REMEDIATION SYSTEM EVALUATION

ELISKIM FACILITY
ANDERSON COUNTY, SOUTH CAROLINA

Report of the Remediation System Evaluation,
Site Visit Conducted at the Eliskim Facility, Anderson County, South Carolina
April 29, 2003

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Remediation System Evaluation
Eliskim Facility
Anderson County, South Carolina

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NOTICE AND DISCLAIMER

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This report has undergone review by the EPA site managers and EPA headquarters staff. For more infomation about this project, contact: Mike Fitzpatrick (703-308-8411 or fitzpatrick.mike@epa.gov) or Kathy Yager (617-918-8362 or yager.kathleen@epa.gov).

EXECUTIVE SUMMARY

A Remediation System Evaluation (RSE) involves a team of expert hydrogeologists and engineers, independent of the site, conducting a third-party evaluation of site operations. It is a broad evaluation that considers the goals of the remedy, site conceptual model, above-ground and subsurface performance, effectiveness in protecting human health and the environment, and site exit strategy. The evaluation includes reviewing site documents, visiting the site for up to 1.5 days, and compiling a report that includes recommendations to improve the system. Recommendations, including estimates of resulting net cost impacts, are provided in the following four categories:

- improvements in remedy effectiveness in protecting human health and the environment
- reductions in operation and maintenance costs
- technical improvements
- gaining site closeout

The recommendations are intended to help the site team (the responsible party and the regulators) identify opportunities for improvements. In many cases, further analysis of a recommendation, beyond that provided in this report, might be needed prior to implementation of the recommendation. Note that the recommendations are based on an independent evaluation by the RSE team, and represent the opinions of the RSE team. These recommendations do not constitute requirements for future action, but rather are provided for the consideration of all site stakeholders.

The Eliskim site is a closed hazardous waste management facility located approximately one mile south of Anderson, South Carolina. The original facility consisted of approximately five acres of property used as an impoundment area (ponds and lagoons) for hazardous waste management associated with a plant originally owned by True Temper that was located on an adjoining parcel. An additional 20 acres east of the Impoundment Area was purchased as part of the ground water remediation. Contaminated ground water is extracted from a ground water collection trench near the toe of the plume and from a single well in the source area. The extracted water is treated with an air stripper and then discharged to surface water. The South Carolina Department of Health and Environmental Control (DHEC) is operating the remedy with funds from a performance surety bond that was set aside when the Eliskim facility filed for bankruptcy.

The RSE team observed a well-maintained remedy. The observations and recommendations contained in this report are not intended to imply a deficiency in the work of either the system designers or operators but are offered as constructive suggestions in the best interest of the EPA, the public, and the facility. These recommendations have the obvious benefit of being formulated based upon operational data unavailable to the original designers.

Recommendations are provided in all four categories: effectiveness, cost reduction, technical improvement, and site closeout. The recommendations to improve effectiveness include the following:

- Ground water contamination should be delineated vertically in three areas of the plume. If substantial contamination is found at depth, additional characterization efforts may be required to better understand ground water flow and contaminant transport at these greater depths and to determine if capture offered by the BP trench is sufficient.

- When developing potentiometric surface maps for analyzing plume capture, the water levels from the observation wells within the trench should be used and the water levels from the operating extraction wells should not be used.

- DHEC should proceed as planned to install a fence around the downgradient property.

- The properties downgradient of the site along Beaver Creek should be contacted to determine if any of them have operating wells. If wells are identified they should be sampled for VOCs.

- Institutional controls should be implemented to notify potential future property owners of the site contamination.

The only recommendation for cost reduction is to reduce sampling and analysis. Analysis of SVOCs and Appendix IX parameters, beyond VOCs and metal contaminants of concern, should be eliminated from the sampling program, semi-annual sampling should be reduced to annual sampling, and toxicity analyses of the treatment plant effluent should be eliminated. This recommendation, if implemented could result in savings as high as $24,000 per year.

The remaining recommendations pertain to technical improvement and site closeout. Notable recommendations include developing annual reports to summarize system performance, conducting an investigation to determine if the roto pond is acting as a continuing source of ground water contamination, implementing targeted remediation, and investigating alternative investment options.

A table summarizing the recommendations, including estimated costs and/or savings associated with those recommendations, is presented in Section 7.0 of this report.

PREFACE

This report was prepared as part of a pilot project conducted by the United States Environmental Protection Agency (USEPA) Office of Solid Waste (OSW) and Technology Innovation Office (TIO). The objective of this project is to conduct Remediation System Evaluations (RSEs) of pump and treat systems under the Resource Conservation and Recovery Act. The following organizations are implementing this project.

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1.0 INTRODUCTION

1.1 PURPOSE

During fiscal years 2000, 2001, and 2002 Remediation System Evaluations (RSEs) were conducted at 24 Fund-lead pump and treat (P&T) sites (i.e., those sites with pump and treat systems funded and managed by Superfund and the States). Due to the opportunities for system optimization that arose from those RSEs, EPA TIO and OSW are performing a pilot study of conducting RSEs at RCRA sites. During fiscal year 2003, RSEs at up to 5 RCRA sites are planned in an effort to evaluate the effectiveness of this optimization tool for this class of sites. GeoTrans, Inc., an EPA contractor, is conducting these evaluations, and representatives from EPA OSW and TIO are attending the RSEs as observers.

The Remediation System Evaluation (RSE) process was developed by the US Army Corps of Engineers (USACE) and is documented on the following website:

http://www.environmental.usace.army.mil/library/guide/rsechk/rsechk.html

A RSE involves a team of expert hydrogeologists and engineers, independent of the site, conducting a third-party evaluation of site operations. It is a broad evaluation that considers the goals of the remedy, site conceptual model, above-ground and subsurface performance, effectiveness in protecting human health and the environment, and site exit strategy. The evaluation includes reviewing site documents, visiting the site for 1 to 1.5 days, and compiling a report that includes recommendations to improve the system. Recommendations with cost and cost savings estimates are provided in the following four categories:

- improvements in remedy effectiveness in protecting human health and the environment
- reductions in operation and maintenance costs
- technical improvements
- gaining site closeout

The recommendations are intended to help the site team (the responsible party and the regulators) identify opportunities for improvements. In many cases, further analysis of a recommendation, beyond that provided in this report, might be needed prior to implementation of the recommendation. Note that the recommendations are based on an independent evaluation by the RSE team, and represent the opinions of the RSE team. These recommendations do not constitute requirements for future action, but rather are provided for the consideration of all site stakeholders.

The Eliskim facility was selected by EPA OSW based on a nomination provided by the South Carolina Department of Health and Environmental Control (DHEC). This report provides a brief background on the site and current operations, a summary of the observations made during a site visit, and recommendations for changes and additional studies. The cost impacts of the recommendations are also discussed.

1.2 TEAM COMPOSITION

The team conducting the RSE consisted of the following individuals:

Peter Rich, Civil and Environmental Engineer, GeoTrans, Inc.
Doug Sutton, Water Resources Engineer, GeoTrans, Inc.

Rob Greenwald, a hydrogeologist from GeoTrans, also contributed to the analysis conducted by the RSE team. Guy Tomassoni from EPA OSW attended the RSE site visit to observe the RSE process.

1.3 DOCUMENTS REVIEWED

Author	Date	Title
Condor	2003	Estimated 6-month costs
DHEC	2003	Historical water level data
Condor/Rogers and Callcott	2002	Ground Water Analytical Data September 2002
Condor/Rogers and Callcott	2001	Ground Water Analytical Data, September 2001
CEC Consultants	2/28/01	Annual Monitoring Report for the Year 2000
CEC Consultants	2/28/01	Engineer's Construction Certification Report
SC DHEC	3/24/99	Permit Number SCD 003 342 938
CEC Consultants	8/98	Toxicity Evaluation Plan Status Report for Treated Groundwater and Surface Water at the Eliskim, Inc, Facility
CEC Consultants	9/19/97 (revised 11/10/99)	Post-Closure Permit Renewal Application, Eliskim, Inc. - Anderson, S.C. - Volume I, Sections I through VII
CEC Consultants	9/19/97	Agency Review Draft Resubmittal, Post-Closure Permit Renewal Application, Eliskim, Inc., Anderson, S.C. - Volume II, Sections VIII through X
Remcor, Inc	12/89	Results of Groundwater Corrective Action Studies and Corrective Action Plan
Remcor, Inc.	9/87	Report of the Roto Pond Investigation and Groundwater Quality Assessment Plan

1.4 PERSONS CONTACTED

The following individuals associated with the site were present for the visit:

Cynde Devlin, SCDHEC - Project Manager
Ken Taylor, SCDHEC - Director, Divsion of Hydrogeology
Joe Bowers, SCDHEC - Manager, RCRA Hydrogeology
Eddie Clements, SCDHEC - Hydrogeologist
Jon Batson, SCDHEC - Hydrogeologist
Sam Weaver, Condor Environmental - Manager
Mike Wilson, Condor Environmental - Operator

1.5 SITE LOCATION, HISTORY, AND CHARACTERISTICS

1.5.1 LOCATION

The Eliskim site is a closed hazardous waste management facility located approximately one mile south of Anderson, South Carolina. Key land parcels are illustrated on Figure 1-1. The original facility (the "Impoundment Area") consisted of approximately five acres of property with ponds and lagoons used for hazardous waste management associated with a plant originally owned by True Temper that was located on an adjoining parcel. The plant was sold to Emhart Corporation in 1985, and is currently operating as a truck depot. An additional 20 acres east of the Impoundment Area (the "Downstream Area") was purchased as part of the ground water remediation. A ground water collection trench and a treatment plant are located on this 20-acre parcel. The property north, east, and south of the Downstream Area is owned by Mr. Joseph Nehme (the "Nehme Property"), and that property contains several monitoring wells that are monitored and are accessible under access agreements.

