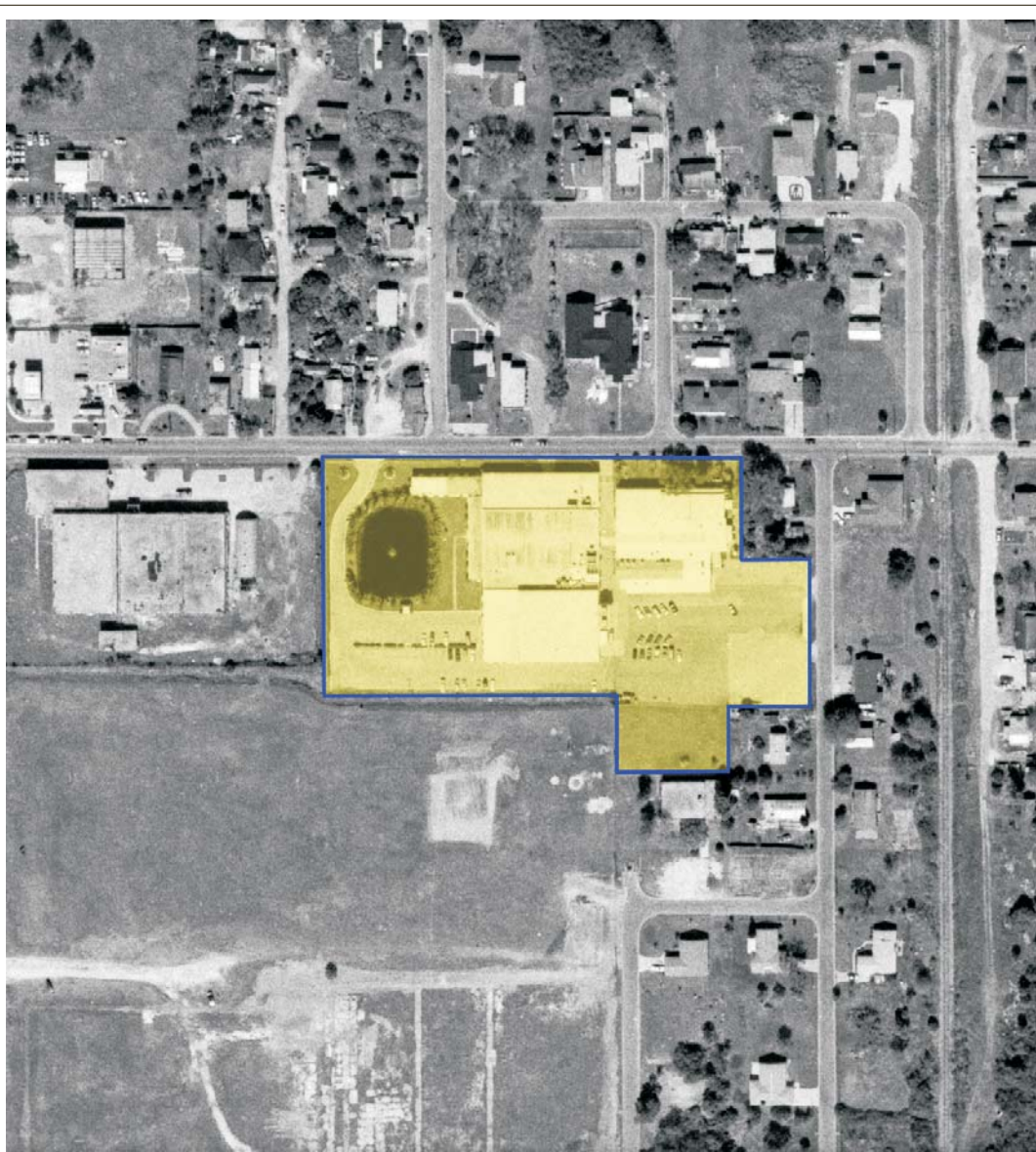
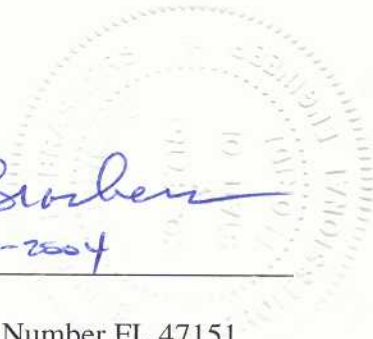


SEPTEMBER 2004 DRAFT INTERIM REMEDIAL ACTION PLAN

**Former American Beryllium Company
1600 Tallevast Road
Tallevast, Florida**



The professional opinions rendered in this document identified as the Initial Remedial Action Plan for the Former American Beryllium Company site in Tallevast, Florida were developed in accordance with commonly accepted procedures consistent with applicable standards of practice. This document is based on information obtained from others and under the supervision of the signing engineer. If conditions are determined to exist differently than those described in this document, then the undersigned professional engineer should be notified to evaluate the effects of any additional information on the project described in this report.


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1.0 INTRODUCTION

1.1 Purpose

This Initial Remedial Action Plan (IRAP) has been prepared to treat the dissolved chlorinated solvent source area at the former American Beryllium Company (ABC) facility in Tallevast, Florida. This IRAP is based on the results of a Contamination Assessment Report (May 2003), supplemented by a Site Investigation (July 2004) performed by the Florida Department of Environmental Protection. These reports provided an estimate of the extent of impacted groundwater in the shallow aquifer system in and around the ABC facility.

This IRAP describes and compares alternatives to treat the high concentration source area of the groundwater plume, and describes the selected alternative.

1.2 Background

Chlorinated volatile organic compounds (VOCs) have been identified in shallow groundwater beneath the former ABC facility in Tallevast, Florida, originating from sources associated with past ABC operations. The affected groundwater has migrated off-site.

In January 2004, Lockheed Martin Corporation (LMC) submitted a preliminary screening of remedial alternatives (Tetra Tech, 2004) that described potential alternatives for groundwater remediation. The preliminary screening identified several viable remedial alternatives, however, additional assessment is required to further delineate the extent of impacted groundwater before a technology can be selected for full scale remediation. In order to expedite site rehabilitation, LMC has requested that Tetra Tech prepare this IRAP to address the high concentration portions of the plume (source area) located on the site while awaiting the results of the additional assessment. The remaining portions of the plume will be addressed later in a full scale RAP.

This IRAP describes the selected groundwater treatment alternative for the source area at the site. For the purposes of the IRAP, the source area is assumed to be the portion of the plume described by the 300 ug/L trichloroethene (TCE) isoconcentration line as defined based on laboratory results from groundwater samples collected during the April 2004 quarterly sampling event. This concentration

was selected based on the natural attenuation default source concentration for TCE. Using the 300 ug/L benchmark, the area to be treated under this IRAP is centered around monitoring wells MW-10 and MW-12. The depth of treatment will be from 10 to 30 feet (below ground surface)bgs. Existing data indicates that there are no significant concentrations in the groundwater from 5 to 10 feet bgs, so no treatment is proposed for that depth under this IRAP. The goal of the IRAP is to reduce the concentrations of contaminants of concern (COCs) in groundwater to less than FDEP Groundwater Cleanup Target Levels (GCTLs) specified in Chapter 62-777 of the Florida Administrative Code (F.A.C.).

Tables and figures are presented as Appendices A and B, respectively. Appendix C provides calculations in support of the IRAP.

1.3 Site Description

The former ABC facility is composed of 5.167 acres of land and is located at 1600 Tallevast Road in Tallevast, Manatee County, Florida. The property is bounded by Tallevast Road to the north, golf course, undeveloped, and residential areas to the south, 17th Street Court East to the east, and an abandoned industrial facility (the former Spindrifft facility) to the west (see Figure 1).

The property is zoned “Heavy Manufacturing” by the Manatee County (Tetra Tech, February 1997). The facility was formerly used as an ultra-precision machine parts manufacturing plant, where metals were milled, lathed, and drilled into various components. Some of the components were finished by electroplating, anodizing, and ultrasonic cleaning. Chemicals used and wastes generated at the facility included oils, petroleum-based fuels, solvents, acids, and metals.

