2023 Hazardous Waste Scanning Project

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FEASIBILITY STUDY REPORT

AVM-Gowanda Site

Town of Persia, New York
Cattaraugus County
Site No. 9-05-025

February 2000

Prepared by
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF ENVIRONMENTAL REMEDIATION

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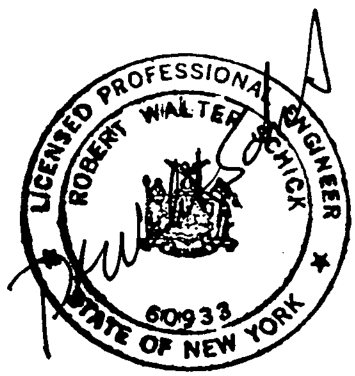

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Table of Contents

SECTION 1 - INTRODUCTION

1.1 General

This Feasibility Study (FS) Report has been prepared for the AVM-Gowanda Site, New York State Department of Environmental Conservation (NYSDEC) Site Registry No. 9-05-025. The site is a Class 2 inactive hazardous waste site located at One Industrial Place in the Town of Persia, Cattaraugus County. The FS has been prepared by the NYSDEC's Division of Environmental Remediation and is based upon the information and data presented in the Remedial Investigation (RI) Report for this site, dated July 1998.

1.2 Site Description/History

The AVM-Gowanda site is located at One Industrial Place in the Town of Persia, Cattaraugus County, New York. The property is approximately 1.75 acres in area and includes two manufacturing buildings and two small storage sheds. The site is currently owned and occupied by the Gowanda Electronics Corporation, a small manufacturer of electrical components such as inductors. Situated in a mixed industrial/residential area the facility has been used for commercial operations since the early 1930's. From World War II until 1979 the facility was used as a metal stamping/machine shop. Gowanda Electronics purchased the facility in 1979 from Automatic Voting Machine Corporation (AVM) and has since used the facility for the manufacture of inductors. The NYSDEC received anonymous complaints of gasoline/solvent odors in the main building in July and November of 1989. Vent pipes were installed on the northwest side of the building to address the odors.

The site property is flat lying and largely covered with either paved parking areas or buildings. Surface drainage is provided via storm drains that ultimately empty into Cattaraugus Creek. The site is bordered by residential property to the north and east, railroad yard to the south, and commercial facilities to the west. The facility and the entire surrounding neighborhood is served with municipal water and sanitary sewer.

A Phase I and Phase II site investigation were completed in the spring of 1994 for Gowanda Electronics by Malcolm Pirnie, Inc. Analysis of surface soil samples showed elevated levels of various metals, total petroleum hydrocarbons (TPHs) and trace levels of volatile organic compounds (VOCs) at the east end of the main building, along the northern property boundary. The company chose to excavate the surface soils for off-site disposal. This surface soil excavation program continued to a depth of approximately seven feet, removing 568 tons of soil, and lead to the discovery of high levels of VOCs which increased in concentration as the depth of the excavation increased. VOCs from this area apparently have migrated to the groundwater table, resulting in significant groundwater contamination. At this point the excavation was backfilled and the company installed a groundwater extraction well, with an air stripper for treatment, that became operational in June 1996. This system continues to operate under a Voluntary Cleanup

Agreement, Index Number B9-0507-96-05, effective January 13, 1998, (VCA) between the NYSDEC and the Gowanda Electronics Corp. The work completed by the company, which included the sampling, soil removal, and the operation of the groundwater extraction system, has provided valuable information for the completion of the off-site RI.

Based on the initial data collected during the on-site activities described above, the NYSDEC suspected groundwater contamination may be migrating away from the site. To further investigate existing subsurface and groundwater conditions near the source area and to identify any potential migration pathways from this source area, a NYSDEC Immediate Investigation Work Assignment (IIWA) was issued to Parsons Engineering Science (ES) in 1995. Field activities associated with the IIWA were conducted during late 1995 with the summary report issued by NYSDEC in January 1996. A significant groundwater contaminant plume was identified, migrating from the source area northward to Torrance Place. The data further suggested that the plume likely extended beyond Torrance Place.

The IIWA provided the basis for the site to be listed on the New York State Registry of Inactive Hazardous Waste Disposal Sites as a Class 2 Site. The Off-Site Remedial Investigation was then conducted to fully define the nature and extent of contamination and determine if any exposure pathways exist that pose a threat to human health or the environment.

1.3 Summary of Remedial Investigation

1.3.1 Site Characterization: The AVM-Gowanda site consists of an industrial facility located at One Industrial Place in the Town of Persia where hazardous wastes were disposed on the ground surface at the east end of the facility, during the course of its operational history. Wastes initially identified by the current owner, Gowanda Electronics, as having been disposed of at the site prior to their ownership, include various metal shavings, cutting oils, and degreasing solvents. Efforts to remove the waste material, contaminated soil, and containment of contaminated groundwater located on-site were initiated by the company in 1993. Excavation of the waste metal and contaminated soil effectively addressed the majority of an existing source of contamination above the water table, however significant groundwater contamination had occurred and migrated off-site to the north. A recovery system consisting of a groundwater extraction well and air stripper treatment unit was installed to remove and treat contaminated groundwater from on-site, and to address further migration of contaminants off-site. The company signed a Voluntary Cleanup Agreement with the NYSDEC on January 13, 1998, specifying the operation and maintenance requirements for the system. This system is currently accomplishing the goal of on-site containment of the remaining contaminants, however a significant volume of waste solvents and contaminated groundwater had migrated beyond the influence of the recovery system prior to implementation, thus the system is not addressing the off-site contamination.

The site, and resulting area of impacted groundwater, is underlain by moderately to highly permeable alluvium comprised of a varying mix of sand and gravel. Within this alluvium are buried stream channels filled with coarser sand and gravel that serve as preferential flow paths and, in part, control groundwater flow. The thickness of the alluvium ranges from 4 to 15 feet. Groundwater occurs within the alluvium under unconfined, or water table, conditions. Below the alluvium, is a dense glacial till that is presumed to serve as a barrier to further downward migration of contaminants. The surface of this till slopes downward from the source area to its deepest point beneath Torrance Place, where a bowl shaped feature has been eroded during post glacial stream flow. The water bearing alluvium is covered with up to 8 feet of flood plain silt and clay, that serves to retard any upward migration of contaminant vapors from the water table.

Waste solvents are the remaining contaminants of concern for the site, consisting primarily of TCE. The TCE apparently migrated downward at the source area on-site, through the aquifer as a DNAPL to the top of the till unit, where it then flowed down slope and along preferential paths such as the channels. The data suggests the DNAPL then accumulated in discrete low points or pockets in the vicinity of Torrance Place, or continues to exist as ganglia (droplets) within the pore spaces of the aquifer. It is likely the DNAPL exists as both pockets and ganglia. Some TCE has dissolved in groundwater as it migrated through the aquifer, with the DNAPL continuing to serve as a source of contamination to the groundwater. The groundwater contaminant plume extends from the source area at One Industrial Place, approximately 1150 feet north, to beyond Chestnut Street. A detailed description of contaminant migration can be found in Section 6.3 of the RI Report. The plume is approximately 450 feet across at its widest point, which is located along Chestnut Street (Figure 1). Significant concentrations of VOCs exist within the plume, with exceptionally high levels, up to 224 ppm total VOC (170 ppm TCE) at MW-4, located in Torrance Place. The plume covers an area of approximately 7.5 acres.

The potential for human contact with contamination is through direct contact with groundwater and soil below the water table during activities such as utility maintenance, both on-site and throughout the area of the plume. All residents in the area are served with municipal water, however, use of groundwater from sources such as private well points for gardening would provide direct exposure to contaminants, through both dermal contact and inhalation of vapors. Volatilization of contaminants associated with the groundwater plume into basements of homes along Torrance Place has been identified as a completed exposure pathway.

Despite efforts to pump and treat contaminated groundwater on-site, significant groundwater contamination continues to migrate northward. Left untreated, the DNAPL suspected to exist in the vicinity of Torrance Place will continue to dissolve into the groundwater, maintaining the high levels of TCE identified throughout the aquifer. Without further controls, it is expected the plume will spread northward toward Walnut Avenue. Remediation of the aquifer is necessary for the full protection of human health and the environment.

Fig 1

1.3.2 Summary of the 3 Dimension High Resolution Seismic Survey: The following section is comprised primarily of excerpts from the Final Fracture Trace Analysis and 3D High Resolution Seismic Reflection Imaging Report prepared by Resolution Resources, Inc. Figures and tables referenced within this section are included in Appendix A.

Resolution Resources, Inc (RRI) was contracted by Parsons Engineering Science, Inc. (ES) to perform a Three-Dimensional High-Resolution seismic reflection survey, for the New York State Department of Environmental Conservation (NYSDEC) at the AVM-Gowanda Site. The purpose of the seismic imaging was to investigate and define the presence of the suspected DNAPL pool, and to better characterize the shallow subsurface stratigraphy in the vicinity of the site.

Seismic reflection surveying is a non-invasive imaging technique used to map geologic structure and/or stratigraphic features. Seismic reflection technology was originally developed by the petroleum industry. However, the technique has seen increasing use in recent years at shallow or near-surface depths to provide information essential for characterizing hazardous waste sites. Seismic reflection imaging is based on the principle that acoustic energy (sound waves) will bounce, or "reflect" off the interfaces between layers within the earth's subsurface. During a seismic survey, energy imparted on the ground surface spreads into the earth. When the sound encounters a change in the physical properties of the material in which it is traveling part of the energy reflects back to the surface. Subsurface reflections of seismic energy most often occur at the interfaces between lithologic changes (a transition from till to rock, for example). As a result, seismic reflections allow the stratigraphy below a site to be mapped. Strata disrupted by fractures are also observable with the seismic method.

The objectives of the seismic survey were to:

- Perform a three-dimensional high-resolution seismic reflection evaluation of the subsurface stratigraphy at the site.
- Image and map the subsurface topography, including the topographic expression of the top of the glacial lodgement till, and the alluvial material above the till.
- Measure the nature and extent of any channeled alluvium at the top of till.
- Provide definition of the potential presence of DNAPL pools in the top of till.
- Define optimal locations and placement of recovery wells.

In order to meet the objectives of the geophysical work, the following tasks were completed that included: the development of a work plan; the review of background information to better plan the survey and interpret the seismic data; data collection in the field; perform vertical seismic profiles (VSPs) in 4 wells to correlate downhole information to the surface seismic survey; the collection, processing, and interpretation of the 3D seismic reflection data; and the generation of a final report.

The background review consisted of the collection and analyses of pertinent information to produce a heightened understanding of the site. Information on the regional and site geology and hydrology was compiled along with the site history, previous site investigation reports, and chemical analysis of the air, soil, soil-gas, and groundwater. Regional data from the topographic map, and from geophysical measurements of the gravity, aeromagnetics, and seismicity were reviewed. LandSat and historical aerial photographs were also utilized, and a fracture trace analysis was performed at the detailed site level on stereographic pairs of aerial photographs. Finally, nearby exposures of overburden and bedrock were explored and documented.

Four vertical seismic profiles (VSPs) were performed at the site. The VSPs were collected in monitor wells MW-3, MW-4, MW-5, and MW-11 at the site located within the boundaries of the 3D survey grid. The purpose of the VSPs was to aid the processing and interpretation of the surface seismic data by measuring the actual near surface seismic velocities at the site. Stratigraphic information from the boring logs combined with travel time information from the VSPs provided data to correlate borehole geology with the surface seismic data.

It is often the case that fractures and faults in bedrock rock are propagated up through unconsolidated sediments to the surface as failure planes. Surface lineaments often represent the surface expression of fractures at depth. In some cases streams may have deposited sand and gravel along these fractures. The fractures represent the more permeable pathways for fluid transport. A very strong correlation was evident among all the various data sources in the background review. The review suggested that two sets of regional fracture trends exist in the area, one set trending northeast-southwest and northwest-southeast, and the other trending north-south and east-west.

The 3D high-resolution seismic survey (data collection) was performed at the AVM-Gowanda site between October 27 and November 1, 1998 to provide detailed information on the subsurface. The primary factors that influenced the 3D survey design included the size and depth of the stratigraphic and structural features of interest, the geologic model (including local structural trends and hydrological conditions), and surface conditions that existed at the site. The 3D survey addressed an area of approximately 220,900 square feet on the surface of the site. A 144-channel seismographic system was used to digitally record the seismic data. Data collection progressed over the survey area from the northwest corner to the south and east.

Important fractures and till surface lows were identified and evaluated throughout the data volume. Nineteen major vertical fractures were identified using the background information and the seismic data. Vertical fractures are of primary interest, because the vertical fractures are often pathways along which contamination will migrate. The vertical fractures also can form the boundaries between high and low areas, and can even act as barriers when they border an upthrown block of the subsurface. The intersections of large vertical fractures are often associated with topographically lower areas and make excellent locations for vertical well screens.

Figure 35 shows the fracture trace analysis superimposed on the site plan and seismic grid.

Surface lineaments from the fracture trace analysis that correlated to apparent faults in the seismic data have been identified as fractures. Nineteen major fractures have been identified at the site. For better visualization, the fracture planes have been shown with the till surface in Figure 38. It is important to note also that there is often a difference between the surface expression of a lineament and the fracture at depth because the fractures are not usually perfectly vertical and planar. As the stress along a fracture is released at the earth's surface the fracture often creates a splayed pattern.

Based upon the analysis of the data collected in the field and the background review, the following conclusions and recommendations were developed for the site.

1.3.2.1 Recommendations of the 3D Seismic Survey Report: The subsurface fractures combined with the alluvium, till and bedrock are believed to control fluid flow and migration of contaminants from the site. The fractures cut the strata to the surface as evidenced by the lineaments on the aerial photographs, however the alluvial sand and gravel are more permeable than the silt and clay in the till. The till also contains sand and gravel layers interspersed throughout the unit. The most permeable zones may be the fractures along which channels were cut, and sand and gravel were deposited. The juncture of 2 or more vertical fractures produces a particularly permeable zone in the form of a fractured column. A vertical fracture column is an optimum place to locate a vertical well, because the well screen is in the best position to influence the fractured matrix with the sediment or rock. Wells located at the juncture of these fractures will produce more water than an unfractured zone. If the juncture of the fractures is in interconnection with the source for VOCs, then more contaminants will also be intercepted in addition to a larger volume of water. Wells placed in these optimal positions should result in a more efficient recovery system.

It is important to note that the 19 fractures identified at the site are not individual fractures, but fracture zones consisting of many failure surfaces in the sediments. Also, there are more than 19 fracture zones at the site. Fractures F1-F19 were identified based on their size and probable influence on groundwater flow and distribution of VOC-impacted water. The size of the fractures is a result not only of the aperture of the fracture zone, but also the length of the fracture system. Fractures F1-F19 are long and extend for many tens of feet through the seismic data volume. It is also highly probable that the fracture zones within the bedrock are also the most permeable flow pathways.

Elevated chemical concentrations in samples taken near the source area from groundwater strongly suggest that at least some DNAPL does occur at the site. Since the site is fractured vertically and DNAPL tends to migrate under the forces of gravity along these fractures, deeper sample points within the large fractures below the source area are required to measure the nature and extent of potential deep DNAPL accumulations (detailed description of contaminant migration can be found in Section 6.3 of the RI Report). The most important factor at the site is the nature of the till. The site data suggest the surface of the till as shown on Figure 41B may be controlled in part by structure, with the weathering and scouring of the surface during the deposition of the alluvium occurring along the orientation of the fractures. It also seems likely that fractures have penetrated the till and may interact with the till to create permeability changes as well as topographic changes. If the fractures below the source area contain DNAPL ganglia, or if small pools of DNAPL exist in low spots on the confining layers, then the exact position of a potential recovery well is the most important factor in the success or failure of that well. The seismic image can help guide this decision making process. The DNAPL ganglia could be very localized in discrete vertical paths within the surface of the till.

