2005 Annual Report

Shepley's Hill Landfill
Long Term Monitoring & Maintenance
Devens, Massachusetts

Prepared for:

Department of the Army
BRAC Environmental
30 Quebec Street, Box 100
Devens, Massachusetts 01432

December 2006

Prepared By:

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EPA Comments on
Draft 2005 Annual Report
Shepley's Hill Landfill
Long Term Monitoring & Maintenance
Devens, Massachusetts
December 2006

Specific Comments:

1. Executive Summary, Page ES-1, Last Para: The last sentence on this page indicates that "(m)aintenance activities are scheduled to be performed including repairs to fencing and gates, maintenance to remove wetland vegetation from drainage swales, and drainage improvements for the landfill cap involving filling of low spots resulting from subsidence." Although the fencing and gate repairs were completed, as reported later in the report, the other maintenance activities are not currently scheduled, and elsewhere in the report, it is noted that these activities are anticipated to occur upon completion of the CSA/CAAA. Please clarify. Note that EPA recently requested that the Army evaluate whether removing wetland vegetation from drainage swales could be completed in the near future (i.e., not waiting until completion of the CSA) and Army is considering this.

2. Executive Summary, Page ES-2, 2nd Para: It is acknowledged that the primary purpose of this report is to document the routine monitoring and maintenance activities, and not to provide data analysis or interpretation. Nevertheless, the statement regarding increased readings in landfill gas vents prompted further scrutiny of previous Annual Reports as well as the data reported in the 2005 document. It is particularly interesting to note that methane concentrations in several gas vents located in the central part of the landfill (e.g., GV-6, GV-7, GV -9, and GV-10) appear to be increasing systematically (please see attached figure). SHL is a "mature" landfill and it is expected that concentrations of methane should show an overall decrease, as the readily-degradable carbon is consumed early in a landfill's history. Therefore, the observed increases may be significant and results of continued monitoring should be assessed.

3. Executive Summary, Page ES-2, 3rd Para: The report notes that the five wells that were not monitored in June 2005 as part of the LTMP were sampled under the Performance Monitoring Plan for the Contingency Remedy and that those results "...are reported elsewhere." Please provide the reference for these data.

4. Section 5.0, Page 7, 2nd Para: This section states that groundwater levels were measured on August 24 and August 26, 2006, as part of the extraction test. The data in Table 5-2 indicate that baseline water levels were measured on 8/24/2005 and maximum drawdown was measured on 8/26/2006. Also, water level elevations are shown on Figures 5-1 and 5-2 for pre-test and maximum drawdown conditions, respectively. The figure captions indicate that these measurements were taken on August 24 and 26, 2005. Please correct these dates.

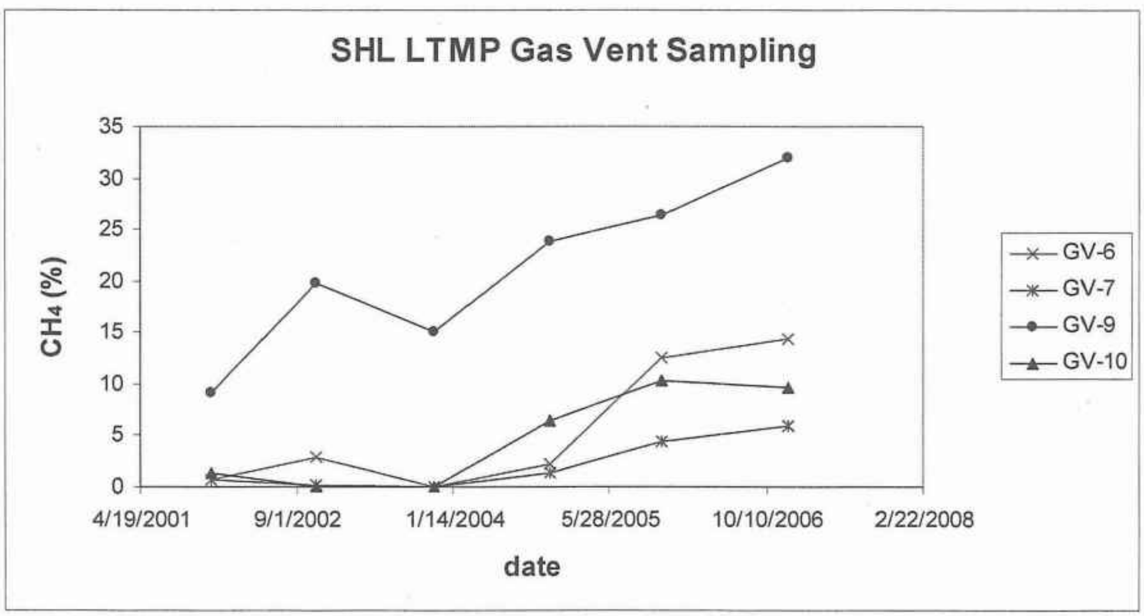
5. Section 5.0, Page 7: Water-level measurements taken during August 2006 confirm the general northerly direction of groundwater flow in the overburden. The last sentence in this

section suggests that results of the extraction test indicate "…that the operation of the groundwater extraction system will create an even greater northerly flow." Comparison of groundwater elevation contours on Figures 5-1 and 5-2 shows essentially no difference in the direction of groundwater flow, except in the immediate vicinity of the extraction wells. Please either explain what is meant by "…even greater northerly flow" or delete this statement.

6. Section 7.3.1, Page 12, 3rd Para: This section notes that "…the highest historic level of arsenic, 3320 ug/L, was recorded at SHM-96-22B during the January 2006 sampling." Does this statement refer only to this well? Please reconcile this statement with the data in Table 7-4, in which the highest historic level of arsenic, 5110 ug/L, was found in SHM-96-5B (May 2000 sampling round).

7. Section 10.1, Page 17, 1st Bullet: The FYR referenced here is the 2000 FYR, not the 2005. Please correct the reference.

8. Section 10.1, Page 17, 2nd Bullet: This bullet repeats text from Section 5.0 regarding the expectation that the groundwater extraction system will create an "…even greater northerly flow." Please see previous Specific Comment 5.



February 5, 2007

Mr. Robert Simeone
BRAC Environmental Coordinator
BRAC Environmental Office
30 Quebec Street, Box 100
Devens, MA 01434

Re: Draft 2005 Annual Report
Shepley's Hill Landfill
Long Term Monitoring & Maintenance
Devens, MA
December 2006

Dear Mr. Simeone:

EPA has reviewed the document titled, "2005 Annual Report, Shepley's Hill Landfill, Long Term Monitoring & Maintenance", dated December 2006, as prepared by CH2M Hill on behalf of the Army. The 2005 Annual Report documents results of long-term monitoring and maintenance activities for Shepley's Hill Landfill, which were conducted in June 2005 and January 2006. Activities detailed in the report include inspection and assessment of the condition of the cap, measurement of water levels, groundwater sampling, gas vent sampling, and installation of new gas monitoring probes along the south side of the landfill. The geotechnical engineering inspection of the landfill cap was completed by the U.S. Army Corps of Engineers. Inspection findings and recommendations for corrective action, based on the Army Corps of Engineers' inspection of the landfill, are included as an appendix to the 2005 Annual Report.

EPA's comments on the Draft 2005 Annual Report are attached. If you have any questions, please feel free to contact me at (617) 918-1754. Thanks.

Sincerely,

Ginny Lombardo
Remedial Project Manager
Federal Facilities Superfund Section

cc: Lynne Welsh, MassDEP
Hui Liang, MassDEP
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EXECUTIVE SUMMARY

This annual report documents the results of long term monitoring and maintenance activities conducted in the summer (June 2005) and winter of 2005 (monitoring event January, 2006), the ninth year of monitoring, at Shepley's Hill Landfill in Devens, Massachusetts. CH2M HILL prepared this report in accordance with the Record of Decision (ROD) for Areas of Contamination 4, 5, and 18 (ABB-ES, Oct 1995), and the approved Long Term Monitoring and Maintenance Plan (LTMMP), SWEC, May 1996. In addition, this report summarized activities associated with the construction and start-up of the Contingency Remedy, involving an arsenic groundwater extraction, treatment, and discharge system. The *Explanation of Significant Differences* (CH2M HILL, June, 2005) states:

> *Among other alternatives, the ROD describes two remedial alternatives: Alternative SHL-2, Limited Action, and Alternative SHL-9, Groundwater Pump and Discharge to the Ayer Publicly-Owned Treatment Works (POTW). These alternatives became the primary and contingency elements of the elected remedy for the Shepley's Hill Landfill remedial action, respectively. Alternative SHL-2 generally involves landfill closure with capping and monitoring. Alternative SHL-9, involving active extraction of groundwater, was selected as a contingency element of the selected remedy in order to supplement SHL-2, should SHL-2 not prove to be effective at controlling site risk.*

Alternative SHL-2, required completion of landfill closure and on-going, post-closure monitoring of the effectiveness of the landfill cover. Monitoring activities are described in the LTMMP and consist of an annual inspection of the landfill cover, annual landfill gas vent monitoring, and semi-annual groundwater chemistry monitoring. The Contingency Remedy, a modification of Alternative SHL-9 (Pump and Discharge to Ayer POTW) has been implemented according to the *Remedial Design and Remedial Action Workplan, Final Hundred Percent (100%) Submittal, Groundwater Extraction, Treatment, and Discharge Contingency Remedy for Shepley's Hill Landfill* (CH2M HILL, May 2005). Performance monitoring for start-up and initial operation of the Contingency Remedy is being conducted in accordance with the design document and the *Shepley's Hill Landfill, Performance Monitoring Plan, Groundwater Extraction, Treatment, and Discharge Contingency Remedy* (CH2M HILL, August, 2005). The LTMMP and the Performance Monitoring Plan will be merged into a single monitoring program in 2006. The results of these activities conducted in 2005 are described below.

An annual landfill inspection was conducted in the Fall of 2005 and observations made regarding the vegetative cover, vegetation types, erosion, settlement, and general condition of the various features. Presently, the landfill is in fair to good condition. The cover surface contains areas of sparse vegetation, intrusive vegetation, and settlement. Intermittent standing water, erosion, overgrowth of vegetation, and encroachment of wetland plants within drainage swales were observed. Maintenance activities are scheduled to be performed including repairs to fencing and gates, maintenance to remove wetland vegetation from drainage swales, and drainage improvements for the landfill cap involving filling of low spots resulting from subsidence.

As part of the annual landfill gas vent monitoring program, readings were collected from eighteen gas vents on the landfill plus four perimeter probes just north of the landfill. Readings collected from the four perimeter probes were similar to levels measured during last year's annual inspection. Readings collected from the 18 gas vents on the landfill indicated levels of carbon monoxide, and carbon dioxide production decreased since last year, while measurements of LEL, methane, oxygen, and hydrogen sulfide remained about the same. As observed in the 2004 monitoring, VOC concentrations were not detected.

LEL readings from the landfill gas vents near the southern end of the landfill have consistently registered higher than other areas in the past. These increased LEL readings, coupled with increased carbon monoxide, carbon dioxide, and methane readings in the landfill gas vents and the proximity of commercial development warranted installation of additional perimeter gas monitoring probes along the property line where the landfill is adjacent to structures. Nine gas monitoring probes were installed in November 2005 at the southern perimeter of the site along the commercial properties. Readings were collected from these monitoring probes in February 2006. Methane and hydrogen sulfide were not detected. Concentrations of VOCs, LEL, carbon monoxide, and carbon dioxide were detected in two or more of the probes.

Group 1 and Group 2 wells were monitored in the summer (June 2005) and winter (January 2006) of 2005 to evaluate the effectiveness of the landfill at reducing risk and achieving cleanup levels for contaminants of concern (COCs) in groundwater. The COCs are arsenic, chromium, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichloroethane, lead, manganese, nickel, sodium, aluminum, and iron. Of the network of 14 monitoring wells, nine were sampled during the June 2005 event. However, the five wells that were not monitored during the June, 2005 event were monitored independently under the Performance Monitoring Plan for the Contingency Remedy in February/April 2005 and August 2005. The data from the Performance Monitoring Plan work are reported elsewhere. Fourteen monitoring wells were scheduled to be monitored as part of the January 2006 monitoring, however, one well, SHL-3, could not be sampled because the well was pumped dry prior to stabilization. Poor recharge in monitoring well SHL-3 has been documented in previous sampling rounds.

The goal of Alternative SHL-2 alone had been to maintain groundwater quality below cleanup levels at Group 1 wells, and to attain cleanup levels at Group 2 wells. Annual reports since capping of the landfill compare the concentrations of COCs to the cleanup levels, supporting five-year site reviews in which the effectiveness of remedial actions are evaluated. Evaluating effectiveness at Group 2 wells is based on reduction of risk rather than reduction of concentration as a measure of progress toward attainment of cleanup levels, because this approach focuses on the cleanup of arsenic, which is the primary contributor to risk in the Group 2 wells. According to the LTMMP, only chemicals that present carcinogenic risk are considered trigger chemicals in the monitoring program. The trigger chemicals are arsenic, 1,2 dichlorobenzene, 1,4 dichlorobenzene and 1,2-dichloroethane. Reduction of carcinogenic risk, rather than simply reduction of contamination, is the measure of progress toward attainment of cleanup. This risk-based approach keeps the focus on mitigation of the most significant contributors to risk.

Originally, all existing wells were designated as Group 2 wells per the LTMMP, including the three newer wells installed in 1996 (SHM-96-5B, SHM-96-5C, and SHM-96-22B) based on their first round of sampling. Risk reduction was evaluated during the first five-year review (FYR) in August 1998 (Stone & Webster 1998). During the August 1998 review, six monitoring wells (SHL-3, SHL-5, SHL-9, SHM-93-10C, SHL-22, and SHM-93-22C) achieved cleanup levels for all chemicals of concern and were reclassified as Group 1 wells. The remaining eight wells continue to be classified as Group 2 wells. Since the August 1998 review, three of the Group 1 wells (SHL-9, SHL-22 and SHM-93-22C) have exceeded the cleanup level for arsenic at least once during the semi-annual monitoring. A basewide five year review for all sites at the former Fort Devens undergoing investigation and remediation, was completed in September, 2000 (HLA, 2000). This comprehensive FYR was triggered by the initiation of soil remediation activities of AOC 44 and 52 on August 11, 1995.

Data evaluated during these two five year reviews relating to Shepley's Hill Landfill triggered the implementation of the Contingency Remedy because risk reduction goals were not being met by the selected remedy, SHL-2. The Army and the regulatory agencies decided to implement the contingency element of the selected remedy, alternative remedy SHL-9, Groundwater Extraction and Discharge. Construction of the groundwater extraction and treatment system for the landfill was undertaken primarily in Fall 2004 through Spring 2005, after a design process that had been initiated in Fall 2003. The completed system is located at the north end of the landfill, near down-gradient monitoring wells SHL-5, SHM-96-5B, SHM-96-5C, SHL-9, SHL-22, SHM-96-22B and SHM-93-22C. This system includes a wellfield with two extraction wells, a treatment plant, and utility berm across the cap connecting with the Devens POTW system and electrical power near Cooke Street. The treatment system became operational in Fall 2005.

A second basewide FYR report was completed by the United States Army Corps of Engineers, New England District (USACE) in September 2005 (Nobis, 2005). The review concluded that a protectiveness statement or determination could not be made at the time until follow-up actions were competed including start-up and performance monitoring of the extraction and treatment system, landfill cap maintenance, and completion of the Comprehensive Site Assessment/Corrective Actions Alternative Analysis (CSA/CAAA). It was anticipated that within 2 years, time enough for completion of the CSA/CAAA a protectiveness determination could be made.

Groundwater sampling was performed at nine LTMMP monitoring wells in June 2005. Two of these monitoring wells are located on the down-gradient edge of the landfill to the north, while the remaining seven are located on the east side of the landfill near Plow Shop Pond. These wells and five others, with the exception of SHL-3, were sampled as part of the January 2006 sampling. SHL-3 could not be sampled because the well was pumped dry prior to stabilization. Samples were collected in accordance with the *EPA's Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells* (July 1996). Samples were analyzed for volatile organic compounds (VOCs), inorganics, and general water quality parameters. Laboratory reports were reviewed for adherence to acceptable laboratory practices. Based on the data evaluation elements reviewed, all data was determined to be of acceptable quality for use, with some qualifications due to low matrix spike duplicate recovery, holding time exceedances, and associated field and method blank contamination in the June 2005 sampling.

Arsenic was the only trigger chemical detected above the cleanup level during the 2005 sampling program (see Table ES-1 on following page). Most results indicated no significant change from previous arsenic levels. However, the highest concentration of arsenic, 3,320ug/L, was recorded at SHM-96-22B during the January 2006 sampling. The previous greatest concentration of 2,500 ug/L was detected during the November 2003 sampling. Northern well SHM-96-5B was the monitoring well location with the highest concentration of arsenic of the wells sampled as part of the 2005 monitoring program. The highest arsenic concentration has been recorded at SHM-96-5B for all of the sampling rounds except fall 2004, in which the highest concentration was observed in well SHM-96-22B. Wells SHM-96-5B and SHM-96-22B are located relatively close to each other and are screened at a similar depth in sand/till. Monitoring wells SHM-96-5B and SHM-96-22B show a trend of generally increasing arsenic concentrations. Both these wells have continuously exhibited the highest arsenic levels measured at the site, one to two orders of magnitude above levels measured at the other compliance wells. Seven of the thirteen monitoring wells sampled in January, 2006 were below the arsenic cleanup level. Northern well SHL-22 was the only Group 1 well having arsenic concentrations exceeding the cleanup level, which has occurred continuously since May 2002. Concentrations measured at Group 2 wells SHL-4, SHL-10 and SHM-96-5C also met the cleanup level for arsenic, a trend that has been occurring over the past years, particularly at SHL-10.

Cleanup levels for the other three trigger chemicals were not exceeded. However, cleanup levels for the COCs iron, manganese and sodium were exceeded in the 2005 sampling events. In general, with the exception of iron, manganese, and sodium concentrations at wells SHL-5, SHM-96-5C and SHM-93-10C, concentrations of iron, manganese, and sodium have remained stable or declined since 2002.

TABLE ES-1 Compliance Point Wells Exceeding Arsenic Cleanup Level of 50 µg/L in 2005

Well	Orientation to Landfill	Geological Designation	Group #	Concentration June 2005	Concentration January 2006
SHL-22	North	Till	1	Not Sampled	154 µg/L
SHM-96-22B	North	Sand/Till	2	Not Sampled	3,320 µg/L
SHM-96-5B	North	Sand/Till	2	Not Sampled	4,130 µg/L
SHL-11	East	Water Table	2	524 µg/L	567 µg/L
SHL-19	East	Water Table	2	26.7 µg/L	156 µg/L
SHL-20	East	Till	2	159 µg/L	189 µg/L

Corrective action recommendations relating to the cap system and associated drainage are included in the Geotechnical Engineering Fall 2005 Annual Inspection Report (USACE, March 2006), provided in Appendix A. These recommendations include the following: (1) repair and replace the security fence and gates as required to control access to the site and (2) place topsoil and seed over the sandy area lacking vegetation on the east side along the perimeter of the cap. Along with the corrective actions listed above, it was recommended: (1) Install additional landfill gas monitoring probes along the commercial property at the south side of the landfill and (2) Repair and re-grade around the catch basins on the south side of the landfill.

Gas monitoring probes were installed along the south side of the landfill in December 2005 and were monitored in February 2006. Although monitoring was conducted in February, 2006 it is reported in this 2005 annual report. These wells will be monitored again in 2006 as part of annual gas monitoring. In addition, in December, 2005 repairs were made to security fences and no-trespassing signs were installed. Regrading activities are anticipated to occur upon completion of the CSA/CAAA. With the exception of the repairs mentioned above, and the other repairs recommended in the report, the landfill is in fair condition and appears to be functioning adequately. All of the above is discussed in more detail in Section 3.0 of this report.

2005 ANNUAL REPORT
SHEPLEY'S HILL LANDFILL
LONG TERM MONITORING & MAINTENANCE
DEVENS, MASSACHUSETTS

1.0 INTRODUCTION

This annual report has been prepared to document the monitoring and maintenance procedures conducted in 2005 at the Shepley's Hill Landfill in Devens, Massachusetts. These procedures were conducted in accordance with the *Record of Decision, Shepley's Hill Operable Unit, Areas of Contamination 4, 5, and 18* (ROD) (ABB-ES Oct 1995) for Shepley's Hill Landfill Areas of Contamination 4, 5, and 18, and the *Long Term Monitoring and Maintenance Plan, Shepley's Hill Landfill* (LTMMP) (SWEC, May 1996). This annual report was prepared by CH2M HILL.

The ROD selected remedy, Alternative SHL-2, which is a source control action that addresses long-term residential exposure to contaminated groundwater, the principal known threat at the Shepley's Hill Landfill Operable Unit. Alternative SHL-2 consisted of completing closure of Shepley's Hill Landfill in accordance with applicable Massachusetts requirements of 310 CMR 19.000, and monitoring and evaluating the effectiveness of the landfill cover system (completed in 1993) to control groundwater contamination and site risk.

The LTMMP for Shepley's Hill Landfill, completed in May 1996, outlines the landfill closure monitoring and maintenance procedures required by the ROD. These procedures include an annual visual inspection and gas emission monitoring of the landfill cap, and a semi-annual groundwater sampling program to monitor contaminants of concern (COCs) and evaluate the effectiveness of the landfill cover system to control groundwater contamination and site risk. The COCs and their cleanup levels for Shepley's Hill Operable Unit are listed in Table 1-1.

1.1 Evaluating Effectiveness of Remedial Objectives

Fourteen compliance point wells are monitored to evaluate the effectiveness of the landfill at reducing risk and achieving cleanup levels in monitoring wells. They are designated as Group 1 or Group 2 wells. The ultimate goal of Alternative SHL-2 is to maintain groundwater quality below cleanup levels at Group 1 wells, and to attain cleanup levels at Group 2 wells.

Five-year site reviews evaluate the effectiveness of Alternative SHL-2 at reducing the potential human health risk from exposure to groundwater and at preventing groundwater from contributing to Plow Shop Pond sediment contamination in excess of human health and ecological risk-based values. Evaluating effectiveness at Group 2 wells is based on reduction of risk rather than reduction of concentration as a measure of progress toward attainment of cleanup levels, because this approach focuses on the cleanup of arsenic, which is the primary contributor to risk in the Group 2 wells.

According to the LTMMP, only chemicals that present carcinogenic risk are considered trigger chemicals in the monitoring program. The trigger chemicals are arsenic, 1,2 dichlorobenzene, 1,4 dichlorobenzene and 1,2-dichloroethane. Reduction of carcinogenic risk, rather than simply reduction of contamination, is the measure of progress toward attainment of cleanup. This risk-based approach keeps the focus on mitigation of the most significant contributors to risk.

The LTMMP states Alternative SHL-2 will be considered effective with regard to Group 2 wells if five-year reviews show an ongoing reduction of potential human health risk (based on trigger chemicals) at Group 2 wells and the ultimate attainment of cleanup levels for all COCs by January 2008. Alternative SHL-2 will be considered effective with regard to Group 1 wells if five-year site reviews show that groundwater quality remains at or below cleanup levels for all COCs.

Chemical concentrations in Group 1 wells have historically attained cleanup goals, while those in Group 2 have not. Originally, all existing wells were designated as Group 2 wells per the LTMMP (Stone & Webster, 1996), including three newer wells installed in 1996 (SHM-96-5B, SHM-96-5C, and SHM-96-22B) based on initial sampling. During the first five-year site review (August 1998), six monitoring wells (SHL-3, SHL-5, SHL-9, SHM-93-10C, SHL-22, and SHM-93-22C) achieved cleanup levels for all chemicals of concern and were reclassified as Group 1 wells. The remaining eight wells continue to be classified as Group 2 wells. The second basewide FYR (HLA, 2000), did not reclassify any of the monitoring wells. However, the review concluded that based on the data collected to date, the required incremental reduction in risk was not achieved and the Army and regulatory agencies decided to implement Alternative SHL-9, Groundwater Extraction and Discharge.

Construction of a groundwater extraction and treatment system for the landfill was undertaken during 2004 and became fully operational following start-up testing in March 2006. The system is located just north of the landfill cap, near the set of compliance point wells that monitor the groundwater down-gradient of the landfill (SHL-5, SHM-96-5B, SHM-96-5C, SHL-9, SHL-22, SHM-96-22B and SHM-93-22C). This construction included a utility dike across the northern half of the cap. The treatment system was not operational at the time of monitoring activities in January 2006. The data collected during 2004, 2005, and January 2006 may therefore serve as baseline data to compare pre-treatment to post-treatment conditions in the future.

1.2 Five-Year Site Reviews

Stone & Webster Environmental Technology & Services (SWEC) conducted the first two years of monitoring in 1996 and 1997. These first two years of monitoring were included in the first *Five Year Review, Shepley's Hill Landfill, Long Term Monitoring* (SWEC, August 1998) required by the ROD, and marking five years since the final capping of the landfill in 1993. Since 1998, monitoring has been conducted by USACE, New England District. In 2000, a review of all Devens sites was performed and included in the *First Five Year Review Report for Devens Reserve Forces Training Area, Devens, MA* (HLA, 2000) which included monitoring conducted for Shepley's Hill Landfill Operable Unit in 1996 through 1999. The second five year review, *2005 Five Year Review* Report, was prepared for monitoring conducted from 2000 through 2004.

1.3 2005 Annual Report Objectives

This annual report covers long term monitoring and maintenance activities conducted in 2005 including the following:

- Landfill cap inspection to identify areas requiring maintenance.
- Installation of nine landfill perimeter gas monitoring probes along the south side of the landfill.
- Landfill gas measurements at 18 gas vents and 13 landfill perimeter gas monitoring probes to establish long-term trends with regard to gas production and venting.
- Monitoring of fourteen compliance point wells for groundwater elevations and COC concentrations to compare to cleanup levels as a measure of determining the effectiveness of the selected remedy.
- Monitoring of an expanded hydraulic network as part of the baseline study established under the Groundwater Extraction, Treatment, and Discharge Remedy.

The findings documented in this annual report support the third five-year site review for monitoring to be conducted from 2005 through 2009 in which the effectiveness of the remedy is formally evaluated with regard to risk reduction and attainment of cleanup levels. Interim recommendations are identified at the end of this report.

2.0 LANDFILL CAP MAINTENANCE ACTIVITIES

The ROD for the Shepley's Hill Landfill requires monitoring and maintenance of the landfill cap based on observations made during the annual inspections. Normally scheduled maintenance activities performed during 2005 included mowing of the landfill vegetative cover and cutting of vegetative growth. An upcoming Comprehensive Site Assessment (CSA), expected to be completed by the fall of 2007, will assess the adequacy of the landfill. Following the CSA, a Corrective Action Alternatives Analysis (CAAA) will be conducted to identify any remedial repairs required. Implementation of the selected options (if required based on the outcome of the CAAA) should improve drainage and function of the landfill cap. The following items should be addressed before the next inspection or as provided for in the final recommendations in the report cited above: (1) repair and replace the security fence and gates as required to control access to the site; (2) Place topsoil and seed over the sandy area lacking vegetation on the east side along the perimeter of the cap. Along with the corrective actions listed above, it is recommended to repair and regrade around the catch basins on the south side of the landfill. With the exception of the repairs mentioned above, and the other repairs recommended in the report, the landfill cap is in fair to good condition and appears to be functioning adequately.

These activities, and all maintenance items monitored during the 2005 cap inspection, are summarized in Section 3.0 of this report. A more detailed report of the monitoring and maintenance activities completed as part of the annual inspection is provided in the Geotechnical Engineering Fall 2005 Annual Inspection Report (USACE, March 2006), which has been included as Appendix A.

3.0 LANDFILL CAP MONITORING ACTIVITIES

The Shepley's Hill Landfill at Devens, Massachusetts was inspected to identify areas requiring maintenance on November 8 and 9 2005 by personnel from the U.S. Army Corps of Engineers, New England District (USACE). Features of the landfill inspected included the cap, drainage system, gas vent system, access roads, and security fence. Observations were made regarding the vegetative cover, vegetation types, erosion, settlement, and general condition of the various features. A narrative of the findings and recommendations of this inspection are included below.

- Catch Basin #3 near the Cooke Street entrance to the site is not set at grade. Soil excavation in this area has left the rim of the grate about six to eight inches higher than the surrounding ground. The rim of this catch basin should be lowered to the surrounding grade.
- The concrete headwall drainage structure at the terminus of the catch basin and underground conduit system on the south side is overgrown with vegetation and is silting in. The grade of the channel bottom is uneven and standing water is present. Wetland species are becoming established as well. The structure and channel immediately downstream is should be cleared, accumulated sediment should be removed, and the channel should be regraded as required to properly drain. The channel will then be reseeded or riprap should be placed, depending on water velocities. This work is scheduled to be performed in 2006. Areas of standing water are present at numerous locations across the landfill surface.
- The northern reaches of the eastern drainage swale have some minor vegetation growth and sand accumulation. The swale should be cleared of vegetation and sand.
- In the vicinity of gas vents 8, 11 and 12, the perimeter of the cap has some areas of sparse/eroded vegetation. The soil in the bare areas is mostly sand and is eroded in some areas. The area should be graded to fill in the eroded areas and topsoil should be placed to a depth of 6 inches over the sand to allow grass to grow. The grass should extend at least twenty feet past the limits of the cap.
- The access roads on the site are in good condition. There are no problems on access roads that warrant repair at this time.
- Portions of the perimeter chain-link security fence are in poor condition. Fence sections and gates are missing and unrestricted access to the site is available at several locations. Some evidence of off-road vehicles (ATV's, dirt bikes, etc.) using the cap area was seen. On the east side near monitoring well SHL-11, the fence has been rolled back and is open. A gate and lock will be added here. There are also several other locations around Plow Shop Pond which provide unrestricted access. The security fence should be repaired, with all missing fence sections, including gates, replaced or repaired.

The recommendations will be addressed in a forthcoming Comprehensive Site Assessment that will be conducted to assess the overall effectiveness of the landfill cap with regard to infiltration. A summary of Corrective Action measures for the Landfill Cap are included in Section 9.0.

4.0 LANDFILL GAS MONITORING RESULTS

The purpose of the landfill gas monitoring program is to establish long-term trends with regard to gas production and venting. A combustible gas survey was performed on 18 passive gas vents on the landfill cover and 13 perimeter gas monitoring probes to determine whether methane, hydrogen sulfide, or volatile organic compounds have accumulated in the subsurface of the landfill site or are migrating off-site, and if so, how these readings compare with the previous year.

Originally, 18 passive gas vents were installed in the landfill cover. In November 2001, four landfill perimeter gas monitoring probes were installed to monitor potential landfill gas migration from Shepley's Hill Landfill towards the north, in the direction of Sculley Road. Nine additional landfill gas monitoring probes were installed along the commercial property at the south side of the landfill in December 2005 after the initial 2005 landfill gas monitoring had been completed. These newly installed probes were sampled in February 2006 as part of a supplemental landfill gas survey.

The annual landfill gas sampling was conducted on November 8, 2005. The weather was clear, with temperatures in the 50's Fahrenheit (°F) and the barometric pressure was 29.9 inches of mercury and rising. The supplemental landfill gas sampling was conducted on February 16, 2006. Weather conditions on this day were recorded as clear, 55 °F and a barometer reading of 30.1 inches mercury and falling. Gas samples were field analyzed for the following parameters using the listed equipment:

Parameter	Gas Monitoring Equipment
Total Volatile Organic Compounds (VOC)	Thermo Environmental 580B (PID) with a 10.6 eV lamp
Percent Oxygen	Landtec GEM 500 landfill gas monitor (November 2005) and Landtec GA90 (February 2006)
Hydrogen Sulfide (ppm)	Industrial Scientific TMX 412 CGI (November 2005) and Industrial Scientific MG 140 (February 2006)
Percent Lower Explosive Limit (LEL)	Industrial Scientific TMX 412 CGI
Carbon Monoxide (ppm)	Industrial Scientific TMX 412 CGI (November 2005) and Industrial Scientific MG 140 (February 2006)
Percent Carbon Dioxide	Landtec GEM 500 landfill gas monitor (November 2005) and Landtec GA90 (February 2006)
Percent Methane	Landtec GEM 500 landfill gas monitor (November 2005) and Landtec GA90 (February 2006)

The equipment used to collect the landfill gas readings was calibrated in the shop by U.S. Environmental. Samples were collected by attaching a rubber Quik cap with a hose clamp to the gas vent pipe. A barbed fitting was placed in a drilled hole in the cap. Tubing was run from the barbed fitting to an Industrial Scientific SKC224-PCXRE air sampling pump in November 2005 and an Industrial Scientific Sampling Pump SP402 in February 2006. The pump was operated for approximately 7 to 10 minutes to purge 2 vent pipe volumes and to ensure that the gases collected were representative of the gas collection layer. The gas monitoring equipment was then attached to the pump and turned on.

The landfill gas monitoring results are provided in the *Geotechnical Engineering Fall 2005 Annual Inspection Report* (Appendix A). The following is a summary of the perimeter landfill gas monitoring results.

November 2005 Landfill Gas Vent Monitoring

VOCs and hydrogen sulfide were not detected in any of the gas vents. The oxygen levels ranged from 0% (V-16, and, V-17) to 21.0% (V-18). LEL readings ranged from 0% (V-15 and V-18) to over 100% LEL in eight of the 18 vents. Carbon monoxide was not measured in 16 of the 18 gas vents. The greatest carbon monoxide concentration, 3 PPM, was detected V-17. Carbon dioxide ranged from 0% (V-15 and V-18) to 27% at V-17. Methane ranged from 0% (V 15 and V-18) to 32.7 % at V-17. Levels of carbon monoxide and carbon dioxide production decreased since last year, while measurements of VOCs, LEL, methane, oxygen, and hydrogen sulfide remained about the stable. Increased levels of LEL, carbon monoxide, carbon dioxide and methane production were observed between the 2003 and 2004 monitoring.

November 2005 Landfill Gas Probe Monitoring

All four perimeter landfill gas monitoring probes (PGP-1, PPG-2, PGP-3, and PGP-4) tested negative for VOC's, LEL, hydrogen sulfide, carbon monoxide, and methane. Carbon Dioxide was detected in all four probes ranging in concentrations from 0.6% to 2.2%. Oxygen levels ranged from 19.2 % at PGP-2 to 20.3% at PGP-1 and PGP-4. Levels of all gases were similar to levels measured during 2004 annual inspection.

February 2006 Landfill Gas Probe Monitoring

VOCs were detected in seven of the nine gas probes installed along the southern border of the landfill. The VOC concentrations ranged from 0.9 ppm at LGP-14 to 0.2 ppm at LGP-7, LGP-8, and LGP-11. LEL concentrations of two percent were observed at LGP-8 and LGP-9 and one percent at LGP-7. Carbon monoxide was detected in two probes: LGP-9 at 1 ppm and LGP-14 at 2 ppm. Carbon Monoxide was detected in eight of the nine probes at concentrations ranging from 0.3 ppm (LGP-5) to 10.7 ppm (LGP-8). Methane and hydrogen sulfide were not detected.

The gas readings are within the parameters of a mature landfill. The major concern with landfill gas is off-site migration. If the gas vents are functioning properly and are adequately spaced there should be no significant off-site migration of landfill gases; however, due to the increased LEL, carbon monoxide, carbon dioxide, and methane readings, and the proximity of residential housing and commercial development, the gas monitoring probes installed along the northern and southern property lines where the landfill is adjacent to structures should continued to be monitored.

5.0 GROUNDWATER ELEVATIONS

Groundwater elevations were collected from the compliance point wells in order to observe any changes in elevation and the direction of groundwater flow. Groundwater elevations at compliance point wells were measured on the first day of each sampling event, June 6, 2005 and January 19, 2006, respectfully. The depth to water table was measured in the field, and then subtracted from the elevation of the reference point to determine the elevation of the water table at each location. Table 5-1 lists the water table elevations (for each sampling round), the geological unit(s) screened by the wells, and the elevation of the screened interval for each well. Groundwater elevations measured in January 2006 were consistently higher than those measured in June 2005.

In addition to these semi-annual groundwater measurements, groundwater measurements of all Shepley's Hill Landfill wells were conducted by CH2M HILL in conjunction with the Performance Monitoring Plan (PMP) implemented as part of the Groundwater Extraction, Treatment, and Discharge Alternative. Site-wide groundwater measurements were collected on February 16, August 1, August, 24, August 26, and August 29, 2006. Water level measurements collected on August 24 and 26 as part of an extraction test are provided as Table 5-2. Data collected on August 24, 2006 represent water level conditions prior to the extraction test and the data collected on August 26 represent water level conditions during the extraction test. The synoptic groundwater data collected prior to and during the extraction tests has been contoured to depict conditions prior to pumping (Figure 5-1) and immediately prior to termination of pumping at 25 gpm (Figure 5-2).

During the first 5-year review (SWEC, August 1998), groundwater elevations were re-evaluated to identify hydraulic gradients and to confirm changes due to the construction of the landfill cap. Groundwater modeling suggested that the landfill cap has reduced the volume of water beneath the cap, resulting in a more northerly groundwater flow (SWEC, 1998). Water level data collected on August 24, 2006, under baseline conditions suggests that the model analysis of a northerly groundwater flow is still valid. The water level data collected during the extraction test indicates that the operation of the groundwater extraction system will create an even greater northerly flow.

6.0 GROUNDWATER SAMPLING

Groundwater sampling is conducted at the landfill on a semi-annual basis in accordance with the LTMMP at assorted compliance point monitoring wells. Nine monitoring wells were sampled as part of the 2005 summer monitoring: SHL-3, SHL-4, SHL-5, SHL-10, SHM-93-10C, SHL-11, SHL-19, SHL-20, and SHM-93-22C in June 2005. The wells were sampled on June 6 and 7, 2005. Fourteen wells were scheduled to be sampled as part of the 2005 winter sampling, including the wells mentioned above as well as SHM-96-5B, SHM-96-5C, SHL-22, and SHM-96-22B. However, monitoring well SHL-3 could not be sampled because the well went dry during purging. Poor recharge in SHL-3 has been documented in previous sampling rounds. The 2005 winter sampling was conducted on January 19, 20, and 25, 2006. The 2005 summer sampling program was conducted by USACE personnel and the 2005 winter sampling was completed by CH2M HILL personnel.

Of these fourteen long term monitoring wells, the seven at the north end of the landfill (SHL-5, SHM-96-5B, SHM-96-5C, SHL-9, SHL-22, SHM-96-22B and SHM-93-22C) are located in the area predicted to experience the greatest intrusion of groundwater flow from the landfill, as suggested by previous modeling results (Harding ESE, A MACTEC Company, 2002). The remaining seven are located along the eastern edge of the landfill, between the landfill and Plow Shop Pond.

Four additional wells located near Molumco Road (SHM-99-31A, SHM-99-31B, SHM-99-31C, and SHM-99-32X) are frequently sampled at the same time as the compliance point wells, for comparison purposes only. However, these wells not sampled during the 2005 monitoring.

In accordance with the ROD and LTMMP, compliance point wells are designated as Group 1 or Group 2 wells. Chemical concentrations in Group 1 wells have historically attained cleanup goals, while those in Group 2 have not. Originally, all existing wells were designated as Group 2 wells per the LTMMP, including three newer wells installed in 1996 (SHM-96-5B, SHM-96-5C, and SHM-96-22B). During the first five-year site review (August 1998), six monitoring wells (SHL-3, SHL-5, SHL-9, SHM-93-10C, SHL-22, and SHM-93-22C) achieved cleanup levels for all chemicals of concern and were reclassified as Group 1 wells. The remaining eight wells continue to be classified as Group 2 wells. The *2005 Five Year Review Report* did not make any changes to the well group designations. If necessary, these group designations will be revised during the next five-year review (based on data collected in the years 2005 to 2009) depending on whether groundwater quality meets the criteria of section 1.2 of the ROD.

6.1 Preparation for Sampling

Sampling activities were coordinated with the Devens BRAC Environmental Office and the contract laboratory prior to commencement of sampling. Bottles were checked to insure they complied with the requirements of the sampling program. Sampling equipment, including YSI water quality meters, portable generators and tubing, was rented (or purchased in the case of supplies) from local vendors. USACE used their own Grundfos Rediflow II pumps, controllers, Heron water level indicators, and HF Scientific DRT-15CE turbidity meters for the sampling events (equipment is occasionally supplemented with identical or similar models rented from U.S. Environmental, as required – these instances are noted on the Groundwater Field Analysis Forms where appropriate). CH2M HILL rented all of the equipment used during the winter sampling from Pine Environmental. All equipment was inventoried and tested to ensure it was accounted for and functioning. The well logs of each of the wells to be sampled were reviewed by the field team prior to the scheduled event to determine tubing requirements, and brought to the landfill during the sampling event to confirm the screened intervals.

6.2 Sampling

Monitoring wells were purged and sampled in accordance with *EPA's Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells* (July 1996) using an adjustable rate, low flow pump.

Before sampling activities commenced, groundwater elevations were measured at each well location to be sampled. YSI water quality meters and turbidity meters were calibrated at the beginning of each day of use. A calibration check was also performed at the end of each day. During sampling, the generator used to power the pumps was located at a downwind area at least 30 feet away from the well being sampled, to minimize potential contamination from the exhaust. Upon initial opening of each well, initial water level measurements were collected. The pump intake was lowered to approximately the middle of the screen of each well to be sampled when possible. When the water level was below the top of the screen, the pump was positioned at a depth approximately midway between the top of the water level and the bottom of the screen.

Water quality parameters, including temperature, specific conductance, pH, oxidation-reduction potential (ORP), turbidity, and dissolved oxygen (DO) were collected every 3 to 5 minutes to ensure proper purging of the wells before each well was sampled. The results are listed on Groundwater Field Analysis Forms located in Appendix B. Most of the water quality parameters, were monitored using a flow-through cell and a Sonde-YSI water meter (YSI 600XL). Turbidity samples were not collected from the flow through cell due to the silt buildup that can occur in the cell. A T-connector with ball valve was set up before the flow-through cell to facilitate the collection of samples for turbidity readings. With the exception of the last day of the winter sampling (January 25, 2006) dissolved oxygen readings were measured in the flow cell. Dissolved oxygen readings on January 25, 2006 were collected with a YSI 85 in-situ probe after the YSI 600 XL began giving erroneous dissolved oxygen readings. Sampling was conducted when water quality parameters became stabilized for three consecutive readings. The tubing was disconnected from the flow-through cell and samples were collected directly from the discharge tubing. Observations made during the sampling activities include:

- To ensure precision of water level measurements, well casings that had faded marks or no marks were remarked.
- At several wells during each event, the water level was lower than the top of the screen, and the pumps were lowered to approximately midway between the water level and the bottom of the screen.
- Monitoring well SHL-3 could not be sampled during the 2006 winter monitoring because the well went dry while purging Previous sampling programs have noted problems with recharge at SHL-3 due to siltation problems

6.3 Equipment Decontamination

All non-disposable sampling and testing equipment that came in contact with the sampling medium was decontaminated to prevent cross contamination between sampling points. The submersible pump was decontaminated using the following procedure:

- Upon removal of the pump from the well following sample collection, the pump was submersed in potable water and detergent (Alconox) solution. At least 1 to 2 gallons of the detergent solution was pumped through (starting the pump at a low flow rate, as in sampling, and increased to a higher speed).
- The pump was removed and sprayed with potable water to minimize the transfer of soap to the riser.
- The pump was then submersed in potable water and at least 1 to 2 gallons were pumped through.
- The pump was then submersed in deionized water and at least 1 to 2 gallons were pumped through.
- The submersible pump was sprayed with isopropyl alcohol (reagent grade) using a hand held spray bottle, over a tub. The pump was then submersed in a final deionized water rinse and at least 1 to 2 gallons were pumped through.
- The pump was air dried and wrapped in clean aluminum foil.

7.0 LABORATORY TESTING

Groundwater samples collected during the summer sampling event were sent to Severn Trent Laboratories in Colchester, Vermont for analysis. Groundwater samples collected during the winter 2005 sampling were submitted to Alpha Analytical Labs of Westborough, Massachusetts. All samples were analyzed for volatile organic compounds, inorganics, and general water quality parameters.

7.1 Sample Handling

Samples were collected in containers compatible with the intended analysis and properly preserved prior to shipment to the laboratory. Each sealed container was placed in a leak proof plastic bag and placed in a strong thermal ice chest filled with bubble wrap packing material, or equivalent, to ensure sample integrity during shipment. Ice was added to cool samples to 4 degrees Celsius (°C) or just below. Chains of custody were used to identify and document the samples being shipped. Sample custody was initiated by the sampling team upon collection of samples and chain-of-custody forms were placed in waterproof plastic bags and taped to the inside lid of the cooler. The cooler was sealed with chain-of-custody seals. Samples collected during the spring sampling were shipped to the laboratory via overnight delivery while the samples collected in January 2006 were delivered by courier.

7.2 Analyses

Contaminants of concern (COCs) for compliance point wells include arsenic, chromium, 1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichloroethane, lead, manganese, nickel, sodium, aluminum, and iron. Cleanup levels for these COCs are listed on Table 1-1. Water analyses were conducted according to SW846 methods 8260B for volatile organic compounds (VOCs), and 6010B for target analyte list (TAL) metals (7471A for mercury). The summer monitoring used the following methods for general chemistry: chemical oxygen demand (COD) by EPA method 410.1, biochemical oxygen demand (BOD) by EPA method 405.1, hardness by Standard Method 2340B, alkalinity by EPA method 310.1, cyanide by EPA method 335.4, anions (chloride, nitrate, and sulfate) by EPA method 300.0, total organic carbon (TOC) by SW846 method 9060, total dissolved solids (TDS) by EPA method 160.1, and total suspended solids (TSS) by EPA method 160.2. The winter monitoring utilized the following methods for the general chemistry analyses: COD by Standard Method 5220D, BOD by Standard Method 5210B, hardness by Standard Method 2340B, alkalinity by Standard Method2320B, cyanide by Standard Method 9014, TOC by SW846 9060, TDS by Standard Method 2540C, TSS by Standard Method 2540D, chloride by Standard Method 9251, nitrate by Standard Method 4500NO3-F, and sulfate by Standard Method 9033B.These analyses were conducted on samples collected from all compliance point wells. As reported in previous annual reports, starting with the fall event of 2001, the method used to determine hardness was changed to Standard Method 2340B in order to eliminate the interference to EPA method 130.2 from other heavy metal ions typically present in some of the wells at the site. Table 7-1 summarizes the analysis procedures used.

7.3 Summary of Results

This annual report compares the COC concentrations with the cleanup levels identified in the ROD, see Table 1-1. The goal of ROD Alternative SHL-2 is to maintain groundwater quality below cleanup levels at Group 1 wells, and to attain cleanup levels at Group 2 wells.

The five-year reviews evaluate the effectiveness of Alternative SHL-2 at reducing the potential human health risk from exposure to groundwater and at preventing groundwater from contributing to Plow Shop Pond sediment contamination in excess of human health and ecological risk-based values. Evaluating effectiveness at Group 2 wells is based on reduction of risk rather than reduction of concentration as a measure of progress toward attainment of cleanup levels, because this approach focuses on the cleanup of arsenic, which is the primary contributor to risk in the Group 2 wells.

According to the LTMMP, only chemicals that present carcinogenic risk are considered trigger chemicals in the monitoring program. The trigger chemicals are arsenic, 1,2 dichlorobenzene, 1,4 dichlorobenzene and 1,2-dichloroethane. Reduction of carcinogenic risk, rather than simply reduction of contamination, is the measure of progress toward attainment of cleanup. This risk-based approach keeps the focus on mitigation of the most significant contributors to risk. Progress toward cleanup as measured by risk reduction is evaluated during five-year reviews.

The LTMMP states Alternative SHL-2 will be considered effective with regard to Group 2 wells if five-year reviews show an ongoing reduction of potential human health risk (based on trigger chemicals) at Group 2 wells and the ultimate attainment of cleanup levels for all COCs by January 2008. Alternative SHL-2 will be considered effective with regard to Group 1 wells if five-year site reviews show that groundwater quality remains at or below cleanup levels for all COCs. The Long Term Monitoring and Maintenance plan (SWET, 1996) considered all of the monitoring wells sampled in 2005 to be Group 2 wells. However, well designation based on the First Five-Year Review, SWEC (1998) considered the wells sampled in 2005 to be classified in the following designations:

- Group 1: SHL-3, SHL-5, SHL-9, SHM-93-10C, SHL-22, and SHM-93-22C;
- Group 2: SHL-4, SHM-96-5B, SHM-96-5C, SHL-10, SHL-11, SHl-19, SHL-20, and SHM-96-22B.

The second five year review did not reclassify any of the monitoring wells. However, the review concluded that based on the data collected to date, the required incremental reduction in risk was not achieved and the Army and regulatory agencies decided to implement Alternative SHL-9, Groundwater Extraction, Treatment, and Discharge. The treatment system was not operational at the time of monitoring activities in January 2006. The data collected during 2004, 2005, and January 2006 may serve as baseline data to compare the pre-treatment and post-treatment conditions. Analytical results for groundwater analyses of samples collected at the compliance point wells are presented in Tables 7-2 and 7-3, for the summer and winter, respectively.

7.3.1 Arsenic Results

Arsenic was the only trigger chemical detected above its cleanup level at the site during the 2005 summer and winter sampling events. Figure 7-1 presents the results for these two sampling events. Historic arsenic data for the fourteen compliance point wells sampled in the 2005 monitoring are provided in Table 7-4. The compliance point monitoring well data was plotted to provide a graphical comparison of historical arsenic concentrations (see Appendix C) as discussed below.

Of the six Group 1 wells sampled in 2005 monitoring, only the sample collected from SHL-22 in January 2006 had arsenic concentrations exceeding the cleanup level (SHL-22 was not sampled in June 2005). Although SHL-22 was designated a Group 1 well in the August 1998 Five Year Review, its arsenic concentrations have consistently measured above the cleanup level since the May 2002 sampling event. Arsenic concentrations have also exceeded clean up levels at least once since the August 1998 Five Year Review in two other Group 1 wells, SHL-9 and SHM-93-22C, but have measured below the cleanup level since October 2002 and May 1999, respectively. Refer to Table 7-6 for wells that exceeded cleanup levels for trigger chemicals since achieving Group 1 status in 1998.

Of the Group 2 wells, arsenic concentrations from SHM-96-5B, SHL-11, SHL-19, SHL-20, and SHM-96-22B exceeded cleanup levels during the 2005 sampling. Most results indicated no significant change from previous arsenic levels. However, the highest historic level of arsenic, 3,320 ug/L , was recorded at SHM-96-22B during the January 2006 sampling. The previous greatest concentration, 2,500 ug/L, was detected during the November 2003 sampling. Group 2 well SHL-10 continues to have minimal to non-detect arsenic concentrations since May 1998. In addition, Group 2 wells SHL-4 and SHM-96-5C have shown arsenic concentrations meeting the cleanup level since May 2003 and November 2003, respectively.

Northern well SHM-96-5B was the sample location with the highest concentration of arsenic. The highest arsenic concentration has been recorded at SHM-96-5 for all of the sampling rounds except fall 2004, in which the highest concentration was observed in well SHM-96-22B. Wells SHM-96-5B and SHM-96-22B are located relatively close to each other and are screened at a similar depth in sand/till. These two northern wells have continuously exhibited the highest arsenic levels, one to two orders of magnitude above arsenic measured in the other compliance wells.

Historic concentrations measured in the eastern wells near Plow Shop Pond indicate arsenic concentrations are the same or decreasing in all wells but SHL-11. SHL-11 is screened at the water table, while the other eastern wells include four more screened at the water table, one at the base of till, and one at bedrock.

Historic concentrations measured in northern wells indicate arsenic concentrations are the same or decreasing in all wells except SHL-22 and SHM-96-22B, which are screened in the sand/till layer and the base of till, respectively. It is notable that concentrations in the northern wells screened at the water table do not generally change over the years monitored. These include Group 1 wells SHL-5 and SHL-9 with arsenic concentrations that usually measure well below the cleanup level, and Group 2 well SHM-96-5C with an arsenic concentration that measured below the cleanup level during 12 of the 18 historic sampling events, including the most recent round completed in January 2006.

In general, similar arsenic concentrations were detected in the eight wells that were sampled in both the summer and winter sampling rounds. The only exception was observed at SHL-19, where the winter concentration (156 ug/L) was greater than the summer arsenic concentration (26 ug/L). Historically, the semi-annual sampling has been performed in the spring and fall seasons. Arsenic concentrations are usually higher in the fall than spring in wells SHL-11, SHL-19 and SHM-96-22B. The opposite is true for SHM-96-5B. The remaining compliance wells don't seem to show a notable seasonal trend for arsenic. The results of the spring and fall events for all COCs are summarized below.

7.3.2 COC Results for Samples Collected Summer 2005

VOCs, metals and general chemistry parameters were analyzed in nine compliance point wells at the landfill site. The compliance point wells sampled included four Group 1 wells, SHL-3, SHL-5, SHM-93-10C, and SHM-93-22C, and five Group 2 wells, SHL-4, SHL-10, SHL-11, SHL-19, and SHL-20.

Detectable levels of the VOC trigger chemicals; 1,2-dichloroethane, 1,2-dichlorobenzene, and 1,3-dichlorobenzene were not observed in the nine monitoring well sampled in June 2005. The COC 1,4-dichlorobenzene was detected at SHL-11 and the corresponding duplicate sample collected at this well at estimated concentrations of 1.5 and 1.4 ug/L, which is significantly less than the Cleanup Level of 70 ug/L. Cleanup Levels for other VOC compounds detected in the sampling were not exceeded.

Arsenic, the only other trigger chemical, was detected at concentrations greater than the cleanup level of 50 μg/L in two Group 2 compliance point wells: SHL-11 (524 ug/L) and SHL-20 (159 ug/L). The duplicate sample (collected from well SHL-11) had a concentration of 518 μg/L. Arsenic concentrations in the samples collected in the 2005 monitoring were generally similar to concentrations observed in the 2004 monitoring.

The other COCs (those not designated as trigger chemicals) detected at concentrations above cleanup levels were also metals (iron, manganese, and sodium). Metal chemicals of concern that were not found to exceed cleanup levels at any of the wells include aluminum, chromium, lead and nickel. Iron was only detected at levels above its cleanup level of 9,100 μg/L at the Group 2 compliance point well SHL-11 (59,400 ug/L and 57,400 ug/L in the corresponding duplicate sample). Iron was not detected above the cleanup level at Group 1 wells. The Group 1 well SHL-5 and Group 2 wells SHL-4, SHL-11 (and the corresponding duplicate sample), SHL-19, and SHL-20 had concentrations of manganese above the cleanup level of 291 μg/L. The maximum value detected for manganese was 2,380 μg/L at SHM-11. Sodium was detected at levels above its cleanup level of 20,000 μg/L at Group 2 wells SHL-11 and SHL-20, at concentrations of 21,600 and 32,000 ug/L, respectively. Sodium was not detected above the cleanup level at Group 1 wells. As summarized in Table 7-5, maximum concentrations of iron, manganese, and sodium detected in the 2005 sampling were generally less than concentrations detected in the 2004 monitoring.

7.3.3 COC Results for Samples Collected Winter 2005

VOCs, metals and general chemistry parameters were analyzed for 13 groundwater monitoring wells in January 2006 as part of the 2005 winter monitoring program. Note that all 13 compliance point wells were sampled and analyzed for all required parameters.

Detectable concentrations of the VOC trigger chemicals; 1,2-dichloroethane, 1,2-dichlorobenzene, 1,3-dichlorobenzene and 1,4-dichlorobenzene were not detected in the 13 wells sampled. Cleanup Levels for other VOC compounds detected in the sampling were not exceeded.

Arsenic, the only other trigger chemical, exceeded the cleanup level of 50 μg/L in the Group 2 compliance point monitoring wells SHM-96-5B (4,130 μg/L), SHL-11 (567 μg/L), SHL-19 (156 μg/L), SHL-20 (189 μg/L), and SHM-96-22B (3,320 μg/L), and in the Group 1 compliance point well SHL-22 (154 ug/L). The duplicate sample (collected from well SHM-96-5B) had a concentration of 4,190 μg/L. Compared to 2004 data, the arsenic concentrations in the wells sampled in January 2006 increased in all the above wells, except for SHL-19.

The other COCs (those not designated as trigger chemicals) detected at concentrations above cleanup levels were also metals (iron, manganese, and sodium). Metal chemicals of concern that were not found to exceed cleanup levels at any of the wells include aluminum, chromium, lead and nickel. Iron was detected at levels above its cleanup level of 9,100 μg/L at Group 2 compliance point wells SHM-96-5B (and corresponding duplicate sample), SHM-96-5C, SHL-11, SHL-19 and SHM-96-22B with the maximum detected (100,000 μg/L) at well SHM-96-5C. Group 1 wells SHL-5, SHL-9, and SHL-22, and Group 2 wells SHM-96-5B (and corresponding duplicate sample), SHM-96-5C, SHL-11, SHL-19, SHL-20 and SHM-96-22B had concentrations of manganese above the cleanup level of 291 μg/L. The maximum value detected for manganese was 7,600 μg/L at SHM-96-5B. Sodium was detected at levels above its cleanup level of 20,000 μg/L at Group 1 well SHL-22, and Group 2 wells SHM-96-5B, SHM-96-5C, SHL-11, SHL-20, and SHM-96-22B, with a maximum concentration of 40,000 ug/L detected at two wells SHM-96-5C and SHL-22. As summarized in Table 7-5, with the exception of iron, manganese, and sodium concentrations at wells SHL-5, SHM-96-5C and SHM-93-10C, concentrations of iron, sodium, and sodium have remained stable or declined since 2002.

8.0 QUALITY CONTROL

Quality assurance/quality control (QA/QC) samples were collected to monitor the sample collection, transportation, and analysis procedures. QA/QC samples included field duplicate samples, matrix spike/ matrix spike duplicate samples, and equipment blanks. The results of the QA/QC sampling as well as an assessment of the data quality of analytical results for water samples collected during the 2005 Annual Shepley's Hill sampling events are provided in Appendix D. Based on the data evaluation elements reviewed, all data was determined to be of acceptable quality for use, with some qualifications due to low matrix spike duplicate recovery, holding time exceedances and associated field and method blank contamination in the June 2005 sampling.

9.0 IMPLEMENTATION OF CONTINGENCY REMEDY

9.1 Description

The rationale for implementing the contingency remedy for the Shepley's Hill groundwater along with detailed plans and specifications is presented in the document entitled, Remedial Design and Remedial Action Workplan, Final Hundred Percent (100%) Submittal, Groundwater Extraction, Treatment, and Discharge Contingency Remedy for Shepley's Hill Landfill. (CH2M HILL, May, 2005). Groundwater modeling work indicated that the system would effectively provide containment of the groundwater moving beneath Shepley's Hill Landfill and to the north if operated at 50 gallons per minute (gpm). The BRAC Cleanup Team (BCT) decided during the completion of the final design effort to conduct initial operation of the system at 25 gpm and initial operational data would be utilized to assess whether or not pumping rates could be increased in the future. The design document (CH2M HILL, May, 2005) provides the following statements about this plan:

> *Although the wellfield design extraction rate is 50 gallons per minute (gpm) total from the wellfield, the startup pumping rate will be a reduced rate of 25 gpm identified by the BCT while the BCT reviews initial extraction test and startup data (e.g., baseline geochemical monitoring, influent concentrations, etc.).*
>
> *The primary performance objective of the extraction system is to contain the arsenic plume in the vicinity of the base boundary near the north end of the landfill. Pump test work (SWET, 1998), a 60% design for an extraction/discharge system (USAEC, 1997), and groundwater modeling (Harding ESE, 2003) provide the basis for development of this design and remedial action work plan. In addition, as mentioned previously, the Army decided in October, 2003 to treat the extracted water stream with a goal for the treatment system of 10 μg/l for arsenic, ensuring 1) that the arsenic concentration and mass-related discharge limitation requirements of the MassDevelopment Industrial Discharge Permit would be easily met and 2) that treatment goals are consistent with the new arsenic drinking water standard of 10 μg/l, promulgated on January 22, 2001 and due to be implemented by public water systems by January 23, 2006. The decision of the BCT to operate the wellfield at lower pumping rate (25 gpm vs the 50 gpm modeled flow) will focus groundwater extraction in the deeper part of the glacial aquifer during initial operations. Higher flow rates will likely be needed in the future to achieve full containment of the groundwater plume.*

Construction of the wellfield, involving two 6-inch extraction wells, was completed in February 2005 and the remainder of system construction and connections with the treatment plant were completed in the Spring and Summer 2005. Concurrent with final design and construction work, CH2M HILL evaluated surface water and groundwater disposal options for treated water from the Arsenic Treatment Plant (CH2M HILL, 2005). This work involved hydraulic modeling to evaluate the impacts of surface water and groundwater discharge at a number of locations east and southeast of the wellfield. Appendix E provides a Technical Memorandum, dated December 22, 2005, providing details of this evaluation. In brief, the evaluation identified locations east of the treatment plant that could be viable for groundwater or surface water discharge. Further work evaluating potential process modifications that may be necessary to provide for dechlorination of effluent is being conducted in 2006.

Start-up wellfield extraction testing, plant process testing, and early system operation were conducted in late August and September 2005. Section 9.2 further describes activities conducted during system start-up.