The closed hazardous waste management units form the highest portion of the site (due to the capping), approximately 25 ft above the surrounding areas. The surrounding area is wooded, with some farms and pastures.

As illustrated on Figure 1-1, two drainage ditches channel runoff from the former True Temper plant property and the capped area to form the unnamed tributary to Beaver Creek. Beaver Creek is located approximately 2,000 feet northeast of the original 5-acre facility.

1.5.2 POTENTIAL SOURCES

Prior to 1977, four unlined lagoons were used for the collection of process wastes, as follows:

- an impoundment for electroplating wastewater
- two ponds for collection of waste fiberglass sludge
- a "roto pond" for collection of polishing grit slurries

The waste treatment area was reconfigured in 1977 to comply with then-new RCRA requirements. The former roto pond was taken out of service, backfilled with soil and sludges, and graded. The other three impoundments were replaced with two lined electroplating waste impoundments, plus four lined settlement ponds that were constructed for fiberglass settling. The two electroplating waste impoundments were removed from service in 1983, and the impounded liquids and solids were removed offsite. The remaining hazardous waste management units were removed from service in 1986, and were formally closed in October 1988 in accordance with RCRA requirements. Metals-contaminated soils from the surrounding area were excavated and placed in the lined ponds. Soils and sludges from the former roto pond area were aerated to reduce TCE concentrations to below 1 mg/kg and placed over other soils. The soils were then graded and covered with a cap that included a synthetic liner.

During the RSE site visit, site managers indicated that the former roto pond might represent a continuing source of TCE impacts to ground water. A 1987 investigation of the roto pond by Remcor indicated the presence of a black sludge 10.5 to 12 feet below grade with TCE concentrations as high as 30,000,000 ug/kg (3%). Concentrations below this depth were lower (13 ug/kg), but at 13.5 to 15.0 feet below grade in another location, the TCE concentration was as high as 22,800 ug/kg. The site documents do not clearly indicate the manner in which the other three pre-1977 ponds were closed when they were replaced, but ground water concentrations in wells near the other original ponds (e.g., W-9, W-10, W-11) are not highly impacted by TCE relative to ground water near the former roto pond (e.g., W-1, W-2). It is unclear if the material in the former roto pond continues to act as a source of ground water contamination or if the majority of contaminant mass has already leached from the pond and reached ground water.

Ground water TCE concentrations in 1989 were over 10,000 ug/L in both W-1 and W-1D. These concentrations have since declined, but it should be noted that EPA uses contaminant concentrations at or greater than 1% of the solubility (approximately 10,000 ug/L for TCE) as a general indicator of non-aqueous phase liquid (NAPL) in the vicinity of a well. Therefore, these 1989 elevated concentrations in W-1 and W-1D may be indicative of NAPL. Sampling since 1989 in these and other surrounding wells suggests that TCE concentrations are consistently lower than 10,000 ug/L but above 1,000 ug/L. While these concentrations are below the 1% solubility level, they are still relatively elevated after many years, indicating a continuing source of dissolved contamination in the area. The fact that no wells have concentrations over the 1% solubility limit does not preclude the presence of NAPL, since the concentration is dependent on sample location.

1.5.3 HYDROGEOLOGIC SETTING

The site is located in the Piedmont physiographic province. Bedrock beneath the site is a biotite gneiss which is overlain by overburden (saprolite which grades from weathered bedrock to silty clay and clayey silt). The contact between competent bedrock and overburden is not well defined. Competent bedrock has been observed onsite at depths ranging from 10 to 51 feet, and at depths up to 88 feet beneath areas along the unnamed tributary. A geologic cross-section is shown in Figure 1-2, and the location of that cross-section is indicated on Figure 1-1.

The water table occurs in the overburden, at depths that ranged from 4 feet below ground surface to 42 feet below ground surface in 2000. Ground water in the overburden generally flows to the northeast (towards Beaver Creek), with some shallow discharge of ground water into the unnamed tributary. Base flow in the unnamed tributary is approximately 100 to 200 gpm. Ground water in the bedrock flows along joints, fractures, and openings along foliation planes (these features decrease with depth).

Based on aquifer testing performed by Remcor, Inc., the transmissivity of the overburden ranges from 2,000 to 2,400 gpd/ft, and Remcor estimated the transmissivity of the shallow bedrock between 2,900 and 3,600 gpd/ft.

The ground water collection trench constructed as part of the ground water remedy forms a dam across the unnamed tributary, allowing surface water to be collected and treated in the treatment system. This surface water collection system has sufficient capacity to treat all of the water typically flowing in the unnamed tributary. This system has been able to collect and treat all of the surface water in all but one or two instances since the system became operational.

1.5.4 POTENTIAL RECEPTORS

Existing residential communities are located approximately 2,000 feet north and south of the site and approximately 5,000 feet to the northeast along Beaver Creek. It is believed that these residences are on public water but the RSE team was unable to determine from the document review and the RSE site visit if any of the properties had wells.

The unnamed tributary to Beaver Creek receives discharge from shallow ground water, and is therefore a potential receptor as is Beaver Creek.

The Nehme property may potentially be developed in the future. During the RSE site visit, the DHEC indicated that the most current plan was to use the property for a landfill.

1.5.5 DESCRIPTION OF GROUND WATER PLUME

Ground water impacted by volatile organic chemicals (VOCs) has migrated beyond the 5-acre parcel where the former impoundments were located. The dominant contaminant is trichloroethene (TCE). The areas with the greatest TCE concentration are the impoundment area (W-2 and W-7D), the western portion of the "downgradient area" (OS-4, OS-5, and OS-5D), and the area immediately upgradient of the recovery trench (OS-8 and OS-8D). TCE was historically detected in the unnamed tributary at concentrations over 100 ug/L and in Beaver Creek at concentrations under 20 ug/L. Surface water sampling from 2000, 2001, and 2002 indicate that TCE is no longer detectable in Beaver Creek.

The depth of VOC contamination has not been defined below OS-5D and OS-8D. Vertical delineation may also be incomplete near W-7D.

Nickel has also been found above the ground water protection standard, but these elevated nickel concentrations appear limited to the former impoundment area. The highest dissolved nickel concentration is 6.8 mg/L in W-2. Nickel concentrations in downgradient wells are either below standards or slightly above standards. For example, in OS-5 the dissolved nickel concentration is 0.17 mg/L compared to the standard of 0.1 mg/L.

2.0 SYSTEM DESCRIPTION

2.1 SYSTEM OVERVIEW

The P&T system became operational October 31, 1997. The ground water extraction system consists of one extraction well near the former roto pond and a collection trench for ground water and surface water that includes three extraction wells. The ground water is treated with an air stripper, with discharge of treated water to Beaver Creek approximately 850 feet east of the treatment plant.

2.2 EXTRACTION SYSTEM

The extraction portion of the system consists of four extraction wells. Three of the extraction wells are completed in a ground water collection trench, and the fourth is located approximately 1,100 feet upgradient near the roto pond. The trench is 250 feet long and is referred to as the BP trench because the original design of the trench included using a bio-polymer to stabilize the trench during construction. The trench is approximately 65 feet deep (installed to the top of bedrock or 70 feet, whichever is shallower). The 3 extraction wells are 8 inches in diameter and are completed 3 feet into the top of bedrock (approximately 65 feet below ground surface). Each of the three wells has a 3-HP Grundfos submersible pump capable of pumping about 75 gpm. The fourth extraction well (EW-4), located in the roto pond area, is 8 inches in diameter and is approximately 23 feet deep. It has a 0.5HP Grundfos electric submersible and can pump up to about 10 gpm.

The unnamed tributary to Beaver Creek is dammed just upgradient from the ground water collection trench. The surface water impoundment is interconnected with the trench so that surface water is pumped into the treatment system. In extremely high precipitation events the surface water will flow over a spillway and not be treated if the capacity of the trench is exceeded. This has occurred only once or twice since the system became operational in 1997.

The extraction pumps run based on amperage settings and transducer settings and combined have an average pumping rate of approximately 65 gpm. However, this extraction rate may be higher during periods of rain or lower during droughts. For the extraction wells in the trench, pump controls are interconnected to maintain a pumping rate that matches the trench infiltration rate. The transducer settings have not been adjusted since system start-up and it is unclear what those settings are. Extraction piping is double contained HDPE with observation sumps and sensors. Each well is piped separately to the treatment building.