Potential target well locations are shown on Figure 41. Figure 41A shows the target wells with the site plan, seismic grid, fracture network, and VOC plume. Figure 41B shows the target wells on a contour map of the till depth superimposed with the VOC plume. Fracture F1 trends east through the industrial building. Groundwater sampling results suggest contaminants have migrated from the source, just east of the building, to the north between F2 and F3, and to the northeast along F7 until it encountered the lower till along F14. It also appears the contaminants have moved along F17 to the west, and to the northeast along F13.

The following target well locations have been recommended at locations where both the till and bedrock surfaces are expected to be at relatively low elevations. The targets have also been located at or near the intersection of large and influential fractures. The fractures are considered large when the width of the fracture extends several seismic traces, and the fracture extends from depth to the near surface. The alluvium and till are most likely more permeable at the locations of the targets. The fractures are believed to be influential when the fractures appear to provide a pathway or barrier to the VOC impacted water.

Table 6 shows each target location along with the reflection time and depth to the top of the till, and the maximum depth of the target anomaly. Wells in each of the target locations could be drilled to the till surface, into the till, or into bedrock depending on expected contaminant distribution and the goals of the remediation. Table 6 also provides the exact location in New York State Plan coordinates (northings and eastings) for each of the target wells.

Target Well 1 (T1) (Figure 41). The existing recovery well is in a relatively good position just northeast of the source area along F7. The only other potential well position in the source area would be near the SE corner of the Gowanda Electronic Building in the structural low at the intersection F2, F3, F7, F13, and F18. This position might offer more control along F3, F13, and F18 in addition to added control along F7.

Target Well 2 (T2) (Figure 41). The second target well is at the till surface low near the intersection of F13, F17, and F19. This well is located near the hot spot associated with the 20,000 ppb total VOC contour. This potential well position may provide for better control and potential mass removal along F17. It is on a public access.

Target Well 3 (T3) (Figure 41). The third target well is at the till surface low near the intersection of F2, F8, F14, and F17. This position may intercept a discrete till surface fracture that may contain higher concentrations of VOCs. This potential well position is within the public right of way.

Target Well 4 (T4) (Figure 41). The fourth target well is located at a till low near the intersection of F7 and F14. This potential well position may intercept discrete vertical fracture in the till surface. It is located on private land.

Due to the fractured nature of the till identified during the seismic survey and the migration potential of TCE DNAPL (see section 6.3 of the RI Report, page 60), monitoring wells installed into the bedrock along the fractures or at the recommended target well locations are required to determine if impacts to the bedrock aquifer have occurred. In order to guard against accidental introduction of contamination downward to the bedrock, it is recommended this additional investigative work is performed only after a remedial system is in place and confirmed to be effective.

1.4 Nature and Extent of Contamination

1.4.1 Applicable Standards, Criteria, and Guidance (SCGs): In order to identify potential exposure pathways, applicable SCGs must be identified. 6 NYCRR Part 375-1.10(c)(1)(I) requires that remedial actions comply with SCGs "unless good cause exists why conformity should be dispensed with." Standards and Criteria are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance. Guidance includes non-promulgated criteria and guidelines that are not legal requirements; however, the site's remedial program should be designed with consideration given to guidance that, based on professional judgement, is determined to be applicable to the site.

SCGs are categorized as chemical specific, location specific, or action specific. These categories are defined as the following:

Chemical Specific: These are health or risk based numerical values or methodologies which, when applied to site specific conditions, result in the establishment of numerical values for the chemicals of interest. These values establish the acceptable amount or concentration of a chemical that may be found in or discharged to the environment.

Location Specific: These are restrictions placed on the concentrations of hazardous substances or the conduct of activities solely because they occur in a specific location.

Action Specific: These are usually technology or activity based requirements or limitations on actions taken with respect to hazardous waste management and site cleanup.

The following lists the principal SCGs that have been identified for the AVM-Gowanda Site (Table 1 at the end of this document lists all of the SCGs for the site):

General - 6 NYCRR Part 375, Inactive Hazardous Waste Disposal Site Remedial Program

Soil - NYSDEC Division of Hazardous Waste Remediation Technical and Administrative Guidance Memorandum (TAGM) 4046, Determination of Soil Cleanup Objectives and Cleanup Levels

- 6 NYCRR Part 371, Identification and Listing of Hazardous Wastes

- 6 NYCRR Part 376 - Land Disposal Restrictions

- NYSDEC Division of Hazardous Substance Regulation TAGM 3028, "Contained in Criteria for Environmental Media" (11/92)

Groundwater - 6NYCRR Part 700-705, Water Quality Regulations for Surface Water and Groundwater

- NYSDEC Division of Water TOGS 1.1.1

Air - Air Guide 1 - Guidelines for the Control of Toxic Ambient Air Contaminants

1.4.2 Summary of Nature and Extent of Contaminated Media: Based on the information developed during previous studies and the RI, contaminants of potential concern have been identified for each environmental medium (see analytical result summaries presented in Table 2). Compounds of potential concern were selected based on frequency of detection, range of concentrations, and potential for migration.

Waste disposal at the east end of the facility at One Industrial Place apparently occurred for several years. Wastes included metal shavings, waste cutting oil, and liquid solvents (VOCs), all of which were disposed onto the ground surface. The waste solvents, consisting primarily of TCE, infiltrated downward as periodic spilling or dumping on the ground surface occurred, saturating the soil. Migration continued to move downward to the surface of the groundwater at a depth of 6 to 8 feet below grade. Upon reaching the groundwater some of the solvents dissolved into the aquifer while a portion likely continued to sink through the aquifer as DNAPL to the top of the till unit, located approximately 18 feet below ground surface. Based on groundwater sampling results indicating the highest levels of contamination currently located beneath Torrance Place, the DNAPL continued to both migrate to the north and dissolve in the groundwater which also flows to the north.

Efforts by the current site owner, Gowanda Electronics, to remove contaminated soil from the source area were largely effective, with some low concentration residual VOC contamination remaining bound to the soil within the zone of influence of the recovery well operating under the VCA. Therefore, groundwater is the only contaminated media requiring remediation.

1.4.2.1 Summary of Human Exposure Pathway Analysis: The groundwater in the area is classified by the NYSDEC as GA (best usage, drinking water), however, groundwater in the area is currently not used for drinking water. All residential dwellings are served with municipal water. Direct contact with groundwater will occur if shallow well points are used within the plume for irrigation or other non potable purposes.

Measurable impacts to indoor air that may be associated with the groundwater plume have been identified in some homes located over the highest groundwater contamination, causing potential direct exposure to VOCs through inhalation. Concentration of VOCs are currently not at levels that pose a health concern, however, continued monitoring will be necessary.

On-site/utility workers could be exposed during excavation or subsurface maintenance activities via dermal contact with waste materials, inhalation of vapors and airborne particulates when working in the area of wastes or the treatment system during operation, and incidental ingestion due to soiled hands.

Table 3 summarizes the contaminated environmental media of concern.

1.4.2.2 Summary of Environmental Exposure Pathways: This section summarizes the types of environmental exposures and ecological risks which may be presented by the site. The Fish and Wildlife Impact Assessment included in the RI presents a more detailed discussion of the potential impacts from the site to fish and wildlife resources.

Field observations at the source area and throughout the residential area did not find any waste material or contamination at the surface. As shown in the analytical data, significant impacts to the groundwater resources have occurred as a result of contaminants migrating from the site. No stressed vegetation on site or along the plume was found to exist. Contamination identified at the site is subsurface and is not impacted by surface runoff during storm events. Analytical results combined with hydrogeologic observations indicate that any migration of contaminants is northward, however it has not reached surface water bodies or resurfaced in the form of springs. Groundwater discharge is to Cattaraugus Creek, however the extent of the contamination plume currently terminates before it reaches Cattaraugus Creek. After consideration of the above potential impacts, along with the current conditions defined for the site, it was determined that there were no present impacts to wildlife as a result of contamination from the site. However, left untreated, continued migration of the plume could impact Cattaraugus Creek in the future.

1.4.2.3 Contaminants of Concern: The contaminant plume, defined based on sampling during this and previous studies, extend from the One Industrial Place facility to the north. Contaminants of concern were selected based on concentration, frequency of detection, and distribution. Table 2 shows the selected Contaminants of Concern for this site.

SECTION 2 - PROJECT GOALS and OBJECTIVES

The goal of this FS is the identification and analysis of remedial alternatives for the AVM-Gowanda site, consistent with the objectives of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Section 121 and 6NYCRR Part 375. The primary objective is the selection of a remedial alternative which is protective of human health and the environment.

Based on the results of the Human Exposure Pathway Analysis and the Habitat Based Analysis, presented in the RI Report, the Remedial Action Objectives (RAOs) for this site are:

- Reduce, control, or eliminate to the extent practicable, the continued migration of contaminated groundwater and suspected DNAPL throughout the residential area north of the site.
- Eliminate potential for direct exposure through the inhalation of contaminant vapors migrating into the homes located over the groundwater contaminant plume or dermal contact with contaminated groundwater or soil.
- Achieve NYSDEC groundwater quality standards to the extent practical.
- Prevent migration of the contaminant plume to Cattaraugus Creek.

The goal of the program will be to reduce contaminant concentrations to levels that are consistent with SCGs (i.e., to reduce groundwater concentrations to NYSDEC groundwater standards). Any remedial alternative that will later be presented as the preferred remedial action must demonstrate that it will be protective of human health and the environment.

SECTION 3 - DEVELOPMENT OF REMEDIAL ALTERNATIVES

The following section will present remedial alternatives that are meant to address the remedial goals presented in the previous section.

3.1 Presumptive Remedies Directive

The EPA has developed policy and procedures for presumptive remedies at sites where commonly encountered characteristics are present. Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. The EPA has: evaluated technologies that have been consistently selected at sites using the remedy selection criteria set out in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); reviewed currently available performance data on the application of these technologies, and; has determined that a particular set of remedies is presumptively the most appropriate for addressing specific types of sites. The objective of a presumptive remedy is to use past experience to speed up the evaluation and selection of remedial options, to ensure consistency in remedy selection, and to reduce the time and cost required to clean up similar types of sites. The use of presumptive remedies eliminates the need for the initial step of identifying and screening a variety of alternatives during the Feasibility Study. The NCP states that "the lead agency shall include an alternatives screening step, when needed, to select a reasonable number of alternatives for detailed analysis." EPA has analyzed feasibility studies for sites with commonly encountered contamination (i.e., sites with VOC-contaminated groundwater) and found that certain technologies are routinely screened out based on effectiveness, implementability, or excessive costs, consistent with the procedures set forth in the NCP. Accordingly, EPA has determined that, for sites that meet the requirements of the presumptive remedies directives, site-specific identification and screening of alternatives is not necessary.

This FS utilizes the following presumptive remedy guidance directives: *Presumptive Remedies: Policies and Procedures*, USEPA Directive 9355.0-47FS, September 1993; and *Presumptive Response Strategy and Ex-situ Treatment Technologies for Contaminated Groundwater at CERCLA Sites*, USEPA Directive 9283.1-12, October 1996.

3.2 Identification of Remedial Alternatives

3.2.1 No Further Action/Groundwater Monitoring: This alternative is identified as no further action in order to acknowledge the work that has already been completed at the site under the Voluntary Cleanup Agreement, specifically the soil removal and groundwater recovery system installed on the site.

The no further action alternative is included as a procedural requirement and as a baseline to evaluate the other alternatives. Under this alternative, no additional remedial action would be undertaken to address contaminated groundwater. Groundwater monitoring would be conducted annually for up to 30 years.

3.2.2 Monitored Natural Attenuation (MNA): Under the MNA alternative natural subsurface processes, such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials, to reduce contaminant concentrations to acceptable levels. Consideration of this alternative will in certain cases usually requires evaluation of contaminant degradation rates and pathways and predicting contaminant concentrations at down gradient receptor points. The primary objective of this evaluation is to demonstrate that natural processes of contaminant degradation will reduce contaminant concentrations below regulatory standards or risk-based levels, before potential exposure pathways are completed. In addition, long term monitoring must be conducted throughout the process to confirm that degradation is proceeding at rates consistent with meeting cleanup objectives and schedules.

Monitored natural attenuation (MNA) is not the same as "no action," although it often is perceived as such. CERCLA requires evaluation of a "no action" alternative but does not require evaluation of MNA which is considered on a case-by-case basis. In all cases where natural attenuation is being considered, extensive site characterization and monitoring would be required, both before and after any potential implementation of this remedial alternative.

Compared with other remediation technologies, MNA has the following advantages:

- Less generation or transfer of remediation wastes.
- It would be less intrusive.
- It may be applied to all or part of a given site, depending on site conditions and cleanup objectives.
- Natural attenuation may be used in conjunction with, or as a follow-up to, other (active) remedial measures.
- Overall cost would likely be lower than active remediation.

Synonyms: Intrinsic Remediation; Bioattenuation; Intrinsic Bioremediation.

Applicability: Target contaminants for natural attenuation are VOCs, SVOCs, and fuel hydrocarbons. Fuel and halogenated VOCs are commonly evaluated for natural attenuation.

Limitations: Factors that may limit applicability and effectiveness include:

- Data used as input parameters for modeling needs be collected.
- Intermediate degradation products may be more mobile and more toxic than the original contaminant.
- Natural attenuation is not appropriate where imminent site risks are present.
- Contaminants may migrate before they are degraded.
- Institutional controls will typically be required, and the site may not be available for reuse until contaminant levels are reduced.
- It is not intended to address source areas or areas of relatively high contamination.
- There are long term monitoring and associated costs associated with this alternative.
- Longer time frames would be required to achieve remediation objectives, compared to active remediation.

3.2.3 In-Well Air Stripping: The intent of in-well stripping would be to greatly increase contact between groundwater and air. In order to achieve equilibrium at the interface of the air and water, VOCs "move" from the contaminated groundwater to the air. In general, in-well air strippers are for contaminated sites with light non-aqueous phase liquids (LNAPLs) and DNAPLs.

Limitations: The following factors may limit the applicability and effectiveness of groundwater pumping as part of the remedial process:

- It is possible that a long time may be necessary to achieve the remediation goal.
- Residual saturation of the contaminant in the soil pores is not typically removed by ground water pumping. Contaminants tend to be sorbed in the soil matrix. Groundwater pumping is not applicable to contaminants with high residual saturation, contaminants with high sorption capabilities, and homogeneous aquifers with hydraulic conductivity less than 10^{-5} cm/sec.
- The cost of procuring and operating treatment systems can be high, in the long term. Additional cost may also be attributed to the disposal of spend carbon and the handling of other treatment residuals and wastes.
- Bio-fouling of the extraction wells, and associated treatment stream, is a common problem which can affect system performance. The potential for this problem should be evaluated prior to the installation.

The following factors may limit the applicability and effectiveness of surfactant-enhanced recovery:

- Subsurface heterogeneities, as with most groundwater remediation technologies, present challenges to the successful implementation of surfactant-enhanced recovery.
- Potential toxic effects of residual surfactants in the subsurface.
- Continued migration of contaminants due to the increase solubility achieved with surfactant injection.

3.2.4.1 Water Treatment: There are a number of water treatment options that would be available after the removal of the contaminated groundwater from the subsurface. Regardless of the treatment option selected, a DNAPL separator would be required within the system due to the potential for DNAPL to be recovered in the extraction wells. The EPA directive, entitled *Presumptive Response Strategy and Ex-situ Treatment Technologies for Contaminated Groundwater at CERCLA Sites*, dated October 1996, has been used to identify the following treatment options for extracted groundwater.

A) Air Stripping

Air stripping involves the mass transfer of volatile contaminants from water to air. For groundwater remediation, this process is typically conducted in a packed tower. The typical packed tower air stripper includes a spray nozzle at the top of the tower to distribute contaminated water over the packing in the column, a fan to force air countercurrent to the water flow, and a sump at the bottom of the tower to collect decontaminated water. Auxiliary equipment that can be added to the basic air stripper includes an air heater to improve removal efficiencies; automated more effective at sites containing high concentrations of dissolved contaminants with high Henry's law constants, as exist at this particular site (see Table 4 at the end of this document).

