	SP-10-1638 RXH		
Lab Sample ID:	F35479-2	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8260B	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, FL		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	N0007386.D	1	10/13/05	KK	n/a	n/a	VN310
Run #2							

	Purge Volume
Run #1	5.0 ml
Run #2	

VOA TCL 4.2 List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone	28.4	25	5.0	ug/l	
71-43-2	Benzene	0.50 U	1.0	0.50	ug/l	
75-27-4	Bromodichloromethane	0.98	1.0	0.50	ug/l	I
75-25-2	Bromoform	0.50 U	1.0	0.50	ug/l	
108-90-7	Chlorobenzene	0.50 U	1.0	0.50	ug/l	
75-00-3	Chloroethane	1.0 U	2.0	1.0	ug/l	
67-66-3	Chloroform	6.6	1.0	0.50	ug/l	
75-15-0	Carbon disulfide	1.0 U	2.0	1.0	ug/l	
56-23-5	Carbon tetrachloride	0.50 U	1.0	0.50	ug/l	
110-82-7	Cyclohexane	0.50 U	1.0	0.50	ug/l	
75-34-3	1,1-Dichloroethane	22.6	1.0	0.50	ug/l	
75-35-4	1,1-Dichloroethylene	0.50 U	1.0	0.50	ug/l	
96-12-8	1,2-Dibromo-3-chloropropane	1.0 U	2.0	1.0	ug/l	
106-93-4	1,2-Dibromoethane	0.50 U	1.0	0.50	ug/l	
107-06-2	1,2-Dichloroethane	0.50 U	1.0	0.50	ug/l	
78-87-5	1,2-Dichloropropane	0.50 U	1.0	0.50	ug/l	
124-48-1	Dibromochloromethane	0.40 U	1.0	0.40	ug/l	
75-71-8	Dichlorodifluoromethane	0.50 U	1.0	0.50	ug/l	
156-59-2	cis-1,2-Dichloroethylene	0.50 U	1.0	0.50	ug/l	
10061-01-5	cis-1,3-Dichloropropene	0.30 U	1.0	0.30	ug/l	
541-73-1	m-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
95-50-1	o-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
106-46-7	p-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
156-60-5	trans-1,2-Dichloroethylene	0.50 U	1.0	0.50	ug/l	
10061-02-6	trans-1,3-Dichloropropene	0.30 U	1.0	0.30	ug/l	
100-41-4	Ethylbenzene	0.50 U	1.0	0.50	ug/l	
76-13-1	Freon 113	38.8	1.0	0.50	ug/l	
591-78-6	2-Hexanone	2.5 U	5.0	2.5	ug/l	
98-82-8	Isopropylbenzene	0.50 U	1.0	0.50	ug/l	
108-10-1	4-Methyl-2-pentanone	2.5 U	5.0	2.5	ug/l	
79-20-9	Methyl Acetate	5.0 U	10	5.0	ug/l	
74-83-9	Methyl bromide	1.0 U	2.0	1.0	ug/l	

U = Not detected   MDL - Method Detection Limit   I = Result >= MDL but < RL   J = Estimated value
RL = Reporting Limit   V = Indicates analyte found in associated method blank
E = Indicates value exceeds calibration range   N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	SP-10-1638-EXU		
Lab Sample ID:	F35470-2	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8260B	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, FL		

VOA TCL 4.2 List

CAS No.	Compound	Result	RL	MDL	Units	Q
74-87-3	Methyl chloride	1.0 U	2.0	1.0	ug/l	
108-87-2	Methylcyclohexane	0.50 U	1.0	0.50	ug/l	
75-09-2	Methylene chloride	1.0 U	5.0	1.0	ug/l	
78-93-3	Methyl ethyl ketone	2.9	5.0	2.5	ug/l	I
1634-04-4	Methyl Tert Butyl Ether	0.50 U	1.0	0.50	ug/l	
100-42-5	Styrene	0.50 U	1.0	0.50	ug/l	
71-55-6	1,1,1-Trichloroethane	0.50 U	1.0	0.50	ug/l	
79-34-5	1,1,2,2-Tetrachloroethane	0.40 U	1.0	0.40	ug/l	
79-00-5	1,1,2-Trichloroethane	0.50 U	1.0	0.50	ug/l	
120-82-1	1,2,4-Trichlorobenzene	0.50 U	1.0	0.50	ug/l	
127-18-4	Tetrachloroethylene	0.82	1.0	0.50	ug/l	I
108-88-3	Toluene	0.50 U	1.0	0.50	ug/l	
79-01-6	Trichloroethylene	7.7	1.0	0.50	ug/l	
75-69-4	Trichlorofluoromethane	0.50 U	2.0	0.50	ug/l	
75-01-4	Vinyl chloride	0.50 U	1.0	0.50	ug/l	
1330-20-7	Xylene (total)	1.0 U	3.0	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	100%		86-118%
17060-07-0	1,2-Dichloroethane-D4	100%		73-126%
2037-26-5	Toluene-D8	107%		86-112%
460-00-4	4-Bromofluorobenzene	101%		83-118%

U = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

I = Result >= MDL but < RL J = Estimated value
V = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Accutest LabLink@17:23 14-Oct-2005 Preliminary Data

Report of Analysis

Client Sample ID:	SP-10-1638-EXU		
Lab Sample ID:	F35470-2	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8270C SW846 3510C	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, FL		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	F011905.D	1	10/10/05	NJ	10/07/05	OP14636	SF660
Run #2							

	Initial Volume	Final Volume
Run #1	1040 ml	1.0 ml
Run #2		

CAS No.	Compound	Result	RL	MDL	Units	Q
123-91-1	1,4-Dioxane	1.9 U	4.8	1.9	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
4165-60-0	Nitrobenzene-d5	61%		40-119%
321-60-8	2-Fluorobiphenyl	60%		46-118%
1718-51-0	Terphenyl-d14	51%		46-135%

U = Not detected MDL - Method Detection Limit I = Result >= MDL but < RL J = Estimated value
RL = Reporting Limit V = Indicates analyte found in associated method blank
L = Indicates value exceeds calibration range N = Indicates presumptive evidence of a compound

Accutest LabLink@17:23 14 Oct 2005 Preliminary Data

Report of Analysis

Page 1 of 2

Client Sample ID:	SP-15-1038-BXD		
Lab Sample ID:	F35479-3	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8260B	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, FL		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	N0007387.D	1	10/13/05	KK	n/a	n/a	VN310
Run #2							

	Purge Volume
Run #1	5.0 ml
Run #2	

VOA TCL 4 2 List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone	34.7	25	5.0	ug/l	
71-43-2	Benzene	0.50 U	1.0	0.50	ug/l	
75-27-4	Bromodichloromethane	0.95	1.0	0.50	ug/l	J
75-25-2	Bromoform	0.50 U	1.0	0.50	ug/l	
108-90-7	Chlorobenzene	0.50 U	1.0	0.50	ug/l	
75-00-3	Chloroethane	1.0 U	2.0	1.0	ug/l	
67-66-3	Chloroform	6.3	1.0	0.50	ug/l	
75-15-0	Carbon disulfide	1.0 U	2.0	1.0	ug/l	
56-23-5	Carbon tetrachloride	0.50 U	1.0	0.50	ug/l	
110-82-7	Cyclohexane	0.50 U	1.0	0.50	ug/l	
75-34-3	1,1-Dichloroethane	10.5	1.0	0.50	ug/l	
75-35-4	1,1-Dichloroethylene	0.50 U	1.0	0.50	ug/l	
96-12-8	1,2-Dibromo-3-chloropropane	1.0 U	2.0	1.0	ug/l	
106-93-4	1,2-Dibromoethane	0.50 U	1.0	0.50	ug/l	
107-06-2	1,2-Dichloroethane	0.50 U	1.0	0.50	ug/l	
78-87-5	1,2-Dichloropropane	0.50 U	1.0	0.50	ug/l	
124-48-1	Dibromochloromethane	0.40 U	1.0	0.40	ug/l	
75-71-8	Dichlorodifluoromethane	0.50 U	1.0	0.50	ug/l	
156-59-2	cis-1,2-Dichloroethylene	0.50 U	1.0	0.50	ug/l	
10061-01-5	cis-1,3-Dichloropropene	0.30 U	1.0	0.30	ug/l	
541-73-1	m-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
95-50-1	o-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
106-46-7	p-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
156-60-5	trans-1,2-Dichloroethylene	0.50 U	1.0	0.50	ug/l	
10061-02-6	trans-1,3-Dichloropropene	0.30 U	1.0	0.30	ug/l	
100-41-4	Ethylbenzene	0.50 U	1.0	0.50	ug/l	
76-13-1	Freon 113	31.1	1.0	0.80	ug/l	
591-78-6	2-Hexanone	2.5 U	5.0	2.5	ug/l	
98-82-8	Isopropylbenzene	0.50 U	1.0	0.50	ug/l	
108-10-1	4-Methyl-2-pentanone	2.5 U	5.0	2.5	ug/l	
79-20-9	Methyl Acetate	5.0 U	10	5.0	ug/l	
74-83-9	Methyl bromide	1.0 U	2.0	1.0	ug/l	

U = Not detected   MDL - Method Detection Limit   J = Result >= MDL but < RL   J = Estimated value
RL = Reporting Limit   V = Indicates analyte found in associated method blank
E = Indicates value exceeds calibration range   N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	SP-15-1638-FXU		
Lab Sample ID:	F35479-3	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8260B	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, FL		

VOA TCL 4.2 List

CAS No	Compound	Result	RL	MDL	Units	Q
74-87-3	Methyl chloride	1.0 U	2.0	1.0	ug/l	
108-87-2	Methylcyclohexane	0.50 U	1.0	0.50	ug/l	
75-09-2	Methylene chloride	1.0 U	5.0	1.0	ug/l	
78-93-3	Methyl ethyl ketone	2.6	5.0	2.5	ug/l	J
1634-04-4	Methyl Tert Butyl Ether	0.50 U	1.0	0.50	ug/l	
100-42-5	Styrene	0.50 U	1.0	0.50	ug/l	
71-55-6	1,1,1-Trichloroethane	0.50 U	1.0	0.50	ug/l	
79-34-5	1,1,2,2-Tetrachloroethane	0.40 U	1.0	0.40	ug/l	
79-00-5	1,1,2-Trichloroethane	0.50 U	1.0	0.50	ug/l	
120-82-1	1,2,4-Trichlorobenzene	0.50 U	1.0	0.50	ug/l	
127-18-4	Tetrachloroethylene	0.50 U	1.0	0.50	ug/l	
108-88-3	Toluene	0.50 U	1.0	0.50	ug/l	
79-01-6	Trichloroethylene	0.50 U	1.0	0.50	ug/l	
75-69-4	Trichlorofluoromethane	0.50 U	2.0	0.50	ug/l	
75-01-4	Vinyl chloride	0.50 U	1.0	0.50	ug/l	
1330-20-7	Xylene (total)	1.0 U	3.0	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	100%		86-115%
17060-07-0	1,2-Dichloroethane-D4	101%		73-126%
2037-26-5	Toluene-D8	107%		86-112%
460-00-4	4-Bromofluorobenzene	101%		83-119%

U = Not detected   MDL - Method Detection Limit   I = Result >= MDL but < RL   J = Estimated value
RL = Reporting Limit   B = Indicates analyte found in associated method blank
E = Indicates value exceeds calibration range   N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	SP 15-1638-EXD		
Lab Sample ID:	F35478-8	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8270C SW846 3510C	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, Fl		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	F011908.D	1	10/10/05	NJ	10/07/05	OP14636	SF650
Run #2							

	Initial Volume	Final Volume
Run #1	1040 ml	1.0 ml
Run #2		

CAS No.	Compound	Result	RL	MDL	Units	Q
123-91-1	1,4-Dioxane	1.9 U	4.8	1.9	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
4165-60-0	Nitrobenzene-d5	69%		48-118%
321-60-8	2-Fluorobiphenyl	70%		45-116%
1718-51-0	Terphenyl-d14	66%		46-135%

U = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

I = Result >= MDL but < RL J = Estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Accutest LabLink@17:23 14-Oct-2005 Preliminary Data