9.2 Start-Up Activities

The extraction/recovery testing was conducted from August 24th through August 30th and involved two 24 hour drawdown tests and one recovery test of the EW-1 extraction well. A technical memorandum describing this testing is provided in Appendix F. Most importantly, hydraulic triggers established for start-up period operations (CH2M HILL, 2005c) were not exceeded during the tests at 25 gallons per minute.

During the start-up period, process testing and adjustments were made over a period of several days to evaluate the appropriate dosage of coagulant needed to achieve treatment to the operational goal of 10 ug/L. Influent and effluent sampling was conducted during this period to document arsenic, iron, and manganese concentrations throughout the testing period. This was necessary for evaluation of coagulant dosage, as well as to document influent/effluent characteristic under full operational pumping at 25 gpm. The testing demonstrated that the treatment process successfully treats a complex matrix (influent groundwater) and meets the goal of 10 ug/L arsenic. A brief summary memo (CH2M HILL, 2005d) provided in Appendix G discusses the process testing in greater detail.

In addition, to start-up process testing, geochemical and water-level monitoring were conducted during the start-up period and subsequently during routine operations in accordance with the Performance Monitoring Plan (CH2M HILL, 2005c). This data collection confirmed that the hydraulic triggers were not exceeded, in addition to demonstrating that groundwater arsenic levels and other geochemical parameters have remained relatively stable in the vicinity of the extraction wellfield and elsewhere during the early operation of the system.

During the first month of start-up operations 35% LEL was detected in the influent tank, 7% LEL in the effluent sump, and 2% LEL in the effluent manhole. Further monitoring indicated that methane was being generated from dissolved methane in influent groundwater as it is brought to the surface and equilibrates with atmospheric pressure. The methane/ethane levels in groundwater proved to be fairly typical for groundwaters having high TOC levels that are undergoing active methanogenesis. The plant was shutdown upgrade systems to ensure that hazardous atmospheres would not develop in headspaces the plant or process. Upgrades including LEL monitors on the clarifier and roll-off; an O_2 monitor on the microfilter (MF) skid; explosion-proof electrical in the effluent sump and extraction wells; and sealing/venting of the effluent sump and MF process tanks were made during the Fall and Winter and the system was brought back on line in early March, 2006.

10.0 CONCLUSIONS AND RECOMMENDATIONS

10.1 Conclusions

- The second five year review was completed by the USACE in September 2005. The five year concluded that the required incremental reduction in risk was not achieved and the Army and regulatory agencies decided to implement the Alternative SHL-9, Groundwater Extraction, Treatment, and Discharge. The groundwater extraction system began operation in March 2006.
- Site-wide groundwater measurements were collected on August 24 and 26, 2005. Water level data collected on August 24, 2006, representing baseline conditions suggests that the previous model analysis of a northerly groundwater flow is still valid. The water-level data collected on August 26 during an extraction test indicates that the operation of the groundwater extraction system will be expected create an even greater northerly flow.
- The locations of the wells in the LTMP remain appropriate, relative to source areas and the direction of groundwater flow.
- Shepley's Hill Landfill Cap appears to be in fair to good condition.
- The Geotechnical Engineering Annual Inspection in 2005 (refer to Appendix A) concluded: *An upcoming Comprehensive Site Assessment will assess the adequacy of the landfill. Following the CSA, a Corrective Action Alternatives Analysis will be conducted to identify any remedial repairs required. Implementation of the selected options (if required based on the outcome of the CAAA) should improve the drainage and function of the landfill cap. The following items should be addressed before the next inspection or as provided for in the final recommendations in the report cited above: (1) Repair and replace the security fence and gates as required to control access to the site; (2) Place topsoil and seed over the sandy area lacking vegetation on the east side along the perimeter of the cap. Along with the corrective actions listed above, it is recommended to (1) Install additional landfill gas monitoring probes along the commercial property at the south side of the landfill (the probes were installed in November 05, after this inspection) (2) Repair and regrade around the catch basins on the south side of the landfill. With the exception of the repairs mentioned above, and the other repairs recommended in the report, the landfill is in fair condition and appears to be functioning adequately.* As noted, gas probes were installed on the south end of the landfill monitored in February, 2006 (refer to Appendix A). Methane was not detected in any of the new or older perimeter gas probes. In addition, in December, 2005 the security fence was repaired and no-trespassing signs were installed.

10.2 Recommendations

- The list of parameters monitored as part of the long term sampling program should be reviewed as recommended in the 2005 Five Year Review Report (USACE, September 2005) with the intent of eliminating parameters that have no significant site history and do not contribute to site risks or to the understanding of the groundwater chemistry. These include copper, lead, nickel, selenium, silver, cyanide, BOD, and VOCs.
- Integrate LTM and PMP groundwater sampling programs.

- Other recommendations made in this annual report that are not currently scheduled but should be addressed in the future include, (1) Repair and regrade around the catch basins on the south side of the landfill; and (2) Repair the hasps on the casings of groundwater monitoring wells SHL-4 and SHL-9.

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Tables

Table 1-1 Contaminants of Concern (COC) - Cleanup Levels Shepley's Hill Landfill Devens, Massachusetts		
COC	**Cleanup Level ug/L**	**Selection Basis**
Arsenic	50	MCL
Chromium	100	MCL
1,2-Dichlorobenzene	600	MCL
1,4-Dichlorobenzene	5	MCL
1,2-Dichloroethane	5	MMCL
Lead	15	Action Level
Manganese	291	Background
Nickel	100	MCL
Sodium	20,000	Health Advisory
Aluminum	6,870	Background
Iron	9,100	Background

Based Upon Record of Decision

Table 5-1
Monitoring Well Specifications and Groundwater Elevations
Shepley's Hill Landfill
Devens, Massachusetts

Well ID	Description	Orientation to Landfill[1]	Ground Surface Elevation[2] (ft msl)	Reference Elevation[2] (ft msl)	Total Depth (feet)	Screen Length (feet)	June 2005		January 2006	
							Water Levels	Groundwater Elevation (ft msl)	Water Levels	Groundwater Elevation (ft msl)
SHL-3	Water Table	East	247.4	248.6	33.29	10	29.75	218.85	29.58	219.02
SHL-4	Water Table	East	226.4	228.1	14.65	10	10.05	218.05	9.69	218.41
SHL-5	Water Table	North	217.9	218.6	13.75	10	2.59	216.01	1.40	217.20
SHM-96-5B	Base of Sand/Till	North	218.5	220.0	92.47	10	4.36	215.64	3.89	216.11
SHM-96-5C	Water Table	North	218.7	219.4	79.62	10	3.88	215.52	5.98	213.42
SHL-9	Water Table	North	221.7	223.0	26.25	10	7.51	215.49	6.72	216.28
SHL-10	Water Table	East	249.1	248.8	29	15	30.35	218.41	30.64	218.47
SHM-93-10C	Bedrock	East	247.1	248.6	56.31	10	28.86	219.74	28.46	220.14
SHL-11	Water Table	East	235.0	236.5	30	15	18.28	218.22	17.99	218.51
SHL-19	Water Table	East	239.5	241.5	32.37	15	22.19	219.31	21.49	220.01
SHL-20	Base of Till	East	235.4	237.0	50.55	10	18.62	218.38	18.34	218.66
SHL-22	Base of Till	North	220.0	220.6	110.6	10	5.24	215.36	4.75	215.85
SHM-96-22B	Sand/Till Interface	North	220.0	221.7	92.42	30	5.10	216.60	4.56	217.14
SHM-93-22C	Bedrock	North	219.9	220.4	137.5	10	6.30	214.10	6.10	214.30

Notes:
1. North wells are located in the direction of groundwater flow away from the landfill.
East wells are located between landfill and East Plow Pond.
2. Elevations based Meridian Associates survey (7&8/2005), referenced to be National Geodetic Vertical Datum of 1929 (NGVD29).

Table 5-2 Groundwater Elevations (Baseline and Extraction Test)
Site-Wide Groundwater Elevations
Shepley's Hill Landfill
Devens, Massachusetts

				Baseline: 8/24/05		***Maximum Drawdown: 8/26/06***	
Well ID	**Ground Surface Elevation[1,3] (ft msl)**	**Outer Casing Elevation[1,3] (ft msl)**	**Reference Elevation[1,3] (ft msl)**	**DTW (TOC) (ft)**	**Elevation (ft msl)**	**DTW (TOC) (ft)**	**Elevation (ft msl)**
SHM-05-39A	222.9	222.9	222.6	11.93	210.7	11.88	210.7
SHM-05-39B	222.9	222.9	222.6	12.70	209.9	12.66	209.9
SHM-05-40X	224.6	224.6	224.4	14.55	209.9	14.56	209.8
SHM-05-41A	223.8	223.8	223.5	10.71	212.8	10.82	212.7
SHM-05-41B	223.6	223.6	223.3	10.53	212.8	10.63	212.7
SHM-05-41C	224.0	224.0	223.6	10.75	212.9	10.86	212.7
SHM-05-42A	214.5	217.9	217.8	4.98	212.8	5.10	212.7
SHM-05-42B	214.5	217.9	217.8	4.93	212.9	5.07	212.7
SHM-99-31A	213.9	215.7	215.4	4.40	211.0	4.28	211.1
SHM-99-31B	213.7	215.5	215.4	4.32	211.1	4.35	211.1
SHM-99-31C	213.7	215.9	215.8	4.59	211.2	4.63	211.2
SHM-99-32X	220.2	222.5	222.3	10.17	212.1	10.24	212.1
SHP-05-47A	214.4	NA	218.5	5.97	212.5	Dry	Dry
SHP-05-47B	214.4	NA	216.3	3.93	212.4	3.81	212.5
SHP-05-48A	213.9	NA	217.0	Dry	Dry	Dry	Dry
SHP-05-48B	213.8	NA	218.4	Dry	Dry	Dry	Dry
SHP-05-49A	213.3	NA	217.8	5.93	211.9	Dry	Dry
SHP-05-49B	213.3	NA	216.2	4.28	211.9	4.65	211.6
SHP-99-33A	222.1	NA	224.1	13.17	210.9	13.19	210.9
SHP-99-33B	222.2	NA	223.7	12.42	211.3	12.55	211.2
SHP-99-34A	223.6	NA	225.7	13.65	212.1	13.56	212.1
SHP-99-34B	223.6	NA	225.6	13.33	212.3	13.25	212.4
WP-01	213.3	NA	213.4	Dry	Dry	Dry	Dry
EW-01	NA	228.2	228.0	14.22	213.8	24.18	203.8
EW-01 pilot	NA	228.2	228.0	14.22	213.8	14.84	213.2
EW-04	NA	228.5	228.1	14.53	213.6	--	--
EW-04 pilot	NA	228.5	228.1	14.62	213.5	14.82	213.3
SHL-13	220.1	222.3	221.8	7.59	214.2	7.52	214.3
SHL-21	258.7	261.2	260.0	45.81	214.2	45.75	214.3
SHL-22	220.0	221.4	220.6	7.36	213.2	7.57	213.0
SHL-23	240.5	242.6	242.3	28.16	214.1	28.17	214.1
SHL-5	217.9	218.9	218.6	5.32	213.3	5.38	213.2
SHL-8D	220.1	222.3	221.8	8.03	213.8	8.04	213.8
SHL-8S	220.1	222.3	222.0	8.22	213.8	8.27	213.7
SHL-9	221.7	223.5	223.0	9.83	213.2	9.95	213.1
SHM-05-45A	227.3	229.7	229.5	15.69	213.8	16.09	*213.3*
SHM-05-45B	227.7	230.3	230.1	16.29	213.8	16.61	*213.0*
SHM-05-46A	227.3	229.4	229.3	15.32	214.0	15.49	*213.5*
SHM-05-46B	227.1	228.8	228.7	14.60	214.1	14.76	*213.7*
SHM-93-22C	220.0	221.7	221.7	8.45	213.3	8.65	213.1
SHM-96-22B	219.9	221.6	220.4	7.23	213.2	7.42	213.0
SHM-96-5B	218.5	220.2	220.0	6.39	213.6	6.65	*213.4*
SHM-96-5C	218.7	219.6	219.4	5.98	213.4	6.12	213.3
SHP-05-43	259.4	262.4	261.7	45.45	216.3	45.36	216.3
SHP-05-44	256.4	259.5	259.1	42.46	216.6	42.40	216.7
N-1, P-1	228.8	231.5	231.0	14.93	216.1	14.86	216.1
N-1, P-2	228.8	231.5	231.0	14.80	216.2	14.77	216.2
N-1, P-3	228.8	231.5	231.2	14.46	216.7	14.40	216.8
N-2, P-1	221.6	223.8	223.1	5.92	217.2	5.85	217.3
N-2, P-2	221.6	223.8	223.0	6.14	216.9	6.08	216.9
PSP-01	NA	NA	216.1	0.94	217.0	0.97	217.1
SHL-11	235.0	237.0	236.5	18.98	217.5	18.91	217.6
SHL-20	235.4	237.0	237.0	19.33	217.7	19.30	217.7
SHL-4	226.4	228.4	228.1	10.77	217.3	11.07	217.0
SHP-01-36X	221.1	NA	225.1	7.16	217.9	8.11	217.0
SHP-01-37X	219.5	NA	223.7	6.91	216.8	6.53	217.2
SHP-01-38A	219.8	NA	221.8	4.39	217.4	4.36	217.4
SHP-01-38B	219.9	NA	222.0	4.49	217.5	4.34	217.7
N-3, P-1	219.8	222.5	221.8	4.76	217.0	4.71	217.1
N-3, P-2	219.8	222.5	221.5	4.78	216.7	4.76	216.7
N-4, P-1[4]	218.3	219.9	219.2	--	--	--	--
N-4, P-2[4]	218.3	219.9	219.2	2.10	217.1	2.09	217.1
N-4, P-3[4]	218.3	219.9	219.2	--	--	--	--
N-5, P-1	241.7	244.9	243.7	23.38	220.3	23.35	220.4
N-5, P-2	241.7	244.9	243.7	23.27	220.4	23.22	220.5
N-6, P-1	257.1	259.9	259.9	36.51	223.4	36.05	223.9
N-7, P-1	254.4	257.7	256.6	30.35	226.3	30.34	226.3
N-7, P-2	254.4	257.7	257.1	30.43	226.7	30.44	226.7
SHL-15	260.1	261.2	260.9	18.93	242.0	18.98	241.9
SHL-18	236.8	238.8	238.6	19.60	219.0	19.62	219.0
SHL-19	239.5	241.8	241.5	23.38	218.1	23.40	218.1
SHL-3	247.4	248.6	248.6	30.77	217.8	30.80	217.8
SHM-93-10C	247.1	249.1	248.6	29.92	218.7	23.93	224.7
SHM-93-10D	246.5	249.1	248.9	30.63	218.3	30.64	218.3
SHM-93-10E	246.6	248.8	248.5	29.73	218.8	29.64	218.9
SHM-93-18B	236.3	238.7	238.3	19.29	219.0	19.30	219.0
SHL-24	237.8	239.9	239.8	15.69	224.1	15.72	224.1
SHP-95-27X	236.3	238.7	238.5	33.02	205.5	16.14	222.4
SHP-99-35X	257.5	259.3	259.2	36.39	222.8	35.05	224.2

NA=Not Available (survey data not available)

Notes:

1. Field survey performed by Meridian Associates, Inc. between July and August 2005.
2. Northing and easting coordinates based upon project system, reported to be North American Datum of 1983 (NAD83).
3. Elevations referenced to National Geodetic Vertical Datum of 1929 (NGVD29).
4. N-4 ice damaged. P-2 measurement approx.
5. Reference elevation generally inner (PVC) casing or zero mark on stageboard. SHL-3 PVC (elev. 247.8) not used for reference due to depth in protective casing.

Table 7-1
Groundwater Sample Analysis and Procedures
Shepley's Hill Landfill
Devens, Massachusetts

Parameters	June 2005 Method	January 2006 Method
Volatile Organic Compounds	SW846 8260B	SW846 8260B
Inorganics		
Aluminum	SW846 6010B	SW846 6010B
Arsenic	SW846 6010B	SW846 6010B
Barium	SW846 6010B	SW846 6010B
Cadmium	SW846 6010B	SW846 6010B
Chromium	SW846 6010B	SW846 6010B
Copper	SW846 6010B	SW846 6010B
Cyanide	EPA Method 335.4	SM 9014
Iron	SW846 6010B	SW846 6010B
Lead	SW846 6010B	SW846 6010B
Manganese	SW846 6010B	SW846 6010B
Mercury	SW846 7470A	SW846 7470A
Nickel	SW846 6010B	SW846 6010B
Selenium	SW846 6010B	SW846 6010B
Sodium	SW846 6010B	SW846 6010B
Silver	SW846 6010B	SW846 6010B
Zinc	SW846 6010B	SW846 6010B
General Laboratory Parameters		
Hardness	SM 2340B	SM 2340B
Total Dissolved Solids	EPA 160.1	SM 2540C
Total Suspended Solids	EPA 160.2	SM 2540D
Chloride	EPA 300.0	SM 9251
Nitrate as N	EPA 300.0	SM 4500NO3-F
Sulfate	EPA 300.0	SM 9038B
Alkalinity	EPA 310.1	SM 2320B
Biological Oxygen Demand - 5 Day	EPA 405.1	SM 5210B
Chemical Oxygen Demand	EPA 410.1	SM 5220D
Total Organic Carbon	SW 846 9060	SW 846 9060
General Field Parameters		
pH	YSI 600 XL	YSI 600 XL
Temperature	YSI 600 XL	YSI 600 XL
Specific Conductivity	YSI 600 XL	YSI 600 XL
Dissolved Oxygen	YSI 600 XL	YSI 600 XL/ YSI 85
Oxygen Reduction Potential	YSI 600 XL	YSI 600 XL
Turbidity	HF Scientific DRT-15CE	LaMotte 202

Table 7-2
Groundwater Analytical Results (ug/L)
June 6-7, 2005
Shepley's Hill Landfill
Devens, Massachusetts

PARAMETERS	CLEANUP LEVEL (1)	Monitoring Well ID									
		SHL-3	SHL-4	SHL-5	SHL-10	SHM-93-10C	SHL-11	SHL-11 DUP	SHL-19	SHL-20	SHM-93-22C
VOLATILES (8260B)											
1,1-Dichloroethane	70 (4)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichlorobenzene	600	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichloroethane	5	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,2-Dichloroethene (total)	70 (2)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	1.4 J	1.4 J	5.0 U	5.0 U	5.0 U
1,3-Dichlorobenzene	600 (2)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
1,4-Dichlorobenzene	5	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	1.8 J	5.0 U	2.1 J	5.0 U
2-Butanone	-	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 UJ	5.0 U	5.0 U
4-Methyl-2-Pentanone	-	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Acetone	3,000 (4)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 UJ	5.0 U	5.0 U
Benzene	5 (2)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	1.5 J	1.4 J	5.0 U	5.0 U	5.0 U
Methyl-t-Butyl Ether	70 (4)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Xylenes	10,000 (2)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 UJ	5.0 U	5.0 U
METALS (6010B or as noted)											
Aluminum	6,870	88 U	88 U	227	88 U	88 U	88 U	88 U	88U	88 U	88 U
Arsenic	50	4.5 U	10.1	7 B	4.5U	8.1 B	**524**	**518**	26.3	**159**	15.8
Barium	2,000 (2)	8.4 U	35 B	9.5 B	8.4 U	8.4 U	78.5 B	77.2 B	10.3 B	86.8 B	70.8 B
Cadmium	5 (2)	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
Chromium	100	2.9 B	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2U	2.4 B
Copper	1,300 (3)	4.2 U	4.2 U	4.2 U	4.2 U	4.2 U	6.6 B	4.2 U	4.2 U	4.2 U	4.2 U
Iron	9,100	37.9 U	1,220	2,930	37.9 U	37.9 U	**59,400**	**57,400**	6,680	5,980	572
Lead	15	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	4.8	2.9 U	2.7 U	2.7 U	2.7 U
Manganese	291 (5)	1.7 B	**361**	**476**	1.5 B	27.5	**2,380**	**2,300**	**1,090**	**6,270**	218
Mercury (7470A)	2 (2)	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	100	3 U	4.2 B	3 U	3 U	3 U	3 U	3 U	4 B	7.2 B	3 U
Selenium	50 (2)	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U
Silver	40 (4)	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U
Sodium	20,000	696 B	7,190	3,240 B	841 B	7,840	**21,600**	**20,900**	1,470 B	**32,000**	9,910
Zinc	2,000 (4)	1.9 B	3.6 U	7 B	4.7 B	1.6 U	5 B	3.6 B	2.5 B	3.1 B	16.4 B
GENERAL CHEMISTRY											
Alkalinity as $CaCO_3$	-	7,600 UJ	58,100 UJ	41,100 UJ	17,600 UJ	191,000 J	201,000 J	207,000 J	32,700 UJ	277,000 J	147,000 J
Biochemical Oxygen Demand	-	1,100 U	1,100 U	1,300	1,100 U	1,100 U	1,400	1,100 U	1,100 U	1,100 U	1,300
Chemical Oxygen Demand	-	20,000 U	20,000 U	20,000 U	20,000 U	20,000 U	20,000 U	20,000 U	20,000 U	20,000 U	20,000 U
Chloride	-	690 U	8,800	6,400	1,100 U	24,300	23,900	22,900	1,100 U	31,700	15,000
Cyanide (Total)	200 (2)	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Hardness as $CaCO_3$	-	5,800	49,800	38,900	17,400	209,000	127,000	123,000	26,500	254,000	149,000
Nitrate as Nitrogen	10,000 (2)	370 U	440 U	200 U	430 U	330 U	420 U	410 U	480 U	550 U	520 U
Sulfate	500,000 (2)	3,900	7,300	910 U	3,000	23,600	880 U	1,200 U	8,900	11,700	8,700
Total Dissolved Solids	-	21,000	81,000	77,000	28,000	270,000	585,000 *	297,000	56,000	362,000	200,000
Total Organic Carbon	-	1,000 U	1,700	6,000	1,000 U	1,000 U	3,600	4,800	1,100	3,000	4,300
Total Suspended Solids	-	1,700	1,200	1,600	500 U	500 U	33,100	41,800	5,000	7,900	1,600
FIELD READINGS (units as noted below)											
Dissolved Oxygen (mg/L)	-	11.2	0.8	0.3	11.2	0.7	0.5	0.5	1.9	0.3	1.0
Oxidation Reduction Potential (mv)	-	176	122	153	211	249	-7	-7	69	-1	-23
pH	-	6.6	5.6	4.2	6.4	7.3	EF	EF	4.9	6.2	6.8
Specific Conductivity (µS/cm)	-	18	141	94	29	433	548	548	88	586	292

Notes:

Shaded areas with bold numbers indicate cleanup level exceedance -
B = (Inorganics) value below laboratory RL but above the IDL
J = estimated value
* = duplicate analysis Relative Percent Difference outside acceptance limits
U = below laboratory RL
NS = not sampled
NA = not analyzed

EF = equipment failure
(1) Cleanup values as developed in the ROD (unless otherwised noted).
(2) No cleanup value was developed so the Federal Maximum Contamination Level was used.
(3) No cleanup value was developed so the Massachusetts Maximum Contamination Level was used.
(4) No cleanup value was developed so the Massachusetts Contingency Plan GW-1 standard was used.
(5) The LTMMP listed a cleanup goal of 1,715 ug/L. This level has been in use by USACE in past years.
The ROD indicated a cleanup goal of 291 ug/L. As there was no ESD prepared,
the ROD value iscurrently reflected in this table.

Table 7-3

Groundwater Analytical Results (ug/L)
January 19, 20, and 25, 2006 Sampling Event
Shelpey's Hill Landfill Compliance Point Wells
Devens, Massachusetts

Parameters	Cleanup Level (1)	Monitoring Well ID													
		SHL-4	SHL-5	SHM-96-5B	SHM-96-5B DUP	SHM-96-5C	SHL-9	SHL-10	SHM96-10C	SHL-11	SHL-19	SHL-20	SHL-22	SHM-96-22B	SHM-93-22C
Volatile Organics (8260B)															
1,1-Dichloroethane	70 (4)	0.75 U	0.75 U	1.0	1.0	1.0	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	1.4	1.3	0.75 U
1,2-Dichlorobenzene	600	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
1,2-Dichloroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,3-Dichlorobenzene	600 (2)	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
1,4-Dichlorobenzene	5	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
2-Butanone	-	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	32
4-Methyl-2-pentanone	-	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Acetone	3,000 (4)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Benzene	5 (2)	0.5 U	0.5 U	0.94	0.94	1.6	0.5 U	0.5 U	0.5 U	1.4	0.5 U	1.1	0.5 U	1.1	0.5 U
Chlorobenzene		0.5 U	0.5 U	0.84	0.88	2.6	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.72	0.5 U
Chloroform		0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U	0.75 U
Ethyl ether		2.5 U	2.5 U	17	17	18	2.5 U	2.5 U	6.7	15	2.5 U	11	19	17	8.2
Methyl tert butyl ether	70 (4)	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Methylene chloride (6)		5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Tetrahydrofuran		10 U	10 U	10 U	10 U	88	10 U	10 U	10 U	10 U	10 U	10 U	140	10 U	33
Vinyl chloride		1.0 U	1.0 U	1.0 U	1.0 U	1.1	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Xylenes (total)	10,000 (2)	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,2-Dichloroethene (Total)	70 (2)	0.75 U	0.75 U	2.1	2.1	2.2	0.75 U	0.75 U	0.75 U	1.2	0.75 U	0.6	1.9	2.5	0.75 U
Total Metals (6010B or as noted)															
Aluminum, Total	6,870	100 U	170	100 U	100 U	100 U	110	100 U	470	100 U	100 U	100 U	100 U	100 U	100 U
Arsenic, Total	50	5 U	5.0 U	**4,130**	**4,190**	43	18	5.0 U	11	**567**	**156**	**189**	**154**	**3,320**	23
Barium, Total	2,000 (2)	10	10	50	50	70	10 U	10 U	10 U	70	10	90	10	70	90
Cadmium, Total	5 (2)	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Chromium, Total	100	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Copper, Total	1,300 (2)	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Iron, Total	9,100	280	2,600	**39,000**	**40,000**	**100,000**	4,400	50 U	490	**57,000**	**13,000**	5,500	650	**70,000**	740
Lead, Total	15	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Manganese, Total	291 (5)	200	**500**	**7,500**	**7,600**	**4,600**	**310**	10 U	60	**2,400**	**980**	**5,500**	**2,600**	**1,700**	250
Mercury, Total (7470A)	2 (2)	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Nickel, Total	100	25 U	25 U	25 U	25 U	25 U	25 U	25 U	25 U	25 U	25 U	25 U	25 U	25 U	25 U
Selenium	50 (2)	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Silver, Total	40 (4)	7 U	7 U	7 U	7 U	7 U	7 U	7 U	7 U	7 U	7 U	7 U	7 U	7 U	7 U
Sodium, Total	20,000	2,000 U	2,500	**28,000**	**28,000**	**40,000**	2,000	2,000 U	9,500	**24,000**	2,000 U	**29,000**	**40,000**	**31,000**	13,000
Zinc, Total	2,000 (4)	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Genearl Chemistry															
Alkalinity, Total	-	17	29	320	330	440	54	14	180	260	35	250	380	320	160
Solids, Total Dissolved	-	25,000	70,000	320,000	340,000	440,000	130,000	25,000	240,000	210,000	73,000	270,000	450,000	300,000	230,000
Solids, Total Suspended	-	5,000 U	5,000 U	59,000	62,000	110,000	5,000 U	6,400	6,700	28,000	33,000	8,500	5,000 U	87,000	9,800
Cyanide, Total	200 (2)	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloride	-	1,000	2,200	21,000	21,000	51,000	6,200	1,200	21,000	22,000	1,000 U	24,000	32,000	23,000	18,000
Nitrogen, Nitrate	10,000 (2)	700	620	220	190	240	100 U	200	100 U	190	100 U	100 U	4,200	210	110
Sulfate	500,000 (2)	10,000 U	24,000	10,000 U	10,000 U	10,000 U	10,000 U	10,000 U	22,000	10,000 U	10,000 U	10,000 U	10,000 U	10,000 U	10,000 U
Chemical Oxygen Demand	(5)	20,000 U	33,000	26,000	29,000	45,000	20,000 U	20,000 U	20,000 U	24,000	20000 U	20,000	20,000 U	26,000	20,000 U
BOD, 5 day	-	2,000 U	2,000 U	2,900	2,000 U	5,000 U	2,000 U	2,000 U	2,000 U	8,200	2,000 U	2,000 U	2,000 U	4,800	2,000 U
Total Organic Carbon	-	850	4,800	4,500	4,400	8,900	6,000	500 U	760	3,800	1,000	3,000	4,000	5,300	4,500
Hardness	-	16,000	43,000	220,000	220,000	270,000	57,000	13,000	200,000	130,000	35,000	180,000	320,000	190,000	160,000
Field Readings (units as noted)															
Dissolved Oxygen (mg/L)	-	5.28	0.65	0.22		0.15	0.45	6.71	0.01	0.63	2.42	0.2	0.16	0.17	0.73
Oxidation Reduction Potential (mv)	-	412	425.2	-82.1		-85.9	-23.4	330.4	228.2	3.7	282.9	-0.2	208.2	-114.0	-235.1
pH	-	5.81	5.2	6.53		6.49	5.92	6.04	7.4	6.2	5.78	6.45	5.17	5.54	8.49
Specific Conductivity (uS/cm)	-	48	113	666		1035	141	39	450	689	120	634	744	730	375

NOTES:
Shaded areas with bold numbers indicate cleanup level exceedance
U = Analyte or compound was analyzed but not detected at a concentration above the reporting limit.
(1) Cleanup values as developed in the ROD (unless otherwise noted)
(2) No cleanup value was developed so the Federal Maximum Contamination Level was used.
(4) No cleanup value was developed so the Massachusetts Contingency Plan GW-1 standard was used.
(5) The LTMMP listed a cleanup goal of 1,715 ug/L. This level has been in use by the USACE in past years. The ROD indicated a cleanup goal of 291 ug/L. As there was no ESD prepared, the ROD value is currently reflected in this table.
(6) Methylene Chloride was detected in the equipment blank a concentration of 8.5 ug/L but not detected in any of the groundwater samples
(7) YSI 600 XLM failed, collected In-situ readings with a YSI 85 probe.

Table 7-4
Comparison of Historic Arsenic Concentrations (ug/L)
Shepley's Hill Landfill Compliance Point Wells
Devens, Massachusetts

Sample	**Monitoring Well ID (group designation)**						
Date	SHL-3 (1)	SHL-4 (2)	SHL-5 (1)	SHM-96-5B (2)	SHM-96-5C (2)	SHL-9 (1)	SHL-10 (2)
Aug-91	35.0	**260**	23.0	NS	NS	37.0	**67.0**
Dec-91	**120**	**140**	38.0	NS	NS	**67.0**	**120**
Mar-93	6.5	2.54	11.4	NS	NS	42.4	**280**
Jun-93	NS	NS	NS	NS	NS	NS	NS
Nov-96	NS	48.8	12.0	**1,440**	**71**	46.9	3.4 B
May-97	<10	**73.6** J	<10	**3,300** J	43.2	16.1 J	<10
Oct-97	<10	**180**	<10	**2,040**	43.1	25.2	**209**
May-98	<5	37.4	<5	**4,300**	49.5	15.0	<5
Nov-98	<5.4	**89.1**	11.5	**3,080**	46.8	27.2	<5.4
May-99	2.7 B	**78.2**	5.0 B	**3,490**	**57**	**71.3**	2.7 B
Nov-99	<1.9	**61.3**	6.5	**2,700**	44.8	28.5	<1.9
May-00	<2.5	**116**	<2.5	**5,110**	**52.2**	15.0	<2.5
Nov-00	17.4	**91.5**	13.8	**2,500**	40.3	31.4	<4.2
May-01	<4.1	**50.8**	13.8	**3,800**	**80.5**	15.1	<4.1
Oct-01	<1.5	**66.0**	14.8	**1,850**	41.1	28.1	<1.5
May-02	2.8 B	47.8 B	11.9 B	**3,800**	**50.4** B	**144**	4.0 B
Oct-02	<3.2	**66.1**	<3.2	**1,970**	41.3	29	<3.2
May-03	<4.7	26.6	7.3	**3,920**	**55.1**	13.4	<4.7
Nov-03	<4.1	13.4	4.7 B	**3,380**	48.3	30.6	<4.1
May-04	<2.6	27.2	7.4 B	**3,950**	47.1	19.8	<2.6
Nov-04	<5.8	19.5	6.8 B	**2,110**	49.5	32.2	<5.8
Jun-05	<4.5	10.1	7.0 B	NS	NS	NS	<4.5
Jan-06	NS	<5	<5	**4,130**	43.0	18.0	<5

Sample	**Monitoring Well ID (group designation)**						
Date	SHM-93-10C (1)	SHL-11 (2)	SHL-19 (2)	SHL-20 (2)	SHL-22 (1)	SHM-93-22B (2)	SHM-93-22C (1)
Aug-91	NS	**320**	**340**	**98**	27	NS	\
Dec-91	NS	**320**	**710**	**89**	25	NS	NS
Mar-93	21.3	**340**	**390**	**330**	32.9	NS	**68.9**
Jun-93	18.1	NS	NS	NS	NS	NS	49.8
Nov-96	12.4	**332**	**138**	**244**	24.8	**324**	44.6
May-97	<10	**252** J	<10	<10	<10	**318** J	40.4
Oct-97	10.5	**366**	**298**	**227**	34.8	**352**	<10
May-98	7.5	**346**	**77.5**	**238**	10.6	**365**	31.6
Nov-98	10.2	**376**	**145**	**218**	<5.4	**406**	**51.1**
May-99	10.8 B	**431**	**156**	**216**	12.2 B	**707**	42.8
Nov-99	8.7	**492**	**176**	**215**	7.3	**1,440**	33.2
May-00	5.9 J	**404**	**41.4**	**216**	14.6	**1,360**	34.4
Nov-00	8.8	**523**	**154**	**172**	45	**1,180**	47.8
May-01	6.9	**487**	**129**	**186**	47.6	**1,540**	19.7
Oct-01	10.1	**573**	**183**	**165**	44.2	**1,670**	31.6
May-02	11.0 B	**469**	**66.9**	**154**	**55.9** B	**2,040**	30.5 B
Oct-02	7.1	**648**	**164**	**175**	**77.1**	**159**	30.1
May-03	9.8	**498**	36.1	**197**	**101**	**2,070**	21.0
Nov-03	<5.2	**639**	**83.6**	**194**	**76.4**	**2,500**	29.8
May-04	7.2 B	**502**	**75**	**136**	**88.1**	**1,690**	27.8
Nov-04	10.6 B	**617**	**121**	**156**	**65.4**	**2,360**	34.9
Jun-05	8.1 B	**524**	26.3	**159**	NS	NS	15.8
Jan-06	11.0	**567**	**156**	**189**	**154**	**3,320**	23.0

Notes:
Bold Number indicates cleanup level exceedances (MCL cleanup level is 50 ug/L)
B = Value within five times of the greater amount detected in the equipment or preparation blank
J = Estimated value
<5 = Concentration less than the indicated method detection limit
NS = Not Sampled

Table 7-5

Comparison of Historic Iron, Manganese, and Sodium Concentrations (ug/L)
Shelpey's Hill Landfill Compliance Point Wells
Devens, Massachusetts

Historical Concentrations for Iron (MCL is 9,100)

Sample Date	Monitoring Well ID (group designation)													
	SHL-3 (1)	SHL-4 (2)	SHL-5 (1)	SHM-96-5B (2)	SHM-96-5C (2)	SHL-9 (1)	SHL-10 (2)	SHM-93-10C (1)	SHL-11 (2)	SHL-19 (2)	SHL-20 (2)	SHL-22 (1)	SHM-93-22B (2)	SHM-93-22C (1)
May-02	30	1,520	1,110	**40,100**	**49,200**	**19,300**	<17.0	71	**55,400**	**13,900**	7,010	606	**92,000**	916
Oct-02	<22.6	4,380	1,120	**18,700**	44,800	8,430	<22.6	53	**64,500**	**27,600**	**9,100**	707	446	778
May-03	56	2,790	1,140	**37,400**	**78,900**	3,280	47	41	**62,200**	6,740	7,720	626	**88,600**	885
Nov-03	540	1,840	1,720	**32,000**	**63,200**	7,820	<45.0	<45.5	**68,700**	**15,400**	8,190	444	**87,000**	904
May-04	30 B	4,330	1,900	**29,000**	**71,100**	5,680	<19.2	32 B	**60,500**	**13,400**	5,640	541	**59,500**	1,010
Nov-04	<35.5	6,690	2,740	**21,600**	**55,400**	8,580	39 B	48 B	**63,000**	**20,000**	6,630	469	**82,900**	1,340
Jun-05	<37.9	1,220	2,930	NS	NS	NS	<37.9	<37.9	**59,400**	6,680	5,980	NS	NS	572
Jan-06	NS	280	2,600	**39,000**	**100,000**	4,400	<50	490	**57,000**	**13,000**	5,500	650	**70,000**	740

Historical Concentrations for Manganese (MCL is 291)

Sample Date	Monitoring Well ID (group designation)													
	SHL-3 (1)	SHL-4 (2)	SHL-5 (1)	SHM-96-5B (2)	SHM-96-5C (2)	SHL-9 (1)	SHL-10 (2)	SHM-93-10C (1)	SHL-11 (2)	SHL-19 (2)	SHL-20 (2)	SHL-22 (1)	SHM-93-22B (2)	SHM-93-22C (1)
May-02	14 B	**573**	289	**11,000**	**4,110**	**446**	1 B	45 B	**2,010**	**2,280**	**5,950**	**1,370**	**1,680**	**425**
Oct-02	<2.5	**436**	259	**13,000**	**4,110**	**484**	<2.5	47	**1,990**	**3,400**	**7,200**	**1,760**	12	**407**
May-03	2	**843**	273	**9,500**	**4,230**	**364**	1	37	**2,180**	**1,200**	**7,260**	**1,860**	**1,340**	**324**
Nov-03	20	**324**	340	**10,600**	**4,260**	**412**	<1.6	46	**3,030**	**2,100**	**7,760**	**2,110**	**1,950**	**425**
May-04	<1.9	**856**	332	**8,910**	**3,960**	**336**	<1.9	30	**2,340**	**1,510**	**6,560**	**1,960**	**798**	**368**
Nov-04	1 B	**1,240**	**439**	**10,800**	**3,970**	**373**	1 B	48	**2,570**	**2,950**	**5,630**	**2,460**	**1,590**	**385**
Jun-05	2 B	**361**	**476**	NS	NS	NS	2 B	28	**2,380**	**1,090**	**6,270**	NS	NS	218
Jan-06	NS	200	**500**	**7,500**	**4,600**	**310**	<10	60	**2,400**	**980**	**5,500**	**2,600**	**1,700**	250

Historical Concentrations for Sodium (MCL is 20,000)

Sample Date	Monitoring Well ID (group designation)													
	SHL-3 (1)	SHL-4 (2)	SHL-5 (1)	SHM-96-5B (2)	SHM-96-5C (2)	SHL-9 (1)	SHL-10 (2)	SHM-93-10C (1)	SHL-11 (2)	SHL-19 (2)	SHL-20 (2)	SHL-22 (1)	SHM-93-22B (2)	SHM-93-22C (1)
May-02	1,340 B	6,370	2,340 B	**38,600**	**34,000**	2,380 B	1,380 B	8,620	**27,600**	2,570 B	**34,000**	**43,700**	**35,900**	18,800
Oct-02	1,570	2,840	2,180	**36,200**	**35,400**	2,560	1,520	8,180	**29,800**	4,240	**35,600**	**45,500**	**114,000**	19,500
May-03	1,220	2,380	2,340	**32,600**	**32,000**	2,080	950	8,990	**31,100**	1,600	**36,800**	**43,400**	**37,300**	14,200
Nov-03	1,360 B	13,400	2,030 B	**33,500**	**34,800**	2,310 B	1,280 B	8,370	**27,000**	2,670	**35,800**	**42,700**	**36,300**	17,400
May-04	1,060 B	5,390	2,040 B	**31,000**	**30,000**	1,620 B	1,020 B	8,650	**22,500**	2,300 B	**33,300**	**40,900**	**56,900**	15,100
Nov-04	684 B	4,060	1,870 B	**32,200**	**32,200**	1,550 B	845 B	8,190	**22,800**	2,280 B	**31,900**	**41,900**	**34,300**	16,100
Jun-05	696	7,190	3,240 B	NS	NS	NS	841 B	7,840	**21,600**	1,470 B	**32,000**	NS	NS	9,910
Jan-06	NS	<2,000	2,500	**28,000**	**40,000**	2,000	<2,000	9,500	**24,000**	<2,000	**29,000**	**40,000**	**31,000**	13,000

Notes:
Bold Number indicates cleanup level exceedances (MCL cleanup level is 50 ug/L)
B = Value within five times of the greater amount detected in the equipment or preparation blank
<5 = Concentration less than the indicated method detection limit
NS = Not Sampled

Table 7-6
Monitoring Well Chemical Cleanup Level Exceedances At Monitoring Wells Previously Attaining Cleanup Goals (Group 1)
Shepley's Hill Landfill
Devens, Massachusetts

Monitoing Well Identification	**Well Designation** (Based on First Five-Year Review, SWEC, 8/98)	**Exceedances of Cleanup Levels for Triggering Chemicals, Since Achieving Group 1 Status**
SHL-3	Group 1	None
SHL-4	Group 2	Not Applicable
SHL-5	Group 1	None
SHL-9	Group 1	71.3 ug/L As (Spring 1999) 144 ug/L As (Spring 2002)
SHL-10	Group 2	Not Applicable
SHL-11	Group 2	Not Applicable
SHL-19	Group 2	Not Applicable
SHL-20	Group 2	Not Applicable
SHL-22	Group 1	55.9 B ug/L As (Spring 2002) 77.1 ug/L As (Fall 2002) 101 ug/L As (Spring 2003) 76.4 ug/L As (Fall 2003) 88.1 ug/L As (Spring 2004) 65.4 ug/L As (Fall 2004) 154 ug/L As (Winter 2005)
SHM-93-10C	Group 1	None
SHM-93-22C	Group 1	51.1 ug/L (Fall 1998)
SHM-96-5B	Group 2	Not Applicable
SHM-96-5C	Group 2	Not Applicable
SHM-96-22B	Group 2	Not Applicable

Notes:
As = Arsenic
B = Value was withing five times of the greater amount detected in the equipment or preparation blank samples

Table 8-1
Sample Preparation and Analysis Methods,
Containers, Holding Times, and Preservatives
Shepley's Hill Landfill
Devens, Massachusetts

Parameters	Analysis Method		Sample Container	Minimum Volume	Preservative	Holding Time
	Jun-05	Jan-06				
Volatile Organic Compounds	SW846 8260B	SW846 8260B	3 x 40 mL Vials with Teflon septa screw caps	40 mL	HCl to pH <2 No Headspace 4° +/- 2° C	14 Days
Metals, except Cyanide Mercury Hardness	SW846 6010B EPA Method 335.4 SW846 7470A SM 2340B	SW846 6010B SM 9014 SW846 7470A SM 2340B	1 Liter HDPE	300 mL	HNO3 to pH <2	180 Days (except Hg) 28 Days Hg
Cyanide	EPA Method 335.4	SM 9014	500 ml HDPE	500 mL	NaOH to pH >12 4° +/- 2o C	14 Days
Anions	EPA 160.1	SM 2540C	500 mL HDPE	100 mL	4° +/- 2° C	
Chloride	EPA 300.0	SM 9251				28 Days
Nitrate as N	EPA 300.0	SM 4500NO3-F				48 Hours
Sulfate	EPA 300.0	SM 9038B				28 Days
Alkalinity	EPA 160.2	SM 2540D				14 Days
Total Dissolved Solids	EPA 160.1	SM 2540C				48 Hours
Chemical Oxicdation Demand	EPA 410.1	SM 5220D	250 mL HDPE	250 mL	H2SO4 to pH <2 4° +/- 2o C	28 Days
Biochemical Oxidation Demand - 5 Day	EPA 405.1	SM 5210B	1 Liter HDPE	1 Liter	4° +/- 2° C	48 Hours
Total Suspended Solids	EPA 160.2	SM 2540D	1 Liter HDPE	1 Liter	4° +/- 2° C	7 Days
Total Organic Carbon	SW 846 9060	SW 846 9060	3 x 40 mL Vials with Teflon septa screw caps	40 mL	H2SO4 to pH <2 4° +/- 2o C	28 Days

Figures

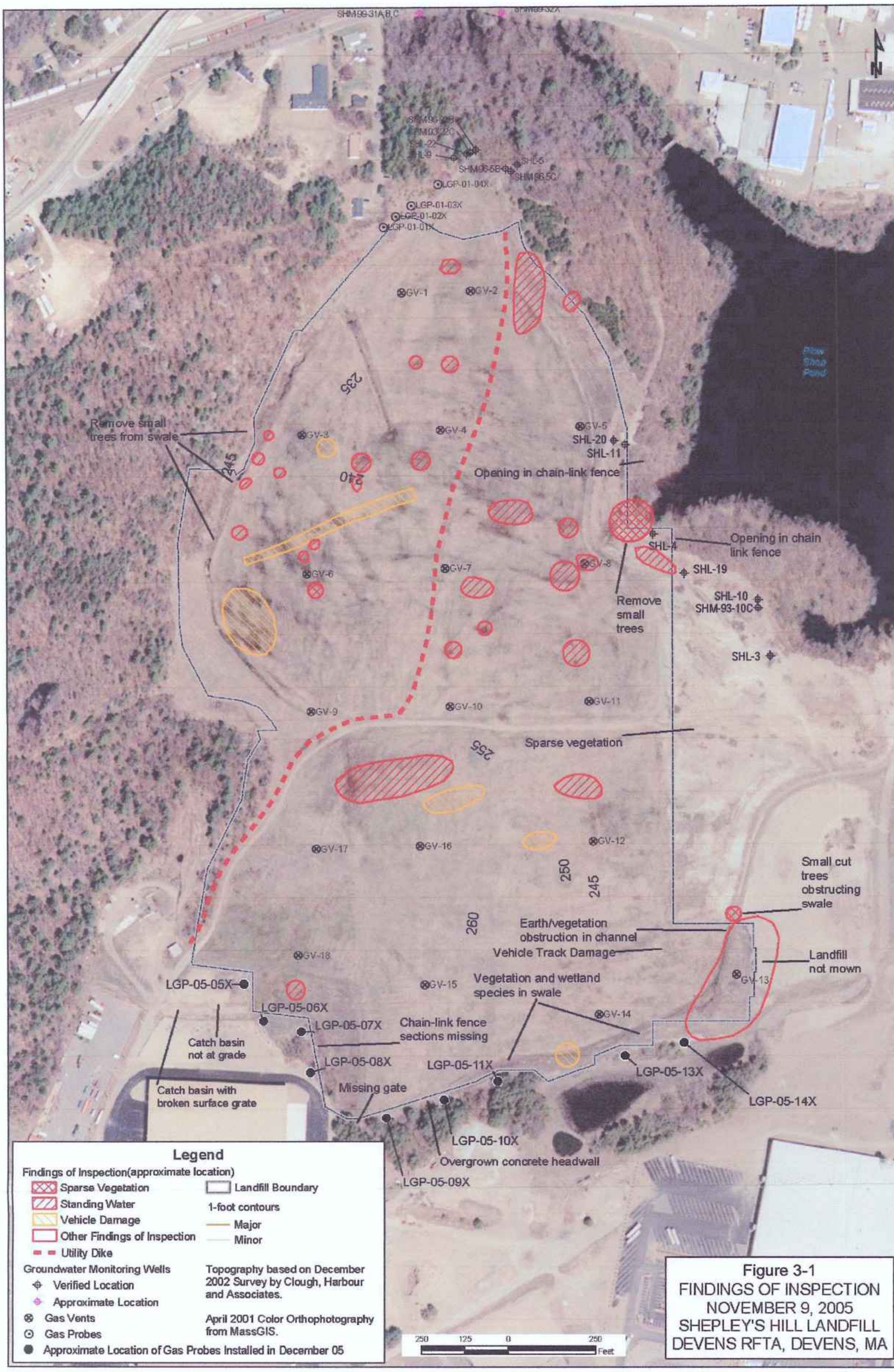
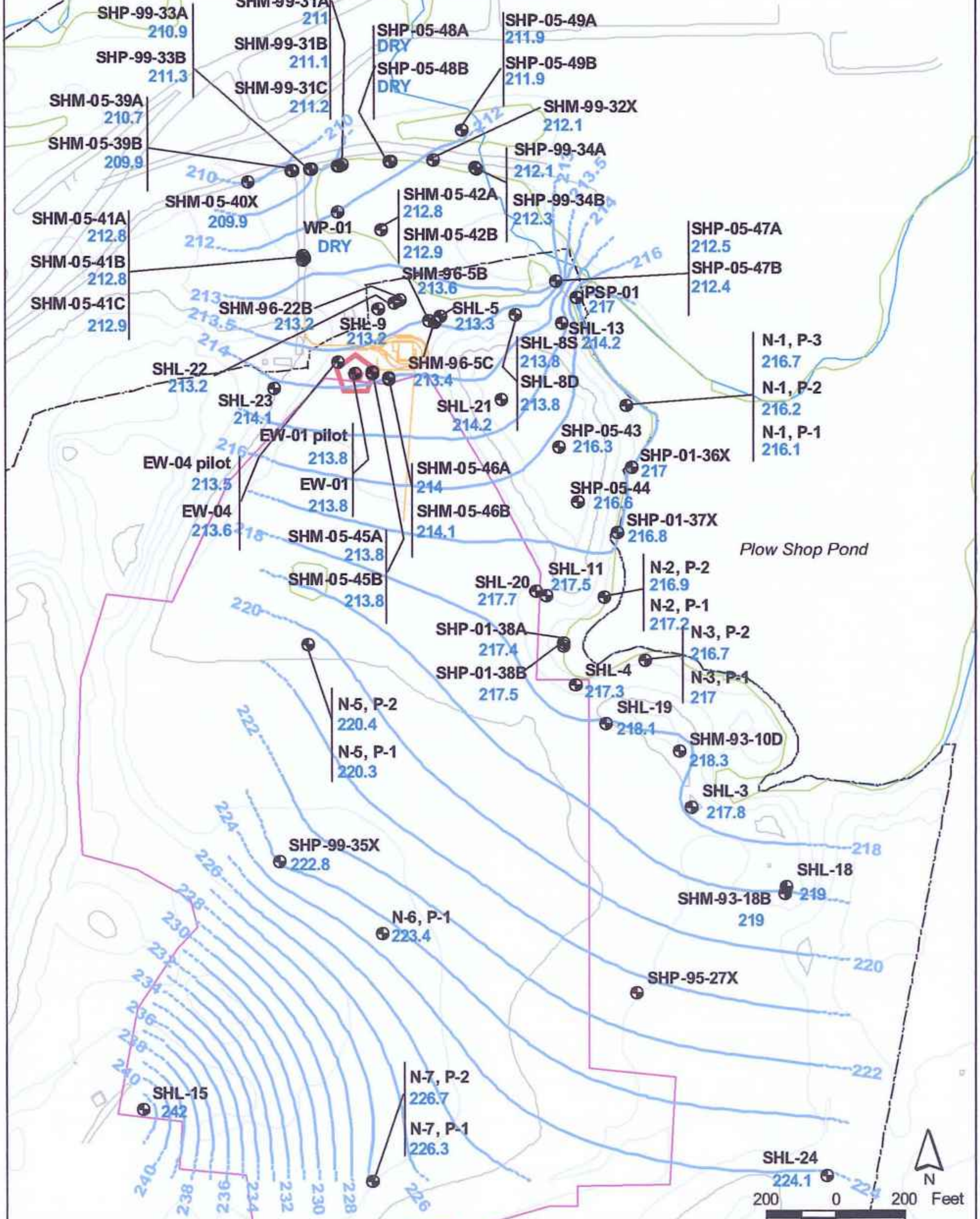


Figure 3-1
FINDINGS OF INSPECTION
NOVEMBER 9, 2005
SHEPLEY'S HILL LANDFILL
DEVENS RFTA, DEVENS, MA



LEGEND

Estimated Groundwater Elevation Contour (dashed where inferred; in feet above mean sea level)

SHL-15 ← Location ID
242 ← Groundwater Elevation
Well, Piezometer, or Stage Board

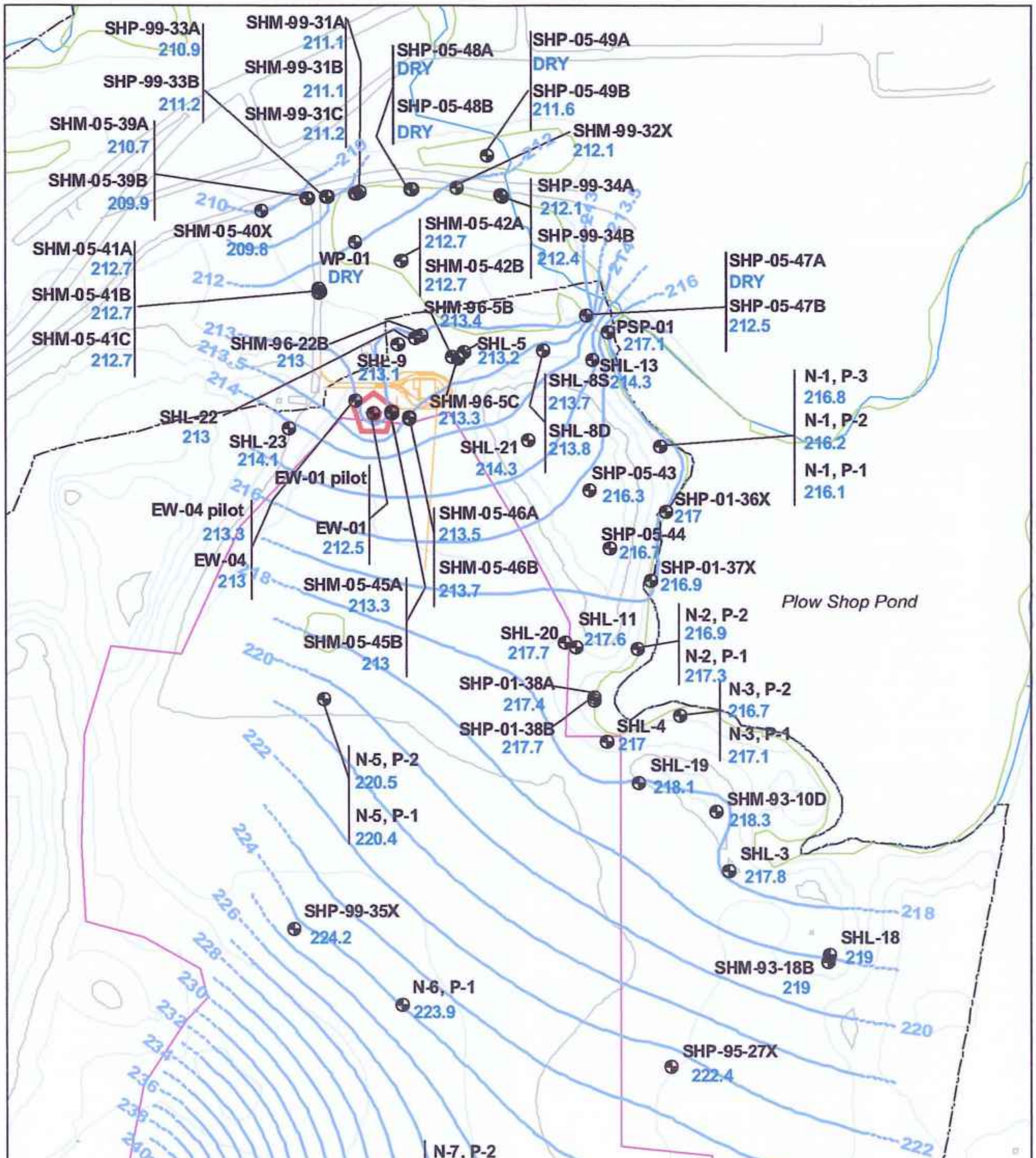
Test Well EW-01

Figure 5-1
Contour Map of Baseline (Pre-Test) Groundwater Elevations Measured on August 24, 2005

Shepley's Hill Landfill, Fort Devens, MA

Contour Interval = 1 foot (except where noted)

CH2MHILL



LEGEND

Estimated Groundwater Elevation Contour (dashed where inferred; in feet above mean sea level)

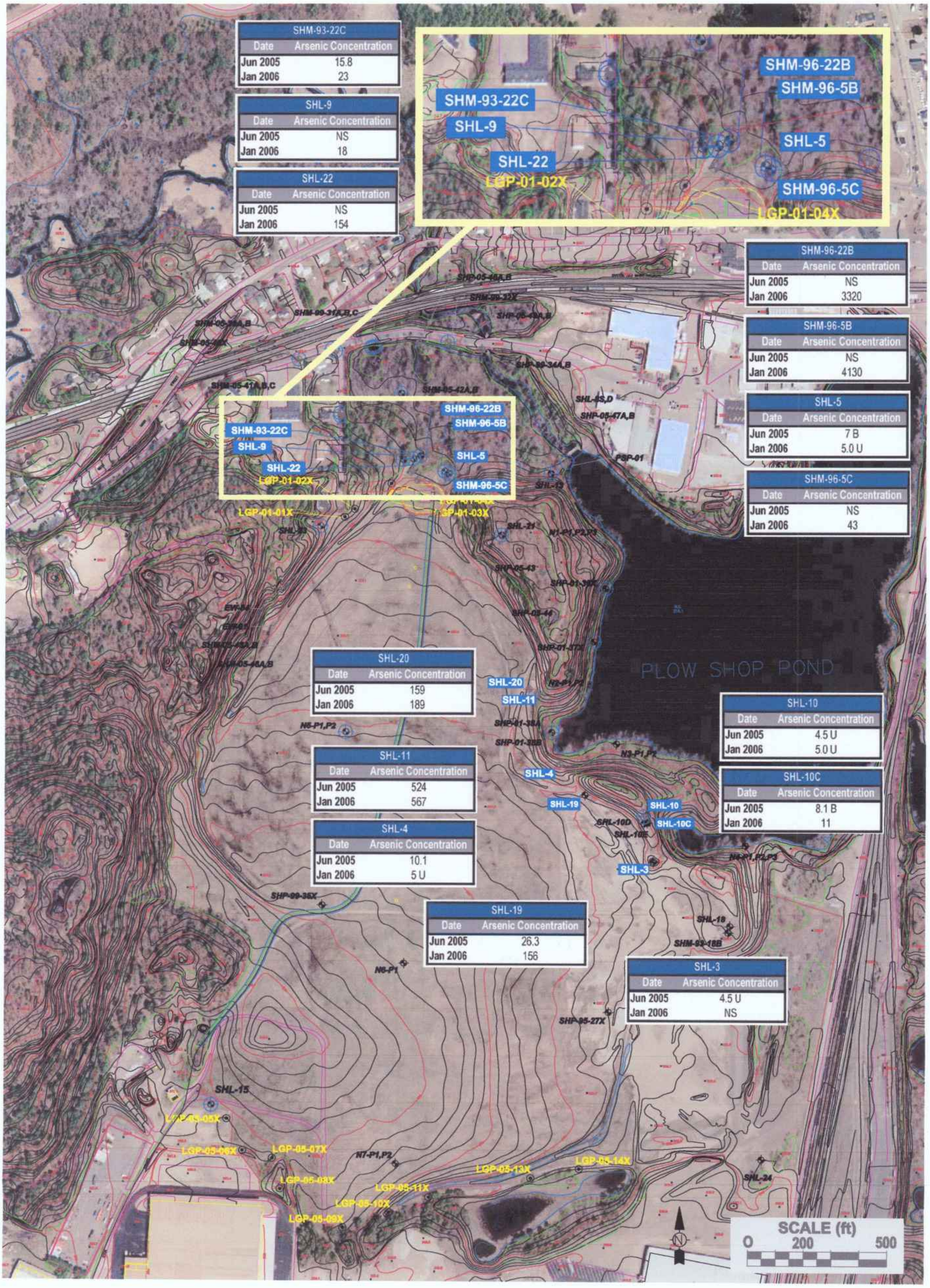
SHL-15 ← Location ID
242 ← Groundwater Elevation
Well, Piezometer, or Stage Board

Test Well EW-01

Figure 5-3
Contour Map of Groundwater Elevations at Maximum Drawdown Measured on August 26, 2005
August 25, 2005 Aquifer Pumping Test
Shepley's Hill Landfill, Fort Devens, MA

Contour Interval = 1 foot (except where noted)

CH2MHILL



LEGEND

Long Term Monitoring Network (SHL-9)

Permanent Gas Monitoring Probes (LGP-05-05X)

Note: Contingency Remedy performance monitoring network included for reference. Includes Hydraulic and Geochemistry monitoring.