2.3 TREATMENT SYSTEM

The treatment system includes:

- A Northeast Environmental Products (NEEP) Shallow-Tray Air Stripper model 31241. This unit has a 15 HP blower and 4 trays. It is rated for 6 to 425 gpm and provides 99.7% removal of TCE at 250 gpm and 50 degree F air and water temperature.

- Appropriate failsafes are present, including building containment with a sump and water sensor, building security and building temperature, air stripper high and low pressure sensor and an air stripper sump high water level sensor. These sensors shut off the treatment system (except the building security and temperature sensors) and activate an autodialer.

- A totalizing flow meter.

Treated water is discharged to Beaver Creek in accordance with an NPDES permit originally issued on October 11, 1995 (it was reported that the permit was renewed on August 1, 2002). The permit requires monthly analysis of select VOCs, total suspended solids and metals, and weekly flow measurements. The TCE discharge limit is 9 ug/l as a monthly average. Final construction approval for the system was issued on November 14, 1997. This approval required weekly system inspections and allowed a discharge flow rate of 1.3 million gallons per day (~900 gpm). No vapor treatment for the air stripper was required when the system was installed due to a waiver of air permitting requirements issued by DHEC on June 11, 1996.

2.4 MONITORING PROGRAM

The monitoring program consists of:

- ground water sampling
- surface water sampling
- treatment system process monitoring

Each is briefly described below.

Ground Water Sampling

Ground water elevations are collected from all monitoring wells and piezometers on a quarterly basis. The required parameters for site monitoring and their ground water protection standards are discussed in Section 3.1 of this report. The sampling locations, constituents, and frequencies for the ground water monitoring program are summarized in Table 2-1 and are indicated in the Post-Closure Care Hazardous Waste Permit.

Surface Water Sampling

Surface water samples are collected quarterly from four surface water locations. Location SW-A monitors contaminant concentrations in surface water diverted from the unnamed tributary to the treatment system. SW-B was located along the unnamed tributary downgradient of the diversion into the treatment plant but has been relocated to Beaver Creek and has been renamed SW-E. SW-C is located in Beaver Creek, upstream of the confluence with the unnamed tributary. SW-D is located in Beaver Creek, downstream of the confluence with the unnamed tributary.

Treatment System Process Monitoring

Treatment plant influent and effluent are sampled monthly. In addition, Whole Effluent Toxicity (WET) tests are performed bimonthly.

Table 2-1. Sampling Locations, Constituents, and Frequency

Well	Constituents	Frequency
W-1	Appendix IX	Annually
W-1D	Appendix IX	Annually
W-2	Section 3.1	Semi-annually
W-3	Section 3.1	Semi-annually
W-5	Section 3.1 without N-Nitrosomorpholine	Semi-annually
W-7D	Section 3.1	Semi-annually
W-8	Section 3.1	Semi-annually
W-9	Section 3.1	Annually
W-10	Section 3.1	Annually
W-11	Section 3.1	Annually
MW-11	Section 3.1	Annually
MW-66	Section 3.1	Annually
OS-1	Section 3.1 without N-Nitrosomorpholine	Semi-annually
OS-4	Section 3.1 without N-Nitrosomorpholine	Semi-annually
OS-5	Section 3.1 without N-Nitrosomorpholine	Semi-annually
OS-5D	Section 3.1	Semi-annually
OS-6	Section 3.1 without N-Nitrosomorpholine	Semi-annually
OS-7	Section 3.1 without N-Nitrosomorpholine	Semi-annually
OS-8	Appendix IX	Annually
	Section 3.1 without N-Nitrosomorpholine	Semi-annually
OS-8D	Section 3.1	Semi-annually
OS-10	Section 3.1 without N-Nitrosomorpholine	Semi-annually
OS-12	Section 3.1 without N-Nitrosomorpholine	Semi-annually
OS-13	Section 3.1 without N-Nitrosomorpholine	Semi-annually
OS-14	Section 3.1	Semi-annually

Section 3.1 refers to those parameters listed in Section 3.1 of this report.

3.0 SYSTEM OBJECTIVES, PERFORMANCE AND CLOSURE CRITERIA

3.1 CURRENT SYSTEM OBJECTIVES AND CLOSURE CRITERIA

According to the DHEC permit (SCD 003 342 938) from 1999, "the Permitee shall ensure that the Ground Water Protection Standard (GWPS), as required under R.61-79.264.92, is being met or that remedial actions are being taken to reduce contaminant levels to meet standards". The implied objective is therefore cleanup. The ground water cleanup levels provided in Table 1 of Module IV of that document are as follows:

Parameter	Concentration Limit	Basis
Chromium	0.1 mg/l	MCL
Cobalt	0.2 mg/l	Region III RBC
Nickel	0.1 mg/l	MCL
Zinc	11 mg/l	Region III RBC
Acetone	370 ug/l	Region III RBC
Chloroethane	3.6 ug/l	Region III RBC
Methylene Chloride	5.0 ug/l	MCL
1,1-Dichloroethane	80 ug/l	Region III RBC
1,1-Dichloroethene	7 ug/l	MCL
cis-1,2-Diclororethene	70 ug/l	MCL
trans-1,2-dichloroethene	100 ug/l	MCL
1,4-dioxane	6.1 ug/l	Region III RBC
Ethylbenzene	700 ug/l	MCL
Methyl Ethyl Ketone	190 ug/l	Region III RBC
N-Nitrosomorpholine	PQL	PQL
Toluene	1000 ug/l	MCL
1,1,1-Trichloroethane	200 ug/l	MCL
Trichloroethene	5 ug/l	MCL
Vinyl Chloride	2 ug/l	MCL

MCL = Maximum Contaminant Level
PQL = Practical Quantitation Limit
RBC = Risk Based Concentration

3.2 TREATMENT PLANT OPERATION STANDARDS

Appendix A-2 of the Engineers Certification Report (CEC, 2001) has the NPDES permit standards. The following requirements pertain to treatment plant effluent:

Parameter	Average Monthly	Daily Maximum	Measurement Frequency	Sample Type
Flow Rate	Report	Report	weekly	Estimated
BOD5	Report	Report	monthly	24-hr composite
TSS	10 mg/l	20 mg/l	monthly	24-hr composite
Chromium III (total)	0.59 mg/l	4.89 mg/l	monthly	24-hr composite
Chromium VI (total)	0.06 mg/l	0.089 mg/l	monthly	grab
Cobalt (total)	0.11 mg/l	0.23 mg/l	monthly	24-hr composite
Copper (total)	0.018 mg/l	0.026 mg/l	monthly	24-hr composite
Nickel (total)	0.18 mg/l	0.37 mg/l	monthly	24-hr composite
Zinc (total)	0.208 mg/l	0.229 mg/l	monthly	24-hr composite
1,1-Dichloroethane	2.39 mg/l	4.79 mg/l	monthly	grab
1,1-Dichloroethylene	0.013 mg/l	0.026 mg/l	monthly	grab
Trans-1,2-Dichloroethene	0.13 mg/l	0.27 mg/l	monthly	grab
Ethylbenzene	0.38 mg/l	0.76 mg/l	monthly	grab
1,1,1-Trichloroethane	0.21 mg/l	0.42 mg/l	monthly	grab
Trichloroethene	0.009 mg/l	0.018 mg/l	monthly	grab
Vinyl Chloride	0.003 mg/l	0.007 mg/l	monthly	grab

Toxicity tests are performed using 7-day chronic renewal tests using *Ceriodaphnia dubia* as the test organism, and are performed in accordance with "Short Term Methods For Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" (EPA/600/4-91/002). If any test results indicate a significant difference between the control and the in-stream waste concentration at the 95% confidence level, the results must be submitted to DHEC, and an additional sample can be optionally be taken and results submitted to DHEC for their consideration.

4.0 FINDINGS AND OBSERVATIONS FROM THE RSE SITE VISIT

4.1 FINDINGS

The RSE team observed a well maintained system. The observations provided below are not intended to imply a deficiency in the work of the system designers, system operators, or site managers but are offered as constructive suggestions in the best interest of the EPA and the public. These observations obviously have the benefit of being formulated based upon operational data unavailable to the original designers. Furthermore, it is likely that site conditions and general knowledge of ground water remediation have changed over time.

The most recent data analysis report was the "Annual Monitoring report for the Year 2000" by Civil & Environmental Consultants, Inc. (CEC) dated February 28, 2001. This report addresses hydraulic gradient, concentration trends and treatment system performance. No formal O&M reports have been prepared since that time.

4.2 SUBSURFACE PERFORMANCE AND RESPONSE

4.2.1 WATER LEVELS

Water levels consistently show ground water flow in both the shallow and deeper portions of the aquifer toward Beaver Creek. Based on the "Annual Monitoring Report For the Year 2000" by CEC, ground water flow in the Impoundment Area is to the east northeast, with a hydraulic gradient magnitude of 0.03 feet per foot for the shallow zone and 0.02 to 0.03 feet per foot for the deep zone. Pumping at well EW-4 causes a localized cone of depression in that area. For the Downstream Area, CEC reports that ground water in the shallow and deep zones flows to the northeast towards the ground water collection trench, with a hydraulic gradient magnitude of about 0.04 feet per foot in both the shallow and deep zones.