The property contains five primary buildings that cover a total surface area of approximately 66,335 ft² (1.523 acres). During ABC’s occupancy, Building #1, the main building structure, was comprised of office space and machining areas. Buildings #2 and #3 contained machining areas and inspection rooms. Building #4 housed a wood working shop and non-hazardous material storage area. Building #5 contained plating and anodizing rooms, a wastewater treatment system and hazardous materials storage areas. The wastewater treatment facility included five subsurface concrete lined sumps that were used to treat industrial process water. Laboratory analysis of soil and groundwater samples collected in the vicinity of the sumps indicated that the concentrations of

COCs exceeded the soil cleanup target levels (SCTLs) and GCTLs in this area. Further historical information is provided in the Phase I Environmental Assessment (EA) Report, dated February 7, 1997.

1.4 Site Geology

The former ABC facility is located on a gently sloping plain at an elevation of about 30 feet above mean sea level (amsl). The site is inland from Sarasota Bay and approximately 1³/₄ miles from the Gulf of Mexico. The ground surface around the site has very low relief and slopes gently towards the south to southwest.

The uppermost 40 feet are comprised of undifferentiated surficial deposits consisting of variably clayey quartz sand and slightly phosphatic, iron-stained sand. From the surface to a depth of 20 feet bgs, these sands are fine to medium grained and unconsolidated. From 20 to 30 feet bgs, the sands are poorly consolidated with clay cement. At approximately 30 feet bgs, very tight clay or dense, cemented sands were encountered. During past site investigations, soil borings could not be advanced deeper than 30 feet bgs using direct-push technology (DPT).

The surficial deposits unconformably overlie approximately 45 feet of relatively pure clay (known as the “Venice Clay”). The clay sequence represents the upper confining beds of the intermediate aquifer system. The contact between the Venice Clay and the underlying Early Miocene undifferentiated Arcadia Formation occurs at approximately 85 feet bgs at the site. Based on lithologic data collected from on-site monitoring well DW-1, fractured limestone was observed in samples collected from 85 to 95 feet bgs. Clay was observed from 95 to 105 feet bgs, the maximum drilled depth at the site. Regionally, the Arcadia Formation extends to a depth greater than 300 feet bgs (SFWMD, 1995).

1.5 Site Hydrogeology

Exploratory drilling and sampling at the site have identified the surficial aquifer system (SAS) and the intermediate aquifer system (IAS). The IAS includes the uppermost confining clay beds and upper semi-confining carbonates (Tetra Tech, 2003).

Groundwater elevations measured from SAS monitoring wells in October 2003 reported depth-to-water values ranging from 2.02 to 3.90 feet bgs across the project area. The corresponding relative groundwater elevations ranged from 25.03 to 28.09 feet amsl. The results of previous monitoring show that groundwater flows generally from southwest to northeast. However, the overall groundwater flow regime appeared radial, as shown by northerly groundwater flow at the northern portion of the project area, and southeasterly flow at the southeastern portion of the project area. In addition, the gradient appears to be slightly greater at the southeast portion of the former ABC property. Groundwater gradient throughout most of the project area was relatively flat, at approximately 0.001 ft/ft, but at the southeastern portion of the property, the gradient is slightly greater, at 0.004 ft/ft (Tetra Tech, 2003). One explanation for the flow patterns may be that groundwater mounding is occurring at the nearby golf course, which is probably being irrigated on a frequent basis. Groundwater patterns may also be impacted by the on-site pond, as well as an adjacent pond on the golf course property.

The IAS includes all water-yielding units and confining units between the overlying SAS and the underlying Floridan Aquifer System. Groundwater was encountered in the IAS at approximately 85 feet. The water table was later measured at approximately 12 feet bgs, confirming that the IAS occurs under confined conditions. The IAS is composed of upper confining and semi-confining beds that occurs between approximately 40 and 85 feet bgs. These confining beds generally consist of a continuous sequence of dense, non-plastic clays, with intermittent sandy clay zones (Tetra Tech, 2003). Figure 2 shows a cross-sectional view of site lithology.

A step pump down test was conducted in March 2003 to estimate the hydraulic conductivity, transmissivity, and average linear velocity of the SAS. These groundwater parameters are estimated as follows:

Hydraulic Conductivity of the aquifer = 20 ft/day;

Transmissivity = 400 ft²/day;

Average Linear Velocity = 0.2 ft/day

1.6 Site History

Site investigation activities have been described in the Contamination Assessment Report (CAR) (Tetra Tech, 2003) and FS (Tetra Tech, 2004) and are detailed in those documents. In summary, groundwater investigations at the site, from 2000 through 2004, have identified groundwater in the SAS impacted by TCE, PCE, and other chlorinated compounds. The highest concentrations are found on the site. In 2004, chlorinated compounds were detected in samples collected from several off-site household potable wells. In June and July 2004, the FDEP conducted a Site Investigation (SI) to further delineate impacted groundwater, particularly in the 20- to 30-foot bgs layer.

1.7 Primary Chemicals of Concern

Based on data collected during the assessment program, a total of five VOCs were detected in groundwater above their GCTLs throughout the investigation area. The VOCs include:

- 1,1-dichloroethane (1,1-DCA)
- 1,1-dichloroethene (1,1-DCE)
- tetrachloroethene (PCE)
- trichloroethene (TCE)
- vinyl chloride.

For the most part, these five VOCs were detected above GCTLs in both grab groundwater samples and monitoring well samples. Table 1 summarizes the groundwater sampling results from the CAR and subsequent sampling. There are only a few data points within the source area; only the results from wells MW-10 and MW-12 along with the FDEP SI DPT data near MW-10 are applicable. Figure 3 depicts the extent of impacted groundwater. The source area plume is considered the area within the footprint of 300 ug/l TCE isoconcentration line of the 10- to 20-foot bgs layer including the underlying 20- to 30-foot bgs layer.

2.0 VOC MASS ESTIMATION IN SOURCE AREA PLUME

The contaminant mass loading in the source area plume was estimated from information presented in the FS. Table 1 in the FS provided an estimate of the mass of TCE in the source area and this information was used to estimate the mass of contaminants in the 10- to 20-foot bgs layer. This quantity included the TCE in the aqueous phase and the TCE sorbed to the soil. The mass of each other contaminant in the source area was calculated by multiplying the TCE mass by the ratio of the contaminant concentration to the TCE concentration in MW-10. Because only about two thirds of the East Plume is within the former ABC property, the mass of contaminants available for treatment is less than the FS value.

The mass of contaminants in the 20- to 30-foot bgs layer was calculated by estimating the average concentration of each contaminant and multiplying by the volume of water. The mass of contaminants in the sorbed phase was calculated using literature values for partitioning coefficients and observed values for porosity and bulk density. The calculation is included in Appendix C and mass of each contaminant in the source area plume is summarized below:

East Plume (within former ABC property only)			
Contaminant	10- to 20-foot layer mass, lb	20- to 30-foot layer mass, lb	Total mass, lb
1,1-DCA	1.1	10	11
1,1-DCE	1.7	16	18
cis-1,2-DCE	0.6	5	6
PCE	0.2	13	13
Vinyl Chloride	< 0.1	0.03	< 0.1
TCE	10	205	215

3.0 SCREENING OF ALTERNATIVES

Tetra Tech conducted a screening of available technologies in the FS (Tetra Tech, 2004) to select the most effective remedial alternative for the entire groundwater plume. This screening is also applicable to the source area treatment described in this IRAP. Because the IRAP must be conducted quickly, in-situ chemical oxidation has been selected as the remedial method for the source. This is a demonstrated technology that can be implemented in a short time period and can result in contaminant reduction in the source area in a relatively short time.

3.1 Evaluation of Groundwater Treatment Alternatives

Based on the CAR and FS, the volume of source-area groundwater plume in the East Plume beneath the former ABC property is about 920,000 gallons. The volume excludes the relatively uncontaminated water in the 5- to 10-foot bgs layer.