Variations of in-well air stripping use either air lift or mechanical pumping systems to draw water into the base of the well, pump the water upward in the well and discharge it out of an upper screen section into the vadose (unsaturated) zone, creating a vertical circulation pattern of groundwater around the well. High volumes of air simultaneously passed through the water within the well, forcing the VOCs in the contaminated groundwater to be transferred from the dissolved phase to the vapor phase by air bubbles. The contaminated air is then drawn to the surface and treated. The partially treated groundwater would not be brought to the surface; it would be forced into the unsaturated zone, and the process would be repeated as water follows a hydraulic circulation pattern or cell that allows continuous cycling of groundwater. As groundwater circulates through the treatment system, contaminant concentrations would gradually be reduced.

The duration of in-well air stripping could be short- to long-term, depending on contaminant concentrations, Henry's law constants of the contaminants, the radius of influence, and site hydrogeology.

Applicability: Target contaminants for natural attenuation are VOCs.

Limitations: The following factors may limit the applicability and effectiveness of the process:

- Fouling of the system may occur by infiltrating precipitation containing oxidized constituents such as iron.
- In-well air stripping may not be efficient in sites with strong natural flow patterns.

3.2.4 Groundwater Extraction and Treatment: Groundwater pumping systems are used to remove dissolved contaminants from the subsurface as well as to hydraulically contain contaminated groundwater to prevent its migration. Groundwater can be extracted either through conventional pumping wells or collection trenches designed to intercept a section of the contaminant plume.

Applicability: Site characteristics, such as hydraulic conductivity, will determine the range of remedial options possible. Chemical and physical properties of the site and plume need to be determined to characterize transport of the contaminant and evaluate the feasibility of groundwater pumping. To determine if groundwater pumping is appropriate for a site, one needs to know the history of the contamination event, the properties of the subsurface, and the biological and chemical contaminant characteristics. Identification of the chemical and physical site characteristics, typically obtained during the RI, are necessary in designing an effective groundwater pumping strategy. Groundwater on-site is currently extracted by means of a single recovery well and treated through air stripping as part of a work the an undertaken by VCA.

Surfactant-enhanced or cosolvent-enhanced recovery may also be used to improve the effectiveness control systems with sump level switches and safety features, such as differential pressure monitors, high sump level switches, and explosion-proof components; and air emission control and treatment systems, such as activated carbon units, catalytic oxidizers, or thermal oxidizers. Packed tower air strippers are installed either as permanent installations on concrete pads or on a skid or a trailer.

Air strippers can be operated continuously or in a batch mode where the air stripper is intermittently fed from a collection tank. The batch mode ensures consistent air stripper performance and greater energy efficiency than continuously operated units because mixing in the storage tanks eliminates any inconsistencies in feed water composition.

The eventual duration of cleanup using an air stripping system may be tens of years and depends on the capture of the groundwater contamination from the pumping system.

Applicability: Air stripping is used to separate VOCs from water. Henry's law constant is used to determine whether air stripping will be effective. Some examples of compounds that can be successfully separated from water using air stripping include benzene/toluene/ ethylbenzene/ xylene (BTEX), chloroethane, TCE, DCE, and PCE. Air stripping is currently used to effectively treat the groundwater extracted on-site under the VCA.

Limitations: The following factors may limit the applicability and effectiveness of the process:

- The potential exists for inorganic (e.g., iron greater than 5 ppm, hardness greater than 800 ppm) or biological fouling of the equipment, requiring pretreatment or periodic column cleaning.
- Most effective for contaminated water with VOC or semi-volatile concentrations with a dimensionless Henry's constant greater than 0.01.
- Consideration should be given to the type and amount of packing used in the tower.
- Process energy costs are high.
- Compounds with low volatility at ambient temperature may require preheating of the groundwater.
- Off-gases may require treatment based on mass emission rate.

B) Granular Activated Carbon

Liquid phase carbon adsorption is a technology in which groundwater is pumped through one or more vessels containing activated carbon to which dissolved organic contaminants adsorb. When the concentration of contaminants in the effluent from the bed exceeds a certain level, the carbon can be regenerated in place; removed and regenerated at an off-site facility; or removed and disposed. Carbon used for explosives- or metals-contaminated groundwater probably cannot be regenerated and should be removed and properly disposed. Adsorption by activated carbon has a long history of use in treating municipal, industrial, and hazardous wastes.

The two most common reactor configurations for carbon adsorption systems are the fixed bed and the pulsed or moving bed. The fixed-bed configuration is the most widely used for adsorption from liquids. Pretreatment for removal of suspended solids from streams to be treated is an important design consideration. If not removed suspended solids in a liquid stream may accumulate in the column, causing an increase in pressure drop. When the pressure drop becomes too high, the accumulated solids must be removed, for example, by backwashing. The solids removal process necessitates adsorber downtime and may result in carbon loss and disruption of the mass transfer zone.

The duration of GAC is usually short-term; however, if concentrations are low enough, the duration may be long-term. The duration of operation and maintenance is dependent on the capture of the groundwater contamination from the pumping system.

Applicability: The target contaminant groups for carbon adsorption are hydrocarbons. Liquid phase carbon adsorption is effective for removing contaminants at low concentrations (less than 10 mg/L) from water at nearly any flow rate, and for removing higher concentrations of contaminants from water at low flow rates (typically 0.5 to 1 gpm). Carbon adsorption is particularly effective for polishing water discharges from other remedial technologies to attain regulatory compliance. Carbon adsorption systems can be deployed rapidly, and contaminant removal efficiencies are high. Logistic and economic disadvantages arise from the need to transport and decontaminate spent carbon.

Limitations: The following factors may limit the applicability and effectiveness of the process:

- The presence of multiple contaminants can impact process performance.
- Streams with high suspended solids (> 50 mg/L) and oil and grease (> 10 mg/L) may cause fouling of the carbon and may require frequent treatment. In such cases, pretreatment is generally required.
- Costs are high if used as the primary treatment on waste streams with high contaminant concentration levels.
- The quality of the carbon, as well as the operating temperature, will impact process performance.
- Small molecules are not adsorbed well.
- All spent carbon will eventually need to be properly disposed.

C) Ultraviolet (UV) Oxidation

UV oxidation is a destruction process that oxidizes organic constituents in water by the addition of strong oxidizers and irradiation with UV light. Oxidation of target contaminants is caused by direct reaction with the oxidizers, UV photolysis, and through the action of UV light, in combination with ozone (O_3) and/or hydrogen peroxide (H_2O_2). The main advantage of UV oxidation is that it is a destruction process, as opposed to air stripping or carbon adsorption, for which contaminants are extracted and concentrated in a separate phase. UV oxidation processes can be configured in batch or continuous flow modes, depending on the throughput under consideration.

The UV oxidation process is generally accomplished with low pressure lamps operating at 65 watts of electricity for ozone systems and lamps operating at 15kW to 60kW for hydrogen peroxide systems.

Applicability: Practically any organic contaminant that is reactive with the hydroxyl radical can potentially be treated. A wide variety of organic contaminants are susceptible to destruction by UV/oxidation, including chlorinated hydrocarbons used as industrial solvents and cleaners. Typically, easily oxidized organic compounds, such as those with double bonds (e.g., TCE, PCE, and vinyl chloride), as well as simple aromatic compounds (e.g., toluene, benzene, xylene, and phenol), are rapidly destroyed in UV/oxidation processes.

Limitations: Limitations of UV oxidation include:

- The aqueous stream being treated must provide for good transmission of UV light (high turbidity causes interference).
- Free radical scavengers can inhibit contaminant destruction efficiency. Excessive dosages of chemical oxidizers may act as a scavenger.
- The aqueous stream to be treated by UV oxidation should be relatively free of heavy metal ions (less than 10 mg/L) and insoluble oil or grease to minimize the potential for fouling.
- When UV/O_3 is used on certain volatile organics, such as TCA, the contaminants may be volatilized (e.g., "stripped") rather than destroyed. They would then have to be removed from the off-gas by activated carbon adsorption or catalytic oxidation.
- Costs may be higher than competing technologies because of energy requirements.
- Pretreatment of the aqueous stream may be required to minimize ongoing cleaning and maintenance.
- Handling and storage of oxidizers require special safety precautions.

Another component of any groundwater extraction system is a groundwater monitoring program to verify its effectiveness. Monitoring the remedial with wells and piezometers allows the operator to make continuous adjustments, as necessary, to the system in response to changes in subsurface conditions caused by the remediation.

3.2.5 Air Sparging: Air sparging is an in-situ technology in which air is injected through a contaminated aquifer. Injected air moves horizontally and vertically in channels through the soil, effectively creating an underground stripper that removes contaminants by volatilization. This injected air helps to "flush" the contaminants up into the unsaturated zone where a vapor extraction system is usually incorporated into the system to remove the generated vapor phase contamination. This technology is designed to operate at high flow rates to maintain increased contact between groundwater and soil. Oxygen, added to contaminated groundwater and unsaturated soils, can also enhance biodegradation of contaminants above and below.

Air sparging has a medium to long duration which may last, generally, up to a few years.

Applicability: The target contaminant groups for air sparging are VOCs and fuels.

Limitations: Factors that may limit the applicability and effectiveness of the process include:

- Air flow through the saturated zone may not be uniform; if this happens it could cause uncontrolled movement of potentially dangerous vapors.
- Depth of contaminants and site-specific geology must be considered.
- Air injection wells must be designed for site-specific conditions.
- Soil heterogeneity may prevent even flow of air through the soil and cause some zones to be relatively unaffected.
- Structures and concerns with mobilizing contaminants.

3.2.6 In-Situ Destruction Technologies: Several in-situ destruction technologies are available as remedial alternatives, especially for areas of high concentrations and suspected DNAPL. Destruction technologies include various forms of in-situ heating of the soil and groundwater, or the injection of oxidizing chemical compounds (usually ozone or hydrogen peroxide) to react with and ultimately destroy the contaminants. High temperature heating can be accomplished through the injection of steam, the passing electrical current, or the induction of radio frequency energy through the area of concern, breaking down the molecular structure of the contaminants. The introduction of ozone or hydrogen peroxide is accomplished by injection through wells into the soil and aquifer. In any case, the contaminants undergo varying degrees of remobilization, increased volatility, and accelerated breakdown with the goal of total destruction. An in-situ destruction system is often supplemented with a soil vapor extraction system to exert some control of the vapors generated during the thermal or chemical reactions occuring at depth.

In-situ destruction technologies are currently applied at the bench scale or pilot testing phase for the most part and have not yet been developed for full scale application with any degree of confidence.

Applicability: The target contaminant groups for in-situ destructive technologies are VOCs.

Limitations: Factors that may limit the applicability and effectiveness of the process include:

- Air flow through the saturated zone may not be uniform; if this happens it could cause uncontrolled movement of potentially dangerous vapors into basements of homes.
- Violent chemical reactions have been known to occur with enhanced oxidation application in areas of DNAPL, releasing heat and dangerous vapors.
- Contaminant breakdown to more toxic vinyl chloride, which could migrate as an uncontrolled vapor.

3.2.7 Permeable Passive/Reactive Treatment Walls: The use of a permeable passive/reactive treatment wall would involve the installation of a permeable reaction wall across the flow path of a contaminant plume, allowing the water portion of the plume to passively move through the wall. These barriers would allow the passage of water while prohibiting the movement of contaminants by employing certain "agents", such as zero-valent metals, sorbents, and microbes. The contaminants would either be degraded or retained (in a concentrated form) by the barrier material. The most appropriate permeable passive/reactive treatment wall for the AVM-Gowanda site would be an iron treatment wall, which is described below.

An iron treatment wall consists of iron granules or other iron bearing minerals for the treatment of chlorinated contaminants such as TCE, DCE, and vinyl chloride. As the iron is oxidized, a chlorine atom is removed from the compound by one or more reductive dechlorination mechanisms, using electrons supplied by the oxidation of iron . The iron granules are dissolved by the process, but the metal disappears so slowly that the remediation barriers can be expected to remain effective for many years.

Applicability: Target contaminant groups for passive treatment walls are VOCs, SVOCs, and inorganics.

Limitations: Factors that may limit the applicability and effectiveness of the process include:

- Passive treatment walls may lose their reactive capacity, requiring replacement of the reactive medium.
- Passive treatment wall permeability may decrease due to precipitation of metal salts.
- The depth and width of barrier is limited to a subsurface lithology that has a continuous aquitard at a depth that is within the vertical limits of trenching equipment.
- The volume/cost of treatment medium.
- Biological activity or chemical precipitation may limit the permeability of the passive treatment wall.
- Design considerations must take into account that breakdown products will develop during the dechlorination process (i.e. 1,1-dichloroethane and vinyl chloride), which could be more difficult to treat than the initial compounds of concern, requiring significant increases in reactive wall thickness for adequate treatment.

3.3 Identification of Remedial Approach for DNAPL

In the EPA document entitled *Presumptive Response Strategy and Ex-situ Treatment Technologies for Contaminated Groundwater at CERCLA Sites*, there is a discussion on the long-term goals to address the presence of DNAPL. DNAPL is considered as a "principal threat" because it will act as a continuing source of contamination to the groundwater. It is the expectation of the NCP to "use treatment to address the principal threats posed by a site, wherever practicable" (Federal Register, 1990a; Section 300.430(a)(1)(iii)(A)). However, based on program experience, the removal of DNAPL from the subsurface can be very difficult. Therefore, the approach that will be proposed to address DNAPL will be to reduce the quantity of/control the migration of DNAPL, to the extent practicable. This will include enhancement to pump and treat options such as cosolvent or surfactant flushing. This approach will be included as a part of the preferred remedy later in this document.

3.4 Summary of Remedial Alternatives Identified

The following is a summary of the remedial alternatives that have been identified for the AVM-Gowanda Site:

Remedial Alternatives Identified

- No Further Action/Groundwater Monitoring
- Monitored Natural Attenuation
- In-Well Air Stripping
- Groundwater Extraction and Treatment
    - Air Stripping
    - Granular Activated Carbon
    - Ultraviolet Oxidation

- Air sparging
- In-Situ Destruction (Chemical oxidation, thermal)
- Permeable Passive/Reactive Treatment Walls
- Cosolvent or surfactant enhancement for groundwater extraction to address potential DNAPL near the source area.

SECTION 4 - PRELIMINARY SCREENING OF ALTERNATIVES

Below is a discussion of the technology that were eliminated as a part of the preliminary screening, and the basis for their elimination.

4.1 Screening Criteria

The criteria used to evaluate technology during the screening of alternatives include effectiveness and implement ability, discussed further below.

Short-term effectiveness assesses the impacts of the alternative during the construction and implementation phase. Alternatives are evaluated with respect to their effects on human health and the environment during implementation of the remedial action. The aspects evaluated include: protection of the community during remedial actions, environmental impacts as a result of remedial actions, time until the remedial response objectives are achieved, and protection of workers during the remedial action.

Long-term Effectiveness addresses the results of a remedial action in terms of its permanence and quantity/nature of waste or residual remaining at the site after response objectives have been met.

The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the waste or residual remaining at the site and operating system necessary for the remedy to remain effective. The factors being evaluated include the permanence of the remedial alternative, magnitude of the remaining risk, adequacy of controls used to manage residual waste, and the reliability of controls used to manage residual waste.

Implementability addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. The evaluation includes: feasibility of construction and operation; the reliability of the technology; the ease of undertaking additional remedial action; monitoring considerations; activities needed to coordinate with other offices or agencies; availability of adequate off-site treatment, storage, and disposal services; availability of equipment; and the availability of services and materials.

4.2 Screening of Alternatives

After reviewing the alternatives identified, it became apparent that some of the alternatives were not appropriate for the AVM-Gowanda site, based on an evaluation utilizing the screening criteria identified above. The following is a summary of the alternatives that were eliminated from further consideration, and the basis for their elimination.