The historical data do not indicate significant seasonal trends in the water levels, but the water levels do vary between relatively dry and relatively wet years. The winters of 1998 and 2003 appear to be the years where the water levels were highest. Potentiometric surface maps were last generated for the water level measurements collected in 2000.

4.2.2 CAPTURE ZONES

It is likely that the BP trench pumping is providing hydraulic containment over the width and depth of the plume, preventing further migration to Beaver Creek and downgradient ground water. However, adequate information is not available to easily confirm this. TCE contamination above 2,000 ug/L is present in OS-8D and no additional monitoring points are installed lower than this to vertically delineate the plume. In addition, the wells downgradient of the BP trench are too far from the trench to show an inward gradient, and the extraction well levels are used to draw the capture zone rather than the observation (non-pumping) wells within the trench. The absence of VOC detections in downstream surface water and the downward trend in VOC concentrations at OS-13 (a downgradient well beyond the capture zone) from over >100 ug/l in 2000 to 65 and 43 ug/l in 2001 and 2002 is a good indication of capture but other lines of evidence should be used.

With the following assumptions, a simple water budget analysis suggests that the width of the capture zone is 520 ft.

- transmissivity (T = 3,000 gpd/ft)
- background gradient (I = 0.04 ft/ft)
- pumping rate (Q = 65 gpm)
- factor of safety (generally between 1.5 and 2.0) to account for additional ground water contributions from recharge, surface water, or underlying formations (F = 1.5)

$$W = \frac{Q}{F \times T \times i} \times (\text{conversion factors})$$

$$W = \frac{65 \text{ gpm}}{1.5 \times 3{,}000 \text{ gpd / ft} \times 0.04 \text{ ft / ft}} \times \left(\frac{1440 \text{ minutes}}{1 \text{ day}} \right) = 520 \text{ ft}$$

This estimated width is approximately the width of the property at the location of the BP trench. This width may or may not be enough to capture all contamination. Although OS-10 had undetectable VOC concentrations in 2002, OS-7 had a TCE concentration of 240 ug/L in 2002. OS-7 is located at the edge of the property boundary approximately 500 feet upgradient of the trench where the property is wider than 500 feet. However, the greater uncertainties associated with this type of calculation are with the transmissivity estimate and the assumptions made about the aquifer thickness.

Historically, VOC impacted ground water likely migrated under Beaver Creek downgradient from OS-13. The extent of impact has not been defined and assuming extraction system capture is adequate, any impacts beyond OS-13 are likely degrading. However, there are residences along Beaver Creek about 1,500 feet downgradient of OS-13. These residences should be checked for the presence of wells. If wells are present, they should be sampled, and future site remediation should consider these potential downgradient receptors.

4.2.3 CONTAMINANT LEVELS

The concentrations from three areas are of particular interest:

- the source area (W-1, W-2, W-5, W-7D, and others)
- the area immediately upgradient of the trench (OS-8 and OS-8D)
- the area downgradient of the BP trench (OS-12 and OS-13)

The source area TCE concentrations have historically been as high as 14,000 ug/L (W-1D in 1989). Although the concentrations in W-1D have decreased to under 100 ug/L (96 ug/L in February 2000 and 74 ug/L in 2002), the TCE concentrations in many of the other source area wells (W-1, W-2, and W-7D) have remained elevated well above 1,000 ug/L. Pumping in this area from EW-4 has occurred, but has likely been too limited to determine if pumping could significantly improve water quality in this area. The persistent concentrations could potentially be due to a continuing source, such as DNAPL in the bedrock and/or residual contamination in the roto pond sludge or to lack of attenuation from flushing or degradation.

Persistent contamination in bedrock is also apparent offsite upgradient of the BP trench. TCE concentrations in OS-8 and OS-8D have also remained above 2,000 ug/L. OS-8 screens the saprolite and OS-8D screens the fractured bedrock and the underlying, apparently more competent bedrock. These persistent concentrations suggest the potential for either a continuing source, continued contaminant transport from upgradient, or lack of attenuation due to flushing or degradation. The persistent concentrations in the source area and this area over a 10-year time period demonstrates that the remedy, in its current form, will not likely restore the aquifer in a reasonable time frame (i.e., within approximately 30 years).

The decreasing concentrations in OS-13 suggest that the BP trench has been effective at limiting the continued migration of VOCs under Beaver Creek. Further monitoring at this location will help confirm to what degree this migration has been limited. If concentrations in OS-13 continue to decrease below MCLs, it is likely the plume capture at this depth interval is complete. The increasing TCE concentrations at OS-12 (from undetectable in both 2000 sampling events to 28 ug/L in 2001 and 400 ug/L in 2002) suggest that OS-12 might be in the capture zone of the BP trench and that contaminated water that once continued to migrate beneath or around OS-12 is now drawn by OS-12 on its way to the BP trench. In previous sampling (May 1993), OS-12 had a concentration of 11 ug/L, which is much lower than the 400 ug/L detected in 2002.

Ground water sampling has detected cis-1,2-Dichloroethene (DCE) in multiple locations, including the source area and OS-8. This is a strong indication that reductive dechlorination is taking place; however, the persistently elevated TCE concentrations and the comparatively low DCE concentrations indicate that natural dechlorination will not add substantially to the site remediation. It could, however, play a larger role if it is enhanced.

4.3 COMPONENT PERFORMANCE

4.3.1 EXTRACTION SYSTEM WELLS AND PUMPS

The 2000 Annual Report stated that the average pumping rate was about 52.5 gpm, which was higher than the flow meter indicated due to problems with the flow meter. During the RSE visit the average flow rate was reported to be approximately 65 gpm. Fouling of the wells and the pumps has not been observed. Extraction from EW-4 remains relatively low (approximately 5 gpm) as expected.

4.3.2 TREATMENT SYSTEM - AIR STRIPPER

$$\frac{65\text{ gal.}}{\text{min.}} \times \frac{3.785\text{ L}}{\text{gal.}} \times \frac{350\text{ ug.}}{\text{L}} \times \frac{1440\text{ min.}}{\text{day}} \times \frac{2.2\text{ lbs.}}{1 \times 10^{9}\text{ ug}} = \frac{0.27\text{ lbs.}}{\text{day}}$$

The treatment system VOC influent concentration in 2000 was approximately 350 ug/L, and the influent concentration has not changed significantly since then. Given a flow rate of 65 gpm this influent concentration translates to a mass removal rate of approximately 0.27 pounds per day. Although fouling of the air stripper has not been a problem, it is cleaned annually and easily meets the discharge criteria of 9 ug/L.

4.4 REMEDY COSTS AND COMPONENTS OR PROCESSES THAT ACCOUNT FOR MAJORITY OF COSTS

The State is operating the site with funds from a performance surety bond set aside prior to the facility's reorganization under bankruptcy laws. The original bond was for approximately $1.6 million, but expenses to date have reduced that value to approximately $1.3 million. According to DHEC, these funds are in a trust managed by the Bank of New York in Florida, and investment options are apparently limited to federally insured interest accounts. If remediation is not completed with these funds, the State will likely pursue the use of other cleanup authorities, including the Federal Superfund program, to address the site.

At the time of the RSE site visit, a long-term contract for system O&M was out for bid. After that visit, and prior to the completion of this report, the bid was awarded. The estimated annual cost for O&M under this contract are as follows. Reporting is not included in these costs because DHEC has maintained responsibility for the reporting.

Item Description	Estimated Cost	% of Total Costs
Labor: system operation and grounds maintenance	$31,000	36%
Labor: ground water sampling and well gauging	$7,600	9%
Utilities: Electric and phone	$8,000	9%
Analysis: NPDES monitoring (includes actual sampling and reporting)	$9,300	11%
Analysis: Groundwater and surface water monitoring (includes QA/QC)	$30,700	35%
Total Estimated Cost	**$86,600**	**100%**

4.4.1 UTILITIES

The utilities are largely driven by the 15 HP blower for the air stripper. Other items that contribute are the pumps in the extraction wells. The three extraction wells in the trench each have 3 HP pumps, but they do not operate continuously. The 0.5 HP pump in EW-4 likely contributes little to the overall electrical costs. The phone only costs approximately $250 per year.

4.4.2 LABOR

Labor associated with the operation of the pump and treat system and grounds includes weekly visits to the air stripper, annual cleaning of the air stripper, monthly maintenance of the vegetative cover, lawn mowing, and the sampling associated with the ground water monitoring. The labor associated with sampling consists of the quarterly surface water sampling and semi-annual and annual ground water sampling.

4.4.3 CHEMICAL ANALYSIS

Chemical analysis comprises over 40% of the total annual costs for the remedy. Of those costs, approximately 75% are associated with the analysis of ground water samples. The unit cost for analyzing all GWPS constituents is $610 per sample. Of that $610, the SVOC analysis costs $370. Analysis of Appendix IX parameters costs approximately $1,350 per sample. The remaining 25% of the total costs for chemical analysis is for the NPDES permit, including the toxicity testing.

