FIVE-YEAR REVIEW REPORT OF REMEDIAL ACTIONS
PLANT 83/GENERAL ELECTRIC OPERABLE UNIT
SOUTH VALLEY SUPERFUND SITE
ALBUQUERQUE, NEW MEXICO

Prepared for

General Electric Aircraft Engines

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PREFACE

In 1979, the City of Albuquerque sampled groundwater from municipal wells SJ-6 and SJ-3, located near the intersection of Broadway Boulevard and Woodward Road SE. Analyses of these groundwater samples indicated chlorinated solvents were present in the groundwater from these wells. Figure 1-2 illustrates the locations of these wells to the east of the Plant 83 facilities.

The Plant 83 area has been the site of manufacturing operations since 1948 when the Eidal Manufacturing Company had a welding operation onsite. In 1951 the Atomic Energy Commission, through American Car Foundry, took over the property and conducted machining of metal parts, plating, welding and other activities. This continued until 1967 when the United States Air Force (USAF) took over the property and converted the plant into an aircraft engine manufacturing facility. The plant, then known as U.S. Air Force Plant 83, was sold to General Electric Aircraft Engines (GEAE) in 1984 and remains an aircraft engine manufacturing facility.

Municipal Wells SJ-6 and SJ-3 were taken out of service in 1980 and are no longer used to provide water to the City of Albuquerque. Environmental investigations have been conducted since 1980 to characterize the impacts to the aquifer. The United States Environmental Protection Agency (EPA) identified Plant 83 as one of several possible locations as the source of impacts to the municipal wells. The EPA also identified six other potential sources for groundwater contamination in this area. The other Potentially Responsible Parties (PRPs) identified by the EPA and New Mexico Environment Department (NMED) included Chevron, Duke City Distributing, Edmunds Street Facility (Univar), Texaco, ATA Pipeline, and Whitfield Tank Lines.

In 1988, the EPA prepared several Record of Decisions (RODs) to establish operable units within the South Valley Superfund Site in order to address the multiple potential contaminant sources that existed in the vicinity of Well SJ-6. Two RODs were issued associated with Plant 83; the Plant 83 ROD and the San Jose Well No. 6 (SJ-6) ROD. The Plant 83 ROD (EPA, 1988a) addresses characterization and remediation of soils and groundwater near the Plant 83 area and to the east of Plant 83. The SJ-6 ROD was written to address water supply issues, and required municipal wells SJ-3 and SJ-6 and select private wells to be abandoned. Both Wells SJ-3 and SJ-6 were abandoned in October 1994. The private wells associated with the SJ-6 ROD were abandoned prior to 1994.

The Plant 83 ROD defined three areas of interest: soil, groundwater in the Shallow Zone Aquifer, and groundwater in the Deep Zone Aquifer. Under an Administrative Order (EPA, 1989), GEAE began conducting additional investigations to address these areas of interest in 1990. These investigations consisted of installing and sampling additional groundwater monitoring wells, conducting soil vapor surveys, and drilling and sampling soil borings. In 1991, GEAE began preliminary designs of remediation systems for the soil and groundwater at the site.

Investigations to date have characterized the volatile organic compounds (VOCs) in the unsaturated portion of the Shallow Zone Aquifer, and the saturated portions of the Shallow Zone and Deep Zone Aquifer to the east of Plant 83. Notably, dense non-aqueous phase liquids (DNAPLs) have not been found in the course of the Plant 83 Operable Unit (OU) investigations. In the unsaturated portion of the Shallow Zone Aquifer, VOCs are present in the vapor phase; dissolved phase VOCs are present within the saturated portions of the Shallow Zone and Deep Zone Aquifers.

Site Geology

The following text describes the geology as characterized and reported previously by Hydrometrics and Geosciences Consultants Limited (H+GCL, 1993a). In summary, the geology consists of unconsolidated alluvial units of the older Santa Fe Group. These sediments (down to approximately 4,300 feet above mean sea level) are primarily ancestral Rio Grande-related, braided fluvial deposits. These sediments contain lenticular deposits of finer-grained, relatively lower conductivity sands, silts, and clays.

High proportions of sands and gravels that form extensive and locally high-conductivity units across the site characterize sediments within the upper 600 to 700 feet of the Rio-Grande Aquifer. Discontinuous silts and clays are present within this interval and the cumulative effect of many of these lower conductivity layers is to limit the downward rate of contaminant movement in the vertical direction. The following two subsections describe the specific geology of the Shallow and Deep Zones of the Rio-Grande Aquifer.

Shallow Zone Aquifer

The Shallow Zone Aquifer is primarily a perched groundwater aquifer. The formation consists of layers of coarse-grained sands, silty sands, clays, and silty clays. The formation generally extends to a depth of approximately 20 to 25 feet below ground surface and is underlain by a relatively continuous silty clay layer (SCL). At the south end of Plant 83, the SCL is absent and may not provide hydraulic separation from the Deep Zone Aquifer. By convention, the Shallow Zone groundwater refers to groundwater that is above the relatively continuous SCL and/or above an elevation of 4,900 feet above mean sea level (msl) (Canonie, 1993).

Deep Zone Aquifer

To model this site and design the Deep Zone Groundwater Remediation System, the Deep Zone Aquifer was divided into five vertical intervals based on interpretations of the geology as defined in the initial groundwater flow model for the site (H+GCL, 1993b). The EPA adopted these intervals as the standard intervals for describing the Deep Zone Aquifer. The groundwater flow model used during the remedial design was further refined and uses nine layers to calculate groundwater flow. The Deep Zone Groundwater Remediation System addresses impacts between elevation 4,840 feet above msl (top of model layer 3) to elevation 4,600 feet above msl (bottom of model layer 6). Remediation activities in the portion of the aquifer represented by Model Layers 1 and 2 are being conducted by others. Figure 4-1 provides a key map that illustrates the correspondence between the intervals, model layers, and physical elevations.

To be consistent with previous reports, the deep-shallow zone (DS) interval ranges from 4,840 to 4,900 feet above msl and corresponds to model layers 1 and 2. The deep-intermediate zone (DI) interval from 4,740 to 4,840 feet above msl corresponds to model layers 3 and 4. This interval was separated for evaluation purposes in this and previous reports. The upper portion of the DI zone from 4,790 to 4,840 feet above msl corresponds to model layer 3. The lower portion of the DI interval consisting of model layer 4 from 4,740 to 4,790 feet above msl is combined with the deep-deep zone (DD) interval from 4,660 to 4,740 feet above msl (i.e., model layer 5) as one evaluation interval (referred to as the DI/DD interval). The deep-low-permeability zone (DLPZ) interval from 4,600 to 4,660 above msl corresponds to model layer 6, remains unchanged as a complete interval for evaluation in this report.

The below-deep-low-permeability zone (BDLPZ) interval ranges from the bottom of the DLPZ (model layer 6) to an elevation of 3,880 feet above msl. The BDLPZ interval is not evaluated in this report because the deep zone plume is not present in this interval.

Figure 4-1 provides the locations of monitoring wells that are screened in each of the upper four intervals (DS, DI, DI/DD, and DLPZ) corresponding to model layers 1 through 6. As described above, the Deep Zone Groundwater Remediation System targets remediation of groundwater between elevation 4,840 feet above msl (top of model layer 3) and elevation 4,600 feet above msl (bottom of model layer 6).

EXECUTIVE SUMMARY

This Five Year Review Report of Remedial Actions summarizes the remedial activities undertaken from June 1993 to June 2000 by General Electric Aircraft Engines (GEAE) under the provisions of the Former Air Force Plant 83/General Electric (GE) Operable Unit (Plant 83 OU) Record of Decision (ROD) (EPA, 1988a) and the San Jose-6 (SJ-6) OU ROD (EPA, 1988b) of the South Valley Superfund Site, Albuquerque, New Mexico.

The first Five Year Review Report was submitted to the regulatory agencies March 15, 1999 and included a summary of remedial activities conducted by GEAE at the South Valley Superfund Site from June 1993 through June 1998. The regulatory agencies reviewed that report and submitted written comments in a letter dated July 5, 2000. At the request of the regulatory agencies, this report has been updated to incorporate agency comments and also includes additional data collected through the second calendar year quarter of 2000 (i.e. through June 2000). Accordingly, this report provides a summary of remedial activities conducted by GEAE from June 1993 through June 2000. The next five-year review will be due in September 2005.

The requirements of the SJ-6 ROD included cleaning and sealing abandoned wells and performing groundwater monitoring for 30 years. GEAE cleaned and abandoned the selected wells, established a groundwater monitoring program, and conducted yearly sampling for this monitoring well program.

Remedial and engineering activities associated with the Plant 83 ROD include the following:

- Completed the characterization of impacts to unsaturated and saturated portions of the Shallow Zone and Deep Zone Aquifer
- Completed soil vapor vacuum extraction to remove volatile organic compounds from unsaturated Shallow Zone Aquifer soils proximate to Plant 83 buildings.

- Initiated groundwater extraction, treatment, and reinjection of treated water back to the saturated portion of the Shallow Zone Aquifer proximate to Plant 83 buildings and adjacent properties
- Initiated groundwater extraction, treatment, and reinjection of treated water back to the Deep Zone Aquifer east of the Plant 83 facility.

Based on requirements of the Administrative Orders issued to GEAE for these operable units (EPA, 1989a and b), GEAE has compiled investigative data, characterized the associated plumes, conducted engineering designs, and implemented the requisite remedial actions. These activities have been fully documented in monthly activity reports, quarterly quality assurance reports, annual reports, engineering design reports, and as-built construction reports. Details of each system can be reviewed in one or more or these reports. This Five Year Review Report has been prepared to provide a summary of remedial activities to demonstrate that each remedial activity has been effective in protecting human health and the environment.

Ongoing remedial activities include groundwater extraction and treatment to remove volatile organic compounds (VOCs) from the saturated portions of the Shallow Zone Aquifer, and groundwater extraction and treatment to remove VOCs from the Deep Zone Aquifer. Groundwater is removed from these two aquifer systems via two separate extraction systems to promote flushing and mitigate further migration of impacted groundwater.

Data collected to date indicate each remedial activity implemented by GEAE has been effective and is successful in protecting human health and the environment.

1.0 INTRODUCTION

On behalf of General Electric Aircraft Engines (GEAE), Harding Lawson Associates (HLA) has prepared this Five-Year Review Report summarizing remedial activities associated with the Former Air Force Plant 83/General Electric (GE) Operable Unit (OU) and the San Jose-6 Operable Unit (SJ-6 OU) of the of the South Valley Superfund Site in Albuquerque, New Mexico.

Five-Year Review

Remedial activities associated with the Plant 83 OU are consistent with the Record of Decision (ROD) (United Sates Environmental Protection Agency [EPA], 1988a) and Administrative Order (AO), Docket No. CERCLA 6-16-89, for the Plant 83 OU (EPA, 1989a). Remedial activities for the SJ-6 OU are consistent with the ROD issued in September 1988 (EPA, 1988b) and AO, Docket No. CERCLA 6-17-89 (EPA, 1989b). This report provides the basis for the 5-year review required by Section 121 (c) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended, and Section 300.430 (f) (4) (ii) of the National Oil and Hazardous Substances Contingency Plan (NCP).

The first Five Year Review Report was submitted to the regulatory agencies March 15, 1999 and included a summary of remedial activities conducted by GEAE at the South Valley Superfund Site from June 1993 through June 1998. The regulatory agencies reviewed that report and submitted written comments in a letter dated July 5, 2000. At the request of the regulatory agencies, this report has been updated to incorporate agency comments and also includes additional data collected through the second calendar year quarter of 2000 (i.e. through June 2000). Accordingly, this report provides a summary of remedial activities conducted by GEAE from June 1993 through June 2000. The next five-year review will be due in September 2005.

The purpose of this report is to summarize the remedial actions at this site during the seven-year period from June 1993 through June 2000, evaluate the effectiveness of the remedial actions, and demonstrate that the remedial actions still in progress are protective of human health and the environment. Remedial actions at this site over this seven-year period include the following:

- For the SJ-6 OU, cleaned and abandoned wells and established a groundwater monitoring program as required. The groundwater monitoring program has been incorporated into the Plant 83 OU as identified in the Performance and Compliance Monitoring Plan (PCMP) (Smith, 1996).
- Completed the remediation of the unsaturated portion of the Shallow Zone Aquifer via vacuum extraction system (VES) proximate to both North Plant 83 and South Plant 83 buildings. The EPA approved the completion of this work and the system was subsequently dismantled.
- Investigation, design, construction, and ongoing operation of the groundwater remediation system for the Shallow Zone Aquifer proximate to both North Plant 83 and South Plant 83 buildings.
- Investigation, design, construction, and ongoing operation of the groundwater remediation system for the Deep Zone Aquifer located east of the Plant 83 facility.

Figure 1-1 provides a Regional Location Map, and Figure 1-2 illustrates the location of the Plant 83 OU site just west of Interstate 25 (I-25) and proximate to Woodward Road. The following sections of this report provide a summary of each remedial action at this site over the seven-year period.