CH2MHILL

FIGURE 7-1
Long Term Monitoring Network

Appendix A

Geotechnical Engineering Fall 2005 Annual Inspection Report

US Army Corps
of Engineers®
New England District

GEOTECHNICAL ENGINEERING FALL 2005 ANNUAL INSPECTION REPORT

SHEPLEY'S HILL LANDFILL
FORMER FORT DEVENS
DEVENS, MASSACHUSETTS

March 2006

1.0 BACKGROUND

Shepley's Hill Landfill encompasses approximately 84 acres in the northeast corner of the main post of the former Fort Devens, Massachusetts (Figure 1). The landfill is bordered to the northeast by Plow Shop Pond, to the north by Nonacoicus Brook (which drains the pond), to the west by Shepley's Hill, to the south by recent commercial development, and to the east by the site of a former railroad roundhouse.

The landfill was reportedly operating by the early 1940s, and evidence from test pits within the landfill suggests earlier usage, possibly as early as the mid-nineteenth century. The landfill contains a variety of waste materials, including incinerator ash, demolition debris, asbestos, sanitary wastes, spent shell casings, glass, and other wastes. The maximum depth of the refuse occurs in the central portion of the landfill and is estimated to be about 40 feet. The volume of waste in the landfill has been estimated at over 1.3×10^6 cubic yards (cy), of which approximately 25 percent is below the water table.

The landfill was closed in five phases between 1987 and 1992-93 in accordance with Massachusetts regulations 310 CMR 19.000 (1985). The Massachusetts Department of Environmental Protection (MADEP) approved the closure plan in 1985. Closure consisted of installing a 30/40-mil polyvinyl chloride (PVC) membrane cap, covered with soil and vegetation and incorporating gas vents. Closure also included installation of wells to monitor groundwater quality around the landfill, and construction of a storm drainage system to control surface water runoff. MADEP issued a Landfill Capping Compliance Letter approving the closure in February 1996.

The ROD outlined the remediation objectives for the site (USEPA, 1995). It requires the Army to monitor groundwater, inspect and maintain the landfill, and prepare annual reports. It also requires that the Army review the effectiveness of the remedy every five years.

2.0 LANDFILL CAP MONITORING ACTIVITIES

The Shepley's Hill Landfill at Devens, Massachusetts was inspected on 8 and 9 November 2005 by personnel from the U.S. Army Corps of Engineers, New England District (NAE). Features of the landfill inspected included the cap, the drainage system, the gas vent system, access roads, and the security fence. Observations were made regarding the vegetative cover, vegetation types, erosion, settlement, and general condition of the various features. A comprehensive site assessment is currently being conducted to assess the effectiveness of the landfill cap. Appendix A of this report contains the Landfill Maintenance Checklist that summarizes the findings of this inspection. All observations are also presented on Figure 1. A narrative of the findings of this inspection follows.

- Catch Basin #3 near the Cooke Street entrance to the site is not set at grade. Soil excavation in this area has left the rim of the grate about six to eight inches higher than the surrounding ground. The rim of this catch basin should be lowered to the surrounding grade.

- The concrete headwall drainage structure at the terminus of the catch basin and underground conduit system on the south side is overgrown with vegetation and is silting in (Photo 1). The grade of the channel bottom is uneven and standing water is present. Wetland species are becoming established as well. The entire southern swale should be cleared, accumulated sediment should be removed, and the channel should be regraded as required to properly drain. The channel should then be revegetated.

- Ponded areas of standing water are present at numerous locations across the landfill surface. See Figure 1 and Photos 2, 3 and 5.

- The northern reaches of the eastern drainage swale have some minor vegetation growth and sand accumulation. The swale should be cleared of vegetation and sand.

- East of gas vents 8, 11 and 12, the perimeter of the cap has some areas of erosion and sparse vegetation. The soil in these areas is comprised predominantly of sand. The areas should be graded to fill in the eroded areas and topsoil should be placed to a depth of 6 inches over the sand to allow grass to grow. The grass should extend at least twenty feet past the limits of the cap.

- The access roads on the site are in good condition. There are no problems on access roads that warrant repair at this time.

- Portions of the perimeter chain-link security fence are in poor condition. Fence sections and gates are missing and unrestricted access to the site is available at several locations. Some evidence of off-road vehicles (trucks, ATV's, dirt bikes, etc. see photo 3) using the cap area was seen. On the east side near monitoring well SHL-11, the fence has been rolled back and is open. A gate and lock should be added here if permanent access is required. There are also several other locations around Plow Shop Pond (see Photo 4) which provide unrestricted access. The security fence should be repaired, with all missing fence sections, including gates, replaced or repaired.

- The gas monitoring probes at the northwest edge of the landfill are in excellent condition, with locked, steel caps. The gas vents are in good condition. All screens and pipes are in functional condition. The older gas vents, painted yellow, are showing signs of age, with rusting/corrosion evident (See Photo 7). They should be scraped, cleaned, and repainted.

- A summary of Corrective Action measures for the Landfill Cap are included in Section 4.0.

3.0 LANDFILL GAS MONITORING RESULTS

The purpose of the landfill gas monitoring program is to establish long-term trends with regard to gas production and venting. A combustible gas survey was performed to determine whether methane, hydrogen sulfide, or volatile organic compounds have accumulated in the subsurface of the landfill site or are migrating off-site. Four landfill perimeter gas monitoring probes were installed on 7 November 2001 on the northern side of the landfill. The purpose of the probes is to monitor potential landfill gas migration from Shepley's Hill Landfill towards Sculley Road. Following this inspection, ten more probes were installed on the the southern perimeter of the landfill and will be available for the next annual report

The annual landfill gas sampling was conducted on 8 and 9 November 2005. The weather was sunny, with temperatures in the 50's (F) and the barometric pressure was 29.9 inches of mercury and rising. Gas samples were field analyzed for the following parameters using the listed equipment:

Parameter	Equipment
Total Volatile Organic Compounds (VOC)	Thermo Environmental 580B (PID) with a 10.6 eV lamp
Percent Oxygen	Landtec GEM 500 landfill gas monitor
Hydrogen Sulfide (ppm)	Industrial Scientific TMX 412 CGI
Percent Lower Explosive Limit (LEL)	Industrial Scientific TMX 412 CGI
Carbon Monoxide (ppm)	Industrial Scientific TMX 412 CGI
Percent Carbon Dioxide	Landtec GEM 500 landfill gas monitor
Percent Methane	Landtec GEM 500 landfill gas monitor

The TMX 412, PID and the GEM 500 were all calibrated in the shop by U.S. Environmental. Samples were collected by attaching a rubber Quik cap with a hose clamp to the gas vent pipe. A barbed fitting was placed in a drilled hole in the cap. Tubing was run from the barbed fitting to a SKC224-PCXRE air pump. The pump was operated for approximately 7 to 10 minutes to purge 2 vent pipe volumes and to ensure that the gases collected were representative of the gas collection layer. The gas monitoring equipment was then attached to the pump and turned on. The readings were recorded on the Landfill Gas Monitoring form (Appendix B) after they had stabilized. The locations of the gas vents are shown in Figure 1.

The results from the monitoring event can be found on Table 1 in Appendix B. The following is a brief summary of the results. The perimeter landfill gas monitoring probes (LGP-01, LGP-02, LGP-03, LGP-04) tested negative for VOC's, hydrogen sulfide, carbon monoxide, and methane. Minimal levels of carbon dioxide were detected, ranging from 0.6 % at LGP-04 to 2.2 % at LGP-02. Oxygen levels ranged from 19.2 % at LGP-02 to 20.3% at LGP-01 and LGP-04.

The following summarizes the gas vent readings. VOCs were not detected in any of the gas vents. The oxygen levels ranged from 0% (Vent # 9, 16,17) to 21.0% (Vent # 15) using the GEM 500. No hydrogen sulfide was detected in any of the gas vents. Methane LEL readings ranged from 0% at V-15 and V-18 to over 100% LEL in many of the vents. No carbon monoxide was detected in any of the gas vents except for V-16 and V-17, which had readings of 2 and 3 ppm, respectively. Carbon dioxide ranged from 0 % (Vent # 15, 18) to 27.0 % at Vent #17. Methane ranged from 0 % (Vent # 15,18) to 32.7 % at Vent #17.

The gas readings are within the parameters of a mature landfill. The vents are functioning properly. The scenario of high atmospheric pressure to low atmospheric pressure results in a venting of landfill gas into the atmosphere. The scenario of low atmospheric pressure to high atmospheric pressure results in air intrusion into the upper portion of the landfill. The scenario during this inspection was most likely the latter, as barometric pressure was rising during the inspection. The major concern with landfill gas is off-site migration. If the gas vents are functioning properly and are adequately spaced there should not be off-site migration of landfill gases; however, due to the high LEL readings and the proximity of residential housing and commercial development, gas monitoring probes should be installed along the property line where the landfill is adjacent to structures (note that this has been done at the northern end near Sculley Road). Gas monitoring probes should also be installed at the southern perimeter of the site along the commercial properties. The LEL readings along the southern perimeter have consistently registered high LEL readings in the past, and were sometimes above 100%. As of the date of this inspection, 10 landfill gas probes were planned to be installed on the southern perimeter of the landfill and will be available for analysis for the next annual inspection.

4.0 CORRECTIVE ACTION

An upcoming Comprehensive Site Assessment will assess the adequacy of the landfill. Following the CSA, a Corrective Action Alternatives Analysis will be conducted to identify any remedial repairs required. Implementation of the selected options (if required based on the outcome of the CAAA) should improve the drainage and function of the landfill cap. The following items should be addressed before the next inspection or as provided for in the final recommendations in the report cited above: (1) Repair and replace the security fence and gates as required to control access to the site; (2) Place topsoil and seed over the sandy area lacking vegetation on the east side along the perimeter of the cap. Along with the corrective actions listed above, it is recommended to (1) Install additional landfill gas monitoring probes along the commercial property at the south side of the landfill (the probes were installed in November 05, after this inspection) (2) Repair and regrade around the catch basins on the south side of the landfill. With the exception of the repairs mentioned above, and the other repairs recommended in the report, the landfill is in fair condition and appears to be functioning adequately.

FIGURE

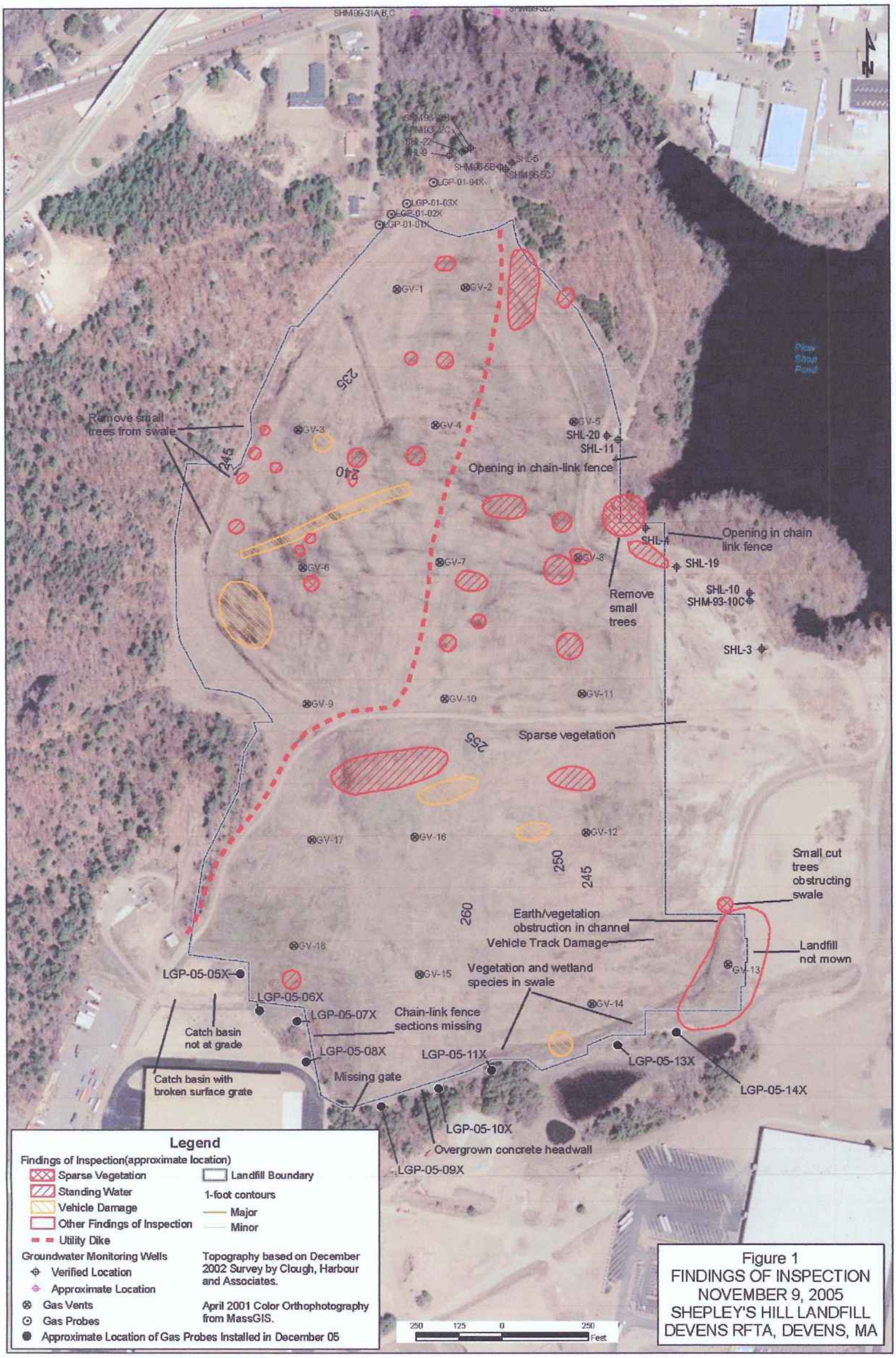


Figure 1
FINDINGS OF INSPECTION
NOVEMBER 9, 2005
SHEPLEY'S HILL LANDFILL
DEVENS RFTA, DEVENS, MA

PHOTOGRAPH LOG

Index of Photographs

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Geotechnical Engineering
Shepley's Hill Landfill
Fall 2005 Annual Inspection Report

Photo 7

APPENDIX A

Inspection & Maintenance Check List

Geotechnical Engineering
Shepley's Hill Landfill
Fall 2005 Annual Inspection Report

DATE: 8 November 2005
INSPECTOR: Kullberg/Michalak

LANDFILL ATTRIBUTE	OBSERVATIONS	RECOMMENDATIONS	SAT/ UNSAT
Cover Surface	1. Vegetative cover is generally satisfactory except as noted in the comments that follow. Various species growing; mowed to about 8 inches height (see Photo 6).	1. See specific comments under the sections that follow.	SAT
	2. There are several areas where settlement has occurred.	2. A Comprehensive Site Assessment (CSA) is being conducted to address this condition.	SAT
	3. Trees were removed in the fall of 2002 & 2004 in the vicinity of GV-13, the southern perimeter, and the eastern perimeter, and have not reestablished.	3. Monitor for tree growth in future	SAT
	4. A utility berm was constructed through the middle of the landfill in 2004. It provides utility service to a newly constructed pumping station at the northeastern corner of the landfill.	4.Observe effect on drainage patterns in the vicinity of the utility berm during future inspections. This may be investigated as part of the ongoing CSA.	NA
	5. Several areas on the landfill have sustained damage by trespassing vehicles, and in some cases damage by lawn mowing equipment (Photo 3).	5. Damaged areas should be repaired as soon as possible.	UNSAT
Vegetative Growth	1. In the vicinity of gas vents 8, 11 and 12, the perimeter of the cap has some areas of sparse/eroded vegetation. The soil in the bare areas is mostly sand and is eroded in some areas. The area should be graded to fill in the eroded areas and topsoil should be placed to a depth of 6 inches over the sand to allow grass to grow. The grass cover should extend at least twenty feet beyond the limits of the cap.	1. This area should be reseeded, with hay or straw placed on the surface, to prevent further erosion. This area to be considered as part of the CSA.	UNSAT
Landfill Gas Vent Wells	1. The gas vents are in good condition. All screens and pipes are in functional condition. All of the non-galvanized vents are showing signs of rusting and corrosion. These include all gas vents except for V-12 through V-15.	1. All of the nongalvanized vents should be scraped, cleaned and painted.	SAT

LANDFILL ATTRIBUTE	OBSERVATIONS	RECOMMENDATIONS	SAT/ UNSAT
Drainage Swales	1. Most of the drainage swale on the south side is being invaded by vegetation/wetland species. There are also intermittent zones of standing water indicating a lack of proper channel slope and drainage.	1. The swale should be cleared of vegetation, accumulated sediment, and debris. The swale should then be regraded to promote adequate drainage.	UNSAT
	2. In the south east side drainage swale, in the vicinity of gas vent #13 and continuing downstream to the rip rap - lined channel, the drainage swale is overgrown with vegetation and wetland species. It appears to be heavily silted in and has a large area of standing water. There is an earth and vegetation obstruction just upstream of the new rock section preventing the drainage of water and turning the channel into a pond.	2. The swale should be cleared of vegetation, accumulated sediment, and debris. The swale should then be regraded to promote adequate drainage.	UNSAT
Culverts	1. The concrete drainage structure at the terminus of the catch basin and underground conduit system on the southwest side is overgrown with vegetation and is silting in. Standing water is present and wetland species are becoming established as well.	1. The structure and channel immediately downstream should be cleaned out and the channel regraded as required to properly drain.	UNSAT
Catch Basins	1. Catch Basin #2 near the entrance to the site has a broken surface grate.	1. The surface grate should be replaced.	UNSAT
	2. Catch Basin #3 near the entrance to the site is not set at grade. The rim of the basin is about six to eight inches higher than the surrounding ground.	2. The rim of this catch basin should be lowered to meet the surrounding grade.	UNSAT

Settlement	1. It appears that many areas of the landfill may be settling. The extent and its effect on the function of the landfill is unknown	1 A Comprehensive Site Assessment is underway to address this condition.	SAT
Erosion	1. No substantial erosion observed.		SAT
Access Roads	1. The access roads on the site are in good condition.	1. There are no problems on access roads which warrant repair at this time.	SAT
Security Fencing	1. The perimeter chain-link security fence is in poor condition. Fence sections and gates are missing and unrestricted access to the site is available at many locations. Some damage to the cap by off-road vehicles (trucks, ATV's, dirt bikes, etc.) using the turfed cap areas was observed.	1. The security fence should be repaired/replaced and extended. This work is currently planned under the maintenance work underway at the landfill.	UNSAT
Wetland Encroachment	1. Wetland encroachment is taking place at several locations, but is not happening on a wide scale. Overall, the areas of encroachment are small. These locations have been noted in above comments.	1. Wetland encroachment should be eliminated by simple mowing in some areas, and by regrading channels in other areas. The above comments address the actions to take at specific locations. A CSA is underway to address this concern at the landfill.	UNSAT

Immediate Action Required: The following problem areas, from among those mentioned in the comments above, are the most critical and should be addressed before the next inspection;

(1) Repair and replace the security fence and gates as required to control access to the site;
(2) Repair damage to cap caused by trespassers and lawn mowing equipment.

SAT – Satisfactory
UNSAT- Unsatisfactory
NA – Not Applicable

APPENDIX B

Landfill Gas Monitoring

APPENDIX B
Landfill Gas Monitoring
Table 1

INSPECTOR: Kullberg/ Michalak TITLE: Civil Engineer DATE: 11/08/05

ORGANIZATION: CENAE-EP WEATHER: Sunny, 55 d F BAROMETER: 29.9 in Hg and rising.

Vent No.	VOC ppm PID	O_2 % GEM 500	H_2S ppm ISTMX	LEL % ISTMX	CO ppm ISTMX	CO_2 % GEM 500	CH4 % GEM 500	Remarks
V-1	0	5.6	0	32	0	10.8	1.7	CGI O2 – 6.9
V-2	0	5.2	0	>100	0	12.8	8.6	CGI O2 – 13.4
V-3	0	2.8	0	>100	0	15.1	9.0	CGI O2 – 3.6
V-4	0	6.4	0	50	0	10.6	4.3	CGI O2 – 12.7
V-5	0	10.4	0	11	0	7.7	1.4	CGI O2 – 17.1
V-6	0	0.4	0	>100	0	18.9	12.5	CGI O2 – 12.9
V-7	0	2.1	0	14	0	12.2	4.4	CGI O2 – 17.6
V-8	0	8.3	0	25	0	8.9	4.2	CGI O2 – 15.8
V-9	0	0	0	>100	0	21.8	26.4	CGI O2 – 9.0
V-10	0	0.6	0	>100	0	14.8	10.3	CGI O2 – 9.3
V-11	0	10.1	0	12	0	6.4	2.2	CGI O2 – 18.4
V-12	0	2.8	0	>100	0	9.4	6.4	CGI O2 – 4.7
V-13	0	20.2	0	25	0	0.5	0.5	CGI O2 – 19.1
V-14	0	20.7	0	6	0	0.2	0.3	CGI O2 – 20.9
V-15	0	20.9	0	0	0	0	0	CGI O2 – 21.0
V-16	0	0	0	>100	2	23.7	20.7	CGI O2 – 0.3
V-17	0	0	0	>100	3	27	32.7	CGI O2 – 0.2
V-18	0	21.0	0	0	0	0	0	CGI O2 – 20.9
LGP-1	0	20.3	0	0	0	0.7	0	CGI O2 – 20.7
LGP-2	0	19.2	0	0	0	2.2	0	CGI O2 – 19.6
LGP-3	0	19.5	0	0	0	1.7	0	CGI O2 – 20.1
LGP-4	0	20.3	0	0	0	0.6	0	CGI O2 – 20.5

CALIBRATION INFORMATION:
Instrument: Thermo Environmental 580B PID 10.6 SN#: 182
Calibrated by: US Environmental Rental Co. 7 November 2005
Calibrated With: 100 ppm isobutylene (R.F. = 1.0)

Instrument: Industrial Scientific TMX412 SN#: 98090009-447
Sampling Pump: Industrial Scientific Sampling Pump SP402 SN#: 9911050-292
Calibrated by: US Environmental Rental Co. 8 November 2005
Calibrated With: 50 ppm CO, 25 H_2S, 50% LEL Methane, 20.9% O_2

Instrument: Landtec GEM 500 Serial#: E-0904
Calibrated by: US Environmental Rental Co. 7 November 2005
Calibrated With: 15% CH_4, 15% CO_2, 20.9% O_2

* Note: Barometric Pressures were obtained from NOAA National weather Service Forecast Office Boston, MA at http://www.erh.noaa.gov/box/stationobs.shtml for the nearest available reporting station at the airport in Fitchburg, MA for the sample date 8 November 2005.

APPENDIX C
Landfill & Gas Probe Supplemental Inspection

1.0 PURPOSE

Perimeter gas probes were installed (Photo 2) on the southern border of the landfill in December 2005 and were sampled for gas levels on February 16, 2006. This supplemental inspection appendix presents the gas level readings recorded, documents the installation of new perimeter fencing at Shepley's Hill Landfill, and documents some damage to the access roads at SHL which occurred during the recent maintenance contract work.

2.0 FENCING AND ACCESS ROADS

New chain link fencing was installed during recent maintenance work at the landfill. On the south side near the former Web Van warehouse, a section of fencing was constructed at a location of unrestricted access (Photo 3). Two other sections of fencing and gates were added on the south and west sides of Plow Shop Pond where the fence had been rolled back for access (Photos 4 & 5). The fencing appeared to be in excellent condition and will help minimize unauthorized access to the landfill by pedestrians and vehicles.

During the recent maintenance work, the access roads were slightly damaged by rutting and erosion (Photos 1 & 6). The access roads should be regraded, gravel added if necessary, and revegetated on the perimeter.

3.0 GAS PROBE READINGS

INSPECTOR: Kullberg/ Michalak TITLE: Civil Engineer DATE: 02/16/06

ORGANIZATION: CENAE-EP WEATHER: Sunny, 55 d F

BAROMETER: 30.1 in Hg @ 1030 BAROMETER: 30.0 in Hg @ 1200

Probe Number	VOC ppm PID	O_2 % GA90	H_2S ppm MG140	LEL % MG140	CO ppm MG140	CO_2 % GA90	CH4 % GA90	Remarks
LGP-5	0.2	20.6	0	0	0	0.3	0	CGI O2 – 20.7
LGP-6	0.7	20.6	0	0	0	0	0	CGI O2 – 21.0
LGP-7	0.2	11.6	0	1	0	3.8	0	CGI O2 –12.4
LGP-8	0.2	11.9	0	2	0	10.7	0	CGI O2 – 13.8
LGP-9	0	12.5	0	2	1	5.9	0	CGI O2 –13.2
LGP-10	0	15.5	0	0	0	7.6	0	CGI O2 – 19.5
LGP-11	0.2	17.8	0	0	0	3.9	0	CGI O2 –18.4
LGP-12	x	x	x	x	x	x	x	Not Installed
LGP-13	0.4	17.0	0	0	0	2.4	0	CGI O2 – 19.2
LGP-14	0.9	8.2	0	0	2	3.2	0	CGI O2 – 9.0

CALIBRATION INFORMATION:
Instrument: Thermo Environmental 580B PID 10.6 SN#: 237
Calibrated by: US Environmental Rental Co. 15 February 2006
Calibrated With: 100 ppm isobutylene (R.F. = 1.0)

Instrument: Industrial Scientific MG 140 SN#: 01044002-134
Sampling Pump: Industrial Scientific Sampling Pump SP402 SN#: 0004373-050
Calibrated by: US Environmental Rental Co. 15 February 2006
Calibrated With: 50 ppm CO, 25 H_2S, 50% LEL Methane, 20.9% O_2

Instrument: Landtec GA90 Serial#: G1457
Calibrated by: US Environmental Rental Co. 15 February 2006
Calibrated With: 15% CH_4, 15% CO_2, 20.9% O_2

4.0 Photographs

PHOTO 1

PHOTO 2

PHOTO 3

PHOTO 4

PHOTO 5

PHOTO 6

Appendix B

Groundwater Field Analysis Forms

June 2005 Monitoring

U. S. Army Corps of Engineers GROUNDWATER LEVEL MEASUREMENT SHEET

SITE INFORMATION

Site Name: Shepley's Hill Landfill
Location: Devens, MA
Date: 06 June 2005

Project Name: Long Term Monitoring &Maint
Personnel: Jack Keenan, Tom Markotte

WEATHER CONDITIONS AND EQUIPMENT

Temperature Range: 70's
Precipitation: drizzle early
Tidally-Influenced [ ] Yes [x] No

Equipment No.:
Barometric Pressure: 30.0"

Monitoring Well	Date/Time	Reference Point	Elevation of Reference Point (feet NGVD)	Water Level Indicator Reading (feet)	Groundwater Elevation (feet NGVD)
SHL-3	1135	top of casing	248.5 (top of cas.)	29.75	218.75
SHL-4	1220	top PVC	228.71	10.05	218.66
SHL-5	1520	top PVC	218.53	2.59	215.94
SHL-9	1532	top PVC	222.84	7.51	215.33
SHL-10	0845	top PVC	248.76	30.35	218.41
SHL-11	1513	top PVC	236.34	18.28	218.06
SHL-19	1320	top PVC	241.34	22.19	219.15
SHL-20	1510	top PVC	236.84	18.62	218.22
SHL-22	1537	top PVC	220.45	5.24	215.21
SHM-93-10C	0845	top PVC	248.42	28.86	219.56
SHM-93-22C	1536	top PVC	221.55	6.30	215.25
SHM-96-5B	1529	top PVC	219.81	4.36	215.45
SHM-96-5C	1527	top PVC	219.25	3.88	215.37
SHM-96-22B	1540	top PVC	220.27	5.10	215.17

U.S. Army Corps of Engineers
Groundwater Sampling Log Sheet
Project Name: Shepley's Hill Landfill, Devens, MA

GWM WELL # SHL-3

SCREEN INTERVAL DEPTH: 25.1 - 35.1' (top of casing) WELL DIAMETER: 2 in

H2O LEVEL: DEPTH, PRE PUMP INSERTION 29.75

DEPTH, POST PUMP INSERTION 29.70

DEPTH SAMPLED: 33.0

REFERENCE POINT: PVC OR CASING (circled: CASING) NGVD

(DEPTHS RECORDED BENEATH)

DATE: 6 June 2005 TIME: 1135

RECORDED BY: JK SS AG TM (circled: TM) SIGNATURE: Thomas J. Marcotte

SAMPLED BY: JK SS AG TM (circled: TM) SIGNATURE: Thomas J. Marcotte

SAMPLE METHOD: EPA LOW STRESS METHOD

Metals/Hardness 1 x 1L HDPE (HNO3)
Cyanide 1 x 250ml HDPE (NaOH)
Anions,Alkalinity,TDS 1 x 500ml HDPE
TSS 1 x 1L HDPE
VOC'S 3 x 40ml glass vials (HCl)
BOD 1 x 1L HDPE
COD 1 x 250mL HDPE (H2SO4)
TOC 3 x 40ml glass vials (H2SO4)

TIME (24hr)	WATER DPTH BELOW MP (feet)	PUMP SETTING	PURGE RATE (ml/min)	CUM. VOLUME PURGED (gal)	WATER TEMP (°C)	SPECIFIC COND. (µS/cm)	pH	ORP/Eh (mv)	D. O. (mg/L)	TURBIDITY (NTU's)	COMMENTS
1030	30.30	118.0	240		11.49	20	7.63	235.0	11.59	7.50	
1034	30.31	118.0	240		11.43	19	7.28	230.7	11.10	6.50	
1038	29.80	118.0	240	0.75 gal	13.29	19	7.06	221.1	10.97	5.95	
1042	29.70	122.8	80		13.96	19	7.05	216.8	10.97	4.85	
1046	29.71	159.2	240	1.00	14.27	19	6.90	219.1	10.91	7.50	
1050	29.85	168.2	240		14.51	19	6.82	189.1	10.64		
1054											Back Flush well, flow had stopped
1100	30.50	121.0	480	1.50	18.42	19	6.83	155.3	10.54	63	
1104	30.12	121.0	600		15.15	18	6.77	167.3	11.14	44	
1108	30.45	121.0	640	2.75	14.42	18	6.73	144.9	11.27	43	
1112	30.48	121.0	600		12.83	18	6.69	147.3	11.31	11	
1116	30.48	121.0	600		12.43	18	6.66	159.9	11.26	6.05	
1120	30.48	121.0	600	4.00	12.26	18	6.65	160.6	11.25	3.65	
1124	30.48	121.0	600	5.00	12.13	18	6.63	174.1	11.20	2.75	
1128	30.48	121.0	600		12.08	18	6.62	174.6	11.20	2.45	
1132	30.48	121.0	600		12.11	18	6.61	175.8	11.20	2.52	
NOTES:					±.36 3%	±0.45 3%	+0.1 unit	+10 mv	10%	10%	

SAMPLE TAKEN AT: 1135

YSI # 00D698 TURBIDITY # 39576 Pump - Grunfos Redi-flow II

GWM WELL #	SHL-4		U.S. Army Corps of Engineers
SCREEN INTERVAL DEPTH:	5.7-15.7'	WELL DIAMETER: 2"	Groundwater Sampling Log Sheet
H2O LEVEL: DEPTH, PRE PUMP INSERTION	10.05		Project Name: Shepley's Hill Landfill, Devens, MA
DEPTH, POST PUMP INSERTION	10.05		SAMPLE METHOD: EPA LOW STRESS METHOD
DEPTH SAMPLED:	13	REFERENCE POINT: (PVC) OR CASING (DEPTHS RECORDED BENEATH)	Metals/Hardness 1 x 1L HDPE (HNO3) — VOC'S 3 x 40ml glass vials (HCl)
DATE: 6/6/05	TIME: 12:20	NGVD	Cyanide 1 x 250ml HDPE (NaOH) — BOD 1 x 1L HDPE
RECORDED BY: JK (SS) AG TM	SIGNATURE: [signature]		Anions,Alkalinity,TDS 1 x 500ml HDPE — COD 1 x 250mL HDPE (H2SO4)
SAMPLED BY: JK (SS) AG TM	SIGNATURE: [signature]		TSS 1 x 1L HDPE — TOC 3 x 40ml glass vials (H2SO4)

TIME (24hr)	WATER DPTH BELOW MP (feet)	PUMP SETTING	PURGE RATE (ml/min)	CUM. VOLUME PURGED (gal)	WATER TEMP (°C)	SPECIFIC COND. (µS/cm) C	pH	ORP/Eh (mv)	D. O. (mg/L)	TURBIDITY (NTU's)	COMMENTS
1234	10.20	73.0	2000	1 gal							Pumped orange/Rusty water before connecting
1237	10.15	70.7	1400	1.5 gal							to YSI
				Connected to	YSI					10.0	Clearer water
1240	10.10	69.0	700	2.5 gal	11.06	142	5.68	117.7	0.95	5.0	
1243	10.10	69.2	700	[illegible] 18	11.10	142	5.65	117.6	0.60	4.8	
1246	10.10	69.2	700	3.5 gal	11.14	142	5.64	117.6	0.61	4.5	
1249	10.10	69.2	700		11.17	142	5.64	117.7	0.63	4.1	
1252	10.10	69.2	700	4.5 gal	11.17	142	5.63	117.8	0.65	3.8	
1255	10.11	69.2	700		11.15	142	5.63	118.9	0.70	3.5	
1258	10.11	69.2	700	5.5 gal	11.19	141	5.62	120.0	0.77	2.8	
1301	10.11	69.2	700		11.16	141	5.62	120.2	0.79	2.0	
1304	10.11	69.2	700	6.5 gal	11.14	141	5.61	121.5	0.80	1.8	

NOTES: ±0.3 3% ±4.2 3% +0.1 unit +10 mv 10% ±0.08 10% <5

SAMPLE TAKEN AT: 1305

YSI # 00D698 TURBIDITY # 39576 Pump - Grunfos Redi-flow II

GWM WELL # SHL-5

SCREEN INTERVAL DEPTH: 5.1 - 15.1 feet WELL DIAMETER: 2"

H2O LEVEL: DEPTH, PRE PUMP INSERTION 2.62'

DEPTH, POST PUMP INSERTION 2.60

DEPTH SAMPLED: 8.0 ft REFERENCE POINT: (PVC) OR CASING (DEPTHS RECORDED BENEATH) NGVD

DATE: 6/7/05 TIME: 1145

RECORDED BY: JK SS AG (TM) SIGNATURE: Thomas J. Marcotte

SAMPLED BY: JK SS AG (TM) SIGNATURE: Thomas J. Marcotte

U.S. Army Corps of Engineers

Groundwater Sampling Log Sheet

Project Name: Shepley's Hill Landfill, Devens, MA

SAMPLE METHOD: EPA LOW STRESS METHOD

Metals/Hardness 1 x 1L HDPE (HNO3) | VOC'S 3 x 40ml glass vials (HCl)

Cyanide 1 x 250ml HDPE (NaOH) | BOD 1 x 1L HDPE

Anions,Alkalinity,TDS 1 x 500ml HDPE | COD 1 x 250mL HDPE (H2SO4)

TSS 1 x 1L HDPE | TOC 3 x 40ml glass vials (H2SO4)

TIME (24hr)	WATER DPTH BELOW MP (feet)	PUMP SETTING	PURGE RATE (ml/min)	CUM. VOLUME PURGED (~~gal~~) l	WATER TEMP (°C)	SPECIFIC COND. (µS/cm)	pH	ORP/Eh (mv)	D. O. (mg/L)	TURBIDITY (NTU's)	COMMENTS
1056	3.05	45.6	560		11.81	92	4.61	123.6	1.12	9.62	
1100	3.03	45.6	400	2 l	12.02	93	4.27	130.7	0.77	5.47	
1104	3.07	45.6	560		12.02	91	4.18	134.2	0.59	3.63	
1108	3.09	45.6	560	5 l	11.95	91	4.11	137.5	0.52	3.49	
1112	3.11	45.6	560		12.08	94	4.08	140.1	0.61	2.80	
1116	2.96	43.7	400	9 l	12.58	95	4.16	141.2	0.43	3.04	
1120	2.96	43.7	400	11	12.65	95	4.13	145.3	0.45	2.65	
1124	2.96	43.7	400		12.49	95	4.06	148.2	0.34	1.40	
1128	2.96	43.7	400	14	12.62	94	4.01	152.6	0.32	1.25	
1132	2.96	43.7	400	15	13.38	94	4.13	152.3	0.38	1.48	
1136	2.96	43.7	400		13.56	94	4.22	152.7	0.35	1.55	
1140	2.96	43.7	400	17	13.60	94	4.24	152.6	0.34	1.47	

NOTES: ±0.36 3% | ±2.5 3% +0.1 unit +10 mv | ±.04 10% | <5 10%

SAMPLE TAKEN AT: 1145

YSI # 98G0508 AA TURBIDITY # 910290

Pump - Grunfos Redi-flow II

GWM WELL # SHL-10		U.S. Army Corps of Engineers
SCREEN INTERVAL DEPTH: 17.8 - 41.8'	WELL DIAMETER: 2"	Groundwater Sampling Log Sheet
H2O LEVEL: DEPTH, PRE PUMP INSERTION 30.35		Project Name: Shepley's Hill Landfill, Devens, MA
DEPTH, POST PUMP INSERTION 30.28		SAMPLE METHOD: EPA LOW STRESS METHOD
DEPTH SAMPLED: 35'	REFERENCE POINT: (PVC) OR CASING	Metals/Hardness 1 x 1L HDPE (HNO3) — VOC'S 3 x 40ml glass vials (HCl)
DATE: 6/16/05 TIME: 845	(DEPTHS RECORDED BENEATH) NGVD	Cyanide 1 x 250ml HDPE (NaOH) — BOD 1 x 1L HDPE
RECORDED BY: JK (SS) AG TM	SIGNATURE: [signature]	Anions,Alkalinity,TDS 1 x 500ml HDPE — COD 1 x 250mL HDPE (H2SO4)
SAMPLED BY: JK (SS) AG TM	SIGNATURE: [signature]	TSS 1 x 1L HDPE — TOC 3 x 40ml glass vials (H2SO4)

TIME (24hr)	WATER DPTH BELOW MP (feet)	PUMP SETTING	PURGE RATE (ml/min)	CUM. VOLUME PURGED (gal)	WATER TEMP (°C)	SPECIFIC COND. (µS/cm)	pH	ORP/Eh (mv)	D. O. (mg/L)	TURBIDITY (NTU's)	COMMENTS
906	30.28	120	400		10.78	30	7.17	149.6	11.51	9.5	Very clear water @ start
910	30.40	119.5	450		10.70	26	6.72	160.7	11.34	5.0	
914	30.40	119.5	500	1 gallon	12.56	26	6.44	170.6	11.26	1.3	
917	30.40	119.5	500		12.78	26	6.39	176.9	11.29	1.0	
920	30.40	119.5	500		12.86	28	6.37	185.2	11.26	0.8	
923	30.40	119.5	500	2 gallons	12.87	28	6.37	187.2	11.23	0.7	
926	30.40	119.5	500		12.90	28	6.37	193.1	11.24	0.5	
929	30.40	119.5	500		12.89	28	6.37	195.5	11.22	0.4	
932	30.40	119.5	500	3 gallons	12.74	28	6.37	198.1	11.20	0.5	
935	30.40	119.5	500		12.80	28	6.37	202.9	11.13	0.5	
938	30.40	119.5	500	4 gallons	12.80	29	6.36	208.2	11.12	0.3	
941	30.40	119.5	500		12.90	29	6.37	209.1	11.12	0.2	
944	30.40	119.5	500	5 gallons	12.88	29	6.37	210.5	11.16	0.2	

NOTES: 3% ±0.37 ✓ | 3% ±0.8 ✓ | +0.1 unit ✓ | +10 mv ✓ | 10% ±1.1 ✓ | 10% <5 ✓

SAMPLE TAKEN AT: 945

YSI # 9860508 TURBIDITY # 910290 Pump - Grunfos Redi-flow II

GWM WELL #	SHM-93-10C		U.S. Army Corps of Engineers
SCREEN INTERVAL DEPTH:	45.7-55.7'	WELL DIAMETER: 4"	Groundwater Sampling Log Sheet
H2O LEVEL: DEPTH, PRE PUMP INSERTION	28.86		Project Name: Shepley's Hill Landfill, Devens, MA
DEPTH, POST PUMP INSERTION	28.70		SAMPLE METHOD: EPA LOW STRESS METHOD
DEPTH SAMPLED:	50'	REFERENCE POINT: (PVC) OR CASING	Metals/Hardness 1 x 1L HDPE (HNO3) / VOC'S 3 x 40ml glass vials (HCl)
DATE: 6/6/05	TIME: 0845	(DEPTHS RECORDED BENEATH) NGVD	Cyanide 1 x 250ml HDPE (NaOH) / BOD 1 x 1L HDPE
RECORDED BY: JK SS (AG) TM	SIGNATURE: [signature]		Anions,Alkalinity,TDS 1 x 500ml HDPE / COD 1 x 250mL HDPE (H2SO4)
SAMPLED BY: JK SS (AG) TM	SIGNATURE: [signature]		TSS 1 x 1L HDPE / TOC 3 x 40ml glass vials (H2SO4)

TIME (24hr)	WATER DPTH BELOW MP (feet)	PUMP SETTING	PURGE RATE (ml/min)	CUM. VOLUME PURGED (gal)	WATER TEMP (°C)	SPECIFIC COND. (µS/cm)	pH	ORP/Eh (mv)	D. O. (mg/L)	TURBIDITY (NTU's)	COMMENTS
0917	29.75	119.5	520		10.86	432	7.14	241.3	1.49	0.22	
0921	29.90	118.7	300	≈1 GAL	11.78	431	7.21	244.5	1.08	0.24	
0924	29.95	118.7	300		11.91	433	7.27	237.5	0.90	0.32	
0929	29.98	118.7	300	≈2 GAL	11.94	433	7.27	239.2	0.85	0.43	
0932	29.98	118.7	300		11.98	433	7.30	241.6	0.77	0.50	
0935	29.98	118.7	300		12.03	433	7.30	243.0	0.77	0.51	
0938	30.0	118.7	300		12.07	433	7.33	245.6	0.75	0.49	
0942	30.0	118.7	300	≈3 GAL	12.13	433	7.34	249.2	0.72	0.52	

NOTES: 3% 3% +0.1 unit +10 mv 10% 10%

SAMPLE TAKEN AT: 0949

YSI # 00D0698 TURBIDITY # 39576 Pump - Grunfos Redi-flow II

GWM WELL # SHL - 11	U.S. Army Corps of Engineers
SCREEN INTERVAL DEPTH: 14.8 - 29.8 feet WELL DIAMETER: 2"	Groundwater Sampling Log Sheet
H2O LEVEL: DEPTH, PRE PUMP INSERTION 18.30 feet	Project Name: Shepley's Hill Landfill, Devens, MA
DEPTH, POST PUMP INSERTION 18.30 feet	SAMPLE METHOD: EPA LOW STRESS METHOD
DEPTH SAMPLED: 25 feet REFERENCE POINT: (PVC) OR CASING (DEPTHS RECORDED BENEATH)	Metals/Hardness 1 x 1L HDPE (HNO3) — VOC'S 3 x 40ml glass vials (HCl)
DATE: 6/7/05 TIME: 830 NGVD	Cyanide 1 x 250ml HDPE (NaOH) BOD 1 x 1L HDPE
RECORDED BY: JK (SS) AG TM SIGNATURE: [signature]	Anions,Alkalinity,TDS 1 x 500ml HDPE — COD 1 x 250mL HDPE (H2SO4)
SAMPLED BY: JK (SS) AG TM SIGNATURE: [signature]	TSS 1 x 1L HDPE — TOC 3 x 40ml glass vials (H2SO4)

TIME (24hr)	WATER DPTH BELOW MP (feet)	PUMP SETTING	PURGE RATE (ml/min)	CUM. VOLUME PURGED (gal)	WATER TEMP (°C)	SPECIFIC COND. (µS/cm) c	pH	ORP/Eh (mv)	D. O. (mg/L)	TURBIDITY (NTU's)	COMMENTS
845	18.35	95.5								1200+	Pumped orange/Rusty water before connecting
848	18.35	95.5		2gal						175	to YSI
			Connected	to YSI							Clearer
850	18.35	95.5	1250	3gal	11.58	550	4.92	-4.1	0.87	130	Reduced pump speed
853	18.35	95.1	1200	4gal	11.61	542	4.71	-17.0	0.48	100	
856	18.35	95.1	1200	5gal	11.61	542	4.48	-19.4	0.47	25	
859	18.35	95.1	1300	6gal	11.63	542	4.25	-20.7	0.49	14.4	Slight odor to water
902	18.34	95.1	1300	7gal	11.61	539	3.97	-20.0	0.50	9.8	
905	18.34	95.1	1300	8gal	11.64	543	3.70	-19.9	0.50	6.6	
908	18.34	95.1	1250	9gal	11.66	542	3.53	-19.0	0.51	5.9	
911	18.34	95.1	1250		11.61	544	3.40	-18.4	0.50	5.1	
913	18.34	95.1	1250	10gal	11.64	546	3.25	-18.5	0.49	4.5	
916	18.34	95.1	1250	11gal	11.61	544	3.03	-15.9	0.52	4.0	
919	18.34	95.1	1250	12gal	11.65	543	2.78	-13.9	0.53	3.8	
922	18.34	95.1	1250	13gal	11.61	546	2.58	-13.4	0.51	3.0	
925	18.34	95.1	1250	14gal	11.61	545	2.36	-11.0	0.54	2.9	
928	18.34	95.1	1250		11.62	548	2.16	-10.2	0.51	2.2	
931	18.34	95.1	1250	15gal	11.65	548	2.01	-9.3	0.51	2.0	
934	18.34	95.1	1250	16gal	11.62	548	1.68	-7.0	0.51	2.1	
							*				Ph sensor is off

NOTES: ±0.3 3% ✓ ±15 ✓ 3% +0.1 unit +10 mv ✓ 10% ±0.05 10% <5 ✓

SAMPLE TAKEN AT: 935

Due to extremely rusty/orange colored water - 2gallons were pumped out until water became clear before connecting to YSI.

YSI # 98G0508 TURBIDITY # 910290 Pump - Grunfos Redi-flow II

* Sample taken @ 935 all parameters stabilized except ph which is off (well below 2 ph)

GWM WELL # SHL-19

SCREEN INTERVAL DEPTH: 17.0 - 32.0' WELL DIAMETER: 4"

H2O LEVEL: DEPTH, PRE PUMP INSERTION 22.19

DEPTH, POST PUMP INSERTION 22.19

DEPTH SAMPLED: 27'

REFERENCE POINT: (PVC) OR CASING (DEPTHS RECORDED BENEATH) NGVD

DATE: 6/6/05 TIME: 1320

RECORDED BY: JK SS AG (TM) SIGNATURE: Thomas J. Marcotte

SAMPLED BY: JK SS AG (TM) SIGNATURE: Thomas J. Marcotte

U.S. Army Corps of Engineers

Groundwater Sampling Log Sheet

Project Name: Shepley's Hill Landfill, Devens, MA

SAMPLE METHOD: EPA LOW STRESS METHOD

Metals/Hardness 1 x 1L HDPE (HNO3)
Cyanide 1 x 250ml HDPE (NaOH)
Anions,Alkalinity,TDS 1 x 500ml HDPE
TSS 1 x 1L HDPE

VOC'S 3 x 40ml glass vials (HCl)
BOD 1 x 1L HDPE
COD 1 x 250mL HDPE (H2SO4)
TOC 3 x 40ml glass vials (H2SO4)

TIME (24hr)	WATER DPTH BELOW MP (feet)	PUMP SETTING	PURGE RATE (ml/min)	CUM. VOLUME PURGED (gal)	WATER TEMP (°C)	SPECIFIC COND. (µS/cm)	pH	ORP/Eh (mv)	D. O. (mg/L)	TURBIDITY (NTU's)	COMMENTS
1246	22.28	105.2	1280		11.31	104	5.68	32.1	1.21	87.7	reddish-Brown slug
1250	22.19	105.2	1500	2.0	11.18	100	5.47	34.1	0.98	61.8	
1254	22.19	105.2	1600	3.5	11.12	96	5.29	41.1	1.08	28.3	
1258	22.25	102.6	960	4.5	11.96	92	5.13	50.7	1.48	16.9	
1302	22.19	102.6	900	5.5	11.94	91	5.11	55.5	1.66	14.8	
1306	22.19	102.6	960	6.5	11.98	90	5.05	59.3	1.66	18.8	
1310	22.19	102.6	900	7.5	11.95	89	4.98	63.7	1.74	20.5	
1314	22.19	102.6	960	8.5	11.99	88	4.92	66.5	1.86	18.5	
1318	22.19	102.6	960	9.5	11.99	88	4.89	68.5	1.88	19.0	

NOTES: ±.36 3% ±2.7 3% +0.1 unit +10 mv 10% 10%

SAMPLE TAKEN AT: 1320

- Let well discharge into bucket at start to eliminate slug (~2.5 gallons)

YSI # 9860508 AA TURBIDITY # 910210 Pump - Grunfos Redi-flow II

GWM WELL # SHL-20

SCREEN INTERVAL DEPTH: 41.0 - 51.0 Feet   WELL DIAMETER: 4"

H2O LEVEL: DEPTH, PRE PUMP INSERTION 18.65 Feet

DEPTH, POST PUMP INSERTION 18.65 Feet

DEPTH SAMPLED: 46 Feet   REFERENCE POINT: PVC OR CASING (DEPTHS RECORDED BENEATH) NGVD

DATE: 6/7/05   TIME: 0830

RECORDED BY: JK SS AG TM   SIGNATURE: [signature]

SAMPLED BY: JK SS AG TM   SIGNATURE: [signature]

U.S. Army Corps of Engineers

Groundwater Sampling Log Sheet

Project Name: Shepley's Hill Landfill, Devens, MA

SAMPLE METHOD: EPA LOW STRESS METHOD

Metals/Hardness 1 x 1L HDPE (HNO3)
Cyanide 1 x 250ml HDPE (NaOH)
Anions,Alkalinity,TDS 1 x 500ml HDPE
TSS 1 x 1L HDPE
VOC'S 3 x 40ml glass vials (HCl)
BOD 1 x 1L HDPE
COD 1 x 250mL HDPE (H2SO4)
TOC 3 x 40ml glass vials (H2SO4)

TIME (24hr)	WATER DPTH BELOW MP (feet)	PUMP SETTING	PURGE RATE (ml/min)	CUM. VOLUME PURGED (gal)	WATER TEMP (°C)	SPECIFIC COND. (µS/cm)	pH	ORP/Eh (mv)	D. O. (mg/L)	TURBIDITY (NTU's)	COMMENTS
0840	18.64	92.1	300		12.65	580	6.25	-17.8	1.31	96.0	
0843	18.65	92.1	300		12.94	585	6.24	-15.0	1.07	80.0	
0846	18.65	92.1	300		13.20	587	6.24	-12.5	1.00	65.5	
0849	18.65	92.1	300	≅1 Gallon	13.58	587	6.23	-10.8	0.82	59.3	
0852	18.65	92.1	300		13.72	589	6.20	-8.2	0.71	54.6	
0855	18.65	92.1	300		13.74	589	6.21	-7.3	0.60	50.0	
0858	18.65	92.1	350	≅2 Gallons	13.85	587	6.22	-7.0	0.52	38.0	
0901	18.65	92.1	350		13.98	585	6.22	-5.6	0.42	34.2	
0904	18.65	92.1	350		13.93	587	6.21	-5.2	0.41	30.6	
0907	18.65	92.1	350		14.00	585	6.21	-4.2	0.39	28.8	
0910	18.65	92.1	350		14.14	584	6.20	-3.6	0.38	25.5	
0913	18.65	92.1	350	≅3 Gallons	14.17	585	6.20	-3.0	0.36	22.8	
0916	18.65	92.1	350		14.13	586	6.19	-2.2	0.34	20.1	
0919	18.65	92.1	350		14.21	586	6.18	-1.5	0.33	18.9	
0922	18.65	92.1	350	≅4 Gallons	14.23	586	6.16	-0.5	0.33	17.9	

NOTES: 3% 3% +0.1 unit +10 mv 10% 10%

SAMPLE TAKEN AT: 0924

YSI # 00D0698   TURBIDITY # 39576   Pump - Grunfos Redi-flow II

GWM WELL # SHM-93-22C	U.S. Army Corps of Engineers Groundwater Sampling Log Sheet Project Name: Shepley's Hill Landfill, Devens, MA
SCREEN INTERVAL DEPTH: 124.3 - 134.3' WELL DIAMETER: 4"	
H2O LEVEL: DEPTH, PRE PUMP INSERTION 6.32'	
DEPTH, POST PUMP INSERTION 5.09'	SAMPLE METHOD: EPA LOW STRESS METHOD
DEPTH SAMPLED: 130' REFERENCE POINT: (PVC) OR CASING (DEPTHS RECORDED BENEATH)	Metals/Hardness 1 x 1L HDPE (HNO3) — VOC'S 3 x 40ml glass vials (HCl)
DATE: 6/7/05 TIME: 1040 NGVD	Cyanide 1 x 250ml HDPE (NaOH) — BOD 1 x 1L HDPE
RECORDED BY: JK (SS) AG TM SIGNATURE: [signature]	Anions,Alkalinity,TDS 1 x 500ml HDPE — COD 1 x 250mL HDPE (H2SO4)
SAMPLED BY: JK (SS) AG TM SIGNATURE: [signature]	TSS 1 x 1L HDPE — TOC 3 x 40ml glass vials (H2SO4)

TIME (24hr)	WATER DPTH BELOW MP (feet)	PUMP SETTING	PURGE RATE (ml/min)	CUM. VOLUME PURGED (gal)	WATER TEMP (°C)	SPECIFIC COND. (µS/cm) c	pH	ORP/Eh (mv)	D. O. (mg/L)	TURBIDITY (NTU's)	COMMENTS
1045	5.10	71.3	↑								clear color
1050	6.30	81.1	Varies as well	2 gal	10.44	433	6.88	-70.9	2.06	3.0	sulfur odor
1055	9.50	97.0	draw down	3 gal	10.60	524	6.75	-117.3	0.30	2.8	
1100	17.00	128.1		6 gal	10.67	362	6.73	-90.1	0.21	2.5	
1105	21.40	153.4		10 gal	10.77	272	6.64	-48.1	0.63	2.0	
1110	29.10	152.4		14 gal	10.81	265	6.67	-10.4	0.79	2.3	
1115	34.43	152.4	↓	17 gal	10.92	260	6.69	-1.4	0.92	2.5	Reduced pump speed
1120	37.12	147.2	1400	20 gal	11.05	263	6.62	-1.6	0.93	2.[illegible]	Reduced pump speed
1125	38.70	139.3	800	21 gal	11.22	269	6.56	-9.2	0.92	1.8	" " "
1130	39.70	136.0	225		12.17	277	6.67	-15.8	0.92	2.0	
1135	39.75	136.0	200		11.96	278	6.71	-14.0	0.98	1.9	
1140	39.80	136.0	150	22 gal	12.10	280	6.73	-11.3	0.99	2.0	well stopped
1143	39.80	136.0	150		12.21	282	6.75	-9.6	1.03	2.1	drawing down
1146	39.81	136.0	150		12.16	285	6.73	-13.9	1.02	2.0	shaded YSI - sun and affecting temp
1149	39.81	136.0	150		12.02	289	6.72	-17.0	1.01	2.3	
1152	39.81	136.0	150		11.87	291	6.73	-20.3	1.00	2.0	
1155	39.81	136.0	150		11.93	292	6.75	-23.1	1.00	1.9	

NOTES: ±0.3 3% ✓ ±8 3% ✓ +0.1 unit ✓ +10 mv ±0.1 10% <5 10% ✓

SAMPLE TAKEN AT: 1155

well has history of low recharge until well is drawn down ~30 feet to increase head in well drawn down at first to reach a level that it will recharge enough to sample

YSI # 00D698 TURBIDITY # 39576 Pump - Grunfos Redi-flow II

January 2006 Monitoring

SHL - 3

Field Data Sheets for Low Flow Ground Water Sampling

Project Name: Shepley LF
Sample Source (Well No./Location) SHL - 3
Weather Conditions Clear 40°F
PID NA (ppm) Condition good
Sample Team TB/LL

Project Number:
Date: 1/19/06 - 1/21/06

Well Stabilization Data

Well Depth 35 (FT.) Datum
Static Water Level 29.58/29.8 (FT.) Diameter: 2"
Water Column (FT.) Purge Method: ~~Peristaltic Pump~~ / Redi - Flow II

Time Purging begins (T_o):
Water Level at time T_o:
Time Purging ends: (T_1)
Water Level at time T_1:

Time	Volume Removed	pH +/- 0.1	~~SP~~COND(mS/cm) (TS) +/- 3%	TEMP.(C) +/- 0.2 or 3%	Redox (mV) +/- 10 mV	Water level (Ft) < 0.3 ft	D.O. (mg/L) +/- 10%	Turbidity (NTU) < 5 NTU	Purge rate (Lpm) 0.3 to 0.5LPM	Appearance
1/19/06 - Water table too deep for peristaltic pump										
1/21/06 - Attempted to pump w/ Grundfos Redi Flow II, well kept going dry @ lowest flow rate (≈ .5 LPM)										
1008	5 Gal	6.17	.017	11.58	309			109		
Collected sample after ≈ 5 vol removed, but sample not submitted										

SAMPLING

Date: 1/21/06
Time: 1015
Field Filtering: NO
Sampling Methodology: Low Flow Sampling
Laboratory: Method of Shipment:
Remarks:

Analysis: NONE

Diameter (inch)	Gallon / Foot	* delta w.t. (ft)	= volume lost (gallons)
1	0.040		
1.5	0.091		
2	0.163		
4	0.652		1gallon = 3.78 liters

Project Name: Shepley's Hill Landfill
Job Number: 284350.OM.02
Field Team: TB/LL
Field Conditions: clear 40-50°F windy

Sampling Event
Date: 1/19/06
Page 1 of 1

Well/Sample Number: SHL-4
Start Time: 1130
Initial Depth to Water: 9.69 TOC ≈ 2.75' AGS
Measure Point: (Well TOC) Steel Casing
Vertical Profiling: Bottom of well 13' bgs; 10' screen

Depth ft below TOC	Time	pH	Conductivity mS/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh / ORP mv

Remarks:

Purge Method: Start @ 1130*
(Geopump) Ded. Pump Other
Split Sample ID: 011906-SHL04
Split Time
Duplicate Sample ID: ——
Dupl. Time ——
Flow Cell: (Y) N
Min. Purge Volume (gal)/(L): 0.5 LPM
Purge Rate (gpm)/(mLpm): 0.5 LPM

Time	Vol. Purged gallons / liters	pH	Conductivity mS/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh / ORP mv
1159	0.5/2L	5.36	.035	NA (clear)	4.15	10.55	326.8
	DTW ≈ 9.71	rate = 0.5 LPM					
1207	18.5L	5.72	.035	NA	4.80	10.79	387
	DTW = 9.71						
1212	22 L	5.69	.036	NA	4.66	10.91	405.3
	DTW = 9.71						
1218		5.68	.035	NA	4.79	10.80	417.5
	DTW = 9.71	rate = 0.5 LPM					
1225		5.83	.035	NA	5.98	10.85	411.4
	DTW = 9.71						
1233		5.81	.037	↓	5.28	10.75	412.0

* 11/04 data had anaerobic D.O. (not sure if this was in-situ)
D.O. data from this is via flow cell

Remarks: * start purge @ 1130 w/ 2nd peristaltic pump (only 1 YSI which was tied in @ 1150) water was clear during purging

Project Name: Shepley's Hill Landfill
Job Number: 284350.OM.02
Field Team: TB & CC
Field Conditions: Clear 40°F

Sampling Event: Devens GW
Date: 1/20/06
Page 1 of 1

Well/Sample Number: SHL-5
Start Time: 8AM
Initial Depth to Water: 1.40
Measure Point: (Well TOC) Steel Casing
Vertical Profiling: Lock on well

Depth ft below TOC	Time	pH	Conductivity mS/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh / ORP mv

Remarks: Army Core 11/04 field data; anaerobic conditions (DO < 1.0 mg/L) w/ + redox

Purge Method: Start @ 0808
(Geopump) Ded. Pump Other
Split Sample ID: 012006-SHL05
Split Time: 0850
~~Duplicate Sample ID~~
~~Dupl. Time~~
Flow Cell: (Y) / N
Min. Purge Volume (gal)/(L):
Purge Rate (gpm)/(mLpm): 0.3LPM

Time	Vol. Purged gallons / liters	pH	Conductivity mS/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh / ORP mv
0819	3L	5.38	0.074	6.08	1.17	4.13	431
	DTW = 1.98 rate = 0.3 Lpm				0.93	4.19	424.1
0830	7L	5.41	0. ~~128~~ 074	5.17			
	DTW = 1.98						
0834	9L	5.26	0.078	5.18	0.75	4.21	428.0
	DTW = 1.98, clear			rate = 0.35 LPM			
0843	12.5	5.20	0.080	3.46	0.68	4.20	428.2
	DTW = 1.98						
0847	15L	5.20	~~0.135~~ .080	2.65	0.62	4.19	426.2
	DTW = 1.98 rate = 0.4 LPM						
0849	17L	5.20	0.080	2.60	0.65	4.20	425.2
	DTW = 1.98 ✓		✓		✓	✓	✓

Remarks: Temp lot colder than 11/04 data

SHM-96-5C

Field Data Sheets for Low Flow Ground Water Sampling

Project Name: Shepley LF
Project Number: 284350
Sample Source (Well No./Location) SHM-96-5C
Date: 1/20/06
Weather Conditions Clear 45° F
PID NA (ppm) Condition good
Sample Team TB/CL

Well Stabilization Data

Well Depth 79' AGS? (FT.) Datum
Static Water Level 5.98 TOC (FT.) Diameter: 4" PVC
Water Column (FT.) Purge Method: Peristaltic Pump

Time Purging begins (T_o): 0852
Water Level at time T_o: 5.98
Time Purging ends: (T_1) 0952
Water Level at time T_1: 3.35*

Time	Volume Removed	pH +/- 0.1	SPCOND(mS/cm) +/- 3%	TEMP.(C) +/- 0.2 or 3%	Redox (mV) +/- 10 mV	Water level (Ft) < 0.3 ft	D.O. (mg/L) +/- 10%	Turbidity (NTU) < 5 NTU	Purge rate (Lpm) 0.3 to 0.5LPM	Appearance
0911	8L	6.24	0.777	8.64	205.5	3.35*	0.22	15.8	0.45	clear
0926	15	6.47	0.784	8.75	-58.5	3.34	0.16	2.35	0.45	clear
0932	17.5	6.47	0.786	8.71	-70.7	3.35	0.14	1.92	0.45	↓
0940	20	6.48	0.786	8.66	-79.2	3.35	0.14	1.33	0.45	
0948	23	6.48	0.780	8.55	-85.4	3.35	0.15	1.46	0.4	
0952	25	6.49	0.779	8.55	-85.9	3.35	0.15	1.39	0.4	
								(battery dying?)		