Report of Analysis

Client Sample ID:	SP-8-1638-EXL		
Lab Sample ID:	F35479-1	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8260B	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, FL		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	J018465.D	5	10/12/05	MM	n/a	n/a	V1762
Run #2							

	Purge Volume
Run #1	5.0 ml
Run #2	

VOA TCL 4.2 List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone	25 U	100	25	ug/l	
71-43-2	Benzene	2.5 U	5.0	2.5	ug/l	
75-27-4	Bromodichloromethane	2.5 U	5.0	2.5	ug/l	
75-25-2	Bromoform	2.5 U	5.0	2.5	ug/l	
108-90-7	Chlorobenzene	2.5 U	5.0	2.5	ug/l	
75-00-3	Chloroethane	5.0 U	10	5.0	ug/l	
67-66-3	Chloroform	2.5 U	5.0	2.5	ug/l	
75-15-0	Carbon disulfide	5.0 U	10	5.0	ug/l	
56-23-5	Carbon tetrachloride	2.5 U	5.0	2.5	ug/l	
110-82-7	Cyclohexane	2.5 U	5.0	2.5	ug/l	
75-34-3	1,1-Dichloroethane	8.6	5.0	2.5	ug/l	
75-35-4	1,1-Dichloroethylene	2.5 U	5.0	2.5	ug/l	
96-12-8	1,2-Dibromo-3-chloropropane	5.0 U	10	5.0	ug/l	
106-93-4	1,2-Dibromoethane	2.5 U	5.0	2.5	ug/l	
107-06-2	1,2-Dichloroethane	2.5 U	5.0	2.5	ug/l	
78-87-5	1,2-Dichloropropane	2.5 U	5.0	2.5	ug/l	
124-48-1	Dibromochloromethane	2.0 U	5.0	2.0	ug/l	
75-71-8	Dichlorodifluoromethane	2.5 U	5.0	2.5	ug/l	
156-59-2	cis-1,2-Dichloroethylene	2.5 U	5.0	2.5	ug/l	
10061-01-5	cis-1,3-Dichloropropene	1.5 U	5.0	1.5	ug/l	
541-73-1	m-Dichlorobenzene	2.5 U	5.0	2.5	ug/l	
95-50-1	o-Dichlorobenzene	2.5 U	5.0	2.5	ug/l	
106-46-7	p-Dichlorobenzene	2.5 U	5.0	2.5	ug/l	
156-60-5	trans-1,2-Dichloroethylene	2.5 U	5.0	2.5	ug/l	
10061-02-6	trans-1,3-Dichloropropene	1.5 U	5.0	1.5	ug/l	
100-41-4	Ethylbenzene	2.5 U	5.0	2.5	ug/l	
76-13-1	Freon 113	3.0 U	5.0	3.0	ug/l	
591-78-6	2-Hexanone	13 U	25	13	ug/l	
98-82-8	Isopropylbenzene	2.5 U	5.0	2.5	ug/l	
108-10-1	4-Methyl-2-pentanone	13 U	25	13	ug/l	
79-20-9	Methyl Acetate	25 U	50	25	ug/l	
74-83-9	Methyl bromide	5.0 U	10	5.0	ug/l	

U = Not detected   MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Result >= MDL but < RL   J = Estimated value
V = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	SP-8-1038 EXL		
Lab Sample ID:	F35479-4	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8260B	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, FL		

VOA TCL 4.2 List

CAS No.	Compound	Result	RL	MDL	Units	Q
74-87-3	Methyl chloride	5.0 U	10	5.0	ug/l	
108-87-2	Methylcyclohexane	2.5 U	5.0	2.5	ug/l	
75-09-2	Methylene chloride	5.0 U	25	5.0	ug/l	
78-93-3	Methyl ethyl ketone	13 U	25	13	ug/l	
1634-04-4	Methyl Tert Butyl Ether	2.5 U	5.0	2.5	ug/l	
100-42-5	Styrene	2.5 U	5.0	2.5	ug/l	
71-55-6	1,1,1-Trichloroethane	2.5 U	5.0	2.5	ug/l	
79-34-5	1,1,2,2-Tetrachloroethane	2.0 U	5.0	2.0	ug/l	
79-00-5	1,1,2-Trichloroethane	2.5 U	5.0	2.5	ug/l	
120-82-1	1,2,4-Trichlorobenzene	2.5 U	5.0	2.5	ug/l	
127-18-4	Tetrachloroethylene	2.5 U	5.0	2.5	ug/l	
108-88-3	Toluene	2.5 U	5.0	2.5	ug/l	
79-01-6	Trichloroethylene	117	5.0	2.5	ug/l	
75-69-4	Trichlorofluoromethane	2.5 U	10	2.5	ug/l	
75-01-4	Vinyl chloride	2.5 U	5.0	2.5	ug/l	
1330-20-7	Xylene (total)	5.0 U	15	5.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	105%		86-118%
17060-07-0	1,2-Dichloroethane-D4	116%		73-126%
2037-26-5	Toluene-D8	89%		85-112%
460-00-4	4-Bromofluorobenzene	112%		83-119%

U = Not detected MDL - Method Detection Limit

RL = Reporting Limit

E = Indicates value exceeds calibration range

J = Result >= MDL but < RL J = Estimated value

B = Indicates analyte found in associated method blank

N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	SP-8-1688 EXL		
Lab Sample ID:	F35479-4	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8270C SW846 3510C	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, FL		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	F011909.D	1	10/10/05	NJ	10/07/05	OP14636	S1650
Run #2							

	Initial Volume	Final Volume
Run #1	1040 ml	1.0 ml
Run #2		

CAS No.	Compound	Result	RL	MDL	Units	Q
123-91-1	1,4-Dioxane	9.9	4.8	1.9	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
4165-60-0	Nitrobenzene-d5	56%		43-119%
321-60-8	2-Fluorobiphenyl	60%		45-118%
1718-51-0	Terphenyl-d14	51%		40-135%

U = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

I = Result >= MDL but < RL J = Estimated value
V = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	SP-16-1638-EXL		
Lab Sample ID:	F35479-5	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8260B	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, FL		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	N0007388.D	1	10/13/05	KS	n/a	n/a	VN310
Run #2							

	Purge Volume
Run #1	5.0 ml
Run #2	

VOA TCL 3.2 List

CAS No	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone	20.4	25	5.0	ug/l	J
71-43-2	Benzene	0.50 U	1.0	0.50	ug/l	
75-27-4	Bromodichloromethane	0.59	1.0	0.50	ug/l	J
75-25-2	Bromoform	0.50 U	1.0	0.50	ug/l	
108-90-7	Chlorobenzene	0.50 U	1.0	0.50	ug/l	
75-00-3	Chloroethane	1.0 U	2.0	1.0	ug/l	
67-66-3	Chloroform	1.7	1.0	0.50	ug/l	
75-15-0	Carbon disulfide	1.0 U	2.0	1.0	ug/l	
56-23-5	Carbon tetrachloride	0.50 U	1.0	0.50	ug/l	
110-82-7	Cyclohexane	0.50 U	1.0	0.50	ug/l	
75-34-3	1,1-Dichloroethane	6.2	1.0	0.50	ug/l	
75-35-4	1,1-Dichloroethylene	0.50 U	1.0	0.50	ug/l	
96-12-8	1,2-Dibromo-3-chloropropane	1.0 U	2.0	1.0	ug/l	
106-93-4	1,2-Dibromoethane	0.50 U	1.0	0.50	ug/l	
107-06-2	1,2-Dichloroethane	0.50 U	1.0	0.50	ug/l	
78-87-5	1,2-Dichloropropane	0.50 U	1.0	0.50	ug/l	
124-48-1	Dibromochloromethane	0.40 U	1.0	0.40	ug/l	
75-71-8	Dichlorodifluoromethane	0.50 U	1.0	0.50	ug/l	
156-59-2	cis-1,2-Dichloroethylene	0.50 U	1.0	0.50	ug/l	
10061-01-5	cis-1,3-Dichloropropene	0.30 U	1.0	0.30	ug/l	
541-73-1	m-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
95-50-1	o-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
106-46-7	p-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
156-60-5	trans-1,2-Dichloroethylene	0.50 U	1.0	0.50	ug/l	
10061-02-6	trans-1,3-Dichloropropene	0.30 U	1.0	0.30	ug/l	
100-41-4	Ethylbenzene	0.50 U	1.0	0.50	ug/l	
76-13-1	Freon 113	0.60 U	1.0	0.60	ug/l	
591-78-6	2-Hexanone	2.5 U	5.0	2.5	ug/l	
98-82-8	Isopropylbenzene	0.50 U	1.0	0.50	ug/l	
108-10-1	4-Methyl-2-pentanone	2.5 U	5.0	2.5	ug/l	
79-20-9	Methyl Acetate	5.0 U	10	5.0	ug/l	
74-83-9	Methyl bromide	1.0 U	2.0	1.0	ug/l	

U = Not detected MDL - Method Detection Limit I = Result >= MDL but < RL J = Estimated value
RL = Reporting Limit V = Indicates analyte found in associated method blank
L = Indicates value exceeds calibration range N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	SP-16-1636-EXL		
Lab Sample ID:	F35479-5	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8260B	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, FL		

VOA TCL 4.2 List

CAS No.	Compound	Result	RL	MDL	Units	Q
74-87-3	Methyl chloride	1.0 U	2.0	1.0	ug/l	
108-87-2	Methylcyclohexane	0.50 U	1.0	0.50	ug/l	
75-09-2	Methylene chloride	1.0 U	5.0	1.0	ug/l	
78-93-3	Methyl ethyl ketone	2.5 U	5.0	2.5	ug/l	
1634-04-4	Methyl Tert Butyl Ether	0.50 U	1.0	0.50	ug/l	
100-42-5	Styrene	0.50 U	1.0	0.50	ug/l	
71-55-6	1,1,1-Trichloroethane	0.50 U	1.0	0.50	ug/l	
79-34-5	1,1,2,2-Tetrachloroethane	0.40 U	1.0	0.40	ug/l	
79-00-5	1,1,2-Trichloroethane	0.50 U	1.0	0.50	ug/l	
120-82-1	1,2,4-Trichlorobenzene	0.50 U	1.0	0.50	ug/l	
127-18-4	Tetrachloroethylene	0.50 U	1.0	0.50	ug/l	
108-88-3	Toluene	0.50 U	1.0	0.50	ug/l	
79-01-6	Trichloroethylene	0.50 U	1.0	0.50	ug/l	
75-69-4	Trichlorofluoromethane	0.50 U	2.0	0.50	ug/l	
75-01-4	Vinyl chloride	0.50 U	1.0	0.50	ug/l	
1330-20-7	Xylene (total)	1.0 U	3.0	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	101%		86-115%
17060-07-0	1,2-Dichloroethane-D4	101%		73-126%
2037-26-5	Toluene-D8	105%		88-112%
460-00-4	4-Bromofluorobenzene	89%		83-119%

U = Not detected MDL - Method Detection Limit J = Result > = MDL but < RL J = Estimated value
RL = Reporting Limit V = Indicates analyte found in associated method blank
E = Indicates value exceeds calibration range N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	SP-16-1638-EXL		
Lab Sample ID:	F45479-5	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8270C SW846 3510C	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, Fl		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	F011920.D	1	10/10/05	NJ	10/07/05	OP14636	SF550
Run #2							

	Initial Volume	Final Volume
Run #1	1040 ml	1.0 ml
Run #2		

CAS No.	Compound	Result	RL	MDL	Units	Q
123-91-1	1,4-Dioxane	1.9 U	4.8	1.9	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
4165-60-0	Nitrobenzene-d5	65%		49-119%
321-60-8	2-Fluorobiphenyl	70%		45-118%
1718-51-0	Terphenyl-d14	61%		46-135%

U = Not detected MDL - Method Detection Limit I = Result >= MDL but < RL J = Estimated value
RL = Reporting Limit B = Indicates analyte found in associated method blank
E = Indicates value exceeds calibration range N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	SP-74-1638-EX1		
Lab Sample ID:	F35470-6	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8260B	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, FL		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	N0007389.D	1	10/13/05	KK	n/a	n/a	VN310
Run #2							