2.0 PLANT 83 OPERABLE UNIT - VACUUM EXTRACTION SYSTEM

The removal of VOCs from the unsaturated portion of the Shallow Zone Groundwater Aquifer proximate to the North Plant 83 and South Plant 83 buildings was required by the ROD (EPA, 1988a). Though concentrations of VOCs detected in the soil did not pose a health threat, VOCs could be mobilized from the unsaturated portion to the saturated portion of the Shallow Zone Aquifer unit. Accordingly, the EPA required that soil vapor extraction be used to remove the VOCs from the unsaturated soil. The majority of this work was completed prior to June 1993. The following provides a brief description of vacuum extraction system (VES) activities.

2.1 Characterization

The unsaturated soil from the Shallow Zone Aquifer unit was characterized by soil sampling conducted in preliminary investigations. Additional soil data were also gathered during the installation of wells used to conduct the soil vacuum extraction activities. These data were used to design the locations of wells and establish baseline conditions prior to the remediation efforts. Based on data collected from the previous investigations and the well installation program, the baseline VOC concentrations were grouped into two depth intervals, ground surface to a depth of 8 feet and depths greater than 8 feet.

Proximate to the North Plant 83 building, the average total initial VOC concentrations (excluding methylene chloride) detected from the ground surface to a depth of 8 feet were 76 micrograms/kilograms (µg/kg). The average total initial VOCs at depths greater than 8 feet were 198 µg/kg. Proximate to the South Plant 83 building, the average total initial VOCs (excluding methylene chloride) detected from the ground surface to a depth of 8 feet was 326 µg/kg. The average total initial VOCs at depths greater than 8 feet were 169 µg/kg. Soil samples collected to date do not indicate the presence of a dense non-aqueous phase liquid (DNAPL) or other source of VOCs. Accordingly, application of the VES technology to remove the low concentrations of VOCs was considered appropriate.

2.2 Remediation Activities

The VES remediation was conducted using a high vacuum pump to pull the vapors from the unsaturated portion of the Shallow Zone Aquifer. This vapor was piped through carbon adsorption vessels to remove the VOCs from the vapor.

The soil vacuum extraction work was conducted as a pilot project during two separate phases as follows:

- Phase I work at the north end of Plant 83 was conducted from June 29, 1992, to August 10, 1992.
- Phase I work at the south end of Plant 83 was conducted from October 18, 1992, to December 2, 1992.
- The Phase IA work at the south end of Plant 83 was conducted from December 28, 1992, to March 10, 1993.
- The Phase IA work at the north end of Plant 83 was conducted from March 12, 1993, to June 24, 1993.

Subsequent to the VES effort, soil samples were collected and analyzed to evaluate the effectiveness of the remediation effort. Based on the results of these operations, the EPA determined additional VES operations were not required. Hence all VES activities were completed on June 24, 1993. Approximately 52 kilograms total of VOCs were removed from both the north end and south end of Plant 83.

2.3 Conclusions

The pilot project VES was effective in removing VOCs, and post-remediation VOC concentrations in the soil were significantly less than the EPA accepted cleanup criteria. Accordingly, the EPA concluded no further soil VES remediation was required as the remedial action accomplished the objectives of being protective of human health and the environment. The EPA approved the termination of the pilot project VES and removal of the VES equipment in the EPA letter dated June 21, 1994. A full scale VES was not implemented.

3.0 PLANT 83 OPERABLE UNIT - SHALLOW ZONE GROUNDWATER REMEDIATION SYSTEM

Removal of VOCs from the groundwater within the saturated portion of the Shallow Zone Groundwater Aquifer proximate to the North Plant 83 and South Plant 83 buildings was also required by the Plant 83 OU ROD (EPA, 1988a). The EPA required groundwater extraction with treatment by carbon adsorption to remediate the impacted groundwater.

Following subsurface investigations and delineation of the impacted groundwater, remedial activities for this portion of the Plant 83 OU required the engineering design, construction, operation, and maintenance of the treatment system. Remedial activities also include the sampling and analysis of groundwater from monitoring wells and effluent from the treatment system (collectively the Shallow Zone Groundwater Remediation System).

The Shallow Zone Groundwater Remediation System was installed to remove dissolved VOCs in the saturated portion of the Shallow Zone Aquifer proximate to the North Plant 83 and South Plant 83 buildings. Based on data collected to date, no DNAPLs or other source of VOCs was located. Hence, the Shallow Zone Groundwater Remediation System was designed and constructed to address dissolved VOCs in groundwater. Figure 3-1 illustrates the locations of the wells associated with the Shallow Zone Groundwater Remediation System.

This work was conducted consistent with the ROD and as specified in the EPA approved Remedial Design Plan, Shallow Zone Ground Water Extraction and Treatment System (Canonie, 1993) and the System Monitoring Plan (Canonie, originally issued in 1993, revised 1994).

3.1 Shallow Zone Groundwater Remediation System Goals

The goals for the remediation of the Shallow Zone Aquifer consisted of three parts (Canonie, 1993):

1. North Plant 83 area was to be remediated by enhancing the natural dewatering process by strategically locating extraction wells to remove groundwater containing VOCs within the silty clay layer depressions. Extraction Wells SEW-01 through SEW-06, and SEW-11 were located for this purpose.
2. South Plant 83 area was to be remediated by placement of an extraction well in the area with localized occurrences of VOCs. Extraction Well SEW-10 was located for this purpose.
3. Where dewatering was not possible or practical, the Shallow Zone Aquifer was to be remediated by removing VOCs via flushing to levels below Applicable or Relevant and Appropriate Requirements (ARARs). ARARs for this site are listed in Table 3.2.

Therefore, the primary goals of the system are to either reduce VOC concentrations below the ARARs or to contain the plume until the Shallow Zone Aquifer is dewatered by the extraction wells or a decline in the natural groundwater level occurs within the project area. The ARARs were established by reference in the ROD (EPA, 1988a). The System Monitoring Plan (revised Appendix B of the Remedial Design Plan, Shallow Zone Ground Water Extraction and Treatment System, Canonie, 1994) was developed to provide a mechanism to monitor the effectiveness of the Shallow Zone Groundwater Remediation System in meeting the remediation goals.

3.2 Shallow Zone Aquifer Geology

The Shallow Zone Aquifer at the Plant 83 OU is primarily a perched groundwater aquifer. The Shallow Zone formation consists of layers of coarse-grained sands, silty sands, clays, and silty clays. This Shallow Zone formation generally extends to a depth of approximately 20 to 25 feet below ground surface (ft bgs). The Shallow Zone formation is underlain by a relatively continuous silty clay layer, except at the south end of Plant 83 where it is absent or does not provide hydraulic separation from the Deep Zone Aquifer [General Electric Aircraft Engines Plant 83 Shallow Groundwater Investigation, by Hydrometrics and Geosciences Consultants Limited (H+GCL, 1993c)]. By convention, the Shallow Zone groundwater refers to groundwater that is above the relatively continuous silty clay layer and/or above an elevation of 4,900 feet above mean sea level (msl) (Canonie, 1993).

3.3 Shallow Zone Groundwater Remediation System Description

The Shallow Zone Groundwater Remediation System includes monitoring wells, extraction wells, and a groundwater treatment system. Table 3-1 provides a list of the 8 extraction and 30 monitoring wells, and Figure 3-1 illustrates the location of the Shallow Zone Groundwater Remediation System wells and the treatment plant building.

Until early 2000, the Shallow Zone Groundwater Remediation System consisted of seven extraction wells to remove the perched groundwater from the Shallow Zone Aquifer. With EPA approval, an additional extraction well (SEW-11) was added to the extraction well network near monitoring well P83-03S; SEW-11 became operational February 2000. As part of the Shallow Zone Groundwater Remediation System modifications, GEAE added an injection well (SIW-01) near the Shallow Zone treatment plant building (Figure 3-1). Injection well SIW-01 has been operational since May 2000.

The Shallow Zone Groundwater Remediation System works by extracting groundwater from eight extraction wells (SEW-01, SEW-02, SEW-03, SEW-04, SEW-05, SEW-06, SEW-10, and SEW-11). The extracted groundwater is conveyed through a dual-contained pipe to the treatment system and is treated using liquid-phase granulated activated carbon to adsorb the VOCs. Following treatment, the groundwater is then discharged. The effectiveness of the system is evaluated by collecting groundwater from extraction and monitoring wells and comparing the data to historical data previously collected.

From the start of the system on May 16, 1994, until October 1997, treated water was discharged to three evaporative cooling towers and used as process make-up water for GEAE's North Plant 83, prior to discharge to the City of Albuquerque sewer system. However, GEAE removed the North Plant 83 from service and treated groundwater was no longer discharged to the cooling towers. From October 1997 to May 2000, the treated groundwater had been collected in the effluent holding tank inside the treatment plant building. The treated groundwater was transported via pickup truck to the Deep Zone Groundwater Treatment Plant located about one mile away. This treated water was treated again at the Deep Zone treatment plant and discharged to the Deep Zone Aquifer via the existing injection well network.

Because the groundwater has already been treated, no special transport license was required. To improve the efficiency of the Shallow Zone Groundwater Remediation System, GEAE installed an injection well near the treatment building in January 2000. Injection Well SIW-01 became operational in May 2000, and since that time treated water from the Shallow Zone Treatment System has been reinjected directly into the shallow aquifer.

3.4 Performance Evaluation of the Shallow Zone Groundwater Remediation System

The performance of the Shallow Zone Groundwater Remediation System has been evaluated based on the following monitoring data collected during system operation:

1. Groundwater quality at the extraction and monitoring wells
2. Influent and effluent water quality monitoring of the groundwater treatment system
3. Water-level monitoring in the extraction wells and selected monitoring wells
4. Flow monitoring at each of the extraction wells and the combined flow of the treatment system

The following sections provide a brief description of each data set collected to evaluate the performance of the Shallow Zone Groundwater Remediation System.

3.4.1 Groundwater Quality Monitoring Data

Groundwater quality monitoring was performed in accordance with the System Monitoring Plan (Canonie, 1994) for the purpose of obtaining accurate, representative, complete, and comparable data for assessing changes in constituent concentrations, compliance with discharge criteria, and performance of the groundwater extraction and treatment system.

Groundwater samples were collected from the extraction and monitoring wells listed in Table 3-1 and shown in Figure 3-1. Monitoring Wells P83-01S, P83-02S, P83-03S, P83-05S, P83-13S, P83-14S, P83-15S, SMW-09 through SMW-14, and S-01 and Extraction Wells SEW-01 through SEW-06 and SEW-11 were designated for water quality monitoring near the North Plant 83 building. Monitoring Well SW-08 and Extraction Well SEW-10 were designated for water quality monitoring near the South Plant 83 building.

Through the fourth quarter of 1999 groundwater was sampled and analyzed semiannually from monitoring wells and quarterly from extraction wells. As a result of the Design Review Committee meeting held on August 26, 1999, and a letter request by GEAE dated November 19, 1999, the EPA approved several modifications to the existing program for the Shallow Zone Remediation System. In its letter dated December 29, 1999 (Appendix G) the EPA approved modifications to the collection of groundwater quality data from a quarterly basis to a semi-annual basis across the South Valley Superfund Site. Groundwater level data will continue to be collected on a quarterly basis, but will be reported to the EPA on a semi-annual schedule concurrent with groundwater quality data reports.

In a letter to the EPA, GEAE requested that the water quality sampling for six shallow zone monitoring wells (i.e. P83-05S, P83-13S, P83-15S, S-01, SMW-13, and SMW-14) be amended from a semi-annual to annual schedule. This request, based on historical data, was approved by the EPA in its letter dated December 29, 1999 (Appendix G). Modifications to the groundwater quality monitoring program for the Shallow Zone System approved by the EPA were implemented beginning first quarter 2000.

Monitoring Wells TX-14, TX-23, SW-01, SW-06, SW-07, and SPG-03 were originally in the well sampling program but were subsequently dropped from the monitoring program as these wells did not contain groundwater with concentrations of compounds in excess of ARARs for at least eight consecutive quarterly sampling events. These wells were dropped from the monitoring program in April 1996 and are not identified in Table 3-1 or on Figure 3-1.

Groundwater sampling was performed in accordance with the System Monitoring Plan (Canonie, 1994). Monitoring wells were purged of a minimum of three casing volumes of groundwater using a decontaminated stainless steel bailer or portable electric pump before being sampled. Groundwater samples were collected from the extraction wells at the sampling port located on the discharge water line from the extraction pump.

The EPA and NMED approved terminating the operation of SEW-06 in July 1996, based on more than eight consecutive quarters of groundwater sample data that indicated the absence of VOCs or VOCs significantly below ARARs. This extraction well was sampled quarterly for water quality analysis since the system was started in May 1994 until July 1997. Subsequent to July 1997, the groundwater pump in Well SEW-06 was not operational which prohibited collection of groundwater samples. GEAE repaired this well pump, and the groundwater has been sampled in this well since November 1998 and will continue to be sampled in future sampling events. Full-time operation of SEW-06 resumed in January 1999.

Groundwater samples from both monitoring and extraction wells were analyzed for VOCs using a modified version of EPA Method 8260. The modification was requested by the EPA in its letter dated October 3, 1996, and consists of lowering the reporting limit to 1 microgram per liter (µg/l) for many of the analytes. Table 3-2 provides a list of the analytes and reporting limits used for this analysis program.