USEPA guidance requires the source of contamination be remediated before MNA can be considered. Although there is currently a pump and treat system operating on-site, hydrogeologic and chemical data strongly suggest a continuing source of contamination in the form DNAPL exists down gradient of the site beyond the influence of the existing system. Additionally, high concentrations of VOCs, are present throughout the contaminant plume, with little evidence that natural processes are actively reducing contamination in the groundwater. Therefore, monitored natural attenuation has been eliminated as stated above alternatives from the screening process.

Significant groundwater contamination exists directly beneath residential dwellings at relatively shallow depths. The inherent risks of potentially driving uncontrolled vapors into home basements associated with the in-situ destruction technologies, both chemical and thermal, have resulted in elimination of these alternatives from the screening process.

For similar reasons associated with contaminant vapors, air sparging has also been eliminated from the screening process. The potential for uncontrolled vapors being driven into basements of homes would actually exacerbate exposure pathways rather than mitigate them.

4.3 Alternatives Retained for Evaluation During the Detailed Analysis

The following alternatives have been retained for the detailed analysis of alternatives:

- No Further Action/Groundwater Monitoring

- In-Well Air Stripping
- Groundwater Extraction and Treatment
  - Air Stripping
  - Granular Activated Carbon
  - Ultraviolet Oxidation
- Permeable Passive/Reactive Treatment Walls
- Cosolvent or surfactant enhancement for groundwater extraction to address potential DNAPL near the source area

SECTION 5 - DETAILED ANALYSIS OF ALTERNATIVES

5.1 Description of Evaluation Criteria

In Section 5.2, each of the alternatives is analyzed with respect to the criteria outlined in the 6 NYCRR Part 375 and NYCRR, which defines the selection process for remedial actions at inactive hazardous waste sites. Each alternative is analyzed with respect to:

1. Overall Protection of Human Health and the Environment: This criterion serves as a final check to assess whether each alterative meets the requirements that are protective of human health and the environment. The overall assessment of protection is based on a composite of factors assessed under other evaluation criteria; especially long-term effectiveness and performance, short-term effectiveness, and compliance with SCGs. This evaluation focuses on how a specific alternative achieves protection over time and how site risks are reduced. The analysis includes how each source of contamination is to be eliminated, reduced or controlled for each alternative.

2. Compliance with SCGs: This evaluation criterion determines how each alternative complies with applicable or relevant and appropriate SCGs, as discussed and identified in Section 1.7. The actual determination of which requirements are applicable or relevant and appropriate is made by the NYSDEC in consultation with the NYSDOH. If an SCGS is not met, the basis for one of the four waivers allowed under 6 NYCRR Part 375-1.10(c)(I) is discussed. If an alternative does not meet the SCGs and a waiver is not appropriate or justifiable, such an alternative should not be considered further.

3. Short-term Impacts and Effectiveness: This evaluation criterion assesses the effects of the alternative during the construction and implementation phase. Alternatives are evaluated with respect to their effects on human health and the environment during implementation of the remedial action. The aspects evaluated include: protection of the community during remedial actions, environmental impacts as a result of remedial actions, time until the remedial response objectives are achieved, and protection of workers during the remedial action.

4. Long-term Effectiveness and Permanence: This evaluation criterion addresses the results

of a remedial action in terms of its permanence and quantity/nature of waste or residual remaining at the site after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the waste or residual remaining at the site and operating system necessary for the remedy to remain effective. The factors being evaluated include the permanence of the remedial alternative, magnitude of the remaining risk, adequacy of controls used to manage residual waste, and the reliability of controls used to manage residual waste.

5. **Reduction of Toxicity, Mobility and Volume**: This evaluation criterion assesses the remedial alternative's use of the technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous wastes as their principal element. The NYSDEC's policy is to give preference to alternatives that eliminate any significant threats at as site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in the contaminants mobility, or reduction of the total volume of contaminated media. This evaluation includes: the amount of the hazardous materials that would be destroyed or treated, the degree of expected reduction in toxicity, mobility, or volume measured as a percentage, the degree in which the treatment would irreversible, and the type and quantity of treatment residuals that would remain following treatment.

6. **Implementability**: This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. The evaluation includes: feasibility of construction and operation; the reliability of the technology; the ease of undertaking additional remedial action; monitoring considerations; activities needed to coordinate with other offices or agencies; availability of adequate off-site treatment, storage, and disposal services; availability of equipment; and the availability of services and materials.

7. **Cost**: Cost estimates are prepared and evaluated for each alternative. The cost estimates include capital costs, operation and maintenance costs, and future capital costs. A cost sensitivity analysis is performed which includes the following factors: the effective life of the remedial action, the O&M costs, the duration of the cleanup, the volume of contaminated material, other design parameters, and the discount rate.

8. **Community Acceptance**: After completion of the FS, a Proposed Remedial Action Plan (PRAP) is prepared and released to the public for comment. Concerns of the community regarding the RI/FS reports the PRAP are evaluated. A "Responsiveness Summary" will be prepared that presents the public comments received and how the Department will address the concerns raised. If the final remedy selected differs significantly from the proposed remedy, notices to the public will be issued describing the differences and reasons for the changes.

5.2 Evaluation of Remedial Alternatives

All remedial alternatives evaluated below would include the continued operation and maintenance of the groundwater extraction and treatment system currently operating on-site under the VCA.

Each of the alternatives below also include routine monitoring of groundwater and indoor air in the houses along Torrance Place as a measure of effectiveness and to ensure the remedy continues to be protective of human health. The costs associated with this monitoring over the expected duration of the remedy is reflected in the annual operation and maintenance (O&M) and the present worth for each alternative.

5.2.1 No Further Action/ Groundwater Monitoring: The no action alternative is evaluated as a procedural requirement and as a basis for comparison. It requires continued monitoring of groundwater and indoor air only, allowing the site to remain in its current state. This alternative would leave the site in its present condition and would not provide any additional protection to human health or the environment.

<u>No Further Action/Groundwater Monitoring</u>	
Present Worth	$355,000
Capital Cost	$ 0
Annual O&M	$ 30,000 (years 0-3)
	$ 16,000 (years 4-30)
Time to Implement	NA

Overall Protection of Human Health and the Environment: Although this alternative does not result in any increased short-term risks, it does not comply with chemical-specific SCGs, and is not effective in the long term. This alternative would not be protective of human health or the environment within an acceptable time frame.

Compliance with SCGs: This alternative would not involve any further active remediation of groundwater, groundwater standards would not be achieved in the near future, and contaminated groundwater would continue to migrate northward.

Short-Term Impacts and Effectiveness: Since the only action would be groundwater monitoring, the only short-term impact would be the possibility of exposure of the samplers to the groundwater. Exposure would be significantly reduced through the use of appropriate levels of personal protective equipment and health and safety procedures. It is unlikely that there would be any increased risk to the public or impacts to the environment during the groundwater monitoring.

Long-Term Effectiveness and Permanence: Since no further active remediation would take place, this alternative would not be effective in reducing contaminant concentrations in the groundwater in a reasonable time frame.

Reduction of Toxicity, Mobility, and Volume: This alternative would not significantly reduce the toxicity, mobility, or volume of the contamination in groundwater. Natural processes could slowly reduce the contamination, but the time frame would be unacceptable.

Implementability: This alternative would be easily implemented. There would be no activities that would need coordination with other agencies during implementation. This alternative would require sampling of groundwater for an extended period of time (30 years is assumed for cost purposes).

Cost: The would be no capital cost for this alternative. The annual O&M cost is $30,000 for the first 3 years and $16,000 thereafter, based on a conservative scenario of sampling seven wells quarterly for the first 3 year, and then annually for up to 30 years, and 8 houses semi-annually for 30 years. The present worth value of this alternative is $355,000 using a 5% discount rate over 30 years.

5.2.2 In-Well Air Stripping: This alternative would involve the installation of in-situ air stripping wells throughout the contaminant plume area, where VOCs would be stripped from the groundwater within the well and transferred in vapor phase via a pipeline to a central treatment area. The vapors would then be treated with options similar to the groundwater extraction alternatives, or if necessary, with granular activated carbon or UV/Oxidation. As the groundwater is processed within the well, it is discharged through an upper screen back into the unsaturated soil above the water table, creating a circulation pattern as it precipitates back to the water table. Due to the relatively impermeable nature of unsaturated soils (flood plain silt and clay), infiltration galleries would need to be excavated, backfilled with select gravel, and the well installed through the backfill material. Continued periodic monitoring of groundwater and indoor air would be performed as a measure of effectiveness of the remedial system.

<u>In-well Air Stripping</u>

Present Worth	$3,223,000
Capital Cost	$2,343,000
Annual O&M	(years 0-3)$121,000
	(years 4-10)$95,000
Time to Implement	6-9 Months
Estimated Time to Completion	10 years

Overall Protection of Human Health and the Environment: The short-term risks associated with this alternative could be easily mitigated with proper controls. This alternative would be protective of human health through significant reduction in contaminant concentrations in the groundwater, thus minimizing volatilization of contaminants contained spread of plume into basements of houses. The time to implement the alternative is estimated at 6 to 9 months, and based on vendor supplied information from similar sites, the length of operation of the system is estimated at approximately 7 to 10 years.

Compliance with SCGs: This alternative would remove and treat VOCs from the groundwater throughout the contaminant plume. Action-specific SCGs for this alternative apply to the excavation and handling of site soils during well installation (monitoring requirements, and OSHA health and safety requirements). Compliance with these SCGs would be achieved by following a site-specific health and safety plan. This treatment system could incorporate an air emission source that would be subject to New York regulations 6 NYCRR 200, 201, and 212, and the New York Air Guide 1, Guidelines for the Control of Toxic Ambient Air Contaminants. Since the air emissions would be treated, as appropriate, these regulatory requirements would be met.

6 NYCRR Part 703, Groundwater Quality Standards, would apply to the groundwater. In-well air stripping has not been widely utilized, therefore it is uncertain how much time is needed for this technology to lower contaminant concentrations, and it is difficult to achieve groundwater standards. However, by hydraulically containing the plume the continued migration of contaminants would be controlled, thereby preventing the volume of contaminated groundwater from increasing.

Short-Term Impacts and Effectiveness: There would be a potential for worker exposure during installation of the in-situ air stripping wells. This exposure could be significantly reduced through the use of personal protection equipment. Air and water emission controls would prevent worker and resident exposure to airborne and waterborne contaminants. Excavation for the installation of power supply to the pumping wells and associated piping necessary to convey the VOC laden airstream to the treatment area on Gowanda Electronics property would be above the water table within the flood plain silt, therefore exposure to airborne contaminants are not expected. However, continuous monitoring and implementation of emission controls, as necessary, would be performed during construction.

Long-Term Effectiveness and Permanence: Contaminants would be permanently removed from the groundwater over time.

Reduction of Toxicity, Mobility, and Volume: This alternative would significantly reduce the toxicity, mobility, and volume of the contamination in groundwater through direct removal of the contaminants.

Implementability: This alternative would be easily implemented from a construction standpoint, however recent attempts to procure these technologies have not been successful due to the proprietary nature of the systems and the State's contracting requirements. There would be activities that would need coordination with other agencies and property owners during implementation. Specifically, utility clearances and working permits from the Village would be required for working in the streets. This alternative would require sampling of groundwater for an extended period of time to monitor effectiveness (10 years are assumed for cost estimating)

Cost: Cost estimates (shown at the beginning of this section) for this alternative have been developed based on a comparison with another FS for a site of similar hydrogeologic and contaminant characteristics and size. The estimate was then increased by a factor appropriate to reflect the discrepancy observed during the bid process compared to engineering estimates at other sites. Inflated costs have been proposed during the bid process on similar remedial projects, exceeding ten times the engineers estimate and several times more expensive than comparable groundwater treatment systems such as pump and treat. Actual costs for this alternative could be expected to vary significantly, however experience has shown there is no reliable method of developing representative estimates due to the severely limited competition in the current marketplace.

5.2.3 Groundwater Extraction and Treatment: This alternative would involve the installation groundwater pumping wells throughout the extent of the contaminant plume, installed to the top of glacial till. Alternatively, groundwater collection trenches excavated to the top of the glacial till would be installed in areas where implementation could easily be accomplished, i.e. areas without buried utilities such as gas, water, and sewer. Due to the channelized nature of the alluvium, collection trenches would be more effective for intercepting preferential flow zones (sand and gravel channel deposits), ensuring complete capture of contaminated groundwater flowing through the alluvial aquifer. It is estimated that the system would operate at an average withdrawal rate of approximately 5 gallons per minute per well (based on current pumping rates for the on-site VCA well) or 20 to 50 gallons per minute within a collection trench extending up to 500 feet across the aquifer, for an estimated period of 30 years. Extraction wells and/or collection trenches would be installed at locations over the entire plume, to separate the plume into smaller sections thereby significantly reducing the time frame required to remediate the aquifer. Once removed, the groundwater would be pumped to the Gowanda Electronics property, treated, and discharged to either surface water or the sanitary sewers, as necessary and appropriate. Continued periodic monitoring of groundwater and indoor air would be performed as a measure of effectiveness of the remedial system.

This section discusses groundwater pump and treat as one alternative. Three different "treat" options are potentially applicable for this site including air stripping (volatile organics are partitioned from extracted ground water by aerating or increasing the surface area of the contaminated water exposed to air; aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration), granular activated carbon (water passes through the carbon system and contaminant molecules are removed from the water by adsorption to the carbon), and ultraviolet oxidation (UV oxidation is a destruction process that oxidizes organic contamination in the water by the addition of strong oxidizers and irradiation with UV light). Treatment via tray aeration air stripping is currently used effectively on site to treat groundwater extracted under the VCA. Therefore, it is also included in the preferred remedy, so that a cost estimate could be developed. However, if included as a part of the preferred remedy, the final decision on the method of treatment for the extracted groundwater would be deferred until the Remedial Design.

Since DNAPL is strongly suspected between the source area and Torrance Place, action must be taken to address this continuing source of contamination to groundwater. Data from the seismic survey indicate that rather than existing in pools as originally believed during the RI, the DNAPL likely exists as ganglia within the pore structure of the aquifer and would therefore be very difficult to remove. The only practical way to address the need to collect/control migration of DNAPL would be to enhance the groundwater extraction with either cosolvents or surfactants, which would dissolve or break loose the DNAPL from the pore space and remobilize it within the aquifer. Cosolvents or surfactants would be injected periodically near the source area only after pumping wells along Torrance Place had established a strong zone of influence to ensure recovery of any remobilized DNAPL . The treatment system would be equipped with a DNAPL "knockout" stage, where DNAPL would be separated from the groundwater. The recovered DNAPL would be temporarily stored on site until enough accumulates to be sent off-site for destruction by incineration. At the end of an estimated five year period, the system would be evaluated and a determination made on whether to continue/ make adjustments to enhance the recovery system, as appropriate.

Groundwater Extraction (**Air stripping**)

Present Worth	$2,582,000
Capital Cost	$485,000
Annual O&M	(years 0-3) $124,000
	(years 4 through 30) $104,000
Time to Implement	6 - 9 months
Estimated Time to Completion	30 years

Overall Protection of Human Health and the Environment: The short-term risks associated with this alternative could be easily mitigated with proper controls. This alternative would reduce the possibility of exposure to contaminated groundwater by controlling/treating it on-site, thus minimizing it as a continuing source for off-site areas. The time to implement the alternative is estimated at 6 to 9 months, and the length of operation of the system is estimated at 30 years.

Compliance with SCGs: This alternative would remove and treat contaminated groundwater throughout the contaminant plume. Action-specific SCGs for this alternative apply to the excavation and handling of site soils during well installation (monitoring requirements, and OSHA health and safety requirements). Compliance with these SCGs would be achieved by following a site-specific health and safety plan. This treatment system could incorporate an air emission source that would be subject to New York regulations 6 NYCRR 200, 201, and 212, and the New York Air Guide 1, Guidelines for the Control of Toxic Ambient Air Contaminants. Since the air emissions would be treated, as appropriate, these regulatory requirements would be met. The treatment system would also result in a water discharge. This water would either be discharged to surface waters or to the local publicly owned treatment works (POTW). If discharged to surface waters, it would be subject to New York regulations for SPDES discharges; if discharged to the POTW, coordination with the local municipality would be required. Since the water discharge would be treated, these requirements would be met.