	Purge Volume
Run #1	5.0 ml
Run #2	

VOA TCL 4.2 List

CAS No.	Compound	Result	RL	MDL	Units	Q
67-64-1	Acetone	16.5	25	5.0	ug/l	I
71-43-2	Benzene	0.50 U	1.0	0.50	ug/l	
75-27-4	Bromodichloromethane	0.50 U	1.0	0.50	ug/l	
75-25-2	Bromoform	0.50 U	1.0	0.50	ug/l	
108-90-7	Chlorobenzene	0.50 U	1.0	0.50	ug/l	
75-00-3	Chloroethane	1.0 U	2.0	1.0	ug/l	
67-66-3	Chloroform	1.5	1.0	0.50	ug/l	
75-15-0	Carbon disulfide	1.0 U	2.0	1.0	ug/l	
56-23-5	Carbon tetrachloride	0.50 U	1.0	0.50	ug/l	
110-82-7	Cyclohexane	0.50 U	1.0	0.50	ug/l	
75-34-3	1,1-Dichloroethane	3.6	1.0	0.50	ug/l	
75-35-4	1,1-Dichloroethylene	0.50 U	1.0	0.50	ug/l	
96-12-8	1,2-Dibromo-3-chloropropane	1.0 U	2.0	1.0	ug/l	
106-93-4	1,2-Dibromoethane	0.50 U	1.0	0.50	ug/l	
107-06-2	1,2-Dichloroethane	0.50 U	1.0	0.50	ug/l	
78-87-5	1,2-Dichloropropane	0.50 U	1.0	0.50	ug/l	
124-48-1	Dibromochloromethane	0.40 U	1.0	0.40	ug/l	
75-71-8	Dichlorodifluoromethane	0.50 U	1.0	0.50	ug/l	
156-59-2	cis-1,2-Dichloroethylene	0.50 U	1.0	0.50	ug/l	
10061-01-5	cis-1,3-Dichloropropene	0.30 U	1.0	0.30	ug/l	
541-73-1	m-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
95-50-1	o-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
106-46-7	p-Dichlorobenzene	0.50 U	1.0	0.50	ug/l	
156-60-5	trans-1,2-Dichloroethylene	0.50 U	1.0	0.50	ug/l	
10061-02-6	trans-1,3-Dichloropropene	0.30 U	1.0	0.30	ug/l	
100-41-4	Ethylbenzene	0.50 U	1.0	0.50	ug/l	
76-13-1	Freon 113	0.60 U	1.0	0.60	ug/l	
591-78-6	2-Hexanone	2.5 U	5.0	2.5	ug/l	
98-82-8	Isopropylbenzene	0.50 U	1.0	0.50	ug/l	
108-10-1	4-Methyl-2-pentanone	2.5 U	5.0	2.5	ug/l	
79-20-9	Methyl Acetate	5.0 U	10	5.0	ug/l	
74-83-9	Methyl bromide	1.0 U	2.0	1.0	ug/l	

U = Not detected   MDL - Method Detection Limit   I = Result >= MDL but < RL   J = Estimated value
RL = Reporting Limit   V = Indicates analyte found in associated method blank
L = Indicates value exceeds calibration range   N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	SP-24-1638-EXT		
Lab Sample ID:	F35479-6	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8260B	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, FL		

VOA TCL 4.2 List

CAS No.	Compound	Result	RL	MDL	Units	Q
74-87-3	Methyl chloride	1.0 U	2.0	1.0	ug/l	
108-87-2	Methylcyclohexane	0.50 U	1.0	0.50	ug/l	
75-09-2	Methylene chloride	1.0 U	5.0	1.0	ug/l	
78-93-3	Methyl ethyl ketone	2.5 U	5.0	2.5	ug/l	
1634-04-4	Methyl Tert Butyl Ether	0.50 U	1.0	0.50	ug/l	
100-42-5	Styrene	0.50 U	1.0	0.50	ug/l	
71-55-6	1,1,1-Trichloroethane	0.50 U	1.0	0.50	ug/l	
79-34-5	1,1,2,2-Tetrachloroethane	0.40 U	1.0	0.40	ug/l	
79-00-5	1,1,2-Trichloroethane	0.50 U	1.0	0.50	ug/l	
120-82-1	1,2,4-Trichlorobenzene	0.50 U	1.0	0.50	ug/l	
127-18-4	Tetrachloroethylene	0.50 U	1.0	0.50	ug/l	
108-88-3	Toluene	0.50 U	1.0	0.50	ug/l	
79-01-6	Trichloroethylene	0.50 U	1.0	0.50	ug/l	
75-69-4	Trichlorofluoromethane	0.50 U	2.0	0.50	ug/l	
75-01-4	Vinyl chloride	0.50 U	1.0	0.50	ug/l	
1330-20-7	Xylene (total)	1.0 U	3.0	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	101%		80-115%
17060-07-0	1,2-Dichloroethane-D4	101%		73-126%
2037-26-5	Toluene-D8	100%		86-112%
460-00-4	4-Bromofluorobenzene	101%		83-119%

U = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

I = Result >= MDL but < RL J = Estimated value
V = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Report of Analysis

Client Sample ID:	SP-24-163B-DXL		
Lab Sample ID:	F35479-6	Date Sampled:	10/03/05
Matrix:	AQ - Water	Date Received:	10/04/05
Method:	SW846 8270C SW846 3510C	Percent Solids:	n/a
Project:	Former American Beryllium, Sarasota, FL		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	Z011911.D	1	10/10/05	NJ	10/07/05	OP14636	SL650
Run #2							

	Initial Volume	Final Volume
Run #1	1040 ml	1.0 ml
Run #2		

CAS No.	Compound	Result	RL	MDL	Units	Q
123-91-1	1,4-Dioxane	1.9 U	4.8	1.9	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
4165-60-0	Nitrobenzene-d5	74%		49-119%
321-60-8	2-Fluorobiphenyl	70%		45-118%
1718-51-0	Terphenyl-d14	61%		48-135%

U = Not detected   MDL - Method Detection Limit   I = Result >= MDL but < RL   J = Estimated value
RL = Reporting Limit   V = Indicates analyte found in associated method blank
E = Indicates value exceeds calibration range   N = Indicates presumptive evidence of a compound

Appendix D

Design Data

BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

MODEL 5S

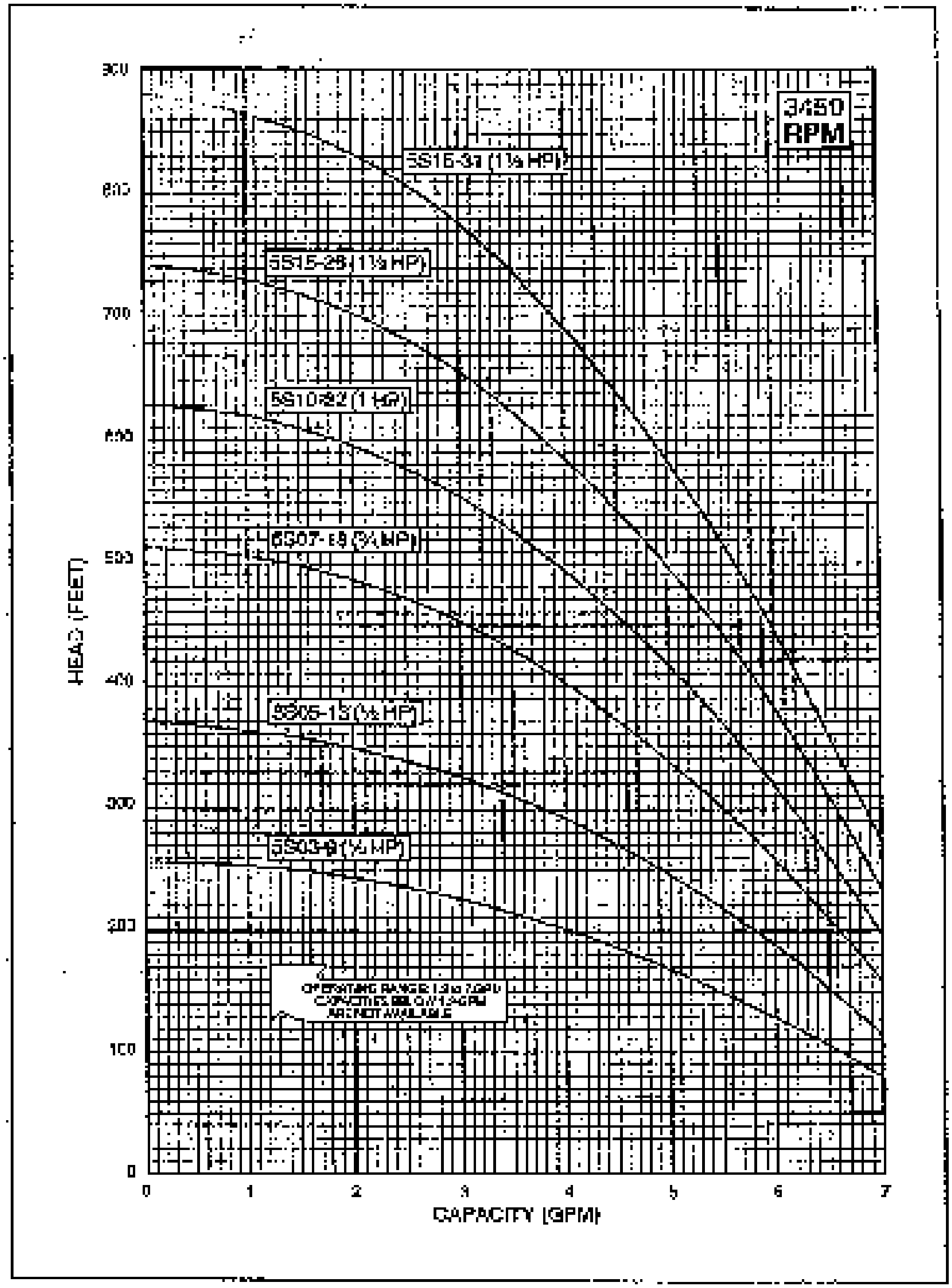
5 GPM

GRUNDFOS

FLOW RANGE
1.2 to 7 GPM

PUMP OUTLET
1" NPT

PERFORMANCE CURVES



DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH (INCHES)	WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
5S03-9	⅓	24 ⅝	3 13/16	27
5S05-13	½	28 ½	3 13/16	31
5S07-18	¾	33 ¼	3 13/16	34
5S10-22	1	37 ⅛	3 13/16	42
5S15-26	1 ½	42	3 13/16	46
5S15-31	1 ½	47 ⅞	3 13/16	59

Specifications are subject to change without notice.