Consistent with previous reports, the analytes chosen to evaluate the groundwater quality in the monitoring wells are 1,1-dichloroethane (1,1-DCA), 1,1-dichloroethene (1,1-DCE), 1,2- dichloroethane (1,2-DCA), tetrachloroethene (PCE), trichloroethene (TCE), and vinyl chloride.

3.4.2 Treatment System Water Quality Data

The Shallow Zone Treatment System uses liquid-phase granulated activated carbon to remove the VOCs from the extracted groundwater. The treatment system includes a flow equalization tank followed by three stages of granulated activated carbon units connected in series to provide redundant capacity and to allow higher VOC loading on the granulated activated carbon. To assess treatment and to prevent discharge of water containing VOCs, sample ports were installed on the influent line to the treatment system before the first carbon unit, between the first and second carbon units, between the second and third carbon units, and on the effluent discharge line.

As prescribed in the System Monitoring Plan (Canonie, 1994), samples of treated groundwater were collected to demonstrate performance of the treatment system and compliance with applicable discharge requirements.

Treatment System Performance Sampling

Performance monitoring samples of the treated groundwater are collected from the effluent line of the primary granulated activated carbon unit. The purpose of performance monitoring is to establish when the primary granulated activated carbon unit (Unit No. 1) needs to be removed from service and the other units moved forward in the series. For example, when Unit No. 1 becomes loaded, Unit No. 2 becomes Unit No. 1, Unit No. 3 becomes Unit No. 2, and a new unit is brought online to become Unit No. 3.

By operating the granulated activated carbon units this way, the granulated activated carbon units become loaded and sufficient redundancy remains to ensure no water containing VOCs is discharged. The granulated activated carbon unit change occurs when analytical results of the effluent from the primary granulated activated carbon unit indicate the presence of a VOC above its respective laboratory detection limit. This is referred to as breakthrough.

Under the original plan, performance samples were collected when granulated activated carbon Unit No. 1 had treated 25,000 gallons, 50,000 gallons, 60,000 gallons, and 70,000 gallons and every 5,000 gallons thereafter until breakthrough occurred. Once breakthrough occurred, the granulated activated carbon units were changed. When changed, the intervals of performance sampling began again when 25,000 gallons had been extracted and treated.

GEAE in a letter to the EPA (described in Section 3.4.1 above) requested to discontinue analysis for inorganic constituents for the Shallow Zone treatment system compliance samples and modify the sampling frequency of performance sample collected from the primary treatment vessel. Specifically, GEAE requested to continue to collect performance samples at 25,000, 50,000, and 60,000-gallon intervals, but change-out the unit at 60,000 gallons treated rather than continue the sampling at 70,000 gallons and every 5,000 gallons thereafter until breakthrough occurred. The EPA approved both of these requests (Appendix G). The modifications to the sampling program were implemented in the first quarter of 2000.

Treatment System Compliance Sampling

Until the new Injection Well SIW-01 was installed, treatment system compliance monitoring samples were collected at the effluent line of the tertiary granulated activated carbon unit (Unit No. 3) on a quarterly basis. At the request of the State of New Mexico Environment Department Groundwater Quality Bureau, and starting in August 2000, GEAE will collected treatment system compliance samples on a monthly basis.

Since the beginning of the Shallow Zone Groundwater Treatment System operations, treated groundwater quality has always been below the established ARARs for both organic and inorganic compounds. The compliance monitoring analytical data collected June 21, 1995 indicated that chloromethane was detected at

2 parts per billion (ppb). Because this compound was also found in the laboratory blank, the presence of chloromethane is considered a laboratory artifact. In addition, acetone was detected in the compliance sample taken March 18, 1998. However, the performance sample collected from granulated activated carbon Unit No. 1 on May 19, 1998, did not have a detect of acetone. If present in the treated water, acetone would have been detected from granulated activated carbon Unit No. 1 before it was detected in granulated activated carbon Unit No. 3. Acetone is also a common laboratory contaminant, and therefore, the presence of acetone in the sample is considered a laboratory artifact.

No other VOCs were detected in any compliance samples. Accordingly, the data collected to date indicate this system has been effective in removing VOCs from the extracted groundwater.

3.4.3 Groundwater-Level Monitoring Data

Groundwater-level monitoring data were collected at the extraction and monitoring wells listed in Table 3-1 and shown on Figure 3-1 to evaluate the groundwater levels in the Shallow Zone Aquifer in response to treatment system operations. Static water levels at monitoring wells were measured on a semi-annual schedule during the second and fourth calendar year quarters, and on a quarterly basis at extraction wells. Groundwater-level measurements were taken after the extraction wells were shut off for a minimum of 2 days (i.e., the shutdown period in accordance with pulse pumping program discussed below).

3.4.4 Flow Monitoring Data

The extracted groundwater flows are monitored for the following purposes:

- Estimate the mass of VOCs removed and to evaluate the treatment system performance
- Record flows required by the State Engineers Office
- Record operating conditions

Cumulative flow measurements are recorded at the extraction wells, and treatment system cumulative and instantaneous flow measurements are recorded in the treatment plant at two locations (on the effluent line of granulated activated carbon Unit No. 3 and on the outfall line of the effluent storage tank). When the discharge to GEAE's cooling towers was discontinued October 1, 1997, flow measurements were taken from the extraction wells and from the effluent of granulated activated carbon Unit No. 3 only.

Table 3-5 provides a summary of the monthly process flows since system startup. From system startup through June 2000, approximately 708,000 gallons of groundwater have been extracted and treated from the Shallow Zone Aquifer.

3.5 Shallow Zone Groundwater Remediation System Effectiveness

This section of the report provides an evaluation of the effectiveness of the Shallow Zone groundwater extraction and treatment system. The remedial design objectives approved by the EPA for the Shallow Zone consisted of three parts:

1. North Plant 83 was to be remediated by enhancing the natural dewatering process by strategically locating extraction wells to remove groundwater containing VOCs within the silty clay layer depressions. Extraction Wells SEW-01 through SEW-06 and SEW-11 were located for this purpose.
2. South Plant 83 was to be remediated by placement of an extraction well in the area with localized occurrences of VOCs. Extraction Well SEW-10 was located for this purpose.
3. Where dewatering was not possible or practical, the Shallow Zone Aquifer was to be remediated by removing VOCs via flushing to levels below ARARs (Table 3-2).

Accordingly, the following performance elements were assessed:

1. Contaminant concentration trends
2. Dewatering of the Shallow Zone Aquifer within the area of extraction
3. VOC mass extracted by the groundwater extraction and treatment system
4. Effectiveness of pulse pumping

These elements of the evaluation are presented in accordance with the System Monitoring Plan (Canonie, 1994).

3.5.1 Contaminant Concentration Trends

Groundwater quality in the extraction wells and monitoring wells was evaluated to assess VOC concentration trends. As shown in Tables 3-3 and 3-4, VOC concentrations in the groundwater from the extraction and monitoring wells have been steadily decreasing. This indicates that the Shallow Zone Groundwater Remediation System is working as designed.

Conclusions based on the data collected to date include the following:

- Total VOCs extracted from the Shallow Zone Aquifer during each monitoring period have generally decreased since the system was started. This trend is expected because as VOCs are removed, there is less VOC mass remaining for subsequent removal (Table 3-6).
- In the North Plant 83 area, the horizontal extent of the 1,1-DCA and 1,1-DCE plumes above ARARs have been continually shrinking. The TCE plume above its ARAR has completely disappeared (Figures 3-2A, 3-2B, 3-3A, 3-3B, 3-4A, and 3-4B).
- In the South Plant 83 area, 1,1-DCA, 1,1-DCE, and TCE continue to be present, but only in the Extraction Well SEW-10 and its nearby Monitoring Well SW-08. The concentrations of these compounds continue to reduce with time (Tables 3-3 and 3-4).
- Groundwater levels have not decreased as expected. GEAE elected to operate the Shallow Zone Groundwater Treatment System on a continuous basis and discharge the treated water to the newly installed Injection Well SIW-01. To improve efficiency of the extraction system, the GEAE installed the new Extraction Well SEW-11 near an area where historic data indicated higher VOC concentrations (i.e. near monitoring well P83-03S).

Reduction in Total VOCs Extracted

Table 3-6 shows total VOCs from each extraction well since system startup in May 1994. As shown in Table 3-6, during each period analyzed, the total VOCs from each extraction well have generally been decreasing with periods of temporary increases in total VOCs extracted. Temporary increases in the concentrations of VOCs is an expected phenomenon as VOCs previously trapped in soil pore space become remobilized to the groundwater. The VOCs become remobilized due to several factors including a temporary rise in groundwater elevation, precipitation events that flush VOCs, or a change in groundwater chemistry that caused the trapped VOCs to be released into the groundwater.

Aerial Extent of VOC Plumes

Figures 3-2A, 3-2B, 3-3A, 3-3B, 3-4A, and 3-4B illustrate the plumes associated with the compounds of 1,1-DCA, 1,1-DCE, and TCE, respectively, for the North Plant 83 area. As shown, the extent of the plumes for each compound are decreasing in size. Based on these figures, the Shallow Zone Groundwater Remediation System is working as designed and reducing the VOC concentrations in the Shallow Zone groundwater.

In the area adjacent to South Plant 83, Extraction Well SEW-10 and its nearby Monitoring Well SW-08 are the only two wells with concentrations of VOCs above ARARs. Figures to illustrate the lateral extent of compounds of 1,1-DCA, 1,1-DCE, and TCE would not be meaningful with only the two wells as data points.

3.5.2 Groundwater Level and Saturated Thickness

Water-level monitoring data were collected at the extraction wells and monitoring wells listed in Table 3-1 and shown in Figure 3-1. Water-level data were used to evaluate the performance of the Shallow Zone Groundwater Remediation System with respect to the design objectives (i.e., enhance dewatering of the Shallow Zone Aquifer, if practical).

Figures 3-5A through 3-5G illustrate the saturated thickness of the groundwater aquifer at each of the extraction wells since the beginning of the remediation period through the present. Extraction well SEW-11 was not included in these figures as the well was only recently installed and there are too few data points. Figures 3-5H through 3-5L illustrate the saturated thickness of the groundwater aquifer at five monitoring wells (P83-02S, P83-03S, SMW-09, SMW-11, and SW-08). These monitoring wells were chosen as these wells continue to demonstrate VOCs above ARARs.

As shown in these figures, the groundwater surface has risen substantially. In some cases, the groundwater levels have risen to levels approximately equal to those levels encountered prior to the start of remediation. Accordingly, GEAE installed a new extraction well and injection well to promote increased flushing of VOCs from the perched groundwater.

Based on data collected to date, the following observations were made:

- The groundwater level within the Shallow Zone Aquifer was steadily declining. However, relatively recent recharge from an unknown source or sources (such as precipitation) has caused the groundwater level to rise to approximately pre-remediation levels.
- The groundwater level is directly related to the amount of water that can be pumped, and this is related to the amount of VOCs that can be removed.
- Extracting groundwater from the Shallow Zone Aquifer to dewater the aquifer is not practical. To improve efficiency, a new extraction well and new injection well was installed.

3.5.3 VOC Mass Removal Trend

The VOC mass extracted by the system is calculated based on the volume of groundwater removed and the total VOC concentrations at each extraction well. Total VOC concentrations are computed as the sum of the VOCs detected. Minor contributions to the total VOC count were made by analytes other than the compounds of interest (1,1-DCE, 1,1-DCA, 1,2-DCA, PCE, TCE, and vinyl chloride). However, these minor contributions were small in comparison to the contribution by the compounds of interest.

Table 3-6 summarizes the mass extracted by each well and for the total system since system startup. Since the beginning of remediation, approximately 380 grams of VOCs have been removed. Extraction Wells SEW-05 and SEW-10 have the highest recorded cumulative VOC mass removal. Extraction Well SEW-06 had the lowest recorded cumulative VOC mass removal (excluding SEW-11, operational February 2000). The figures in Appendix A provide a comparison of VOC mass removed per the volume pumped by each extraction well.

Figure 3-6 illustrates the total VOC mass removal trend with time, since the Shallow Zone Groundwater Remediation System started in May 1994. As shown in this figure, the VOC mass removed appears to be reaching an asymptote. This trend is expected and well documented in the technical literature for groundwater remediation via pump and treat where the principal mechanism of remediation is flushing. The figures in Appendix B provide a comparison of total VOC concentration and cumulative mass removed by each extraction well since the start of the Shallow Zone Groundwater Remediation System.

3.5.4 Pulse Pumping

The Shallow Zone Groundwater Remediation System had been pulse pumped from startup in May 1994 to May 2000 when the new Injection Well SIW-01 became operational. Initially, the pulse pumping program consisted of a pumping period of 5 days beginning on a Monday followed by a 2-day resting period. In August 1996, the pulse pumping program consisted of a pumping period of 5 days beginning on Monday followed by a 9-day resting period.

Given that the saturated thickness of the perched water in the Shallow Zone Aquifer has not decreased as expected, pulse pumping with a resting period of 9 days has been discontinued. GEAE resumed the original pumping schedule of 5 days followed by a rest period of 2 days (each weekend). The system has been operated continuously (i.e. no further pulse pumping) since May 2000 when the new injection well SIW-01 became operational.