4.5 Recurring Problems or Issues

Trespassing is a recurring issue. During the site visit, the plant operator provided anecdotal evidence of gunshots and vandalism. There is no fence surrounding the property. Staff wear fluorescent, reflective vests to remain clearly visible while on site. DHEC plans to install a fence around the property to limit access to trespassers.

Lightning is another recurring issue. During the summer the system shuts down due to lightning up to 3 times per week.

4.6 Regulatory Compliance

The site has had a problem with the treatment plant effluent failing toxicity testing. The RSE team notes that, in their experience, toxicity testing is subject to notoriously random results. It is unusual for continuing regular toxicity testing to be required at a ground water treatment site, especially one where no chemicals are added. In our reviews of 24 Superfund Fund-lead sites and 3 RCRA sites we have not seen continuing toxicity testing requirements at more than five of the sites. Typically, effluent was tested once (or until passing results were achieved) and then toxicity testing requirements were eliminated.

4.7 Treatment Process Excursions and Upsets, Accidental Contaminant/Reagent Releases

No treatment process upsets or releases were reported during the site visit.

4.8 Safety Record

The facility has no reported health and safety incidents.

5.0 EFFECTIVENESS OF THE SYSTEM TO PROTECT HUMAN HEALTH AND THE ENVIRONMENT

5.1 GROUND WATER

Decreasing concentrations at OS-13 suggest that extraction from the BP trench is containing the plume. However, contamination has not been fully delineated vertically, and there might be the potential for contaminated ground water to leave the site at depth. Ground water has not been sampled beyond OS-13 and therefore it is not known how far contamination has extended beyond the property boundary. Residences are located downgradient along Beaver Creek, but it is not known if any of those residences have operating wells or have plans to install a well.

There are no institutional controls for the property in place to notify future owners of the contamination.

The contaminated ground water is reportedly one of the reasons the neighboring property owner has decided to use his property for a landfill rather than for developing a residential area.

5.2 SURFACE WATER

The unnamed tributary, which is formed by seeping ground water, is contaminated with TCE. The remedy effectively collects this water and treats it before discharging it to Beaver Creek. During the initial investigations Beaver Creek had TCE concentrations less than 20 ug/L. However, recent surface water sampling shows no detectable concentrations.

5.3 AIR

The site is undeveloped and there are no known complete exposure pathways for exposure to volatilizing VOCs.

5.4 SOILS

Soil contamination is likely present in the roto-pond area. These soils are covered and are not of concern for dermal exposure unless excavations occur. There are no deed restrictions on the property or notices with the local authorities regarding the site contamination.

5.5 WETLANDS AND SEDIMENTS

Wetlands associated with the unnamed creek are likely impacted. Wetlands and sediments associated with Beaver Creek have not been sampled, but the undetectable concentrations in surface water suggest that impacts, if present, would be minimal.

6.0 RECOMMENDATIONS

Cost estimates provided herein have levels of certainty comparable to those done for CERCLA Feasibility Studies (-30/+50%), and these cost estimates have been prepared in a manner consistent with EPA 540-R-00-002, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, July 2000.

6.1 RECOMMENDATIONS TO IMPROVE EFFECTIVENESS IN PROTECTING HUMAN HEALTH AND THE ENVIRONMENT

6.1.1 VERTICALLY DELINEATE THE TCE CONTAMINATION

Vertical delineation of TCE should be considered for three areas:

- the source area
- the area immediately upgradient of the BP trench (OS-8D)
- the area downgradient of the BP trench (OS-13)

Delineation in the source area would serve two purposes. First, it would help determine if contamination has the potential to migrate from the source area through the bedrock formation at depths that might not be sampled by the current program. There are deep wells in the source area that penetrate the bedrock. They are generally all installed to the same elevation, approximately 745 feet above mean sea level. The TCE concentrations in some of these deep wells were as high as 1,200 ug/L in 2002 (W-7D). Second, it would help in evaluating or planning source area remediation.

Monitoring well OS-8D is screened in the bedrock upgradient of the BP trench and had a TCE concentration of 2,100 ug/L in 2002. There are no monitoring points beneath OS-8D. If there is contamination below OS-8D, it is possible that it could migrate under the trench. Although decreasing TCE concentrations at OS-13 suggests that most contamination is captured, OS-13 is screened in the saprolite and might not intercept any contamination that is migrating offsite in the bedrock.

The RSE team recommends additional vertical delineation points in each of these three areas. The tops of the screened intervals of these new wells should be at least five feet lower than the bottom of the deepest well in each area. If contamination is found at depth, more information about regional ground water flow may be necessary to determine the extent of ground water contamination at depth, the degree of capture offered by the BP trench, and the potential need for further remediation. If necessary, relatively simplistic ground water flow modeling might be helpful in determining the vertical extent of the capture offered by the BP trench.

For costing, the RSE team estimates that the well in the source area would be 65 feet deep, the well near OS-8D would be 90 feet deep, and the well near OS-13 would be 105 feet deep. Drilling and surveying these wells with the appropriate reporting would likely cost approximately $25,000. Sampling them semi-annually for one year would cost approximately $2,200 for that year and sampling annually thereafter would cost approximately $1,100 per year. This assumes that the samples are analyzed only for GWPS VOCs and metals, not SVOCs or Appendix IX parameters.

6.1.2 USE BP TRENCH OBSERVATION WELLS FOR GENERATING POTENTIOMETRIC SURFACE MAPS

The potentiometric surface maps generated with the 2000 water level data used the water levels collected from operating extraction wells. As noted in Section 4.2.2, this may bias the potentiometric surface in favor of capture. Observation wells are completed within the trench. Water level data from these non-pumping well should be collected and used for generating the potentiometric surface maps instead of the water levels from the extraction wells. The resulting potentiometric surface map should then be analyzed to interpret the extent of the horizontal capture zone. This interpreted capture zone and a target capture zone should be drawn on the potentiometric surface map.

The costs associated with the analysis and reporting are included in Section 6.3.1. Collecting the water levels from the observation wells should not require any additional capital or annual costs.

6.1.3 IMPLEMENT PLANNED NEW FENCE

During the site visit DHEC indicated that they planned to install fencing around the downgradient property the encompasses the plume footprint. DHEC mentioned that the estimated capital cost is approximately $25,000. This would improve security and reduce trespassing and vandalism and therefore enhance the safety of site workers. The RSE team agrees with the need to install the fence.

6.1.4 DETERMINE IF RESIDENCES ALONG BEAVER CREEK HAVE ACTIVE WELLS

The RSE team recommends that DHEC determine if the residences along Beaver Creek have active supply wells. During the site visit DHEC noted that most, if not all, of the properties in that area are on public water. This should be confirmed, perhaps by a door to door well canvass. The RSE team estimates that the number of residences is likely less than 20 and that such a canvass could be conducted for under $5,000. If active wells are found, they should be sampled and the well records should be evaluated to determine the construction details. Abandonment of such wells might be necessary.

6.1.5 IMPLEMENT INSTITUTIONAL CONTROLS TO NOTIFY FUTURE PROPERTY OWNERS OF CONTAMINATION

Institutional controls should be in place with the County to notify any potential future property owners of the known ground water contamination and the contamination that was left in place in the roto pond. The RSE team estimates that this might cost $3,000 to work with the County in developing an appropriate notice. However, given the State-lead on the project, it is likely that this will be accomplished in-house by DHEC.

6.2 RECOMMENDATIONS TO REDUCE COSTS

6.2.1 CONSIDER REDUCING SAMPLING AND ANALYSIS

With regard to constituents and sampling frequency, the ground water contamination has been well characterized and some reductions could be made in the monitoring programs without compromising the effectiveness of the remedy. First, the sampling frequency could be reduced to annual as has been the practice for the past two years. Second, the SVOC analyses for N-Nitrosomorpholine could be eliminated. This constituent was never detected at the site in significant quantities and the 4 most recent sampling events have only shown two detections: one at the GWPS of 10 ug/L and another at 11 ug/L.

These low concentrations would be expected to decrease well below the GWPS as ground water flows toward the BP trench. Alternatively, if the SVOC analysis cannot be completely, eliminated, it could be reduced to the wells where the detections occurred (OS-2D and OS-4). Third, the Appendix IX parameters other than the VOC and metal contaminants of concern could likely be eliminated from the sampling. These parameters have not been detected at significant quantities and these analyses are not providing useful information to evaluate the system performance. EPA Headquarters has indicated that the State has significant discretion in revising the monitoring program without having to go through administrative steps.

The site team should also discuss eliminating the toxicity testing from the process monitoring. No chemicals are added during treatment of the water, and the effluent routinely meets the discharge standards for all constituents. Moreover, VOCs are removed by aeration, a process that would naturally occur as water in Beaver Creek flows down stream. In conducting RSEs at 24 Superfund Fund-lead sites and 3 RCRA sites around the country, the RSE team has not seen regular toxicity testing at this stage of remedy if chemicals are not added during the treatment process. At an EPA site in Massachusetts, toxicity testing is required quarterly, but this is because hydrogen peroxide is added during treatment. The Eliskim system has passed testing a number of times, and given potential interferences associated with the testing (see Chapter 13 of EPA 600-4-91-002) the occasional failed tests may not be due to the treatment process.