The following action has been identified for remediation of groundwater in the source area and will be evaluated further this IRAP:

- In-situ Chemical Oxidation (Fenton's reagent, Potassium Permanganate (KMnO_4), or ozone)

The following technologies have been ruled out and rationales for ruling them out are listed below:

- Natural Attenuation – Physical processes, including biological degradation, rely of the ability of the biological activity to remove contaminants. However, this was not considered further because the process takes a long time, usually years.
- Enhanced Bioremediation and Electron Donor Addition – Biological activity removes contaminants. However, this was not considered further because the biological process takes a long time, usually years.

-
- Air Sparging/ Vapor Extraction (AS/VE) – Injection of air into the groundwater has the potential to lead to air emissions in the neighborhood, although the VE system can be expected to control emissions. The shallow water table limits the effectiveness of VE. Noise from blowers and vacuum pumps could create a noise nuisance. Treatment time could be relatively long, possibly a year or two. Private property interferences make the technology difficult to apply off-site, so any experience gained by use of the technology at the source could not be applied off-site.
 - In-situ Thermal Treatment – This method is not economical compared to other VOC-remediation methods. Application problems are similar to AS/VE, and a VE system would be needed to recover off-gases.
 - In-situ Chemical Reduction – Injection of micro- or nano-sized particles of zero valent iron promote the decomposition of chlorinated compounds by reduction. The alternative was not considered further because of the high cost relative to other technologies.
 - Extraction and Treatment – Extraction processes were eliminated because of the large amounts of groundwater that must be pumped out, treated, and disposed of. In addition to the impacted source water, large volumes of relatively uncontaminated groundwater would also be removed. Additional modeling would also be required to select well locations and pumping rates.

The following section briefly discusses in-situ chemical oxidation methods that were considered.

3.2 In-Situ Chemical Oxidation

Fenton's Reagent

Fenton's reagent is a reaction between hydrogen peroxide (H_2O_2) and ferrous iron that yields hydroxyl radicals. These radicals are powerful oxidizing agents. Typically, a solution of H_2O_2 (about 10 percent) and ferrous sulfate are injected into the groundwater at multiple locations. Acid is usually required to lower to pH to 4, which is preferable, but the reaction will occur in the pH range of 5 to 6. The basic reaction is:



Where OH^\bullet is the hydroxyl radical. The hydroxyl radical reacts with chlorinated and non-chlorinated compounds to yield carbon dioxide, water, and chloride. Heat is produced by the reaction with the organic compounds, and where high concentrations of contaminant and organic material are present, hot gas and volatile compounds can be evolved. The number of injection points is usually dependant on the permeability of the soil and the thickness of the impacted plume.

Potassium Permanganate

Potassium permanganate (KMnO_4) is an oxidizing agent that oxidizes organic compounds containing carbon-carbon double bonds, aldehyde groups, and hydroxyl groups. Therefore, it is effective in treating DCE, TCE, and PCE, but is ineffective for DCA. The reaction of KMnO_4 and these compounds yield carbon dioxide, water, chloride, and manganese dioxide, but unlike Fenton's reagent, much less heat is generated. The reaction occurs best in the neutral range.

A solution of KMnO_4 typically around 2 to 4 percent is injected into the groundwater at multiple locations as described in the preceding section. The number of injection points is usually dependant on the permeability of the soil and the thickness of the plume.

Ozone

Ozone (O_3) is a strong oxidizing agent. Unlike the other two oxidizers, ozone is injected into the groundwater in the gas phase. An ozone generator produces ozone from air or oxygen, but this has to be delivered to the ground at 1 to 3 percent concentrations, through a system similar to an air sparging system. Because the air will strip VOCs from the groundwater, a VE system is usually required to capture the off-gases. The number of injection points is usually a dependant on the permeability of the soil. The injection of ozone is usually a long-term process, compared to the single injections of the liquid-borne oxidizers, such as Fenton's reagent and KMnO_4 .

3.3 Comparison of Alternatives

Ozone was eliminated for the following reasons:

-
- A VE system would be required to collect off-gases, adding to costs and operating requirements.
 - The system requires a long-term, continuous operation that would not be suitable for off-site portions of the plume, so any experience gained by use of the technology at the source could not be applied off-site.

Fenton's reagent and KMnO_4 are both suitable for the site. However, Fenton's reagent was selected for the following reason:

- Fenton's reagent treats a wide variety of compounds. DCA is present in the source area groundwater at concentrations greater than the GCTL, and DCA is not affected by KMnO_4 .

Heat generation and vapor release can be controlled through the rate of feed and concentration of H_2O_2 in the feed. Concentrations of organic compounds are relatively low in the 10- to 20-foot bgs layer and significant heat generation is unlikely. Concentrations of organic compounds are relatively high in the 20- to 30-foot bgs layer and significant heat generation must be considered. Although H_2O_2 is a hazardous chemical, proper safety and training allow for its safe use. Experience gained from source applications can be used if off-site treatment is to be considered.

H_2O_2 will leave behind a residual oxygen concentration that can limit anaerobic biological degradation of the chlorinated compounds. The effective treatment of all of the chlorinated compounds in the source, including DCA, outweigh the potential benefits of KMnO_4 (slightly safer to handle, slightly lower cost, less heat generation, no pH adjustments needed). KMnO_4 may still be considered for treatment of the off-site portions of the plume.

The preferred remedial alternative presented in this IRAP was selected based on it providing treatment of the source area plume in a short period of time. The potential remedial technologies and process options were identified and screened, and the results were presented in previous sections. The selected alternative for the source area is in-situ chemical oxidation with Fenton's reagent.

4.0 TECHNOLOGY DESCRIPTION

The major components of the treatment system include the following:

- Site preparation/survey
- Pilot Study
- Injection point installation/chemical injection
- Monitoring
- Injection Point Abandonment

Figure 4 shows the areas to be treated.

4.1 Site Preparation

This step includes site survey and well abandonment.

Prior to performing any intrusive work, the areas to be treated should be checked for any substructures, utility lines (particularly natural gas and fiber optics), and other potential interferences. A professional survey to verify locations of site utilities was not conducted for this report; however, active or inactive subsurface obstructions may include electric lines, piping for sewer, gas distribution, etc.

Monitoring wells within the limits of the source area plume will be inspected and evaluated for continued use. Monitoring wells (MW-10 and MW-12) that will be needed for long-term monitoring will be modified with a blow-off proof cap to prevent release of water during injection at nearby injection points. Wells that are no longer needed for the evaluation of the site, such as RW-1 and Phase I temporary wells, will be abandoned by grouting from the bottom of the well to approximately 2 feet bgs with bentonite cement grout. The grout should be pumped from the bottom of the borehole to the top by pressure grouting using a tremie pipe. The total depth of the well should be sounded prior to sealing, and the level of grout should be monitored during pumping with a weighted tape to insure complete placement of the grout. The grout level should be checked 24 hours after emplacement and refilled to replace any losses due to settling. In addition, all local and state regulations shall be followed for well abandonment. Prior to

abandonment, the locations of the surficial aquifer wells will be surveyed so that new wells may be installed near the existing locations, but not into the grout plug.

Planning documents, such as Health and Safety Plan, and necessary permits must also be obtained.

4.2 Pilot Study

A pilot study will be performed to establish injection point spacings and dosage rates. Twelve injection points will be installed. The Fenton's reagent solution will be injected at a rate estimated from existing data, and the results of the treatment and injection will be observed through monitoring wells and other injection points. After the pilot work is completed, the radius of influence will be confirmed as well as the chemical dosage rate.

4.3 Injection Point Installation/Chemical Injection

Based on the results of the pilot study, the injection point array will be surveyed in the field. The injection point spacing will be adjusted as needed to account for buried utilities and other physical obstructions. Within the buildings, the floor will be cored as needed. The injection points will consist of 3/4-inch diameter CPVC pipe and screen with a flush-mount protective casing and will be installed using DPT methods. Each point will be finished at the surface as a flush-mounted well with an 8-inch protective casing. The top of each injection point is designed so that the Fenton's reagent can be injected from a supply truck. The H₂O₂ solution will be diluted with water to about 10 percent. Ferrous iron catalyst will be added prior to injection, and sulfuric acid or phosphoric acid will be added for pH adjustment, if needed.