3.6 Conclusions and Recommendations

The Shallow Zone Groundwater Remediation System has been effective in reducing the concentrations of VOCs, but has not been effective in dewatering the saturated thickness of the perched groundwater. The compound 1,1-DCA was detected during the second quarter 2000 sampling event at concentrations above its ARAR in Wells P83-02S, P83-03S, and SW-08 and in Extraction Wells SEW-02, SEW-05, SEW-10, and SEW-11.

During the second quarter 2000 sampling event the compound 1,1-DCE was detected at concentrations above its ARAR in Wells P83-01S, P83-02S, P83-03S, and SW-08 and in Extraction Wells SEW-02, SEW-03, and SEW-05. Concentrations of this compound are below ARARs in the other monitoring and extraction wells.

During the second quarter 2000 sampling event the compound vinyl chloride was detected at concentrations above its ARAR in Well SW-08 and in Extraction Well SEW-05. Concentrations of this compound are below ARARs in the other monitoring and extraction wells.

During the second quarter 2000 sampling event the compound TCE was not detected above its ARAR in any monitoring or extraction well of the Shallow Zone System.

The Shallow Zone Aquifer is not being dewatered. Hence, the remediation mechanism will be flushing versus removal of perched groundwater. The new Extraction Well SEW-11 and Injection Well SEW-01 were added to improve flushing efficiency. The data indicates an asymptotic removal rate (i.e., less and less VOC removal with time). As such, the next review of system operations should evaluate natural attenuation or other remedial/regulatory options.

Based on data collected to date, GEAE requested and the EPA and NMED approved changes to the data collection schedule for monitoring wells and extraction wells. Extraction wells are now sampled and analyzed semi-annually, and Monitoring Wells, P83-05S, P83-13S, P83-15S, S-01, SMW-13, and SMW-14 are now sampled and analyzed annually. Concentration data from these monitoring wells indicate that VOCs have been absent or significantly below their respective ARARs for at least eight consecutive quarters. The remaining Monitoring Wells P83-01S, P83-02S, P83-03S, P83-14S, SMW-09, SMW-10, SMW-11, SMW-12, SW-06, SW-07, and SW-08 continue to be sampled and analyzed on a semi-annual basis.

4.0 PLANT 83 OPERABLE UNIT - DEEP ZONE GROUNDWATER REMEDIATION SYSTEM

The Plant 83 OU ROD (EPA, 1988a) also required removal of VOCs from the Deep Zone Groundwater Aquifer east of the Plant 83 facility. The EPA required groundwater extraction, treatment by air stripping and carbon adsorption to remove the VOCs from the impacted groundwater, and then injection of treated water to the Deep Zone Aquifer.

Work accomplished during this reporting period (June 1993 through June 2000) included delineation of chemicals in the deep zone aquifer east of Plant 83 (Deep Zone Plume). Work also included the construction, operation, and maintenance of the Deep Zone Aquifer groundwater extraction and treatment system and the sampling and analysis of groundwater from monitoring wells and process water from the treatment system. The extraction and injection wells, treatment system, and monitoring program collectively make up the Deep Zone Groundwater Remediation System.

This work was conducted as specified in the 100-Percent Design Report, Deep Zone Ground Water Remediation System (Canonie, 1995) and the Performance and Compliance Monitoring Plan (PCMP) (Smith, 1996). Figure 4-1 illustrates the locations of the wells associated with the Deep Zone Groundwater Remediation System.

The Deep Zone Groundwater Remediation System consists of three high volume extraction wells that remove groundwater with concentrations of VOCs in excess of ARARs, a treatment system that removes the VOCs from the extracted water by air stripping followed by redundant treatment using liquid-phase granulated activated carbon. When treated, the water is returned to the Deep Zone Aquifer at the same elevation it was extracted via 10 injection wells. Monitoring wells are located within and proximate to the extraction and injection area to provide a means to monitor the progress of the remediation.

4.1 Deep Zone Groundwater Remediation System Goals

The remedial design objectives approved by the EPA and outlined in the 100% Design Report, Deep Zone Ground Water Remediation System (Canonie, 1995) include but are not limited to the following:

- Meet the requirements of the ROD (EPA, 1988a)
- Delineate the Deep Zone Plume
- Provide hydraulic control of the Deep Zone Plume
- Remediate impacted groundwater within the Deep Zone Plume via flushing to concentrations less than the ARARs (EPA approved ARARs for this site are listed in Table 4-2)
- Operate the GEAE remedial system to avoid detrimental effects to nearby remediation systems operated by others
- Provide adequate safeguards within the system to prevent detrimental system failures

The following text provides an evaluation of this system in comparison to the objectives listed above.

4.2 Deep Zone Aquifer Geology and Groundwater Flow Model

The Deep Zone Aquifer is the aquifer encountered at the site below an elevation of 4,900 feet above msl. In the ROD (EPA, 1988a) this aquifer is referred to as both the Intermediate and the Deep Zones. Groundwater beneath the site area is encountered at an elevation proximate to 4,900 feet above msl corresponding to depths below the ground surface of 49 to 115 feet. Groundwater impacted with dissolved VOCs being remediated by the Deep Zone Groundwater Remediation System ranges from 4,840 to 4,600 feet above msl.

Deep Zone Aquifer Geology

The following text describes the geology as characterized and reported previously (H+GCL, 1993a). In summary, the geology consists of unconsolidated alluvial units of the older Santa Fe Group. These sediments (down to approximately 4,300 feet above msl) are primarily ancestral Rio Grande-related, braided fluvial deposits. These sediments contain lenticular deposits of finer grained, relatively lower conductivity sands, silts, and clays.

Sediments within the upper 600 to 700 feet of the Deep Zone Aquifer (the area where groundwater is being remediated) are characterized by high proportions of sands and gravels that form extensive and locally high-conductivity units across the site. Discontinuous silts and clays are present within this interval, and the cumulative effect of many of these lower conductivity layers is to limit the downward rate of contaminant movement in the vertical direction. Note that these silts and clays form confining layers in upper portions of the aquifer, but these confining layers are not laterally extensive. There is no evidence to suggest a laterally extensive confining layer east of the Albuquerque Metropolitan Arroyo and Flood Control Authority (AMAFCA) South Diversion Channel, in the area of interest.

Groundwater Flow Model

To model this site and design the Deep Zone Groundwater Remediation System, the Deep Zone Aquifer was divided into five vertical intervals based on interpretations of the geology as defined in the initial groundwater flow model for the site (H+GCL, 1993b). The EPA adopted these intervals as the standard intervals for describing the Deep Zone Aquifer. The groundwater flow model was further refined and uses nine layers to calculate groundwater flow. The Deep Zone Groundwater Remediation System addresses impacts between an elevation of 4,840 feet above msl (top of Model Layer 3) to an elevation of 4,600 feet above msl (bottom of Model Layer 6). Figure 4-1 provides a key map that illustrates the correspondence between the intervals, model layers, and physical elevations.

To be consistent with previous reports, the deep shallow zone (DS) interval ranges from 4,840 to 4,900 feet above msl and corresponds to Model Layers 1 and 2. The deep intermediate zone (DI) interval from 4,740 to 4,840 feet above msl corresponds to Model Layers 3 and 4. This interval was separated for evaluation purposes in this and previous reports. The upper portion of the DI zone from 4,790 to 4,840 feet above msl corresponds to Model Layer 3. The lower portion of the DI interval consisting of Model Layers 4 and 5 from 4,740 to 4,790 feet above msl is combined with the deep deep zone (DD) interval from 4,660 to 4,740 feet above msl as one evaluation interval (referred to as the DI/DD interval). The deep low-permeability zone (DLPZ) interval from 4,600 to 4,660 above msl corresponds to Model Layer 6 and remains unchanged as a complete interval for evaluation in this report.

The below deep low-permeability zone (BDLPZ) interval ranges from the bottom of the DLPZ (Model Layer 6) to an elevation of 3,880 feet above msl. The BDLPZ interval is not evaluated in this report because the Deep Zone Plume is not present in this interval.

Figure 4-1 provides the locations of monitoring wells that are screened in each of the upper four intervals (DS, DI, DI/DD, and DLPZ) corresponding to Model Layers 1 through 6. As described above, remediation of impacted groundwater occurs between elevation 4,840 feet above msl (top of Model Layer 3) and elevation 4,600 feet above msl (bottom of Model Layer 6).

4.3 Deep Zone Aquifer Plume Characterization

Impacts to the Deep Zone Aquifer were characterized during preliminary investigations conducted prior to this reporting period, and investigations conducted during this reporting period to support the design of the Deep Zone Groundwater Remediation System. These investigations were used as the basis to delineate the extent of the Deep Zone Plume.

Data from investigations conducted by other Potentially Responsible Parties (PRPs) (e.g., Univar, Texaco, Chevron, ATA Pipeline, and others) at the South Valley Superfund Site indicate multiple sources may have impacted the Deep Zone Aquifer. These data were summarized by the respective parties and provided to the regulatory agencies in various reports. These impacts include chlorinated solvent compounds and petroleum related compounds in both the unsaturated and saturated portions of the Deep Zone Aquifer. The other parties at the South Valley Superfund Site have characterized plumes associated with these impacts under separate agreements between those PRPs and the EPA Region VI and/or the NMED.

For the purposes of this report, the Deep Zone Plume is that area described by dissolved phase chlorinated solvents above ARARs in the saturated portion of the Deep Zone Aquifer between elevation 4,600 feet above msl (bottom of Model Layer 6) and 4,840 feet above msl (top of Model Layer 3).

Numerous wells were installed to identify the boundary of the Deep Zone Plume. Based on the data collected from numerous monitoring wells, the plume boundary was established. Figure 4-1 illustrates the locations of the monitoring wells used to characterize the Deep Zone Plume. Figure 4-1 illustrates the wells with screen midpoints at different depths associated with the groundwater flow model used to design the extraction and injection system.

The lateral extent of the Deep Zone Plume is inscribed within the area between Broadway Boulevard on the west boundary to Interstate I-25 on the east boundary, and between Woodward Road on the north boundary and Stockton Drive on the south boundary. Based on data collected from the wells within this boundary, VOCs are not present in the groundwater from Well WB-07 above ARARs; other wells with no VOCs above ARARs include HL-02, P83-08D and DMW-02. These wells were installed upgradient of the Deep Zone Plume and hence, these wells are considered upgradient wells. Also based on data, VOCs above ARARs have not been reported in samples from the Well P83-19 cluster. This well cluster is located downgradient of the Deep Zone Plume and hence, this cluster therefore form the downgradient wells.

As noted in the 100 % Design Report, Deep Zone Ground Water Remediation System (Canonie, 1995), the area of highest VOC concentrations within the Deep Zone Plume was located in the area of Monitoring Wells P83-09D, and Westbay Well WB-01 screens (2), (3), (4), and (5). Samples taken from these wells from 1992 (initial sampling after well installation) until 1996 (prior to initiation of groundwater extraction in the Deep

Zone) reflect the highest VOC concentrations throughout the area of investigation. Refer to Appendix E-1, E-2, and Figures 4-17 through 4-25.

4.4 Deep Zone Groundwater Remediation System Description

The Deep Zone Groundwater Remediation System was constructed during 1995 and 1996 and operations began in March 1996. The Deep Zone Groundwater Remediation System includes monitoring wells, extraction wells, and a groundwater treatment system. Table 4-1 provides a list of the 3 extraction and 77 groundwater quality monitoring well points. Note that Westbay wells have multiple sample ports associated with each well. For example, Westbay Well WB-04 has ports 1, 2, 3, 4, 5, 10, 11, and 12 that are sampled to monitor the effectiveness of the Deep Zone Groundwater Remediation System. Figure 4-1 illustrates the location of the wells and the treatment plant building.

The Deep Zone Groundwater Remediation System operates by extracting groundwater from three large diameter extraction wells, and conveys this groundwater via dual-contained pipe to the treatment system located on the northwest intersection of Woodward Road and the AMAFCA South Diversion Channel. The extracted groundwater is brought into the treatment plant via separate pipelines and is then combined in the influent tank. A linear phosphate (AquaMag™) is added to the water to prevent scaling of minerals during treatment and injection. AquaMag™ is acceptable for use in drinking water and drinking water-supply aquifers.

From the influent tank, the groundwater is then pumped through two air-stripping towers where the VOCs are removed. This water then flows through two granulated activated carbon vessels for redundant treatment and is then piped into a single effluent holding tank. From the effluent tank, the treated water is piped through a filter system to remove particles, and then it is conveyed via a single-contained pipe to 10 injection wells where it is returned to the Deep Zone Aquifer at the same elevation where it was removed. Carbon dioxide is added to the treated water just after the filter system to lower the pH of the water. Monitoring wells are used to monitor the progress of the remediation in both the horizontal and vertical extent within and outside of the plume boundary.

In addition to the treatment of the groundwater for remediation purposes, a potable water treatment system was built inside the Deep Zone Groundwater Remediation System treatment plant. A portion of the treated water from the effluent tank is diverted to provide a potable water supply for the facilities at the treatment plant. The quantity of water diverted for this purpose is monitored, and a record of this is provided to the State Engineers Office once per month.

A complete description of this system is provided in the 100% Design Report, Deep Zone Ground Water Remediation System, Plant 83/General Electric Operable Unit, South Valley Superfund Site, Albuquerque, New Mexico (Canonie, 1995).