The RSE team estimates the following potential savings from implementing the above changes:

Item	Estimated Potential Annual Cost Savings
Eliminate semi-annual sampling event	$11,100 per year
Eliminate SVOCs and Appendix IV from annual sampling	$10,800 per year
Eliminate Bi-monthly toxicity testing	$2,100 per year
Total	**$24,000 per year**

6.3 MODIFICATIONS INTENDED FOR TECHNICAL IMPROVEMENT

6.3.1 PREPARE ANNUAL O&M REPORTS

The most recent data analysis report was the "Annual Monitoring Report for the Year 2000" by Civil & Environmental Consultants, Inc. (CEC) dated February 28, 2001. This report addresses hydraulic gradient, concentration trends, and treatment system performance. Reports should be produced on an annual basis so that the site status can be determined and reviewed. In addition, these reports will provide a basis for future decisions. The CEC report can be used as a model for the format of future reports but the number of large scale figures should be reduced. Most figures in the report should be no larger than 11x17. In addition to the contents of that report, annual reports should include the following items pertaining to system goals:

- the short-term and long-term remedy goals (cleanup, containment, or both)
- if both cleanup and containment are goals, the relative priority of each remedy goal

- the items to be measured to evaluate whether or not the goals are attained and/or if progress is being made with respect to those goals?

- conditions that must be met to terminate all (or some) of the P&T system

It should also include:

- extraction rates at each location (compare to historic values and design values)

- influent concentrations (compare to historic values and design values)

- effluent concentrations (compare to discharge criteria, historic values and design values)

The annual reports should also include a brief statement of the site conceptual models and any potential gaps associated with that site conceptual model, and should also include an interpretation regarding progress towards achieving remedy goals. Although DHEC maintains the responsibility for the reporting, it is unlikely that DHEC has the personnel resources to compile the reports. The O&M contractor or a consultant should be selected by DHEC to produce the report and potentially assist with other site administrative duties. The RSE team estimates that an annual report of this nature might cost $15,000 per year for a fairly detailed report. More streamlined annual reports may be produced for approximately $10,000 per year, once the initial report is completed and can be used as a template for future reports.

6.4 CONSIDERATIONS FOR GAINING SITE CLOSE OUT

6.4.1 CLARIFY CONCEPTUAL MODEL FOR THE SOURCE AREA

Although ground water contaminant concentrations in the source area have decreased substantially since initial investigations in 1989, the source area and some downgradient areas have persistently elevated contaminant concentrations. These concentrations and the lack of targeted remediation in those areas suggests that the remedy, as it currently functions, will not meet the objectives in a reasonable time frame (i.e., in 30 years) or within the limits of the current trust fund. As a result, targeted remediation is likely merited.

The conceptual model regarding continuing sources is not clearly understood at this site, and this can affect the choice of the remedial technology. The conceptual model should therefore be clarified prior to proceeding with targeted remediation. The RSE team envisions three potential conceptual model scenarios (others may also be possible):

- There is minimal continuing source of dissolved ground water contamination. The persistently elevated concentrations are primarily due to lack of attenuation from flushing or degradation.

- NAPL is providing a continuing source of dissolved contamination. The TCE concentrations below the 1% of solubility “rule of thumb” suggests that limited or no NAPL is present in close vicinity of the monitoring wells, assuming the wells are screened in the intervals of maximum contamination. The higher TCE concentrations in the shallower wells in the source area relative to the deeper wells argue against the free product migrating deeper, but the vertical delineation mentioned in Section 6.1.1 should help determine if free product has or has not migrated deeper as a DNAPL.

- The residual material in the roto pond continues to leach contamination to ground water and therefore acts as a continuing source, but to a much lesser extent than it did back in 1989. A limited direct push soil sampling event could be done in the roto pond to determine if the source material is still present and to determine if soil contamination is present to the water table (indicating leaching).

The deep well in the source area, recommended as part of Section 6.1.1., and the above-mentioned direct-push investigation could provide valuable information in clarifying the source area conceptual model. From the deep well, DHEC can determine how deep targeted remediation would need to be or if concentrations at depth are indicative of free product. From the direct-push sampling event, DHEC may determine if the roto pond is worth excavating (and the approximate volume to excavate) or if the majority of contaminant mass has already leached to the aquifer. The RSE team envisions a $25,000 effort for a direct-push event, including sampling, analysis, and reporting.

The RSE team notes that additional investigation beyond these two efforts (the deep well and the direct-push event) will likely not be cost-effective in clarifying the conceptual model and selecting a remedial approach. However, depending on the conditions found, more characterization may be required to properly implement a selected remedy. The RSE team cautions against excavating the roto pond without these two recommended investigation efforts. The RSE team also cautions against looking for visual evidence of NAPL because such efforts are generally costly and are often unsuccessful. Historical data and the data from the above-mentioned investigations should provide enough information to make decisions regarding source area remediation.

6.4.2 IMPLEMENT TARGETED REMEDIATION BASED ON CONCEPTUAL MODEL

The appropriate remedial approach depends, in large part, on the results from implementing the recommendations in Section 6.4.1 If investigations suggest that contamination is leaching from the roto pond, the trust fund money would be wisely spent on excavating the roto pond. If free product or concentrations indicative of free product are found at depth, additional characterization may be required to delineate that contamination and investigate ground water flow in the deeper formation. Aggressive and costly measures would be required to remove the DNAPL and success would not be guaranteed. If such conditions are present, a subset of the site may be technically impracticable to remediate and a remedy goal of containment may be more appropriate for that subset or the entire site.

If neither of these is the case, and the persistent contamination concentrations are due to lack of attenuation or minimal amounts of residual product, then trust fund money would be wisely spent on targeted remediation with the hope of removing contaminant mass and making significant progress toward remediation. The RSE team provides four potential approaches to addressing the elevated concentrations in the source area, OS-5, and OS-8/OS-8D. The first involves additional pumping and the other three involve injection of reagents. The RSE team notes that regardless of the approach for targeted remediation, operation of the pump and treat system would need to continue for years in order to provide containment for the large downgradient plume. An approximate cost estimate is provided for the additional pumping, but cost estimates for the other approaches are generally limited to a three to six month pilot-scale effort.

Potential Option #1: Additional Pumping

Additional extraction wells could be added in select locations for targeted mass removal. In particular, wells could be installed in the source area, near OS-5, and near the OS-8/OS-8D cluster. The treatment system has the capacity to easily treat the additional water. The NPDES limit for nickel may affect how much additional water from the source area may be processed without altering the treatment system. If DHEC opts for this approach, the RSE team would recommend that extraction rates should be adjusted so that modifications to the treatment plant would not be required.

The extraction would specifically be for source removal, but it would also enhance plume capture. If sufficient treatment capacity is not available during high flow events, the extraction from these wells could be discontinued in order to preferentially treat the water from the BP trench that is extracted for containment purposes. No modifications to the treatment system would be necessary, and the annual O&M costs would remain largely unchanged. Extraction could be discontinued periodically to determine the presence of rebound and can be restarted if necessary. Once concentrations are sufficiently low, the site team could consider modifying the remedy to monitored natural attenuation in accordance with EPA guidance.

W-7D is reportedly a 6-inch well and could be reconfigured as an extraction well. The other monitoring wells at the site are generally 2 or 4 inches in diameter and therefore not as well suited for extraction. In addition to converting W-7D, the RSE team would recommend installing additional extraction wells (preferably 8 inches in diameter) with similar locations and depths to W-1, OS-5, and OS-8 (with a screened interval comparable to OS-8 and OS-8D combined). These would provide extraction at the areas of the plume with the highest known concentrations. New piping to the treatment system should be installed to both accommodate the new flow and to bring power and controls from the treatment system to the new extraction wells. If it has not already been replaced, the pump in EW-4 (a 0.5 HP 25S05-3) should be replaced with a 0.5 HP 10S05-9, which appears more appropriate for the operating flow rate and head. The RSE team estimates the following costs for this recommendation.

Item	Estimated Cost
Convert W-7D to an extraction well (pump, cable, drop tube, transducer, and vault)	$15,000
Three new extraction wells with vaults and controls (50 feet deep on average)	$60,000
New double containment pipe with cable and controls (assuming 1,200 feet at $100/ft)	$120,000
Replace pump in EW-4	$2,000
Total	**$197,000**

Potential Option #2: Bioaugmentation

Bioaugmentation refers to the injection of both nutrients and microorganisms to enhance the in-situ degradation of site contaminants. In some cases, bioaugmentation simply supplies the nutrients for an existing population of microorganisms, and in other cases, biougmentation supplies both the nutrients and microorganism cultures. Because specific microbe populations can be introduced, degradation from TCE to harmless products (i.e., ethene) is possible in locations where natural degradation generally leads to only DCE or vinyl chloride. Bioaugmentation has shown the ability to reduce concentrations to below MCLs by degrading TCE to ethene. The microbes are also rather robust and have been shown to survive in ground water with dissolved concentrations similar to those found at this site.