GRUNDFOS 5 GPM

MODEL 5S

SELECTION CHARTS

(Ratings are in GALLONS PER HOUR – GPH)

FLOW RANGE
1.2 to 7 GPM

PUMP OUTLET
1" NPT

DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET

PUMP MODEL	HP	PSI	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	340	400	460	520	600	700	800	900	1000	1100
5S03-9	⅓	0				426	401	374	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	127													
		20		420	398	365	343	312	[illegible]	[illegible]	[illegible]	[illegible]															
		30		389	362	335	306	278	[illegible]	[illegible]	[illegible]																
		40	383	353	330	308	265	228	[illegible]																		
		50	359	327	295	265	208	150	[illegible]																		
		60	337	294	253	211	114																				
Shut-off PSI:			102	94	85	76	69	59	50	42	33	24	16	7													
5S05-13	½	0						425	407	[illegible]	[illegible]	349	330	311	[illegible]	267	253	197									
		20			437	416	399	380	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	183	117										
		30		434	415	396	377	359	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	170	117											
		40	431	412	393	374	355	338	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	104												
		50	409	390	372	353	335	316	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]													
		60	388	369	350	332	312	290	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]														
Shut-off PSI:			157	143	134	126	117	108	100	91	82	74	65	56	48	39	30	12									
5S07-18	¾	0								427	413	400	386	373	362	348	333	305	264	183							
		20						425	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	315	300	257	195								
		30					421	407	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	299	282	242	[illegible]								
		40			432	418	405	392	378	365	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	281	260	212	[illegible]								
		50		430	417	403	390	376	362	348	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	259	236	173									
		60	428	416	401	388	374	361	347	334	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	234	209	122									
Shut-off PSI:			213	204	195	187	173	167	161	152	143	135	126	117	109	100	91	74	48	22							
5S10-22	1	0										428	415	404	392	382	371	349	316	279	226	103					
		20								423	412	401	390	377	368	357	346	324	290	241	167						
		30							421	410	[illegible]	[illegible]	[illegible]	[illegible]	355	345	[illegible]	311	273	216	[illegible]						
		40						420	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	332	[illegible]	297	[illegible]	185	[illegible]						
		50				428	418	407	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	319	[illegible]	[illegible]	[illegible]	149							
		60			427	416	405	394	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	309	290	[illegible]	[illegible]	[illegible]							
Shut-off PSI:					245	237	228	219	211	202	194	186	176	168	159	150	142	124	98	72	48	12					
5S15-26	1½	0												427	418	408	390	381	353	325	279	245	120				
		20										[illegible]	416	406	398	387	378	369	332	303	258	202					
		30									423	[illegible]	[illegible]	[illegible]	[illegible]	376	367	353	321	291	243	175					
		40								422	412	[illegible]	[illegible]	[illegible]	375	365	357	338	310	277	[illegible]	142					
		50							420	411	401	392	383	374	364	355	349	327	298	262	214	102					
		60						419	409	406	391	381	372	363	354	345	335	317	286	245	180						
Shut-off PSI:								260	250	242	240	234	226	217	208	200	190	174	148	122	96	61	18				
5S15-31	1½	0														425	417	401	378	355	331	292	248	159			
		20												423	415	407	399	383	360	337	313	277	212	94			
		30											421	419	406	396	390	374	351	329	306	265	191	53			
		40										420	413	405	397	389	381	365	342	318	293	252	168				
		50								427	418	411	403	395	388	380	372	357	333	300	288	237	138				
		60							426	418	410	402	395	387	379	371	363	346	324	[illegible]	271	218	124				
Shut-off PSI:									320	311	300	294	285	277	268	254	251	235	207	191	155	121	77	34			

BBL®
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

SUBJECT	PROJ. NO.	BY	DATE	SHEET
Former ABC Site - USAS Well Pumps		DMS	12/9/05	1

CALCS. BY ____________ ; DATE ____________ CHECKED BY ____________ ; DATE ____________

Down Well Extraction Pump

a) pumping rate: 5 gpm

b) discharge pipe size: 2" sch 80 PVC

c) friction loss = 0.10 psi/100' 2" pipe

d) ΔH = 40' (depth of pump inlet to top of influent tank

e) straight pipe run = 300'

f) # 90° elbows = 5 x 5' = 25'

g) # check valves = 1 x 17' = 17'

h) # ball valves = 1 x 50' = 50'

i) Total pipe run including fittings/valves = 392'

$$\text{Total friction loss} = \frac{0.10 \text{ psi}}{100 \text{ feet}} \times 392' = 0.392 \text{ psi}$$

or

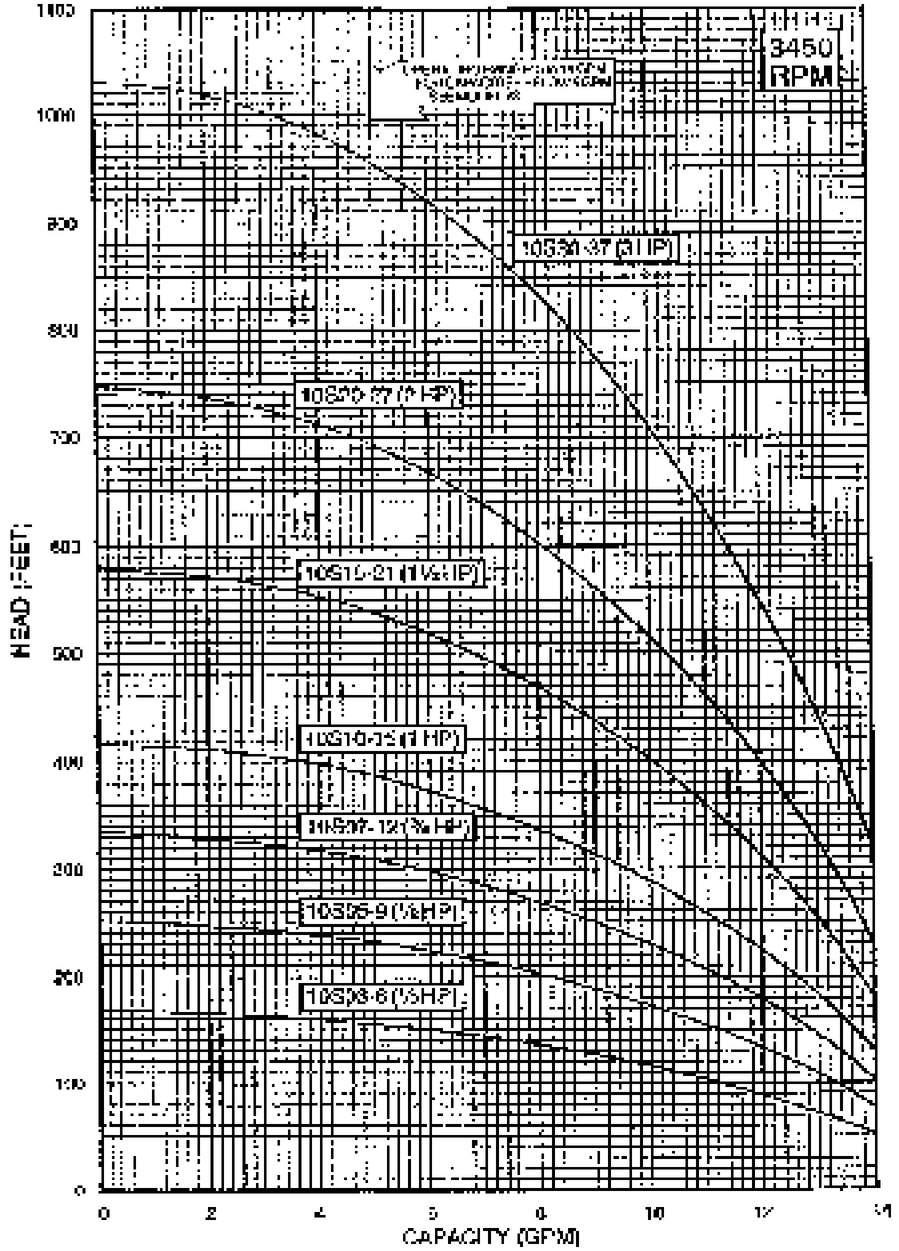
0.90' of H_2O

$$\boxed{\text{TDH required} = 40' + 0.90 = 40.9'}$$

MODEL 10S | # 10 GPM | **GRUNDFOS**

FLOW RANGE
5 to 14 GPM
PUMP OUTLET
1¼" NPT

PERFORMANCE CURVES



DIMENSIONS AND WEIGHTS

MODEL NO.	HP	LENGTH (INCHES)	WIDTH (INCHES)	APPROX. UNIT SHIPPING WT. (LBS.)
→ 10S03-6	⅓	22	3 ¹⁵⁄₁₆	26
10S05-9	½	25 ½	3 ¹⁵⁄₁₆	29
10S07-12	¾	28 ¼	3 ¹⁵⁄₁₆	33
10S10-15	1	31 ¼	3 ¹⁵⁄₁₆	34
10S15-21	1 ½	37 ½	3 ¹⁵⁄₁₆	44
10S20-27	2	42	3 ¹⁵⁄₁₆	49
10S30-37	3	57 ¾	3 ¹⁵⁄₁₆	63

Specifications are subject to change without notice.

GRUNDFOS 10 GPM

MODEL
10S

SELECTION CHARTS
(Ratings are in GALLONS PER HOUR – GPH)

FLOW RANGE
5 to 14 GPM

PUMP OUTLET
1¼" NPT

PUMP MODEL	HP	PSI	DEPTH TO PUMPING WATER LEVEL (LIFT) IN FEET																								
			20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	340	400	460	520	600	700	800	900	1000	1100
10S03-6	⅓	0		[illegible]	311	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]																	
		20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]																		
		30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]																			
		40	[illegible]	[illegible]	[illegible]	[illegible]																					
		50	[illegible]	547	536	150																					
		60	[illegible]	232																							
Shut-off PSI:			64	55	47	38	29	21	12	8																	
10S05-9	½	0				[illegible]	[illegible]	746	765	678	583	499	330	207													
		20		[illegible]	715	[illegible]	[illegible]	608	549	472	347	120															
		30	[illegible]	711	718	653	[illegible]	538	[illegible]	330	173																
		40	[illegible]	[illegible]	620	600	538	440	[illegible]																		
		50	[illegible]	[illegible]	[illegible]	516	[illegible]	258																			
		60	[illegible]	[illegible]	514	478	278																				
Shut-off PSI:			100	92	83	74	66	57	48	40	31	23	14	5													
10S07-12	¾	0					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	570	571	457	352										
		20			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	503	392	273	156											
		30		[illegible]	812	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	404	412	302	121												
		40	[illegible]	[illegible]	765	[illegible]	[illegible]	631	597	541	484	403	279	85													
		50	[illegible]	[illegible]	719	[illegible]	629	580	530	473	387	254															
		60	[illegible]	[illegible]	681	617	[illegible]	525	462	370	259																
Shut-off PSI:			137	129	120	111	103	94	86	77	68	59	51	42	33	25	16										
10S10-15	1	0							843	816	785	755	714	678	643	608	573	489	225								
		20					[illegible]	[illegible]	775	739	703	667	632	596	562	522	472	312									
		30				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	662	627	597	556	515	466	388	165									
		40		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	621	587	553	[illegible]	454	[illegible]	275										
		50	[illegible]	[illegible]	792	780	[illegible]	[illegible]	[illegible]	616	581	544	507	[illegible]	305	256	93										
		60	810	780	750	717	[illegible]	[illegible]	611	576	538	495	454	352	215												
Shut-off PSI:			174	166	157	149	139	131	122	113	105	96	87	79	70	61	53	35	10								
10S15-21	1½	0									859	836	817	796	772	747	725	669	594	519	375						
		20							849	831	811	789	764	720	718	687	665	611	553	415	136						
		30						845	828	807	784	763	736	700	689	657	632	583	495	349							
		40					843	825	804	783	756	731	705	679	653	628	604	552	449	248							
		50				840	822	800	777	752	727	701	675	650	625	600	575	519	360	120							
		60		854	837	818	797	773	748	723	697	671	646	621	596	571	541	476	308								
Shut-off PSI:				237	229	220	211	203	194	185	177	168	159	151	142	133	125	107	81	55	29						
10S20-27	2	0												847	834	819	803	768	707	697	602	509	204				
		20										844	853	814	797	779	763	729	690	605	541	425	97				
		30									842	827	818	796	778	757	737	697	638	580	514	523					
		40							852	839	835	809	792	778	754	734	714	674	615	565	485	309					
		50						850	837	825	807	788	770	751	731	713	691	651	539	534	445	225					
		60					848	835	820	804	788	767	745	728	708	684	669	629	570	502	398	128					
Shut-off PSI:							286	276	268	259	250	242	233	224	216	207	193	181	155	129	105	63	25				
10S30-37	3	0																841	806	769	735	667	593	519	389		
		20														847	829	816	770	736	651	631	562	472	309		
		30													848	833	828	822	782	749	675	617	545	446	252		
		40												845	825	824	813	787	748	702	659	611	525	411	165		
		50											845	853	822	811	798	772	728	685	641	585	554	372	105		
		60										842	837	821	813	789	783	758	712	668	626	568	461	328			
Shut-off PSI:												362	354	345	336	328	319	302	276	250	224	189	146	109	69		

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SUBJECT	PROJ. NO.	BY	DATE	SHEET
Former ABC Site - LSAS Well Pumps		DMC	12/9/05	1