4.5 Performance of the Deep Zone Groundwater Remediation System

The performance of the Deep Zone Groundwater Remediation System was evaluated based on monitoring data collected during the baseline event (April 1996) and subsequent events and include the following:

- Water-level monitoring in the extraction wells injection wells and selected monitoring wells
- Groundwater quality at the extraction and monitoring wells
- Effluent water quality monitoring of the groundwater treatment system
- Flow monitoring at each of the extraction wells, injection wells, and the combined flow of the treatment system

In a letter to the EPA dated November 19, 1999, GEAE proposed several modifications to the water quality sampling program of the Deep Zone Groundwater Remediation System based on historical information collected to date. The EPA approved GEAE's request to modify groundwater quality sampling from a quarterly to a semi-annual basis in a letter dated December 29, 1999 (Appendix G).

Semi-annual sampling will coincide with the second and fourth calendar year quarters. This change in protocol was implemented first quarter 2000. Also stated in the letter, groundwater level measurements will continue to be collected on a quarterly basis, with reporting occurring semi-annually.

The following sections provide a summary of collected data, a comparison of data with time, and an evaluation of the performance of the remedy.

4.5.1 Groundwater-Level Monitoring Data

Groundwater levels are measured at the monitoring wells, extraction wells, and injection wells to observe the groundwater total head (total energy) fluctuations in response to operating the Deep Zone Groundwater Remediation System. The design objectives of the Deep Zone Groundwater Remediation System include hydraulic control of the Deep Zone Plume and flushing the VOCs from the Deep Zone Aquifer to meet ARARs.

Appendix D provides a summary table of well completion information. Groundwater-level data and hydrographs from conventional monitoring wells are summarized in Appendix C-1. The Westbay™ groundwater-level data and hydrographs are tabulated in Appendix C-2. Extraction and injection well groundwater-level data and hydrographs are tabulated in Appendix C-3.

4.5.2 Groundwater Quality Data

Groundwater quality monitoring is performed for the purpose of obtaining accurate, representative, complete, and comparable data for assessing changes in constituent concentrations, compliance with discharge criteria, and performance of the groundwater extraction and treatment system. Data collection activities for both the Plant 83 OU and the SJ-6 OU are specified in the Performance and Compliance Monitoring Plan (Smith, 1996).

The laboratory analytical results are used for the following purposes:

- Monitor the time-related changes of analyte concentrations in the groundwater
- Evaluate when analyte concentrations in the Deep Zone Aquifer are below ARARs
- Determine when the granulated activated carbon treatment units have become loaded with VOCs requiring a change of carbon

During the sample events, groundwater quality samples are collected at the conventional wells, Westbay™ wells, and piezometers listed in Table 4-1. A conventional well is a well that has only casing and one screen interval and a Westbay™ well has one casing, but several screen intervals. A piezometer is a well that has one casing and one screen interval but the screen interval is relatively short and is used primarily for measuring fluctuations in the groundwater table.

The groundwater quality samples are analyzed for the VOCs listed in the Modified Method 8260 list, plus 1,2-dibromoethane (also known as ethylene dibromide or EDB) and Methyl tert butyl ether (MTBE). This list is an extended EPA Method 8240 list amended to accommodate Method 8260 detection limits. The compounds EDB and MTBE were added to monitor impacts to the groundwater Deep Zone Plume. These compounds are specifically related to petroleum hydrocarbon compounds and petroleum storage activities not associated with Plant 83 operations.

Table 4-2 provides a summary of the analytes, EPA methods, and reporting limits. On an annual basis (i.e., during the second calendar year quarter), groundwater samples are also analyzed for inorganic compounds and parameters using the EPA methods identified in Table 4-2.

Groundwater samples collected during the second calendar year quarter for the SJ-6 OU annual monitoring event were analyzed for VOCs, inorganic compounds, and parameters shown in Table 4-2. VOC concentration data with time for conventional wells that are a part of this monitoring program are shown in

Appendix E-1. VOC concentration data with time for the Westbay™ wells that are a part of this monitoring program are shown in Appendix E-2. VOC concentration data for the extraction and injection wells are shown in Appendix E-3.

4.5.3 Treatment System Water Quality Data

During routine operations, treatment system compliance samples are collected to verify compliance with the State of New Mexico discharge permit issued to GEAE on December 21, 1995. Compliance samples are collected monthly, as required by the discharge permit, at the effluent Sample Port No. 425 (SP-425) of the groundwater treatment system located between the injection filters and injection wells. As specified in the PCMP (Smith, 1996), the monthly treatment system compliance samples are analyzed for VOCs, and the inorganic compounds iron, manganese, and total dissolved solids (TDS). In addition, the compound EDB, is analyzed by EPA Method 504.1 to a minimum detection limit of 0.1 µg/l (or ppb) since its ARAR is 0.5 µg/l.

4.5.4 Flow Monitoring

Groundwater flow recovery from the extraction wells (influent to the treatment plant) and discharge to the injection wells (effluent from the treatment plan) are monitored to:

- Assess hydrologic capture and contaminant removal performance of the remediation system
- Verify compliance with both the State of New Mexico Drill and Use Permit issued December 29, 1995, the State of New Mexico Permit to Appropriate Underground Waters issued January 24, 1996

Extraction and injection flow are monitored via totalizing flow meters located at the discharge line of each extraction well, the inlet line of each injection well, and downstream of the potable water treatment unit. The total flow from the extraction wells to the treatment plant and from the treatment to the injection wells is recorded continuously during treatment plant operations by the Supervisory Control and Data Acquisition (SCADA) computer control system. The total flow of effluent diverted to the potable water treatment system is monitored continuously and recorded manually once per week.

Table 4-3 summarizes the extraction well and injection well flows for each month and also provides a monthly volume of water diverted from the Deep Zone Aquifer for remediation and sanitary purposes since the start-up of operations. This table also indicates the average operational flow rate at each extraction and injection well.

4.6 Deep Zone Groundwater Treatment System Effectiveness

This section of the report provides an evaluation of the effectiveness of the Deep Zone Groundwater Remediation System. The remedial design objectives for the Deep Zone consisted of three parts:

1. Provide hydraulic control of the Deep Zone Plume
2. Remediate impacted groundwater via flushing to concentrations less than the ARARs
3. Operate the remedial system to avoid detrimental effects to nearby remediation systems operated by other PRPs that address impacts to the Deep Zone Aquifer.

Accordingly, the following elements were assessed to evaluate the effectiveness of the Deep Zone Groundwater Remediation System:

- Groundwater elevations
- Contaminant concentration trends
- Treatment system water quality
- VOC mass extracted by the groundwater extraction and treatment system
- Flushing of the Deep Zone Aquifer within the area of extraction

These elements of the evaluation are presented in accordance with the PCMP (Smith, 1996).

4.6.1 Groundwater Elevation Trends

GEAE measured the depth to water in the conventional monitoring wells, piezometers, and extraction/injection wells and recorded hydrostatic pressure in Westbay™ monitoring wells during the baseline and subsequent groundwater monitoring events. Because monitoring wells are screened at various elevations throughout the Deep Zone Aquifer, groundwater elevation or potentiometric surface (total head) contour maps were prepared for the four upper evaluation intervals. These intervals include DS – Model Layers 1 and 2, DI – Model Layer 3, DI/DD – Model Layers 4 and 5, and DLPZ – Model Layer 6.

For comparison purposes, total head data were plotted in plan view for the baseline event in April 1996 (i.e., second quarter 1996 data). The second quarter monitoring events were chosen to give the same temporal snapshots of the water-level conditions and to be consistent with previous reports.

1995 and 1996

Figure 4-2 illustrates the total head contours for Model Layers 1 and 2. Figure 4-5 illustrates the total head contours for Model Layer 3. Figure 4-8 illustrates the total head contours for Model Layers 4 and 5. Figure 4-11 illustrates the total head contours for Model Layer 6.

1997 and 1998

Figure 4-3 illustrates the total head contours for Model Layers 1 and 2. Figure 4-6 illustrates the total head contours for Model Layer 3. Figure 4-9 illustrates the total head contours for Model Layers 4 and 5. Figure 4-12 illustrates the total head contours for Model Layer 6.

1999 and 2000

Figure 4-4 illustrates the total head contours for Model Layers 1 and 2. Figure 4-7 illustrates the total head contours for Model Layer 3. Figure 4-10 illustrates the total head contours for Model Layers 4 and 5. Figure 4-13 illustrates the total head contours for Model Layer 6.

Note that the Deep Zone Groundwater Remediation System was operational in March 1996 and affects the total head in Model Layers 3, 4, 5, and 6. Accordingly, the contours shown for these intervals indicate the effects of pumping from the 3 extraction wells and injection back to the aquifer via the 10 injection wells.

Based on data collected to date, the Deep Zone Remediation System has maintained capture and mitigated the migration of groundwater impacted with VOCs. As shown in Figures 4-6, 4-7, 4-9, 4-10, 4-12, and 4-13, groundwater flow converges toward the extraction wells forming a capture zone of the VOC plume. In reviewing these figures, the groundwater flows patterns in the extraction and injection wells have not changed significantly since the system was started.

Based on these figures, there is hydraulic capture along the direction of groundwater flow eastward to Interstate I-25. Data illustrated in these figures also demonstrate hydraulic capture from the injection wells along the north side of the plume proximate to monitoring well D-02, to the injection wells located on the south side of the plume proximate to Monitoring Well WB-05. These recorded groundwater data confirm the expected result predicted by the design groundwater flow model (Canonie, 1995).

4.6.2 Contaminant Concentration Trends

The preremediation extent of impacts to groundwater in the Deep Zone Plume and SJ-6 OU were delineated in both the horizontal and vertical directions based on groundwater sampling results from May 1992 through April 1996. These results have been published in previous reports and formed the basis of the Deep Zone Groundwater Remediation System design (Canonie, 1995).

To assess the Deep Zone Groundwater Remediation System, results from second quarter 1995, 1996, 1997, 1998, 1999, and 2000 were compared. The second quarter 1996 results are preremediation and therefore, provide a baseline for comparison purposes. During these reporting periods, the following compounds were detected in the groundwater above their respective ARARs:

- TCE
- PCE
- 1,1-DCE

- 1,1-DCA
- 1,2-DCA
- Vinyl chloride
- Methyl tert butyl ether (MTBE)

No additional compounds were detected above their respective ARAR during this reporting period. The compounds 1,2-DCA and MTBE are additives to petroleum products, and are not associated with Plant 83 operations. The compounds listed above have been detected above ARARs in the Deep Zone Plume area.

Data analyses indicate that since the startup of the Deep Zone Groundwater Remediation System, the VOCs are declining both in concentration and in aerial extent. In addition, no VOCs have ever been detected above their respective ARARs in the downgradient Monitoring Well P83-19 Screens U, M, and LR. Accordingly, the Deep Zone Groundwater Remediation System is accomplishing another of its primary objectives (i.e., hydraulic capture and flushing to reduce VOCs to levels at or below ARARs).

For consistency with the previous reports, the second quarter VOC data were selected for contouring and are displayed on distribution maps and cross sections along the main axis of the plume. Figure 4-14 illustrates pre-remediation 1995 and 1996 VOC concentrations in Model Layers 1 and 2. The remediation system does not address VOC impacts in Model Layers 1 and 2. Impacts above model layer 3 are being addressed separately by remediation systems operated by other PRPs.

Figure 4-17 illustrates pre-remediation 1995 and 1996 VOC concentrations in Model Layer 3. Figure 4-20 illustrates pre-remediation 1995 and 1996 VOC concentrations in Model Layers 4 and 5. Similarly, Figure 4-23 illustrates pre-remediation 1995 and 1996 VOC concentrations in Model Layer 6.

Figure 4-15 illustrates VOC concentrations in Model Layers 1 and 2 during 1997 and 1998. Figure 4-18 illustrates VOC concentrations in Model Layer 3 during 1997 and 1998. Figure 4-21 illustrates VOC concentrations in Model Layers 4 and 5 during 1997 and 1998. Similarly, Figure 4-24 illustrates VOC concentrations in Model Layer 6 during 1997 and 1998.

Figure 4-16 illustrates VOC concentrations in Model Layers 1 and 2 during 1999 and 2000. Figure 4-19 illustrates VOC concentrations in Model Layer 3 during 1999 and 2000. Figure 4-22 illustrates VOC concentrations in Model Layers 4 and 5 during 1999 and 2000. Similarly, Figure 4-25 illustrates VOC concentrations in Model Layer 6 during 1999 and 2000.

These figures also provide summary tables that compare each VOC concentration detected during the second quarter events. Based on these figures, the aerial extent of the Deep Zone Plume is shrinking, and concentrations of VOCs have reduced significantly since the Deep Zone Plant became operational in March 1996.

To further illustrate the reduction of VOCs in the Deep Zone Aquifer, Figures 4-26 through 4-30 illustrate the VOCs detected above their respective ARARs in cross-section view for second quarter 1996, 1997, 1998, 1999 and 2000. As shown, these figures illustrate each of the VOCs detected above ARARs in the remediation zone. Based on these figures, the cross-section extent of the Deep Zone Plume is shrinking, and concentrations have reduced significantly since the Deep Zone Plant became operational in March 1996.