The first step in assessing bioaugmentation is a technical evaluation of site-specific conditions, including hydrogeology and geochemistry, from existing data. The potential to create a reducing environment is evaluated and the expected radius of influence of potential injection points is estimated. The RSE team estimates the cost for this step at $5,000. The second step is to conduct laboratory genetic analyses and bench testing. Ground water is analyzed to determine the presence of halorespiring bacteria using genetic tests, to determine which microbes (if any) need to be introduced to the subsurface, and to estimate the amount of nutrients that would be required to maintain the reducing environment. The RSE team estimates the cost for this step at $5,000 to $10,000.

The third step is a field test. For this facility, the field test might include injecting microbes and nutrients into MW-66, W-1, and W-2 and monitoring changes in concentrations in W-3, W-7D, OS-1, and other monitoring wells in the area where there is a historical record of TCE concentrations. Injections would take place over a period of three to six months and could be conducted by the O&M contractor. The RSE team estimates the cost for this step at $50,000 to $100,000. Injection at other areas, such as OS-4, OS-5, and OS-8/OS-8D, would be more difficult to monitor given the relative absence of other monitoring wells in those locations. If injections occurred in OS-8 and OS-8D, decreases in concentrations in the plant influent may be apparent, but it would be difficult to determine if those decreases were due to injections made at OS-8/OS-8D or in the source area where EW-4 is pumping. Therefore, additional monitoring wells may be necessary, potentially increasing the cost of this option by an addition $25,000 to $50,000.

If DHEC opts for this approach, it should monitor the potential for fouling. The reducing environment resulting from this type of injection generally increases ferrous iron concentrations in ground water and that iron could oxidize and foul the trench (only likely if injections occur in OS-8/OS-8D), extraction wells, and/or air stripper. The RSE team estimates that if injection and monitoring were to continue at multiple locations, the costs for the material, injections, and monitoring might require up to $75,000 per year.

Potential Option #3: Nano-Scale Zero-Valent Iron

This technology involves the injection of zero-valent iron powder, carried by nitrogen gas, into the subsurface. The corrosion of the zero-valent iron to ferrous iron yields hydrogen gas that then combines with a chlorinated compound and results in the dechlorination of the contaminant. This technology is marketed by ARS Technologies (**www.arstechnologies.com**) under the trade name FEROX. Other vendors might be available but could not be located by the RSE team. Bedrock applications are considered ideal for this application because the iron can be injected efficiently.
A typical radius of influence in bedrock might be 20 to 40 feet. Implementing this technology would likely be similar to implementing bioaugmentation. An evaluation, bench test, and pilot test are generally recommended. As with bioaugmentation the potential for iron injection to foul the P&T system should be considered.

Based on discussions with ARS, the RSE team estimates that the cost for a pilot test of this technology would be similar to that of bioaugmentation (i.e., approximately $60,000 to $115,000 in the source area and $85,000 to $165,000 for multiple locations).

Potential Option #4: Chemical oxidation

Chemical oxidation has frequently been used to address contamination in-situ. Unlike more saturated compounds, TCE and its daughter products can be successfully oxidized by a number of oxidants including potassium permanganate. Stronger oxidants such as ozone or Fenton's reagent could also be used. Given that the target areas for remediation are away from buildings and above-ground activities, the heat and off-gas produced should not be a problem. Because the heat generated by in-situ chemical oxidation can melt PVC, the wells on-site could not be used for injection. Additional injection points with steel casings would be likely required, which would increase the costs of this approach. Even if other injection points are used, some of the current monitoring wells may need to be replaced. The RSE team estimates that a chemical oxidation pilot in the source area at this site would cost more than $150,000.

6.4.3 INVESTIGATE OTHER INVESTMENT OPTIONS

If DHEC has funds currently invested in federally insured interest bearing accounts, then the rate of return is likely only sufficient to offset inflation. The RSE team recommends investigating other investment options. For example, insurance companies such as AIG-Environmental and Zurich offer insurance packages to accompany fixed-price to closure remediation. While the funds for this site are not sufficient to pay for a guaranteed fixed-price to closure option, some insurance companies might be willing to manage the funds and provide a higher interest rate, even after their fee. This may especially be true if this process is needed for a number of sites that can be "bundled" together. In a sense, DHEC would purchase a fixed-price O&M package for a certain length of time that would be longer than the O&M duration that could be accomplished under the current investment program.

The following table illustrates how the remediation duration is extended by improving the interest rate on the trust fund principal. For these illustrative purposes, the trust fund principal at the beginning of 2003 is assumed to be $1.3 million, the annual O&M expenses are assumed to be $90,000 in 2003, and inflation is assumed to be 2%. Two scenarios are presented, one that is similar to the current investment plan with an interest rate similar to inflation (2%) and an improved investment plan with an interest rate (after management fees) of 5%. As is evident, improved interest rate provides approximately $500,000 at the end of year 2016, allowing remediation to continue for an additional 4 to 5 years beyond the what the current investment plan would allow.

Year	O&M Expense (with inflation at 2%)	End of Year Trust Fund Balance	
		with Current Investment (assumed 2% interest rate)	with Improved Investment (assumed 5% interest rate)
2003	$90,000	$1,234,000	$1,271,000
2004	$92,000	$1,165,000	$1,238,000
2005	$94,000	$1,093,000	$1,201,000
2006	$96,000	$1,017,000	$1,161,000
2007	$97,000	$938,000	$1,117,000
2008	$99,000	$856,000	$1,068,000
2009	$101,000	$770,000	$1,015,000
2010	$103,000	$680,000	$957,000
2011	$105,000	$586,000	$895,000
2012	$108,000	$488,000	$826,000
2013	$110,000	$385,000	$753,000
2014	$112,000	$279,000	$673,000
2015	$114,000	$168,000	$586,000
2016	$116,000	$53,000	$493,000

For a conservative estimate, the interest is calculated on the trust fund principal after expenses have been paid.

6.5 SUGGESTED APPROACH TO IMPLEMENTATION

The RSE team recommends proceeding with the recommendations in Sections 6.1, 6.2, and 6.3 as soon as possible. Once the new wells from Section 6.1.1 are installed and sampled, more data will be available for consideration of the source area conceptual model (Section 6.4.1) and the depth of contamination. If there is contamination at depth at any of the 3 locations, the potential exists for continued migration and additional investigation may be required to delineate the contamination and to better understand ground water flow at depth.

If the results of the recommendations from Section 6.1.1 indicate that substantial contamination does not exist at depth and capture is sufficient then funding should be directed toward targeted remediation to shorten the lifetime of the remedy. The first step would be limited characterization of the roto pond (Section 6.4.1) to determine if contamination remains and is reaching ground water. If it is, the roto pond may require excavation. If it is not, then targeted remediation as suggested in Section 6.4.2 may be appropriate.

Based on the provided costs O&M costs, the trust fund balance, the recommendations, and an assumption that significant source material is not present, the RSE team estimates that active remediation with existing funds might last through 2017 and even longer if a higher rate of return is available for the trust fund.

7.0 SUMMARY

The RSE team observed a well-maintained remedy. The observations and recommendations contained in this report are not intended to imply a deficiency in the work of either the system designers or operators but are offered as constructive suggestions in the best interest of the EPA and the public. These recommendations have the obvious benefit of being formulated based upon operational data unavailable to the original designers.

Recommendations are provided in all four categories: effectiveness, cost reduction, technical improvement, and site closeout. Recommendations for effectiveness include vertical delineation of the contaminant plume in multiple locations, modifications to the capture zone analysis, installation of the planned fence surrounding the downgradient property, a search for wells downgradient of the site, and institutional controls. Recommendations for cost reduction primarily involve reduction or elimination of redundant sampling and analysis. The sole recommendation for technical improvement is to generate annual reports. A list of items to include in those reports is provided. Recommendations for site close out pertain to evaluating the presence of source material and then, based on the information collected, conducting targeted remediation with one of four listed technologies. The RSE team also estimates that improved investment of the remediation trust fund with only a modest increase in the interest rate should extend the remediation under State lead for an additional 4 to 5 years.

Table 7-1 summarizes the costs and cost savings associated with each recommendation in Sections 6.1 through 6.4. Both capital and annual costs are presented. Also presented is the expected change in life-cycle costs over a 30-year period for each recommendation. For the purposes of this table, it is assumed that interest on the trust fund principle essentially balances inflation such that no discounting for net present value is appropriate.