SAMPLING

Date: 1/20/06
Analysis: 012006-SHM-96-5C
Time: 0951
Field Filtering:
Sampling Methodology: Low Flow Sampling
Laboratory: Method of Shipment:
Remarks: Sample time ID = 0951
Actual sample time = 0953

Diameter (inch)	Gallon / Foot	* delta w.t. (ft)	= volume lost (gallons)
1	0.040		
1.5	0.091		
2	0.163		
4	0.652		1gallon = 3.78 liters

*Switched to steel casing for reference point

SHM-96-5b

Field Data Sheets for Low Flow Ground Water Sampling

Project Name: Shepley LF
Project Number: 284350
Sample Source (Well No./Location) SHM-96-5b
Date: 1/20/06
Weather Conditions Clear 40°F
PID NA (ppm) Condition Clr good
Sample Team TB / CC

Well Stabilization Data

Well Depth 92 [illegible] ' BGS (FT.) Datum
Static Water Level. 3.89 TOC (FT.) Diameter: 4" PVC
Water Column (FT.) Purge Method: Peristaltic Pump

Time Purging begins (T_o): 0940 1040
Water Level at time T_o: 3.89
Time Purging ends: (T_1) 1025
Water Level at time T_1: 4.11

Time	Volume Removed	pH + / - 0.1	SPCOND(mS/cm) (TS) + / - 3%	TEMP.(C) + / - 0.2 or 3%	Redox (mV) + / - 10 mV	Water level (Ft) < 0.3 ft	D.O. (mg/L) + / - 10%	Turbidity (NTU) < 5 NTU	Purge rate (Lpm) 0.3 to 0.5LPM	Appearance
1003	13L	6.59	0.509	8.66	-85.5	4.11	0.54	0.6	0.4	Clear
1012	16L	6.54	0.503	8.77	-81.3	4.11	0.26	0.43	0.4	Clear
1016	18L	6.54	0.502	8.74	-81.4	4.11	0.24	0.62	"	Clear
1022	21L	6.53	0.503	8.82	-82.1	4.11	0.22	0.59	0.4	Clear

SAMPLING

Date: 1/20/06
Time: 1040
Analysis: ID: 012006-SHM-96-5b
Field Filtering:
Sampling Methodology: Low Flow Sampling
Laboratory: Alpha
Method of Shipment: Courier
Remarks:

Diameter (inch)	Gallon / Foot	* delta w.t. (ft)	= volume lost (gallons)
1	0.040		
1.5	0.091		
2	0.163		
4	0.652		1gallon = 3.78 liters

Project Name: Shepley's Hill Landfill
Job Number: 284350.OM.02
Field Team: T.B & CC
Field Conditions: clear 50°F

Sampling Event
Date: 1/20/06
Page 1 of 1

Well/Sample Number: ~~SHL-10~~ ~~SHL-10~~ SHL-9
Start Time: 1400
Initial Depth to Water: 6.72'
Measure Point: (Well TOC) Steel Casing
~~whale~~ pump

Vertical Profiling   Bottom = 25' BGS / 2" well

Depth ft below TOC	Time	pH	Conductivity mS/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh / ORP mv

Remarks: Had to cut lock b/c key hole had been welded shut

Purge Method: Begin pump @1400 (Geopump) Ded. Pump Other
Split Sample ID: 012006-SHL09   Split Time: 1515
Duplicate Sample ID: X   Dupl. Time: X
Flow Cell: (Y) / N
Min. Purge Volume (gal)/(L): 0.4 LPM
Purge Rate (gpm)/(mLpm): 0.4 LPM

Time	Vol. Purged gallons / liters	pH	Conductivity mS/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh / ORP mv
*1441	25 L	6.20	.109	3.10	0.70	9.13	-102.2
	rate = 0.4 LPM		DTW = 7.22				
1451	29 L	5.76	.107	3.89	0.53	9.04	-31.6
	DTW =	7.22	rate = 0.4 LPM				
1456	31 L	5.82	.105	3.49	0.47	9.06	-31.4
1500	33 L	5.87	.108	3.41	0.48	9.00	-27.4
1505	36 L	5.92	.107	3.33	0.45	9.00	-23.4
	DTW =	7.22	rate = 0.4 LPM				

* collected reading as soon flow cell filled w/ H_2O (so ~~be~~ away

Remarks:

SHL – 10

Field Data Sheets for Low Flow Ground Water Sampling

Project Name: Shepley LF
Project Number:
Sample Source (Well No./Location) SHL – 10
Date: 1 / 25 / 06
Weather Conditions Clear 40°F
PID NA (ppm) Condition good but no lock
Sample Team TB/DR

Well Stabilization Data

Well Depth 39' BGS (FT.) Datum
Static Water Level 30.64 TOC (FT.) Diameter : 4" Steel
Water Column (FT.) Purge Method: ~~Peristaltic Pump~~ (TB) Grundfos Redi Flow II

Time Purging begins (T_0): 1115
Water Level at time T_0: 30.64
Time Purging ends: (T_1) 1240 *
Water Level at time T_1: 30.72

Time	Volume Removed	pH +/- 0.1	~~SP~~COND(mS/cm) (TB) +/- 3%	TEMP.(C) +/- 0.2 or 3%	Redox (mV) +/- 10 mV	Water level (Ft) < 0.3 ft	D.O. (mg/L) ** +/- 10%	Turbidity (NTU) < 5 NTU	Purge rate (Lpm) 0.3 to 0.5LPM	Appearance	
1150	Can't get w.l. reading; stopped pumping dropped pump 1' &										
	got w.l. reading					30.70					
1210	Connected Flow Cell										
1212	47	7.29	.034	13.87	206.2	*	11.92(?)	1.70	0.6	Clear	127.2
1219	52	6.21	.033	14.22	329.9	*	11.78 ?	0.99	0.6	"	
1224	54	6.08	.032	13.94	355.5	*	11.98 ?	0.59	"	Clear	126.9
1227	56	6.03	.034	13.65	369.2	*	12.08 ?	0.49	0.6	clear	
1230	58	6.02	.033	13.64	367.2	*	12.18 ?	0.17	"	"	126.6

SAMPLING

Date: / /
Time:
Field Filtering:
Sampling Methodology: Low Flow Sampling
Laboratory: Method of Shipment:
Remarks:

Analysis:

see Pg. 2

Diameter (inch)	Gallon / Foot	* delta w.t. (ft)	= volume lost (gallons)
1	0.040		
1.5	0.091		
2	0.163		
4	0.652		1gallon = 3.78 liters

SHL-10

Field Data Sheets for Low Flow Ground Water Sampling

Project Name: Shepley LF
Project Number:
Sample Source (Well No./Location) SHL-10
Date: 1/25/06
Weather Conditions Clear 40°F
PID NA (ppm) Condition good no lock
Sample Team TB/DR

Well Stabilization Data

Well Depth 39 (FT.) Datum
Static Water Level 30.64 (FT.) Diameter: 4" steel
Water Column ______ (FT.) Purge Method: ~~Peristaltic Pump~~ Grundfos Redi Flow II

Time Purging begins (T_0): 1115
Water Level at time T_0: 30.64
Time Purging ends: (T_1) ______
Water Level at time T_1: ______

Time	Volume Removed	pH +/- 0.1	~~SPCOND~~ (TB) (mS/cm) +/- 3%	TEMP.(C) +/- 0.2 or 3%	Redox (mV) +/- 10 mV	Water level (Ft) < 0.3 ft	D.O. (mg/L) ** +/- 10%	Turbidity (NTU) < 5 NTU	Purge rate (Lpm) 0.3 to 0.5LPM	Appearance
1233	60	6.03	.032	13.66	369.8	*	12.27?	0.11	0.6	Clear
1236	63	6.04	.032	13.69	373.2	*	12.31?	0.13	0.6	Clear 128.7
1240	(Immediately After Sampling ~~Pumping~~)									
						30.72				
1600	Pumped	10	min @	0.6	LPM	(128.2)				
			.032		330.4		6.71			

SAMPLING

Date: 1/25/06
Time: 1250
Field Filtering: NO
Sampling Methodology: Low Flow Sampling
Laboratory: Alpha Method of Shipment: courier
Remarks:

Analysis: ID = 012506-SHL-10
VOCs, Metals, TCN
Hardness, TDS, Alk,
Cl, NO_3, SO_4, TSS,
BOD, COD, & TOC

Diameter (inch)	Gallon / Foot	* delta w.t. (ft)	= volume lost (gallons)
1	0.040		
1.5	0.091		
2	0.163		
4	0.652		1gallon = 3.78 liters

** D.O. meter in YSI 600 not working, returned w/ YSI 85 @ 1600

* water level not working in well, got last reading after sampling & pushed down deeper

SHM-96-10C   1 OF 2

Field Data Sheets for Low Flow Ground Water Sampling

Project Name: Shepley LF   Project Number:
Sample Source (Well No./Location) SHM-96-10C   Date: 01/25 06
Weather Conditions Snow Flurries 35°F
PID NA (ppm) Condition Good - NO lock
Sample Team TB/DR

Well Stabilization Data

Well Depth 54' BGS (FT.)   Datum ______
Static Water Level 28.46 TOC (FT.)   Diameter: 4"
Water Column ______ (FT.)   Purge Method: ~~Peristaltic Pump~~ Grundfos Redi Flow #

Time Purging begins (T_o): 0910
Water Level at time T_o: 28.46
Time Purging ends: (T_1) 1029
Water Level at time T_1: 31.34

Time	Volume Removed	pH +/- 0.1	SPCOND(mS/cm) (15) +/- 3%	TEMP.(C) +/- 0.2 or 3%	*Redox (mV) +/- 10 mV	Water level (Ft) < 0.3 ft	** D.O. (mg/L) +/- 10%	Turbidity (NTU) < 5 NTU	Purge rate (Lpm) 0.3 to 0.5LPM	Appearance
0917						31.09			1.2	Clear
0925		7.63	0.354	11.48	257.8	31.01	0.77	15.0	1.0	
0937	20L		0.354	11.35	239.1	32.19	0.45		0.55	
0953	27L					31.38				
	re-start pump @ 0955									
1002	30	7.55	0.358	12.05	173.8		0.67	10.34	0.4	clear
1008	33	7.47	0.358	12.11	179.8	31.34	0.36	9.97	0.4	clear 126.2
1008	(CONTINUED)								0.4	

SAMPLING

Date: __/__/__   Analysis:
Time: ______
Field Filtering: ______
Sampling Methodology: Low Flow Sampling   See Pg. 2
Laboratory: Method of Shipment:
Remarks:

Diameter (inch)	Gallon / Foot	* delta w.t. (ft)	= volume lost (gallons)
1	0.040		
1.5	0.091		
2	0.163		
4	0.652		1gallon = 3.78 liters

SHM - 96 - 10C

Field Data Sheets for Low Flow Ground Water Sampling

Project Name: Shepley CF
Project Number:
Sample Source (Well No./Location) SHM-96-10C
Date: 1/25/06
Weather Conditions SNOW Flurries 35°F
PID NA (ppm) Condition good no lock
Sample Team TB DR

Well Stabilization Data

Well Depth 54' (FT.) Datum
Static Water Level 28.46 (FT.) Diameter:
Water Column (FT.) Purge Method: ~~Peristaltic Pump~~ (TB) RCD: Flow II

Time Purging begins (T_o): 0910
Water Level at time T_o: 28.46
Time Purging ends: (T_1) 1029
Water Level at time T_1: 31.27

Time	Volume Removed	pH +/- 0.1	SPCOND(mS/cm) (TB) +/- 3%	TEMP.(C) +/- 0.2 or 3%	* Redox (mV) +/- 10 mV	Water level (Ft) < 0.3 ft	** D.O. (mg/L) +/- 10%	Turbidity (NTU) < 5 NTU	Purge rate (Lpm) 0.3 to 0.5LPM	Appearance	
1015	35L	7.43	.356	12.07	186.2	31.27	0.31	6.55	0.4	Clear	126.2
1023	38L	7.42	0.359	12.14	193.0	31.34	0.29	4.07	0.4	↓	126.2
1029	40L	7.40	.358	12.17	191.6	31.34	0.29	4.01	0.4	↓	126.2
** 1615	Pumped	For	10 min	@	130.0						
				12.04	228.2	in-situ = 0.0 **					

SAMPLING

Date: 01/25/06
Time: 1030
Field Filtering: NO
Sampling Methodology: Low Flow Sampling
Laboratory: Method of Shipment:
Remarks:

Analysis: Metals, VOCs, Hardness, SO_4, NO_3 TSS, ~~ET~~ TCN, Alk, Cl, BOD, COD TOC

Diameter (inch)	Gallon / Foot	* delta w.t. (ft)	= volume lost (gallons)
1	0.040		
1.5	0.091		
2	0.163		
4	0.652		1gallon = 3.78 liters

ID = 012506 - SHM-96-10C

Devens_DataSheets.xlstemplate-low flow

* Army Corp 11/04 sampling noted D.O. < 1 mg/L & + ORP

Project Name: Shepley's Hill Landfill
Job Number: 284350.OM.02
Field Team: CC/TB
Field Conditions: Cold, clear, windy ~40°F

Sampling Event: Devens GW sampling
Date: 1/19/06
Page 1 of 1

Well/Sample Number: SHL-11
Start Time: 1307
Initial Depth to Water: ~~17.99~~ cc 17.99 TOC
Measure Point: Well TOC Steel Casing

Vertical Profiling
Bottom = 27' BGS

Depth ft below TOC	Time	pH	Conductivity mS/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh / ORP mv

Remarks: [Replacing battery in YSI during 1st part of purging]

Purge Method: (Geopump) Ded. Pump Other
Split Sample ~~ID~~ Time @ 13:55
~~Split time~~ ID 011906-SHL11
Duplicate Sample ID: X
Dupl. Time: X
Flow Cell: (Y) / N
Min. Purge Volume (gal)/(L)
Purge Rate (gpm)/(mLpm): 0.4 LPM

Time	Vol. Purged (gallons)/liters	pH	Conductivity mS/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh / ORP mv
13:24	2.0	6.34	0.539	–	0.66	10.50	89.0
13:34	3.5	6.19	0.541	–	0.50	10.57	37.2
	DTW: 18.0	rate = 0.4 LPM					
13:38	~3.7	6.20	0.546	–	0.50	10.55	27.9
13:42	4.0	6.20	0.542	–	0.51	10.55	16.0
13:46	4.5	6.20	0.534	–	0.59	10.27	5.5
13:50	~4.8	6.20	0.532	–	0.63	10.23	3.7
	DTW: 18.0	rate = 0.4 LPM					

Remarks: Sampled @ 1355

Project Name: Shepley's Hill Landfill
Job Number: 284350.OM.02
Field Team: CC/TB
Field Conditions: clear, windy, ~40°F

Sampling Event
Date: 1/19/06
Page 1 of 1

Well/Sample Number: SHL-19
Start Time: 1030
Initial Depth to Water: 21.49' TOC
Measure Point: Well TOC Steel Casing

Vertical Profiling: Bottom = 30' BGS

Depth ft below TOC	Time	pH	Conductivity mS/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh / ORP mv
0							

Remarks:

Purge Method: (Geopump) Ded. Pump Other

Split Sample ID: 011906-SHL19
Split Time: 1140
Duplicate Sample ID: X
Dupl. Time: X

Flow Cell: (Y) / N
Min. Purge Volume (gal)/(L):
Purge Rate (gpm)/(mLpm): ~0.5 LPM

Time	Vol. Purged (gallons) / liters	pH	Conductivity mS/cm 3	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh / ORP mv
1038	0.5	6.13	0.137	silty, Turbid	0.66	8.66	197.1
1042	1.0	5.79	0.132	–	0.94	8.99	200.3
1046	1.5	5.78	0.131	–	1.03	9.06	201.6
1050	2.0	5.78	0.128	–	1.51	9.09	211.7
1056	2.5	5.77	0.123	–	1.82	9.12	220.1
1102	3.0	5.76	0.129	–	1.84	9.21	230.4
DTW: 21.51					~~2.21~~	~~9.22~~	~~252.8~~
1115	4.0	5.76	0.123	–	2.21	9.22	252.8
1122	4.5	5.77	0.123	–	2.06	9.30	261.3
1128	5.0	5.78	0.120	–	2.34	9.28	274.0
1135	5.5	5.78	0.120	–	2.42	9.23	282.9

Redox didn't stabilize, sampled after 1 hr.

11/04 sample, Redox did not stabilize

Remarks: MS/MSD taken here: Lg amount of iron precipitate initially, until approximately 3 gallons purged, then started to clear

SHL-20

Field Data Sheets for Low Flow Ground Water Sampling

Project Name: Shepley Hill LF
Project Number: 28435C
Sample Source (Well No./Location) SHL-20
Date: 1/19/06
Weather Conditions Clear 50°F
PID NA (ppm) Condition good
Sample Team TB/CC

Well Stabilization Data

Well Depth ______ (FT.) Datum TOC
Static Water Level 18.34 (FT.) Diameter: 4" Steel
Water Column ______ (FT.) Purge Method: Peristaltic Pump

Time Purging begins (T_o): 1415
Water Level at time T_o: 18.34
Time Purging ends: (T_1) 1445
Water Level at time T_1: 18.35

Time	Volume Removed (L)	pH +/- 0.1	SPCOND(mS/cm) +/- 3%	TEMP.(C) +/- 0.2 or 3%	Redox (mV) +/- 10 mV	Water level (Ft) < 0.3 ft	D.O. (mg/L) +/- 10%	Turbidity (NTU) < 5 NTU	Purge rate (Lpm) 0.3 to 0.5LPM	Appearance
1426	1.0	6.43	0.471	10.51	0.6	18.34	0.83	NA	0.4	Clear
1429	1.2	6.44	0.479	10.51	0.3	18.35	0.61	NA	0.4	Clear
1434	1.6	6.45	.487	10.64	0.3		0.42		"	
1438	2.0	6.46	0.489	10.57	0.2		.32		.4	
1441	2.3	6.46	0.490	10.64	0.0	18.35	0.29		0.4	
1444	2.5	6.45	.491	10.72	-0.2		0.25		"	
1450	3.0	6.45	0.492	10.69	-0.2		0.22		0.4	
1453	3.2	6.35	0.493	10.65	0.2	18.35	.20		.4	

SAMPLING

Date: 01/19/06
Time: 1455
Field Filtering: ______
Sampling Methodology: Low Flow Sampling
Laboratory: Method of Shipment:
Remarks:

Analysis:

Diameter (inch)	Gallon / Foot	* delta w.t. (ft)	= volume lost (gallons)
1	0.040		
1.5	0.091		
2	0.163		
4	0.652		1gallon = 3.78 liters

Project Name: Shepley's Hill Landfill
Job Number: 284350.OM.02
Field Team: TB/CC
Field Conditions: clear, cold

Sampling Event: Devens GW
Date: 1/20/06
Page 1 of 1

Well/Sample Number: 4.75 L
Start Time: 1217
Initial Depth to Water: SHL-22
Measure Point: Well TOC Steel Casing

Vertical Profiling

Depth ft below TOC	Time	pH	Conductivity mS/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh / ORP mv

Remarks: * Army Corp 11/04 field data observed + redox w/ D.O. < 1 mg/L also

Purge Method: Start @ 1222 — Geopump (circled) / Ded. Pump / Other
Split Sample ID: 012006-SHL20 @ 13:30 ~~13:35~~ cc
~~Duplicate Sample ID~~ — Dupl. Time — cc
Flow Cell: Y (circled) N — Min. Purge Volume (gal)/(L)
Purge Rate (gpm)/(mLpm): 0.375

Time	Vol. Purged gallons / liters	pH	Conductivity mS/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh / ORP mv
1236	6.5L	5.41	0.579	2.03	0.25	9.85	-8.9
	DTW: → 5.22 ft						
1241	8.0L	5.25	0.575	0.44	0.23	9.62	13.1
	DTW → 5.22 ft						
1247	10 L	5.07	0.577	1.18	0.20	9.89	49.7
	Rate = .375 LPM		DTW = 5.22				
1254	12L	4.99	0.578	1.32	0.17	10.05	92.1
	DTW → 5.22 ft		Rate = 0.375 LPM				
1303	16L	5.00	0.575		0.17	9.95	136.0
	DTW = 5.25'						
1309	18.5L	4.99	0.575	2.06	0.17	10.07	169.0
1319	23L	4.97	0.574	1.43	0.16	9.98	215.4
1325	26L	5.17	0.592	1.02	0.16	9.94	208.2
	DTW → 5.25		Rate = 0.375				

* redox did not stabilize, sampled after 1 hour

TB (circled)

Remarks:

Project Name: Shepley's Hill Landfill
Job Number: 284350.OM.02
Field Team: TB & CL
Field Conditions: · Clear, ~45°

Sampling Event: Devens GW
Date: 1/20/06
Page 1 of 1

Well/Sample Number: SHM-93-22B
Start Time: 13:45 start purging
Initial Depth to Water: 4.56 ft TOC
Measure Point: (Well TOC) Steel Casing

Vertical Profiling

Depth ft below TOC	Time	pH	Conductivity mS/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh / ORP mv

Remarks:

Purge Method: (Geopump) Ded. Pump Other

Split Sample ID: 012006-SHM93-22B
Split Time: 14:30
~~Duplicate Sample ID~~ —
~~Dupl. Time~~ —

Flow Cell: (Y) N
Min. Purge Volume (gal)/(L):
Purge Rate (gpm)/(mLpm): 0.375

Time	Vol. Purged gallons / liters	pH	Conductivity mS/cm	Turbidity NTU	Diss. Oxygen mg/L	Temp. °C	Eh / ORP mv
13:53	3L	6.19	0.554	4.06	0.17	9.31	-106.0
DTW: 4.56	Purge rate: 0.375						
14:04	7L	6.19	0.555	4.21	0.17	9.42	-112.0
DTW: 4.56	Purge Rate: 0.375						
14:11	10L	6.08	0.560	3.2	0.17	9.78	-114.4
DTW: 4.56	Purge rate: 0.375						
14:17	12L	5.78	0.560	3.0	0.17	9.80	-114.5
DTW 4.56	Purge Rate: 0.375						
14:21	13L	5.63	0.560	2.6	0.17	9.87	-114.3
14:25	14.5L	5.54	0.559	2.73	0.17	9.90	-114.0
DTW 4.56	Rate: 0.375						

Remarks: sample @ 1430

SHM-93-22C 1 OF 2

Field Data Sheets for Low Flow Ground Water Sampling

Project Name: SHepley CF
Project Number: 284350
Sample Source (Well No./Location) SHM-93-22C
Date: 1/25/06
Weather Conditions Clear 50°F
PID NA (ppm) Condition good
Sample Team TB/DR

Well Stabilization Data

Well Depth ______ (FT.) Datum ______
Static Water Level 6.10* (FT.) Diameter: 4"
Water Column ______ (FT.) Purge Method: ~~Peristaltic Pump~~ (TB) Redi Flow II

Time Purging begins (T_o): 1330
Water Level at time T_o: 6.10*
Time Purging ends: (T_1) 1515*
Water Level at time T_1: 48.29*

Time	Volume Removed	pH +/- 0.1	~~SP~~COND(mS/cm) (TB) +/- 3%	TEMP.(C) +/- 0.2 or 3%	Redox (mV) +/- 10 mV	Water level (Ft) < 0.3 ft	D.O. (mg/L) +/- 10%	Turbidity (NTU) < 5 NTU	Purge rate (Lpm) 0.3 to 0.5LPM	Appearance	
1400	48L					37.15			0.8		
1420		8.72	.236	10.82	73.5	45.93	NOT** WORKING	5.79	0.7	Clear	Hz
1423		8.61	.242	10.75	0.9	46.02			0.7	↓	164.4
1429		8.52	.249	10.88	-113.5	46.26		4.93	0.7		
1440		8.60	.262	10.85	-154.2	46.78			0.7		
1445		8.60	.270	10.82	-175.4	47.37		5.33	0.7		
1458	↖	8.55	.279	10.85	-199.8	47.93		5.01	0.7	↓	163.2
	72L										

SAMPLING

Date: __/____/____
Time: ______
Field Filtering: ______
Sampling Methodology: Low Flow Sampling
Laboratory: Method of Shipment:
Remarks:

Analysis: See Pg. 2

Diameter (inch)	Gallon / Foot	* delta w.t. (ft)	= volume lost (gallons)
1	0.040		
1.5	0.091		
2	0.163		
4	0.652		1gallon = 3.78 liters

* Start @ 1330; based on 11/04 Army Corp data large initial drop in water table (w.t.) so pumped @ high flow until 1342

** Generator powering redi-flow ran out of gas @ 1400, restarted @ 1415

SHM-93-22C 2 of 2

Field Data Sheets for Low Flow Ground Water Sampling

Project Name: Shepley LF
Project Number:
Sample Source (Well No./Location) SHM-93-22C
Date: 1/25/06
Weather Conditions Clear 50°F
PID N/A (ppm) Condition Good
Sample Team TB/DR

Well Stabilization Data

Well Depth ______ (FT.) Datum ______
Static Water Level 6.10* (FT.) Diameter: 4"
Water Column ______ (FT.) Purge Method: ~~Peristaltic Pump~~ Redi Flow II

Time Purging begins (T_0): 1330*
Water Level at time T_0: 6.10*
Time Purging ends: (T_1) 1515*
Water Level at time T_1: 48.46*

Time	Volume Removed	pH +/- 0.1	SPCOND(mS/cm) (TS) +/- 3%	TEMP.(C) +/- 0.2 or 3%	Redox (mV) +/- 10 mV	Water level (Ft) < 0.3 ft	D.O. (mg/L) +/- 10%	Turbidity (NTU) < 5 NTU	Purge rate (Lpm) 0.3 to 0.5LPM	Appearance
1505	77L	8.50	,282	10.86	-225.2	48.05	Not working	4.17	0.7	Clear
1510	81	8.52	.288	10.88	-230.0	48.18		4.21	↓	
1515	84L	8.49	,292	10.81	-235.1	48.29		4.18		
1530						~~Test~~ D.O				
				** *		w/ YSI 85	0.73			
						& Flow cell				

162.2

SAMPLING

Date: 1/25/06
Time: 1515
Field Filtering: NO
Sampling Methodology: Low Flow Sampling
Laboratory: Method of Shipment:
Remarks:

Analysis:
ID = 012506 - SHM 93-22C
Metals, VOC, Hardness
TCN, TDS, Cl, NO_3, SO_4
Alk, BOD, COD, TOC

Diameter (inch)	Gallon / Foot	* delta w.t. (ft)	= volume lost (gallons)
1	0.040		
1.5	0.091		
2	0.163		
4	0.652		1gallon = 3.78 liters

Appendix C

Comparison of Arsenic Results

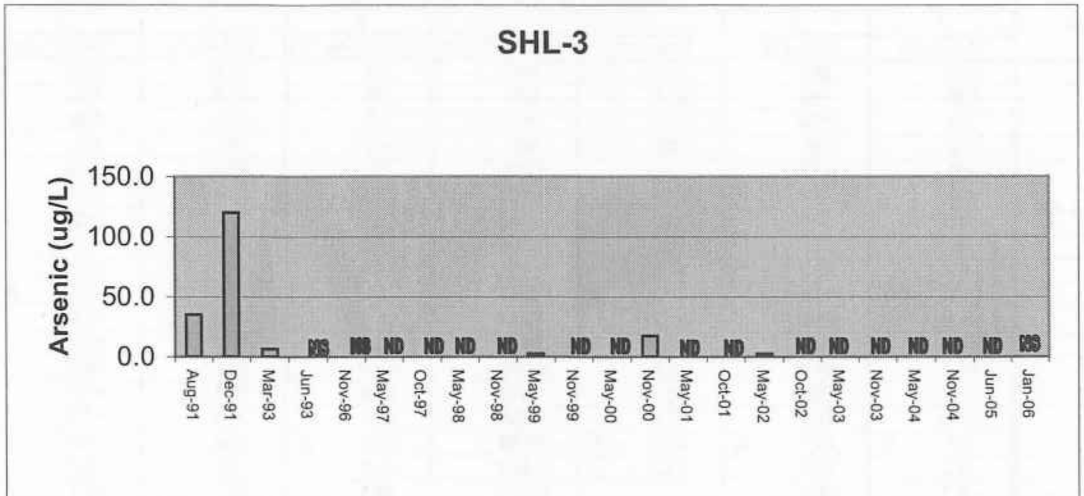
Table 7-4
Comparison of Historic Arsenic Concentrations (ug/L)
Shelpey's Hill Landfill Compliance Point Wells
Devens, Massachusetts

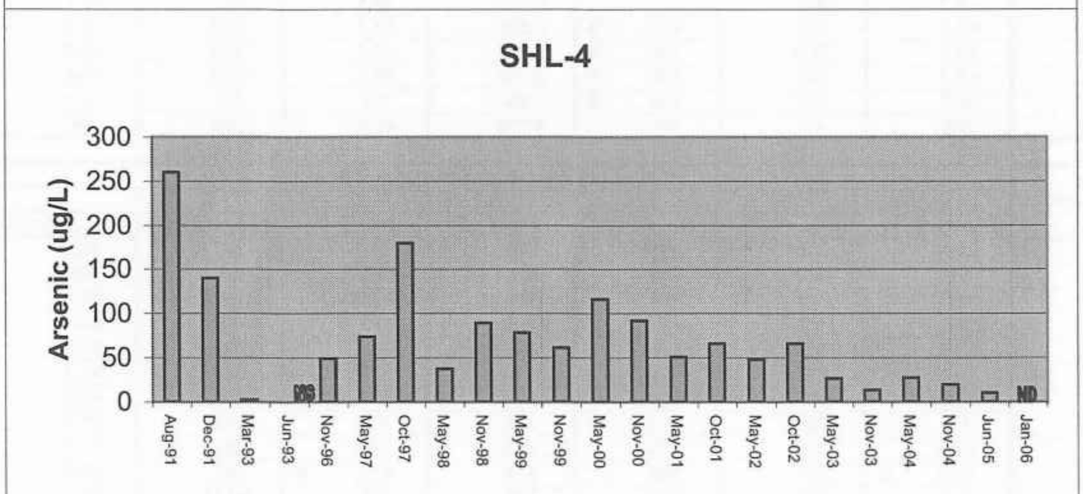
Sample	Monitoring Well ID (group designation)						
Well Group #	2	2	2	2	2	2	2
Date	SHL-3 (1)	SHL-4 (2)	SHL-5 (1)	SHM-96-5B (2)	SHM-96-5C (2)	SHL-9 (1)	SHL-10 (2)
Aug-91	35.0	**260**	23.0	NS	NS	37.0	**67.0**
Dec-91	**120**	**140**	38.0	NS	NS	**67.0**	**120**
Mar-93	6.5	2.54	11.4	NS	NS	42.4	**280**
Jun-93	NS	NS	NS	NS	NS	NS	NS
Nov-96	NS	48.8	12.0	**1,440**	71	46.9	3.4 B
May-97	<10	**73.6** J	<10	**3,300** J	43.2	16.1 J	<10
Oct-97	<10	**180**	<10	**2,040**	43.1	25.2	**209**
May-98	<5	37.4	<5	**4,300**	49.5	15.0	<5
Nov-98	<5.4	**89.1**	11.5	**3,080**	46.8	27.2	<5.4
May-99	2.7 B	**78.2**	5.0 B	**3,490**	**57**	**71.3**	2.7 B
Nov-99	<1.9	**61.3**	6.5	**2,700**	44.8	28.5	<1.9
May-00	<2.5	**116**	<2.5	**5,110**	**52.2**	15.0	<2.5
Nov-00	17.4	**91.5**	13.8	**2,500**	40.3	31.4	<4.2
May-01	<4.1	**50.8**	13.8	**3,800**	**80.5**	15.1	<4.1
Oct-01	<1.5	**66.0**	14.8	**1,850**	41.1	28.1	<1.5
May-02	2.8 B	47.8 B	11.9 B	**3,800**	**50.4** B	**144**	4.0 B
Oct-02	<3.2	**66.1**	<3.2	**1,970**	41.3	29	<3.2
May-03	<4.7	26.6	7.3	**3,920**	**55.1**	13.4	<4.7
Nov-03	<4.1	13.4	4.7 B	**3,380**	48.3	30.6	<4.1
May-04	<2.6	27.2	7.4 B	**3,950**	47.1	19.8	<2.6
Nov-04	<5.8	19.5	6.8 B	**2,110**	49.5	32.2	<5.8
Jun-05	<4.5	10.1	7.0 B	NS	NS	NS	<4.5
Jan-06	NS	<5	<5	**4,130**	43.0	18.0	<5

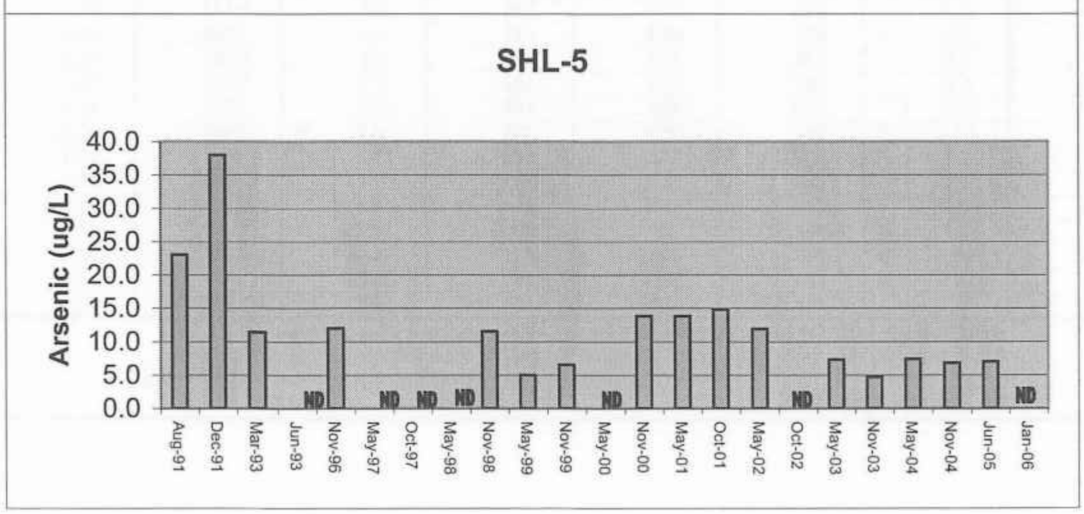
Sample	Monitoring Well ID (group designation)						
Well Group #	2	2	2	2	2	2	2
Date	SHM-93-10C (1	SHL-11 (2)	SHL-19 (2)	SHL-20 (2)	SHL-22 (1)	SHM-93-22B (2	SHM-93-22C (1)
Aug-91	NS	**320**	**340**	**98**	27	NS	NS
Dec-91	NS	**320**	**710**	**89**	25	NS	NS
Mar-93	21.3	**340**	**390**	**330**	32.9	NS	**68.9**
Jun-93	18.1	NS	NS	NS	NS	NS	49.8
Nov-96	12.4	**332**	**138**	**244**	24.8	**324**	44.6
May-97	<10	**252** J	**<10**	**<10**	<10	**318** J	40.4
Oct-97	10.5	**366**	**298**	**227**	34.8	**352**	<10
May-98	7.5	**346**	**77.5**	**238**	10.6	**365**	31.6
Nov-98	10.2	**376**	**145**	**218**	<5.4	**406**	51.1
May-99	10.8 B	**431**	**156**	**216**	12.2 B	**707**	42.8
Nov-99	8.7	**492**	**176**	**215**	7.3	**1,440**	33.2
May-00	5.9 J	**404**	**41.4**	**216**	14.6	**1,360**	34.4
Nov-00	8.8	**523**	**154**	**172**	45	**1,180**	47.8
May-01	6.9	**487**	**129**	**186**	47.6	**1,540**	19.7
Oct-01	10.1	**573**	**183**	**165**	44.2	**1,670**	31.6
May-02	11.0 B	**469**	**66.9**	**154**	**55.9** B	**2,040**	30.5 B
Oct-02	7.1	**648**	**164**	**175**	**77.1**	**159**	30.1
May-03	9.8	**498**	36.1	**197**	**101**	**2,070**	21.0
Nov-03	<5.2	**639**	**83.6**	**194**	**76.4**	**2,500**	29.8
May-04	7.2 B	**502**	**75**	**136**	**88.1**	**1,690**	27.8
Nov-04	10.6 B	**617**	**121**	**156**	**65.4**	**2,360**	34.9
Jun-05	8.1 B	**524**	26.3	**159**	NS	NS	15.8
Jan-06	11.0	**567**	**156**	**189**	**154**	**3,320**	23.0

Notes:
Bold Number indicates cleanup level exceedances (MCL cleanup level is 50 ug/L)
B = Value within five times of the greater amount detected in the equipment or preparation blank
J = Estimated value <5 = Concentration less than the indicated method detection limit
NS = Not Sampled

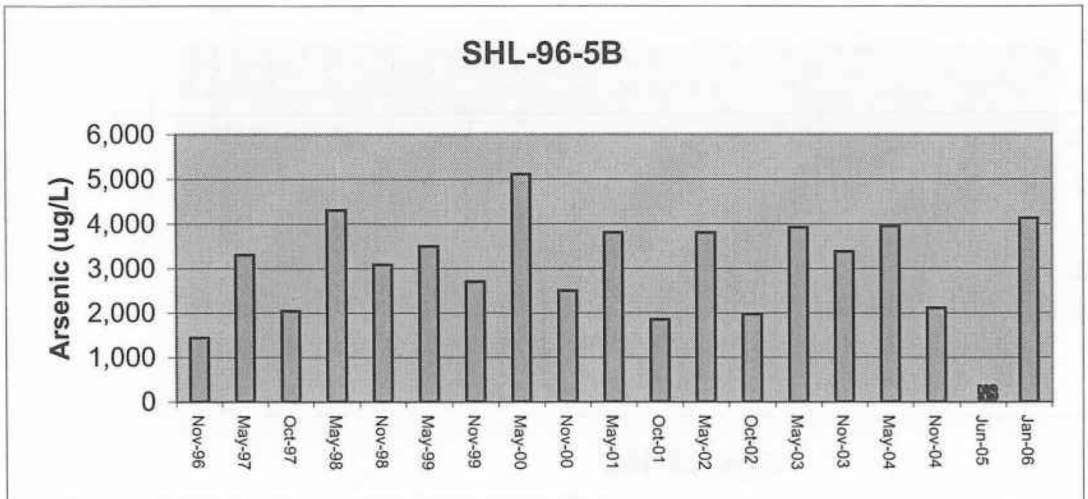
Shepley's Hill Landfill Historic Arsenic Groundwater Concentrations (ug/L)

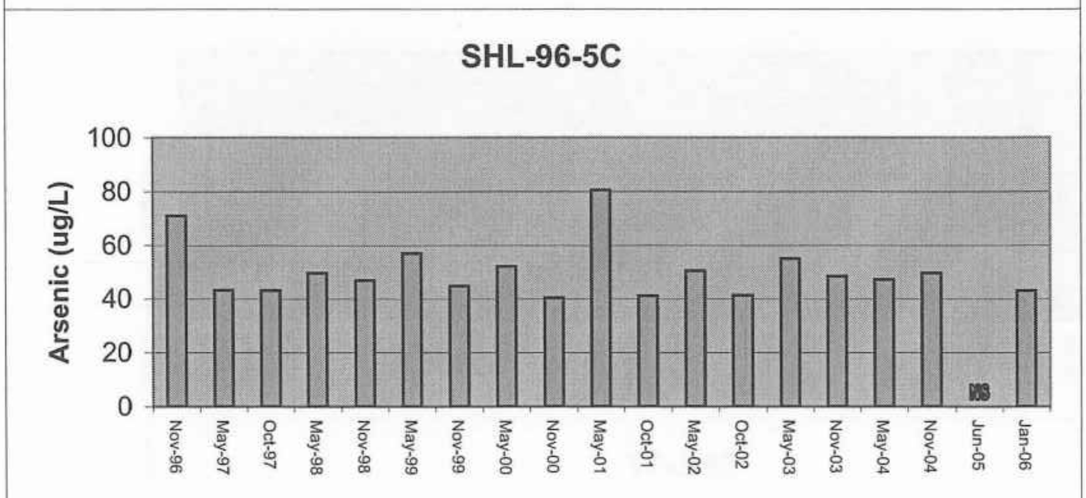


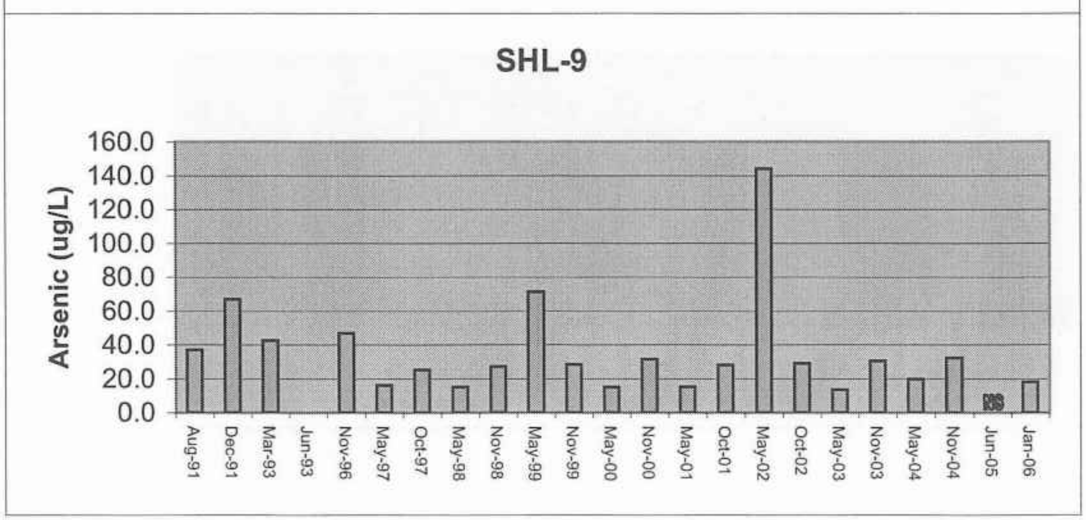




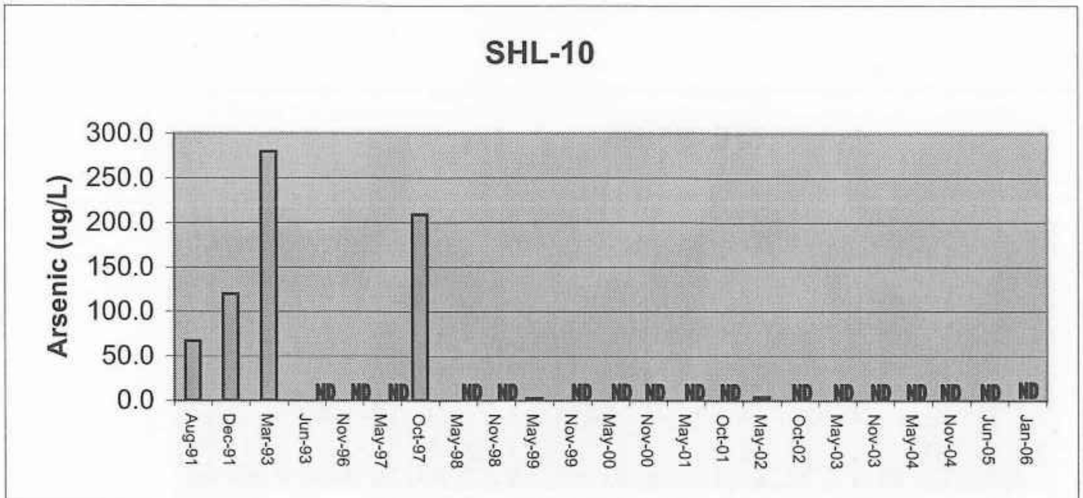
Shepley's Hill Landfill Historic Arsenic Groundwater Concentrations (ug/L)

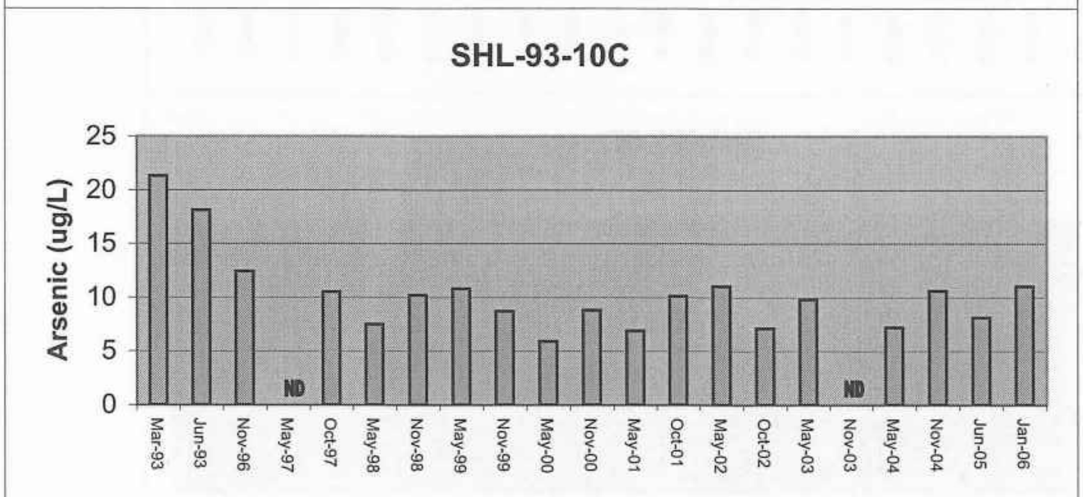


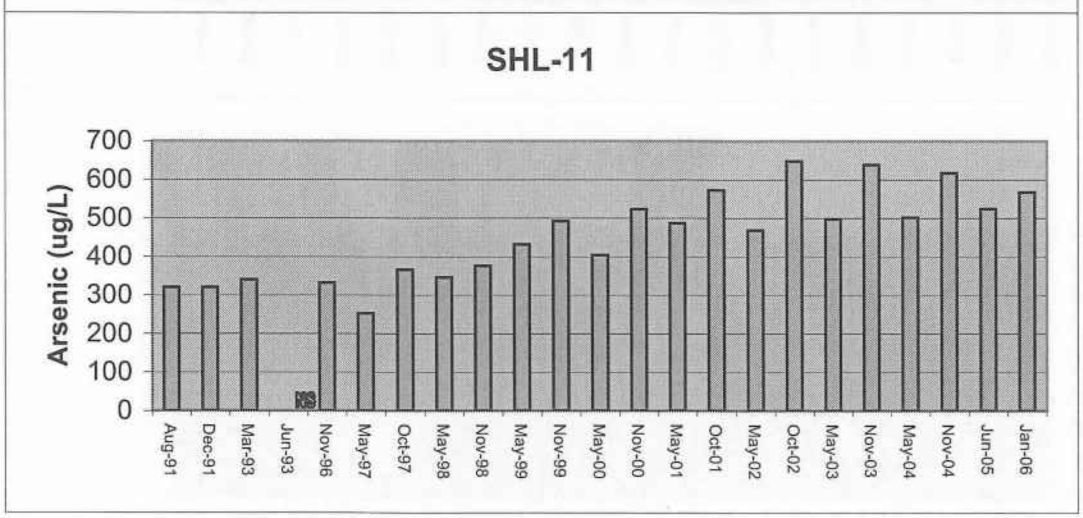




Shepley's Hill Landfill Historic Arsenic Groundwater Concentrations (ug/L)

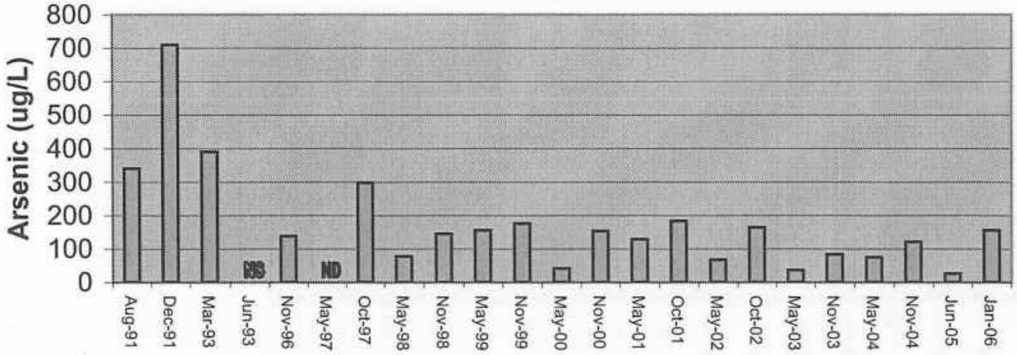




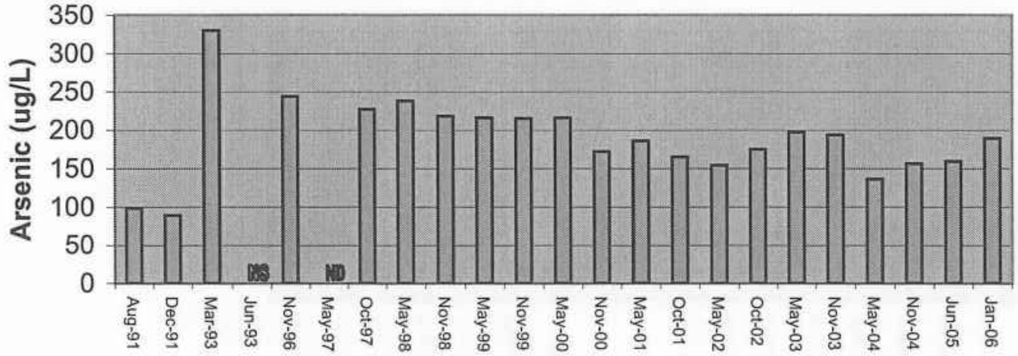


Shepley's Hill Landfill Historic Arsenic Groundwater Concentrations (ug/L)

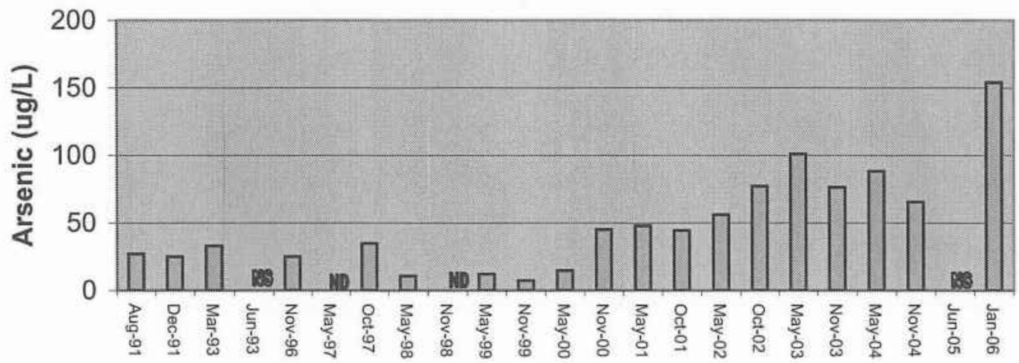
SHL-19



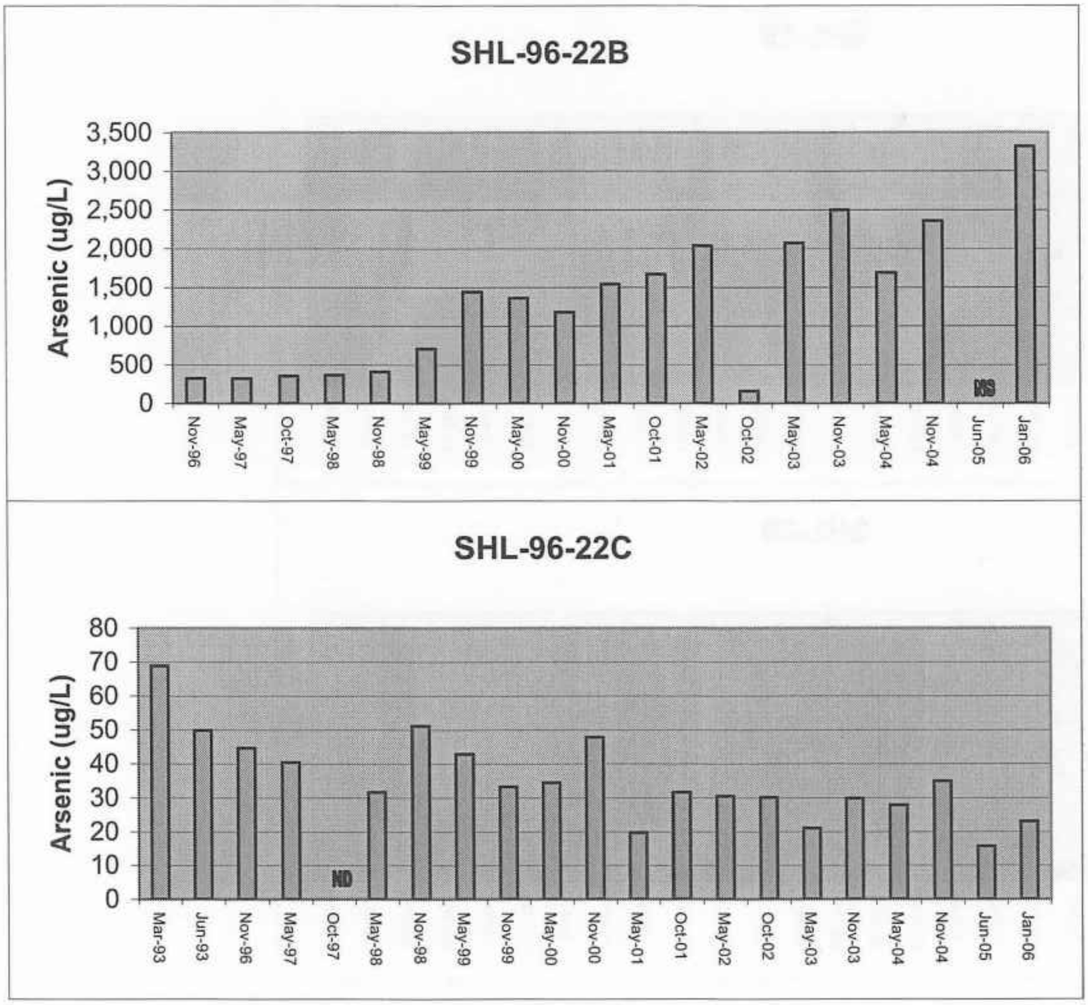
SHL-20



SHL-22



Shepley's Hill Landfill Historic Arsenic Groundwater Concentrations (ug/L)



Appendix D

Data Quality Evaluation and Chemical Quality Analysis Reports

June 2005 Monitoring

Data Evaluation Report
For
Shepley's Hill Landfill, Fort Devens, MA
Long Term Monitoring Groundwater Samples
Samples Collected June 2005

Introduction

Nine total groundwater samples were collected were collected from Shepley's Hill Landfill at the former Fort Devens, Ayer, Massachusetts. The samples were analyzed at Severn Trent Laboratories (in Colchester VT) for Volatile Organic Compounds (VOCs), Project specific Metals, Alkalinity, Anions (Nitrate, Phosphate, Sulfate, and Chloride), Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Total Hardness, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Cyanide and Total Organic Carbon (TOC). The samples were collected on June 6 and 7, 2005 (see Groundwater Analytical Results Table.

Laboratory reports were reviewed for adherence to acceptable laboratory practices. The data evaluation elements reviewed include sample shipment temperatures, holding times, blank sample results, surrogate recoveries, LCS/LCSD recoveries and precision, MS/MSD recoveries and precision, and precision between sample duplicates.

The results were evaluated for acceptability in accordance with the laboratory's defined acceptance limits, with standard EPA SW846 guidance, with guidelines provided in EM 200-1-3, Appendix I "Shell For Analytical Requirements", dated 1 February 2001, and/or EM 200- 1 - 10 (DRAFT/Final), "Guidance for Evaluating Performance Based Chemical Data Packages".

Sample Shipment and Receipt

All sample coolers were packed with ice in the field. Sample shipments were received at the laboratory on June 7 and 8, 2005. All samples were appropriately preserved. There are no sample shipment or receipt anomalies associated with these samples.

Data Qualification by Method

Volatile Organic Compounds (VOCs, SW-846 Method 5030/8260B)

SAMPLES :

SHL- 19 - Results for 2-butanone, acetone and xylenes are qualified ("J") estimated due to low matrix spike duplicate recovery, low matrix spike recovery, and low matrix spike recovery and high RPD between MS and MSD, respectively.

SHL-11-DUP - Due to equipment blank contamination, the reported value for acetone for this sample, 2.4 J ug/L, is elevated to the reporting limit for acetone and is reported as 5.0 U ug/L.

Metals (SW-846 Method 601 0B; Mercury Method 7470)

No data review qualifiers were applied. All data is acceptable and useable as reported.

Alkalinity (Method 310.1)

All alkalinity results are qualified as ("J") estimated due to holding time exceedance of date of sampling to date of analysis.

Biological oxygen Demand (BOD_5, EPA Method 405.1)

No data review qualifiers were applied. All data is acceptable and useable as reported.

COD (Method 410.4)

No data review qualifiers were applied. All data is acceptable and useable as reported.

Anions (Method 300.0)

SAMPLES:

SHL-3 - Due to equipment blank contamination, the reporting limit for chloride is elevated to the level found in the sample and reported as 690 U ug/L.

SHL-5 - Due to equipment blank contamination, the reporting limit for sulfate is elevated to the level found in the sample and reported as 910 U ug/L.

SHL-10 - Due to equipment blank contamination, the reporting limit for chloride is elevated to the level found in the sample and reported as 1,100 U ug/L.

SHL-11 - Due to equipment blank contamination, the reporting limit for sulfate is elevated to the level found in the sample and reported as 880 U ug/L

SHL-11 DUP - Due to equipment blank contamination, the reporting limit for sulfate is elevatedto the level found in the sample and reported as 1,200 U ug/L.

SHL-19 - Due to equipment blank contamination, the reporting limit for chloride is elevated to the level found in the sample and reported as 1,100 U ug/L.

All sample results for nitrate are qualified. Due to equipment blank contamination, the reporting limit for nitrate is elevated to the level found in each sample and reported as ("U").

Hardness as $CaC0_3$ (Method 130.2)

No data review qualifiers were applied. All data is acceptable and useable as reported.

Total Cyanide (EPA Method 335.4)

No data review qualifiers were applied. All data is acceptable and useable as reported.

TDS (Method 160.1)

No data review qualifiers were applied. All data is acceptable and useable as reported.

TSS (Method 160.2)

No data review qualifiers were applied. All data is acceptable and useable as reported.

Total Organic Carbon (SW-846 Method 9060)

No data review qualifiers were applied. All data is acceptable and useable as reported.

CHEMICAL QUALITY ASSURANCE REPORT

LONG TERM GROUNDWATER MONITORING AT
SHEPLEY'S HILL LANDFILL
DEVENS, MASSACHUSETTS
JUNE 2005 SAMPLING ROUND

PREPARED BY
DAVID LUBIANEZ
OF THE
GEOLOGY & CHEMISTRY SECTION
ENGINEERING/PLANNING DIVISION

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS

MARCH 3, 2006

CHEMICAL QUALITY ASSURANCE REPORT

LONG TERM GROUNDWATER MONITORING AT SHEPLEY'S HILL LANDFILL DEVENS, MASSACHUSETTS JUNE 2005 SAMPLING ROUND

One groundwater QA sample from Shepley's Hill Landfill Long Term Monitoring, Devens Massachusetts project was analyzed by the QA laboratory, resulting in a total of 37 target determinations. In 24 of these determinations analytes were detected by one or both laboratories. Results from the analysis of QA samples were compared with results from analyses of the corresponding primary samples.