6 NYCRR Part 703, Groundwater Quality Standards, would apply to the groundwater. The history of groundwater extraction and treatment shows that overall, time is needed for this technology to lower contaminant concentrations, and that it is difficult to achieve groundwater standards. However, by hydraulically containing the plume the continued migration of contaminants would be controlled, thereby preventing the volume of contaminated groundwater from increasing.

Short-Term Impacts and Effectiveness: There would be a potential for worker exposure during installation of both groundwater extraction wells and collection trenches. This exposure could be significantly reduced through the use of personal protection equipment. Excavation techniques for installation of the groundwater collection trenches such as the "one pass" system would greatly reduce exposure to contaminated soils, groundwater, and air emissions. Air and water emission controls would prevent worker and resident exposure to airborne and waterborne contaminants. Excavation for the installation of power supply to the pumping wells and associated piping necessary to convey the contaminated water to the treatment area on Gowanda Electronics property would be above the water table within the flood plain silt, therefore exposure to airborne contaminants are not expected. However, continuous monitoring and implementation of emission controls, if necessary, would be performed during construction.

Long-Term Effectiveness and Permanence: Groundwater concentrations would be expected to decrease with time as a result of the extraction and treatment of the contaminated groundwater, assisted by natural processes. If appropriate, the enhancement with cosolvents or surfactants would dislodge and allow removal of any remaining source DNAPL, providing for permanent restoration of the aquifer.

Reduction of Toxicity, Mobility, and Volume: By removing contaminants from the groundwater and treating the removed contaminants, the toxicity and volume of the contaminants in the groundwater in this location would be reduced. Since hydraulically containing the contaminant plume would prevent further migration of contaminants in groundwater, the contaminant mobility would be significantly reduced, and an increase in the volume of contaminated groundwater would be avoided.

Implementability: The equipment and material needed to install a groundwater extraction and treatment systems are commercially available from several vendors. There are no anticipated administrative or legal barriers to the implementation of this alternative. The ability to construct a groundwater collection trench along or within the streets would be significantly complicated by the presence of buried utilities, whereas the installation of extraction wells could easily be accomplished by drilling vertically between the horizontal utility lines. The injection of surfactants or cosolvents would require coordination with current site owner and also require a temporary variance from 6 NYCRR Part 703, Groundwater Quality Standards.

Cost: The costs are discussed at the beginning of this section.

5.2.4 Permeable Passive/Reactive Iron Walls: This alternative would involve the installation of reactive media (reactive iron is the most appropriate for the site specific contaminants) in the form of a wall across a vertical section of the groundwater contaminant plume. This would be accomplished by excavating a trench east to west, perpendicular to the flow of groundwater to the top of the lodgement till, the trench would be backfilled with the reactive media to above the water table, then clean fill to ground surface and seeded or paved as appropriate. As groundwater passes through the wall, oxidation of the iron provide electrons for the dechlorination of the contaminants in the groundwater, treating the groundwater as it naturally flow to the north. Due to the relatively high groundwater velocities and high contaminant concentrations within the southern and central sections of the plume, significant horizontal thickness of reactive iron media would be required to adequately reduce the compounds of concern and associated breakdown products that are expected during the dechlorination process that occurs within the reactive wall. Several walls (3 assumed for cost estimate purposes) would be installed across the plume so that the plume would be broke into three segments to stop continued migration of contaminated groundwater. Eventually, the treated water emerging beyond the first reactive iron wall would reach the next reactive iron wall under natural flow gradients, to the point that groundwater between the reaction walls would be completely treated. This would not be expected to occur as a sharply defined line between contaminated and clean groundwater due to mixing and adsorption of contaminants to soil particles, but rather as a gradual decrease in concentration until contaminants have either been flushed through the aquifer to the reactive wall or degraded under natural biologic processes. Chemical and hydraulic groundwater monitoring on each side of each wall would be performed to ensure the walls were breaking down the contamination and not restricting natural flow patterns. Additionally, periodic monitoring of groundwater and indoor air would be performed as a measure of effectiveness of the remedial system.

With this alternative, no groundwater is removed or diverted and there is no need for further treatment.

<u>Permeable Passive/Reactive Iron Walls</u>	
Present Worth	$ 3,937,000
Capital Cost	$3,709,000
Annual O&M	(years 0-3)$ 46,000
	(years 4-30) $20,000
Time to Implement	6 - 9 months
Estimated Time to Completion	30 years

Overall Protection of Human Health and the Environment: The short-term risks associated with this alternative could be easily mitigated with proper controls. This alternative would reduce the possibility of exposure to contaminated groundwater by treatment below ground and reduce the exposure to contaminated indoor air by reduction of contaminant concentrations in groundwater. The time to implement the alternative is estimated at 6 to 9 months, and the length of operation of the system is estimated at approximately 30 years.

Compliance with SCGs: This alternative would treat contaminated groundwater throughout the contaminant plume. Action-specific SCGs for this alternative apply to the excavation and handling of site soils during reactive wall installation (monitoring requirements, and OSHA health and safety requirements). Air emission and water discharge criteria would not apply to this alternative.

6 NYCRR Part 703, Groundwater Quality Standards, would apply to the groundwater. The relatively short history of reactive wall technology show it to be effective for achieving groundwater standards at similar sites.

Short-Term Impacts and Effectiveness: There would be a potential for worker exposure during installation of the reactive walls. This exposure could be significantly reduced through the use of personal protection equipment. Air and water emission controls would prevent worker and resident exposure to airborne and waterborne contaminants. Excavation techniques such as the "one pass" system would greatly reduce exposure to contaminated soils, groundwater, and air emissions.

Long-Term Effectiveness and Permanence: Groundwater concentrations would be expected to decrease with time as a result of the destruction of contaminants within the groundwater, assisted by natural processes.

Reduction of Toxicity, Mobility, and Volume: By destroying contaminants within the groundwater, the toxicity and volume of the contaminants in the groundwater in this location would be reduced. Mobility of contaminants would be restricted according to the spacing between the reactive walls.

Implementability: The equipment and material needed to install reactive iron walls are commercially available from several vendors. There are no anticipated administrative or legal barriers to the implementation of this alternative. Installation requires the excavation of a continuous trench to depths approaching 30 feet in depth and over 10 feet in width in the areas of highest contaminant levels, therefore installation in areas of buried utilities, gas, water, and sewer, would be difficult.

Cost: The costs are discussed at the beginning of this section.

5.2.5 Groundwater extraction in combination with Permeable Passive/Reactive Iron Wall: This alternative would involve the installation groundwater extraction wells along Torrance Place, the installation of a groundwater collection trench across the plume located between Torrance Place and Chestnut Street, and the installation of a reactive iron wall at the leading edge of the contaminant plume between Chestnut Street and Walnut Street. With this alternative, groundwater with the highest degree of contamination, generally in the vicinity of Torrance Place, would be extracted through the pumping wells and the collection trench, then treated on the Gowanda Electronics property as discussed in section 5.3.4 above. Also as discussed above, enhancement using either surfactants or cosolvents may be implemented if operational data indicate a DNAPL is present. Pumping from beneath Torrance Place is expected to create a zone of influence that will extend northward to approximately beneath the homes on the north side of the street, and southward to meet and compliment the current zone of influence resulting from the on-site pumping well. Contaminated groundwater beyond the influence of the pumping wells would continue to migrate north to be intercepted by the collection trench. The hydraulic zone of influence of the collection trench would be controlled to work with the pumping wells to efficiently remove contaminants and to ensure contaminants are not drawn northward beneath the residences on the north side of Torrance Place. For cost estimation purposes, the extraction system, including the wells and collection trench, has been conservatively estimated to generate 100 gallons per minute of groundwater. Contaminated groundwater beyond the northern influence of the collection trench would continue to migrate northward and be intercepted by the reactive iron wall, where the reaction described in Section 5.3.2 would occur and allow treated groundwater to emerge out of the north side of the wall.

<u>Groundwater extraction in combination with Permeable Passive/Reactive Iron Wall</u>

Present Worth	$ 2,685,000
Capital Cost	$688,000
Annual O&M	(years 0-3) $124,000
	(years 4-30) $98,000
Time to implement	6 - 9 months
Estimated Time to Completion	30 years

Overall Protection of Human Health and the Environment: The short-term risks associated with this alternative could be easily mitigated with proper controls. This alternative would reduce the possibility of exposure to contaminated groundwater by controlling/treating it on-site through the use of extraction wells as well as treatment below ground through the use of the reactive iron Wall. This alternative would reduce the exposure to contaminated indoor air by reduction of contaminant concentrations in groundwater. The time to implement the alternative is estimated at 6 to 9 months, and the length of operation of the system is estimated at approximately 30 years.

Compliance with SCGs: The groundwater extraction component of this alternative would remove and treat contaminated groundwater from the area of the plume containing the highest levels of contamination while the reactive iron wall component would intercept and treat contaminated groundwater throughout the remainder of the plume. Action-specific SCGs for this alternative apply to the excavation and handling of site soils during well installation (monitoring requirements, and OSHA health and safety requirements). Compliance with these SCGs would be achieved by following a site-specific health and safety plan. The treatment system associated with the extraction component could incorporate an air emission source that would be subject to New York regulations 6 NYCRR 200, 201, and 212, and the New York Air Guide 1, Guidelines for the Control of Toxic Ambient Air Contaminants. Since the air emissions would be treated, as appropriate, these regulatory requirements would be met. The treatment system would also result in a water discharge. This water would either be discharged to surface waters or to the local publicly owned treatment works (POTW). If discharged to surface waters, it would be subject to New York regulations for SPDES discharges; if discharged to the POTW, coordination with the local municipality would be required. Since the water discharge would be treated, these requirements would be met.

6 NYCRR Part 703, Groundwater Quality Standards, would apply to the groundwater. The history of groundwater extraction and treatment shows that overall, time is needed for this technology to lower contaminant concentrations, and that it is difficult to achieve groundwater standards. However, by hydraulically containing the plume the continued migration of contaminants would be controlled, thereby preventing the volume of contaminated groundwater from increasing. The relatively short history of reactive wall technology show it to be effective for achieving groundwater standards at similar sites.

Short-Term Impacts and Effectiveness: There would be a potential for worker exposure during installation of the extraction wells and reactive iron wall. This exposure could be significantly reduced through the use of personal protection equipment. Air and water emission controls would prevent worker and resident exposure to airborne and waterborne contaminants. Excavation techniques for installation of the reactive iron wall such as the "one pass" system would greatly reduce exposure to contaminated soils, groundwater, and air emissions.

Long-Term Effectiveness and Permanence: Groundwater concentrations would be expected to decrease with time as a result of the removal and treatment of contaminated groundwater in the area of extraction and the destruction of contaminants within the groundwater intercepted by the reactive iron wall, assisted by natural processes. Additionally, removal of the suspected DNAPL, if confirmed, will be greatly accelerated through surfactant or cosolvent enhancement to the extraction system.

Reduction of Toxicity, Mobility, and Volume: By both removal and destruction of contaminants within the groundwater, the toxicity and volume of the contaminants in the groundwater in this location would be reduced. Mobility of contaminants would be restricted according to the influence of the extraction wells and the spacing between the collection trench and the reactive wall.

Implementability: The equipment and material needed to install a groundwater extraction and treatment system and the reactive iron wall are commercially available from several vendors. There are no anticipated administrative or legal barriers to the implementation of this alternative. Installation of the reactive iron wall at the leading edge of the plume requires the excavation of a continuous trench to depths approaching 15 feet. Installation of the collection trench requires the continuous excavation of a trench to depths approaching 20 feet. The areas of buried utilities; gas, water, and sewer, along Torrance Place would be addressed with the extraction wells.

Cost: The costs are discussed at the beginning of this section.

5.3 Comparative Analysis of Alternatives

Overall Protection of Human Health and the Environment: The no further action alternative would not be protective of human health or the environment within an acceptable time frame. The remaining alternatives would actively address the contamination and would be protective of human health and the environment through either removal and/or destruction of contaminants. In-well air stripping published data suggest remediation could be expected within 7 to 10 years, pump and treat historical data suggest up to 30 years or more may be necessary. If DNAPL remains in the subsurface as a continuing source of contamination, as expected, the cosolvent or surfactant enhancement will be necessary to meet or possibly shorten these time expectations. The combined groundwater extraction and reactive iron wall alternative would still provide for the DNAPL enhanced recovery if necessary. Reactive iron wall remediation time would be dependent on the natural velocity of groundwater flow, which varies throughout the plume, the degree of the saturated soil's ability to adsorb contaminants, and the number and spacing of walls installed.

Compliance with SCGs: The no further action alternative would not meet SCGs since significant concentrations of contaminants would remain in the groundwater. SCGs for groundwater would be met with the remain alternatives. Since they will be injected into the aquifer, selection of specific cosolvents or surfactants will be based on compliance with SCGs for groundwater. Engineering controls would be employed to ensure SCGs for emissions and soils were met during construction and operation of all alternatives.

Short-Term Impacts and Effectiveness: The no further action alternative would cause no increased short-term impacts since no intrusive work would take place.

All the alternatives except the no further action alternative would involve the handling of contaminated media. These actions could potentially impact worker health and safety, the environment, and the local community. In-situ well air stripping would have limited potential for worker exposure, since the only intrusive activity would be the installation of wells. Groundwater extraction would have more potential due to the installation of groundwater collection trenches in addition to the wells. Subsurface work for either of these alternatives associated with power supply and plumbing are not expected to have any significant impact due to the relatively shallow depth and distance from the water table, however continuous monitoring would be performed during construction. Reactive iron walls would involve more extensive soil handling, since an increased volume of contaminated soil would be excavated and hauled off-site during installation. However, the use of engineering controls would minimize and/or eliminate any possible impact during excavation. These controls would include air monitoring, personal protective equipment, and dust suppression measures. Off-site disposal could pose a short-term risk due to possible spilling of contaminated media offsite. This could be mitigated by properly covering contaminated media and by establishing proper emergency spill response measures.

The length of time over which short-term impacts would occur would be approximately 6 to 9 months during construction of these alternatives. Again, it would be possible to control these impacts through the use of engineering controls.

Long-Term Effectiveness and Permanence: The no further action alternative would allow the continued migration of contaminants through groundwater and from the groundwater into basements in vapor form. The remaining alternatives would be effective by immediately reducing contaminant concentrations through removal and/or destruction of the chemical compounds. Because the source DNAPL, if present, would be addressed and the groundwater treated, the enhanced groundwater extraction system would provide the highest degree of effectiveness and permanence. The combined groundwater extraction and reactive iron wall alternative would utilize enhanced groundwater extraction in the area of highest contamination where it is needed most. The collection trench component of the groundwater extraction and reactive iron wall alternative would provide the most effective means of terminating any further northward migration of the contaminant plume due to the fact that it would cut across the entire plume, intercepting all preferential flow pathways.

Reduction of Toxicity, Mobility, and Volume: With the no further action alternative, reduction in the toxicity, mobility, or volume of waste would occur very slowly through natural flow and dispersion of contaminants, not in an acceptable time frame. In-situ air stripping, groundwater extraction, and reactive iron walls all would reduce toxicity through the reduction in contaminant concentration; would reduce mobility through either recovery or the interception of contaminated groundwater; and would reduce volume through the actual removal or destruction of contamination from the aquifer. However, the ability of in-situ air stripping wells or groundwater extraction wells to reduce mobility are dependent on the spacing of the wells to ensure an overlapping of the zones of influence, whereas the reactive iron wall or collection trench would be more effective since it would be installed over the entire cross section of the aquifer. The goal of the groundwater extraction enhancement with cosolvent and surfactant would be to increase mobility of contaminants only once the groundwater extraction system demonstrates a zone of influence sufficient to capture the DNAPL. Since the DNAPL is separate phase chemical product, enhanced groundwater extraction would provide a higher efficiency rate of reduction in toxicity and volume.