Table 7-1. Cost Summary Table

Recommendation	Reason	Additional Capital Costs ($)	Estimated Change in Annual Costs ($/yr)	Estimated Change In Life-cycle Costs ($) [1]
6.1.1 Vertically delineate the TCE contamination	Effectiveness	$25,000	$1,100[2]	$58,000
6.1.2 Use BP trench observation wells for generating potentiometric surface maps	Effectiveness	$0	$0	$0
6.1.3 Implement Planned New Fence	Effectiveness	$25,000	$0	$25,000
6.1.4 Determine if residences along Beaver Creek have active wells	Effectiveness	$5,000	$0	$5,000
6.1.5 Implement institutional controls to notify future property owners of contamination	Effectiveness	$3,000	$0	$3,000
6.2.1 Consider reducing sampling and analysis	Cost Reduction	$0	($24,000)	($720,000)
6.3.1 Prepare Annual O&M Reports	Technical Improvement	$0	$15,000	$450,000
6.4.1 Clarify conceptual model for the source area (including direct-push event)	Site Closeout	$25,000	$0	$25,000
6.4.2 Implement targeted remediation based on conceptual model Additional pumping Bioaugmentation (pilot) Nano-scale iron (pilot) Chemical oxidation (pilot)	Site Closeout	 $197,000 $60,000 - $165,000 $60,000 - $165,000 >$150,000	 $0 not provided not provided not provided	$60,000 to $197,000
6.4.3 Investigate other investment options	Site Closeout	not calculated	not calculated	>$400,000

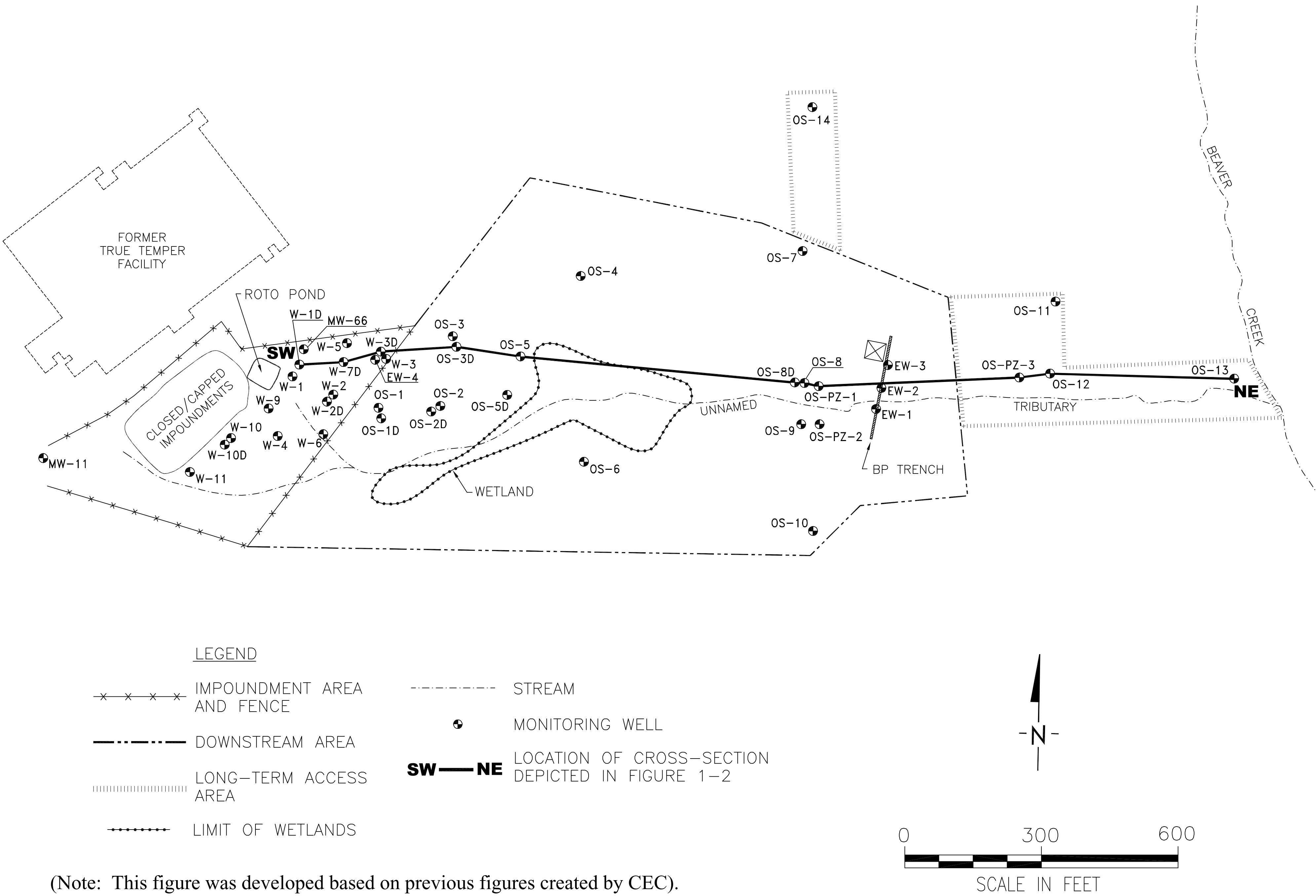
Costs in parentheses imply cost reductions.

[1] assumes 30 years of operation with a discount rate of 0% (i.e., no discounting)

[2] the annual cost is $2,200 for the first year and $1,100 for each year thereafter

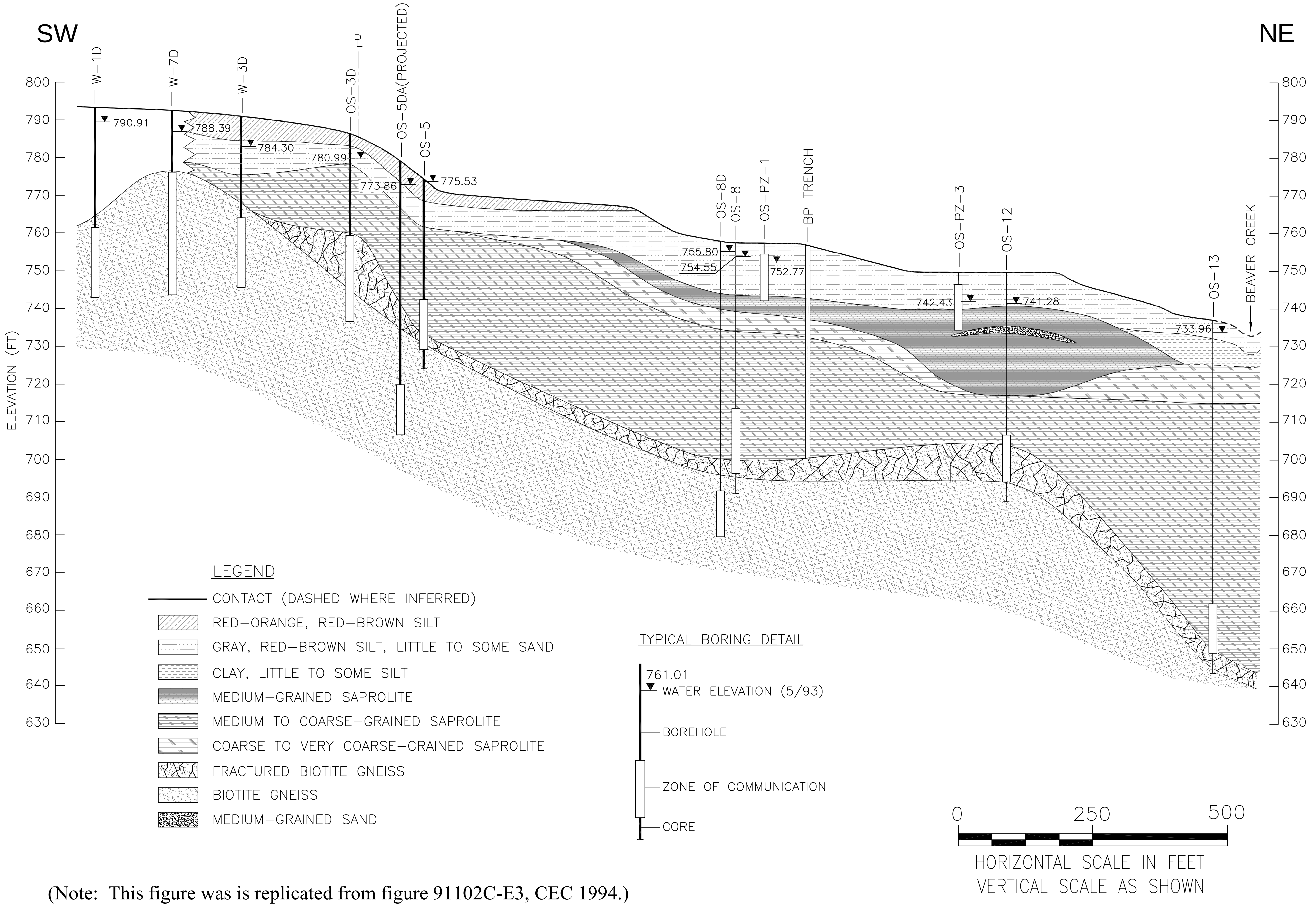
FIGURES

FIGURE 1-1. THE ELISKIM PROPERTY, DOWNGRADIENT AREA, AND MONITORING WELL LOCATIONS INDICATING TCE CONCENTRATIONS FROM THE 2002 SAMPLING EVENT.



(Note: This figure was developed based on previous figures created by CEC).

FIGURE 1-2. SOUTHWEST/NORTHEAST CROSS SECTION DEPICTED ON FIGURE 1-1.



(Note: This figure was is replicated from figure 91102C-E3, CEC 1994.)