Vent wells may be installed through building floors and paved areas as needed to allow gases to escape. Vent wells, if needed, will be constructed of stainless steel screens across the entire vadose zone. An estimated 10 vent wells will be installed.

Assuming that the radius of influence of an injection well is 15 feet with 20-foot spacing for full coverage and that injection points are required at two depths per injection location, 70 points are needed. The contaminant concentrations are relatively low in the 10- to 20-foot bgs layer, but relatively high in the 20- to 30-foot bgs layer. The TOC concentrations are relatively high

throughout. In addition, to maintain a minimum concentration of H_2O_2 in the groundwater to promote the reaction, the minimum H_2O_2 that can be used is about 1,000 lb per injection point. A total of 70,000 pounds of H_2O_2 are required for two layers. About 1 month is required for the pilot study and the injection point installation. An additional 2 weeks is required to inject most of the H_2O_2 . A follow-up polishing injection of about 15% of the total will be performed several weeks later, if needed. See Appendix C for calculations.

It is estimated that only the primary and single follow-up injection will be needed. After injection, the injection points will be capped and secured for reuse if needed. However, if monitoring shows that additional treatment is needed, the process will be repeated.

4.4 Monitoring

The groundwater in the source area plume will be sampled and analyzed prior to and after treatment. Existing wells MW-10 and MW-12 will be sampled and analyzed for VOCs prior to injection, one week after injection, then monthly relative to injection for three months, and then semi-annually for one year. If monthly monitoring suggests incomplete treatment, or an increase in contaminants from desorption from soil particles, the injection process may be repeated, as needed. The sampling prior to injection and at semi-annual intervals will be performed as part of the routine quarterly monitoring program.

4.5 Injection Point Abandonment

After the source area treatment goals have been met, and it is determined that no additional chemical injection is required, the injection points will be abandoned as described in the Site Preparation step, above. Injection point piping will be discarded and the holes will be grouted.

5.0 MONITORING

Treatment is expected to be completed with one injection step. Thus, long-term activities are limited to monitoring and reporting.

5.1 Monitoring Plan

A monitoring program is anticipated to be initiated upon approval of this IRAP and subsequent implementation of the interim remedial action system. The objective of the monitoring plan is to track the overall effectiveness of the treatment. This plan will be integrated with other monitoring programs for the downgradient portions of the plume, and is not intended to replace other plans.

The proposed monitoring plan includes the following:

- Measurements of groundwater levels in the selected source area wells. Measurement will be performed using a water level indicator.
- Sampling of wells MW-10 and MW-12 and analyzing the samples for VOCs. The wells will be sampled at the following intervals:
 - 1 to 2 months prior to injection
 - 1 week after injection
 - Monthly, after injection for three months
 - Semi-annually for at least 1 year

As noted above, the sampling prior to injection and at semi-annual intervals will be performed as part of the routine quarterly monitoring program.

- The results of sampling will be reported every quarter in a status report (See Section 5.2)

5.2 Status Reports

During the implementation and monitoring of the remedial action described in this IRAP, quarterly status reports will be prepared and submitted to the FDEP. The reports will summarize all remedial activities and will contain at a minimum the following information:

- Pilot test results, including injection well locations, monitoring well sample results, and quantities of chemicals injected.
- Injection dates, quantities of chemicals injected.
- Monitoring well sampling results.
- Conclusions as to the effectiveness of the remedial action and recommendations on further monitoring.

6.0 REFERENCES

1. Florida Department of Environmental Protection, Water Well Permitting and Construction Requirements, Chapter 62-532, F.A.C., December 9, 1996.
2. Florida Department of Environmental Protection, Development of Soil Cleanup Criteria, Chapter 62-777, F.A.C., May 26, 1999.
3. Florida Department of Environmental Protection, Drinking Water Standards, Monitoring and Reporting, Chapter 62-550, F.A.C., August 1, 2000.
4. Jianzhong, He., et. al., Detoxification of Vinyl Chloride to Ethene Coupled to Growth of an Anaerobic Bacterium, *Nature*, Volume 424, 3 July 2003, Pages 62 – 65.
5. Lendvay, F., et. al., Bioreactive Barriers: A Comparison of Bioaugmentation and Biostimulation for Chlorinated Solvent Remediation, *Environmental Science & Technology*, Volume 37, No. 7, 2003, Pages 1422-1431.
6. Major, David, et. al., Discussion of Environment vs. Bacteria and “Oxygen Revisited”, *Groundwater Monitoring & Remediation*, Volume 23, No. 2, Spring 2003, Pages 32-48.
7. Southwest Florida Water Management District, Final Report, ROMP TR7-2 ONECO Monitor Well Site, Manatee County, Florida, Drilling and Testing, January 1995.
8. Tetra Tech, Inc., Final Phase I Environmental Assessment, Former American Beryllium Company. February 7, 1997.
9. Tetra Tech, Inc., Final Preliminary Site Investigation Report, Former American Beryllium Company. October 20, 1997.
10. Tetra Tech, Inc., Contamination Discovery Report, Building #5, Former American Beryllium Company. July 7, 2000.
11. Tetra Tech, Inc., Initial Remedial Action Report, Former American Beryllium Company, December 12, 2001.
12. Tetra Tech, Inc., Interim Data Report and Contamination Assessment Plan Addendum #2, Former American Beryllium Company, September 13, 2002.

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13. Tetra Tech, Inc., Final Contamination Assessment Report, Former American Beryllium Company, May 2003.
 14. Tetra Tech, Inc., Remedial Technology Evaluation Report, Former American Beryllium Company, January 2004.
 15. Tetra Tech, Inc., Draft 1st Quarter 2004 Groundwater Sampling Report, Former American Beryllium Company, June 2004.
 16. Florida Department of Environmental Protection, Site Investigation Section, Tallevast Community, Tallevast, Manatee County Florida, Preliminary Contamination Assessment Report, July 2004.
 17. Tetra Tech, Inc., Draft Site Assessment Plan Addendum, Former American Beryllium Company, August 2004.

APPENDIX A

TABLES

TABLE 1
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
VOLATILE ORGANIC COMPOUNDS

Sample ID	Date Collected	Chloromethane	Dichlorodifluoromethane	1, 1 -Dichloroethane	1,1-Dichloroethene	cis-1,2 - Dichloroethene	trans 1, 2 - Dichloroethene	Methylene Chloride	Tetrachloroethene	Vinyl Chloride	Dibromofluoromethane	Trichloroethene
GCTL ⁽¹⁾	N/A	N/A	1,400	70	7	70	100	N/A	3.0	1	N/A	3.0
TT-MW-3	9/9/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/17/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/14/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-4	9/10/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3.1
	12/17/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.6
	4/15/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-5	9/10/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/17/2003	<1	<1	2.4	<1	<1	<1	<1	<1	<1	<1	<1
	4/16/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-6	9/10/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/17/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/16/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-7S	9/9/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/17/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/14/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

TABLE 1
SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
VOLATILE ORGANIC COMPOUNDS

Sample ID	Date Collected	Chloromethane	Dichlorodifluoromethane	1, 1 -Dichloroethane	1,1-Dichloroethene	cis-1,2 - Dichloroethene	trans 1, 2 - Dichloroethene	Methylene Chloride	Tetrachloroethene	Vinyl Chloride	Dibromofluoromethane	Trichloroethene
GCTL ⁽¹⁾	N/A	N/A	1,400	70	7	70	100	N/A	3.0	1	N/A	3.0
TT-MW-7D	9/9/2003	<1	<1	1.9	4.0	<1	<1	<1	6.7	<1	<1	9.0
	12/17/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/16/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-8S	9/9/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/17/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/15/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-8D	9/9/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/17/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/15/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-9S	9/11/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/17/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/15/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-9D	9/11/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/17/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/14/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