All primary lab analyses were performed by Severn Trent Laboratories, Inc., Colchester, VT. Analyses performed were VOCs; trace metals, aluminum, arsenic, barium, cadmium, chromium, copper, iron, manganese, lead, nickel, silver, selenium, sodium, zinc, and mercury; total dissolved solids (TDS), chloride, nitrate, sulfate, alkalinity, total cyanide, biological oxygen demand (BOD), total organic carbon (TOC), total suspended solids (TSS) and chemical oxygen demand (COD). QA laboratory analyses were performed by AMRO Environmental Laboratories, Merrimack, NH.

Comparability and agreement was evaluated and expressed in terms of relative percent difference (RPD). For all analyses, RPD values greater than or equal to 75% RPD constituted a data discrepancy. For VOCs and metals, only project specific targets were used for comparison.

The primary and QA samples agreed overall in 33 (89%) of the comparisons. Primary and QA samples agreed quantitatively in 19 out of 24 (79%) of the comparisons. Refer to Table 1 for a QA split sample data comparison summary. Quantitative agreement represents only those determinations where analyte was detected by at least one laboratory.

Primary laboratory QC was evaluated and reported in the data evaluation report. See that report for findings. QA laboratory data was evaluated for custody, holding times, and laboratory QC compliance and found to be within criteria except as noted: sample SHL-11 had the pH adjusted to >12 upon receipt at the laboratory and the analysis for nitrate was performed outside of holding time. These discrepancies could result in possible low bias. Any other noted QC anomalies did not seriously impact the QA data or its usability and are not considered significant. None of the above noted QC issues significantly impact the usability of the QA data. All QA data is acceptable for its intended use and data comparison between laboratories exhibits mostly good agreement except for metals, which exhibited only fair agreement.

Table 1

Quality Assurance Split Sample Data Comparison Summary

Project: Shepley's Hill Landfill, LTM , Devens, Massachusetts

	Overall Agreement (1)		Quantitative Agreement (2)	
Test Parameter	**Number**	**Percent**	**Number**	**Percent**
VOC	12/12	100	3/3	100
Trace Metals	11/15	73	6/11	54
TDS	1/1	100	1/1	100
Chloride	1/1	100	1/1	100
Nitrate	1/1	100	1/1	100
Sulfate	1/1	100	1/1	100
Alkalinity	1/1	100	1/1	100
Total Cyanide	1/1	100	1/1	100
BOD	1/1	100	1/1	100
COD	1/1	100	1/1	100
TOC	1/1	100	1/1	100
TSS	1/1	100	1/1	100
Total	33/37	89	19/24	79

NOTES:

(1) Represents the number and percentage agreement of all determinations including analytes not detected by either laboratory.

(2) Represents the number and percentage agreement of only those determinations where an analyte was detected by at least one laboratory.

Groundwater Analytical Results - June 6-7, 2005 Sampling Event
Shepley's Hill Landfill
Devens, Massachusetts
(Sheet 1 of 1)

PARAMETERS	Well No. CLEANUP LEVEL (1) µg/L	SHL-11 µg/L	SHL-11-QA µg/L	RPD
VOLATILES (8260B)				
1,1-Dichloroethane	70 (4)	5.0 U	2.0 U	N/A
1,2-Dichlorobenzene	600	5.0 U	2.0 U	N/A
1,2-Dichloroethane	5	5.0 U	5.0 U	N/A
1,2-Dichloroethene (total)	70 (2)	1.4 J	1.2 J	15
1,3-Dichlorobenzene	600 (2)	5.0 U	2.0 U	N/A
1,4-Dichlorobenzene	5	5.0 U	1.6 J	N/A
2-Butanone	-	5.0 U	10 U	N/A
4-Methyl-2-Pentanone	-	5.0 U	10 U	N/A
Acetone	3,000 (4)	5.0 U	10 U	N/A
Benzene	5 (2)	1.5 J	1.4	7
Methyl-t-Butyl Ether	70 (4)	5.0 U	2.0 U	N/A
Xylenes	10,000 (2)	5.0 U	2.0 U	N/A
METALS (6010B or as noted)				
Aluminum	6,870	88 U	480	N/A
Arsenic	50	**524**	**527**	1
Barium	2,000 (2)	78.5 B	67 U	16
Cadmium	5 (2)	0.6 U	5.0 U	N/A
Chromium	100	1.2 U	10.0 U	N/A
Copper	1,300 (3)	6.6 B	4.82 J	31
Iron	9,100	**59400**	**57000**	4
Lead	15	4.8	1.1 J	125
Manganese	1,715	**2380**	**2410**	1
Mercury (7470A)	2 (2)	0.1 U	0.2 U	N/A
Nickel	100	3 U	4.94 J	N/A
Selenium	50 (2)	3.8 U	5.0 U	N/A
Silver	40 (4)	1.8 U	2.36 J	N/A
Sodium	20,000	**21600**	**21100**	2
Zinc	2,000 (4)	5 B	27.4	138
GENERAL CHEMISTRY				
Alkalinity as $CaCO_3$	-	201,000	170,000	17
Biochemical Oxygen Demand	-	1,400	2,000 U	N/A
Chloride	-	23,900	25,000	4
Chemical Oxygen Demand	-	20,000 U	16,000 J	N/A
Cyanide (Total)	200 (2)	10 U	5.0 J	N/A
Hardness as $CaCO_3$	-	127,000	123,000	3
Nitrate as Nitrogen	10,000 (2)	420 U	51 J	N/A
Sulfate	500,000 (2)	880 U	730 J	N/A
Total Dissolved Solids	-	585,000*	380,000	42
Total Suspended Solids	-	33,100	21,000	45
Total Organic Carbon	-	3,600	3,600	0

Notes:

Shaded areas with bold numbers indicate cleanup level exceedance -

B = value within 5 times of the greater amount detected in the equipment or preparation blank samples

B (inorganics)= value below PQL but above IDL

J = estimated value

U = Below laboratory RL

*** = duplicate analysis Relative Percent Difference outside acceptance limits**

N/A = not applicable

January 2006 Monitoring

Fort Devens
2005 Annual Shepley's Hill Sampling
Data Quality Evaluation Report

Introduction

The objective of this Data Quality Evaluation (DQE) report is to assess the data quality of analytical results for water samples collected for Fort Devens during the 2005 Annual Shepley's Hill sampling event. Individual method requirements, guidelines from the USEPA Contract Laboratory National Functional Guidelines for Inorganic Data Review, July 2002 (NFG) were used in this assessment.

This report is intended as a general data quality assessment designed to summarize data issues.

Analytical Data

This DQE report covers 17 normal (N) and one field duplicate (FD) environmental samples. These samples were reported under three sample delivery groups. Samples were collected between January 19 and January 25, 2006 and delivered to the laboratory the same day as collection. Alpha Analytical Laboratories (APHW) in Westborough, Massachusetts performed the analyses. Selected samples were analyzed for the following analytes/methods:

Table 1
Analytical Parameters

Parameter	Method	Laboratory
Total Alkalinity	A2320B	APHW
Total Dissolved Solids	A2540C	APHW
Total Suspended Solids	A2540D	APHW
Total Cyanide	SW9014	APHW
Chloride	SW9251	APHW
Nitrogen, Nitrate	A4500	APHW
Sulfate	SW9038	APHW
Chemical Oxygen Demand	A5220D	APHW
Biochemical Oxygen Demand (5-day)	A5210B	APHW
Total Organic Carbon	SW9060	APHW
Hardness	A2340B	APHW
Methylene Chloride	SW8260B	APHW
1,1-Dichloroethane	SW8260B	APHW
Chloroform	SW8260B	APHW
Carbon Tetrachloride	SW8260B	APHW
1,2-Dichloropropane	SW8260B	APHW

Table 1
Analytical Parameters

Parameter	Method	Laboratory
Dibromochloromethane	SW8260B	APHW
1,1,2-Trichloroethane	SW8260B	APHW
Tetrachloroethene	SW8260B	APHW
Chlorobenzene	SW8260B	APHW
Trichlorofluoromethane	SW8260B	APHW
1,2-Dichloroethane	SW8260B	APHW
1,1,1-Trichloroethane	SW8260B	APHW
Bromodichloromethane	SW8260B	APHW
trans-1,3-Dichloropropene	SW8260B	APHW
cis-1,3-Dichloropropene	SW8260B	APHW
1,1-Dichloropropene	SW8260B	APHW
Bromoform	SW8260B	APHW
1,1,2,2-Tetrachloroethane	SW8260B	APHW
Benzene	SW8260B	APHW
Toluene	SW8260B	APHW
Ethylbenzene	SW8260B	APHW
Chloromethane	SW8260B	APHW
Bromomethane	SW8260B	APHW
Vinyl Chloride	SW8260B	APHW
Chloroethane	SW8260B	APHW
1,1-Dichloroethene	SW8260B	APHW
trans-1,2-Dichloroethene	SW8260B	APHW
Trichloroethene	SW8260B	APHW
1,2-Dichlorobenzene	SW8260B	APHW
1,3-Dichlorobenzene	SW8260B	APHW
1,4-Dichlorobenzene	SW8260B	APHW
Methyl tert butyl ether	SW8260B	APHW
m,p-Xylene	SW8260B	APHW
o-Xylene	SW8260B	APHW
cis-1,2-Dichloroethene	SW8260B	APHW
Dibromomethane	SW8260B	APHW
1,2,3-Trichloropropane	SW8260B	APHW
Styrene	SW8260B	APHW
Dichlorodifluoromethane	SW8260B	APHW
Acetone	SW8260B	APHW
Carbon disulfide	SW8260B	APHW

Table 1
Analytical Parameters

Parameter	Method	Laboratory
2-Butanone	SW8260B	APHW
4-Methyl-2-pentanone	SW8260B	APHW
2-Hexanone	SW8260B	APHW
Bromochloromethane	SW8260B	APHW
Tetrahydrofuran	SW8260B	APHW
2,2-Dichloropropane	SW8260B	APHW
1,2-Dibromoethane	SW8260B	APHW
1,3-Dichloropropane	SW8260B	APHW
1,1,1,2-Tetrachloroethane	SW8260B	APHW
Bromobenzene	SW8260B	APHW
n-Butylbenzene	SW8260B	APHW
sec-Butylbenzene	SW8260B	APHW
tert-Butylbenzene	SW8260B	APHW
o-Chlorotoluene	SW8260B	APHW
p-Chlorotoluene	SW8260B	APHW
1,2-Dibromo-3-chloropropane	SW8260B	APHW
Hexachlorobutadiene	SW8260B	APHW
Isopropylbenzene	SW8260B	APHW
p-Isopropyltoluene	SW8260B	APHW
Naphthalene	SW8260B	APHW
n-Propylbenzene	SW8260B	APHW
1,2,3-Trichlorobenzene	SW8260B	APHW
1,2,4-Trichlorobenzene	SW8260B	APHW
1,3,5-Trimethylbenzene	SW8260B	APHW
1,2,4-Trimethylbenzene	SW8260B	APHW
Ethyl ether	SW8260B	APHW
Isopropyl ether	SW8260B	APHW
Ethyl tert butyl ether	SW8260B	APHW
Tertiary amyl methyl ether	SW8260B	APHW
1,4-Dioxane	SW8260B	APHW
Total Aluminum	SW6010B	APHW
Total Arsenic	SW6010B	APHW
Total Barium	SW6010B	APHW
Total Cadmium	SW6010B	APHW
Total Chromium	SW6010B	APHW
Total Copper	SW6010B	APHW

Table 1
Analytical Parameters

Parameter	Method	Laboratory
Total Iron	SW6010B	APHW
Total Manganese	SW6010B	APHW
Total Mercury	SW7470A	APHW
Total Nickel	SW6010B	APHW
Total Silver	SW6010B	APHW
Total Sodium	SW6010B	APHW
Total Zinc	SW6010B	APHW

The assessment of data includes a review of: (1) the Chain-of-Custody (CoC) documentation; (2) holding time compliance; (3) the required quality control (QC) samples at the specified frequencies; (4) flagging for method blanks; (5) laboratory control spiking samples (LCS); (6) analytical spike data; (7) matrix spike/matrix spike duplicate (MS/MSD) samples; and (8) flagging for equipment blank.

Data flags were assigned according to the NFG. Multiple flags are routinely applied to specific sample method/matrix/analyte combinations, but there will be only one final flag. A final flag is applied to the data and is the most conservative of the applied validation flags. The final flag also includes matrix and blank sample impacts.

The data flags are those listed in the NFG and are defined below:

- J = Analyte is present but the reported value may not be accurate or precise (estimated).
- R = The data are unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.
- U = Analyte was not detected at the specified detection limit.
- UJ = Analyte was not detected and the specified detection limit may not be accurate or precise (estimated).

Findings

The overall summaries of the data validation findings are contained in the following sections:

Holding Times

All holding-time criteria were met.

Method Blanks

Method blanks were analyzed at the required frequency and were free of contamination.

Equipment Blank

An equipment blank was collected and analyzed at the required frequency. Methylene chloride, chloroform, and acetone were detected in the equipment blank. None of these target analytes were detected in any of the samples so no flags were applied.

Trip Blank

Trip blanks were collected and analyzed at the required frequency. No target analytes were detected in the trip blanks so all acceptance criteria were met.

Field Duplicates

FDs were collected and analyzed at the required frequency. The relative percent differences (RPD) between the N and FD results met the acceptance criteria.

Laboratory Control Samples

Laboratory control sample/laboratory control sample duplicates were analyzed as required. Tetrahydrofuran was above the RPD limit but all samples were non-detects and no flagging is required per the NFG. Carbon tetrachloride and 1,2,3-trichloropropane was above the laboratory control limit but all samples were non-detects so no flags were applied. All other accuracy and precision criteria were met.

Matrix Spike/Matrix Spike Duplicate Samples

Matrix spike/matrix spike duplicates (MS/SD) were analyzed as required. Total mercruy did not meet MS/SD acceptance criteria for sample 011906-SHL19. The associated result was non-detect so no flags were applied. All other accuracy and precision criteria were met.

Chain of Custody

Methods outlined on the CoC were performed by the lab using the equivalent Standard Method. No other discrepancies were noted.

Completeness

Out of approximately 1350 points, there were no data points rejected due to QC exceedances, no data points were qualified as non-detect due to blank exceedances, and no data points were qualified as estimated due to QC exceedances. These numbers indicate that the overall completeness goals for the project were met and that the quality of the analytical program and laboratory is sufficient to meet the project data quality objectives.

Overall Assessment

The final activity in the data quality evaluation is an assessment of whether the data meets the data quality objectives. The goal of this assessment is to demonstrate that a sufficient number of representative samples were collected and the resulting analytical data can be used to support the decisionmaking process. The precision, accuracy, representativeness, completeness and comparability are addressed in the NFG. The following summary highlights the data evaluation findings for the above-defined events:

1. The completeness objectives were met for all method/analyte combinations.
2. There were no results qualified because of low-level blank contamination.
3. The precision and accuracy of the data, as measured by laboratory QC indicators, suggest that the NFG goals have been met.

Appendices E – G

CD Enclosed

Final On-Site Discharge Evaluation– Shepley's Hill Groundwater Extraction, Treatment, and Discharge System

PREPARED FOR: BRAC Clean-Up Team (BCT)

PREPARED BY: CH2M HILL

DATE: December 22, 2005

Introduction

CH2M HILL has conducted this evaluation for the Devens BRAC Environmental Office to evaluate on-site discharge for the Shepley's Hill Landfill Arsenic Treatment Plant (ATP). Currently, the treatment plant is constructed and includes a discharge pipeline across the landfill connected to the Devens Regional Waste Water Treatment Facility (DRWWTF) sewer system at the intersection of Cook and Antietam Streets. The Army BRAC Environmental Office has requested that CH2M HILL undertake an effort, expected to bring considerable life-cycle operational cost savings, to evaluate both surface water and groundwater discharge of treated water within the immediate area of the ATP.

This effort involved evaluation of the following elements:

- The hydraulics relating to both groundwater and surface water discharge;
- Applicable Relevent and Appropriate Requirements (ARARs);
- Potential treatment plant process needs.

To conduct this effort, CH2M HILL staff met with the Base Clean-Up Team (BCT) first to introduce the effort in early May. Following completion of the initial hydraulic modeling effort, CH2M HILL met with the BCT again at a technical meeting on June 2, 2005 to present findings, solicit input, and develop a short list of alternatives to carry forward for further evaluation. A draft technical memorandum, dated June 29, 2005 was prepared and presented at the BCT on June 30, 2005. DEP and EPA submitted formal comments, dated August 12, 2005 and September 16, 2005, respectively. Responses to these comments were provided to the BCT and on-site discharge was discussed further at the October 6, 2005 BCT meeting.

The following sections of this technical memorandum (Tech Memo) present the hydraulic modeling analysis, applicable relevant and appropriate requirements (ARARs), potential process needs, a summary feasibility screening comparison, and recommendations based on the analysis conducted and responses to comments on the draft analysis from the BCT.

Hydraulic Modeling Analysis

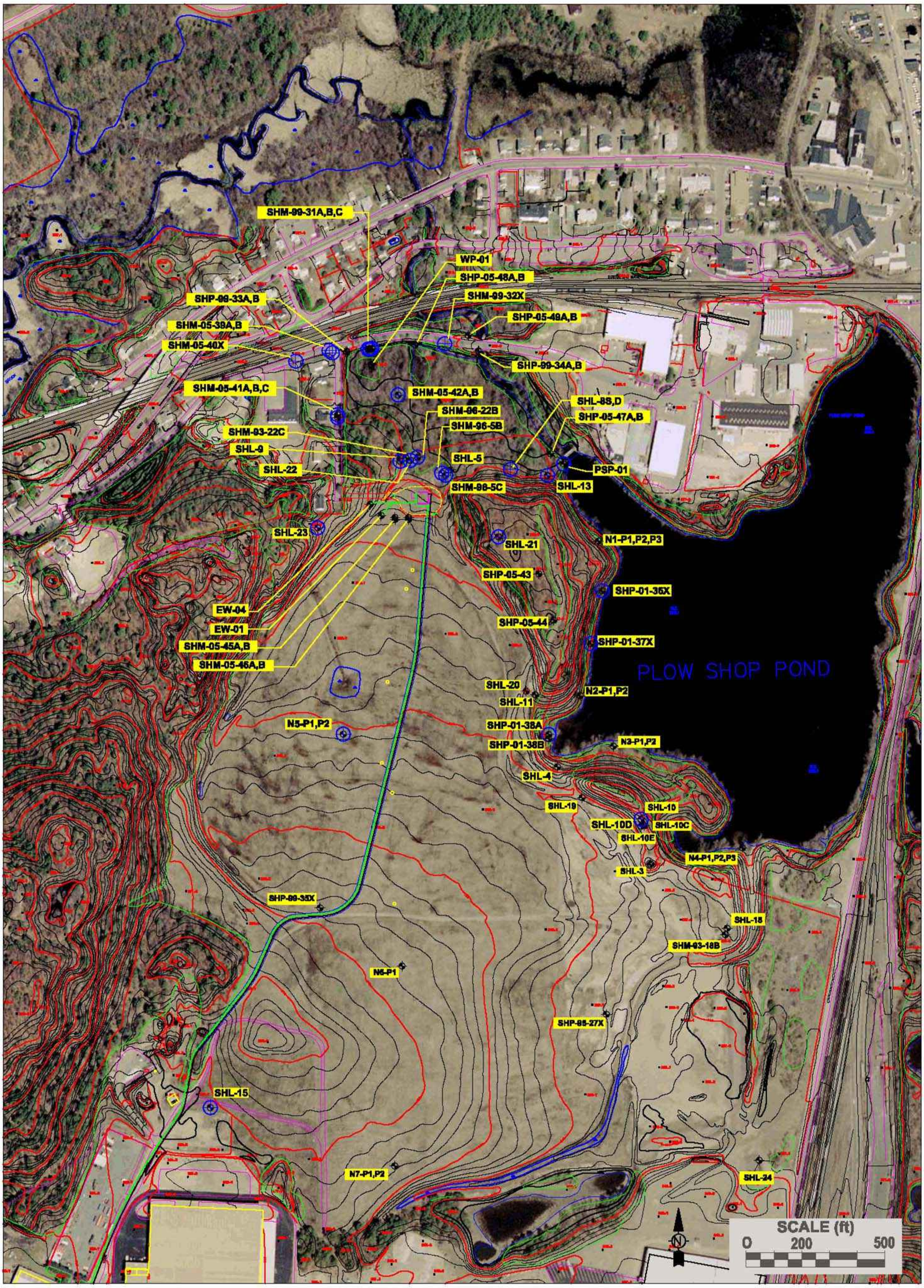
The Shepley's Hill landfill groundwater model developed over several years by the Army (HLA, 2003) was utilized for the design of the extraction well field installed north of the landfill during the winter of 2004/2005. Details of the design basis are provided in the Remedial Design and Remedial Action Workplan, Groundwater Extraction, Treatment, And Discharge Contingency Remedy, Final 100% Submittal (CH2M HILL, 2005).

Figure 1 provides a map depicting the location of two extraction wells (EW-01 and EW-04) that will be operated at a total cumulative rate of 25 gallons per minute (gpm) during the initial operation of the groundwater extraction system. The alignment of the discharge pipeline/berm across the capped landfill and along Cook Street is also depicted in Figure 1. Installation of this pipeline was completed in December, 2004. Figure 1 also depicts the performance monitoring network developed for both geochemical monitoring and hydraulic monitoring during the three month start-up period. Following collection of data during this period, the monitoring network may be modified. If a decision is made to complete final design and construction of an on-site discharge option, this network and other wells located in the Shepley Hill landfill area would be available to monitor performance of a combined, on-site extraction and discharge system.

Prior to initiating the hydraulic modeling effort, the landfill property and vicinity were reviewed for locations for placement of groundwater discharge points, including reinjection wells, trenches/infiltration galleries, and basins. In addition, optimal locations for surface water discharge were considered. The results of this preliminary review, briefly presented to the BCT on May 12, 2005, consisted of the following elements:

- On-site groundwater discharge would not be evaluated within the footprint of the capped areas;
- The primary goal of groundwater discharge would be to enhance the performance of Run 412, the final design model run used for siting of the extraction wellfield;
- Groundwater discharge on the west side of the landfill was not considered to be viable due to shallow overburden adjacent to Shepley's Hill and expected inefficiency involving potential recirculation of treated water back to the extraction wellfield.
- Generally, offbase discharge to the north of the extraction wellfield was not considered due to off-base access requirements, the existence of good viable alternatives to the east of the landfill, and expected concerns regarding the geochemical effects of downgradient discharge into the aquifer zone impacted by groundwater from the landfill.

In summary, this meant that the modeling evaluation would focus generally to the east of the landfill area, as defined by the capped area, and the treatment plant. Following the preliminary evaluation, several locations for testing of groundwater discharge were developed. The modeling effort was then conducted in two phases with the best alternatives from the first phase being carried forward to the second phase. Table 1 summarizes the scope of the modeling effort conducted during Phase 1 and 2.



LEGEND

- Hydraulic Monitoring Network
- Geochemistry Sentinel Network

Note: New Well Locations Approximate (to be surveyed)

FIGURE 1
Performance Monitoring Network

CH2MHILL

TABLE 1
Groundwater Modeling Phases

Modeling Phase	Objective/Description
Phase 1	Evaluate the modeled hydraulic response of the extraction wellfield to the design flow of 50 gpm, involving reinjection in Layer 1.
Phase 2	Further analysis of alternatives selected from Phase 1. Evaluate the modeled hydraulic response to groundwater discharge of the existing extraction wellfield operating at both 25 and 50 gpm. This analysis also included simulation of a pair of injection wells, infiltration trenches/galleries, and infiltration basins.

Results of the first modeling phase were presented to the BCT at a technical meeting on June 2, 2005 and a set of alternatives was selected to carry forward for further analysis. Table 2 provides a summary of the simulations that were conducted in each phase and a brief description of the characteristics of each of them.

TABLE 2
Groundwater Modeling Scenarios

Model Run	Phase	Discharge Approach	Flow (gpm)	Comment
412	n/a	POTW (offsite)	50	Design scenario selected for 100% design.
Northern Area (N-Series)				
N001	1	Inject, single well	50	kame terrace
N002	1	Inject, single well	50	East of ATP, foot of kame terrace
N002-2	2	Inject, single well	25	
N002A	2	Inject, two well	50	
N002-2A	2	Inject, two well	25	
N002B	2	Infilt., trench/gallery	50	
N002-2B	2	Infilt., trench/gallery	25	
N002C	2	Infilt., basin	50	
N002-2C	2	Infilt., basin	25	
N003	1	Inject, single well	50	North of ATP near boundary
N004	1	Inject, single well	50	East of ATP, foot of kame terrace
N004-2	2	Inject, single well	25	
N004A	2	Inject, two well	50	
N004-2A	2	Inject, two well	25	
N004B	2	Infilt., trench/gallery	50	
N004-2B	2	Infilt., trench/gallery	25	
N004C	2	Infilt., basin	50	
N004-2C	2	Infilt., basin	25	
N005	1	Inject, single well	50	Kame Terrace

Model Run	Phase	Discharge Approach	Flow (gpm)	Comment
Central Area (C-Series)				
C001	1	Inject, single well	50	Center, upgrad. PSP
C002	1	Inject, single well	50	Center, upgrad. PSP
C003	1	Inject, single well	50	Center, dngrad. PSP
C004	1	Inject, single well	50	Center, upgrad. PSP
C004-2	2	Inject, single well	25	
C004A	2	Inject, two well	50	
C004-2A	2	Inject, two well	25	
C004B	2	Infilt., trench/gallery	50	
C004-2B	2	Infilt., trench/gallery	25	
C004C	2	Infilt., basin	50	
C004-2C	2	Infilt., basin	25	
Southern Area (S-Series)				
S001	1	Inject, single well	50	Southeast
S002	1	Inject, single well	50	Southeast
S002-2	2	Inject, single well	25	
S002A	2	Inject, two well	50	
S002-2A	2	Inject, two well	25	
S002B	2	Infilt., trench/gallery	50	
S002-2B	2	Infilt., trench/gallery	25	
S002C	2	Infilt., basin	50	
S002-2C	2	Infilt., basin	25	
S003	1	Inject, single well	50	Southeast
S004	1	Inject, single well	50	Southeast
S005	1	Inject, single well	50	South
S006	1	Inject, two wells	50	South
S007	1	Inject, single well	50	Southeast
S008	2	Inject, single well	50	Southeast

Footnotes:

1. Table includes 50 and 25 gpm scenarios. The 50 gpm scenarios were tested due to 50 gpm extraction well design criteria and viable alternatives from Phase 1 testing were then tested in various discharge configurations and at 50 and 25 gpm.
2. The "B" series simulate discharge to a 40' by 80' area orthogonal to flow lines through infiltration using trenches, or a gallery/basin. The "C" series simulate discharge to an 80' by 80' area through infiltration using trenches, or a gallery/basin.

Run 412, the 50 gpm design run (CH2M HILL, 2005), involving offsite discharge of water to the DRWWTF (local POTW), is provided for reference. In the case of "off-site" discharge, groundwater in the area of Shepley's Hill landfill is only responding to the extraction stress. When treated water is place back in the aquifer through infiltration or reinjection in the vicinity of the wellfield, some effect on the performance of the extraction wellfield is expected. As mentioned previously, the primary goal of this modeling effort was to identify discharge arrangements that would be expected to enhance the performance of the extraction wellfield without requiring pumping rates to be modified (ie. increased) to achieve similar capture.

Alternatives of surface water release either at Nonacoicus Brook (NB) or Plow Shop Pond (PSP), are considered to perform similarly to Run 412. This is due to the general discharge of groundwater in the lower reaches of the Nonacoicus Brook, 18.9 square mile drainage.

Particle tracking and the results of capture zone analyses for each of the model runs conducted in Phase 1 were presented to the BCT and the pros and cons of each arrangement were discussed. A set of model runs including N002, N004, C004, and S002 was selected to carry forward to Phase 2 for further analysis. Table 2 provides a summary of all the model runs that were conducted in Phase 1 and 2.

The objective of Phase 2 of the modeling effort was to further test a variety of discharge schemes for the shortlist of groundwater discharge locations. These would be tested at 50 gpm and 25 gpm. These discharge schemes involved a pair of injection wells (in adjacent 40′ by 40′ model cells) and infiltration involving a 40′ by 80′ areas (two cell combination) and 80′ by 80′ areas (4 cell combination) to simulate trenches, galleries, or basins. These schemes were designated the A, B, and C cases, respectively.

For injection, the "A" case, a pair of injection wells was selected since a minimum of two injection wells would help to facilitate long-term maintenance. These wells were placed in adjacent model cells arranged orthogonal to flow. The infiltration approaches were simulated through adjustments in existing model recharge values to account for additional recharge of 25 gpm and 50 gpm across the discharge cells. In the "B" and "C" cases, two adjacent cells located orthogonal to flow and four cells in a square configuration were used to simulate areas that would be used for infiltration trenches, galleries, or basins. Calculations of infiltration capacity and review of other projects utilizing infiltration in similar sandy materials indicate that these are sufficient areas for infiltration of water at 50 gpm. Infiltration capacity is a parameter that during system operations may change considerably with time. This is usually due to fouling associated with precipitation of effluent dissolved constituents at the infiltration bed interface, associated with changes in redox and associated biological growth. In the case of ATP, much of the dissolved load will have been removed from the effluent stream so this is not expected to be a significant issue. However, it will be considered during final design of an infiltration approach.

The results of the Phase 2 runs are provided in Attachment A and are discussed later in the feasibility screening section.

Applicable or Relevant and Appropriate Requirements

According to Section 121 of CERCLA, work at CERCLA sites should result in a standard of control equal to that of any other applicable or relevant and appropriate requirements (ARARs) or standards promulgated under any federal or more stringent state environmental statutes. Requirements under other environmental laws may be either "applicable" or "relevant and appropriate" but not both.

To evaluate ARARS, the first step is to determine if a requirement is applicable. As identified in the National Contingency Plan, Section 300.5, applicable requirements are cleanup standards, levels of control, limitations, or other substantive requirements promulgated under federal or state environmental laws that address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstances of a CERCLA site.

If a standard is identified as not directly "applicable", then the next step in the process is to determine if it may be "relevant and appropriate". Relevant and appropriate requirements mean those standards and other substantive requirements, criteria, or limitations that while not "applicable" to a hazardous substance pollutant, or contaminant, remedial action, location, or other circumstances at a CERCLA site, address situations similar enough to those encountered at the CERCLA sites such that they are "relevant and appropriate".

CERCLA remedial actions are exempt from permitting requirements; consequently, only substantive portions of ARARs must be complied with. Permitting and reporting requirements, which are considered to be administrative requirements, are not ARARs. ARARs are typically divided into three categories: chemical-specific ARARs relating to the substances present at the site, location-specific ARARs relating to where the site is situated, and action-specific ARARs relating to the type of actions that may be taken to address the problem.

A remedial action may be selected that does not meet all ARARs (ie. involving an ARAR waiver) per Section 121(d)(4)). The circumstances of a waiver are a) the remedial action is an **Interim Measure** or only part of the complete remedy, b) compliance with the standard would present **greater risk** to human health and the environment, c) compliance with a standard is **technically impracticable**, d) **equivalent performance** will be achieved to that under an otherwise applicable standard or limitation, e) a **State has inconsistently applied requirements** in similar remedial situations, and f) the remedial action does not provide a balance between the need for remedial action at a site and the availability of the Fund for other sites (ie **Fund balancing**). This last circumstance or rationale for a waiver is not available to DoD.

ARARs have been reviewed and summarized for groundwater and surface water discharge and are presented in a table presented in Attachment B. The primary applicable standards of compliance for this project relate to discharge limitations for groundwater and surface water. The Record of Decision (ROD) establishes groundwater clean-up standards for a number of parameters for the Shepley's Hill Landfill project. These may be assumed to indirectly represent effluent limitations if remediation system effluent is being discharged to groundwater on site. In addition, State groundwater quality standards (314 CMR 6.00), as applied through the groundwater discharge permit program (314 CMR 5.00), are applicable.

Currently, the area is classified as a Class I groundwater. Table 3 provides the ROD clean-up goals and the Class I groundwater standards and limitations.

TABLE 3
Groundwater Discharge Standards

Chemical of Concern	Limitation (ug/L)	Basis
ROD Cleanup Goals		
Arsenic	50[1]	MCL
Chromium	100	MCL
1,2-Dichlorobenzene	600	MCL
1,4-Dichlorobenzene	5	MMCL
1,2-Dichloroethane	5	MCL
Lead	15	Action Level
Manganese	1715	Site Risk Assessment
Nickel	100	MCL
Sodium	20,000	Health Advisory
Aluminum	6,870	Background
Iron	9,100	Background
State Groundwater Standards (314 CMR 5 and 6)		
Coliform Bacteria	Shall not be discharged in amounts sufficient to render ground waters detrimental to public health, safety or welfare, or impair the ground water for use as a source of potable water.	314 CMR 5
Arsenic	50[1]	314 CMR 5
Barium	1000	314 CMR 5
Cadmium	10	314 CMR 5
Chromium	50	314 CMR 5
Flouride	2400	314 CMR 5
Lead	50	314 CMR 5
Mercury	2	314 CMR 5
Total Trihalomethanes	100	314 CMR 5
Selenium	10	314 CMR 5
Silver	50	314 CMR 5

[1] The Safe Drinking Water Act required EPA to revise the existing 50 ug/L standard for arsenic in drinking water. On January 22, 2001 EPA adopted a new drinking water MCL for arsenic of 10 ug/L. All community water systems must comply with the standard beginning on January 23, 2006.

Chemical of Concern	Limitation (ug/L)	Basis
Endrin (1,2,3,4,10, 10-hexachloro-1,7-epoxy-1, 4,4a,5,6,7,8,9a-octahydro-1, 4-endo,endo-5,8-dimethano naphthalene)	.2	314 CMR 5
Lindane (1,2,3,4,5, Shall not exceed 0.004 mg/l 6-hexachlorocyclohexane, gamma isomer)	4	314 CMR 5
Methoxychlor (1,1,1- Shall not exceed 0.1 mg/l Trichloro-2, 2-bis (p-methoxyphenyl) ethane)	100	314 CMR 5
Toxaphene (C10H10C18, Shall not exceed 0.005 mg/l Technical Chlorinated Camphene, 67-69% chlorine)	5	314 CMR 5
Chlorophenoxys: 2,4-D,(2,4-Dichloro- Shall not exceed 0.1 mg/l phenoxyacetic acid)	100	314 CMR 5
2,4,5-TP Silvex (2,4, Shall not exceed 0.01 mg/l 5-Trichlorophenoxypropionic acid)	10	314 CMR 5
Radioactivity	Shall not exceed the maximum radionuclide contaminant levels as stated in the National Interim Primary Drinking Water Standards.	314 CMR 5
Toxic Pollutants (other than those listed above)	Shall not exceed "Health advisories"	314 CMR 5
Secondary Effluent Limitations for Class I and II Groundwater		
Copper	1000	314 CMR 5
Foaming Agents	1000	314 CMR 5
Iron	300	314 CMR 5
Manganese	50	314 CMR 5
Oil and Grease	15,000	314 CMR 5
pH	6.5 to 8.5 std units	314 CMR 5
Sulfate	250,000	314 CMR 5
Zinc	5000	314 CMR 5
All other pollutants	None in such concentrations which in the opinion of the Department would impair the ground water for use as a source of potable water or cause or contribute to a condition in contravention of standards for other classified waters of the Commonwealth.	314 CMR 5
Additional Effluent Limitation Class I Groundwater		
Nitrate Nitrogen (as Nitrogen)	10,000	314 CMR 5
Total Nitrogen (as Nitrogen)	10,000	314 CMR 5
Chlorides	250,000	314 CMR 5
TDS	1,000,000	314 CMR 5

It should be noted, however, that a portion of the area surrounding the Shepley's Hill landfill is designated as a Non-Potential Drinking Water Source Area (NPDWSA), per the MCP (310 CMR 40.0006). This is due to the level and type of development, including railroads, warehouses, shopping areas, and etc., over the medium and high yield deposits mapped by the USGS and qualifying as Potentially Productive Aquifers, per 310 CMR 40.0006. Landfills are not included in the definition of developed areas. The landfill area does not overlay a Zone II or IWPA for municipal wells. The McPherson Well Zone II is to the north and west of the site and is likely hydraulically isolated from groundwater from the Shepley's Hill area which discharges in the upper reaches of the Nonacoicus in the vicinity of West Main Street. The potential for a hydraulic connection will be further evaluated in the Shepley's Hill Landfill CSA/CAAA being conducted by Army BRAC.

The Nonacoicus Brook and Plow Shop Pond are considered Class B waters according to the Massachusetts Surface Water Quality Standards (314 CMR 4.06). They are not used for water supply in the area, but are habitat for fish, other aquatic life and wildlife and may support contact recreation. In addition, neither are considered an "Outstanding Resource Water", according to 314 CMR 4.06(3) which would prohibit any new discharges, unless the discharge is considered to enhance the resource.

In accordance with the Clean Water Act, each state establishes a program to assess the quality of surface water resources and reports its findings to EPA every two years (due on April 1 in even numbered years). This process output results in the development of a § 303(d) list of "impaired waters" for the state. Impaired water bodies are then further evaluated and a "total maximum daily load" (TMDL) is calculated for specific parameters such that if point and non-point sources are controlled in a manner that loading goals are met, applicable surface water quality standards may then be met for the water body. Regulations that govern the preparation of the § 303(d) lists require states to make use of all available monitoring data, including NPDES reporting, in making their assessments. The 2002 final and 2004 draft listings for PSP and NB are Category 5 ("waters requiring a TMDL") and Category 3 ("no uses assessed"), respectively. PSP is indicated to be 29 acres in size and needing TMDLs for metals, noxious aquatic plants, and exotic species. NB is indicated to be 1.5 miles in length from the outlet of Plow Shop Pond to the confluence with the Nashua River and the Category 3 listing essentially indicates that insufficient information was available for the State to list as "impaired or threatened and needing or not needing a TMDL" (Category 4 or 5) or unimpaired for some or all uses (Category 1 or 2).

Plow Shop Pond and the Nonacoicus Brook are included in the upper reaches of the Squannasitt Area of Critical Environmental Concern (ACEC). These include a 200 foot riverfront area and a 100 foot wetlands buffer zone around Plow Shop Pond. Though this designation does not preclude treated water discharges or other projects from occurring in the area, it does mean that State environmental resource agencies specifically engage in environmental reviews of projects to ensure that the interests contained within the ACEC designation are protected. State mapping of biological resource areas, including estimated and priority habitats, wetlands and vernal pools (identified and certified), and the Natural Heritage and Endangered Species Program (NHESP) "Biomap" and "Living Waters" initiatives which identify core upland biological and aquatic habitats (including supporting watersheds) important for protecting biodiversity, is provided in Attachment C. Previous discussions with the State project manager indicate that a rare species of grass and turtle may be present in the area of the Nonacoicus Brook and Plow Shop Pond. CH2M HILL also talked with the Daniel Nein, Endangered Species Project Analyst, of the MassWildlife, Natural Heritage and Endangered Species Program (NHESP) and submitted a letter, dated July 15, 2005, requesting a review of their database for the area of Plow Shop Pond and the Nonacoicus Brook near the dam. Attachment D provides a copy of this letter and the NHESP response, dated August 11, 2005. In addition, 2005 MassGIS data for estimated and priority habitats was researched. These habitats, defined as polygons, are consistent with those identified by NHESP and listed in the 11th Edition (2003) of the Massachusetts Natural Heritage Atlas.

Table 4 provides a summary of the species identified by NHESP and provides notes/comments concerning the habitat they are associated with. Much of this information comes from rare species fact sheets available from NHESP and other organizations. The priority habitat and estimated habitat polygons are the same as those identified previously through review of the 2001 Atlas; however, they have been renumbered as follows: Priority Habitat 290 is now 269, Estimated Habitat 4018 is now 567, and Priority Habitat-317 is now 300. This renumbering was confirmed with NHESP.

The Priority Habitat-300 (formerly PH 317) polygon previously identified in the landfill area involves primarily upland species not expected to be affected by operation of the treatment system. The wetlands species are identified in the Priority Habitat-269/Estimated Habitat-567 (formerly PH-290/WH-4018) polygon north of West Main Street. It is not anticipated that on-site discharge or drawdown from the extraction wells would have an appreciable impact this far north. No habitat polygons have been identified in the reach of the Nonacoicus between the Dam and West Main Street.

Currently, maintenance schedules for the landfill cap, involving once a year mowing, account for the Grasshopper Sparrow's nesting season. Construction of any new discharge pipelines and discharge areas would need to be planned to ensure protection of the species identified in Priority Habitat 300.

TABLE 4
NHESP Rare Species Associated with Priority Habitat-300 and Priority Habitat-269/Estimated Habitat-567 Polygons

Common Name	Scientific Name	Taxonomic Group	State Status	Notes/Comment
Plants				
Houghton's Flatsedge	*Cyperus houghtonii*	Plant	Endangered	Priority Habitat-300; Landfill area/woods; species likely on dry upland areas (Shepley's Hill?)
Ovate Spiked-Sedge	*Eleocharis ovata*	Plant	Endangered	Priority Habitat-269/Estimated Habitat-567; Area north of West Main Street; wetland species
Wild Senna	*Senna hebecarpa*	Plant	Endangered	Priority Habitat-269/Estimated Habitat-567; Area north of West Main Street; likely upland areas

Common Name	Scientific Name	Taxonomic Group	State Status	Notes/Comment
Animals				
Upland Sandpiper	*Bartramia longicauda*	Bird	Endangered	Priority Habitat-300 and Priority Habitat-269; Landfill area/woods and area north of West Main Street; habitat "open grassy areas, wet meadows, old fields, and pastures"
Grasshopper Sparrow	*Ammodramus savannarum*	Bird	Threatened	Priority Habitat-300; Landfill Area/woods; habitat "in sandplain grasslands, pastures, hayfields, and airfields characterized by bunch grasses"
Blanding's Turtle	*Emydoidea blandingii*	Reptile	Threatened	Priority Habitat-269/Estimated Habitat-567; Area north of West Main Street; habitat "primarily aquatic preferring densely vegetated shallow ponds, marshes and small streams."
Wood Turtle	*Clemmys insculpta*	Reptile	Special Concern	Priority Habitat-269/Estimated Habitat-567; Area north of West Main Street; "The preferred habitat of the Wood Turtle is riparian areas. Slower moving streams are favored, with sandy bottoms and heavily vegetated stream banks."
Blue Spotted Salamander	*Abystoma laterale*	Amphibian	Special Concern	Priority Habitat-269/Estimated Habitat-567; Area north of West Main Street; "Blue spotted salamanders require moist, moderately shaded environments… having depressions available for seasonal flooding [vernal pools]"

An evaluation of baseflow of the Nonacoicus Brook was conducted as part of this project. Review of drainages of similar size nearby, particularly Priest Brook in Winchendon, which is 19.4 square miles and which has an 86 year record, indicate that the flow characteristics of the ungaged Nonacoicus would be expected to be as follows in Table 5, based on a drainage area of 18.9 square miles.

TABLE 5
Drainage-Area Ratio Calculation

River	Area (sq. mi)	Discharge Unit	Min.	Mean	Max.
Priest Brook	19.4	cfs	4.8	42.3	226
		gpm	2,154	18,986	101,456
Nonacoicus Brook	18.9	cfs	4.7	41.2	220
		gpm	2,110	18,492	101,436

Table 6 presents surface water discharge limitations identified in the NPDES Remediation General Permit for the state of Massachusetts. The NPDES program in Massachusetts is jointly administered by the EPA and DEP. The general permit was released for public comment in December, 2004 and was issued final on September 9, 2005 (see 70 Federal Register 53663). The permit reflects the substantive requirements that are applicable to remediation projects including CERCLA projects. The NPDES process, through exclusions, has provided a means for remediation projects to be initiated and move forward quickly. All non-CERCLA remediation projects in Massachusetts in the future will be required to meet the requirements of the General Remediation Permit. The State surface water discharge regulations provide an exemption at 314 CMR 5.05(3) for remediation projects, as follows:

> *Any discharge in compliance with the written instructions of an On-Scene Coordinator pursuant to 33 CFR Part 153 - Control of Pollution by Oil and Hazardous Substances, Discharge Removal and 40 CFR Part 300, Subchapter J - Superfund, Emergency Planning, and Community Right-To-Know Programs, Subparts B and C, or if conducted as an Immediate Response Action in compliance with M.G.L. c. 21E and the regulations promulgated thereunder, 310 CMR 40.0000, or if approved in writing by the Department, as necessary to abate, prevent, or eliminate an imminent hazard to the public health, or safety, welfare or the environment.*

Whether or not this exemption applies to the ATP project, in the short term for start-up operations or for long-term operations, the discharge limitations have been evaluated here.

TABLE 6
NPDES Remediation General Permit -- Surface Water Discharge Limitations

Effluent Characteristic	Units	Discharge Limitation	Monitoring Requirement	
			Measurement Frequency	Sample Type
pH Range for Class A and Class B Waters[1]	Standard Units	6.5 to 8.3[2]	1/Month	Grab[3]
Daily Max. Temp. – Fisheries Warm water /Cold water	^oF	83/68	1/Month	Grab[4]
Temperature Change Class B – Warm/Cold & Lakes and Pond	^oF	5/3	1/Month	Grab[4]
Table V. Chemical Effluent Limits and Monitoring Requirements by Sub-Category c. Sites Containing Primarily Metals				
Pollutants to be Monitored	**Effluent Limit**	**Limit Type**	**Sample Type**	**Sampling Frequency**
All Metals listed in Appendix III (See below)	See Appendix III	See Appendix III	grab	1/month
Cyanide	SW = 1.0 ug/l , FW = 5.2 ug/l[5]	monthly average	grab	1/month
Carbon Tetrachloride	4.4 ug/l	daily maximum	grab	1/month
1,2 (or o)-Dichlorobenzene (DCB)	600 ug/l	daily maximum	grab	1/month

1,3 (or m)-Dichlorobenzene	320 ug/l	daily maximum	grab	1/month
1,4 (or p)-Dichlorobenzene	5.0 ug/l	daily maximum	grab	1/month
Total Dichlorobenzene	763 ug/l - NH only	daily maximum	grab	1/month
1,1-Dichloroethane (DCA)	70 ug/l	daily maximum	grab	1/month
1,2-Dichloroethane	5.0 ug/l	daily maximum	grab	1/month
1,1-Dichloroethylene (DCE)	3.2 ug/l	daily maximum	grab	1/month
cis-1,2-Dichloroethylene	70 ug/l	daily maximum	grab	1/month
Methylene Chloride	4.6 ug/l	daily maximum	grab	1/month
Tetrachloroethylene (PCE)	5.0 ug/l	daily maximum	grab	1/month
1,1,1-Trichloroethane (TCA)	200 ug/l	daily maximum	grab	1/month
1,1,2 Trichloroethane	5.0 ug/l	daily maximum	grab	1/month
Trichloroethylene (TCE)	5.0 ug/l	daily maximum	grab	1/month
Vinyl Chloride	2.0 ug/l	daily maximum	grab	1/month
Total Suspended Solids (TSS)	30.0 mg/l	monthly average	grab	1/month

Appendix III Effluent Limitations – Metal Parameters				
Metal parameters	**Total Recoverable Metal Limit @ H = 50 mg/l CaCO36 for Discharges in Massachusetts (ug/l)**	**Total Recoverable Metal Limit @ H = 25 mg/l CaCO37 for Discharges in New Hampshire (ug/l)**	**Averaging Time**	**Sample Type**
Antimony	5.6	5.6	daily maximum	grab
Arsenic	FW = 10 SW = 36	FW = 10 SW = 36	monthly average	grab
Cadmium	FW = 0.2 SW = 8.9	FW = 0.8 SW = 9.3	monthly average	grab
Chromium III	FW = 48.8 SW = 100	FW = 27.7 SW = 100	monthly average	grab
Chromium VI	FW = 11.4 SW = 50.3	FW = 11.4 SW = 50.3	monthly average	grab
Copper	FW = 5.2 SW = 3.7	FW = 2.9 SW = 3.7	monthly average	grab
Lead	FW = 1.3 SW = 8.5	FW = 0.5 SW = 8.5	monthly average	grab

Mercury	FW = 0.9 SW = 1.1	FW = 0.9 SW = 1.1	monthly average	grab
Nickel	FW = 29.0 SW = 8.2	FW = 16.1 SW = 8.2	monthly average	grab
Selenium	FW = 5.0 SW = 71	FW = 5.0 SW = 71	monthly average	grab
Silver	FW = 1.2 SW = 2.2	FW = 0.4 SW = 2.2	daily maximum	grab
Zinc	FW = 66.6 SW = 85.6	FW = 37 SW = 85.6	monthly average	grab
Iron	1,000	1,000	daily maximum	grab

1. State certification requirement.
2. The permittee may request that the pH range be widened to within 6 to 9 s.u. or another range due to naturally occurring conditions in the receiving water. Similarly, permittees may request such a change if the naturally occurring source water is unaltered by the permittee's operation. The scope of any demonstration must receive prior approval from the MA DEP. An NOC must be submitted to the EPA-NE Director upon approval from the state (see Appendix V).
3. pH sampling for compliance with permit limits may be performed using field methods as provided for in EPA test method 150.1.
4. Temperature sampling per Method 170.1
5. Limits for cyanide are based on EPA's water quality criteria expressed as micrograms (ug) of free cyanide per liter. There is currently no EPA approved test method for free cyanide. Therefore, total cyanide must be reported. Although the maximum values for cyanide are 5.2 ug/l and 1.0 ug/l for freshwater and saltwater, respectively, the compliance limits are equal to the minimum level (ML) of the test method used as listed in Appendix VI (i.e., 10 ug/l).
6. Assumes FW Hardness Value (H) = 50 mg/l as CaCO3 in MA: Cadmium, Chromium III, Copper, Lead, Nickel, Silver, and Zinc which are Hardness Dependent.
7. Assumes FW Hardness Value (H) = 25 mg/L in NH for: Cadmium, Chromium III, Copper, Lead, Nickel, Silver, and Zinc which are Hardness Dependent.

TABLE 7
NPDES Remediation General Permit – Metals Limitations with Dilution

Appendix IV Total Recoverable Metals Limitations (ug/L) At Selected Dilution Ranges and Technology Based Ceiling Limitations For Facilities Located In Massachusetts (for discharges to freshwater at H = 50 mg/L CaCO3)1						
Parameter	**Dilution Range Concentration**					
	0 - 5	5 -10	10 - 50	50 - 100	>100	Ceiling value
1. Antimony	5.6	30	60	141	141	141 [2]
2. Arsenic	10	50	100	500	540	540 [3]
3. Cadmium	0.2	1.0	2.0	10.0	20.0	260
4. Chromium III	48.8	244	489	1,710	1,710	1,710
5. Chromium VI	11.4	57	114	570	1,140	1,710 [4]
6. Copper	5.2	26	52	260	520	2,070

7. Lead	1.3	6.5	13	66	132	430
8. Mercury	0.9	2.3	2.3	2.3	2.3	2.3 [5]
9. Nickel	29.0	145	290	1,451	2,380	2,380
10. Selenium	5.0	25	50	250	408	408 [6]
11. Silver	1.2	6	12	57	115	240
12. Zinc	66.6	333	666	1,480	1,480	1,480
13. Iron	1,000	5,000	5,000	5,000	5,000	5,000

1. Based on 7Q10 Flow.
2. Based on 40 CFR 437.42, "The Centralized Waste Treatment Point Source Category - Subpart D - Multiple Wastestreams -Best Practicable Control Technology" (BPT) daily maximum for Antimony
3. Based on 40 CFR 445.11, "RCRA Subtitle C Landfill Best Practicable Control Technology" (BPT) for Arsenic.
4. Assumes Hexavalent Chromium reduced to Tri-valent Chromium in treatment.
5. Based on 40 CFR 437.42, "The Centralized Waste Treatment Point Source Category - Subpart D - Multiple Wastestreams -Best Practicable Control Technology" (BPT) daily maximum for Mercury.
6. Based on 40 CFR 437.42, "The Centralized Waste Treatment Point Source Category - Subpart D - Multiple Wastestreams -Best Practicable Control Technology" (BPT) daily maximum for Selenium.

The NPDES program provides for the consideration of dilution in the development of discharge limitations for metals. Table 7 also shows ranges of dilution factors and associated limitations for various metals. The dilution ranges are based on the relationship of the effluent flow to the seven (7) day mean, ten year low flow (7Q10).

K.G. Ries, III, and P. J. Friesz (USGS, 2000) provide a summary of two key methods that have been used to evaluate low flow statistics for ungaged drainages. These methods include the 1) the drainage-area ratio method, used above and 2) a multiple linear regression analysis method. The drainage-area ratio method is commonly used to calculate low-flow statistics for ungaged drainage basins; however, basins of similar size and hydrologic (i.e. geologic, climatic, and development) characteristics should be used for this type of analysis. The second method provides a means to utilize data from multiple gage sites within a region and account for the influence of multiple independent physical and climatic variables. This method has been developed, in cooperation with the Massachusetts Departments of Environmental Management and Environmental Protection, into an on line accessible method merged with a GIS system for evaluation of streams in Massachusetts (USGS, 2000). This system, referred to as Stream Stats, enables the efficient calculation of the 7-day, 10-year low-flows (7Q10) for drainages of interest and is accepted by NPDES regulatory programs. The Stream Stats calculated 7Q10 for the lower reach of Nonacoicus Brook is in Table 8.

TABLE 8
Stream Statistics 7Q10

Statistic	Estimated Streamflow	90% Prediction Interval	
		Minimum	Maximum
7-day, 10-year low flow	1.36 cfs	0.36 cfs	4.72 cfs
	610 gpm	162 gpm	2119 gpm

This indicates that at 25 and 50 gpm, the estimated flow of Nonacoicus Brook provides a dilution of 25 times and 13 times, respectively. Consequently, the discharge limitations for metals that are applicable are those associated with the 10-50 times dilution range in Table 7. For surface water discharge, the arsenic limitation is indicated to be 100 ug/l.

Discussion and comment on this analysis by EPA and DEP indicate that Stream Stats may not be a valid approach to conduct 7Q10 analyses since the watershed is developed and altered with impoundments (e.g. Plow Shop Pond and Grove Pond). In addition, it is not possible with the current on-line tool to develop precise drainage area calculations for the anticipated discharge location immediately downstream of the PSP dam/spillway. Further work relating to development of the 7Q10 and determination of dilution factors may be conducted later during detailed design work, as needed. The BCT will be consulted during development of the specific approach. Comments and responses on the draft document are provided in Appendix E.

In addition, comments by DEP relate to suggested monitoring work for the Army to undertake, particularly relating to satisfying the Antidegradation Provisions of the Massachusetts surface water quality standards (314 CMR 4.04). Although EPA is the NPDES issuing authority in Massachusetts, EPA looks to the state to conduct anti-degradation reviews. DEP has an antidegradation review procedure. The Tier I element of this procedure, involving review for protection of existing uses, involves 1) identification of existing uses, 2) evaluation of quality impacts including water quality, hydrologic modification, or habitat alteration; and 3) comparison with water quality criteria.

As a Class B water, the Nonacoicus is considered a high quality water and subject to Tier II evaluation. High quality waters and significant resource waters are "protected and maintained for their existing level of quality (antidegradation review procedure)." The Tier II evaluation has two steps: 1) determination of whether significant water quality lowering would occur and 2) authorization of a variance. The Director may determine that the discharge is insignificant because it is de minimus, temporary, or the effluent is of equal or better quality than the receiving water. A variance may also be granted where the applicant can demonstrate compliance with four provisions of 314 CMR 4.04 (a) 1-4. These provisions are 1) demonstration of socio/economic importance, 2) demonstration of no less damaging alternative site, 3) demonstration of mitigation of the discharge (designed and operated to minimize impacts to water quality) and lastly, 4) a demonstration that the "discharge will not impair existing water uses…a level of water quality less than that specified for the Class."

DEP through an email, dated November 9, 2005, provided a memo from Paul Hogan, NPDES Program Chief, suggesting the types of data needed to support an Antidegradation Review. Further discussion of the scope of this effort and the extent to which existing background and plant operational data may satisfy these data needs will be undertaken during detailed design work should surface water discharge be pursued.

In the overall evaluation of ARARs, it is important for project stakeholders, including the regulatory agencies, the Army, and the public to keep in mind that the objective of the contingency remedy, in simple terms is to protect downgradient receptors. As such, the net effect of the operating remediation system on downgradient resources should be considered. If there are any impacts related to the selected approach for discharge to ecological resources, these need to be balanced against the overall reduction in risks to human health and to ecological resources over the length of the Nonacoicus River downstream where groundwater impacted by the Shepley's Hill landfill vicinity is expected to discharge.

Potential Process Needs

The treatment process is designed to aggressively oxidize iron and remove arsenic in association with precipitated iron. Bench-scale tests conducted during the system design process support this observation. Initial bench tests also indicated that sodium hypochlorite or ferric chloride would provide significant arsenic removal; however, in order to minimize potential manganese fouling of microfilter membranes, a more aggressive oxidant, chlorine dioxide, was selected. This would ensure that during the inline mixing of influent, manganese would be more fully precipitated and thus would collect on the microfilter membrane surface rather than within the filter membrane, providing for effective backwashing and removal. Early operation of the treatment system in August, 2005 indicates that the process effectively removes arsenic, reaching a goal of 10 ug/L with a high enough dose of chlorine dioxide.

To control the chlorine residual (free chlorine, chlorite, and chlorine dioxide) in the process effluent stream, chemical additions (dosing) will need to be carefully controlled and monitored during operations. The level of treatment dosing will be balanced against arsenic removal to ensure that chlorine residual is minimized. To achieve extremely low arsenic loading in the effluent may require heavy dosing of the influent stream; however, if slightly higher levels of arsenic are acceptable, then reduced dosing is possible. Process designers are confident that under the POTW scenario, and with the loading limitation of .07 pounds per day and a concentration limitation of 150 ug/l received at the POTW plant, the plant could be operated efficiently, balancing treatment dosing against the level of arsenic treatment. Discussions between the Army and the POTW, since issuance of the original POTW discharge permit in July, 2003 have led to reduced triggers for corrective action at the plant, however, they are still greater than the expected discharge limitation of 10 ug/l under the current Class I groundwater classification. As indicated in the ARARs section of the memo, the 7Q10 low-flow analysis indicates that under a surface water discharge scenario, NPDES discharge limitations in Massachusetts may allow up to 100 ug/l arsenic to be released with the effluent since the dilution falls within the 10 to 50 times range. If a reevaluation of the 7Q10 results in a 5-10 dilution range, then the target concentration would be 50 ug/L.

Under the POTW discharge scenario, much of the chlorine residual is expected to be consumed in the 2-3 miles of pipeline between the ATP and the DRWWTF. However, for on-site discharge, chlorine residual is of concern due to the short distance to discharge and the potential that this residual could generate total trihalomethanes in groundwater which have a limitation of .1 mg/l. For surface water the RGP provides a total residual chlorine (TRC) limit of 11 ug/L for projects involving hydrostatic testing of pipelines and tanks. This limit is not listed specifically in the permit for other types of projects; however, associated permit guidance indicates that this limit applies to treatment systems that use chlorine compounds. In summary, if on-site discharge to either groundwater or surface water is selected, a dechlorination step in the process may be needed. Though a number of methods are available for dechlorination, granular activated carbon (GAC) in a contact tank, often provides necessary treatment to address chlorine residual and thus minimize the generation of total trihalomethanes in the effluent stream or within the aquifer. Further evaluation of this process need will be conducted, should either groundwater or surface water discharge be selected for final design and construction. During the early operation of the treatment system monitoring data relating to chlorine residual in the effluent will be collected.

Although other metals are not expected to be an issue from a groundwater or surface water discharge limitation perspective, it is expected that the load of metals, other than Arsenic, Iron, and Manganese, would be reduced, as well, through the process with the production of ferric hydroxide from dissolved iron. The jar testing that was completed for the project indicated that raw water pH will be below 7 and that the finished water pH may be as high as about 8, within the acceptable range under state groundwater and surface water limitations. Plant data collected for treated water during early operation of the plant indicate that the pH of treated water ranges between 6 and 7 standard units.

Feasibility Screening and Modeling Results

This section provides a feasibility screening for Run 412 (design model) and the on-site discharge options that have been considered in more detail as part of this evaluation. Table 9 provides a feasibility screening comparison matrix that considers effectiveness, implementability, and cost associated with the north, central, and south groundwater discharge locations and the surface water discharge locations. It compares them with the current designed/constructed system involving POTW discharge.