The following provides the most notable remarks about the presence of VOCs in the Deep Zone Aquifer before and after the Deep Zone Groundwater Remediation System became operational:

- Model Layers 1 and 2:

  Compounds detected in the groundwater sampled from monitoring wells included MTBE, PCE, TCE, and 1,2-DCA. These compounds are no longer present above their respective ARARs in 2000. See Figures 4-14, 4-15, and 4-16.

- Model Layer 3:

  Compounds detected in the groundwater sampled from monitoring wells in 1996 included PCE, TCE, 1,2-DCA, 1,1-DCA, and 1,1-DCE. Compounds 1,2-DCA and 1,1-DCA are no longer present above their respective ARARs in 2000. In addition, the aerial extent of the remaining compounds has decreased from 1995 to 2000. See Figures 4-17, 4-18, and 4-19.

- Model Layers 4 and 5:

  Compounds detected in the groundwater sampled from monitoring wells in 1996 included PCE, TCE, 1,2-DCA, 1,1-DCA, 1,1-DCE, and vinyl chloride. Compounds 1,2-DCA and vinyl chloride are no longer present above their respective ARARs in 2000. The aerial extent of the remaining compounds has decreased from 1995 to 2000. See Figures 4-20, 4-21, and 4-22.

- Model Layer 6:

  Compounds detected in the groundwater sampled from monitoring wells in 1996 included PCE, TCE, 1,1-DCA, and 1,1-DCE. Compounds PCE and 1,1-DCA are no longer present above their respective ARARs in 2000. The aerial extent of the remaining compounds has decreased from 1995 to 2000. See Figures 4-23, 4-24, and 4-25. 1,2-DCA was detected above ARARs in 1997 and 1998. Since 1998, 1,2-DCA has not been reported above its ARAR.

- VOC Contours in Vertical Cross-Section:

  Figures 4-26 through 4-30 show the approximate VOC contours in vertical cross-section from April/May 1996 through April/May 2000. The overall shape of the VOC plume appears to be reducing in size. Additionally, from 1996 to 2000, vinyl chloride, MTBE, and 1,2-DCA appear to have been reduced below their respective ARARs.

VOC concentrations over time were plotted for the Deep Zone Groundwater Remediation System monitoring wells that are part of the Deep Zone Plume groundwater monitoring program. These time series plots are included in Appendix E. VOC data are plotted for each well since sampling began at each respective well location. Similar to the figures identified above, the plots indicate significant reduction of VOC concentrations in monitoring wells.

4.6.3 Treatment System Water Quality

Water quality samples are routinely collected and analyzed to verify compliance with the State of New Mexico discharge permit issued to GEAE on December 21, 1995. Compliance samples were collected monthly, as required by the discharge permit, at the effluent SP-425 of the groundwater treatment system located between the injection filters and injection wells. Sample collection frequency and analysis were conducted as prescribed in the PCMP (Smith, 1996). As required by the PCMP (Smith, 1996), the compound EDB was analyzed by EPA Method 504.1 to a lower detection limit.

During the system startup, the compound MTBE was detected in the influent groundwater from the extraction wells. This compound is a fuel additive (i.e., an oxygenating agent) in gasoline.

The presence of MTBE was anticipated in the design of the Deep Zone Groundwater Remediation System (Canonie, 1995); however, the concentrations detected in the groundwater from the extraction wells were substantially higher than those anticipated in the design. The anticipated average composite concentration of MTBE was 13.7 ppb (Canonie, 1995). The average composite concentration of MTBE actually encountered by the extraction wells during the first 3 months of operation was 61.9 ppb. The composite MTBE concentrations ranged from 29 ppb to 160 ppb (BDM, 1997). As of June 1998, the MTBE composite concentration was approximately 18 ppb. Figure 4-31 illustrates the influent concentration of MTBE with time since the treatment plant became operational in 1996.

During startup, the treated effluent of the Deep Zone Groundwater Remediation System was rigorously monitored for VOCs including MTBE. No VOCs had been detected in the treated effluent from the time of system startup through July 8, 1996. However, GEAE noted the presence of MTBE in the treated effluent samples beginning on July 8, 1996 (BDM, 1997). GEAE researched this issue and concluded that the MTBE was being stripped from the water by the air strippers, however, because the influent concentrations were much higher than anticipated, the air stripper towers were unsuccessful in complete MTBE removal.

The Deep Zone Groundwater Remediation System uses carbon adsorption as a redundant treatment. In discussions with carbon vendors, GEAE learned that the carbon was being loaded by MTBE. This provides an explanation for detections of MTBE in the treated water effluent that began in July 1996. GEAE contacted EPA Region VI regarding the presence of MTBE. Because the ARAR for MTBE is 100 ppb and the concentrations of MTBE in the treated effluent from the carbon units have remained 10 ppb or less, the EPA concluded that the treatment system was still in compliance with discharge requirements. Figure 4-32 illustrates the MTBE concentrations in the treated effluent from the treatment plant since the system was started.

On one occasion since the Deep Zone Plant became operational, VOCs other than MTBE were detected in the treated effluent sample. The compounds chloromethane and trichloroethene were detected at concentrations of 2 and 1.2 µg/l respectively in the treated effluent collected during the October 1999 compliance sample event (SP-425). However, confirmatory samples contained no detectable concentrations of any VOCs. Accordingly, this data is considered suspect. In addition, the concentration levels reported for these two compounds, if valid, are significantly below their respective ARARs.

4.6.4 VOC Mass Extracted by the Treatment System

VOC mass removal is used to evaluate the Deep Zone Remediation System performance by quantifying the cumulative mass of VOCs removed from the aquifer. The VOC mass removal by the system is calculated based on the volume of treated groundwater and the average total VOC concentrations removed by the treatment plant. Total VOC concentrations were computed as the sum of all detectable VOCs, of which the most common were 1,1-DCA, 1,1-DCE, 1,2-DCA, MTBE, PCE, and TCE.

Table 4-4 and Figure 4-33 summarize the mass of VOCs removed by the Deep Zone Remediation System since startup. Since the system was started, through June 2000 approximately 879 pounds of VOC mass have been removed. As shown on Figure 4-34, the influent concentrations of total VOCs and TCE (the most prevalent VOC) have decreased with time.

4.6.5 Flushing of the Deep Zone Aquifer

To demonstrate the rate at which the Deep Zone Aquifer is being flushed, GEAE used the calibrated groundwater flow model established for this site during design. GEAE operated the groundwater flow model using the average rates for groundwater extraction and injection well rates as measured throughout the June 1998 through July 1999 reporting year, as input parameters. Since system startup, groundwater extraction and injection flow rates have remained approximately the same. Accordingly, use of the 1999 reporting year data is considered representative of groundwater flows since the system became operational.

The groundwater flow model had been calibrated previously using approximately the same groundwater extraction and injection rates. A description of the model calibration was provided in the Revised Annual Report, March 1996 through May 1997, Former Air Force Plant 83/General Electric and San Jose–6 Record of Decision Operable Units, South Valley Superfund Site (BDM, 1997).

The groundwater flow model output was processed through a post-processor designed to calculate the pore volumes flushed through each cell of the model. The output of the post-processor was then contoured for graphical illustration. The approach and process are documented in the technical paper "Numerical Prediction of Aquifer Pore Volume Flushing Rates for Remedial Design," (Sjostrom, et al., 1994). A copy of this paper has been included in Appendix F.

Figure 4-35 illustrates the average pore volumes per year flushed through the groundwater flow Model Layers 3, 4 and 5, and 6. As shown in this figure, flushing is pronounced (greater than three pore volumes per year) in the areas proximate to the extraction and injection wells. Flushing is less pronounced further from the extraction wells and approaches one pore volume per year at the VOC plume boundary.

The pore volumes flushed in each layer as demonstrated in Figure 4-35 support the design concept. In the design of the Deep Zone Groundwater Remediation System, more flushing was to occur in the areas of highest concentration (i.e., near extraction wells) with lesser flushing in areas of lower concentration (i.e., VOC plume boundary) (Canonie, 1995). Figure 4-35 confirms that flushing is occurring as designed.

4.6.6 Treatment Plant On-line Efficiency

Since system startup, the Deep Zone treatment plant has been fully operational 24 hours per day except for routine maintenance and unplanned stoppages. Routine maintenance is conducted to avoid prolonged unplanned stoppages due to equipment failure and/or to conduct plant inspections.

The unplanned stoppages since startup of the system were related to the following issues:

- High water levels in the injection wells
- Ice formation on the air stripper tower blower grates
- Repairs to the pumps in Extraction Wells EW-001 and EW-003
- Lightning that causes erroneous signals to the plant control room
- High winds that interfered with the air stripper blowers

Aside from unpredictable weather issues, regular inspection and maintenance has kept the treatment plant operational. Through June 2000, the plant run-time has had an efficiency of 88.3 percent. Table 4-5 provides a summary of run-time for the treatment plant.

4.7 Overall Effectiveness and System Optimization

GEAE expended a significant effort during the design of the Deep Zone Groundwater Remediation System to maximize the effectiveness of the system, in terms of maximizing capture and minimizing flow rate. During the design, over 300 runs were made with the groundwater flow model to design the system and ensure effectiveness.

GEAE has always looked for continuous improvements in the efficiency of the current system. GEAE has rehabilitated injection wells and maintained other treatment plant equipment to reduce the amount of time the system is down due to unplanned stoppages. In addition, GEAE has scheduled other maintenance while the plant was already down to improve efficiency of the overall treatment system. GEAE will continue to explore ways to make the system operate more efficiently.

4.8 Conclusions

The following conclusions were derived from data and observations collected to date regarding the Deep Zone Groundwater Remediation System:

- A complete lateral capture zone has been maintained from the upgradient (i.e. near Monitoring Well WB-07) eastward to I-25 and north-south between the injection wells (Figures 4-6, 4-9, and 4-12). A complete vertical capture zone has been created by pumping and maintained from an elevation of 4,840 feet above msl to an elevation of about 4,600 feet above msl.
- The VOC plume has been captured by the Deep Zone Remediation System. Flushing continues to reduce the extent and concentration of the VOC plume.
- There have been no VOCs above ARARs in the downgradient Well Cluster P83-19. Accordingly, the plume has been captured and migration has been mitigated (Figure 4-26 through 4-30).
- The treatment system has been effective in removing constituents to concentrations below the ARARs, and water injected back into the Deep Zone Aquifer is in compliance with the applicable discharge requirements. VOCs, with the exception of MTBE, continue to be removed to below detection limits by the treatment plant.
- Approximately 1.4 billion gallons of groundwater has been extracted, treated, and injected since system startup through June 2000 (Table 4-3).

- Since the system startup through June 2000, approximately 879 pounds of VOC mass have been removed (Table 4-4 and Figure 4-33).
- The Deep Zone Groundwater Remediation System has had an average on-line efficiency of approximately 88.3 percent (Table 4-5).
- Flushing is pronounced (greater than three pore volumes per year) in the areas proximate to the extraction and injection wells. Flushing is less pronounced further from the extraction wells and approaches one pore volume per year at the VOC plume boundary (Figure 4-35).

Based on information compiled to date, the extraction and injection rates for the Deep Zone Remediation System should remain unchanged and continue to follow guidelines for extraction and injection rates for normal and contingency operations as presented in Table 4.1 of the Operation and Maintenance Manual (Smith, 1997).

5.0 OVERALL CONCLUSIONS

Overall conclusions for the remedial work conducted to date include the following:

Entire Site

- GEAE has fully investigated and characterized VOC impacts to the unsaturated and saturated portions of the Shallow Zone Aquifer, including areas north of GEAE Plant 83 property boundary.

- The impacts due to dissolved phase VOCs in the saturated portion of the Deep Zone Aquifer have been fully investigated and characterized.

- Dense non-aqueous phase liquids have not been found in site investigations. In the unsaturated portion of the Shallow Zone Aquifer, VOCs are present in the vapor phase; in the saturated portion of the Shallow and Deep Aquifers, VOCs are present in the dissolved phase.

Unsaturated Portion of the Shallow Zone Aquifer

- Vapor phase VOCs in the unsaturated portion of the Shallow Zone Aquifer have been remediated to regulatory cleanup levels and pose no threat to human health or the environment.

Saturated Portion of the Shallow Zone Aquifer

- The Shallow Zone Groundwater Remediation System has mitigated the migration of VOCs in the saturated portion of the Shallow Zone Aquifer.

- Based on data collected to date, it is not feasible to eliminate the perched groundwater within the saturated portion of the Shallow Zone Aquifer. Hence, flushing of VOCs will be the primary mechanism by which VOC impacts to the Shallow Zone Aquifer will be remediated.

- Flushing via groundwater extraction continues to reduce the concentration of VOCs in the saturated portion of the Shallow Zone Aquifer.

- During the second quarter 2000 sampling event, the compound 1,1-DCA was detected at concentrations above its ARAR in Wells P83-02S, P83-03S, and SW-08 and in Extraction Wells SEW-02, SEW-05, SEW-10, and SEW-11. Concentrations of this compound are below ARARs in the other monitoring and extraction wells.

- During the second quarter 2000 sampling event, the compound 1,1-DCE was detected at concentrations above its ARAR in Wells P83-01S, P83-02S, P83-03S, and SW-08 and in Extraction Wells SEW-02, SEW-03, and SEW-05. Concentrations of this compound are below ARARs in the other monitoring and extraction wells.