CALCS. BY ______ ; DATE ________ CHECKED BY ________ ; DATE ________

Down Well Extraction Pump

a) Pumping rate: 10 gpm

b) discharge pipe size: 2" Sch 80 PVC

c) friction loss: 0.29 psi / 100' 2" pipe

d) ΔH = 55' (depth of pump inlet to top of influent tank)

e) straight pipe run = 300'

f) # 90° elbows = 5 x 5' = 25'

g) # check valves = 1 x 17' = 17'

h) # ball valves = 1 x 50' = 50'

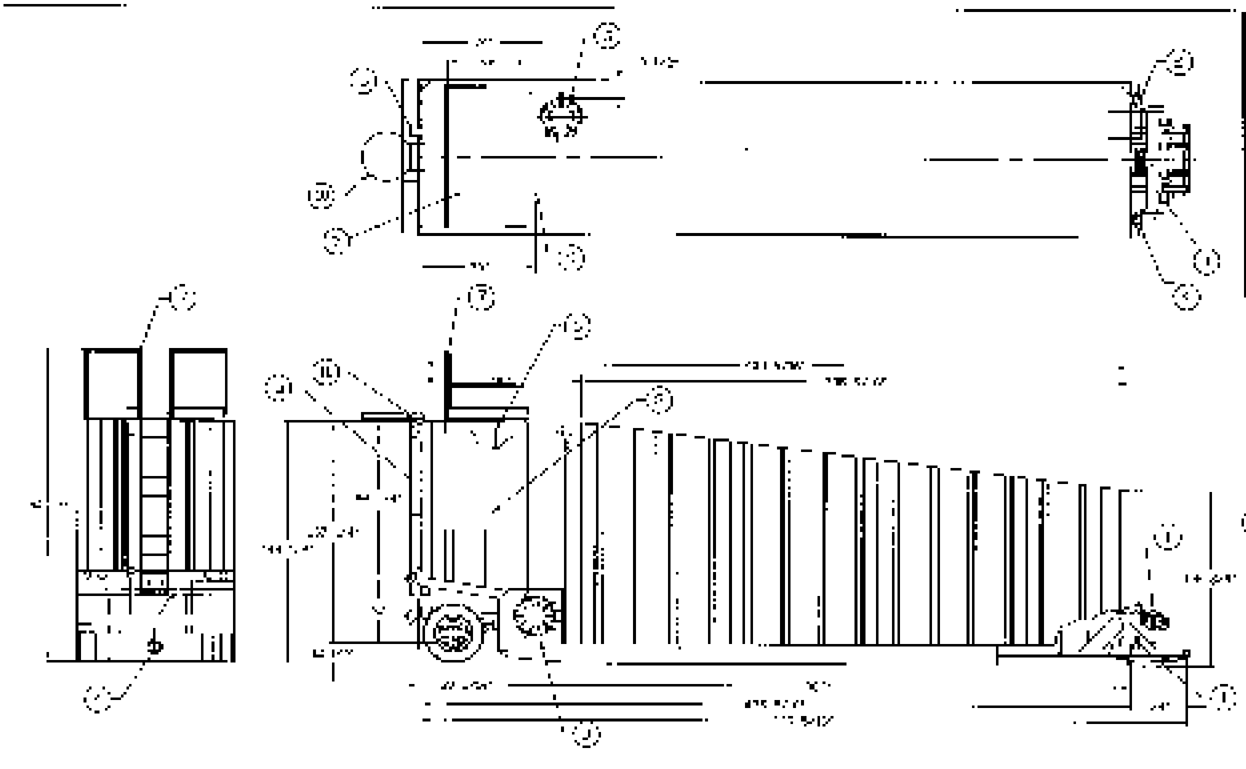
i) Total pipe run including fittings / valves = 392'

$$\text{Total friction loss} = \frac{0.29 \text{ psi}}{100 \text{ feet}} \times 392' = 1.14 \text{ psi}$$

or

2.6' of H_2O

$$\boxed{TDH_{\text{required}} = 55' + 2.6' = 57.6'}$$



ITEM	QTY	DESCRIPTION
1		[illegible]
2		[illegible]
3		[illegible]
4		[illegible]
5		[illegible]
6		[illegible]
7		[illegible]
8		[illegible]
9		[illegible]
10		[illegible]
11		[illegible]

SPECIFICATIONS:
1) NOMINAL TANK CAPACITY: [illegible] GAL ([illegible] BBL)
2) NOMINAL TANK WEIGHT: [illegible] LBS

1. THIS DRAWING IS A BASELINE [illegible] FOR THIS [illegible] TANK. VARIATIONS BETWEEN THE DRAWING AND THE ACTUAL EQUIPMENT IN THE FIELD CAN AND DO EXIST, PRIMARILY WITH APPURTENANCE LOCATIONS, SIZES AND [illegible]
2. THIS TANK IS [illegible]
3. THIS TANK IS CONSTRUCTED OF CARBON STEEL

BAKER TANKS
3020 OLD RANCH PARKWAY
SEAL BEACH, CA 90740-2751

SCALE: Do Not Scale
REV
TITLE: [illegible] FRAC TANK
DRAWING NO. [illegible]

PRODUCT DATA SHEET

March, 2001

FRAC TANK

GENERAL INFORMATION

This tank is sloped downward from working surface at rear of tank to the front. The rear axle is fixed to the tank (permanent).

WEIGHTS AND MEASURES

➢ **Capacity:**	500 BBL. (21,000 gal.)
➢ **Height:**	Front: 8'-9", Rear: 12'-9" Handrail up: 15'-8"
➢ **Width:**	8'-0"
➢ **Length:**	34'-6" (tank only) 37'-2" (overall)
➢ **Weight:**	18,000 lbs. (est.)

STRUCTURAL DESIGN

➢ **Floor:**	Carbon steel
➢ **Sides/Ends:**	Carbon steel
➢ **Top Deck:**	Carbon steel
➢ **Internal Cross Bracing:**	Round stock, 3/4" – 7/8" depending on manufacturer

ACCESSORIES

➢ **Manifold:**	Some are equipped, some are not
➢ **Valves:**	Rear: one (1) - 4" butterfly valve Front Fill: one (1) - 4" butterfly valve Front Manifold: four (4) - butterfly valves
➢ **Relief Valve:**	Standard style: None Safety Vapor style: Blaylock Model L-10, Buna-N seal, 16 oz. Pressure setting, 0.4 oz. Vacuum setting
➢ **Top Access:**	One (1) access door
➢ **Front Access:**	One (1) access door
➢ **Side Access:**	One (1) access door (passenger side)

ACCESSORIES – cont.

➢ **Guardrails:**	At rear platform only
➢ **Exterior Ladder:**	One (1) at rear of tank
➢ **Internal Ladder:**	One (1) located at top access door
➢ **Front Drain:**	One (1) 4" connection
➢ **Rear Flush:**	One (1) 4" capped nipple
➢ **Level Gauge:**	None
➢ **Rear Wheels:**	Fixed axle
➢ **Overflow:**	One (1) 3" overflow pipe at rear of tank
➢ **Vent:**	Original design tanks have flip open hatch
➢ **Main Rails:**	Channel shaped steel

SURFACE DETAILS

➢ **Exterior Coating:**	Carboline® 134HS (High Gloss Acrylic Aliphatic Polyurethane)*
➢ **Interior Coating:**	Some tanks are not lined and others are coated with Carboline 187
➢ **Safety Paint:**	None
➢ **Equipment Number:**	F9***, FF***, FTS***, FTSC***, FTSCE***, FV***, or F00*
➢ **Decals:**	2- DCL8: Property of Baker Tanks... 2- DCLD01: Danger-Do Not Enter... 2- DCLW04: Warning Do Not Move...
➢ **Placard Mounts:**	None

TESTS/CERTIFICATIONS

➢ **Test Performed:**	Major repairs – hydrotest Scheduled- Level I, II and III Inspections

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SUBJECT	PROJ. NO.	BY	DATE	SHEET
Former ABC Site - Influent Tank		DMS	12/8/05	1

CALCS. BY ; DATE
CHECKED BY ; DATE

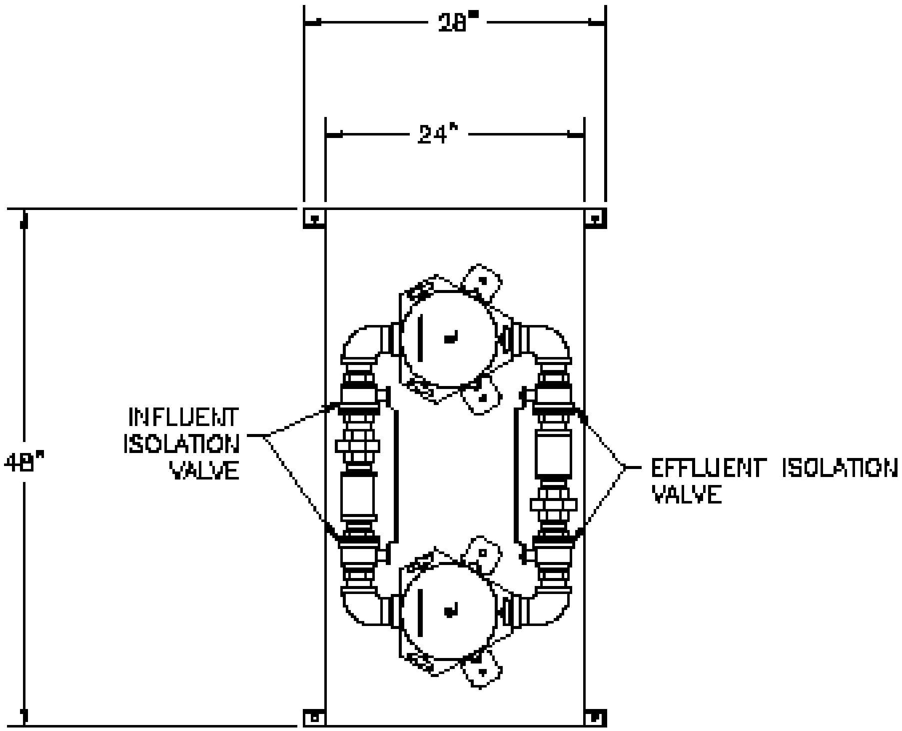
50 gpm influent flowrate

Baker Frac Tank = 21,000 gallons

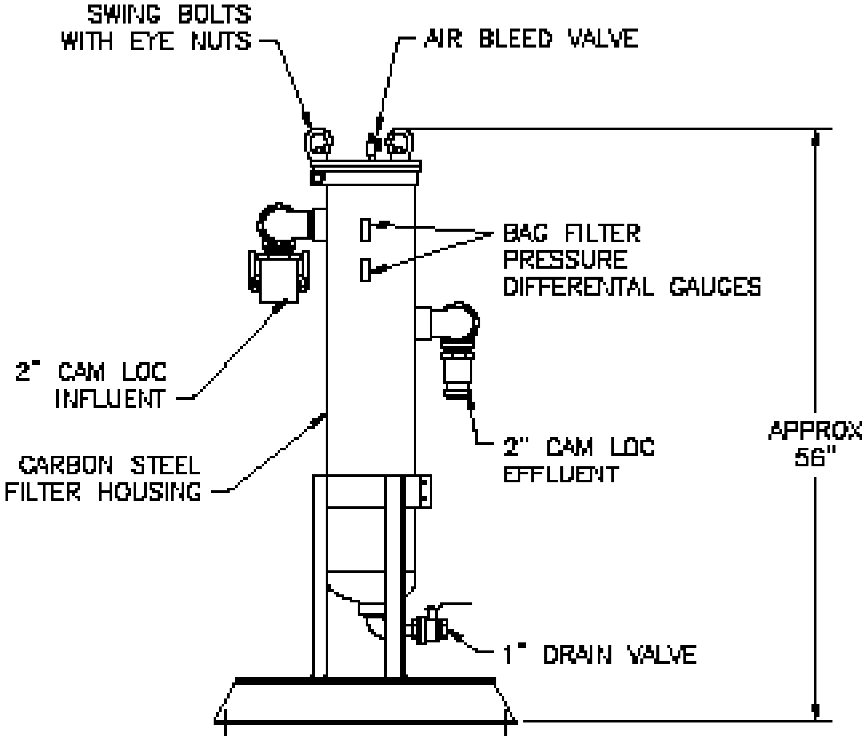
21,000 gallons / 50 gallons/min = 420 min (7hr)
Retention Time