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Sample ID	Date Collected	Chloromethane	Dichlorodifluoromethane	1, 1 -Dichloroethane	1,1-Dichloroethene	cis-1,2 - Dichloroethene	trans 1, 2 - Dichloroethene	Methylene Chloride	Tetrachloroethene	Vinyl Chloride	Dibromofluoromethane	Trichloroethene
GCTL ⁽¹⁾	N/A	N/A	1,400	70	7	70	100	N/A	3.0	1	N/A	3.0
TT-MW-10	9/9/2003	<1	2.1	140.0	76.0	34.0	7.1	<1	26.0	1.5	<1	<1
	12/17/2003	4.0	<1	330.0	120.0	37.0	3.6	21.0	15.0	<1	<1	830.0
	4/14/2004	<1	<1	420.0	130.0	16.0	<1	<1	20.0	8.0	<1	450.0
TT-MW-11	9/11/2003	<1	<1	110.0	48.0	41.0	7.7	<1	5.1	<1	<1	480.0
	12/17/2003	<1	<1	17.0	7.2	6.6	<1	9.3	5.4	<1	<1	180.0
	4/15/2004	<1	<1	5.2	3.7	3.9	<1	<1	4.6	<1	<1	110.0
TT-MW-12	9/9/2003	<1	<1	2.3	2.8	1.5	<1	<1	72.0	<1	<1	96.0
	12/17/2003	<1	<1	11.0	12.0	3.7	<1	<1	190.0	<1	<1	270.0
	4/13/2004	<1	<1	19.0	19.0	6.8	<1	<1	420.0	3.2	<1	910.0
TT-MW-13S	9/10/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/16/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/13/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-13D	9/10/2003	<1	<1	<1	1.6	<1	<1	<1	<1	<1	<1	<1
	12/16/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/13/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

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VOLATILE ORGANIC COMPOUNDS

Sample ID	Date Collected	Chloromethane	Dichlorodifluoromethane	1, 1 -Dichloroethane	1,1-Dichloroethene	cis-1,2 - Dichloroethene	trans 1, 2 - Dichloroethene	Methylene Chloride	Tetrachloroethene	Vinyl Chloride	Dibromofluoromethane	Trichloroethene
GCTL ⁽¹⁾	N/A	N/A	1,400	70	7	70	100	N/A	3.0	1	N/A	3.0
TT-MW-14S	9/10/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/16/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/13/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-14D	9/10/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/16/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/13/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-15S	10/7/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/16/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/13/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-15D	10/6/2003	<1	<1	1.5	<1	<1	<1	<1	<1	<1	<1	<1
	12/16/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/15/2004	<1	<1	1.5	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-16S	9/11/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/16/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/14/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

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SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
VOLATILE ORGANIC COMPOUNDS

Sample ID	Date Collected	Chloromethane	Dichlorodifluoromethane	1, 1 -Dichloroethane	1,1-Dichloroethene	cis-1,2 - Dichloroethene	trans 1, 2 - Dichloroethene	Methylene Chloride	Tetrachloroethene	Vinyl Chloride	Dibromofluoromethane	Trichloroethene
GCTL ⁽¹⁾	N/A	N/A	1,400	70	7	70	100	N/A	3.0	1	N/A	3.0
TT-MW-16D	9/11/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/16/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/13/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-17S	10/6/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/16/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/14/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-17D	10/6/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/16/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/15/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-18S	10/6/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/16/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/13/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
TT-MW-18D	10/6/2003	<1	<1	2.4	1.2	5.8	8.8	<1	<1	<1	<1	<1
	12/16/2003	<1	<1	3.2	1.7	7.8	12.0	<1	<1	<1	<1	<1
	4/13/2004	<1	<1	3.3	1.7	8.4	16.0	<1	<1	<1	<1	<1

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SUMMARY OF GROUNDWATER ANALYTICAL RESULTS
VOLATILE ORGANIC COMPOUNDS

Sample ID	Date Collected	Chloromethane	Dichlorodifluoromethane	1, 1 -Dichloroethane	1,1-Dichloroethene	cis-1,2 - Dichloroethene	trans 1, 2 - Dichloroethene	Methylene Chloride	Tetrachloroethene	Vinyl Chloride	Dibromodifluoromethane	Trichloroethene
GCTL ⁽¹⁾	N/A	N/A	1,400	70	7	70	100	N/A	3.0	1	N/A	3.0
TT-DW-1	9/9/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/17/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/16/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Trip Blank	9/12/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	12/17/2003	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4/16/2004	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Values reported in micrograms per liter.

⁽¹⁾ Groundwater Cleanup Target Level as defined by Chapter 62-777, F.A.C.

Shaded values are positive detections.

Values shown in bold are at concentrations exceeding GCTL.

Note: All other VOCs on the EPA 8260B list were non-detect (ND)

APPENDIX B

FIGURES

FIGURE 1
SITE LOCATION MAP

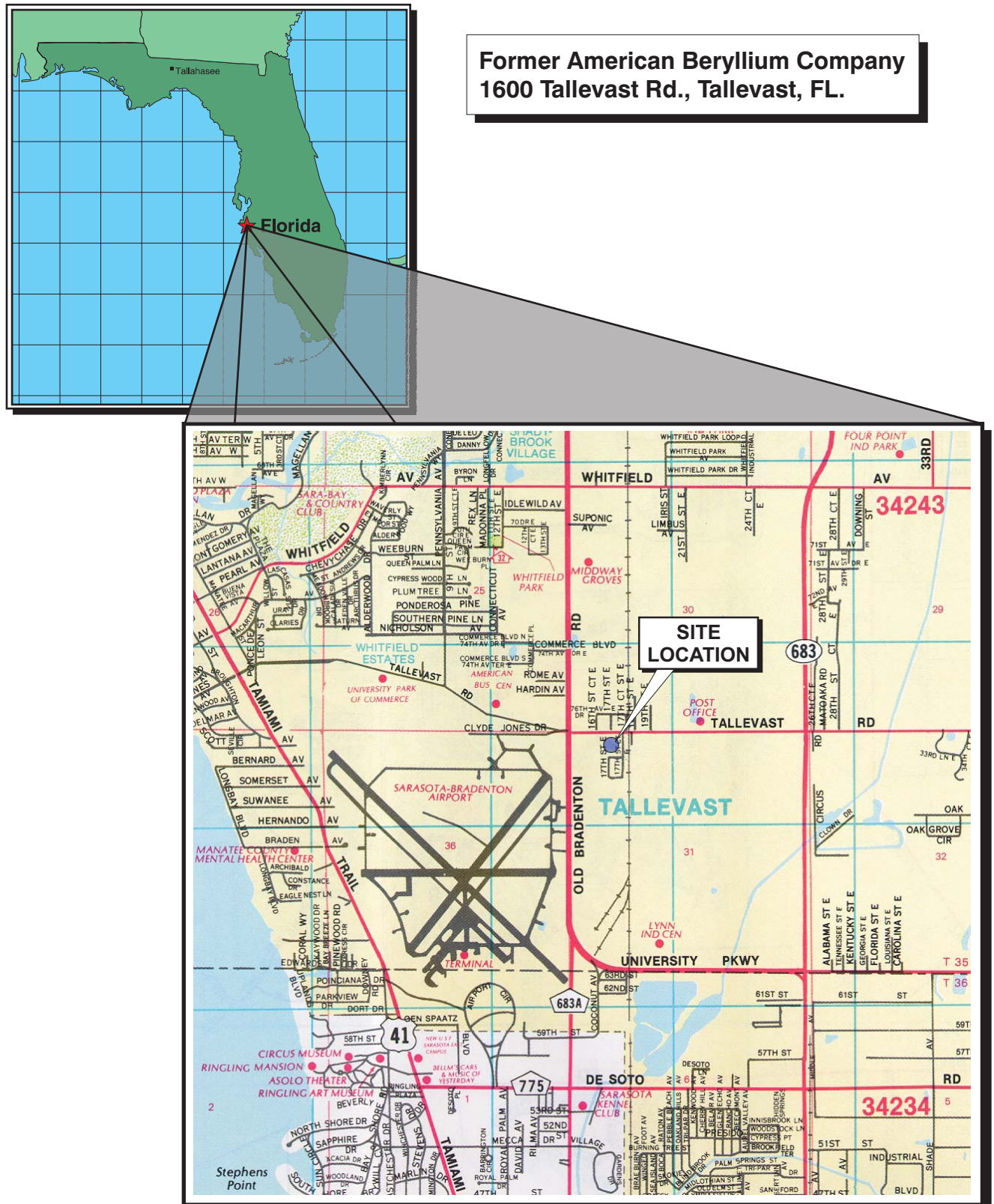


FIGURE 2
CROSS-SECTION A-A'