TABLE 9
Feasibility Screening
Surface and Groundwater Discharge

Scenario	Effectiveness	Implementability	Cost
Discharge to POTW			
1. Run 412 with Discharge to POTW	Advantages Modeling suggests effective capture at 50 gpm with discharge off-site to POTW.	Advantages Easily implemented with completed sewer at Cook Street	Advantages Very low additional capital costs.
	Disadvantages Potential drawdown impacts to north and east of extraction wellfield.	Disadvantages Long-term pipeline/berm maintenance.	Disadvantages Annual discharge fees, monitoring/reporting costs, permit renewal/ maintenance costs.
Surface Water Discharge			
2. Surface water discharge to Nonacoicus Brook	Advantages Returns water locally to Nonacoicus River ecosystem offsetting potential drawdown. Impacts to extraction wellfield capture zone expected to be negligible. Arsenic standard for treated water may be higher under NPDES program.	Advantages Pipeline and eductor easily installed and maintained. Utilize established corridor between plant and brook.	Advantages Low capital costs to install/maintain pipe and eductor and to modify treatment process, if needed.
	Disadvantages Additional potential discharge limitations to meet substantive NPDES requirements.	Disadvantages Adjustments to process, expected to be minor, may be necessary. Potential habitat monitoring due to ACEC. Potential negative perception of point source discharge.	Disadvantages
3. Plow Shop Pond	Advantages Returns water locally to PSP/Nonacoicus River ecosystem. Impacts to extraction wellfield capture zone expected to be negligible. Arsenic standard for treated water may be higher under NPDES program.	Advantages Pipeline and eductor easily installed and maintained. Utilize established corridor between plant and brook.	Advantages Low capital costs to install /maintain pipe and eductor and to modify treatment process, if needed.

Scenario	Effectiveness	Implementability	Cost
	Disadvantages Additional potential discharge limitations to meet substantive NPDES requirements.	Disadvantages Adjustments to process, expected to be minor, may be necessary. Potential habitat monitoring due to ACEC. Potential negative perception of point source discharge.	Disadvantages
Groundwater Discharge			
4. Site East of Treatment Plant (N002/N004 Area)	Advantages Enhanced capture zone relative to Run 412. Drawdown of Run 412, in vicinity of Nonacoicus, offset by mounding from groundwater recharge. Discharge to aquifer zone not affected by landfill derived groundwater. Shallow groundwater oxic with positive ORP.	Advantages Pipeline and infiltration system (trenches or infiltration galleries) or injection wells easily installed. Little sitework or clearing needed.	Advantages Relatively low capital costs to install pipeline and discharge approach. These costs offset by POTW discharge fee savings.
	Disadvantages Concerns about geochemical effects in aquifer zone between property line and West Main Street /Nonacoicus Brook	Disadvantages Adjustments to process may be necessary to ensure trihalomethane generation negligible and standard met. Chemical-specific ARARs based on Class I groundwater. Additional monitoring downgradient may be needed.	Disadvantages Additional treatment process may be needed to meet substantive requirements of Massachusetts groundwater discharge permit program (314 CMR 5).
5. Site East of Landfill (C004)	Advantages Capture zone improved over the southern landfill footprint relative to Run 412. Discharge to aquifer zone not expected to have been significantly affected by landfill derived groundwater. Geochemistry in this area expected to be oxic with positive ORPs, particularly for shallow groundwater.	Advantages Pipeline easily installed along east side of landfill.	Advantages Relatively low to moderate capital costs to install pipeline around east side of landfill. These costs offset by POTW discharge fee savings.

Scenario	Effectiveness	Implementability	Cost
	Disadvantages Capture zone less effective in vicinity of "Red Cove"; however, over time treated water expected to replace water that escapes capture in this area.	Disadvantages Discharge area along fairly steep slope adjacent to southern arm of PSP (may be outside fence line). Site work would be needed to accommodate infiltration system or injection wells. Adjustments to process may be necessary to ensure trihalomethane generation negligible and standard met. Chemical-specific ARARs based on Class I groundwater	Disadvantages Additional treatment process may be needed to meet substantive requirements of Massachusetts groundwater discharge permit program (314 CMR 5).
6. Site East of Landfill (S002)	Advantages Capture zone improved in southern most area of landfill footprint relative to Run 412. Discharge to aquifer zone not expected to have been significantly affected by landfill derived groundwater. Geochemistry in this area expected to be oxic with positive ORPs, particularly for shallow groundwater.	Advantages Pipeline and infiltration system (trenches or infiltration galleries) or injection wells easily installed.	Advantages Relatively low to moderate capital costs to install pipeline around east side of landfill. These costs offset by POTW discharge fee savings.
	Disadvantages Capture zone less effective along eastern boundary and in vicinity of "Red Cove"; however, over time groundwater with little or no landfill impact and treated water expected to replace water that escapes capture in this area.	Disadvantages Adjustments to process may be necessary to ensure trihalomethane generation negligible and standard met. Chemical-specific ARARs based on Class I groundwater	Disadvantages Additional treatment process may be needed to meet substantive requirements of Massachusetts groundwater discharge permit program (314 CMR 5).

Additional groundwater modeling work was conducted during the Phase 2 modeling effort for the short list of alternatives selected at the conclusion of Phase 1, to better understand how these would operate under differing discharge scenarios. Table 2 provides a list of these runs which included both 25 and 50 gpm simulations with two-well reinjection and infiltration (simulating trenches, galleries or basins) over areas of 40′ by 80′ and 80′by 80′. The earlier Hydraulic Modeling Analysis section provides discussion of the modeling approach.

Attachment A provides particle tracking plots for each of the short list of on-site model runs at 25 and 50 gpm, including N002, N004, C004, and S002, vs. Run 412 (POTW discharge). Capture zone plots are provided for all of these new simulations at 50 gpm under a total of four differing discharge arrangements. In addition, a capture zone plot for N002, N004, C004, and S002 in the single well configuration (Phase 1) is provided at 25 gpm. At the reduced pumping rate, the capture zone is not sensitive to differing discharge approaches, so plots of these capture zones were not generated for comparison.

The calibrated groundwater model budget statistics indicate that the "river cells" representing the boundary condition between the groundwater, advective flow model and Nonacoicus Brook are discharging only downstream of the Plow Shop Pond dam. Therefore, it is likely that surface water discharge options would behave hydraulically much like Run 200 (the unpumped condition) or Run 412, with groundwater largely discharging and surface water gaining volume with distance downstream of the dam. As part of the modeling effort, a zone budget analysis was conducted to quantify how pumping and reinjection stresses affect the movement of water between the groundwater model and surface water. Figure 2 provides an illustration of the model domain with zones identified and Table 10 provides budget statistics for each of the zones.

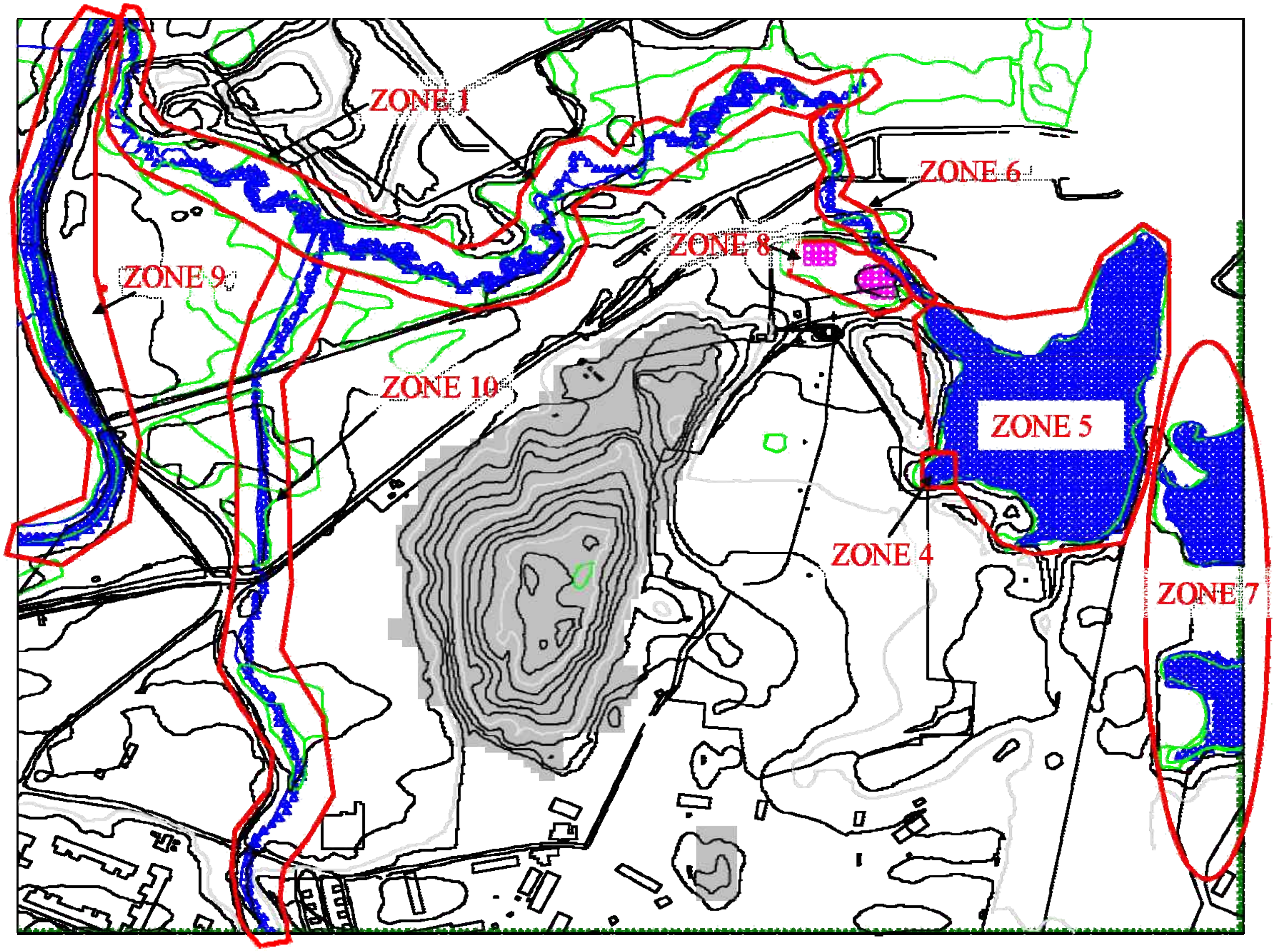


FIGURE 2
Surface Water Zone Budget Analysis

CH2MHILL

TABLE 10
Simulated Water Budget for Surface Water Features
Shepley's Hill Groundwater Flow Model

Simulation ID	Extraction Rate	Eastern Ponds Zone 7				Red Cove Zone 4				Western Shoreline of Plow Shop Pond Betw. Red Cove and Nona. Brook Zone 11			
		Out - SW Discharge gpm	Out - SW Discharge (ft3/d)	In - GW Discharge gpm	In - GW Recharge (ft3/d)	Out - SW Discharge gpm	Out - SW Discharge (ft3/d)	In - GW Discharge gpm	In - GW Recharge (ft3/d)	Out - SW Discharge gpm	Out - SW Discharge (ft3/d)	In - GW Recharge gpm	In - GW Recharge (ft3/d)
Run 200	NA	93.24	17,949	0.00	0	3.32	640	0.000	0	0.11	21	15.86	3,052
Run 412	50 GPM	92.97	17,896	0.00	0	1.49	287	0.005	0.89	0.00	0	19.08	3,674
Run 412-2	25 GPM	93.06	17,915	0.00	0	2.41	465	0.000	0	0.02	3	17.40	3,350
N002	50 GPM	93.05	17,913	0.00	0	2.09	402	0.000	0	0.01	2	13.70	2,637
N002-2	25 GPM	93.08	17,917	0.00	0	2.76	531	0.000	0	0.05	9	14.75	2,839
N004	50 GPM	93.09	17,919	0.00	0	2.43	467	0.000	0	0.02	5	15.46	2,975
N004-2	25 GPM	92.95	17,893	0.00	0	2.92	562	0.000	0	0.07	13	15.60	3,003
C004	50 GPM	95.74	18,430	0.00	0	3.76	723	0.000	0	0.04	8	18.60	3,580
C004-2	25 GPM	94.48	18,188	0.00	0	3.53	679	0.000	0	0.07	13	17.23	3,316
S002	50 GPM	105.23	20,256	0.00	0	2.28	439	0.000	0	0.00	0.25	18.76	3,611
S002-2	25 GPM	99.25	19,106	0.00	0	2.83	544	0.000	0	0.04	7	17.21	3,313

Simulation ID	Extraction Rate	Plow Shop Pond minus Red Cove Original Zone 5				Nona Brook - Segment Below Pond Dam Zone 6				Nona. Brook minus segment below Plow Shop Pond Zone 1			
		Out - SW Discharge gpm	Out - SW Discharge	In - GW Recharge gpm	In - GW Recharge	Out - SW Discharge gpm	Out - SW Discharge (ft3/d)	In - GW Recharge gpm	In - GW Recharge (ft3/d)	Out - SW Discharge gpm	Out - SW Discharge (ft3/d)	In - GW Recharge gpm	In - GW Recharge (ft3/d)
Run 200	NA	42.01	8,088	64.05	12,329	107.53	20,700	0.00	0	201.14	38,719	1.44	277
Run 412	50 GPM	39.96	7,692	76.73	14,770	89.85	17,297	0.00	0	196.12	37,753	1.44	277
Run 412-2	25 GPM	40.91	7,874	70.18	13,510	98.89	19,037	0.00	0	198.63	38,236	1.44	277
N002	50 GPM	41.20	7,931	57.76	11,119	107.28	20,651	0.00	0	198.20	38,153	1.44	277
N002-2	25 GPM	41.65	8,018	60.78	11,700	107.42	20,679	0.00	0	199.65	38,432	1.44	277
N004	50 GPM	41.29	7,949	62.93	12,115	108.21	20,831	0.00	0	199.59	38,422	1.44	277
N004-2	25 GPM	41.70	8,026	63.20	12,165	108.01	20,791	0.00	0	200.34	38,565	1.44	277
C004	50 GPM	77.01	14,824	73.63	14,174	90.78	17,476	0.00	0	196.55	37,835	1.44	277
C004-2	25 GPM	59.66	11,485	68.80	13,244	99.10	19,076	0.00	0	199.00	38,307	1.44	277
S002	50 GPM	60.64	11,672	75.14	14,464	90.60	17,441	0.00	0	196.45	37,817	1.44	277
S002-2	25 GPM	51.33	9,881	69.26	13,333	99.39	19,132	0.00	0	198.78	38,266	1.44	277

Simulation ID	Extraction Rate	Wetlands Zone 8		Western Tributary Zone 10				Nashua River Zone 9			
		Out - SW Discharge gpm	Out Only- SW Discharge (ft3/d)	Out - SW Discharge gpm	Out - SW Discharge (ft3/d)	In - GW Recharge gpm	In - GW Recharge (ft3/d)	Out - SW Discharge gpm	Out - SW Discharge (ft3/d)	In - GW Recharge gpm	In - GW Recharge (ft3/d)
Run 200	NA	19.18	3,692	57.01	10,975	223.31	42,988	335.46	64,576	4.96	955
Run 412	50 GPM	11.19	2,153	57.01	10,975	223.34	42,992	335.41	64,566	4.97	956
Run 412-2	25 GPM	15.18	2,922	57.00	10,973	223.32	42,989	335.44	64,573	4.96	955
N002	50 GPM	19.98	3,846	57.01	10,975	223.33	42,991	335.42	64,569	4.97	956
N002-2	25 GPM	19.53	3,759	56.99	10,971	335.45	64,575	335.45	64,575	4.96	955
N004	50 GPM	22.11	4,256	57.01	10,975	223.32	42,989	335.44	64,572	4.96	956
N004-2	25 GPM	20.68	3,980	56.98	10,968	223.30	42,986	335.50	64,583	4.96	954
C004	50 GPM	11.60	2,232	57.00	10,973	223.34	42,993	335.41	64,567	4.97	956
C004-2	25 GPM	15.31	2,947	57.01	10,974	223.32	42,989	335.44	64,572	4.96	956
S002	50 GPM	11.54	2,222	57.01	10,975	223.33	42,991	335.41	64,567	4.97	956
S002-2	25 GPM	15.40	2,965	57.01	10,975	223.32	42,990	335.43	64,571	4.96	956

Figure 3 illustrates the modeled distribution of water flux at the surface water/groundwater interface for Runs N002, N004, C004, and S002 compared with Run 412. Blue areas are those areas where groundwater is discharging to surface water at a rate of 0 and 4 gpm and yellow-orange areas where surface water is recharging groundwater at a rate between 0 and 4 gpm. This type of plot provides a good visual representation of the hingeline of Plow Shop Pond. The hingeline separates areas of PSP having discharging or recharging groundwater and illustrates that Nonacoicus Brook is receiving groundwater discharge through out the full length of the reach north of the Plow Shop Pond dam.

The following are key observations concerning the model simulations:

Particle Tracking and Capture Zone Assessment

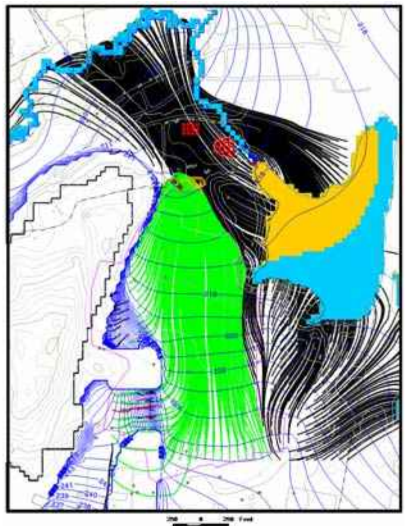
- All discharge locations tested are not particularly sensitive to the type of discharge approach selected. The 80′ by 80′ basin arrangement for C004 is slightly different than other arrangements, demonstrating some expansion of the capture zone on the eastern side of the landfill (similar to Run 412). This location is far enough east that the spreading of the recharge stress in the basin configuration is reducing the effect on the wellfield capture zone.
- An additional simulation conducted for a new area, numbered S008, near the extreme east side of the landfill property has performance characteristics very similar to Run 412. In this case, discharged water is having little effect on the characteristics of the extraction wellfield capture zone.

Water Budget (zone budget analysis)

- Nonacoicus Brook and the wetlands downstream are discharging groundwater. Nonacoicus Brook is a discharging stream over most of its length, particularly the section downstream of the dam to the area near West Main Street.
- Run 412 reduces the flow of groundwater to the Nonacoicus in the area north of the dam to north of West Main Street ("Zone 6") by 18 gpm. With on-site discharge to the northern locations (N002/N004) the volume of groundwater discharging in this reach is roughly restored to the 108 gpm that exists under unpumped conditions.
- PSP on the whole, is recharging groundwater in all simulations except C004 (50gpm) in which the overall budget shifts to an overall discharging situation. Note, however, that the distribution of groundwater recharge or surface water discharge is dependent upon location within the pond. This pond generally receives groundwater in the upstream end and discharges to groundwater in the downstream end.
- The upstream ponds (Grove Pond) at the edge of the model discharges to groundwater.
- A small amount of water, approximately 3 gpm, discharges to the Red Cove area in Zone 4. This discharge is reduced by approximately 55% with the operation of the Run 412 wellfield. On-site discharge generally has the effect of restoring the net discharge of groundwater to Red Cove. The C004 run (50 gpm) increases the flow to Red Cove to 4 gpm; however, this is likely a combination of treated water and water east of the landfill footprint being forced toward Red Cove. Note that the water discharging to surface water represents a small percentage of the water moving across pond model cells between groundwater and surface water.

- Roughly 130 gpm of ground water is leaving the groundwater model and going to surface water (including wetlands) in the area immediately downstream of the PSP dam (Zones 6 and 8) under unpumped conditions (Run 200). With pumping at 50 gpm (Run 412), this is reduced to approximately 100 gpm. On site discharge roughly restores this balance of 130 gpm leaving the model with the N002/N004 configuration. C004 and S002 are very similar to Run 412 with groundwater discharge reduced to approximately 100 gpm in the Zone 6/Zone 8 area. However, this is offset by increased discharge to surface water in PSP (Zone 7).

No Reinjection



Run 412

Volumetric Flux at Surface Water/Groundwater Interface

(River Package Source/Sink Term)

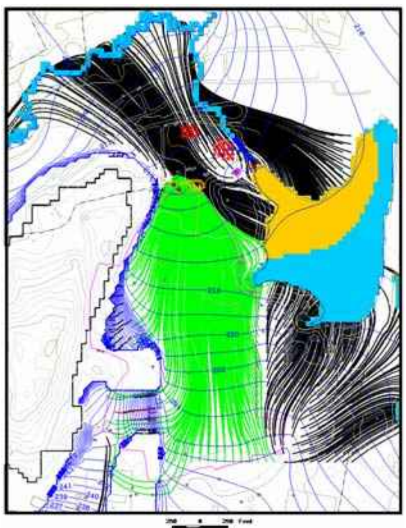
(dark navy)	-8.00 to -12.00
(blue)	-4.00 to -8.00
(light blue)	0.00 to -4.00
(orange)	0.00 to 4.00
(red)	4.00 to 8.00

Gallons Per Minute

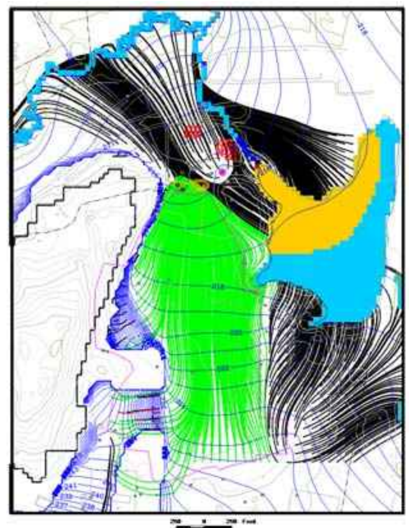
Negative flux=discharge to surface water (out of model)

Positive flux=groundwater recharge from surface water (into model)

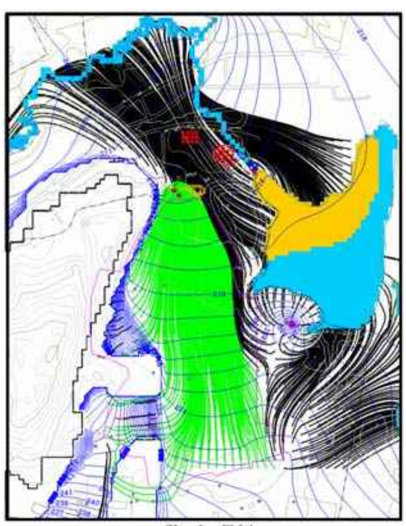
Reinjection



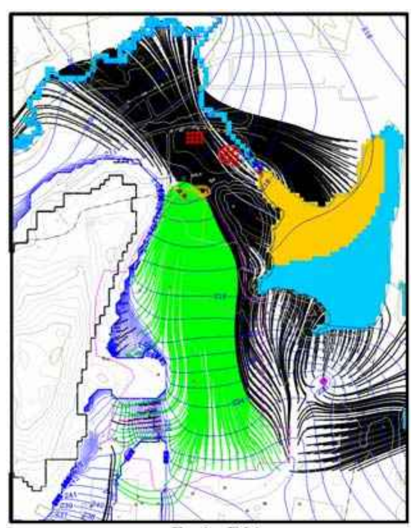
Run N002



Run N004



Run C004



Run S002

LEGEND

- Reinjection Well in Layer 1
- Extraction Well in Layer 1
- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Wetland
- Surface Water
- Fort Devens Boundary
- Shepley's Hill Landfill Extent
- Approximate Treatment Plant Location

N

FIGURE 3
Volumetric Flux at Surface Water/Groundwater Interface in Model Layer 1
Runs N002, N004, C004, and S002 with 50 GPM Total Flow for Single Well Reinjection as Compared with Design Model Run 412 (No Reinjection)
Shepley's Hill Landfill
Fort Devens

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Conclusions and Recommendations

The modeling and feasibility screening for the alternatives evaluated indicate the following:

- Run 412, operating at 50 gpm, reduces groundwater discharge from the model to surface water in the area of "Red Cove" (Zone 4) by 55% with pumping, reducing the discharge from 3.32 gpm to 1.49 gpm.
- Surface water discharge is a viable alternative from an effectiveness, implementability, and cost perspective for discharge near Shepley's Hill. This approach provides water to Nonacoicus Brook in the reach where groundwater modeling indicates pumping in the extraction wellfield would reduce discharge of groundwater to surface water by roughly 30 gallons per minute. The best location for surface water discharge would be in the Nonacoicus Brook near the Plow Shop Pond Dam. It is expected that surface water discharge may be accomplished in a manner protective of brook habitat and dechlorination steps in the process could be accomplished to meet the total residual chlorine limitation. In addition, it is anticipated that further evaluation of the 7Q10 and effluent monitoring for the operating plant (with POTW connection) will demonstrate that the surface water antidegradation provisions of 314 CMR 4.04 may be met. Overall, reduction of the arsenic load in the area of plume discharge, expected with operation of the treatment system over time, should provide a net benefit to the Nonacoicus Brook ecosystem.
- Of the groundwater discharge options tested, the northern locations (N002/N004) perform the best, providing capture of water along most of the length of the landfill (as defined by the capped area), reducing the flow of water to Red Cove, and balancing the extraction stress with reinjection, providing groundwater recharge in Zone 6 and 8 along the Nonacoicus Brook back to the levels of the unstressed condition. Discharge would be best accomplished with trenches or infiltration galleries such that effluent would interact with shallow groundwater that has positive ORP values and high DO (refer to data from MW 8S). In addition, a small network of wells may be established immediately downgradient to assess geochemistry.

Effluent data are being collected with the early operation of the treatment plant. These data, other information, and further work with the BCT will be utilized by the Army to determine whether a groundwater or surface water discharge approach or a combination of the two will undergo further design evaluation in the area directly east of the treatment plant. It is anticipated that needed data may be derived from existing background information, plant monitoring data, or some limited new data collection to support the final design of either or both types of discharge. In addition, the performance monitoring network may be easily modified to collect data necessary to ensure that groundwater or surface water discharge limitations are met.

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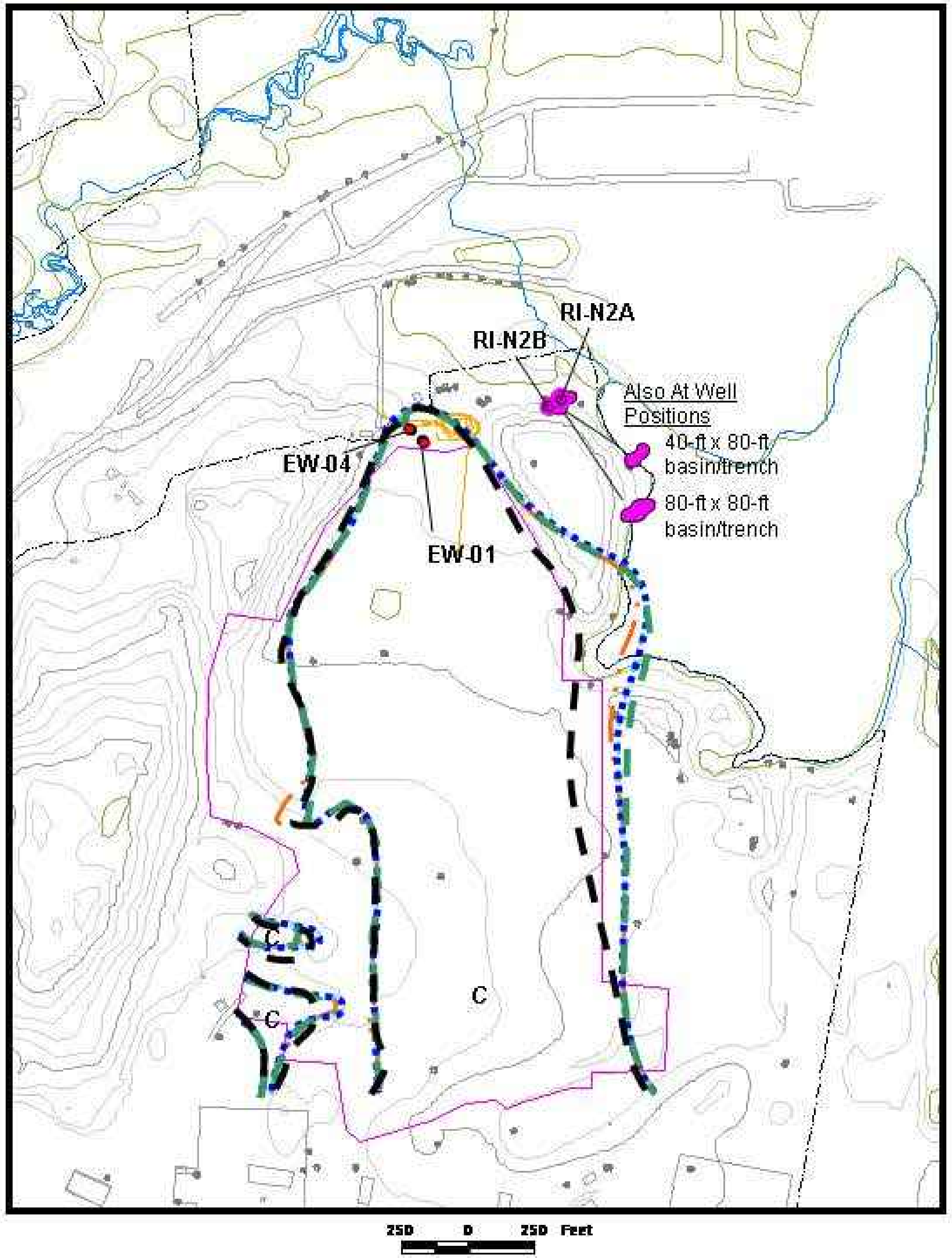
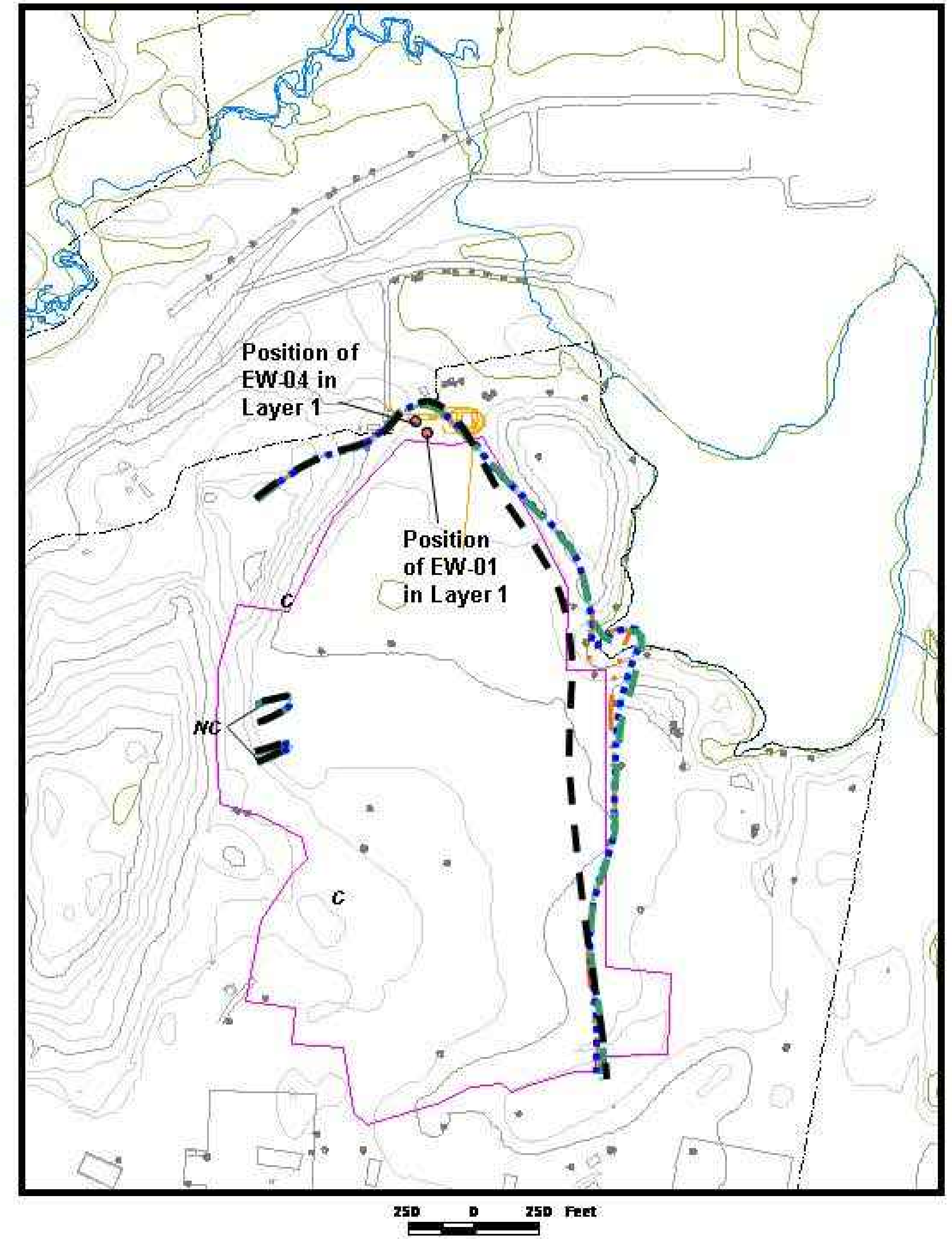
ATTACHMENT A – Phase 2 Modeling



Capture Zones in Model Layer 1



Capture Zones in Model Layer 2

Notes:
C = Captured
NC = Not Captured
GPM = Gallons Per Minute

N

LEGEND

- **Reinjection Well in Layer 1**
- **Extraction Well in Layer 1**
- **Approximate Treatment Plant Location**
- **Shepley's Hill Landfill Extent**
- **Fort Devens Boundary**
- **Surface Water**
- **Wetland**
- Capture Zone for Run 412 (no reinjection)
- Capture Zone for Run N002 (reinjection well RI-N2A)
- Capture Zone for Run N002-A (reinjection wells RI-N2A and RI-N2B)
- Capture Zone for Run N002-B (40-ft x 80-ft Reinfiltration Basin/Trench)
- Capture Zone for Run N002-C (80-ft x 80-ft Reinfiltration Basin/Trench)

Capture Zones in Model Layers 1 and 2
N002 Series Simulations with 50 GPM Total Flow for
Reinjection or Reinfiltration
as Compared with Design Model Run 412 (No Reinjection)
Shepley's Hill Landfill, Fort Devens, MA

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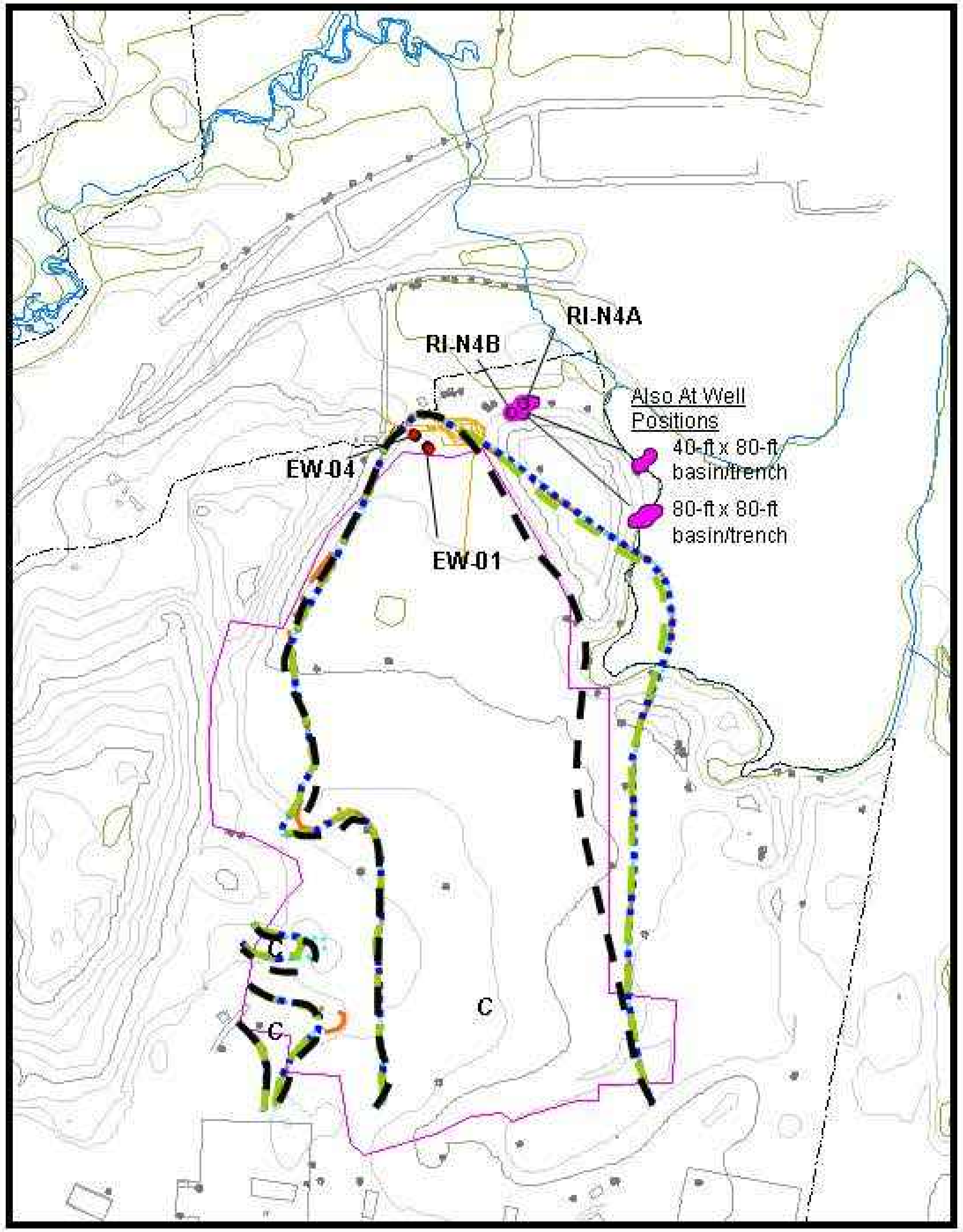
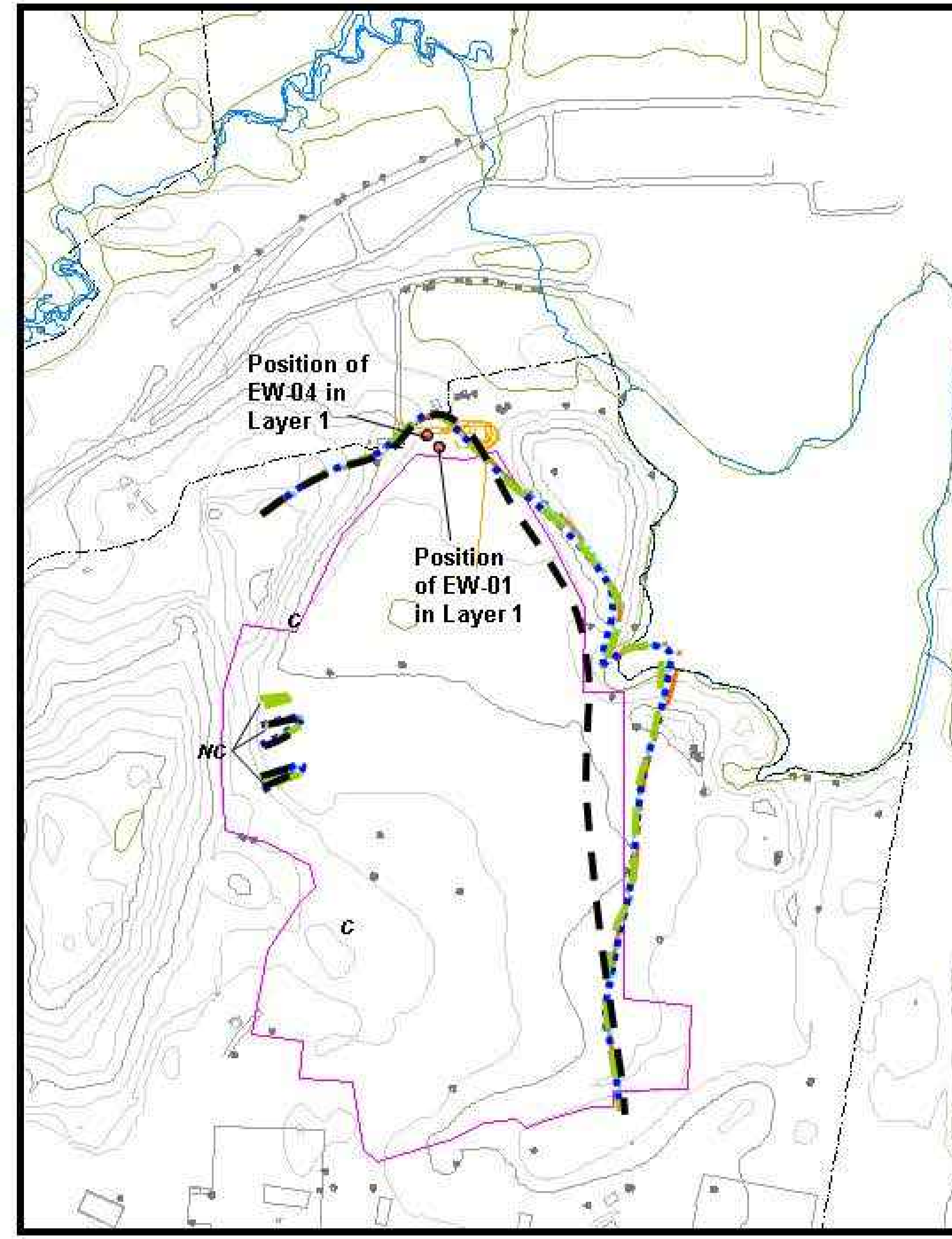


Capture Zones in Model Layer 1



Capture Zones in Model Layer 2

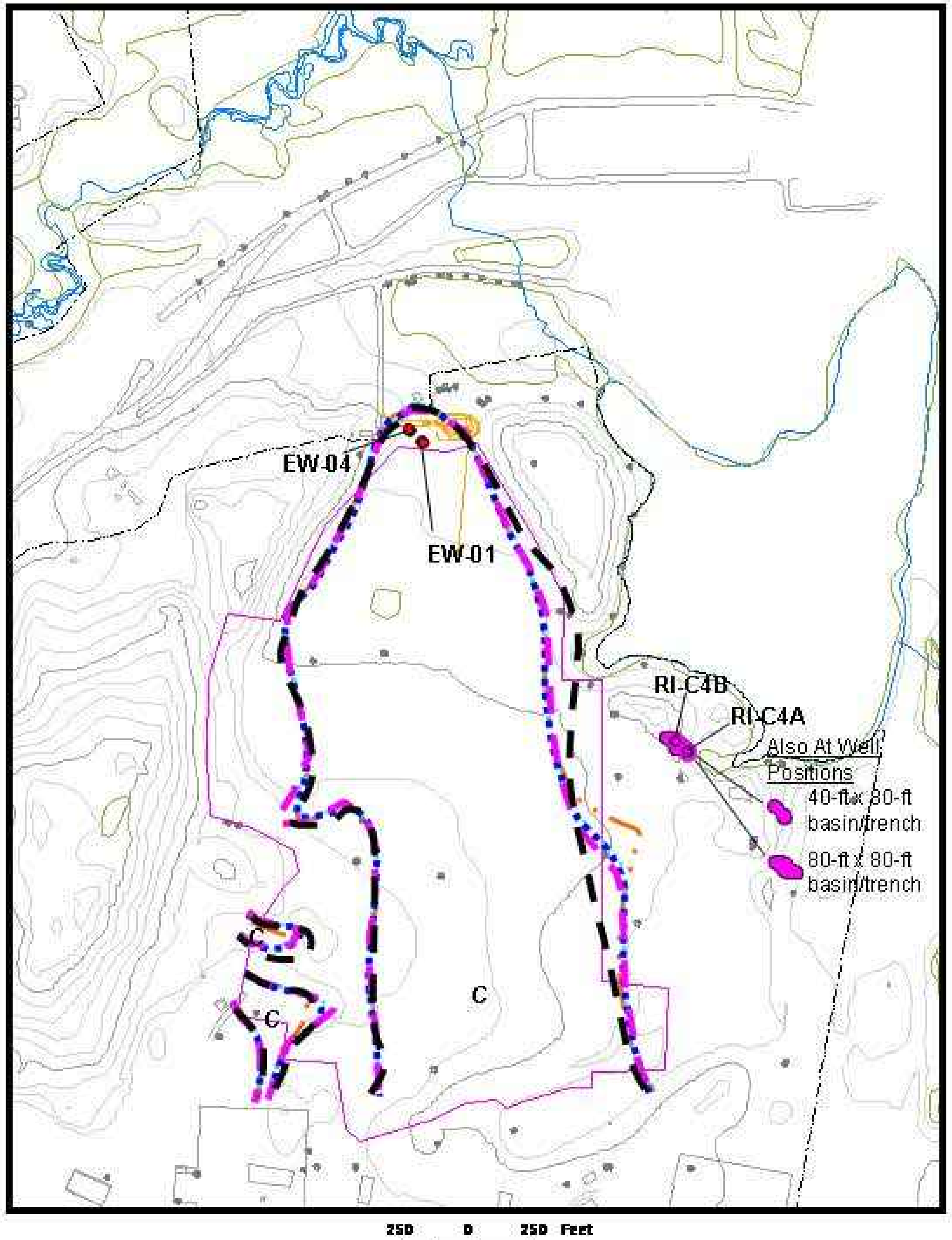
Notes:
C = Captured
NC = Not Captured
GPM = Gallons Per Minute

LEGEND
- Reinjection Well in Layer 1
- Extraction Well in Layer 1
- Approximate Treatment Plant Location
- Shepley's Hill Landfill Extent
- Fort Devens Boundary
- Surface Water
- Wetland
- Capture Zone for Run 412 (no reinjection)
- Capture Zone for Run N004 (reinjection well RI-N4A)
- Capture Zone for Run N004-A (reinjection wells RI-N4A and RI-N4B)
- Capture Zone for Run N004-B (40-ft x 80-ft Reinfiltration Basin/Trench)
- Capture Zone for Run N004-C (80-ft x 80-ft Reinfiltration Basin/Trench)

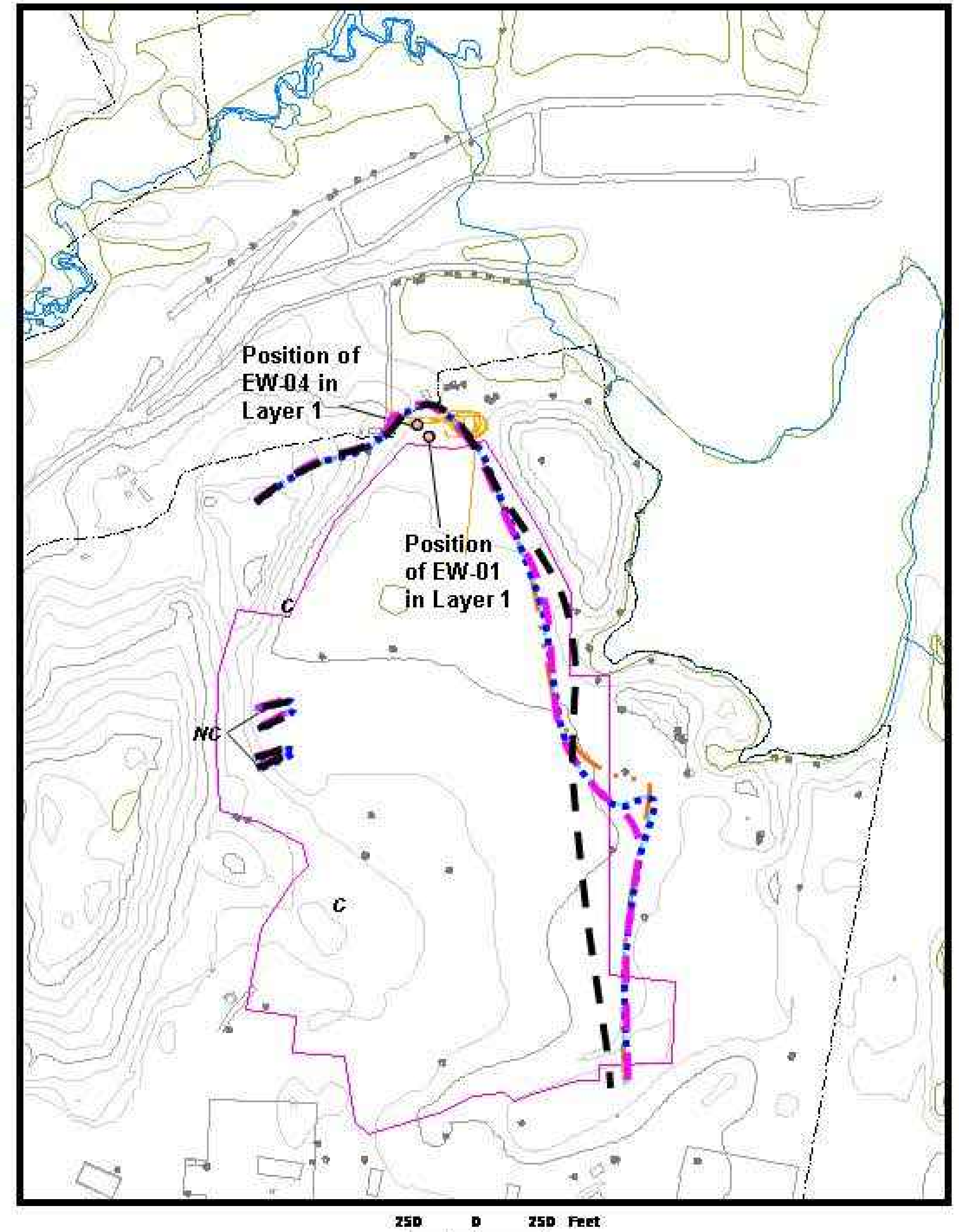
N

Capture Zones in Model Layers 1 and 2
N004 Series Simulations with 50 GPM Total Flow for
Reinjection or Reinfiltration
as Compared with Design Model Run 412 (No Reinjection)
Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



Capture Zones in Model Layer 1



Capture Zones in Model Layer 2

Notes:
C = Captured
NC = Not Captured
GPM = Gallons Per Minute

N

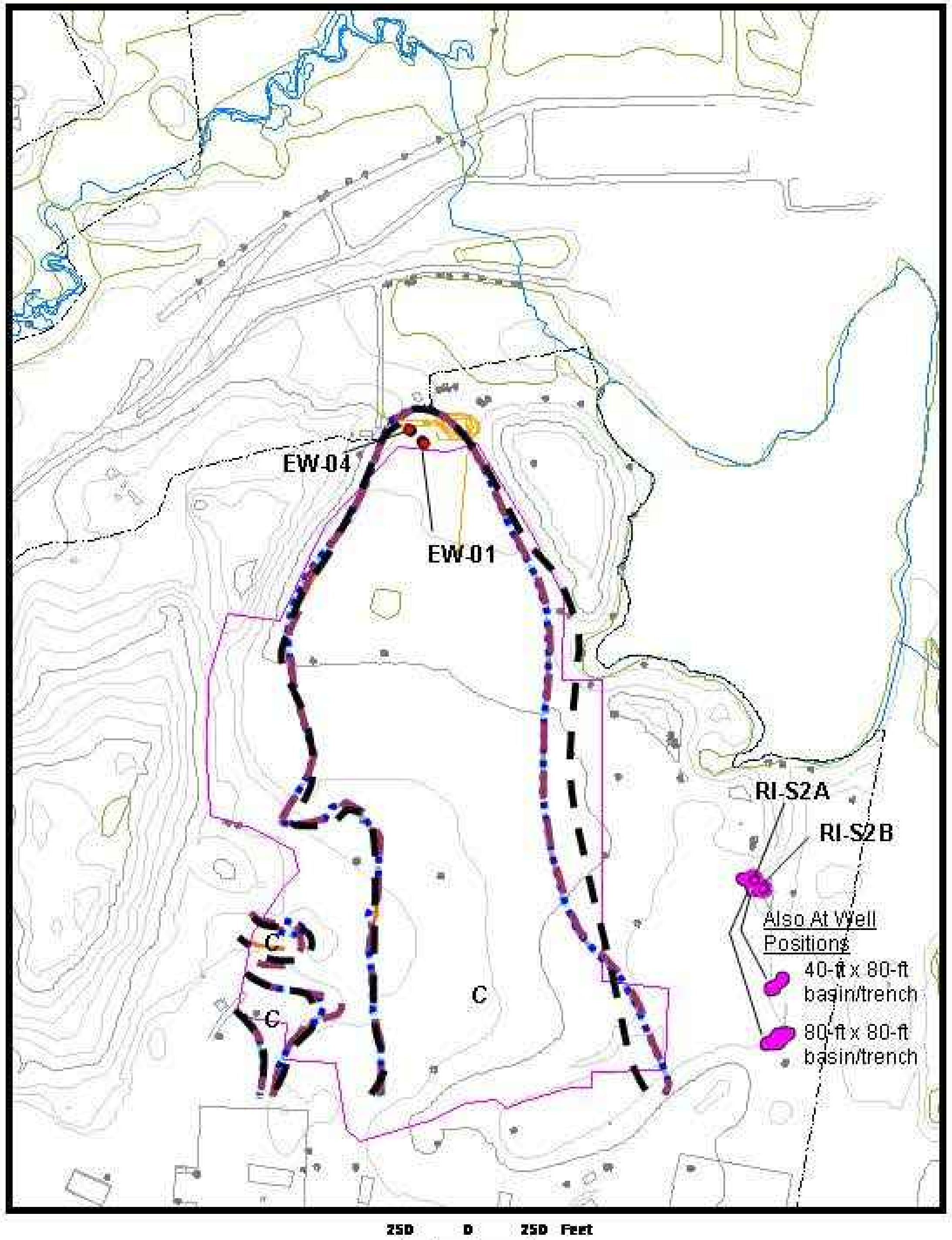
LEGEND

- **Reinjection Well in Layer 1**
- **Extraction Well in Layer 1**
- **Approximate Treatment Plant Location**
- **Shepley's Hill Landfill Extent**
- **Fort Devens Boundary**
- **Surface Water**
- **Wetland**

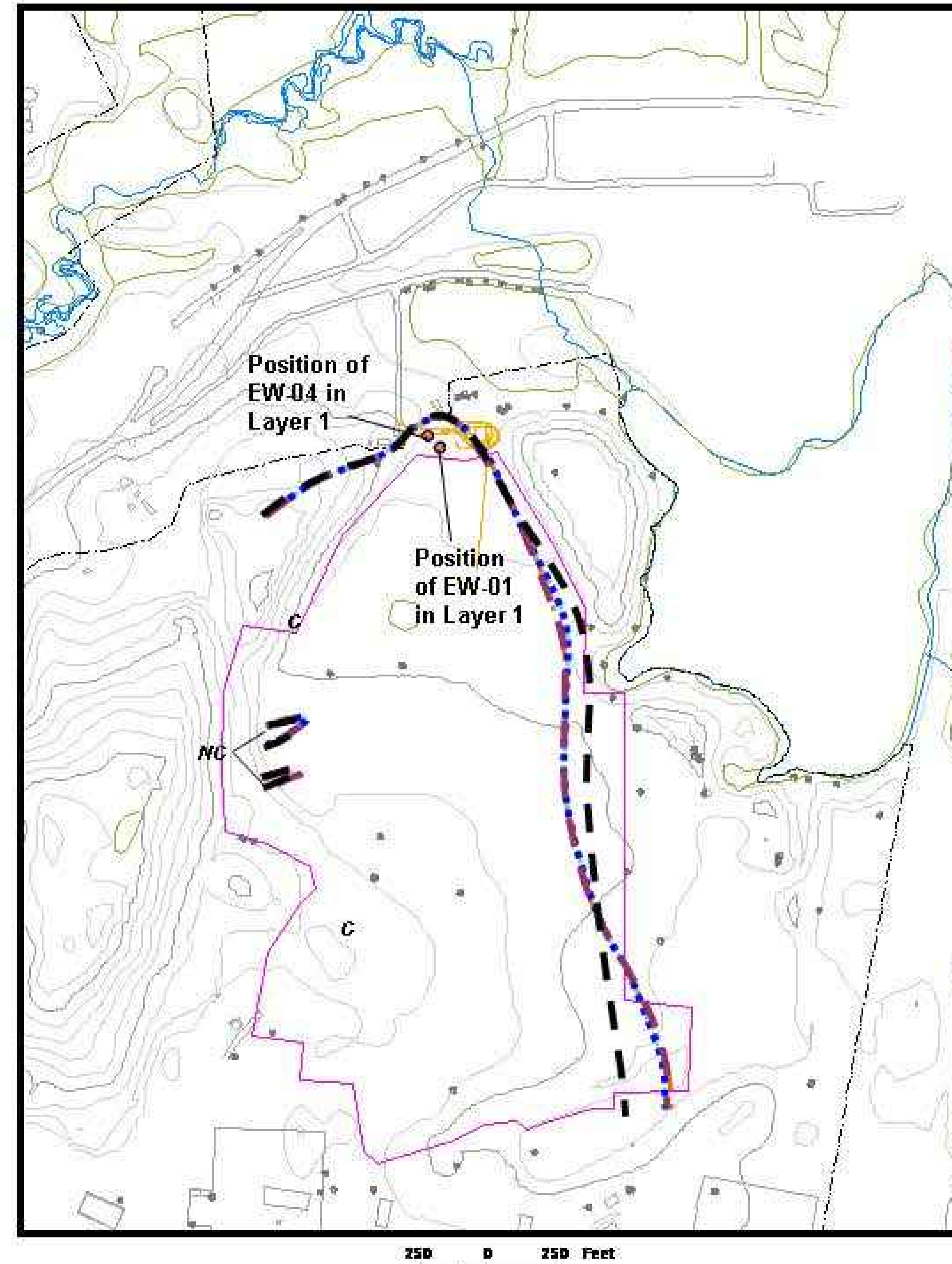
- Capture Zone for Run 412 (no reinjection)
- Capture Zone for Run C004 (reinjection well RI-C4A)
- Capture Zone for Run C004-A (reinjection wells RI-C4A and RI-C4B)
- Capture Zone for Run C004-B (40-ft x 80-ft Reinfiltration Basin/Trench)
- Capture Zone for Run C004-C (80-ft x 80-ft Reinfiltration Basin/Trench)

Capture Zones in Model Layers 1 and 2
C004 Series Simulations with 50 GPM Total Flow for
Reinjection or Reinfiltration
as Compared with Design Model Run 412 (No Reinjection)
Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



Capture Zones in Model Layer 1



Capture Zones in Model Layer 2

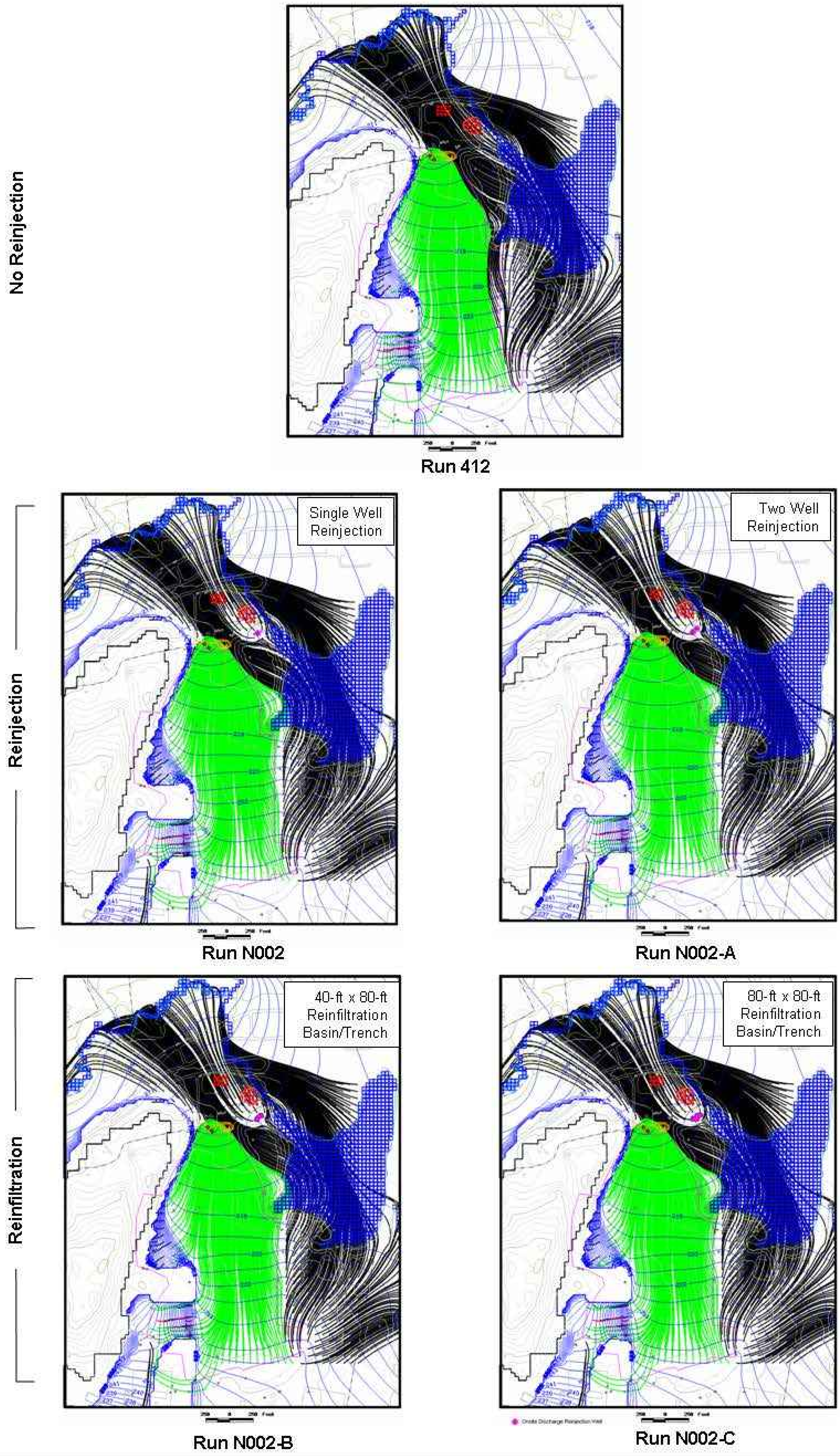
Notes:
C = Captured
NC = Not Captured
GPM = Gallons Per Minute