REVISIONS

REV	ECO	DESCRIPTION	DATE	DRWN
-	—	—	—	—



PLAN VIEW



ELEVATION VIEW

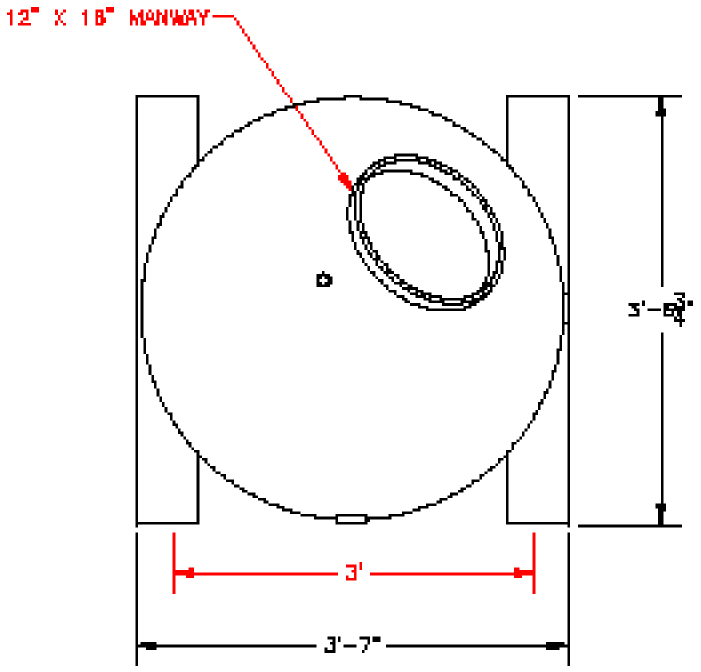
CARBONAIR

PLOT# D

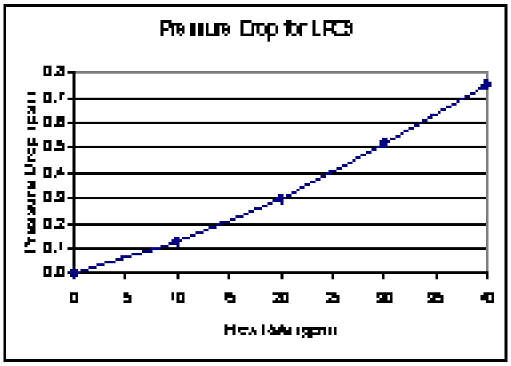
48" X 24" BAG FILTER SKID
RENTAL SKID

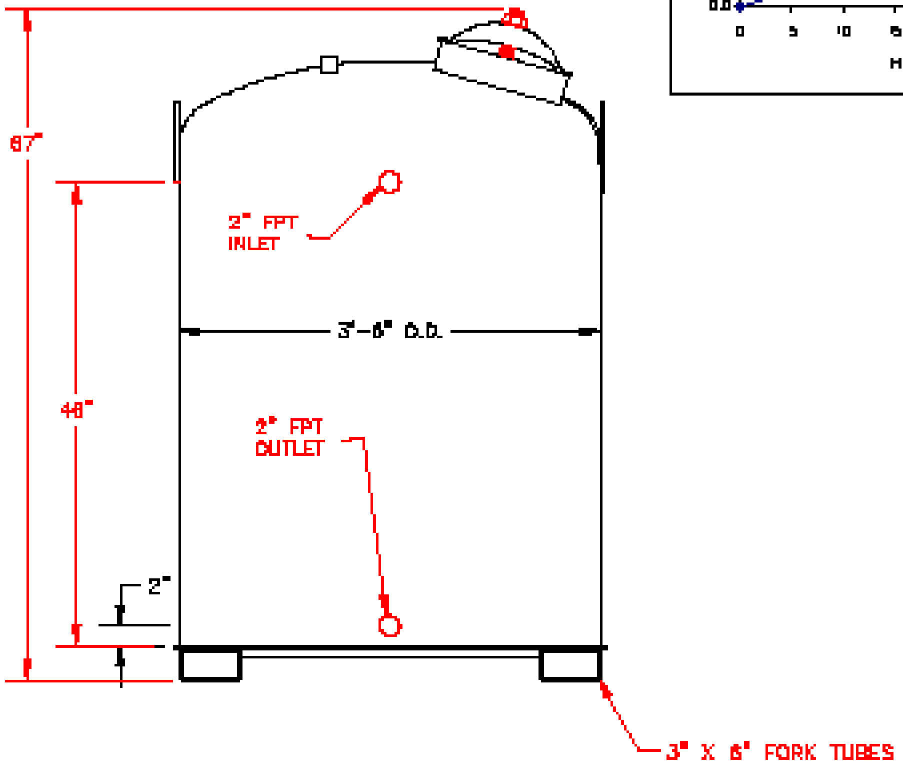
B	DWG. NO. 215646	REV	*
1-16		SHEET 1 OF 1	

Carbon Adsorber – Liquid Phase
LPC-9



PLAN VIEW





ELEVATION

Sales Drawing #188435
02/16/05

Purifics®

Photo-Cat Water Treatment

Advanced, Chemical-Free Process:

Photo-Cat destroys organic contaminants in water through a patented TiO_2 slurry-based photocatalytic process to purify or detoxify the fluid stream of concern. The process is fully automated, sealed, generates no waste stream, and is fully backed by our World Wide Support Program.

Photo-Cat lifecycle costs are significantly less than conventional technologies such as activated carbon, UV ozone, UV peroxide, chemical oxidation, air stripping with off-gas treatment, and reverse osmosis, making Photo-Cat the economical choice for multi-year projects.

This highly automated process can treat water to very high standards that significantly exceed drinking water standards. Photo-Cat is essentially a solid state, automated device that operates unattended, with lamp life and service intervals exceeding 18,000 hours. The modular design facilitates adaptation to increasingly stringent environmental standards and treatment requirements.

Purifics is the world's only producer of commercial & industrial photocatalytic systems.

Applications:

- Groundwater Remediation
- Industrial Process Wastewater
- Exhaust Air Emissions
- Potable Water
- High Purity Water
- Disinfection & Sterilization
- Bilge and Ballast Water
- Anatomical Waste
- Soil Washing

Models

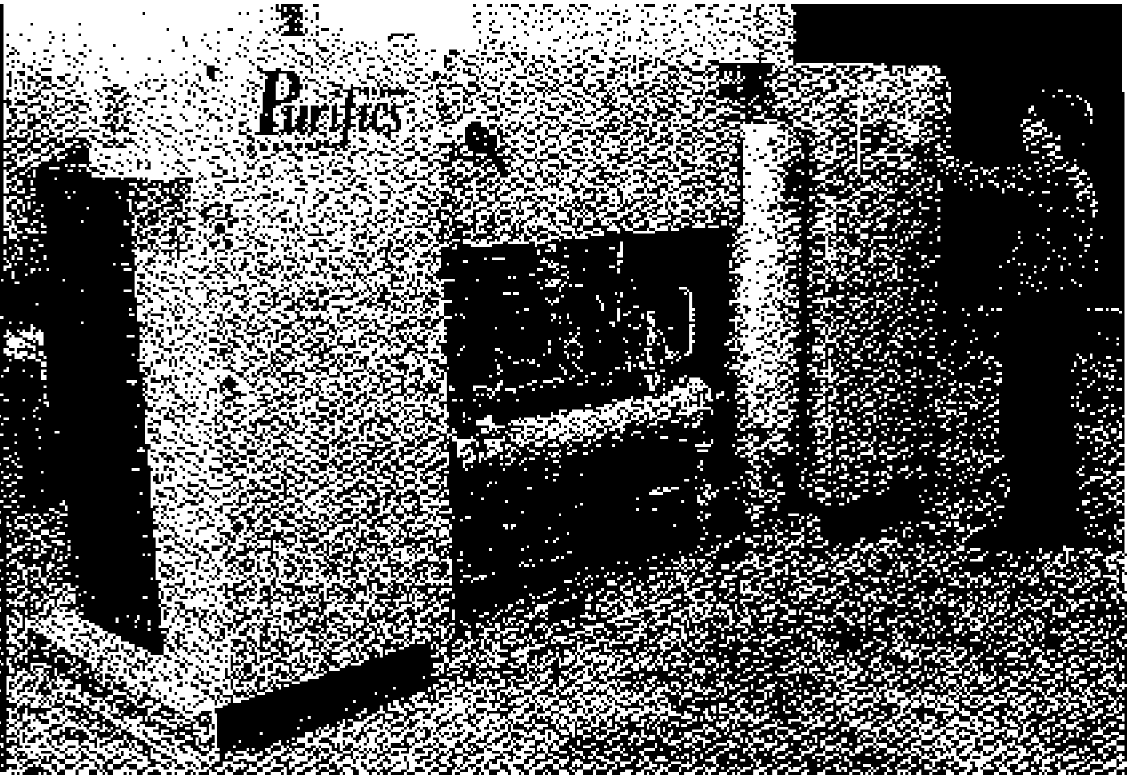
Photo-Cat RI:
Remediation & Industrial

Photo-Cat NM:
Nuclear & Military

Photo-Cat HF:
High Flow

Photo-Cat A:
Air Treatment

Photo-Cat L:
Laboratory & Research



Engineering Purity - Eliminating Your Problem

www.Purifics.com

Features & Benefits:

Efficient	Low lifecycle cost - approx 1/4 the O&M of other AOPs Long lamp life - 18,000 hrs between service periods Quick lamp changes - 1 min. w/flooded system No catalyst loss - continuously recovers catalyst Continuous 24/7 duty	Automated	Unattended operation Computer/PLC programmed operation Digital service and training manual online Remote monitoring, control, and data logging Automatic fault detection and recovery Smart sensors
Ability to Treat	Insensitive to dissolved solids and opaque fluids Not inhibited by turbidity or pH levels Not affected by pressure, temperature, alkalinity No fouling - operates with water containing iron Advanced coalescor technology	Serviceability	Generic parts, easy service availability No quartz tube wipers or quartz tube service Service can be performed by end-users, staff and trades
Manufacturing Excellence	Corrosion resistent High grade stainless steel construction NEMA 4 rating One day installations Highly reliable using highly developed standard off the shelf components	Design Benefits	Created for sustainable development 25 year life expectancy Moduler design customized to client requirements No pre-treatment required for removal of metals, dissolved solids or turbidity Easily expanded / reduced for application variability
Small Footprint	Starting at 3.6m L x 1.02m W x 1.98m H (11'10" L x 3'4" W x 6'6" H) Palletized for convenience	High Compliance Factor	Established compliance history of regulated discharge spanning 10 years
Community Acceptance	Extremely low noise No off-gas No waste generated	Permitted Installations	History of efficient permitting by regulators such as the EPA and MOE for surface water discharge
Chemical Free	Can be operated without TiO_2 and no ozone	High Turn Down Ratios	5% to 100% turn down rates 5% increments

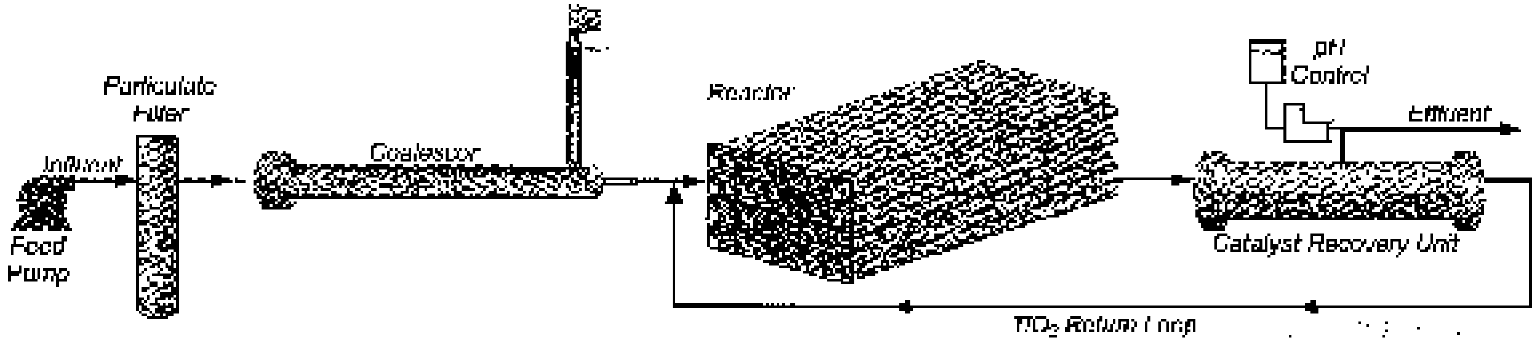


Photo-Cat is a photocatalytic process that destroys organic pollutants when they are mixed with the titanium dioxide slurry and exposed to UV light in the reactor. The reactor is composed of photocatalytic racks linked together in serial and/or parallel mode.