- During the second quarter 2000 sampling event, the compound vinyl chloride was detected at concentrations above its ARAR in Well SW-08 and in Extraction Well SEW-05. Concentrations of this compound are below ARARs in the other monitoring and extraction wells.

- During the second quarter 2000 sampling event, the compound TCE was not detected above its ARAR in any monitoring or extraction well of the Shallow Zone System.
- The aerial extent of VOCs above ARARs is reducing due to continued groundwater extraction.

Saturated Portion of Deep Zone Aquifer

- A complete lateral capture zone has been maintained from upgradient near Well WB-07, eastward to I-25 and in the north-south direction between the injection wells. A complete vertical capture zone has been maintained from an elevation of 4,840 feet above msl to an elevation of about 4,600 feet above msl.
- The VOC plume has been captured by the Deep Zone Remediation System. Flushing continues to reduce the concentrations of VOCs within the Deep Zone Plume.
- There are no VOCs above ARARs in the downgradient Well Cluster P83-19. Accordingly, the Deep Zone Plume has been captured and migration has been mitigated.
- The treatment system has been effective in removing all VOC constituents to concentrations below the ARARs, and water injected back into the Deep Zone Aquifer is in compliance with the applicable discharge requirements. VOCs, with the exception of MTBE, continue to be removed to below detection limits by the treatment plant.
- Since the startup of the system through June 2000, approximately 879 pounds of VOC mass have been removed.

Closing Remarks

Overall, impacts associated with the Plant 83 OU and SJ-6 OU have been characterized fully and the remedial systems that have been implemented have fully mitigated further migration of VOCs. In addition, the remedial systems have worked and are working as designed and are effective in protecting human health and the environment.

The Shallow Zone Aquifer contains perched groundwater that is recharged by naturally occurring precipitation and other potential sources. Hence, complete dewatering is unlikely. Data indicate flushing is the primary mechanism by which the VOCs are being reduced to levels below their respective ARARs. GEAE added another extraction well in the property north of the Plant 83 property boundary to increase the system efficiency and further reduce the VOCs to levels below ARARs in that area. Similarly, GEAE added an injection well near the Shallow Zone Groundwater Treatment Plant so that the groundwater extraction rate in the extraction wells can be maximized.

The Deep Zone Groundwater Remediation System is operating as designed, has maintained capture of impacted groundwater in the Deep Zone Plume, and has reduced concentrations of VOCs within the area influenced by the remediation system. VOCs above ARARs have not been detected in any monitoring or water supply wells downgradient of the remediation system. Accordingly, modification of the remediation system is not warranted or recommended as a result of this review of system performance. Going forward, GEAE will review cost-effective innovative technologies, consistent with the requirements of the NCP, for further consideration which may enhance future system performance. Based upon the data collected to date and analysis presented in this performance review, the GEAE Shallow Zone Aquifer and Deep Zone Aquifer remedial systems are protective of human health and the environment.

6.0 ACRONYMS

µg/kg	Microgram per kilogram
µg/l	Microgram per liter
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCA	1,2- dichloroethane
AMAFCA	Albuquerque Metropolitan Arroyo and Flood Control Authority
AO	Administrative Order
ARAR	Applicable or Relevant and Appropriate Requirement
BDLPZ	Below deep low-permeability zone
Canonie	Canonie Environmental Services, Corp.
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
DD	Deep deep zone
DI	Deep intermediate zone
DNAPL	dense non-aqueous phase liquid
DLPZ	Deep low-permeability zone
DS	Deep shallow zone
EDB	Ethylene dibromide
EPA	U.S. Environmental Protection Agency
Ft bgs	Feet below ground surface
GE	General Electric
GEAE	General Electric Aircraft Engines
H+GCL	Hydrometrics and Geosciences Consultants Limited
HLA	Harding Lawson Associates
I-25	Interstate 25

Kg	Kilogram
Msl	Mean sea level
MTBE	Methyl tertiary butyl ether
NCP	National Oil and Hazardous Substances Contingency Plan
NMED	New Mexico Environment Department
OU	Operable unit
PCE	Tetrachloroethene
PCMP	Performance and Compliance Monitoring Plan
Plant 83 OU	Former Air Force Plant 83/GE Operable Unit
ppb	Part per billion
PRP	Potentially Responsible Party
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
SCADA	Supervisory Control and Data Acquisition
SCL	Silty clay layer
SJ-6	San Jose-6
Smith	Smith Environmental Technology, Corp.
SP-425	Sample Port No. 425
TCE	Trichloroethene
TDS	Total dissolved solid
VC	Vinyl chloride
VES	Vacuum extraction system
VOC	Volatile organic compound

7.0 REFERENCES

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TABLES

FIGURES

APPENDIX A

VOC MASS REMOVED PER VOLUME OF GROUNDWATER PUMPED

APPENDIX B

TOTAL VOC CONCENTRATION AND CUMULATIVE MASS REMOVED TRENDS

Appendix C

HYDROGRAPHS (GROUNDWATER ELEVATIONS VERSUS TIME)

Appendix C-1 Groundwater Elevations – Selected Conventional Monitoring Wells
Appendix C-2 Groundwater Elevations – Westbay™ Monitoring Wells
Appendix C-3 Groundwater Elevations – Extraction and Injection Wells

Appendix D

SITE WELL CONSTRUCTION DATA

Appendix D-1 Shallow Zone Well Construction Data
Appendix D-2 Deep Zone Well Construction Data

Appendix E

SUMMARY OF SELECTED VOC CONCENTRATIONS OVER TIME

Appendix E-1 VOC Concentrations over Time – Selected Conventional Monitoring Wells
Appendix E-2 VOC Concentrations over Time – Westbay™ Monitoring Wells
Appendix E-3 VOC Concentrations over Time – Extraction Wells

Appendix F

PORE VOLUME FLUSH TECHNICAL PAPER REFERENCE

NUMERICAL PREDICTION OF AQUIFER PORE VOLUME FLUSHING RATES FOR REMEDIAL DESIGN

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ABSTRACT

Aquifer pore volume flushing rates may be used to illustrate the range of hydraulic control and effectiveness of a remediation system. This paper presents a method to numerically calculate pore volume flushing rates using a post-processor for the three-dimensional finite difference ground water flow model, MODFLOW. The post-processor computes the pore volume flushing rate through each cell of the modeled area. The pore volume flushing rate is then contoured and the resulting map is a useful tool for a practitioner in designing remedial measures. From the map, the practitioner can identify areas of high and low flushing rates and, through subsequent simulations, flushing through the areas of concern may be optimized.

To illustrate the usefulness of predicting the distribution of pore volume flushing rates in two and three dimensions for design and optimization of remedial measures, examples are presented using a numerical ground water flow model. From the ground water flow model output, the number of pore volumes flushed through the aquifer system is computed for several ground water flow scenarios in homogeneous and heterogenous aquifers under steady state and transient flow conditions.

INTRODUCTION

Ground water contamination transport modeling is often used to justify the design and efficiency of ground water extraction systems. To utilize contaminant transport, a number of parameters must be identified to account for the mechanisms of adsorption, dispersion, advection, and decay. However, on many sites, these parameters are often not available or exist with associated uncertainties. A useful tool that is available for practitioners is the calculation of pore volume flushing rates. The pore volume flushing rate can be useful to assess the effectiveness of a remediation system in flushing pore volumes through an impacted portion of the aquifer.

For relatively simple aquifer systems with homogenous properties and linear flow, aquifer pore volume flushing rates may be estimated analytically. However, as the complexity of the aquifer system increases with varying aquifer properties throughout the porous medium and aquifer stresses are introduced, the need to numerically predict the aquifer pore volume flushing rates increases.

Mathematical Development

The general equations used to numerically compute pore volume flushing rates are summarized below. Consider a control volume of porous medium as shown in Figure 1. The pore volume, PV, of the control volume is:

$$PV = \phi_e \Delta X \Delta Y \Delta Z \tag{1}$$

where

ϕ_e - effective porosity of the porous medium, and
$\Delta x, \Delta y, \Delta z$ = dimensions of the control volume.

The pore volume flushing rate out of the control volume, PVR, is computed as:

$$PVR = \frac{Q_{OUT}}{PV} \tag{2}$$

where

Q_{out} - total combined flow out of the control volume in the x, y, and z directions.

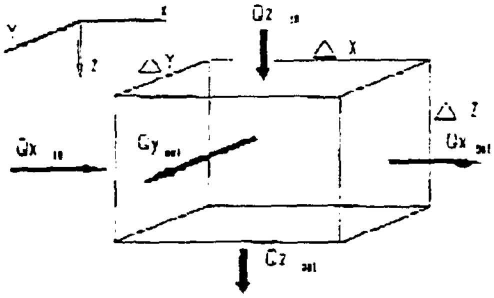

Figure 1. Control Volume

Equations 1 and 2 may be applied to each cell in a finite difference model to compute the cell by cell pore volume flushing rates. However, when the finite difference model does not consist of uniform cell dimensions, it is more appropriate to normalize the equations to the dimensions of a specific cell in the model area. For instance, consider a finite difference cell with dimensions $\Delta x'$, $\Delta y'$, $\Delta z'$, which will serve as the cell to which pore volume flushing rates will be normalized. For the cell shown in Figure 1, the normalized pore volume, PV', is:

$$PV' = \phi_e \Delta X \Delta Y \Delta Z \frac{\Delta X' \Delta Y' \Delta Z'}{\Delta X \Delta Y \Delta Z} \tag{3}$$

The flow entering and exiting the cell is also affected by cell dimension and must also be normalized. The normalized flows Q'_x, Q'_y, and Q'_z in the x-, y-, and z- directions respectively are:

$$Q'_x = Q_x \frac{\Delta Y' \Delta Z'}{\Delta Y \Delta Z} \quad , \quad Q'_y = Q_y \frac{\Delta X' \Delta Z'}{\Delta X \Delta Z} \quad , \quad Q'_z = Q_z \frac{\Delta X' \Delta Y'}{\Delta X \Delta Y} \tag{4,5,6}$$

where Q_x, Q_y, and Q_z represent the actual flow out of the cell (or into the cell if computing flushing into the cell) in the x-, y-, and z- directions respectively. By summing the flows computed in equations 4, 5, and 6 and dividing by the normalized pore volume, the normalized pore volume flushing rate out of the cell, PVR', is:

$$PVR' = \frac{Q'_x + Q'_y + Q'_z}{PV'} \qquad (7)$$

Numerical Model Development

A post-processor module for the three-dimensional ground water flow model MODFLOW (McDonald and Harbaugh, 1988) was developed to solve equations 3 through 7 presented above for each cell of a finite difference ground water flow model. By reading the MODFLOW, Basic and Block-Centered Flow input files, the number of cells and the cell dimensions are obtained. Flow through each cell is obtained by reading the cell by cell flow output file produced by MODFLOW. Porosity, not required by MODFLOW for ground water flow computations, is required for pore volume computations. The porosity is read from an additional file containing porosity values for each model cell created by the practitioner. After obtaining the required input parameters, the pore volume flushing rate by cell is computed and written to a file for contouring and plotting of the pore volume flushing rates by a contour package such as SURFER ((C) Golden Software 1989).

There are certain assumptions and limitations in the post-processor module. Change in storage of water within cells is not considered in the pore volume flushing rate calculations. If the total inflow into a cell does not equal the total flow exiting the cell because storage is significant or the cell is a boundary condition cell, the module selects the larger between the inflow and outflow for computing the pore volume flushing rate in that cell. Lastly, the present module is limited to only confined (i.e. fully saturated) layers with rm thickness. Future modifications to the module will more adequately es cell storage and unconfined conditions.

Numerical Study Approach

To assess the effectiveness of predicting the distribution of pore volume lushing rates in two and three dimensions, a ground water flow model for a ypothetical aquifer system was developed. The aquifer is confined and consists f silty-sandy soil becoming more clayey with depth. Regional ground water flow rom north to south was assumed with a hydraulic gradient of 0.011. An effective orosity of 0.3 and 0.4 were assumed in the silty-sandy and clayey portions of he aquifer respectively. The horizontal hydraulic conductivity varies from 30 /day in the upper portion of the aquifer to 5 m/day in the lower portion of the quifer. A constant vertical hydraulic conductivity of 0.3 m/day was assumed hroughout the aquifer. An aquifer storage coefficient of 0.01 was chosen.

The portion of the hypothetical aquifer system for which the ground water low system was constructed is 1000 meters by 1000 meters by 30 meters deep. igure 2 shows the ground water flow model grid. The grid consists of 41 rows nd 41 columns and 3 layers. Column and row widths vary from 100 meters on the dges to 10 meters near the center of the modeled area. Each layer is 10 meters hick. To simulate the regional ground water flow from north to south, constant ead boundary conditions were assigned to the northern and southern boundaries.

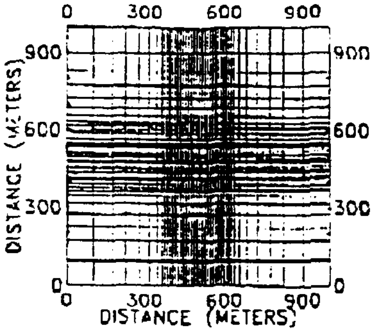

Figure 2. Finite Difference Model Grid

Numerical Simulations

To demonstrate how the post-processor module computes pore volume flushing rates and the utility of identifying pore volume flushing rates to a practitioner several simulations were performed. A steady state, linear flow simulation is first presented analytically and numerically followed by more complex simulations involving steady state flow in a heterogenous aquifer, and an extraction well in a homogeneous aquifer. The final simulation involves predicting pore volume flushing rates in response to extraction and injection wells under transient conditions.