Implementability: The no further action alternative would be the easiest to implement, since no construction would be necessary. The remaining alternatives require substantial construction in a residential area, including private property, and therefore require additional considerations for implementation. Groundwater extraction systems are readily available from numerous contractors and are relatively easy to construct using standard well and associated utility installation procedures, but would require routine maintenance which could be difficult from a long term access to private property viewpoint. Additionally, once installed, each well would have a subsurface vault and manhole cover, which would not be expected to cause concern if constructed within a street. Wells can be located and installed in public rights of way to easily fit among buried utilities.

Construction of groundwater collection trenches are commercially available from several vendors and are relatively easy to install, involving either conventional excavation of a trench or the use of "one pass" system. The one pass system excavates and simultaneously places piping and select material to the desired depth.

Implementation of the groundwater extraction enhancements would be straightforward, involving the injection of a cosolvent or surfactant into the aquifer at the head of the plume utilizing wells already installed on the Gowanda Electronics property.

In-situ air stripping systems require construction techniques similar to groundwater extraction systems, however due to the relatively impermeable nature of unsaturated soils (flood plain silt and clay), infiltration galleries would need to be excavated, backfilled with select gravel, and the well installed through the backfill material. Commercial availability of in-situ air stripping systems is very limited. This limitation has resulted in actual costs reflected in bids on similar sites to be ten times more expensive than an engineer's estimate, and several times more expensive than comparable pump and treat systems. Due to the limited availability of the technologies, the State's procurement process has yet to generate competitive bids for a project and therefore not been able to secure a contractor to implement a system.

Reactive iron walls are commercially available from several vendors and are relatively easy to install, involving either conventional excavation of a trench or the use of "one pass" system depending on site conditions. The one pass system excavates and simultaneously excavates a trench and places select material to the desired depth. Once in place, reactive iron walls do not require any routine maintenance, only monitoring of groundwater to verify effective treatment of groundwater. Over time, it may be necessary to replace the iron media if it becomes depleted before restoration of the aquifer. Since installation requires a continuous trench from the ground surface, construction would be significantly complicated with buried utilities in public right of ways, such as the streets. Reactive walls do not require groundwater treatment and discharge.

Due to the limitations cited above, the combined groundwater extraction and reactive iron wall alternative remains the most implementable alternative, with groundwater extraction component in the area that would prove most difficult for reactive iron walls.

Cost: A summary of the costs are presented in Table 5. The costs are the present worth based on a 5% discount rate over the estimated life of the project.

SECTION 6 RECOMMENDED REMEDIAL ALTERNATIVE

The NYSDEC has performed a development and evaluation of remedial alternatives based on the guidance provided in 6 NYCRR Part 375-1.10, *Inactive Hazardous Waste Disposal Site Remedial Program, Remedy Selection*. Based on this analysis, the NYSDEC is recommending:
Groundwater extraction (pump and treat) along Torrance Place combined with groundwater collection trench and reactive iron wall to the north. Based on pump and treat operating data over the first year, the extraction system would be enhanced with a cosolvent or surfactant injection as appropriate to accelerate remediation of DNAPL.

6.1 Basis For Recommendation

The no action alternative was rejected because this alternative is not protective of human health or the environment, does not meet/satisfy SCGs, and does not satisfy the RAOs. It would leave a continuing source of contamination to the groundwater and allow expansion of the contaminated groundwater plume to the north.

In-situ air stripping was rejected due to implementation issues, specifically the inability to procure a system for remediation under the State Superfund process.

The two remaining alternatives (evaluated during detailed analysis) were groundwater extraction and treatment and reactive iron walls, both of which have proven to be effective at sites with similar characteristics. The selection of a combination system consisting of groundwater extraction in the area of highest contamination in the vicinity of Torrance Place and the installation of a reactive iron wall further to the north was largely based on implementability and minimization of impacts to private residential property. Groundwater extraction wells will be easier to install along Torrance Avenue among the buried utilities and the close proximity to the site will make it easier to transfer the contaminated water to the treatment area on the Gowanda Electronics property via underground piping. Excavation of the collection trench between Torrance Place and Chestnut Street would be relatively narrow compared to the width of a trench for reactive iron and therefore more implementable, and is located close enough to the site that the transfer of contaminated groundwater could easily be incorporated with the extraction well system. The collection trench would provide the most effective means of terminating any further northward migration of the contaminant plume due to the fact that it would cut across the entire plume, intercepting all preferential flow pathways. The reactive iron wall will be easy to install north of Chestnut Street. There are no associated buried utilities or active operation of the reactive iron walls, once installed.

A groundwater extraction system for the entire plume could have been developed, consisting of pumping wells along Torrance Place and collection trenches to the north. However the additional construction for the conveyance of contaminated groundwater to a treatment and discharge point from north of Chestnut Street as well as the continuous operation and maintenance that would have been necessary would have been more complicated than the simple installation of the passive reactive iron wall. Conversely, a remedial system of passive reactive walls over the entire plume could also have been developed, but the excavation of a continuous trench for the installation of a wall along Torrance Place would have required temporary disconnection and reconstruction of buried utilities, including sewer, gas, and water. The massive size, over 10 feet thick, of the reactive iron wall that would have been required between Torrance Place and Chestnut Street would have significantly more disruption to private property than a groundwater collection trench.

The groundwater extraction component of the selected remedy, consisting of both the collection trench and the extraction wells, will establish the highest degree of hydraulic control necessary to apply the cosolvent or surfactant enhancements with confidence that any mobilized DNAPL will be fully recovered and treated.

The combination approach to the remediation of the plume will be protective of human health and the environment, will be relatively quick to install, and is expected to be the least disruptive to the community of all the alternatives considered.

6.2 Conceptual Design of Preferred Remedy

The implementation of the remedy is discussed below in general terms. The remedial design (RD) will address the components of the remedy in detail. During the RD it may be deemed appropriate to modify various components of the conceptual design to best accommodate the treatment processes and associated equipment.

This remedy includes the continued operation and maintenance of the groundwater recovery system currently operating on-site under the VCA.

This alternative is preferred largely based on implementability and because it would have lower impacts to private residential property than any of the other alternatives. The only component of this remedy that would be visible to the public is the treatment building, which would be located on the Gowanda Electronics property. All remaining components of the remedy would be located at or below the ground surface.

The remedy will be designed and constructed to split the overall contaminant plume into three smaller units in order to accelerate the required cleanup time and prevent further migration of contamination. The natural and induced (from groundwater extraction) hydraulic gradients at the site will play a key role in the efficient achievement of the RAO's for this project. The natural groundwater flow is to the north/northwest.

The first section of the plume (nearest the source area) will consist of the area beneath and adjacent to Torrance Place. Two to three groundwater extraction wells will be installed within the street and pumped to create a zone of influence extending beneath the homes on either side of the street. This area is known to contain the highest concentration of contamination. Contaminated groundwater will be pumped back to the Gowanda Electronics property for treatment and discharge of the clean water to a surface water body, either directly or via storm sewers.

The second section of the plume will consist of the area between Torrance Place and Chestnut Street. This area will be addressed with a groundwater collection trench extending up to 500 feet across the plume approximately midway between the streets. Groundwater will be extracted at a rate to establish a maximum zone of influence on both sides of the trench without overriding the zone of influence maintained by the pumping wells at Torrance Place. This rate control is important so as not to pull contamination from within the influence of the extraction wells northward beneath the homes, yet intercept and prevent further northward migration of contaminants that are not recovered by the extraction wells. The extraction wells within Torrance

Place and the collection trench between the streets will operate together to contain and collect the majority of contaminated groundwater, from south of Torrance Place to the south side of Chestnut Street. Groundwater collected from the trench would also be pumped back to the Gowanda Electronics property for treatment and discharge of the clean water to a surface water body, either directly or via storm sewers.

It may be necessary, based on operation monitoring data, to enhance the groundwater extraction with either cosolvents or surfactants, which would dissolve or break loose the DNAPL from the pore space and remobilize it within the aquifer. Once remobilized, the DNAPL would be extracted by the extraction wells or collection trench and sent for treatment. This would be performed only after confirmation that hydraulic containment had been established for the groundwater extraction system to ensure the DNAPL would be collected.

The third and final section of the plume will consist of the area from Chestnut Street northward approximately 350 feet to the end of the plume as defined in the RI. This section will be addressed with a permeable passive reactive iron wall to intercept and treat the remaining contaminated groundwater from the plume. It is expected this wall will extend 250 feet in length, 4 feet thick, and approximately 18 feet deep. Groundwater within this section is at considerably lower contaminant concentrations and would be expected to remain so with the operation of the groundwater extraction system in the first and second sections. As groundwater within this third continues to be recharged and flow toward the reactive iron wall, contaminants will be flushed from the aquifer resulting in remediation of the area.

While each section would be addressed with a unique remedial technique, they will be operated and monitored together as a interdependent system as the most efficient remedy capable of addressing a relatively large groundwater contaminant plume. Groundwater and indoor air monitoring will be performed to measure the effectiveness of the remedy. A conceptual layout of the remedial system is shown on Figure 2.

SECTION 7 REFERENCES

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TABLE 1
Standards, Criteria, & Guidance
AVM-Gowanda Site - No. 9-05-025

Div./ Agcy.*	Title	Std./ Guid.	Requirements
DAR	Air Guide 1 - Guidelines for the Control of Toxic Ambient Air Contaminants	G	▸ control of toxic air contaminants ▸ screening analysis for ambient air impacts ▸ toxicity classifications ▸ ambient standards - short term/annual
DAR	6 NYCRR Part 200 (200.6) - General Provisions; 1/29/93	S	▸ prohibits contravention of AAQS or causes air pollution
DAR	6 NYCRR Part 201 - Permits & Certificates; 3/31/93	S	▸ prohibits construction/operation w/o permit/certificate
DAR	6 NYCRR Part 211 (211.1) - General Prohibitions	S	▸ prohibits emissions which are injurious to human, plant, or animal life or causes a nuisance
DAR	6 NYCRR Part 212 - General Process Emission Sources	S	▸ establishes control requirements
DAR	6 NYCRR Part 257 - Air Quality Standards	S	▸ applicable air quality standards
DFW	Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites (FWIA); 10/94	G	▸ habitat assessments ▸ contaminant impact assessments ▸ ecological effects of remedies ▸ remedial requirements ▸ monitoring ▸ checklist
DER	TAGM HWR-89-4031 Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites; 10/27/89	G	▸ dust suppression during IRM/RA
DER	TAGM HWR-92-4030 Selection of Remedial Actions at Inactive Hazardous Waste Sites; 5/90	G	▸ remedy selection criteria/evaluations
DER	TAGM HWR-92-4046 Determination of Soil Cleanup Objectives and Cleanup Levels; 1/24/94	G	▸ soil cleanup goals
DER	TAGM HWR-92-4048 Interim Remedial Measures - Procedures; 12/9/92	G	▸ identifying and implementing IRMs

DER	6 NYCRR Part 375 - Inactive Hazardous Waste Disposal Site Remedial Program; 5/92	S	▸ requirements regarding remedial programs ▸ private party programs, state funded programs, state assistance to municipalities
DOW	Analytical Services Protocols (ASP); 11/91	G	▸ analytical procedures
DOW	TOGS 1.1.2 - Groundwater Effluent Limitations; 8/94	G	▸ guidance for developing effluent limits for groundwater
DOW	TOGS 1.1.1 - Ambient Water Quality Standards & Guidance Values; 10/93	G	▸ compilation of ambient water quality stds. and guidance values
DOW	TOGS 1.2.1 -Industrial SPDES Permit Drafting Strategy for Surface Waters; 4/90	G	▸ guidance for developing effluent and monitoring limits for point source releases to surface water
DOW	TOGS 1.3.8 - New Discharges to Publicly Owned Treatment Works; 10/26/94	G	▸ limits on new or changed discharges to POTWs strict requirements regarding bioaccumulative and persistent substances plus other considerations
DOW	6 NYCRR Part 702-15(a), (b), (c), (d) & (e) -	S	▸ Empowers DEC to Apply and Enforce Guidance where there is no Promulgated Standard
DOW	6 NYCRR Part 700-705 - NYSDEC Water Quality Regulations for Surface Waters and Groundwater; 9/1/91	S	▸ 700 - Definitions, Samples and Tests; 701 - Classifications Surface Waters and Groundwaters; 702 - Derivation and Use of Standards and Guidance Values; 703 - Surface Water and Groundwater Quality Standards and Groundwater Effluent Standards;
DOW	6 NYCRR Part 750-757 - Implementation of NPDES Program in NYS	S	▸ regulations regarding the SPDES program
DRS	6 NYCRR Part 364 - Waste Transporter Permits; 1/12/90	S	▸ regulates collection, transport, and delivery of regulated waste
DSHM	TAGM 3028 "Contained In" Criteria for Environmental Media; 11/92	G	▸ Soil Action Levels
DSHM	6 NYCRR Part 360 - Solid Waste Management Facilities; 10/9/93	S	▸ solid waste management facility requirements landfill closures; C&D landfill requirements; used oil; medical waste; etc.
DSHM	6 NYCRR Part 370 - Hazardous Waste Management System: General; 1/14/95	S	▸ definitions of terms and general standards applicable to Parts 370-374 & 376
DSHM	6 NYCRR Part 371 - Identification and Listing of Hazardous Wastes; 1/14/95	S	▸ haz. waste determinations

DSHM	6 NYCRR Part 372 - Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities; 1/14/95	S	▸ manifest system and recordkeeping, certain management standards
DSHM	6 NYCRR Part 376 - Land Disposal Restrictions - 1/14/95	S	▸ identifies hazardous waste restricted from land disposal
DSHM	6 NYCRR Subpart 373-1 - Hazardous Waste Treatment, Storage and Disposal Facility Permitting Requirements; 1/14/95	S	▸ hazardous waste permitting requirements: includes substantive requirements
DSHM	6 NYCRR Subpart 373-2 - Final Status Standards for Owners and Operators of Hazardous Waste Treatment Storage and Disposal Facilities; 1/14/95	S	▸ hazardous waste management standards e.g., contingency plan; releases from SWMUs; closure/post-closure; container/management; tank management; surface impoundments; waste piles; landfills; incinerators; etc.
DSHM	6 NYCRR Subpart 373-3 - Interim Status Standards for Owners and Operators of Hazardous Waste Facilities - 1/14/95	S	▸ similar to 373-2
OSHA/ PESH	29 CFR Part 1910.120; Hazardous Waste Operations and Emergency Response	S	▸ health and safety
USEPA	Hydrologic Evaluation of Landfill Performance (HELP) Model Hydrologic Simulation of Solid Wast Disposal Sites	G	▸ cover system performance/hydrology
USEPA	Integrated Risk Information System (IRIS)	G	▸ verified RfDs and cancer slope factors
USEPA	Risk Assessment Guidance for Superfund - Volume 1 - Human Health Evaluation Manual; 12/89	G	▸ human health risk assessments

DAR: Division of Air Resources
DEP: Division of Environmental Permits
DER: Division of Environmental Remediation
DFW: Division of Fish and Wildlife
DOH: Department of Health
DOW: Division of Water
DSHM: Division of Solid and Hazardous Materials
USEPA: US Environmental Protection Agency

TABLE 2
Nature and Extent of Contamination
COMPOUNDS OF CONCERN

Media	Class	Contaminant of Concern	Concentration Range	Frequency of Exceeding SCGs	SCG (ppb)
Groundwater	Volatile Organic Compounds (VOCs)	Trichloroethene	6.1 - 170,000	75/102	5
		1,2-Dichloroethene (T)	7.4 - 45,000	71/102	5
		1,1,1-Trichloroethane	6.6 - 1800	30/102	5
		1,1-Dichloroethane	5.2 - 8100	48/102	5
		1,1-dichloroethene	6.6 - 1600	11/102	5

TABLE 3

IDENTIFICATION OF ENVIRONMENTAL MEDIA OF CONCERN

Medium of Concern	Release Mechanism	Receiving Medium
Contaminated Groundwater	Lateral and vertical movement through the sand and gravel alluvium.	The saturated section of the and the sand and gravel alluvial deposits. The hydraulic gradient identified at site indicates contaminants will continue to migrate northward.
	Pumping	Irrigation - if shallow GW is used in the immediate area and documented to be contaminated.
	Volatilization	Air beneath residential dwellings. Contaminant concentrations off-site are high enough to cause indoor air impacts in the Torrance Place vicinity.