LEGEND

- Reinjection Well in Layer 1
- Extraction Well in Layer 1
- Approximate Treatment Plant Location
- Shepley's Hill Landfill Extent
- Fort Devens Boundary
- Surface Water
- Wetland
- Capture Zone for Run 412 (no reinjection)
- Capture Zone for Run S002 (reinjection well RI-S2A)
- Capture Zone for Run S002-A (reinjection wells RI-S2A and RI-S2B)
- Capture Zone for Run S002-B (40-ft x 80-ft Reinfiltration Basin/Trench)
- Capture Zone for Run S002-C (80-ft x 80-ft Reinfiltration Basin/Trench)

Capture Zones in Model Layers 1 and 2
S002 Series Simulations with 50 GPM Total Flow for
Reinjection or Reinfiltration
as Compared with Design Model Run 412 (No Reinjection)
Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



LEGEND

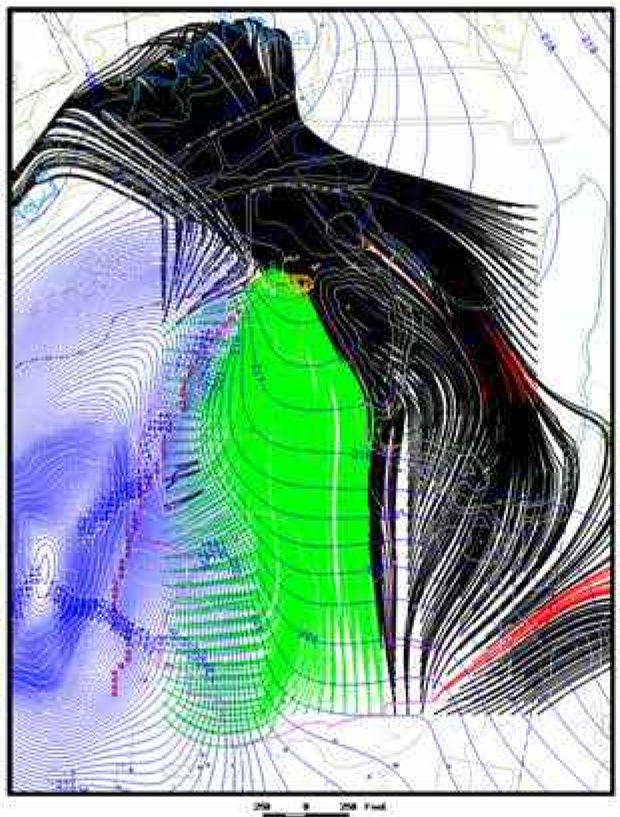
- Reinjection Well in Layer 1
- Extraction Well in Layer 1
- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Wetland
- Surface Water
- Fort Devens Boundary
- Shepley's Hill Landfill Extent
- Approximate Treatment Plant Location
- Reinfiltration Basin/Trench

N

Pathlines for Particles Started in Model Layer 1
N002 Series Simulations with 50 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 (No Reinjection)
Shepley's Hill Landfill
Fort Devens

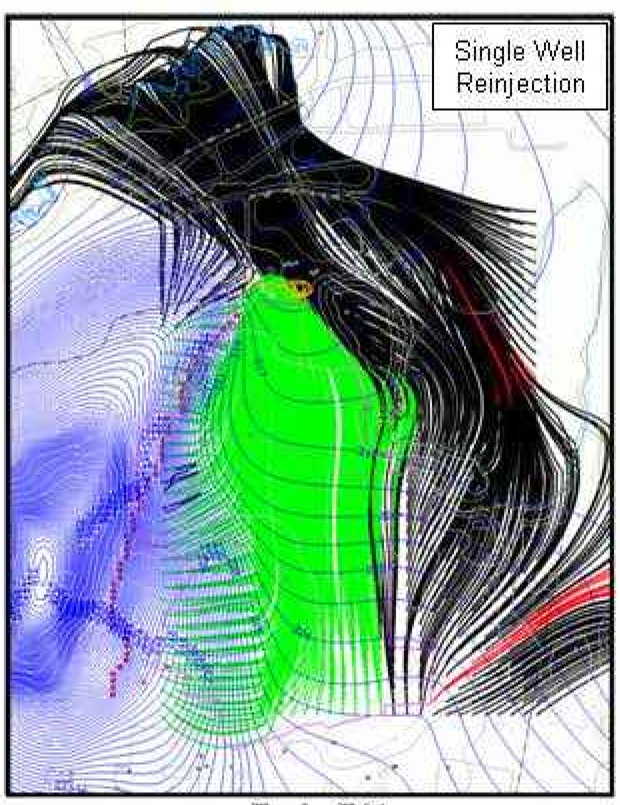
CH2MHILL

No Reinjection

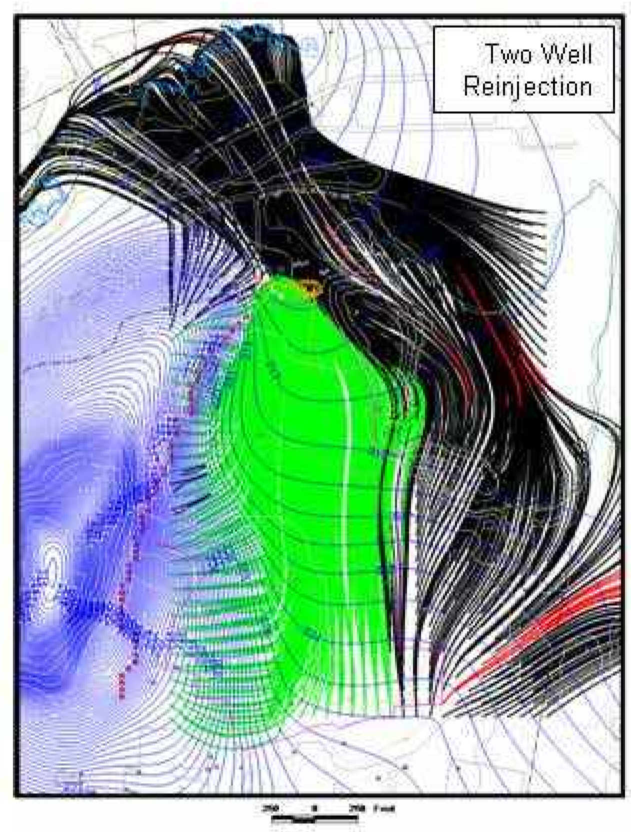


Run 412

Reinjection

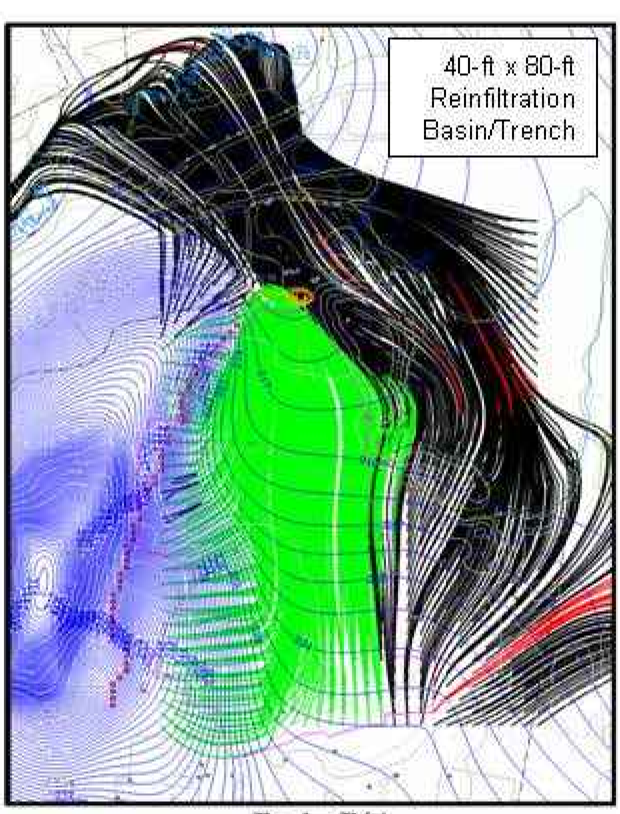


Run N002

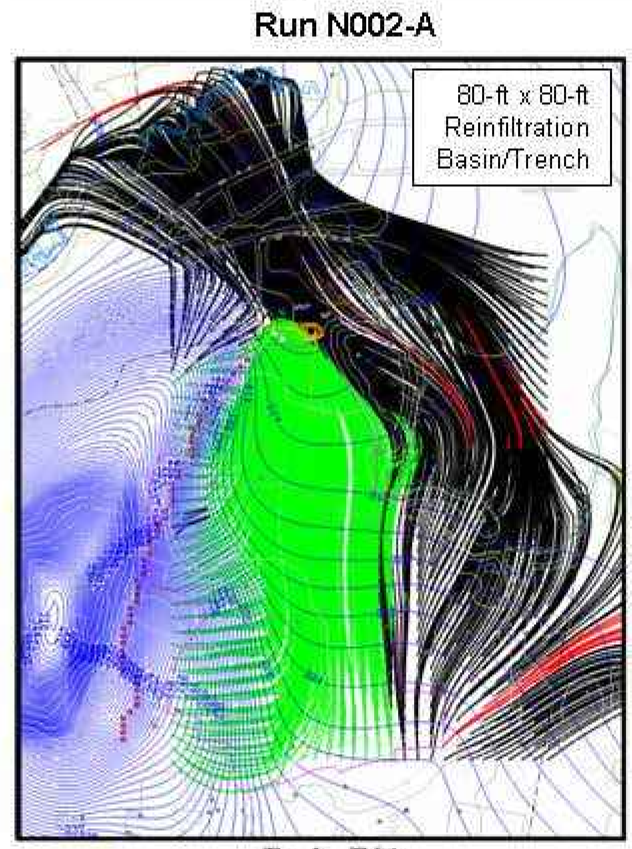


Run N002-A

Reinfiltration



Run N002-B



Run N002-C

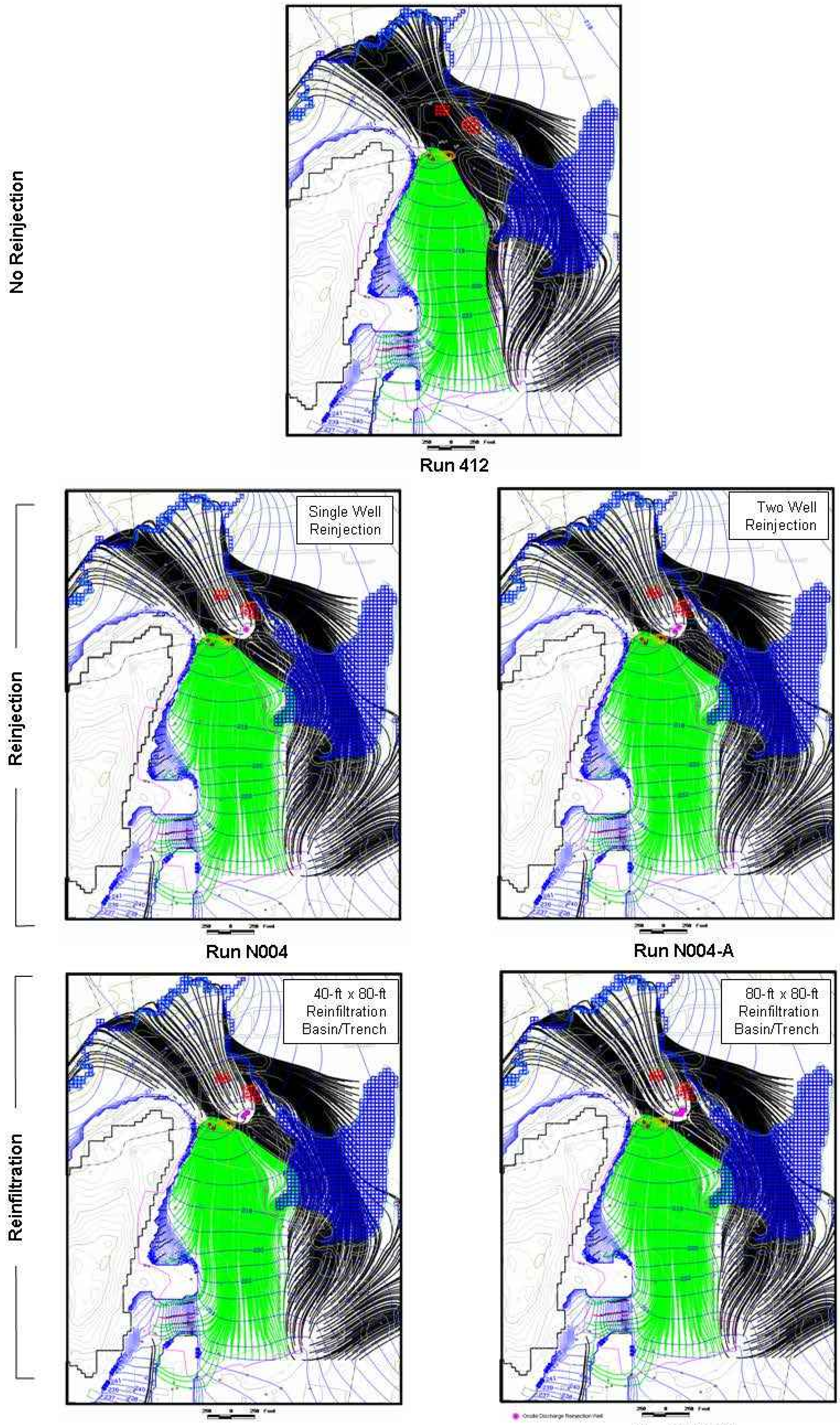
LEGEND

- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Wetland
- Surface Water
- Fort Devens Boundary
- Shepley's Hill Landfill Extent
- Approximate Treatment Plant Location

N

Pathlines for Particles Started in Model Layer 2
N002 Series Simulations with 50 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 (No Reinjection)
Shepley's Hill Landfill
Fort Devens

CH2MHILL



LEGEND

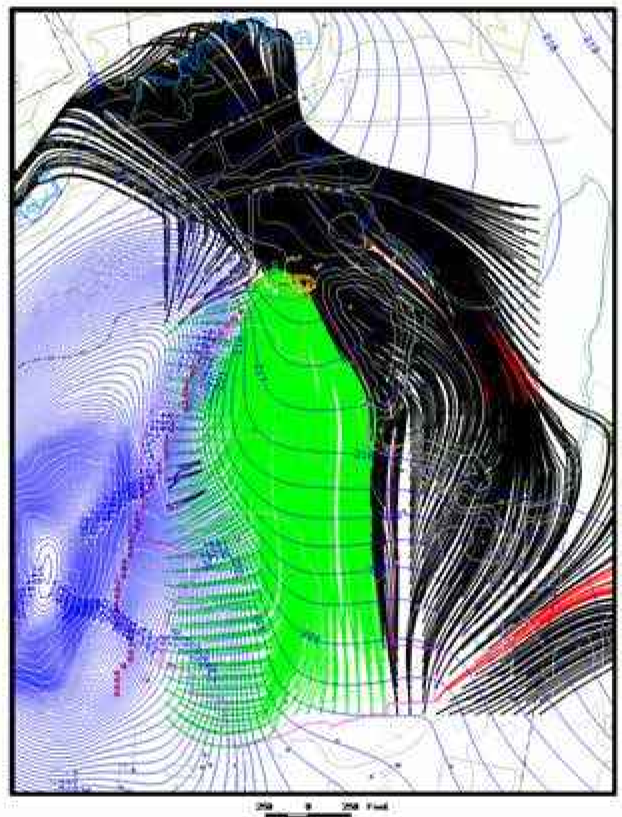
- Reinjection Well in Layer 1
- Extraction Well in Layer 1
- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Wetland
- Surface Water
- Fort Devens Boundary
- Shepley's Hill Landfill Extent
- Approximate Treatment Plant Location
- Reinfiltration Basin/Trench

N

Pathlines for Particles Started in Model Layer 1
N004 Series Simulations with 50 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 (No Reinjection)
Shepley's Hill Landfill
Fort Devens

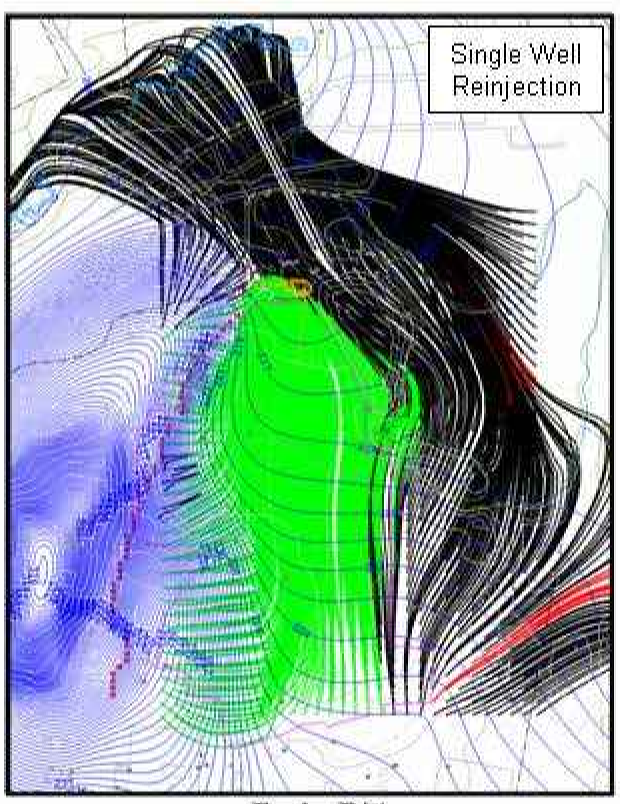
CH2MHILL

No Reinjection

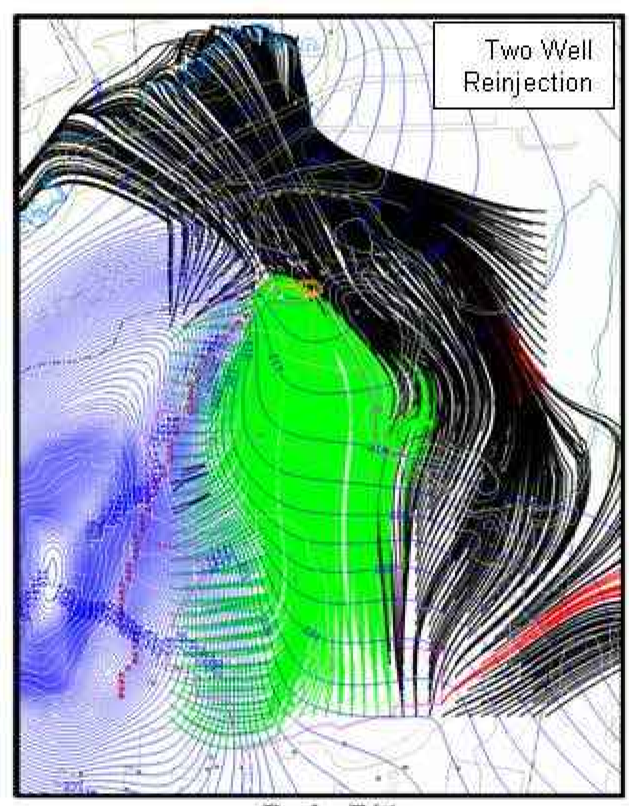


Run 412

Reinjection

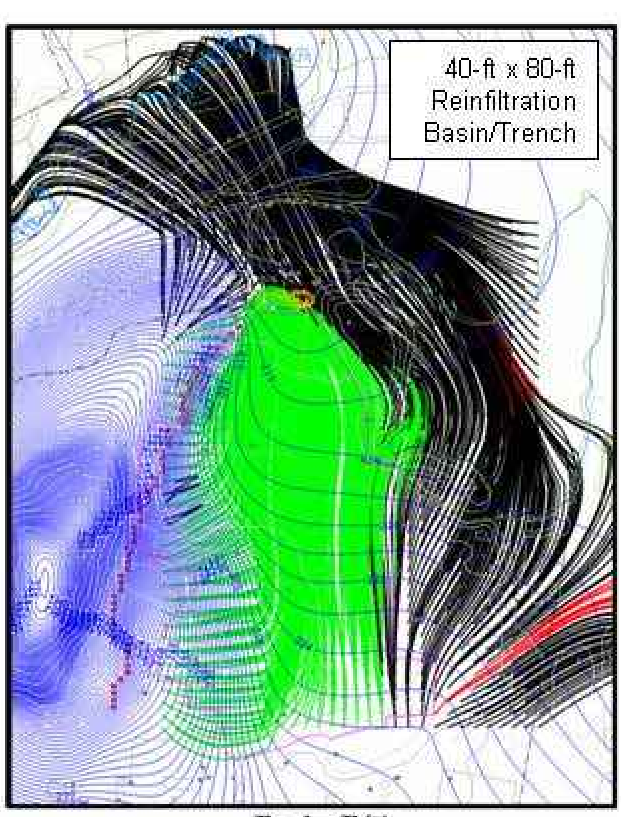


Run N004

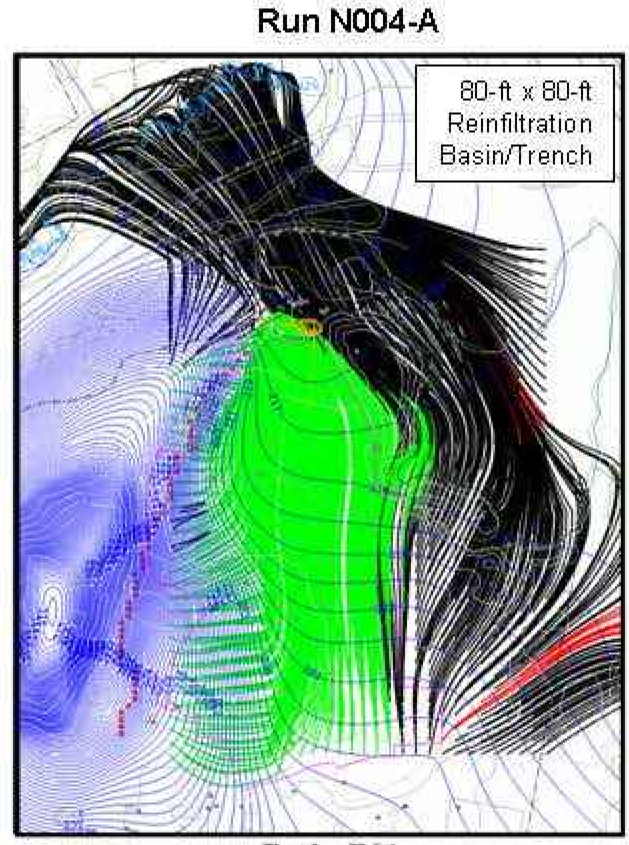


Run N004-A

Reinfiltration



Run N004-B



Run N004-C

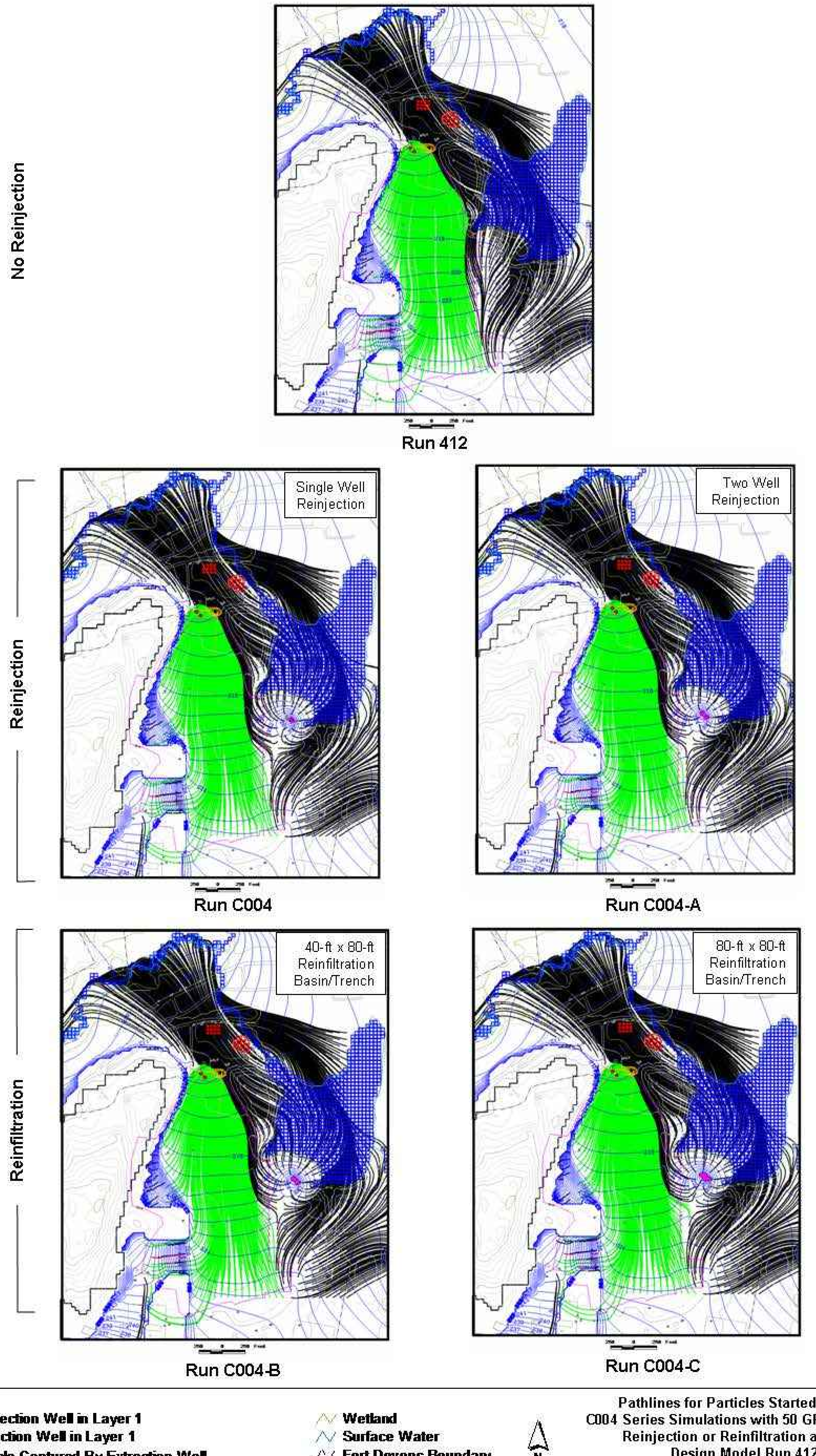
LEGEND

- **Particle Captured By Extraction Well**
- **Particle Exiting Through Other Layer 1 Boundaries**
- **Particle Exiting Through Layer 2 Boundaries**
- **Simulated Hydraulic Head Contour**
- **Wetland**
- **Surface Water**
- **Fort Devens Boundary**
- **Shepley's Hill Landfill Extent**
- **Approximate Treatment Plant Location**

N

Pathlines for Particles Started in Model Layer 2
N004 Series Simulations with 50 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 (No Reinjection)
Shepley's Hill Landfill
Fort Devens

CH2MHILL



LEGEND

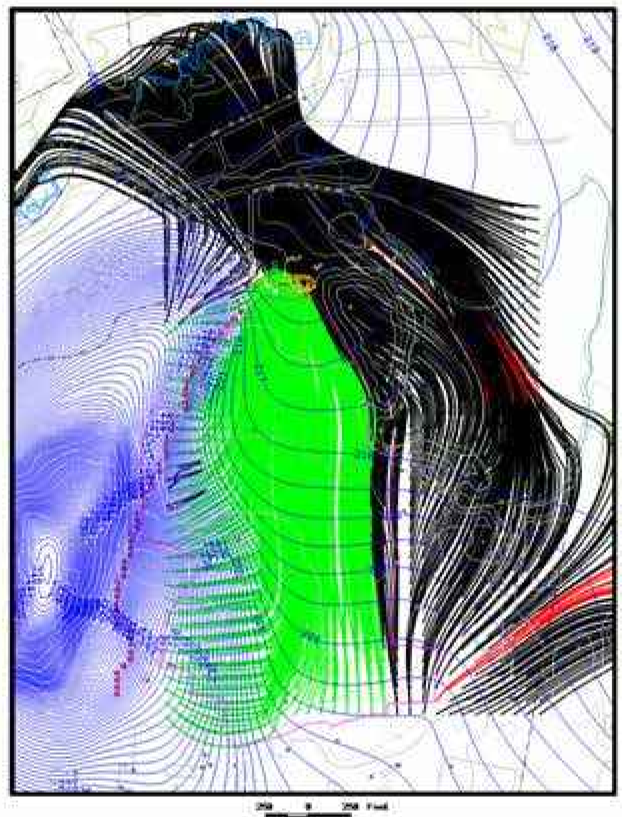
- Reinjection Well in Layer 1
- Extraction Well in Layer 1
- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Wetland
- Surface Water
- Fort Devens Boundary
- Shepley's Hill Landfill Extent
- Approximate Treatment Plant Location
- Reinfiltration Basin/Trench

N

Pathlines for Particles Started in Model Layer 1
C004 Series Simulations with 50 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 (No Reinjection)
Shepley's Hill Landfill
Fort Devens

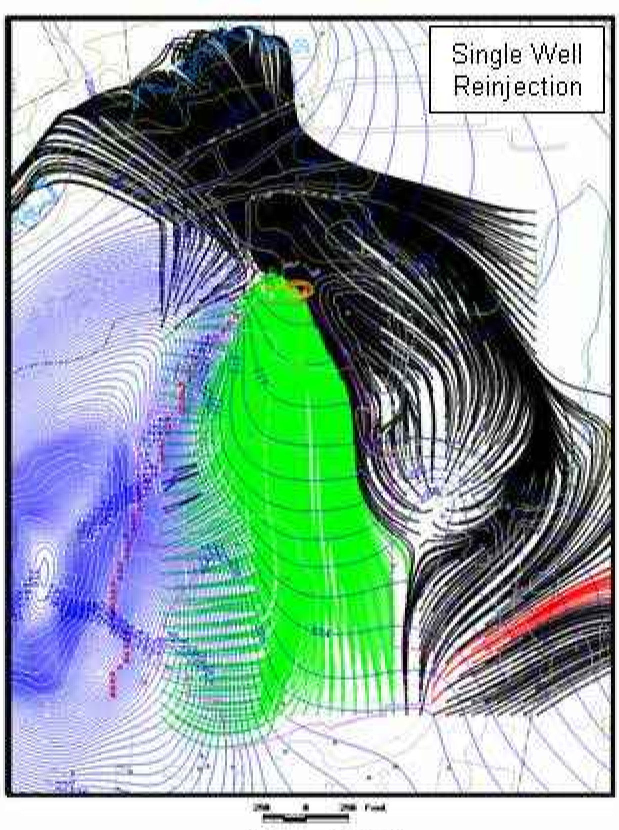
CH2MHILL

No Reinjection

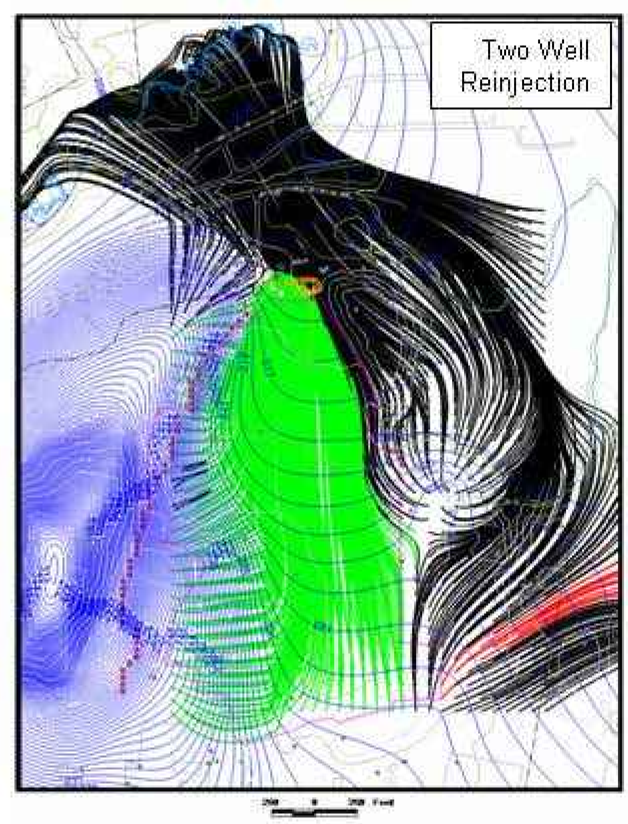


Run 412

Reinjection

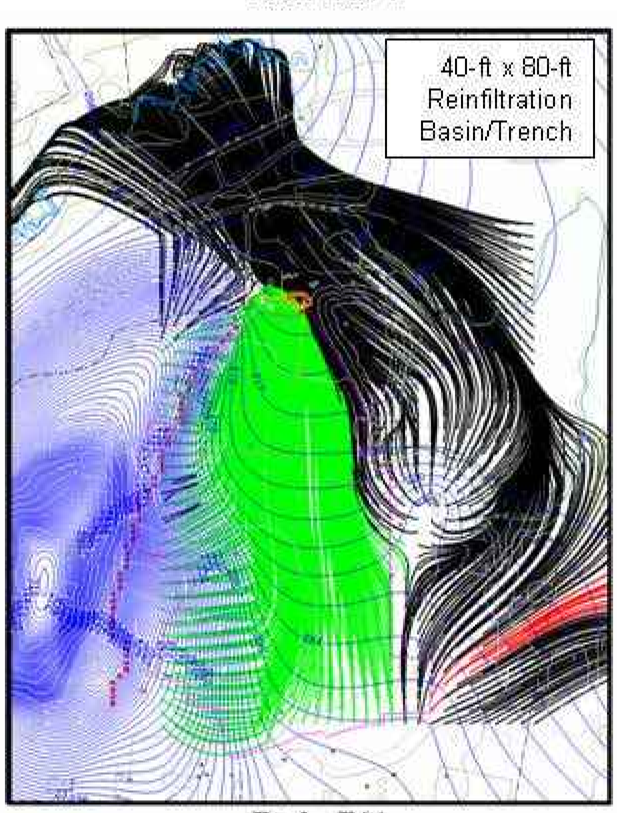


Run C004

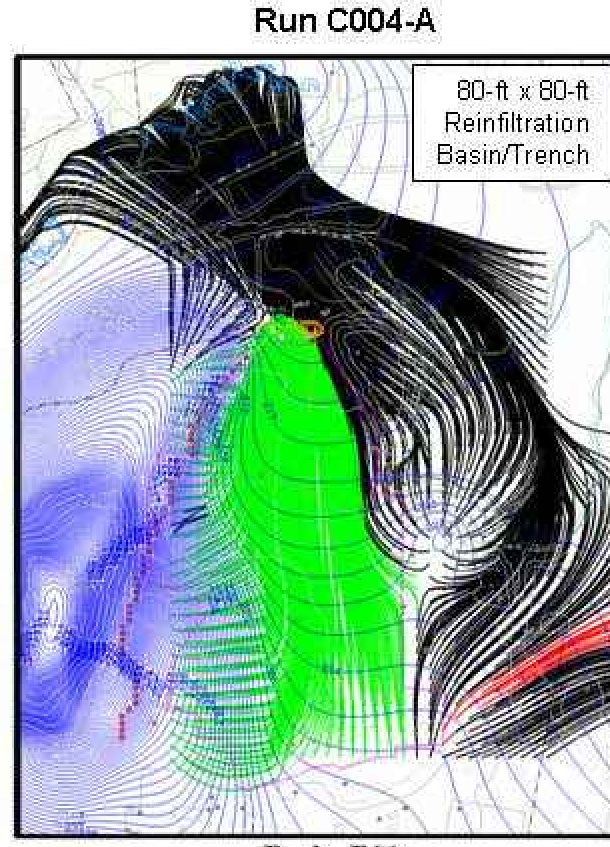


Run C004-A

Reinfiltration



Run C004-B



Run C004-C

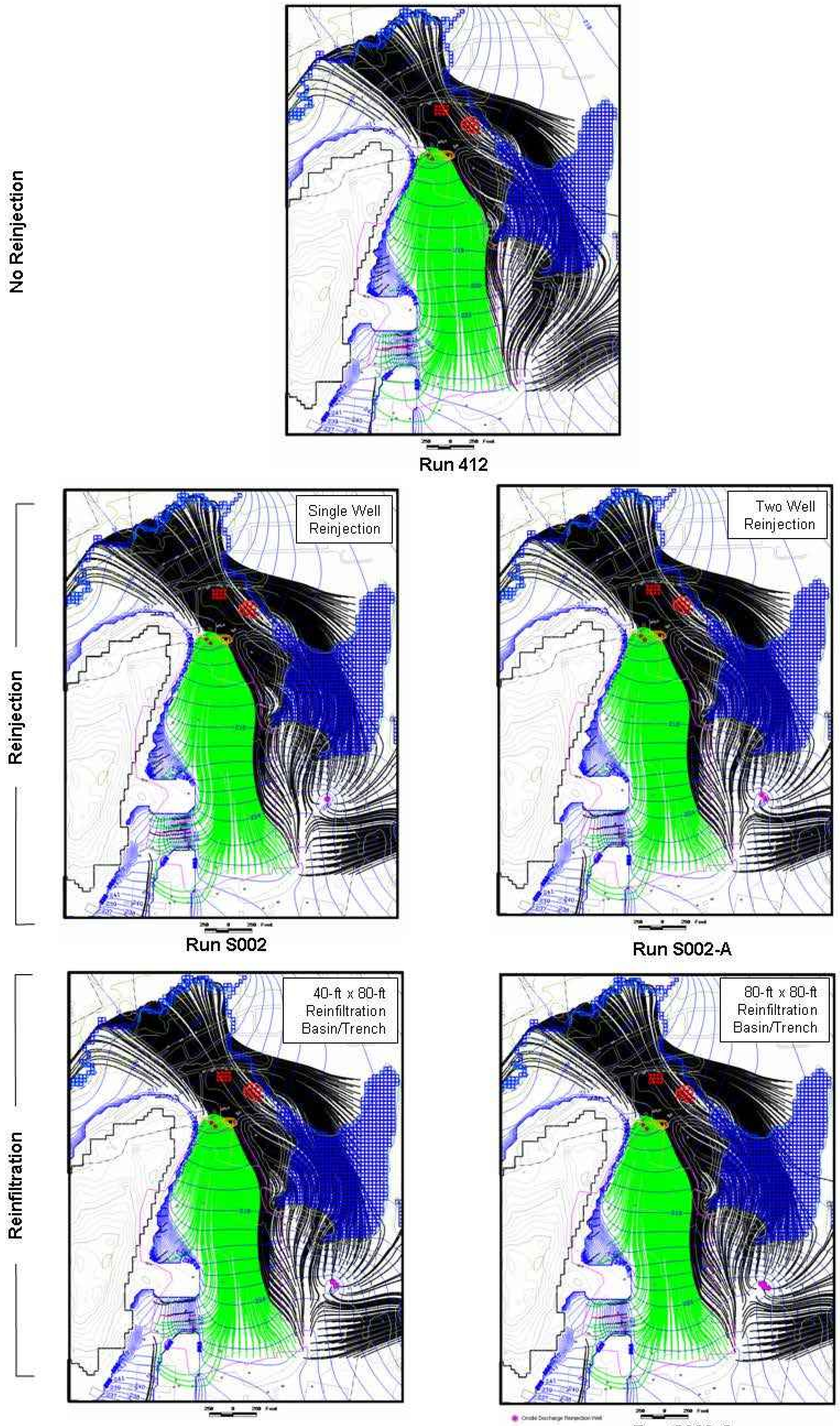
LEGEND

- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Wetland
- Surface Water
- Fort Devens Boundary
- Shepley's Hill Landfill Extent
- Approximate Treatment Plant Location

N

Pathlines for Particles Started in Model Layer 2
C004 Series Simulations with 50 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 (No Reinjection)
Shepley's Hill Landfill
Fort Devens

CH2MHILL



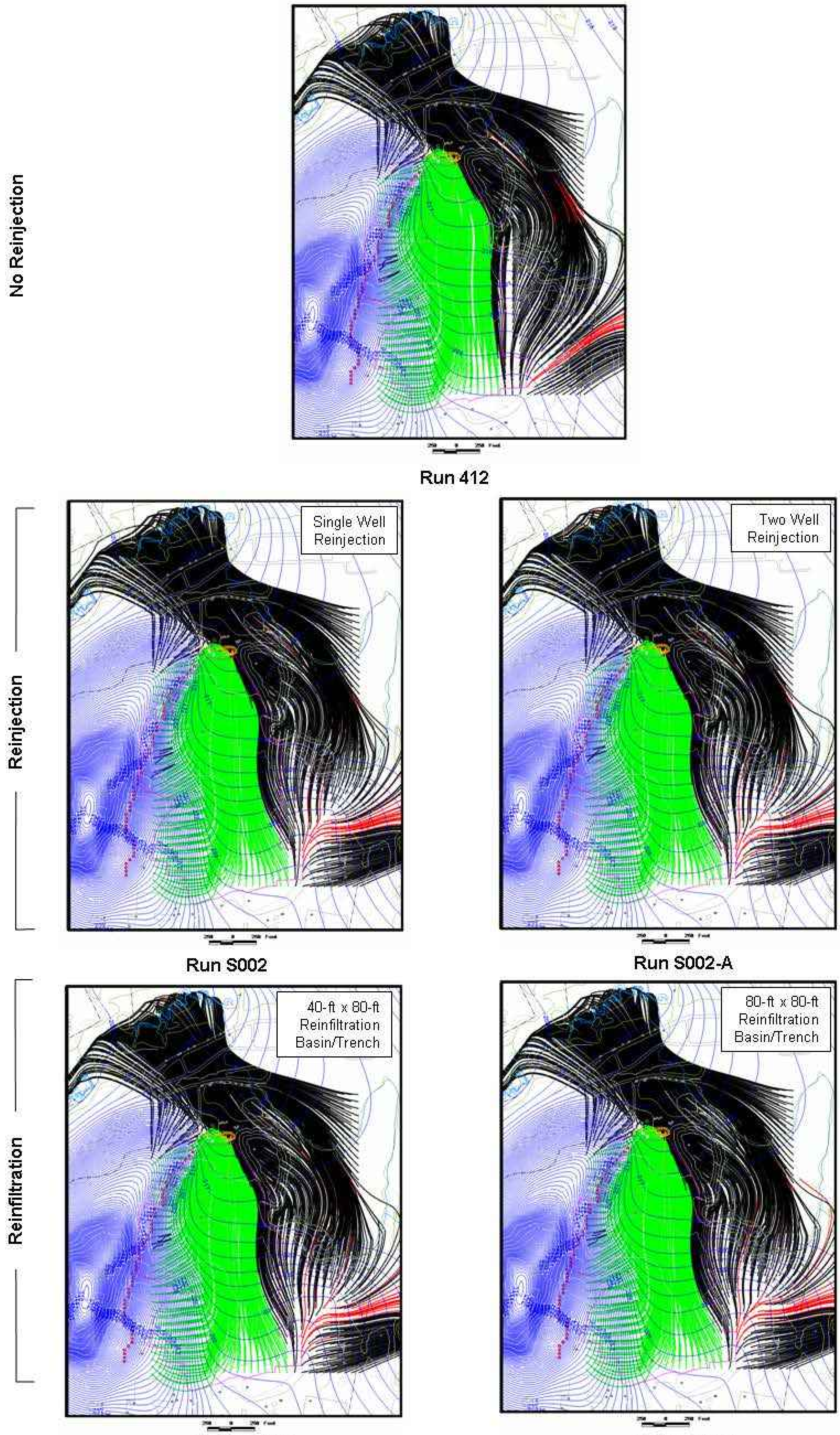
LEGEND

- Reinjection Well in Layer 1
- Extraction Well in Layer 1
- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Wetland
- Surface Water
- Fort Devens Boundary
- Shepley's Hill Landfill Extent
- Approximate Treatment Plant Location
- Reinfiltration Basin/Trench

N

Pathlines for Particles Started in Model Layer 1
S002 Series Simulations with 50 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 (No Reinjection)
Shepley's Hill Landfill
Fort Devens

CH2MHILL



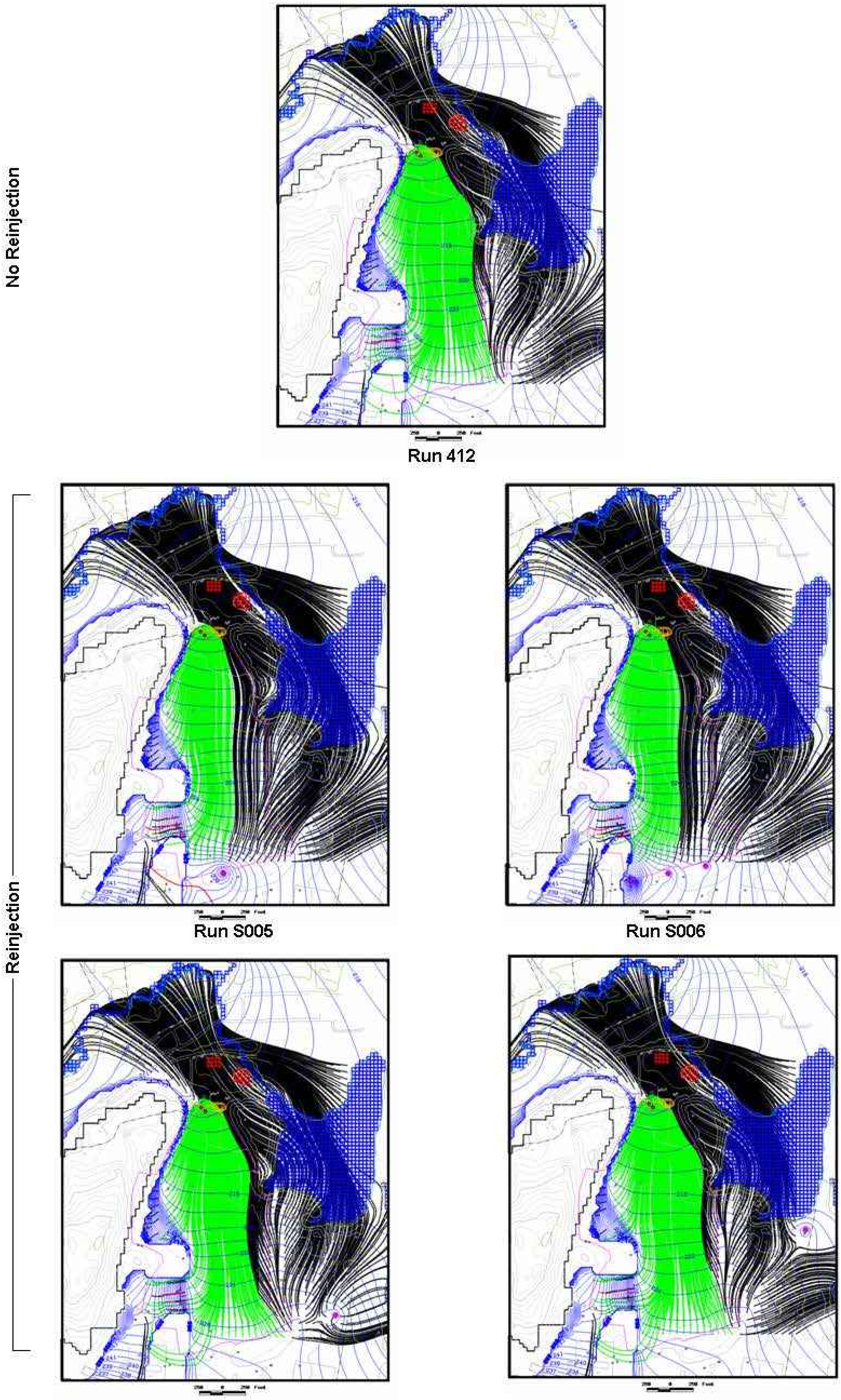
LEGEND

- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Wetland
- Surface Water
- Fort Devens Boundary
- Shepley's Hill Landfill Extent
- Approximate Treatment Plant Location

N

Pathlines for Particles Started in Model Layer 2
S002 Series Simulations with 50 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 (No Reinjection)
Shepley's Hill Landfill
Fort Devens

CH2MHILL



LEGEND

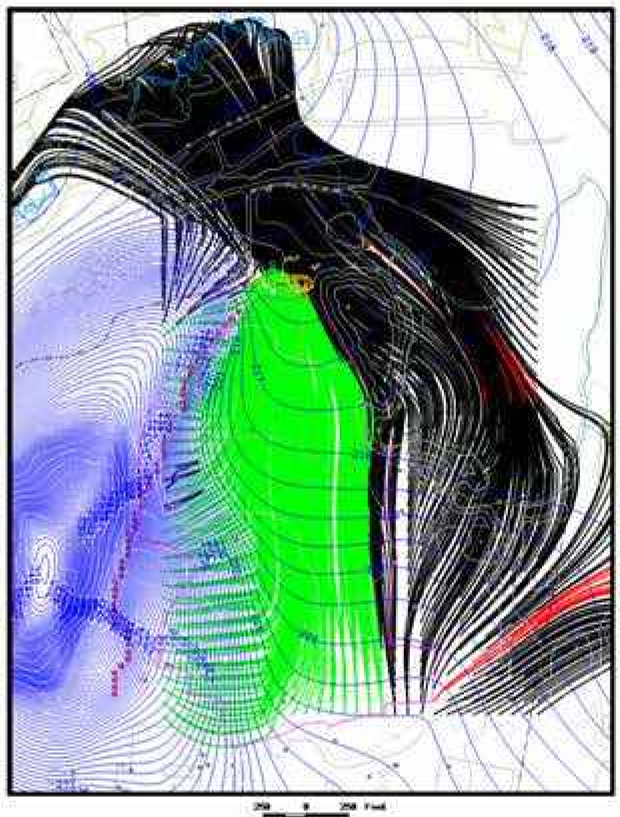
- Reinjection Well in Layer 1
- Extraction Well in Layer 1
- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Wetland
- Surface Water
- Fort Devens Boundary
- Shepley's Hill Landfill Extent
- Approximate Treatment Plant Location

N

Pathlines for Particles Started in Model Layer 1
Single or Multiple Reinjection Wells Operating at 50 GPM for Runs S005 through S008 as compared with Design Model Run 412 (no reinjection)
Shepley's Hill Landfill
Fort Devens

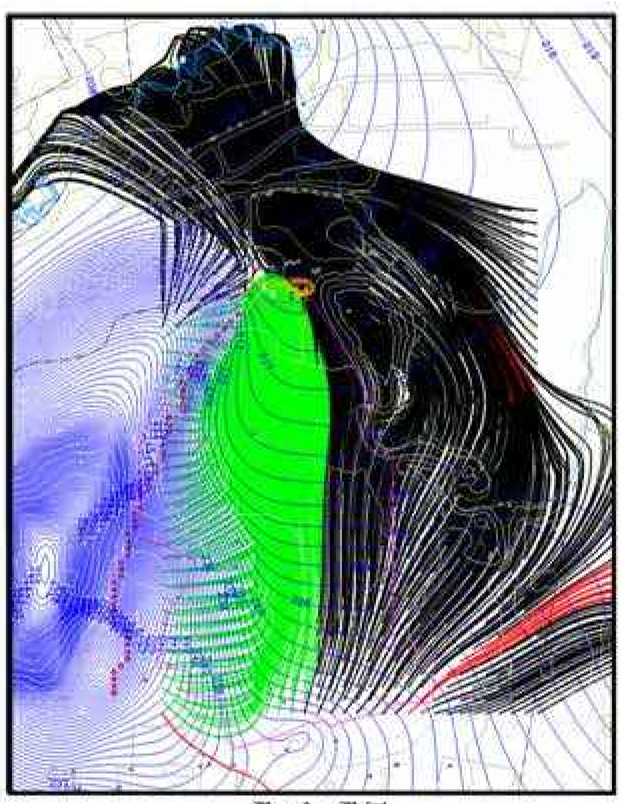
CH2MHILL

No Reinjection

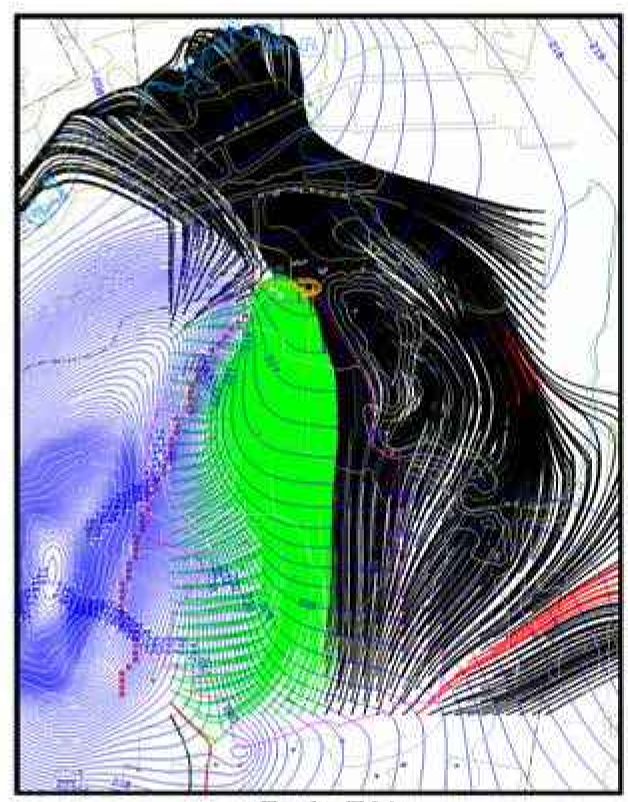


Run 412

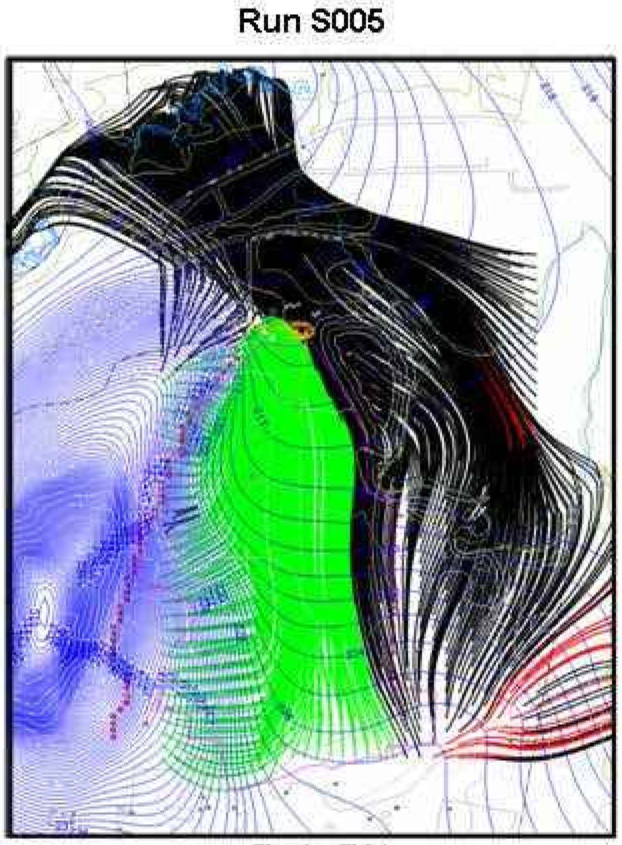
Reinjection



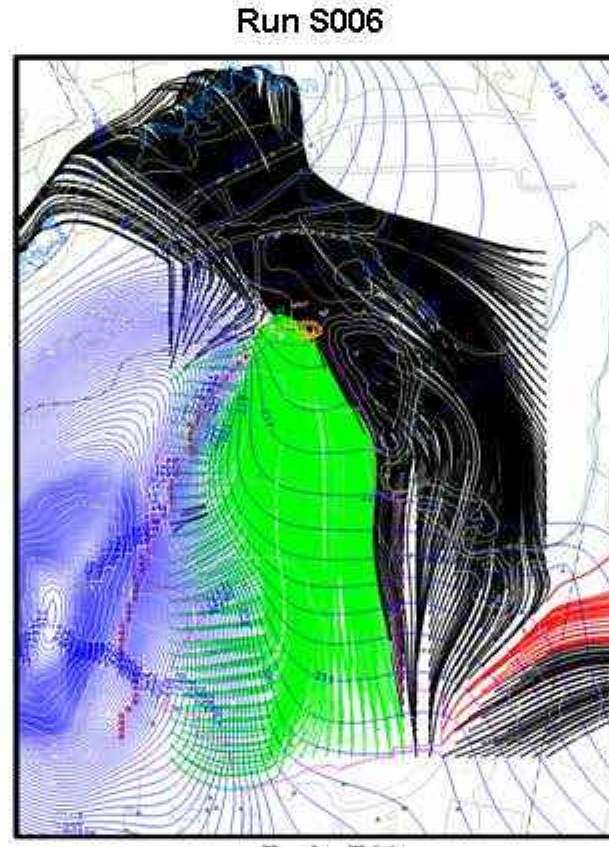
Run S005



Run S006



Run S007



Run S008

LEGEND

- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Wetland
- Surface Water
- Fort Devens Boundary
- Shepley's Hill Landfill Extent
- Approximate Treatment Plant Location

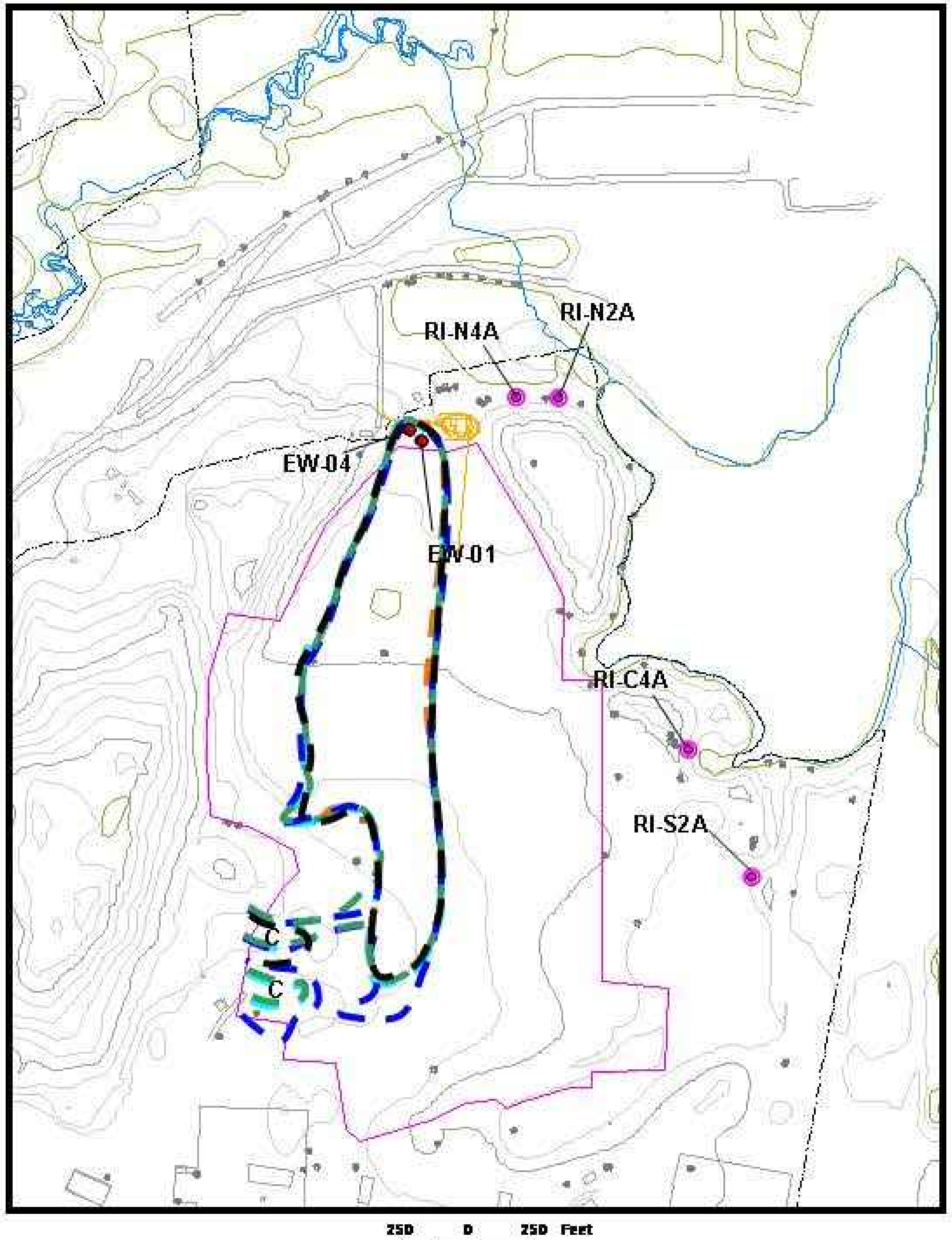
N

Pathlines for Particles Started in Model Layer 2 Single or Multiple Reinjection Wells Operating at 50 GPM for Runs S005 through S008 as compared with Design Model Run 412 (no reinjection)