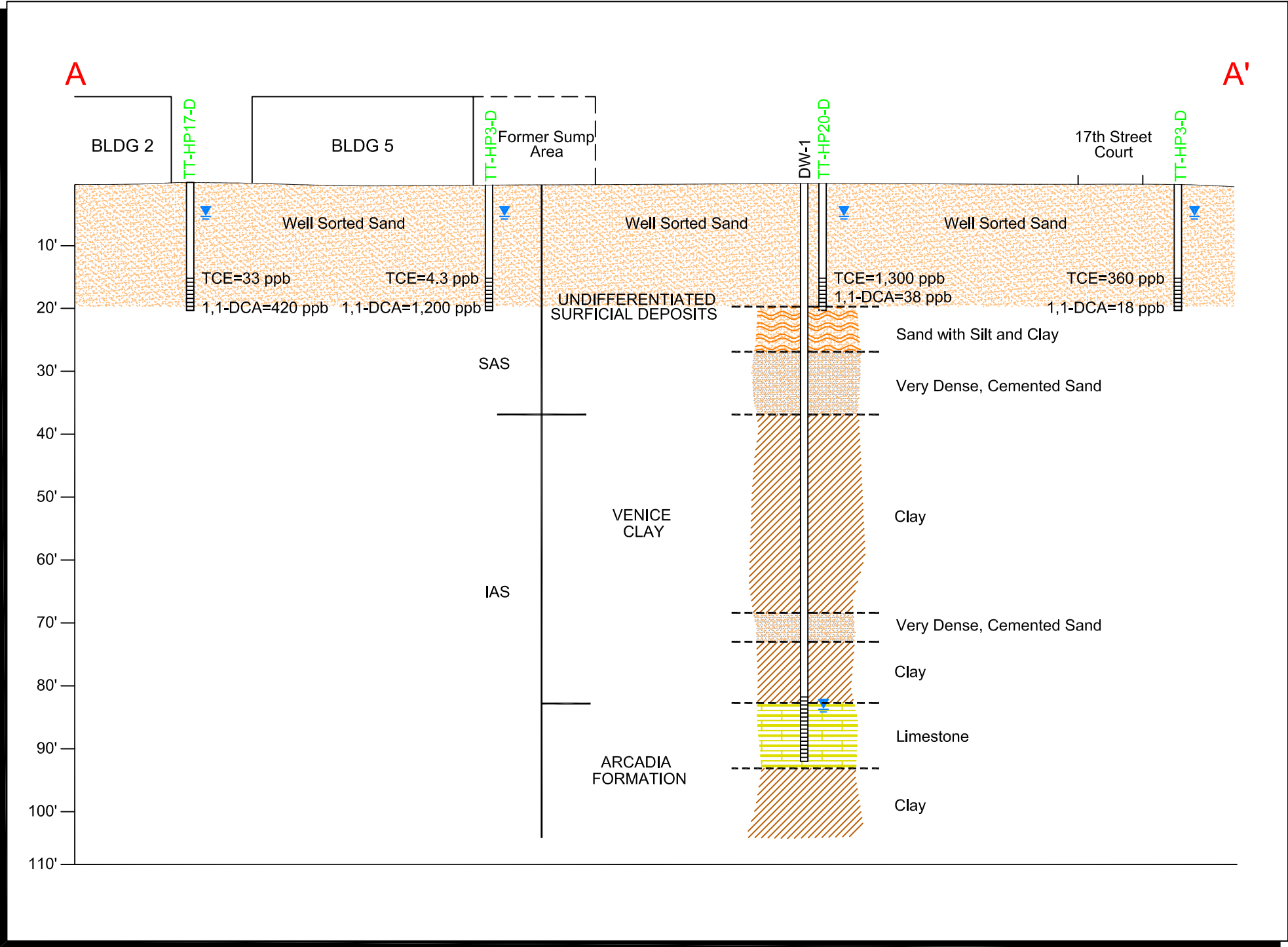
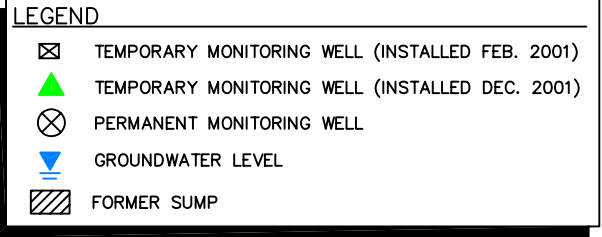
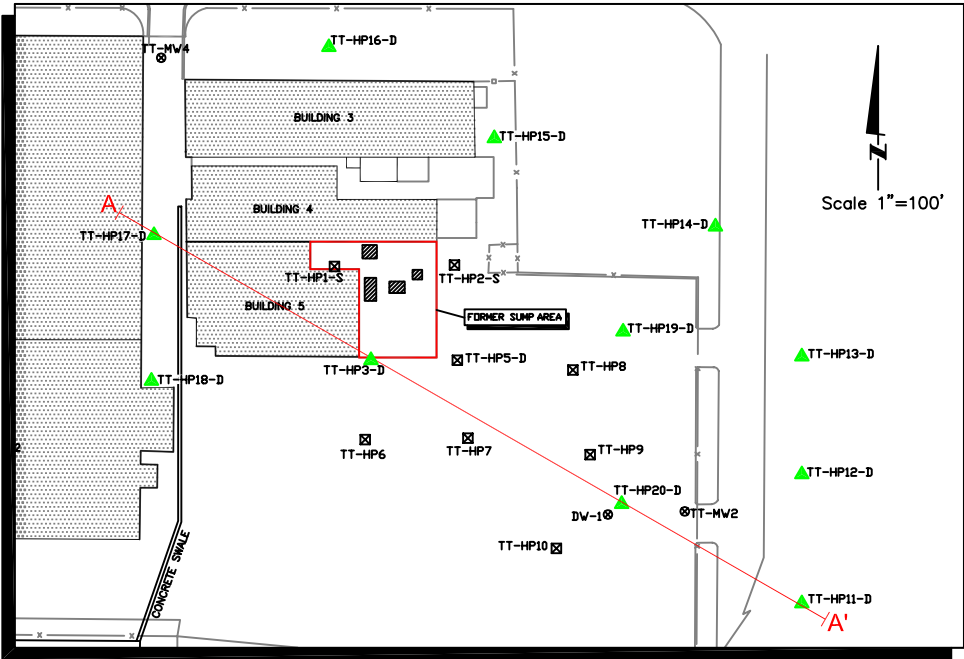