TABLE 4

Henry's Constants/Vapor Pressures for Volatile Organic Contaminants of Concern

Contaminant of Concern	**Dimensionless Henry's Law Constant** (at 10 ^{0}C)	**Vapor Pressure (mm Hg)**
1,2-dichloroethene (1,2-DCE)	0.1162	215
1,1,1-trichloroethane (1,1,1-TCA)	0.4153	124
trichloroethene (TCE)	0.2315	59
1,1-dichloroethene	0.6628	500
1,1-dichloroethane	0.1584	182

References: Terra Vac In-situ Vacuum Extraction System Applications Analysis Report (EPA/ 540/A5-89/003, July 1989)/ Toxicological Profiles prepared for the Agency for Toxic Substances and Disease Registry (ATSDR)

TABLE 5

Remedial Alternative Costs

Remedial Alternative	Capital Cost	Annual O&M	Total Present Worth
1 - No Further Action	$0	$29,928 (years 0 - 3) $16,182 (years 4 - 30)	$355,411
2 - In-Well Air Stripping	$2,343,200	$121,052 (years 0 - 3) $95,492 (years 4 - 10)	$3,223,200
3 - Groundwater Extraction w/Air Stripping	$485,067	$123,760 (years 0 - 3) $103,640 (years 4 - 30)	$2,582,058
4 - Permeable Passive/ Reactive Iron Walls	$3,708,709	$45,680 (years 0 - 3) $20,120 (years 4 - 30)	$3,937,115
5 - Groundwater Extraction in Combination with Permeable Passive/Reactive Iron Wall	$688,378	$123,839 (years 0 - 3) $98,279 (years 4 - 30)	$2,684,889

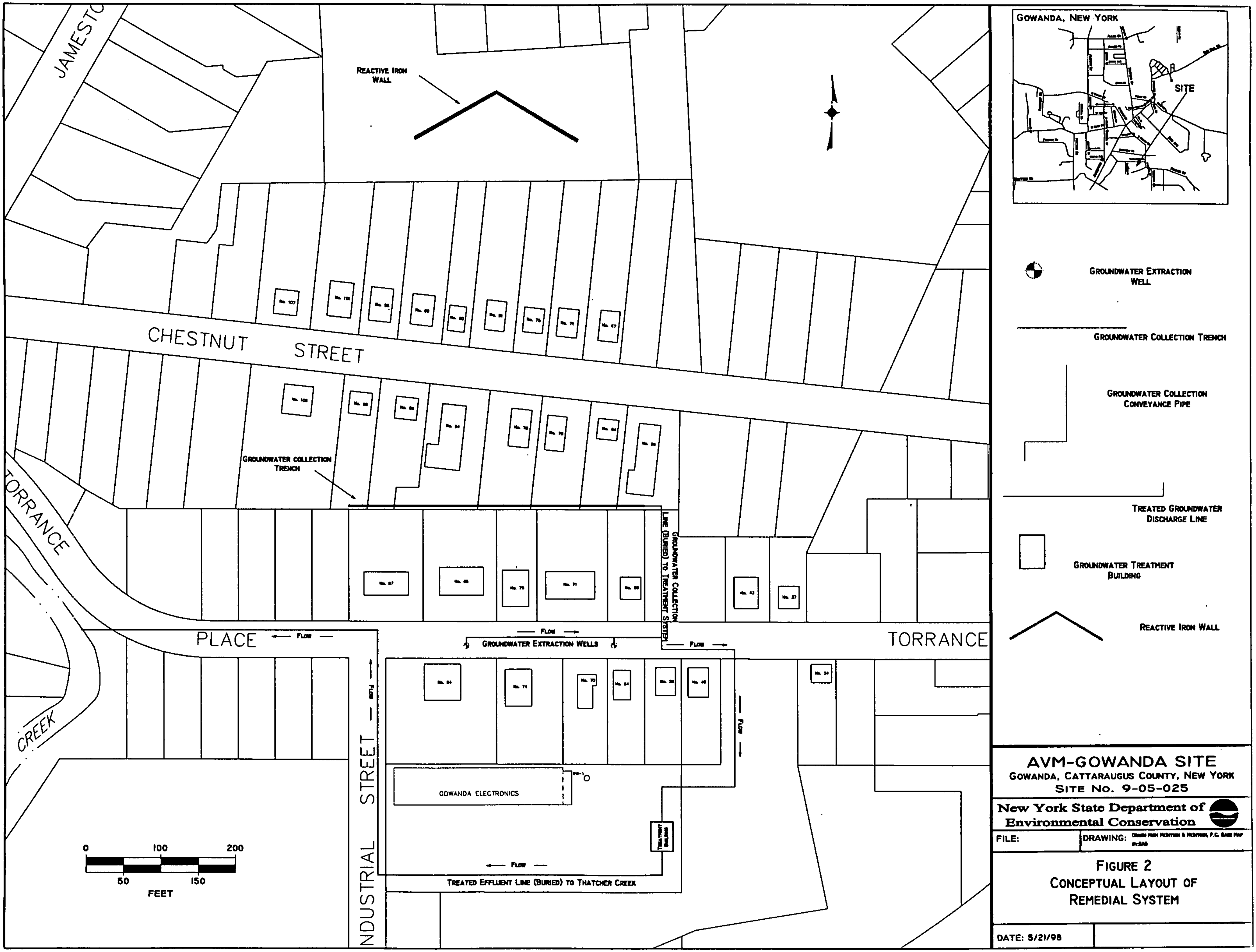
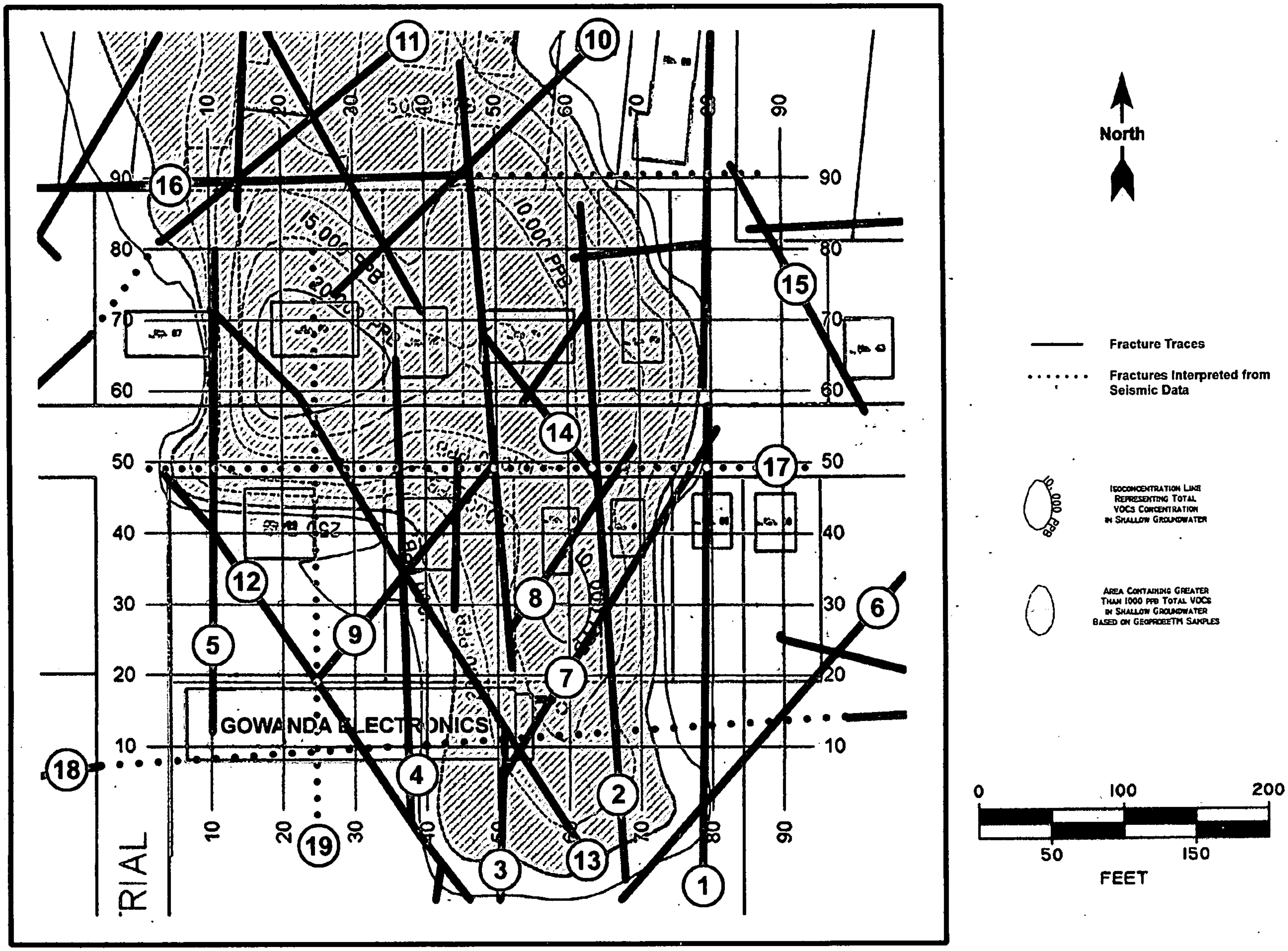


FIGURE 2
CONCEPTUAL LAYOUT OF REMEDIAL SYSTEM

Appendix A
3D Seismic Figures and Tables

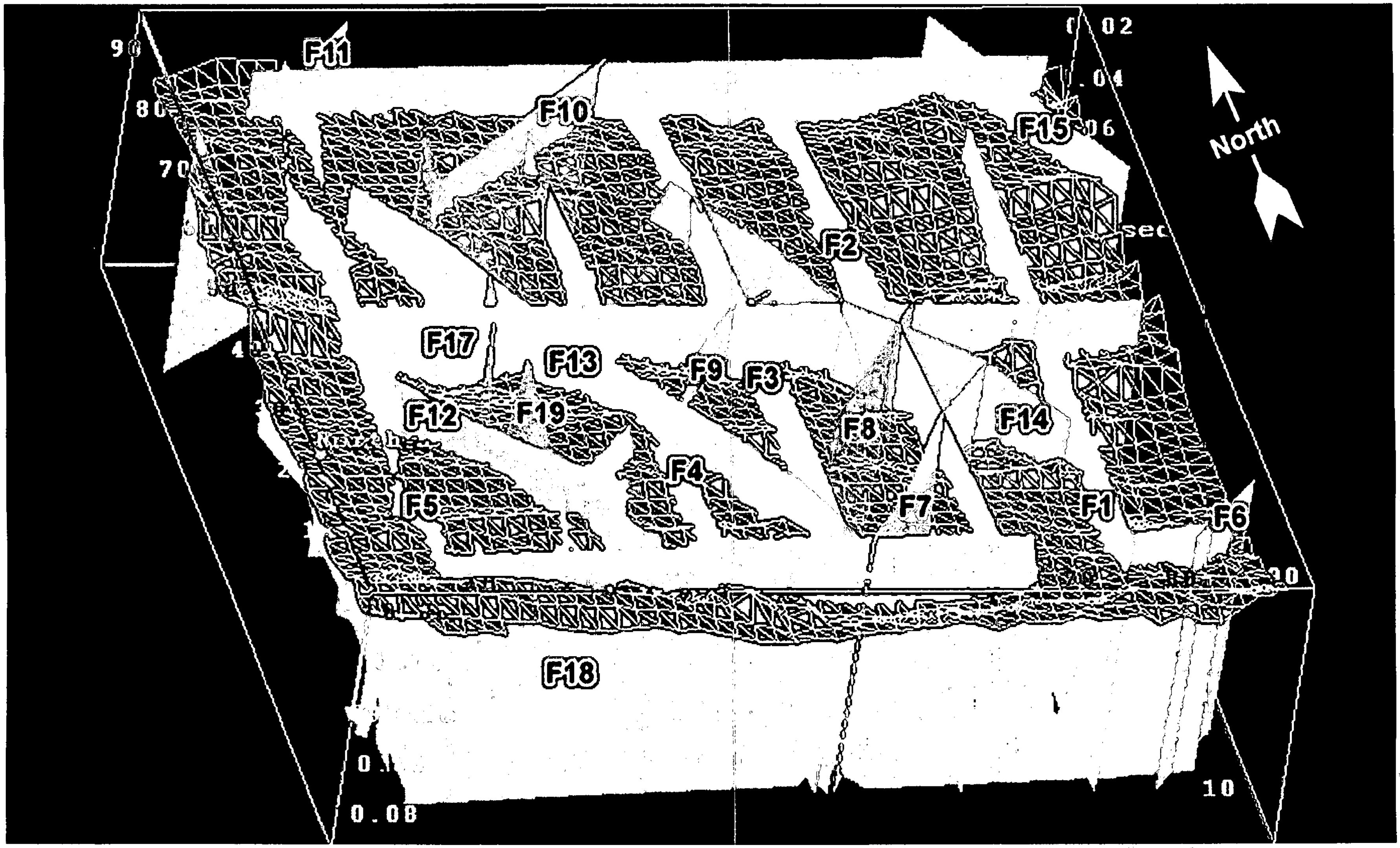


Resolution Resources, Inc.
3D Acoustic Imaging for the Environment
3636 Goodwin Road
Ionia, MI 48846
Tel: (517) 647-1832
Fax: (517) 647-2862

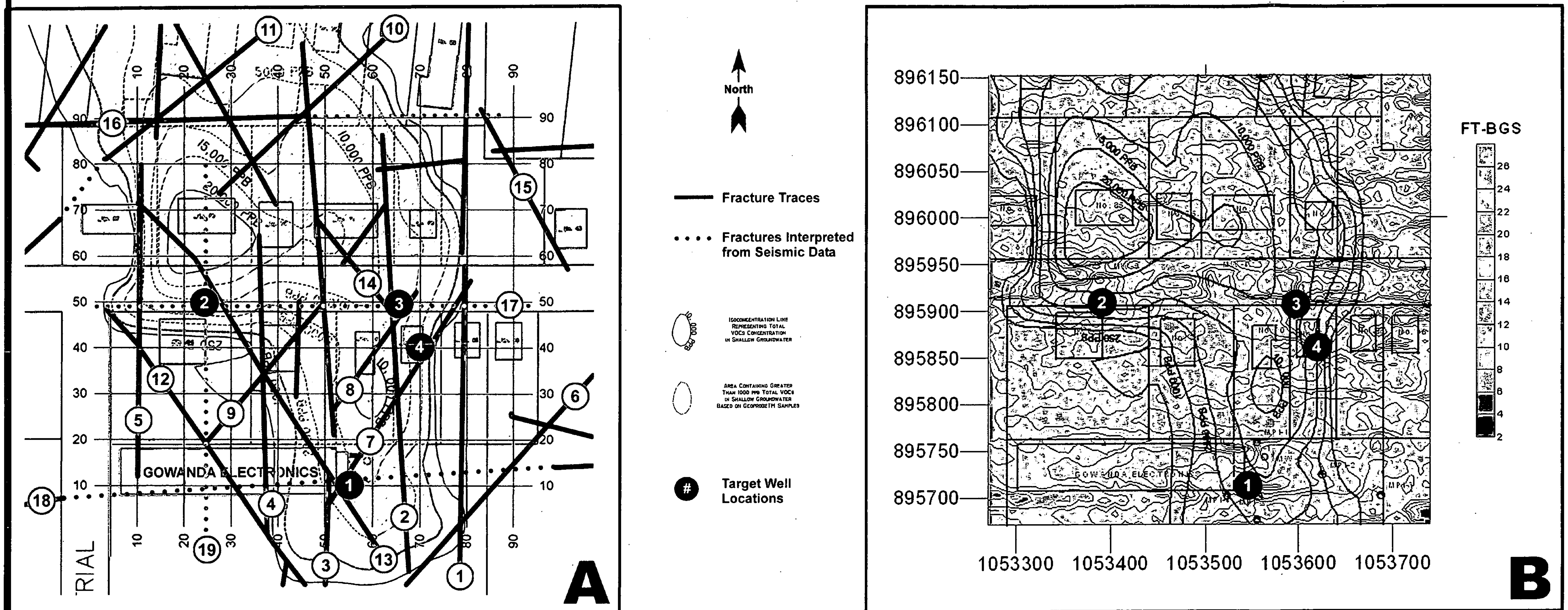
Title: Fracture Trace, Site Plan, & Seismic Grid Composite