A key element of Purifics photocatalytic process is the patented continuous TiO_2 separation process which allows the catalyst to be completely recaptured and reintroduced into the inlet stream.

WORLDWIDE SUPPORT
provides our customers with responsive technical assistance, after-sale support, and spares.

Purifics ES Inc.
340 Sovereign Road, London, ON, Canada, N6M 1A8
Ph: 519.473.5788, info@Purifics.com, www.Purifics.com

Purifics products are protected by one or more of the following US Patents: #5,462,674 / #5,554,300 #5,589,078 / #6,136,203 / #6,215,126B1 / #6,398,971B1
Other patents domestic and foreign are pending. Purifics & Photo-Cat are registered trademarks.

Rev. November 17, 2005

PHOTO-CAT
CASE HISTORIES

Submitted to:

ATTN: Don Sauda
<email: dfs@bbl-inc.com>

BBL
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Syracuse, NY 13214-0066
Tel: 315-446-9120 x19214
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December 12, 2005

For Additional Information Contact:

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Rev. October 20, 2005

EXECUTIVE SUMMARY

This document provides an overview of relevant Photo-Cat equipment installations. The installations have been categorized into groundwater installations, process installations, pending installations and laboratory. Equipment pictures and a brief explanation of the application are provided.

Section 5 shows pictures of various models of Photo-Cat systems installed. For treatment of groundwater at the ABC site, the model of Photo-Cat that has been proposed is shown in Section 5.1.

Additional detail on the Photo-Cat system and why it is selected over competing oxidation technologies is provided in Section 6.

TABLE OF CONTENTS

1 GROUNDWATER

1.1.1 1,4-Dioxane Destruction

Location: Denver, CO USA
Installed: September 2005
Performance:

- 100 L/min – 10kW Photo-Cat
- Treats from 150ppb below 3 ppb
- Groundwater also contains bromide, which the Photo-Cat does not oxidize to bromate
- Photo-Cat destroys 1,4-dioxane without hydrogen peroxide

1.1.2 Herbicide & VOC Destruction Groundwater

Location: Adelaide, Australia
Installed: September 2005
Performance:

- Former Herbicide Manufacturing Plant
- 100 L/min – 24/7 Operation
- 150ppm total contaminents, 99% removal
- Treated water is reinjected.

1.1.3 1,4-Dioxane Destruction

Location: Denver, CO USA
Installed: September 2003
Performance:

- Photo-Cat destroys 1,4-dioxane and other chlorinated organics
- 25kW Photo-Cat system
- 80 L/min flow rate
- PLC controlled unmanned operation with remote monitoring, data logging and control
- Duty 24/7

1.1.4 VOC Destruction - Japan

Location: Tokyo, Japan
Installed: 2003
Performance:

- Photo-Cat system is leased out for temporary groundwater treatment
- Contaminants are chlorinated VOCs and dioxins. Treats to levels below detection limit

1.1.5 1,4-Dioxane Destruction

Location: Waterloo, ON Canada
Permit: MOE C. of A. *Air*: 0711-599J5Q &
Water: 8148-54ULYB
Installed: July 2002
Performance:

- 1,4-dioxane is easily destroyed by Photo-Cat even though it does not adsorb to carbon, cannot be air stripped and cannot be biologically decomposed
- Photo-Cat destroys 1,4-dioxane and other chlorinated organics to levels below detection limit
- Treatment from 10,200 ppb to < 5 ppb
- 7.2kW Photo-Cat system
- 8 L/min from 3 wells
- PLC controlled unmanned operation with remote monitoring, data logging and control
- Duty 24/7

1.1.6 Groundwater and Collection Trench Off-Gas

Location: London, ON Canada
Installed: 2001
Permit: MOE C. of A. #6235-5A6PJ3
Performance:

- Site of former coal gasification plant alongside an urban river bank
- PAH destruction to below detection limits
- Slugs of NAPL and suspended solids
- 60 L/min (designed capacity)
- Housed in two 8-ftx20-ft shipping containers
- Remotely operated by Purifics: duty 24/7/365
- Run Time >10,000 hours

1.1.7 Groundwater and Lagoon Wastewater

Location: Fort Saskatchewan, AB Canada
Installed: 2000
Permit:

- TOC removal from 710 ppm to < 50 ppm
- 2,4-D removal from 391 ppm to < 0.005 ppm
- Treating high levels of chlorides in the 5,000ppm range

Requirements:

- Process for sustained automated treatment of water with slugs of oil, 5,000 ppm of chlorides, and wide variations in VOC levels
- Treating opaque fluids with high salts
- Unattended operation

1.1.8 PCB Destruction

Location: Newfoundland, Canada
Installed: 1999
Requirements:

- Modular Photo-Cat system destroying PCBs
- Remote Operation
- Unattended operation

1.1.9 Chlorinated VOCs

Location: Ingersoll, ON Canada
Installed: 1998
Permit: MOE C. of A. #4-0140-96-987
Water: 30,000 gal/day from 3 wells

- Operating costs are \$0.37 per m^3
- Surface water discharge to Thames River
- Influent water has high levels of oil and grease
- Key operating parameters are continuously logged onto a computer for compliance purposes
- Duty 24 hrs/day, 7 days/wk
- Run Time > 41,000 hours
- Displaced Carbon Train

1.1.10 Chlorinated Solvents

Location: Toronto, ON
Installed: 1996
Performance:

- Several horizontal wells, collecting groundwater in a collection trench.
- Treated groundwater re-injected
- Autonomous operation
- 4 gpm
- Treats contaminants from 200 ppm TOC to < 10ppm

1.1.11 Chlorinated Solvents - Superfund Site: EPA Region VI

Location: Houston, TX USA
Permit: CERCLA ID #TXD980629851
Installed: 1994
Performance:

- Water treatment from tar pit collection wells, treating chlorinated solvents
- Eliminated $ millions in Capital and O&M costs
- Autonomous operation
- 4-8 gpm
- Run Time > 35,000 hours
- Corrosion resistant
- Oxygen deprivation design to remove explosion hazard
- Treats contaminants from 200,000 ppb to < 5 ppb
- Displaced UV/OX train

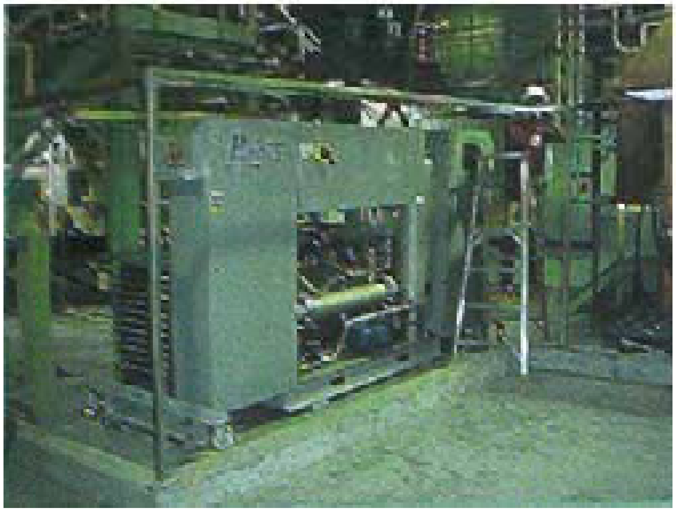
2 PROCESS WATER

2.1.1 Aircraft Depainting Fluid Treatment

Location: Edmonton, AB Canada
Permit: Not required
Installed: August 2005
Performance:

- Depainting fluid is easily treated by Photo-Cat even though it is opaque
- Treatment from 12000 ppm COD to sanitary sewer guidelines
- 25kW Photo-Cat system
- 4.5 L/min flow rate
- PLC controlled unmanned operation with remote monitoring, data logging and control
- Duty 24/7, on demand

2.1.2 Heavy Water Purification in a Nuclear Application



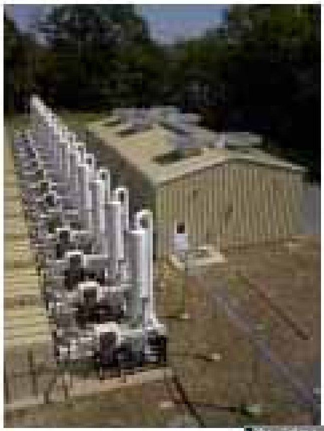
Location: Halifax, NS Canada
Permit: Not required
Installed: July 2005
Performance:

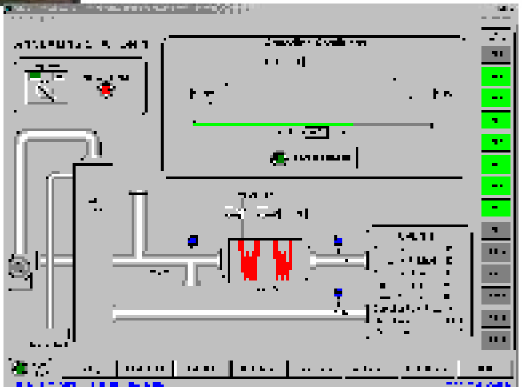
- Heavy water treatment
- Photo-Cat destroys organic contaminants effectively in heavy water
- Treatment from 1500 ppm TOC to below 25 ppm.
- 15 kW Photo-Cat system.
- Chemical free operation.
- PLC controlled unmanned operation with remote monitoring, data logging and control
- Duty 24/7
- This is the second Photo-Cat unit that the client has procured

2.1.3 Pollution Free Plant

Location: DoD Facility, MD, USA
Installed: 2002
Performance:

- Closed loop air & water reuse process
- Treatment 53 kg/day of Nitroglycerin and other Resins
- Identified Best Available Technology
- Complete process control and energy management
- 10,000 cfm air regeneration and supply
- 1,000 gpm water regeneration and supply
- Nitric Acid Concentration for reuse
- Chemical free system; no Peroxide
- State of the Art Design





Sample SCADA Screen

2.1.4 Process Water

Location: Roseville, CA USA
Installed: 1996
Permit: Cal EPA

- O&M cost is 25% of disposal costs
- 15 month payback
- 50 kW Photo-Cat® versus 180 kW UV/H_2O_2 alternative
- 90% Duty 7 days a week
- 50 kg/day of organic destroyed

3 PENDING INSTALLATIONS

3.1.1 EPA Superfund Site (Ottati & Goss/Kingston Steel Drum)

Location: Kingston, NH USA
EPA ID#: NHD990717647
To Be Installed: 2006
Performance:

- TCE, PCE, DCE, VC & 1,4-Dioxane destruction below detection levels.
- 30gpm
- Peroxide free operation
- Photo-Cat selected over UV/peroxide

3.1.2 Treatment of Landfill Leachate

Location: Chester, NS Canada
Site: Kaizer Meadow Landfill, Chester
To Be Installed: Spring 2006
Performance:

- TOC of 200 ppm treated below 50ppm. Organics consist of chlorinated solvents, PCBs, toluene and phenols.
- 21Lpm, 24/7 Operation
- Photo-Cat selected over UV/peroxide???
- Automated, Remote Operation

4 LABORATORY RESEARCH

4.1.1 Academic Research

Institute: Fanshawe College, London ON: 2005

4.1.2 Advanced Life Support

Institute: University of Florida (Environmental Sciences-Commercial Space Technology Center- ES CSTC): 2004

4.1.3 Detection & Destruction of Toxic Chemicals & Hazardous Biological Matter

Institute: Advanced Concepts and Technologies: 2005

5 PHOTO-CAT MODELS

5.1 DDL Model : 25-50kW

5.2 DL Model : 2.5-25kW

5.3 Photo-Cat L (Laboratory)

5.4 Standards

The Photo-Cat systems are also available in remediation, industrial, nuclear, military, ultra pure and food grade standards. Pressure vessel certification, other North American and European standards are available as well. Photo-Cat system can be engineering to specific client requirements.