FIGURE 3
TCE ISOCONCENTRATION MAP

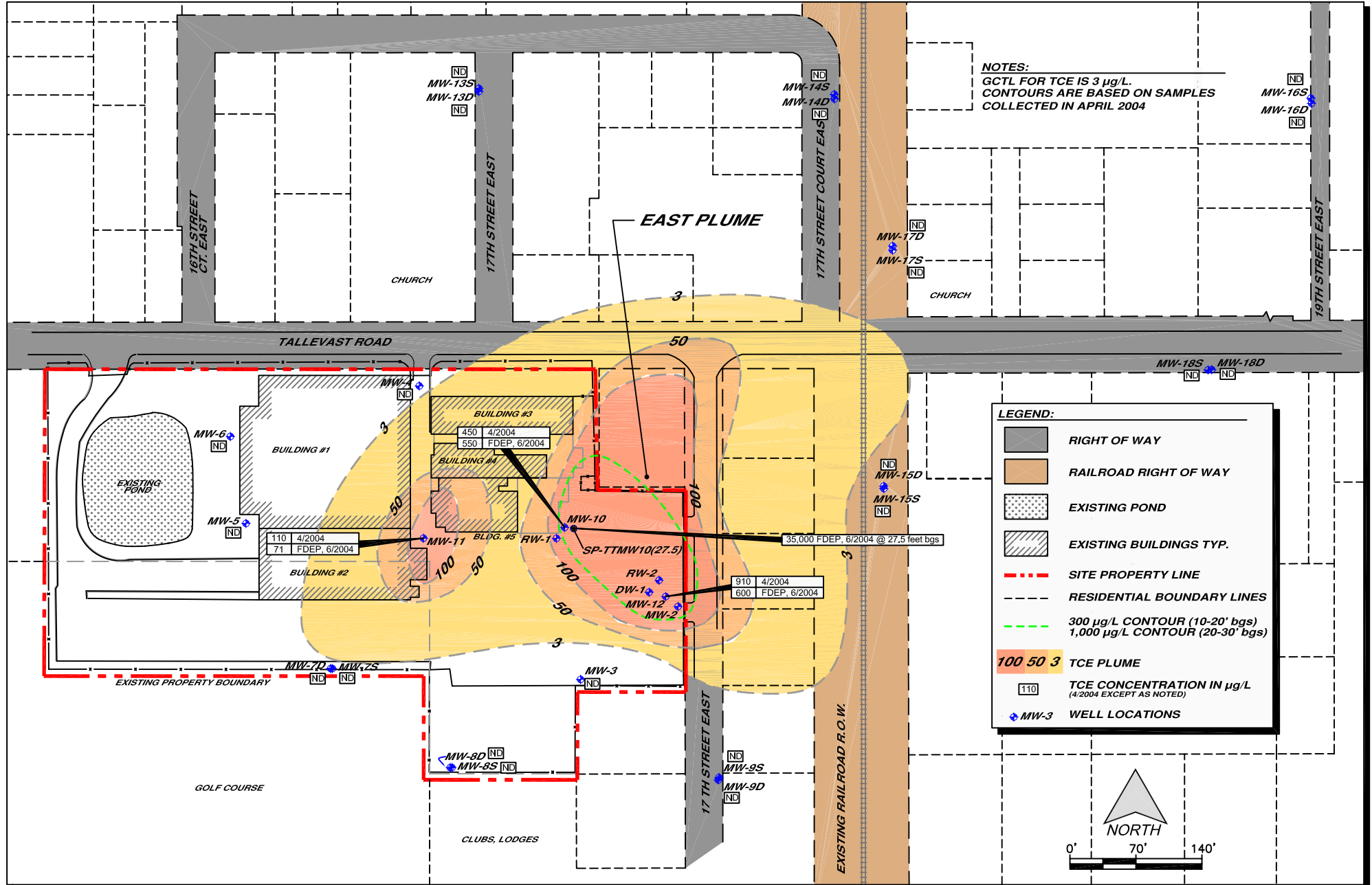
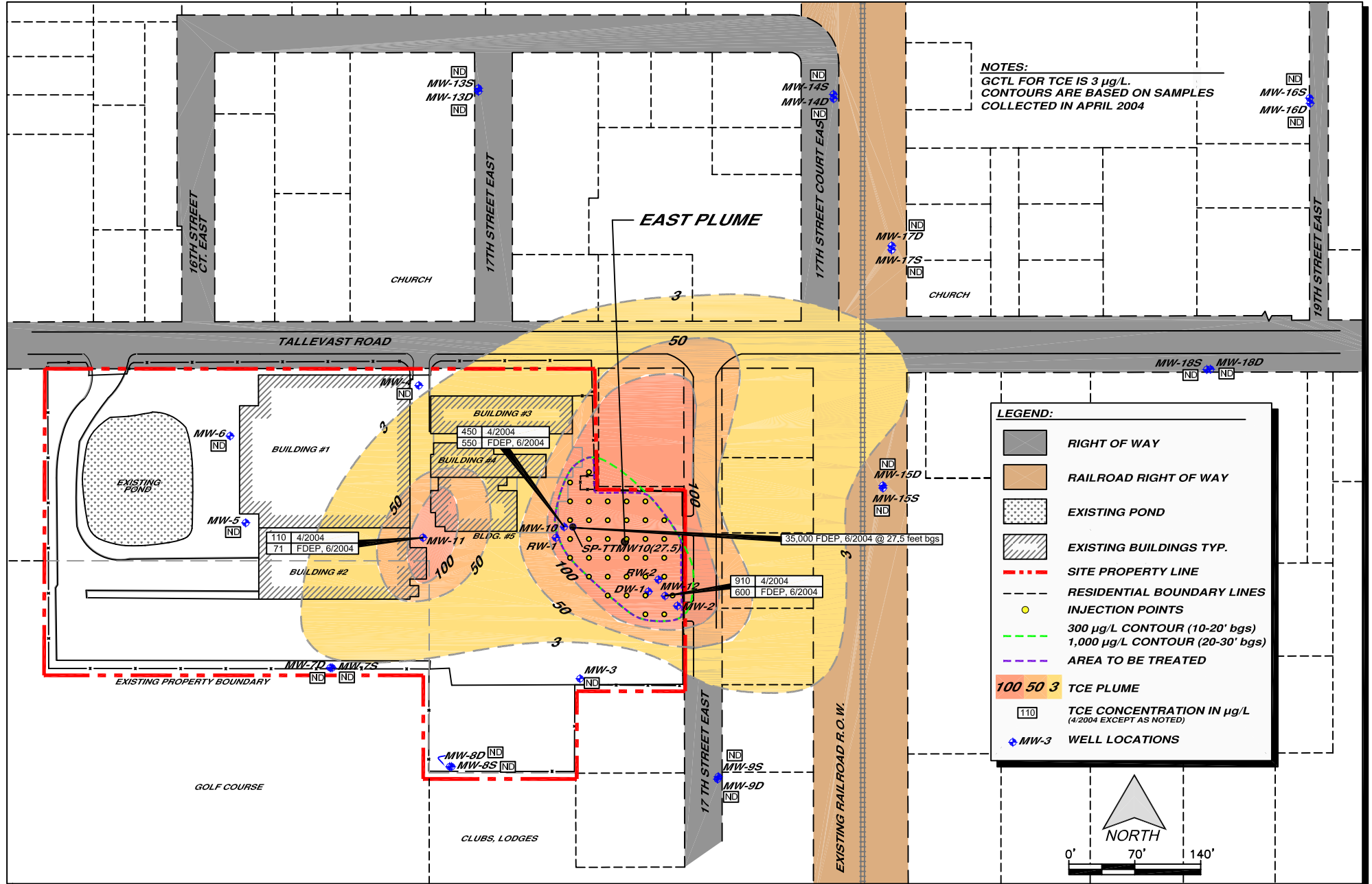


FIGURE 4
IRAP TREATMENT AREAS



APPENDIX C

CALCULATIONS

Tetra Tech, Inc.		STANDARD CALCULATION SHEET	
CLIENT: Lockheed	FILE No: N1075	BY: JWL	PAGE: 1 of 1
SUBJECT: American Beryllium - IRAP – Volume of Contaminated Groundwater in Source areas		CHECKED BY:	DATE: 09/14/04

Purpose: Estimate the volume of groundwater in the source areas

Assumptions:

Porosity = 0.24 (from FS)

Area of East plume from the FS and as modified by the 1st Quarterly Monitoring Report. See Figure 4 for area to be treated within the 300 ug/L contour. Area is 14,700 ft².

Calculations:

East Plume

Portion on ABC property:

Volume of water = 14,700 ft² x 20 ft x 0.42 x 7.481 gallons/ft³ = 920,000 gallons

This corresponds to 460,000 gallons in the 10' to 20' layer, and 460,000 gallons in the 20' to 30' layer.

Tetra Tech, Inc.		STANDARD CALCULATION SHEET	
CLIENT: Lockheed	FILE No: N1075	BY: JWL	PAGE: 1 of 2
SUBJECT: American Beryllium - IRAP – Mass of Contaminants in Source Area Plumes		CHECKED BY:	DATE: 09/14/04

Purpose: Estimate mass of contaminants in the source area plume.