Reference

Figure No. 35



Resolution Resources, Inc. 3D Acoustic Imaging for the Environment 3636 Goodwin Road Ionia, MI 48846 Tel: (517) 647-1832 Fax: (517) 647-2862	Title 3D Visualization of Fractures & Till Horizon	Reference	Figure No. 38



Resolution Resources, Inc.
3D Acoustic Imaging for the Environment

3636 Goodwin Road
Ionia, MI 48846
Tel: (517) 647-1832
Fax: (517) 647-2862

Title

Target Well Locations: A) Site Plan, Seismic Grid, VOC Plume, & Fracture Trace; B) Till Surface & VOC Plume

Reference

Figure No. 41

TABLE 6: TARGET WELL DESCRIPTIONS

Target	Line	Xline	Northing	Easting	Corrected Till (time)	Corrected Till (depth)	Comment
T1	10	55	1053551.07	895716.55	0.029	20.3	Near source area at the rear of Gowanda Electronics Building. Centered on a till surface low near the intersection of fractures F3, F7, F13 & F18. This proposed position would provide an alternative pumping location that may be in better connection with fractures F3, F13, & F18 than the present recovery well.
T2	50	24	1053395.09	895916.92	0.033	23.1	Along Torrance Place road NW of the source area. The proposed well is located near the intersection of fractures F13, F17, & F19, and near a till low. It is positioned to intercept VOCs along either F13 or F17. This well may influence the hot spot of 20,000 ppb below Home #85 using interconnections with F13 & F19.
T3	49	65	1053600.83	895911.44	0.036	25.2	Along Torrance Place road N of the source area. This proposed well is located near the intersection of fractures F2, F8, F14, & F17 in a till low. The topographic low at this position may be a collection point for VOCs.
T4	40	70	1053623.58	895866.38	0.034	23.8	Located N of the source area in a till low near the intersection of fractures F7 & F14. The topographic low at this position may be another convenient control point.

NOTE: All times are in seconds, and all depths in feet-bgs

Appendix B
Remedial Alternative Cost Estimates

No Further Action/Continued Monitoring

Operational and Maintenance Costs

Item	Item Number*	Units	Quantity	Unit Cost	Total Cost
Groundwater Monitoring[1]					
VOC Analysis	33 02 0508	EA	7	$226.00	$1,582
Sampling Labor		HR	40	$40.00	$1,600
Report Labor		HR	20	$50.00	$1,000
Equipment		HR	1	$400.00	$400
Subtotal					$4,582
Indoor Air Monitoring[2]					
Analytical cost		EA	8	$100.00	$800
Sampling Labor		HR	40	$105.00	$4,200
Equipment		HR	2	$400.00	$800
Subtotal					$5,800
Annual Cost (0-3 years)					$29,928
Annual Cost (4-30)					$16,182
Present Value (30 years 3%/year)					$355,411
Total O&M					**$355,411**
Total Cost					**$355,411**

[1]Quarterly for 3 years. Annual for years 4-30
[2]Semi-annual

In-Well Air Stripping
Capital Costs

Item	Item Number*	Units	Quantity	Unit Cost	Total Cost
Process Equipment					$2,042,000
(assumes 10 in-situ stripping wells, 2 separate treatment systems)					
Vapor Collection and Treatment					
Air Line Piping	19 02 0129	LF	1611	$17.11	$27,564
Sand Bedding	17 03 0426	CY	358	$8.85	$3,168
Compaction	17 03 0515	CY	1074	$2.23	$2,395
Trench 4-6' Cat 215, 3' wide	17 03 0257	CY	1074	$1.07	$1,149
Vapor Phase GAC (Air 5000 Poly Carbon Absorbers)		EA	8	$12,000.00	$96,000
Treatment Building (2)		SF	700	$75.00	$105,000
Water Supply (2)		LF	100	$55.00	$11,000
Gas Supply (2)		LF	100	$50.00	$10,000
Subtotal					$2,298,277
Disposal					
Non-Hazardous Landfill	33 19 7270	CY	445	$101.00	$44,945
Subtotal					$44,945
Total Capital Cost					$2,343,222

*1998 RS Means Environmental Remediation Cost Data

In-Well Air Stripping
Operational and Maintenance Costs

Item	Item Number*	Units	Quantity	Unit Cost	Total Cost
Testing					
Groundwater[1]					
VOC Analysis	33 02 0508	EA	20	$226.00	$4,520
Sampling Labor		HR	40	$40.00	$1,600
Report Labor		HR	40	$50.00	$2,000
Equipment		HR	1	$400.00	$400
Subtotal					$8,520
Indoor Air[2]					
Analytical cost		EA	8	$100.00	$800
Sampling Labor		HR	40	$105.00	$4,200
Equipment		HR	2	$400.00	$800
Subtotal					$5,800
Operation					
Carbon (40,000lbs/mo)		YR	1	$50,000.00	$50,000
Electricity (20hp total)		KWH	130646	$0.08	$10,452
Operator		HR	104	$60.00	$6,240
Maintenance		HR	96	$80.00	$7,680
Well Maintenance		EA	10	$100.00	$1,000
Subtotal					$75,372
Annual Cost Years 0-3					$121,052
Annual Cost Years 4-10					$95,492
Present Value 10 Years, 3%/year					$880,000
Total O&M					$880,000
Total Cost					**$3,223,222**

*1998 RS Means Environmental Remediation Cost Data
[1]Quarterly for 3 years. Annual for years 4-30
[2]Semi-annual

Groundwater Extraction and Treatment via Air Stripping
Capital Costs

Item	Item Number*	Units	Quantity	Unit Cost	Total Cost
Wells					
Drilling	33 23 1103	LF	200	$65.13	$13,026
6" Submersible Pump (50-150 gpm)	33 23 0540	EA	5	$1,870.00	$9,350
6" Stainless Casing (5@25')	33 23 0124	LF	125	$177.74	$22,218
6" Stainless Screen (5@15')	33 23 0223	LF	75	$195.26	$14,645
Monitoring Wells		EA	8	$600.00	$4,800
Subtotal					$59,238
Groundwater Collection					
Sump Pump 75 gpm 2" discharge	33 29 0402	EA	1	$2,484.00	$2,484
24'x36" RCP Wet well	19 02 0310	EA	1	$12,884.00	$12,884
Trenching Cat 225 10-20' deep (18x500x3)	17 03 0260	CY	1000	$3.82	$3,820
Gravel (500x3x10)	17 03 0430	CY	555	$9.49	$5,267
4" Slotted PVC	33 26 0802	LF	500	$5.87	$2,935
Subtotal					$27,390
Water Collection					
2.5"/4" Double Wall PVC Piping	33 26 0623	LF	150	$24.94	$3,741
3" Class 200 PVC Piping	19 01 0206	LF	1461	$4.98	$7,276
Sand Bedding	17 03 0426	CY	120	$8.85	$1,062
Compaction	17 03 0515	CY	716	$2.23	$1,597
Trench 4-6' Cat 215, 2' wide	17 03 0257	CY	716	$1.07	$766
Subtotal					$14,442
Water Treatment					
Treatment Building (2@700 SF Each)		SF	1400	$75.00	$105,000
100 gpm oil water separator -	19 04 0413	EA	1	$13,589.00	$13,589
Air Stripper-100 gpm, 120 ppm TCE	Price Quote**	EA	1	$36,000.00	$36,000
Air Stripper-30 gpm, 2 ppm TCE	Price Quote**	EA	1	$16,000.00	$16,000
Oxidizer	Price Quote**	EA	1	$68,000.00	$68,000
Scrubber	Price Quote**	EA	1	$60,000.00	$60,000
Waste Water Discharge (8" CMP)	19 03 0101	LF	625	$7.45	$4,656
Compaction	17 03 0515	CY	280	$2.23	$624
Trench 4' deep. Cat 215, 3' wide	17 03 0257	CY	280	$1.07	$300
Chemical Storage		LS	2	$3,000.00	$6,000
Subtotal					$339,052
Disposal					
Non-Hazardous Landfill	33 19 7270	CY	445	$101.00	$44,945
Subtotal					$44,945
Total Capital Cost					$485,067

*1998 RS Means Environmental Remediation Cost Data
** From Notheast Environmental Products (NEEP)

Groundwater Extraction and Treatment via Air Stripping
Operational and Maintenance Costs

Item	Item Number*	Units	Quantity	Unit Cost	Total Cost
Groundwater Monitoring[1]					
VOC Analysis	33 02 0508	EA	20	$226.00	$4,520
Sampling Labor		HR	40	$40.00	$1,600
Report Labor		HR	40	$50.00	$2,000
Equipment		HR	1	$400.00	$400
Subtotal					$8,520
Indoor Air Monitoring[2]					
Analytical cost		EA	8	$100.00	$800
Sampling Labor		HR	40	$105.00	$4,200
Equipment		HR	2	$400.00	$800
Subtotal					$5,800
Operation					
Electricity (25hp total)		KWH	165000	$0.08	$13,200
Operator		HR	104	$60.00	$6,240
Maintenance		HR	96	$80.00	$7,680
Well Maintenance		EA	3	$100.00	$300
Caustic Soda (NaOH) (20%)		Gal	24000	$0.90	$21,600
Hydrogen Peroxide (50%)		Gal	10000	$3.45	$34,500
Subtotal					$83,520
Annual Cost Years 0-3					$123,760
Annual Cost Years 4-30					$103,640
Present Value 30 Years, 3%/year					$2,096,991
Total O&M					$2,096,991
Total Cost					**$2,582,058**

*1998 RS Means Environmental Remediation Cost Data
[1]Quarterly for 3 years. Annual for years 4-30
[2]Semi-annual

Permeable Passive/Reactive Iron Walls

Capital Costs

Item	Item Number*	Units	Quantity	Unit Cost	Total Cost
Iron Wall #1					
Trench - 10'x18'x450'	17 03 0260	CY	3000	$3.82	$11,460
Iron Filings		CY	2000	$756.00	$1,512,000
Subtotal					$1,523,460
Iron Wall #2					
Trench - 10x16x500	17 03 0260	CY	2963	$3.82	$11,319
Iron Filings		CY	1853	$756.00	$1,400,868
Subtotal					$1,412,187
Iron Wall #3					
Trench - 4'x18'x250'	17 03 0260	CY	666	$3.82	$2,544
Iron Filings		CY	445	$756.00	$336,420
Subtotal					$338,964
Disposal					
Non-Hazardous Landfill	33 19 7270	CY	4298	$101.00	$434,098
Subtotal					$434,098
Total Capital Cost					**$3,708,709**

Operational and Maintenance Costs

Item	Item Number*	Units	Quantity	Unit Cost	Total Cost
Groundwater Monitoring[1]					
VOC Analysis	33 02 0508	EA	20	$226.00	$4,520
Sampling Labor		HR	40	$40.00	$1,600
Report Labor		HR	40	$50.00	$2,000
Equipment		HR	1	$400.00	$400
Subtotal					$8,520
Indoor Air Monitoring[2]					
Analytical cost		EA	8	$100.00	$800
Sampling Labor		HR	40	$105.00	$4,200
Equipment		HR	2	$400.00	$800
Subtotal					$5,800
Annual Cost Years 0-3					$45,680
Annual Cost Years 4-30					$20,120
Present Value 30 Years, 3%/year					$228,406
Total O&M					**$228,406**
Total Cost					**$3,937,115**

*1998 RS Means Environmental Remediation Cost Data
[1]Quarterly for 3 years. Annual for years 4-30
[2]Semi-annual

Groundwater Extraction in Combination with Permeable Passive/Reactive Iron Walls

Capital Costs

Item	Item Number*	Units	Quantity	Unit Cost	Total Cost
Wells					
Drilling	33 23 1103	LF	120	$65.13	$7,816
6" Submersible Pump (50-150 gpm)	33 23 0540	EA	3	$1,870.00	$5,610
6" Stainless Casing (3@25')	33 23 0124	LF	75	$177.74	$13,331
6" Stainless Screen (3@15')	33 23 0223	LF	45	$195.26	$8,787
Monitoring Wells		EA	8	$600.00	$4,800
Subtotal					$35,543
Groundwater Collection					
Sump Pump 75 gpm 2" discharge	33 29 0402	EA	1	$2,484.00	$2,484
24'x36" RCP Wet well	19 02 0310	EA	1	$12,884.00	$12,884
Trenching Cat 225 10-20' deep (18x500x3	17 03 0260	CY	1000	$3.82	$3,820
Gravel (500x3x10)	17 03 0430	CY	555	$9.49	$5,267
4" Slotted PVC	33 26 0802	LF	500	$5.87	$2,935
Subtotal					$27,390
Water Collection					
3" Class 200 PVC Piping	19 01 0206	LF	1611	$4.98	$8,023
Sand Bedding	17 03 0426	CY	120	$8.85	$1,062
Compaction	17 03 0515	CY	716	$2.23	$1,597
Trench 4-6' Cat 215, 2' wide	17 03 0257	CY	716	$1.07	$766
Water Treatment					
Treatment Building		SF	700	$75.00	$52,500
100 gpm oil water separator	19 04 0413	EA	1	$13,589.00	$13,589
Air Stripper-100 gpm, 120 ppm TCE	Price Quote**	EA	1	$36,000.00	$36,000
Oxidizer	Price Quote**	EA	1	$68,000.00	$68,000
Scrubber	Price Quote**	EA	1	$60,000.00	$60,000
Chemical Storage		LS	2	$3,000.00	$6,000
Subtotal					$241,537
Iron Wall					
Trench - 4'x18'x250'	17 03 0260	CY	666	$3.82	$2,544
Iron Filings		CY	445	$756.00	$336,420
Subtotal					$338,964
Disposal					
Non-Hazardous Landfill	33 19 7270	CY	445	$101.00	$44,945
Subtotal					$44,945
Total Capital Cost					$688,378

*1998 RS Means Environmental Remediation Cost Data
** From Notheast Environmental Products (NEEP)

Groundwater Extraction in Combination with Permeable Passive/Reactive Iron Walls

Operational and Maintenance Costs

Item	Item Number*	Units	Quantity	Unit Cost	Total Cost
Groundwater Monitoring[1]					
VOC Analysis	33 02 0508	EA	20	$226.00	$4,520
Sampling Labor		HR	40	$40.00	$1,600
Report Labor		HR	40	$50.00	$2,000
Equipment		HR	1	$400.00	$400
Subtotal					$8,520
Indoor Air Monitoring[2]					
Analytical cost		EA	8	$100.00	$800
Sampling Labor		HR	40	$105.00	$4,200
Equipment		HR	2	$400.00	$800
Subtotal					$5,800
Operation					
Electricity (15hp total)		KWH	97985	$0.08	$7,839
Operator		HR	104	$60.00	$6,240
Maintenance		HR	96	$80.00	$7,680
Well Maintenance		EA	3	$100.00	$300
Caustic Soda (NaOH) (20%)		Gal	24000	$0.90	$21,600
Hydrogen Peroxide (50%)		Gal	10000	$3.45	$34,500
Subtotal					$78,159
Annual Cost Years 0-3					$123,839
Annual Cost Years 4-30					$98,279
Present Value 30 Years, 3%/year					$1,996,510
Total O&M					$1,996,510
Total Cost					**$2,684,889**

[1]Quarterly for 3 years. Annual for years 4-30
[2]Semi-annual