6 PRINCIPLES & ADVANTAGES OF THE PHOTO-CAT PURIFICATION PROCESS

Photo-Cat is a flexible purification technology that destroys organic pollutants in water at ambient temperatures and pressures. The technology is a Photocatalytic oxidation and reduction process that utilizes an illuminated or light activated titanium dioxide (TiO_2) slurry catalyst. The Photo-Cat process is similar to other catalytic processes such as the catalytic converter on automobiles. The major difference in TiO_2 Photocatalytic oxidation is that the TiO_2 catalyst uses light energy for activation, rather than heat energy, as is the case with conventional catalyst technologies. Essentially, the only input to the Photocatalytic technology is electric power required to produce the light for catalyst activation.

Photolysis

The Photocatalytic process should not be confused with UV/H_2O_2 or UV/O_3, which are photolytic processes. Photolytic technologies generate hydroxyl radicals by using high energy photons to cleave the peroxide molecule: $H_2O_2 + UV \rightarrow 2{\cdot}OH$. The efficiency of this type of process is greatly reduced by the fact that in the range of 75% of the $\cdot OH$ recombine back to H_2O_2 without accomplishing any work. Photolytic technologies typically use medium or high pressure lamps to generate the photons. Photolysis can also photolyze organic compounds directly, and can create random intermediates. Random intermediates are a concern.

TiO_2 Photocatalysis

TiO_2 Photocatalysis uses the full spectrum of ultraviolet light to activate the TiO_2 catalyst as opposed to the photons cleaving chemical bonds. The UV light photo-generates electrons into the conduction band of the catalyst semiconductor and positive "holes" at the surface of the TiO_2. When this occurs, the catalyst is in an activated state and four organic destruction pathways exist (both oxidative and reductive) as listed below.

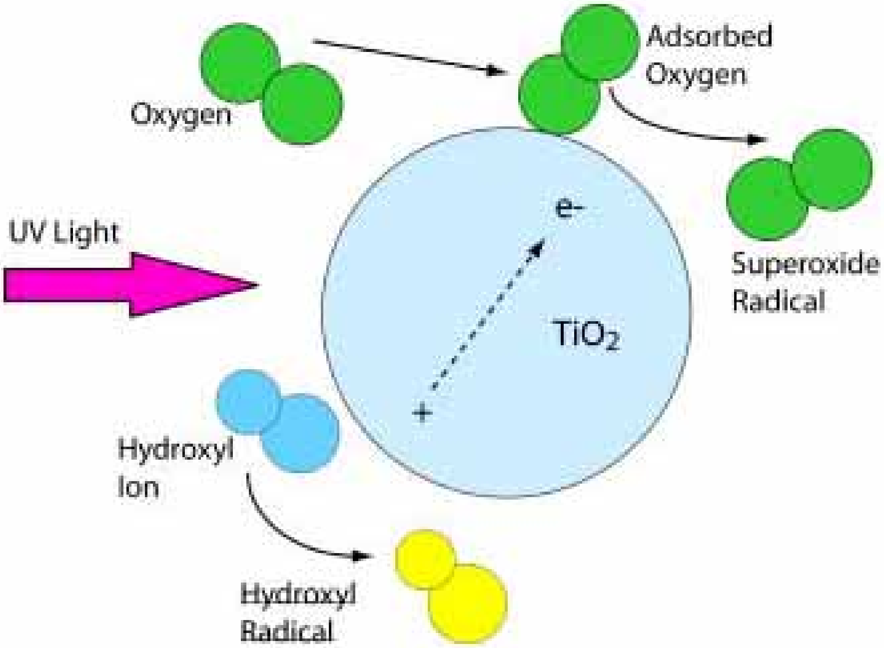
1 & 2) The most typical oxidative pathway involves the reduction of oxygen, creating the <u>superoxide radical</u>. Subsequently, a water molecule or hydroxyl ion is oxidized at the positive hole and creates a <u>hydroxyl radical</u>. Both radicals, which are generated with one photon of light, readily oxidize the organic contaminants. Refer to the Aqueous Phase Photochemistry diagram below in Figure 1.

3) A third oxidative pathway is oxidation of the adsorbed organic contaminant directly at the <u>photo-generated hole</u>. The oxidative power of the photo-generated hole is about 15% stronger than the hydroxyl radical.

4) The last degradative pathway is a reductive pathway via reduction by the <u>conduction band electron</u>. This degradative pathway is very efficient at

destroying refractive organic contaminants that are resistant to the hydroxyl radical attack. An example of this treatment mode is the photocatalytic reduction of 1,3,5-trinitrobenzene (TNB) in the remediation of TNT contaminated water.

Figure 1: Aqueous Phase Photochemistry



In all four degradation pathways listed above, organic contaminants are destroyed on the surface of the TiO_2. The light energy is used only as an energy source for catalyst activation. Consequently, photocatalytic by-products are controlled and consistent because the degradative pathways do not create organic radicals.

Table 1 lists the oxidative strength of various radicals and oxidizing species

Table 1: Relative Oxidizing Power Versus Various Oxidizing Species

Oxidizing Species	Relative Power
Photo-Generated Hole on TiO_2 *	**2.35**
Fluorine	2.23
Hydroxyl Radical *	**2.06**
Atomic Oxygen	1.78
Ozone	1.52
Hydrogen Peroxide	1.31
Permanganate	1.24
Hypochlorous Acid	1.10
Chlorine	1.00

*Oxidizing Species Generated by Photo-Cat

This table is important to illustrate why Photo-Cat is the most aggressive technology for oxidizing organic contaminants, and the lowest cost solution.

Principles of Photo-Cat Operation – Understanding the Differences Between UV/H_2O_2

Since the Photo-Cat, TiO_2 slurry based photocatalytic technology creates hydroxyl radicals; it is referred to as an advanced oxidation process (AOP). Based on this generic classification, it is wrongly assumed that Photo-Cat suffers from the same problems and shortcomings of Photolysis technologies such as UV/peroxide.

The biggest difference between these two technologies is in the way radicals are generated. The Photo-Cat uses a light-activated TiO_2 catalyst to generate radicals, and the powerful photocatalytic positive hole. These oxidizing species are the first and third strongest oxidizing species. The catalyst reduces the activation energy required to generate the radicals, thus reducing energy requirements. Unlike UV/peroxide, which requires photons with sufficient energy to break chemical bonds, Photo-Cat only requires photons at a wavelength of less than 388nm capable of exciting electrons. This provides a high degree of freedom in selecting UV sources for the Photo-Cat, and allows Purifics to utilize the highest efficiency lamps, with the greatest lamp life (41% efficient with over 18,000 hour life).

In the Photo-Cat process, essentially all of the UV light is absorbed by the photocatalyst and is absorbed at the surface of the quartz-water interface.

Photolysis reactions are eliminated, along with the issues associated with the production of random intermediates. The Photo-Cat system does not rely on transmittance of photons through the water. This makes the Photo-Cat process completely impervious to any type of absorbance issues, such as turbidity, high TDS, or colour. This ability also reduces complexity by eliminating pre-treatment, and provides greater overall efficiency. Unlike traditional UV/peroxide technologies which operate in laminar flow regimes, the Photo-Cat reactor is highly turbulent (Re as high as 40,000), which provides maximum mass transfer of contaminant, TiO_2 and photons, providing optimum destruction efficiency.

The high mixing rates obtained in the Photo-Cat reactor coupled with the honing ability of the TiO_2 catalyst eliminates any fouling mechanisms on the quartz sleeves of the reactor. Thus, no wiper mechanisms are required, hence eliminating any cleaning requirements during the life of the system. The elimination of UV-quartz wipers reduces system complexity, cost, and the potential for a failure.

TiO_2 Photocatalysis: Slurry Vs Fixed

Photo-Cat is a process that uses the TiO_2 in a slurry form, and then effectively recovers 100% of the slurry in a continuous process. Other TiO_2 processes have experimented with an immobilized or fixed TiO_2. Technically this process works but its commercial viability is very limited. Fixed TiO_2 processes have unsolved issues for bonding, fouling, masking, mass transfer, and photon efficiency that at best give them an order of magnitude poorer performance than slurry photocatalysis, with limited duration.

Photo-Cat Materials of Construction

The Photo-Cat is constructed of quarts glass, high grade stainless steel, ceramic, gaskets and electronics. Fabrication standards meet or exceed client's requirements. With the exception of a few valves and pumps it is essentially a solid state device. The result is a system that does not leach or corrode, with high reliably and proven durability in high cycle operations or sustained 24/7 duty.

About Lamps

The Photo-Cat utilizes a high efficiency low pressure mercury lamp as the light source to excite the TiO_2. The catalyst is able to use the full spectrum of the lamp from 360nm to 185nm. This provides us with a lamp efficiency of 41% UV output. In addition the lamp has been developed with a long life capability to operate reliably and durably from just above the freezing point of water to elevated ambient temperatures >40C for a period of 18,000 hrs with less than 30% degradation.

Oxidation without Hydrogen Peroxide or Ozone

Photo-Cat utilizes dissolved oxygen to generate radicals. **No hydrogen peroxide or ozone is required** in the process. Consequently most Photo-Cat installations are installed without the need for chemical oxidants.

Eliminating the need for hydrogen peroxide is extremely important for drinking water applications. First there is a real cost (avoidance) saving related to the elimination of hydrogen peroxide. Typical dosages for UV/peroxide systems in drinking water can range from 5-50ppm, and have to be added in excess. Typical peroxide consumptions is very low, consequently, the majority of the peroxide is wasted and must be removed downstream (this creates additional cost and complexity). Finally, there are undesirable **stabilizer compounds** (both inorganic and organic) **in the peroxide**, which are very resistance to oxidation. Typical organic stabilizer compounds can be 8-hydroxyquinline, pyridine carboxylic acids, tartaric and benzoic acids, and acetanilide and acetophenetidin compounds. Similarly, 1,4-dioxane was a stabilizer used in chlorinated degreasing agents

The Proof is in the Test

It is not a sound practise to categorically generalize the performance of treatment technologies individually or collectively. This is due to the fact that the characteristic parameters of wastewater dramatically impact the kinetics of the contaminants of concern, hence the selection of the appropriate treatment technology. Another common oversight is the absence of considering the "total cost" of the solution. Frequently, only the AOP cost is incorrectly taken into consideration on an "apples to apples" basis, which is grossly misleading. For example, the total cost of a UV/peroxide system is comprised of the following; the AOP, O&M, pre-treatment, lamp allocation, service contracts, scheduled maintenance, etc. If the total costs of all technology solution options are calculated in this manner, a fair and objective comparison is more likely to result.

The ultimate proof results from testing the actual water of concern so a comparison of the overall system efficiency can be performed. It is also prudent to fully understand the true O&M cost structure beyond simple power and chemical usage.

Summary

The Photo-Cat technology provides much greater degrees of freedom in comparison to UV/peroxide technologies; elimination of H_2O_2, no UV-quartz wipers, use of highest efficiency and longest life lamp, greatest mass transfer reactor for optimal organic destruction, reduced energy requirements by catalytic radical formation, two radicals generated per photon of energy, and no effects of UV absorption. **The net effect is a 3:1 operating cost advantage of Photo-Cat versus UV/peroxide technologies.** Throughout Purifics' twelve years of existence, the Photo-Cat technology has routinely demonstrated this level of cost advantage over competing UV/peroxide technologies.