Simulation 1 - Steady State Linear Flow

The first simulation involves one-dimensional steady state with no imposed aquifer stresses. The predicted steady state potentiometric surface as computed by MODFLOW for the ground water flow system described above is shown in Figure 3. Using the cell by cell flow terms provided by MODFLOW, model cell dimensions, and aquifer porosity, the pore volume flushing rate for each cell in the model area was determined using the post-processor module. To demonstrate the importance of normalized pore volume flushing rates when finite cell dimensions are not uniform, both non-normalized and normalized pore volume flushing rates were computed. Non-normalized pore volume flushing rates are presented in Figure 4 for layer 1 of the model.

To verify the numerically computed pore volume flushing rates shown in Figure 4, the pore volume flushing rates are computed analytically. From Figure 3, the hydraulic gradient is approximately 0.011 m/m. In the center of the modeled area, row, column, and layer dimensions are 10 meters. The effective porosity in model layer 1 is 0.3. Using Darcy's Law, the flow through this portion of the modeled area can be computed as follows:

$$Q = K\,i\,A$$

where

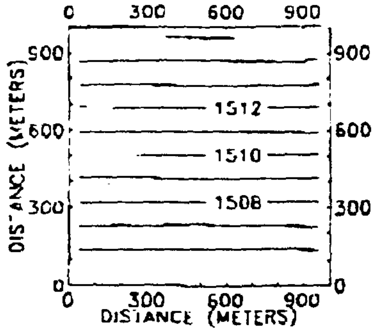

Figure 3. Steady State Potentiometric Surface

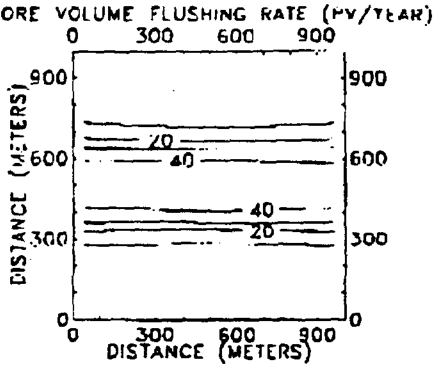

Figure 4. Steady State Linear Flow Pore Volume Flushing Rates

Q = rate of ground water flow, m^3/day;
K = hydraulic conductivity - 30 m/day for model layer 1.
i = hydraulic gradient - 0.011 m/m;
A = area perpendicular to flow = 10 m x 10 m = 100 m^2

Therefore, the flow, Q, is: Q = 30 m/day x .011 m/m x 100 m^2 = 33 m^3/day

From equation 1, the pore volume of the center cell is calculated as:

PV = 0.3 x 10 m x 10 m x 10 m = 300 m^3, or 300 m^3 of water must pass through the cell for one cell pore volume to be flushed.

From equation 2, the pore flushing rate per year is:

PVR = (33 m^3/day) / (300 m^3/1 PV) x 365.25 day/year = 40 PV/year

Closer to the edge of the model, where the row width is 50 m and the column width is 10 m, the pore volume flushing rate is 8 PV/year. These rates are in agreement with the numerically predicted pore volume flushing rates shown in Figure 4. However, in a homogenous aquifer under steady state conditions with no imposed aquifer stresses, the pore volume flushing rate must be uniform. The exhibited variation in pore volume flushing is due to the non-uniform grid size in the model. To obtain uniform flushing, pore volume calculations must be normalized. By normalizing the pore volume flushing rate in each cell using equations 3 through 7 above, the pore volume flushing rate in each cell will be equal to 40 PV/year.

Simulation 2 - Heterogeneous Aquifer

The purpose of simulation 2 is to demonstrate pore volume flushing in a heterogeneous aquifer. The western two-thirds of the modeled area is assumed to have a hydraulic conductivity of 30 m/day and the eastern one-third of the modeled area is assumed to have a conductivity of 15 m/day. A steady state ground water flow simulation was performed followed by computation of the cell by cell pore volume flushing rates. The contoured normalized pore volume flushing rates are shown in Figure 5. On the western two-thirds of the modeled area where the hydraulic conductivity is higher, the flow in the aquifer is higher and accordingly, the pore volume flushing rate is higher.

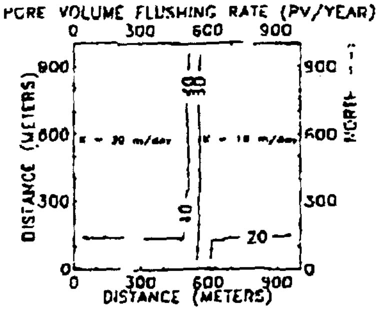

Figure 5. Normalized Pore Volume Flushing Rates in Heterogeneous Aquifer

Simulation 3 - Extraction Well

This simulation demonstrates pore volume flushing in response to an extraction well. A single, fully penetrating extraction well pumping at 500 m^3/day was placed in the center of the modeled area. Well pumpage was distributed to each layer by weighting according to hydraulic conductivity such that the majority of the water is being withdrawn from layer 1 (K = 30 m/day), a lesser amount from layer 2 (K = 15 m/day) and the least amount from layer 3 (K = 5 m/day). Steady state flow conditions are simulated.

The normalized pore volume flushing rates in layer 1 are presented in

Figure 6. To present pore volume flushing in three dimensions, pore volume flushing rates through a cross section along the middle row of the model were contoured in Figure 7. In general, pore volume flushing rates decrease with depth because of decreasing hydraulic conductivities with depth.

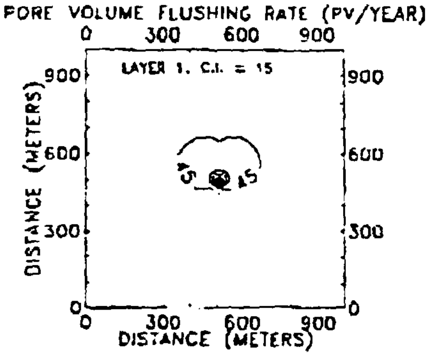

Figure 6. Pore Volume Flushing Rate in Response to Single Extraction Well

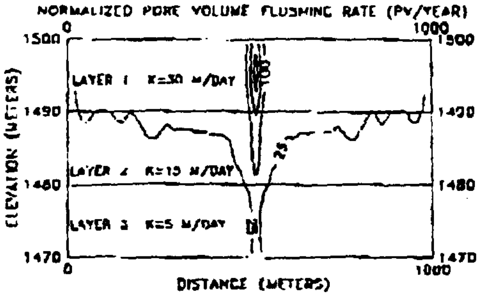

Figure 7. Cross Section of Pore Volume Flushing Rates Through Model Layers

Simulation 4 - Transient Simulation

The final simulation is a transient simulation involving two extraction wells on either side of an injection well. Wells are screened only in layer 3. Each extraction well is extracting at 500 m^3/day and the injection well is injecting at 1000 m^3/day. Results for layer 1 after 1 hour and after 10 days since the beginning of operation are presented in Figures 8 and 9. Pore volume flushing rates are a function of time, and the extent of flushing in layer 1 increases from 1 hour to 10 days at which time steady state conditions have been reached.

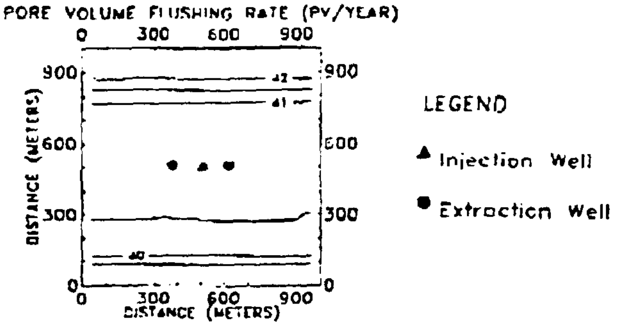

Figure 8. Normalized Pore Volume Flushing Rate in Model Layer 1 After 1 Hour

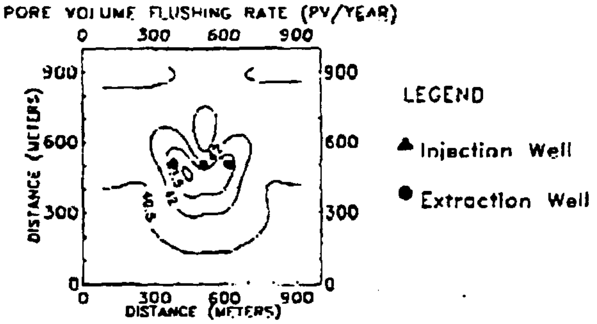

Figure 9. Normalized Pore Volume Flushing Rate in Model Layer 1 After 10 Days.

CONCLUSIONS

Numerically computing pore volume flushing rates can be a useful tool to a practitioner. When analyzing relatively simple aquifer systems (i.e., homogeneous/isotropic) analytical solutions are easily applied. However, in more complex aquifers with properties which vary spatially and directionally and with the introduction of stresses to the aquifer, it becomes increasingly necessary to predict aquifer pore volume flushing rates numerically.

Future revisions to the post-processor module include modifications to incorporate model layers with non-uniform top and bottom elevations and to enhance the module to compute pore volumes through partially saturated cells. Plans also include revising the module to more appropriately consider change in cell storage.

REFERENCE

McDonald, M.G., and Harbaugh, A.W., 1988, "A Modular Three-Dimensional Finite Difference Ground Water Flow Model," TWRI, Book 6, Chapter A1.

Appendix G

U.S. Environmental Protection Agency's Approval Letter regarding Monitoring Program Revisions

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

December 29, 1999

Mr. Oscar Lackey
Environmental Health and Safety Manager
General Electric Aircraft Engines
336 Woodward Road, SE
Mail Drop 26
Albuquerque, New Mexico 87102

Re: Proposed Monitoring Program Modifications at the South Valley Superfund Site

Dear Mr. Lackey:

Pursuant to the Design Review Committee meeting that was held on August 26, 1999, and your letter request, dated November 19, 1999, the U.S. Environmental Protection Agency (EPA) approves the modification of collecting groundwater quality data from a quarterly basis to a semi-annual basis. In order to ensure data consistency across the South Valley Superfund site, the groundwater quality data will be collected during the second and fourth quarters of the calendar year, specifically, during the months of April and October.

Groundwater level measurements will continue to be collected on a quarterly basis. However, the groundwater level measurements may be reported to the EPA on a semi-annual basis as well.

General Electric Aircraft Engines (GEAE) requested to continue to collect performance samples at 25,000, 50,000, and 60,000 gallon intervals from the primary carbon treatment vessel, but change the unit out at 60,000 gallons rather than continue the required sampling frequency of every 5,000gallons once the 70,000 gallon interval has been reached and until breakthrough occurs. GE views this approach as more cost effective than continuing the frequent sampling that is currently required following the 60,000 gallon sample. The EPA approves this request.

The monitoring wells associated with the Shallow Zone are currently on a semiannual schedule for groundwater quality sampling. Therefore, the overall change to semi-annual sampling for water quality data does not affect these wells. However, there are six Shallow Zone monitoring wells that have had constituent concentrations reported as either non-detect or as being below the Applicable or Relevant and Appropriate Requirements (ARARs) since at least the third quarter of 1997. GEAE requested that the following six wells be sampled annually for groundwater quality data: P83-05S, P83-13S, P83-15S, S-01, SMW-13, and SMW-14. The EPA approves this request.

GE also requested to discontinue inorganic sampling for the Shallow Zone. This was a requirement imposed by the City of Albuquerque when GEAE was discharging Shallow Zone treated water to the plant's cooling towers and ultimately to the City of Albuquerque sewer system. GEAE has not discharged treated Shallow Zone water to the sewer system since the fourth quarter of 1997. Since GEAE is in the process of obtaining the necessary approvals from the State of New Mexico Environment Department (NMED) to install an injection well for the disposal of the Shallow Zone water following treatment, the EPA approves this request. If NMED should impose a requirement for inorganic sampling of this water, GEAE will be required to amend the monitoring program to comply.

GE also requested to discontinue groundwater quality sampling of the Westbay monitoring well WB-04, screens 10, 11, and 12. This proposed change is based on the fact that since the implementation of the groundwater treatment program, there has not been a detection of volatile organic compounds (VOC) above the ARARs. GEAE also stated that the screen midpoints are at elevations between 3880.61 and 4131.21 feet above mean sea level (amsl), well below the remediation area of the deep zone, which exists between 4660 and 4840 feet amsl. The EPA does not approve this request at the current time. These monitoring points are acting as down-gradient monitoring wells to ensure that chlorinated solvent contamination is not migrating deeper. If GEAE can provide monitoring information that show monitoring points above these three screens, but below the contamination, act as an early detection system, then the EPA will be open to approving this request.

If you have any questions concerning these issues, please contact me at 214-665-8317, or e-mail me at *lyssy.gregory@epa.gov*.

Sincerely,

Greg J. Lyssy
Remedial Project Manager

Susan Morris, NMED - Superfund Oversight Section