Assumptions:

The source area plume is the area within the 300 ug/L isoconcentration line at 10 to 20 feet bgs. This corresponds to a 1,000 ug/L contour at 20-30 feet bgs.

For the East Plume, this area within the 300 ug/L isoconcentration line was calculated with a planimeter, based on the plume depicted in the Draft 1st Quarter Groundwater Sampling Report.

The mass of TCE calculated in Table 1 of the FS is proportional to the area of the footprint of the 100 ug/L isoconcentration line. In the FS, the area within the 100 ug/L line was 28,349 ft² and there were 40 lb of TCE in a 30 foot thick layer. It is assumed that only the 10 to 20 foot bgs layer (10 feet thick) corresponds to this layer in the FS. The FS plume area was 28,000 ft² and the corresponding 4th quarter plume was 21,000 ft². For conservativeness, the mass within the 100 ug/L contour is assumed to equal the mass within the 300 ug/L contour.

Thus, the mass of TCE is scaled from the FS mass (40 lb):

$$\text{Mass of TCE} = 40 \text{ lb} \times 28,000 \text{ ft}^2 / 21,000 \text{ ft}^2 \times 10 \text{ feet} / 30 \text{ feet} = 10 \text{ lb}$$

This is conservative since it considers a larger area including the off-site portion.

Calculations:

The mass of each contaminant in the 10 to 20 foot bgs layer was calculated as follows:

1. Determine the mass of TCE, starting with Table 1 of the FS.
2. Determine the ratio of each contaminant to TCE based on the sampling results from a well representative of the plume. For the East Plume, MW-10.
3. For each contaminant, multiply the concentration ratio by the mass of TCE in the plume.

See the attached spreadsheet for the other contaminants.

The mass of each contaminant in the 20 to 30 foot bgs layer was calculated as follows:

- The sampling screen length of the FDEP SIS was 4 feet (Page 5 of the SIS report).
- The upper edge of the layer has a concentration of 820 ug/L, based on well MW10.
- An arithmetic mean will be taken over the top to bottom at MW10 and the FDEP DPT point at MW10.
- A geometric mean will be taken outward from the above value to 1,000 ug/L to take into account the higher values observed by the FDEP to the north and south. 1,000 ug/L is the estimated concentration at the edge of the 20' to 30' plume that is coincidental with the 399 ug/L contour of the 10' to 20' plume above.

The MW10 location arithmetic average:

$$(820 + 35,000) / 2 = 18,000 \text{ ug/L}$$

Tetra Tech, Inc.		STANDARD CALCULATION SHEET	
CLIENT: Lockheed	FILE No: N1075	BY: JWL	PAGE: 2 of 2
SUBJECT: American Beryllium - IRAP – Mass of Contaminants in Source Area Plumes		CHECKED BY:	DATE: 09/14/04

Plume geometric average:

$$v(18,000 \times 1,000) = 4,200 \text{ ug/L}$$

The mass of each contaminant is calculated by multiplying the average concentration by the volume of water in the layer and assumes the same proportions of other contaminants to TCE as in the 10' to 20' layer.

The sorbed phase mass was calculated using Koc values and an assumed foc of 0.02. See the attached spreadsheet.

SOURCE COMPOSITION - 9/15/04

East Plume - 10 to 20 feet bgs

Well				
Constituent	Conc, ug/L	C/CTCE	Ave, ug/L	GCTL, ug/L
1,1-DCA	90	0.110	55	70
1,1-DCE	140	0.171	85	7
cis-1,2-DCE	48	0.059	29	70
MeCl	40	0.049	24	5
PCE	13	0.016	8	3
Vinyl Chloride	1.1	0.001	0.7	1
TCE	820	1	500	3

TOC in soil samples collected from saturated zone have ranged from 1,000 to 5,000 mg/kg.
Source area: 14,700 Ft²

East Plume - 20 to 30 feet bgs

Well				
Constituent	Conc, ug/L	C/CTCE	Ave, ug/L	GCTL, ug/L
1,1-DCA	90	0.110	461	70
1,1-DCE	140	0.171	717	7
cis-1,2-DCE	48	0.059	246	70
MeCl	40	0.049	205	5
PCE	13	0.016	67	3
Vinyl Chloride	1.1	0.001	6	1
TCE	820	1	4200	3

Notes: ave TCE concentration is from MW-10.
Other components have been scaled in proportion to TCE.

The plume average concentration is assumed to be geometric mean of 820 and 300 ug/L.

495.9839
say 500

The average concentration over depth at MW10 is assumed to be the average of MW10 and the DPT at MW10, 820 and 35,000 respectively. This equals 18,000 ug/L.

The plume average concentration is assumed to be geometric mean of 18,000 and 1,000 ug/L.

4242.641
say 4,200

TABLE
PLUME MASS AT SOURCES
9/15/04

Use a 300 ug/L contour line in the 10-20 feet bgs layer.

Assume that mass within the 300 ug/L contour is the same as in the 100 ug/L, for conservativeness.

Only use the east plume.

At 30 feet thick and 28,000 ft², TCE mass was 40 lb.

But with the smaller 4th Q plume, the area was 21,000 ft²

Thus, the mass is first scaled to the smaller area, and then to the thinner thickness of 10 feet:

Mass = $40 \times 21,000 / 28,000 \times 10 / 30 = 10 \text{ lb}$

Estimate mass of other constituents

Aqueous and sorbed phases combined.

East Plume 10-20 feet bgs

Mass of TCE, lb:		10	
Constituent	Conc, ug/L	C/CTCE	Mass, lb
1,1-DCA	90	0.11	1.1
1,1-DCE	140	0.17	1.7
cis-1,2-DCE	48	0.06	0.6
MeCl	40	0.05	0.5
PCE	13	0.02	0.2
Vinyl Chloride	1.1	0.00	0.0
TCE	820	1.00	10
Total			14.1

Based on MW-10, CAR Table 3-6.

Mass of TCE is from FS Table 1.

Source area: 21,000 Ft², as modified by 1st Quarterly Report plume Figure

TABLE
PLUME MASS AT SOURCES
9/15/04

East Plume 20-30 feet bgs

Constituent	Ave, ug/L	Mass (aq), lb	Koc, L/kg	Kd	Cs, ug/kg	Mass, sorbed, lb	Total
1,1-DCA	461	1.8	65	1.3	599	8	10
1,1-DCE	717	2.7	65	1.3	932	13	16
cis-1,2-DCE	246	0.9	59	1.18	290	4	5
MeCl	205	0.8	8	0.16	33	0.5	1
PCE	67	0.3	665	13.3	886	12	13
Vinyl Chloride	6	0.0	8.2	0.164	1	0.01	0.03
TCE	4,200	16.1	160	3.2	13,440	189	205
Total		22.6				228	250

Koc source
assume like DCE
COE SVE
COE SVE
assume like VC
COE SVE
COE SVE
COE SVE

Volume of water, in gallons, from earlier calculation, is:
460,000

Foc: 0.02
Soil density, g/cm³ 1.54
porosity 0.42

mass = vol water/porosity * bulk density * Cs * conversion factors.

Tetra Tech, Inc.		STANDARD CALCULATION SHEET	
CLIENT: Lockheed	FILE No: N1075	BY: JWL	PAGE: 1 of 1
SUBJECT: American Beryllium - IRAP – Estimate of injection points		CHECKED BY:	DATE: 09/16/04

Purpose: Estimate number of injection points.

Assumptions

Radius of influence of each injection point: 15 feet (typical), but the recommended spacing is 20 feet, for an effective ROI of 10 feet

Area of injection point: $20^2 = 400 \text{ ft}^2$

Calculation

Area East Plume = $14,700 \text{ ft}^2$

Number of injection locations:

East Plume: $14,700 \text{ ft}^2 / 400 \text{ ft}^2 = 36 \text{ points}$

Multiple depths are typically needed. Using 2 depths, total number of injection points is:

East Plume: $2 \times 36 \text{ points} = 72$

A Preliminary Estimate was obtained from Geo-Cleanse International. Based on their preliminary estimate, the following number of injectors:

East Plume: 70 (includes pilot area.)

These values will be used in other calculations.