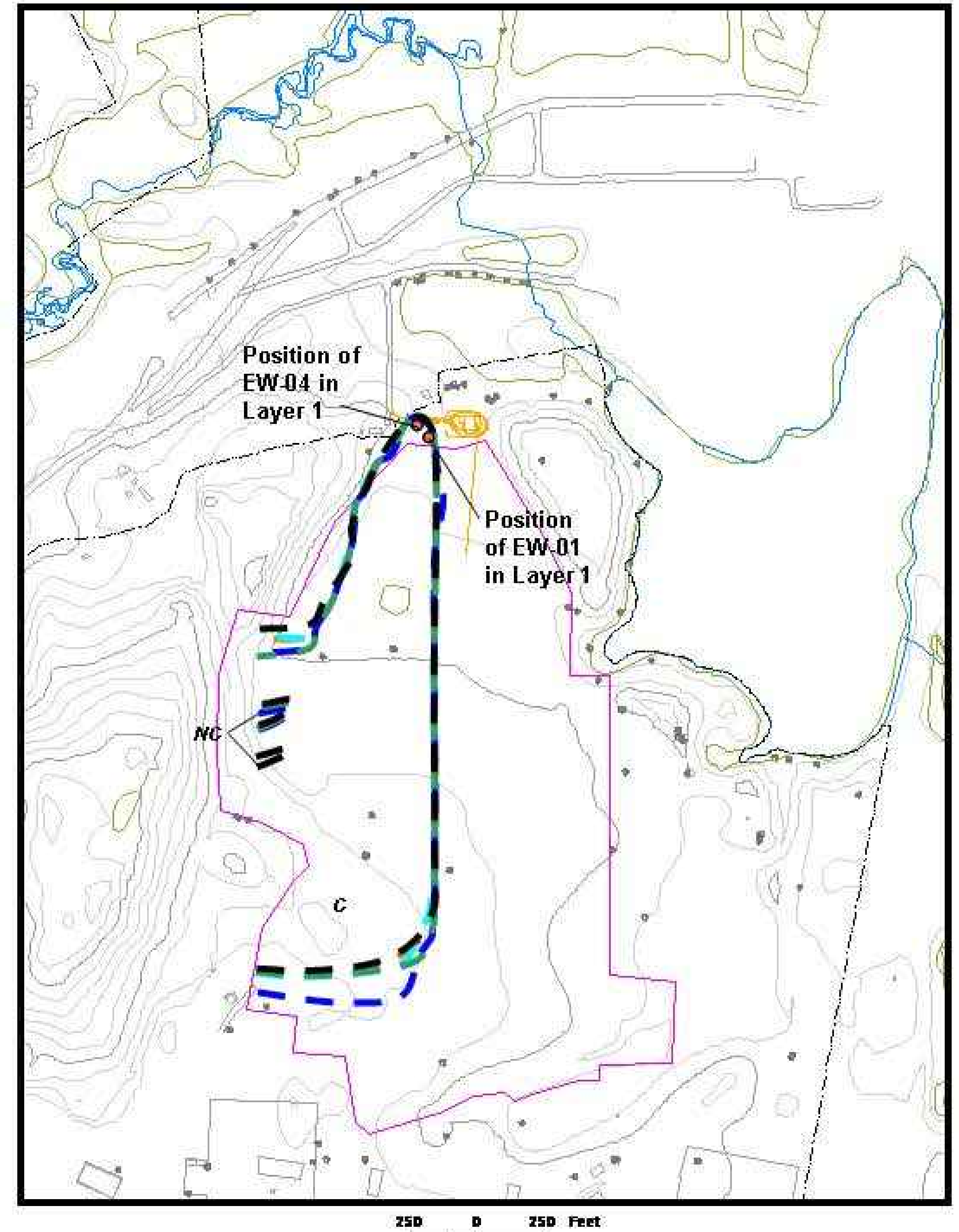
Shepley's Hill Landfill

Fort Devens

CH2MHILL



Capture Zones in Model Layer 1



Capture Zones in Model Layer 2

Notes:
C = Captured
NC = Not Captured
GPM = Gallons Per Minute

N

LEGEND

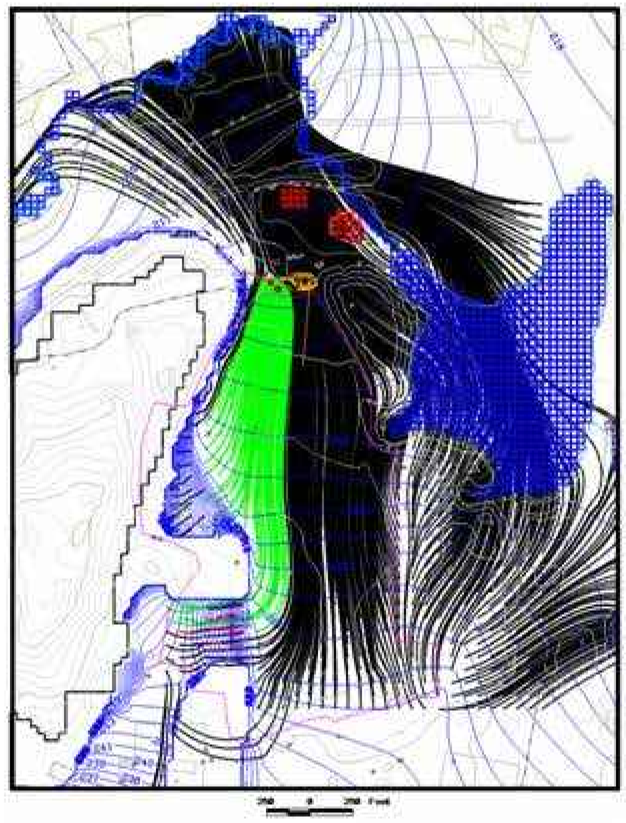
- **Reinjection Well in Layer 1**
- **Extraction Well in Layer 1**
- **Approximate Treatment Plant Location**
- **Shepley's Hill Landfill Extent**
- **Fort Devens Boundary**
- **Surface Water**
- **Wetland**

- Capture Zone for Run 412 (no reinjection)
- Capture Zone for Run N002-2 (reinjection well RI-N2A)
- Capture Zone for Run N004-2 (reinjection well RI-N4A)
- Capture Zone for Run C004-2 (reinjection well RI-C4A)
- Capture Zone for Run S002-2 (reinjection well RI-S2A)

Capture Zones in Model Layers 1 and 2
Simulation Runs N002, N004, C004, and S002 with 25 GPM Total Extraction Flow and 25 GPM Total Reinjection Flow as Compared with Design Model Run 412 at 25 GPM (No Reinjection)
Shepley's Hill Landfill, Fort Devens, MA

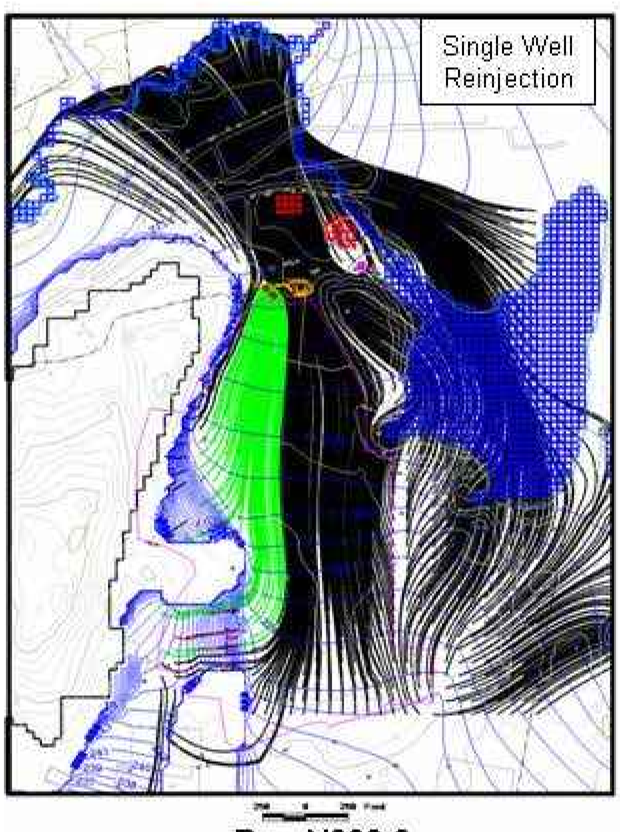
CH2MHILL

No Reinjection

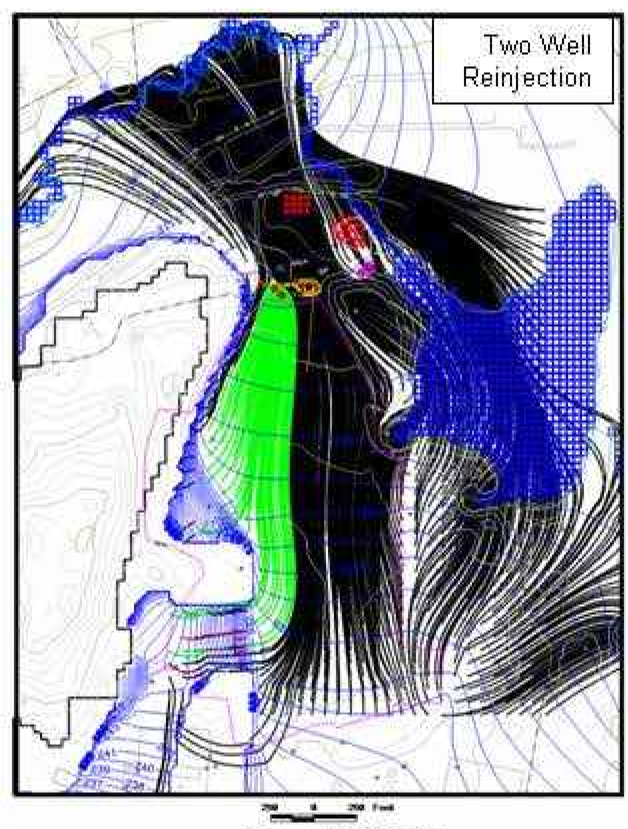


Run 412 at 25 GPM

Reinjection

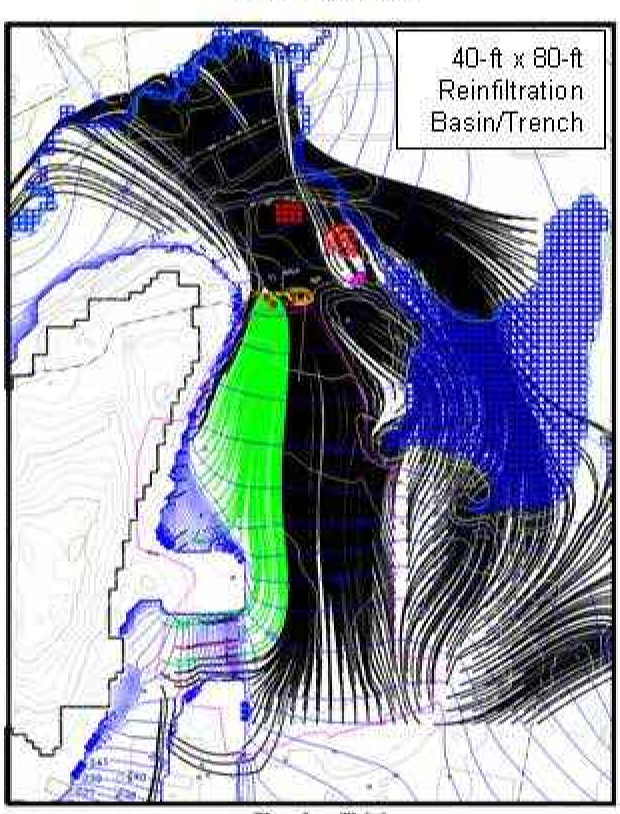


Run N002-2

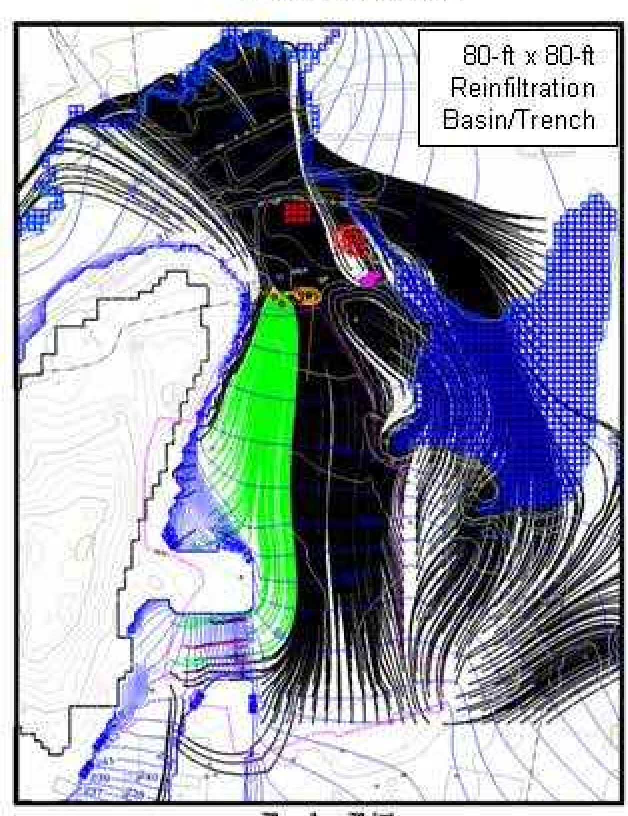


Run N002-2A

Reinfiltration



Run N002-2B



Run N002-2C

LEGEND

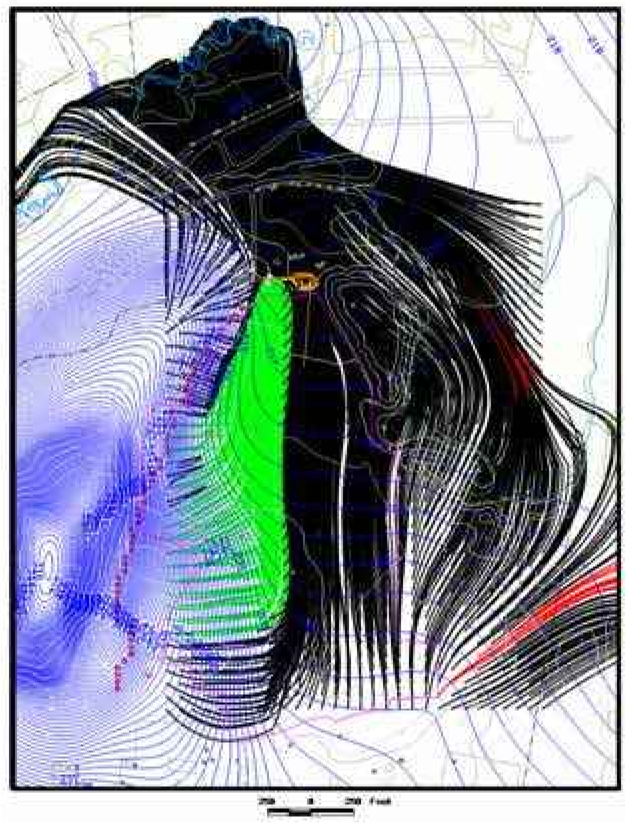
- Reinjection Well in Layer 1
- Extraction Well in Layer 1
- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Wetland
- Surface Water
- Fort Devens Boundary
- Shepley's Hill Landfill Extent
- Approximate Treatment Plant Location
- Reinfiltration Basin/Trench

N

Pathlines for Particles Started in Model Layer 1
N002 Series Simulations with 25 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 at 25 GPM (No Reinjection)
Shepley's Hill Landfill
Fort Devens

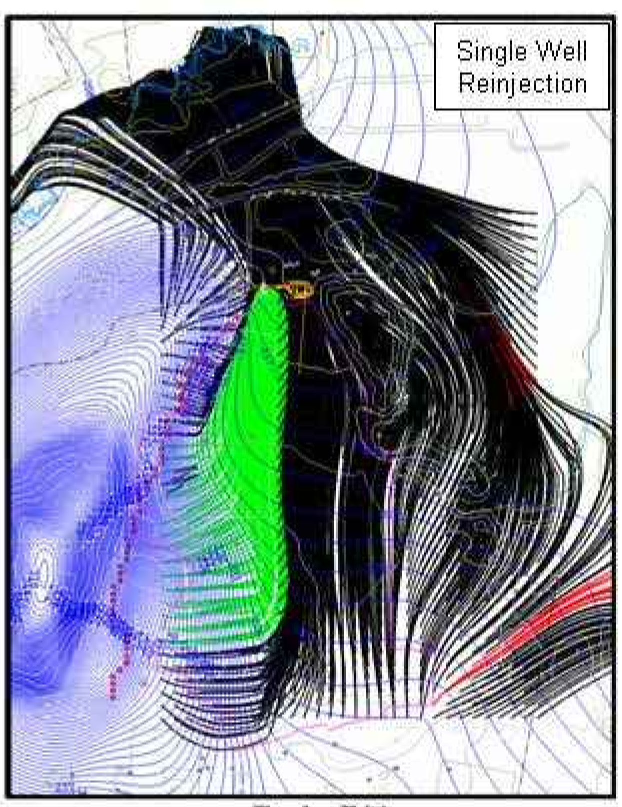
CH2MHILL

No Reinjection

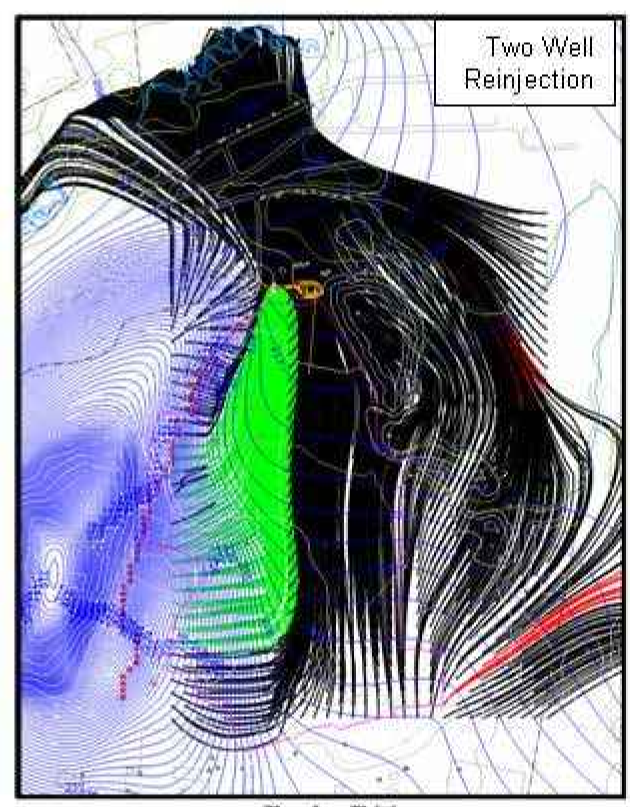


Run 412 at 25 GPM

Reinjection

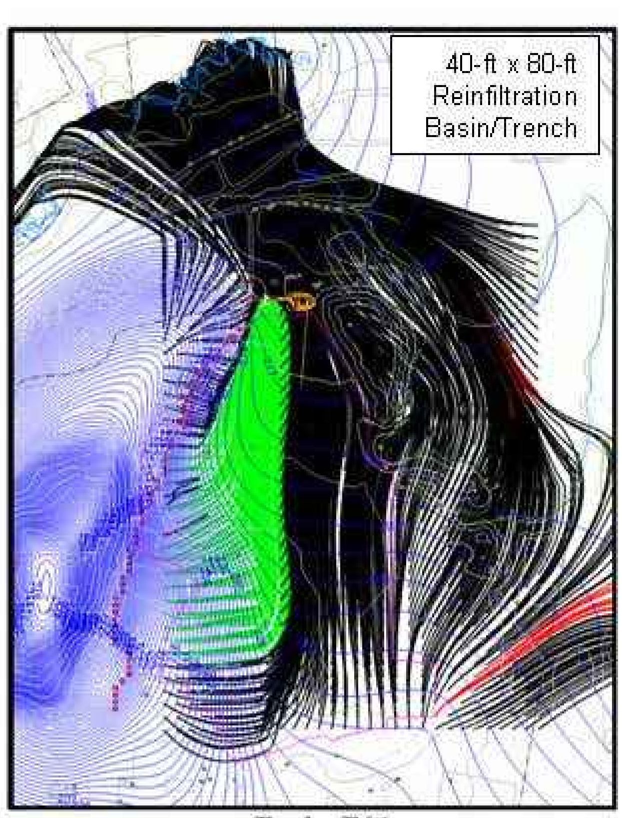


Run N002-2

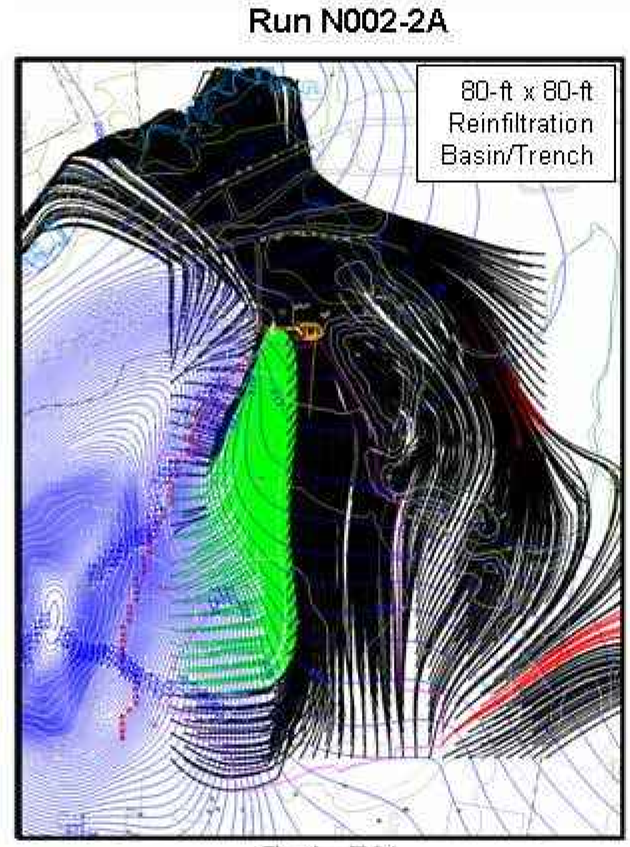


Run N002-2A

Reinfiltration



Run N002-2B



Run N002-2C

LEGEND

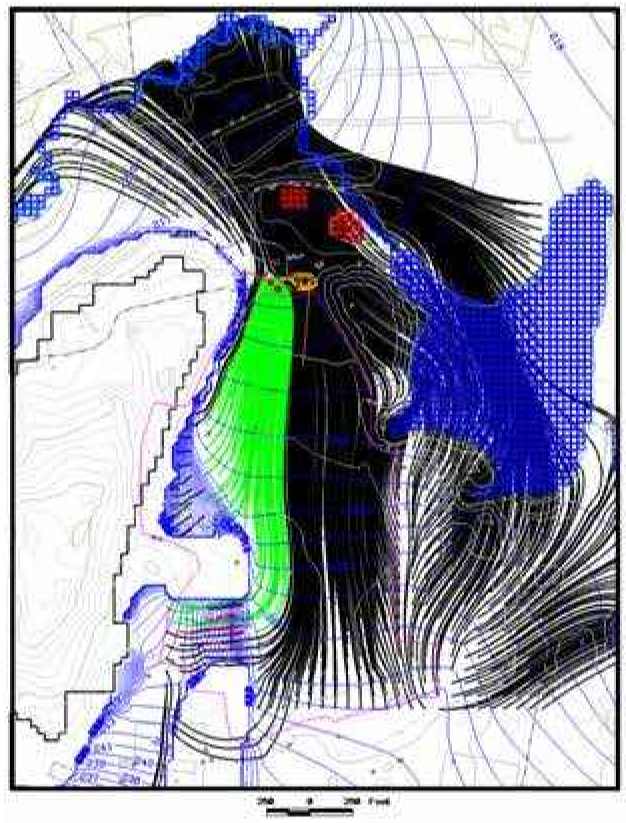
- **Particle Captured By Extraction Well**
- **Particle Exiting Through Other Layer 1 Boundaries**
- **Particle Exiting Through Layer 2 Boundaries**
- **Simulated Hydraulic Head Contour**
- **Wetland**
- **Surface Water**
- **Fort Devens Boundary**
- **Shepley's Hill Landfill Extent**
- **Approximate Treatment Plant Location**

N

Pathlines for Particles Started in Model Layer 2
N002 Series Simulations with 25 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 at 25 GPM (No Reinjection)
Shepley's Hill Landfill
Fort Devens

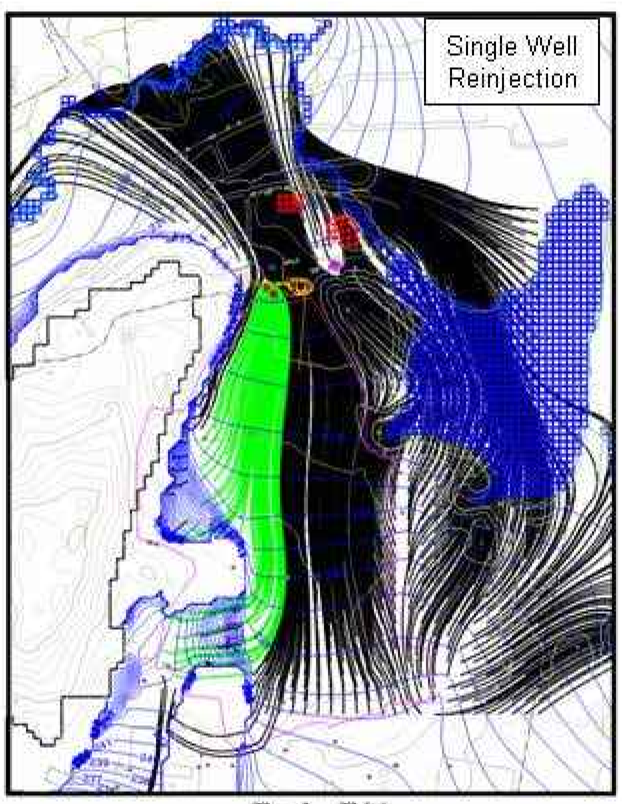
CH2MHILL

No Reinjection

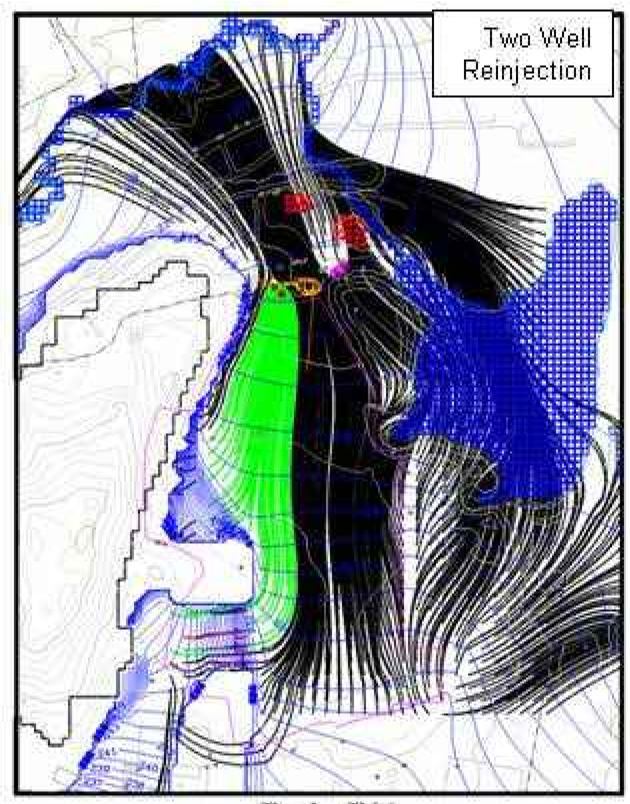


Run 412 at 25 GPM

Reinjection

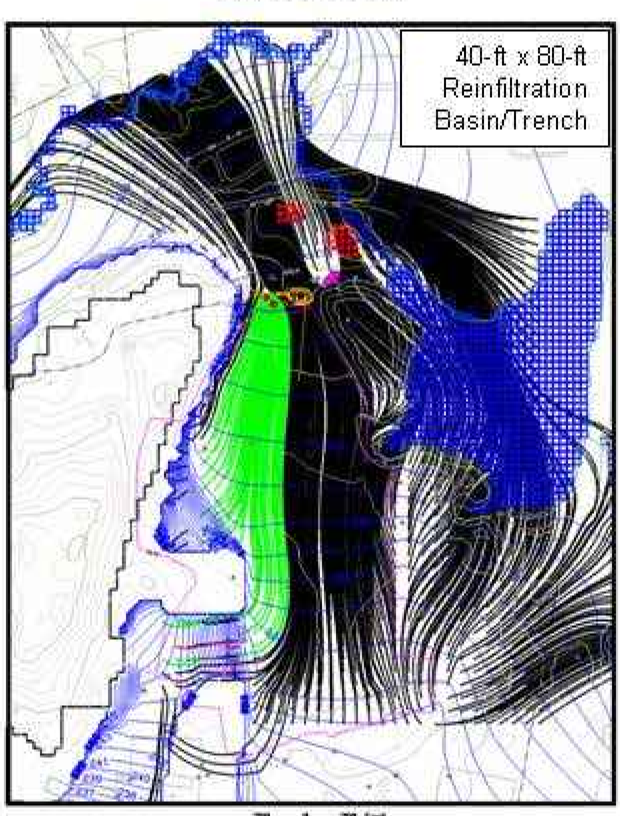


Run N004-2

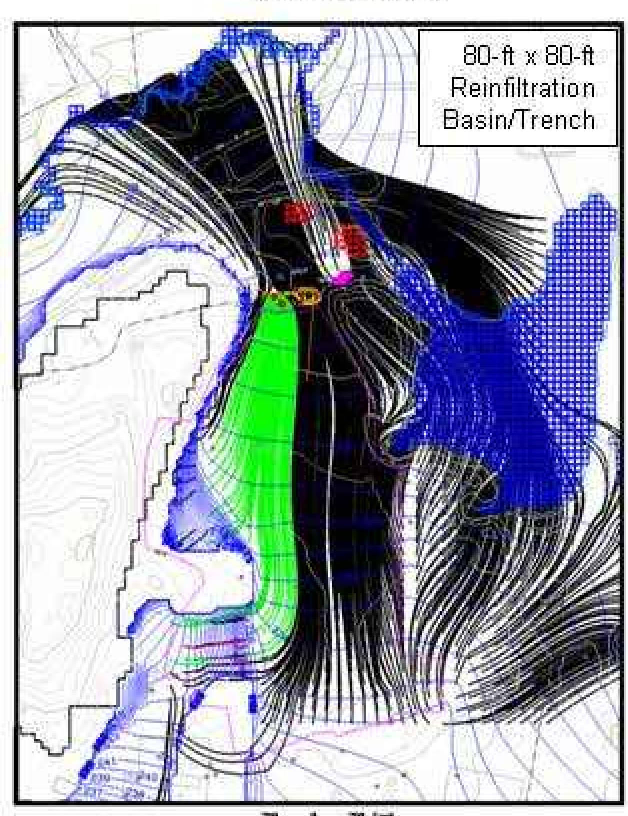


Run N004-2A

Reinfiltration



Run N004-2B



Run N004-2C

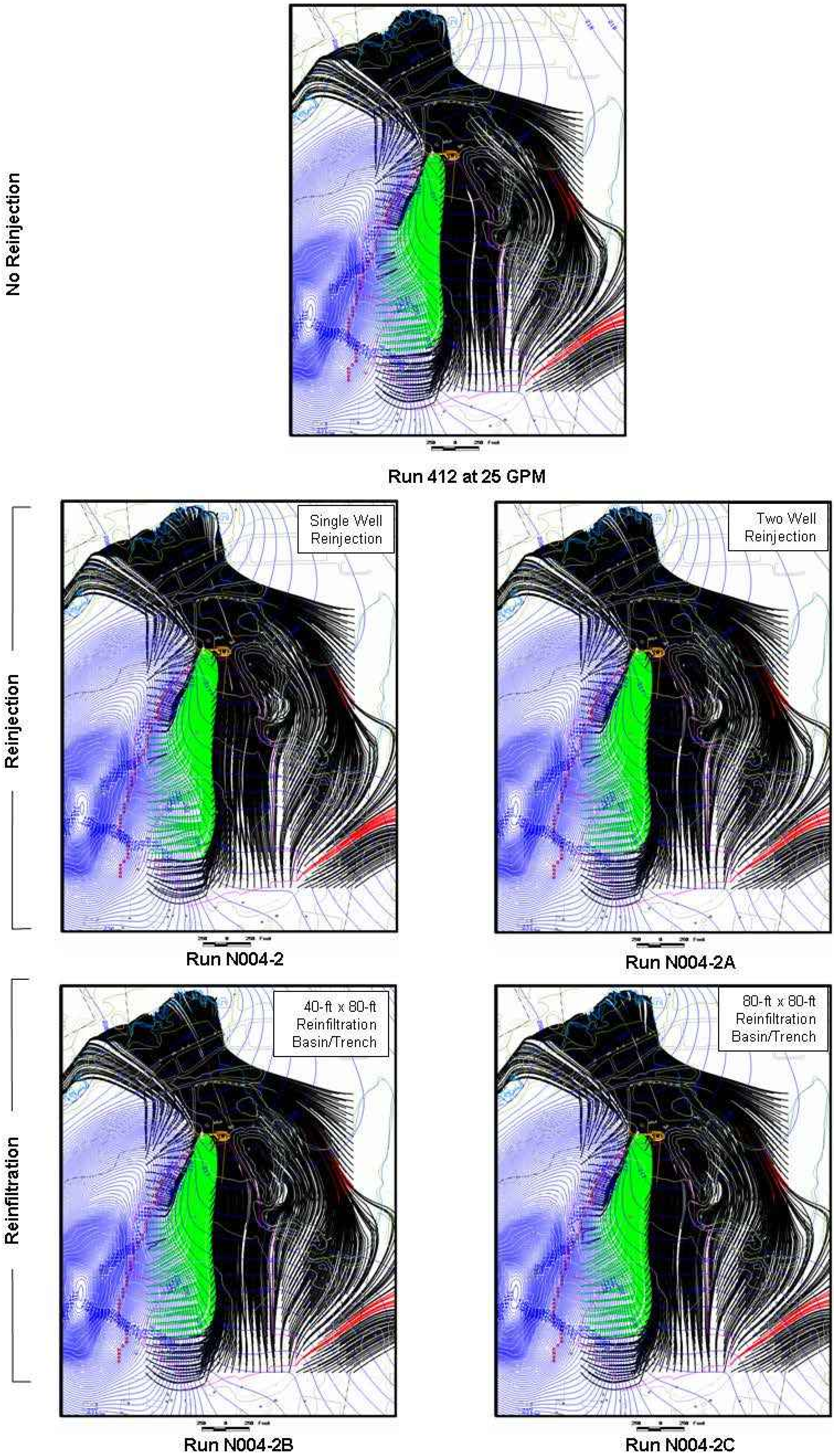
LEGEND

- Reinjection Well in Layer 1
- Extraction Well in Layer 1
- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Wetland
- Surface Water
- Fort Devens Boundary
- Shepley's Hill Landfill Extent
- Approximate Treatment Plant Location
- Reinfiltration Basin/Trench

N

Pathlines for Particles Started in Model Layer 1
N004 Series Simulations with 25 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 at 25 GPM (No Reinjection)
Shepley's Hill Landfill
Fort Devens

CH2MHILL



LEGEND

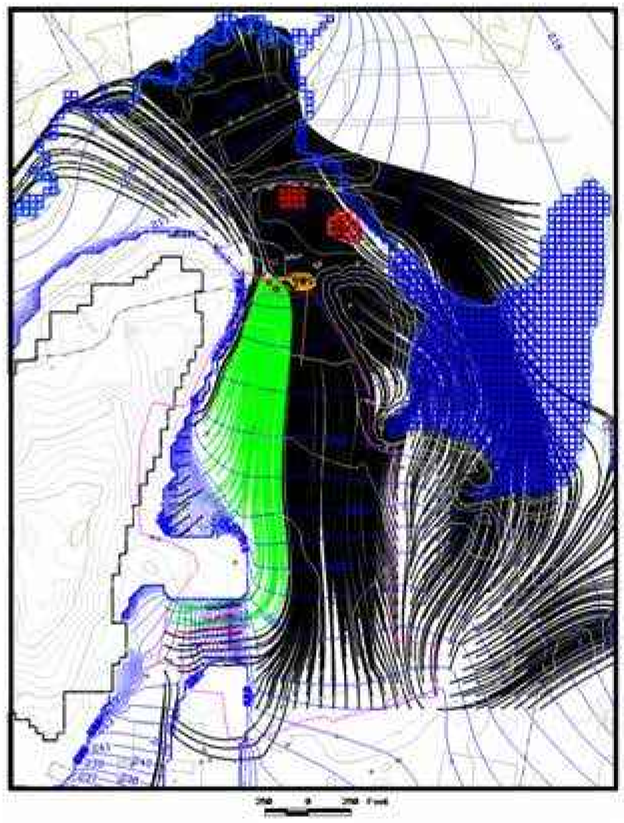
- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Wetland
- Surface Water
- Fort Devens Boundary
- Shepley's Hill Landfill Extent
- Approximate Treatment Plant Location

N

Pathlines for Particles Started in Model Layer 2
N004 Series Simulations with 25 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 at 25 GPM (No Reinjection)
Shepley's Hill Landfill
Fort Devens

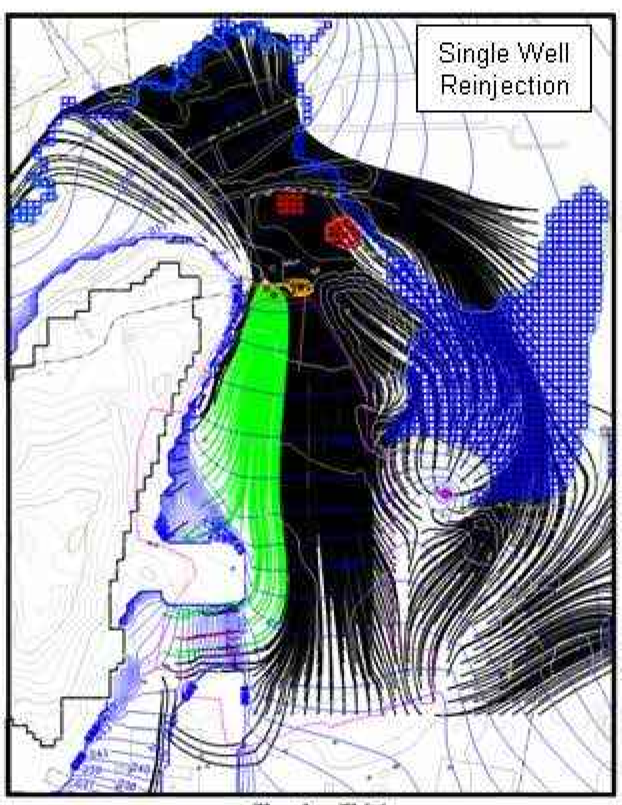
CH2MHILL

No Reinjection

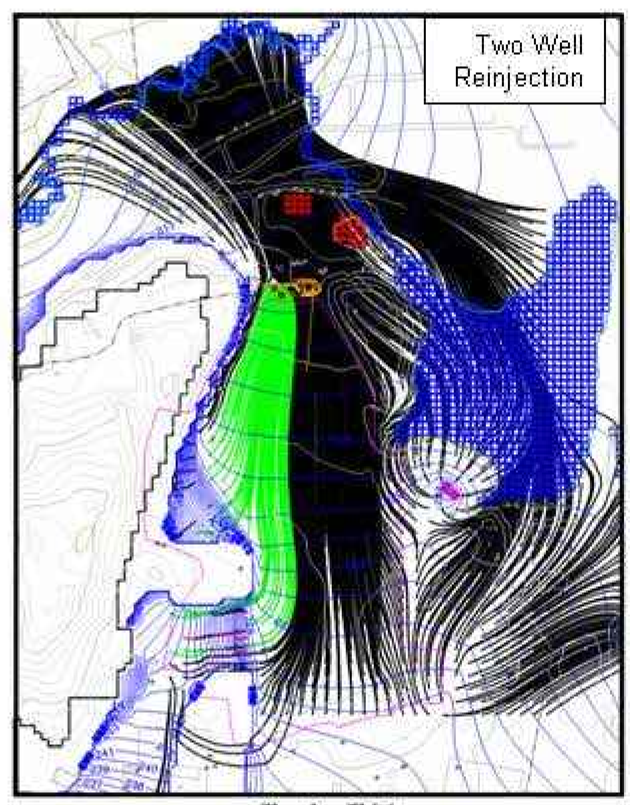


Run 412 at 25 GPM

Reinjection

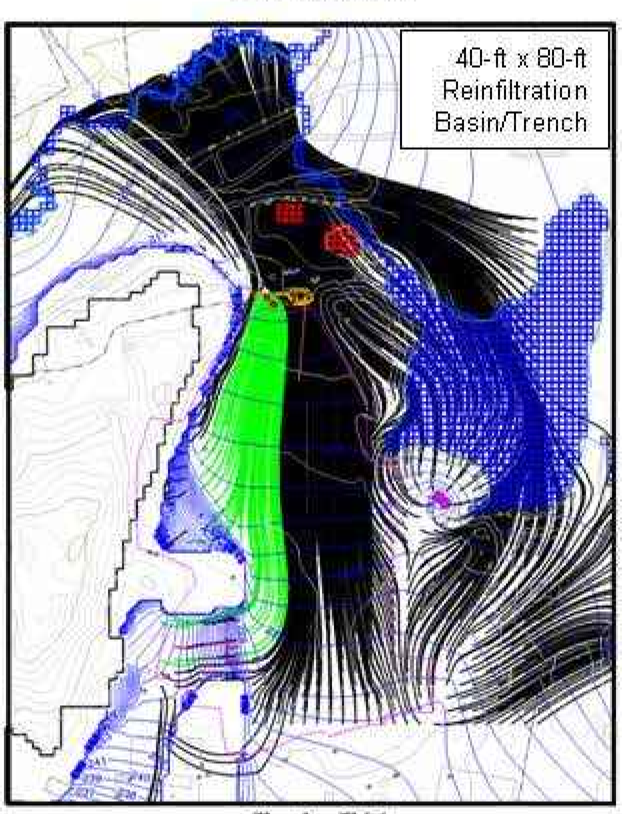


Run C004-2

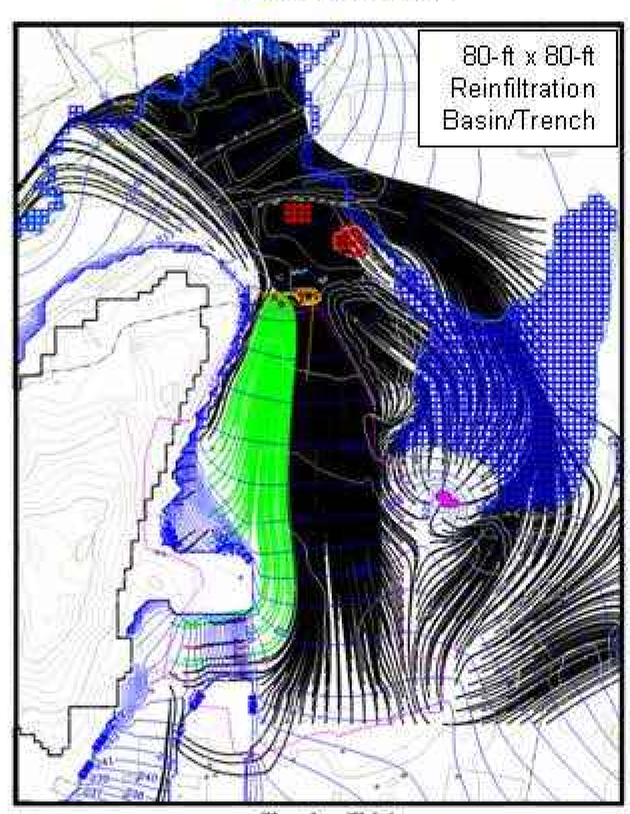


Run C004-2A

Reinfiltration



Run C004-2B



Run C004-2C

LEGEND

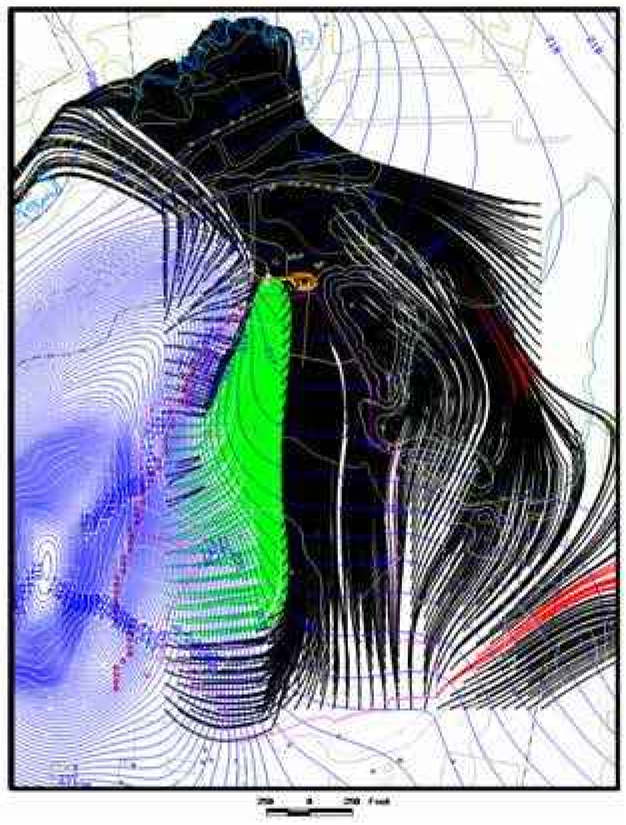
- Reinjection Well in Layer 1
- Extraction Well in Layer 1
- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Wetland
- Surface Water
- Fort Devens Boundary
- Shepley's Hill Landfill Extent
- Approximate Treatment Plant Location
- Reinfiltration Basin/Trench

N

Pathlines for Particles Started in Model Layer 1
C004 Series Simulations with 25 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 at 25 GPM (No Reinjection)
Shepley's Hill Landfill
Fort Devens

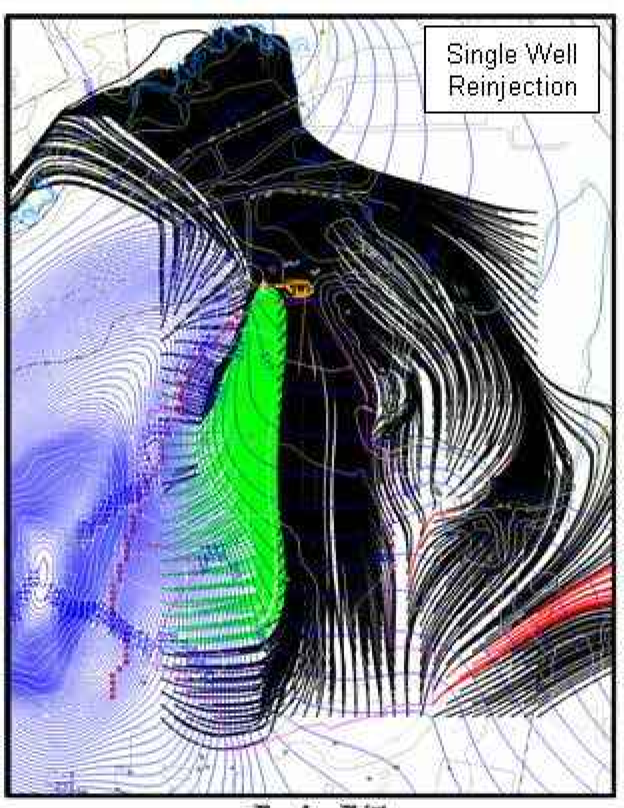
CH2MHILL

No Reinjection

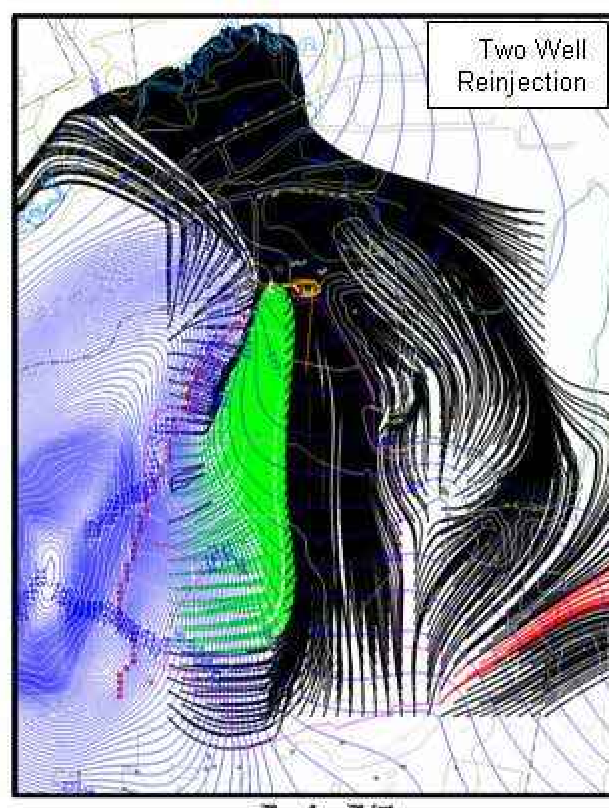


Run 412 at 25 GPM

Reinjection

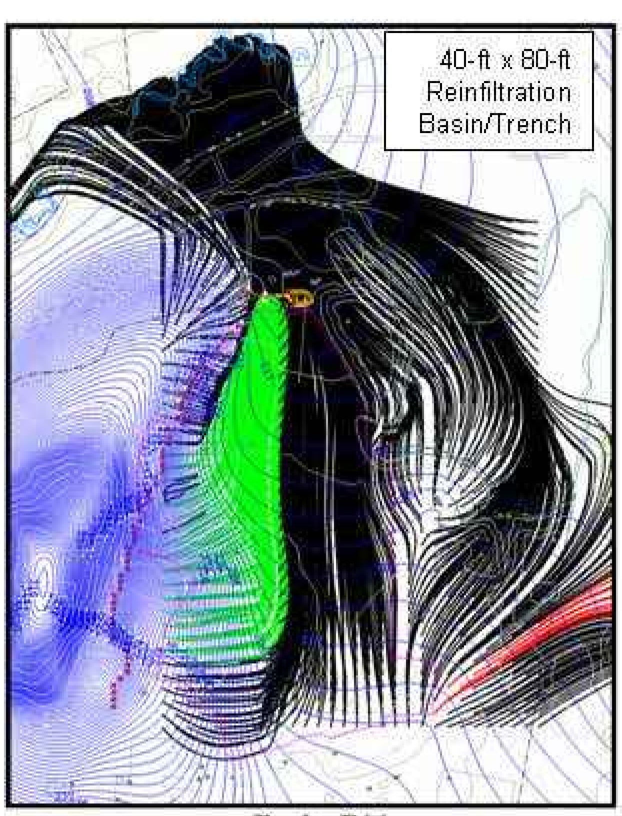


Run C004-2

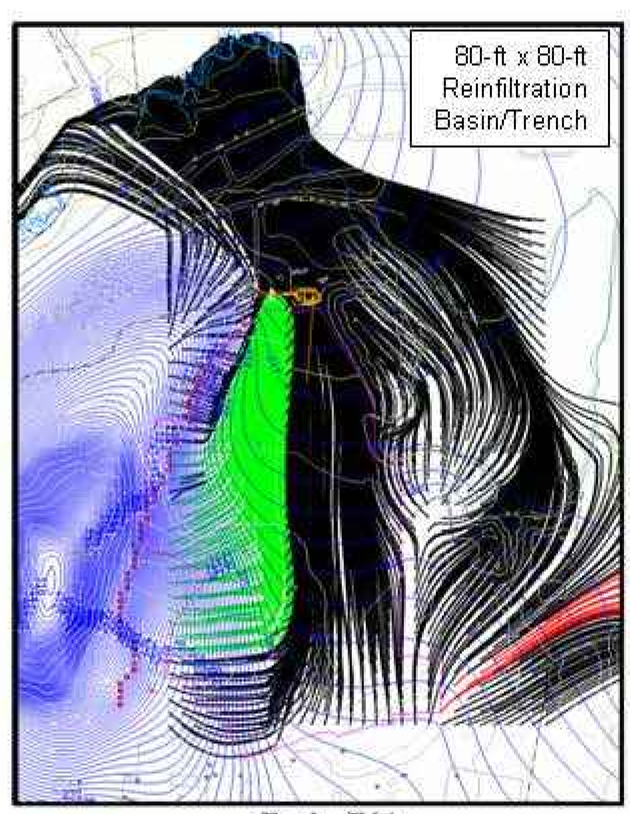


Run C004-2A

Reinfiltration



Run C004-2B



Run C004-2C

LEGEND

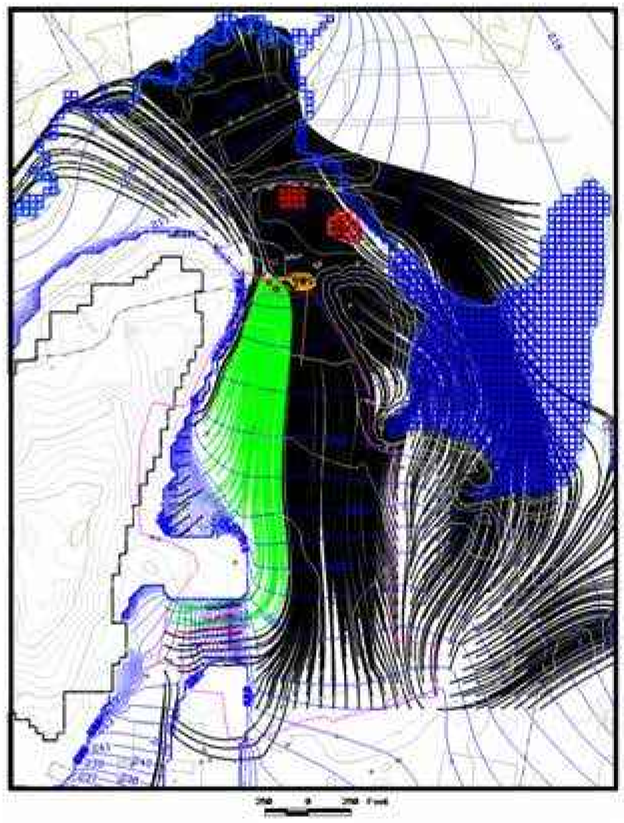
- **Particle Captured By Extraction Well**
- **Particle Exiting Through Other Layer 1 Boundaries**
- **Particle Exiting Through Layer 2 Boundaries**
- **Simulated Hydraulic Head Contour**
- **Wetland**
- **Surface Water**
- **Fort Devens Boundary**
- **Shepley's Hill Landfill Extent**
- **Approximate Treatment Plant Location**

N

Pathlines for Particles Started in Model Layer 2
C004 Series Simulations with 25 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 at 25 GPM (No Reinjection)
Shepley's Hill Landfill
Fort Devens

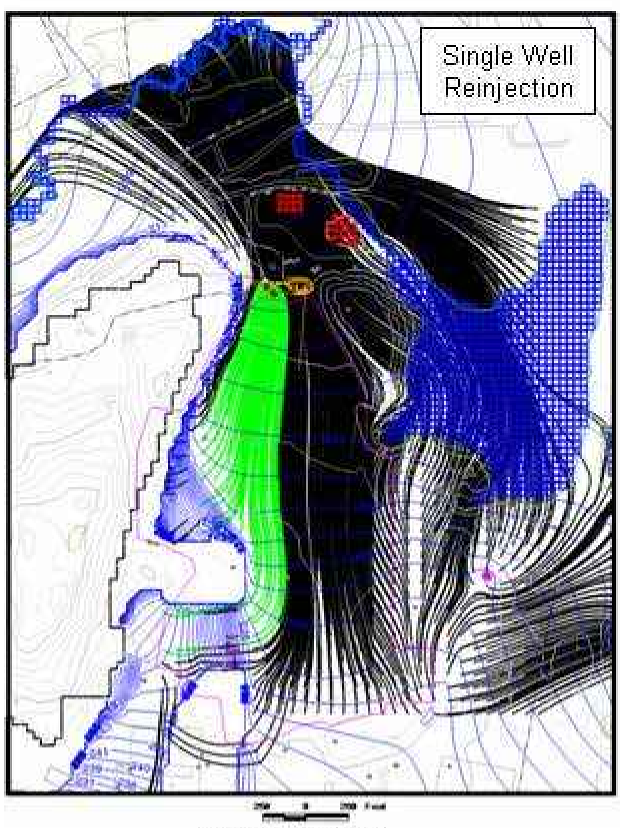
CH2MHILL

No Reinjection

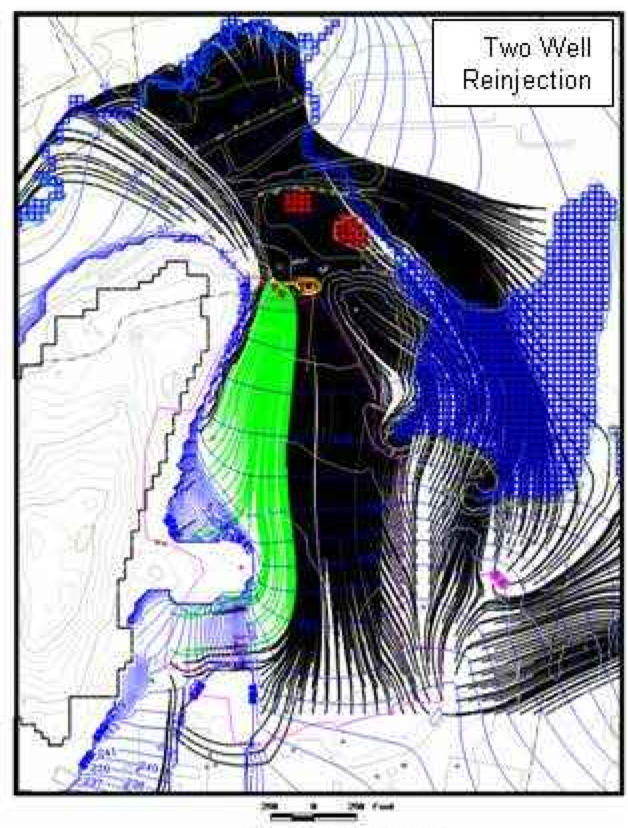


Run 412 at 25 GPM

Reinjection

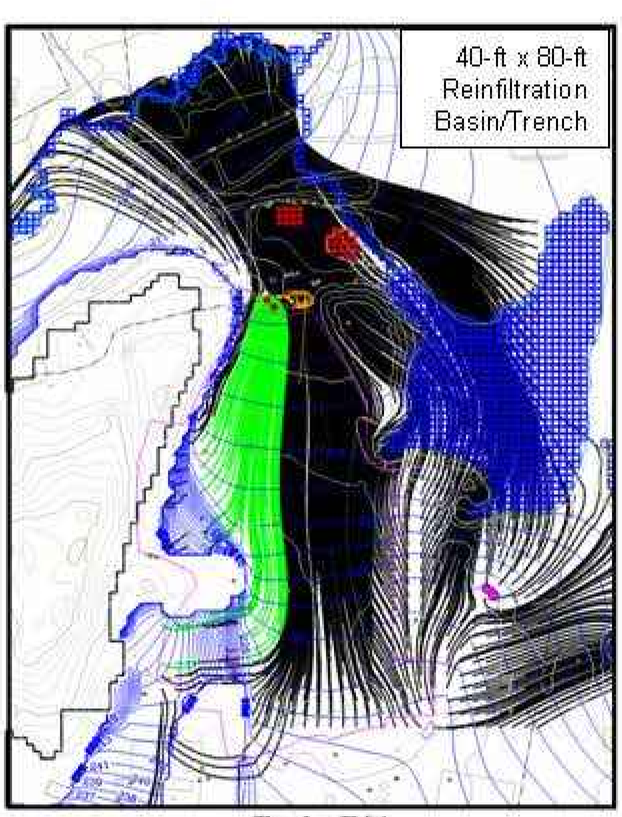


Run S002-2

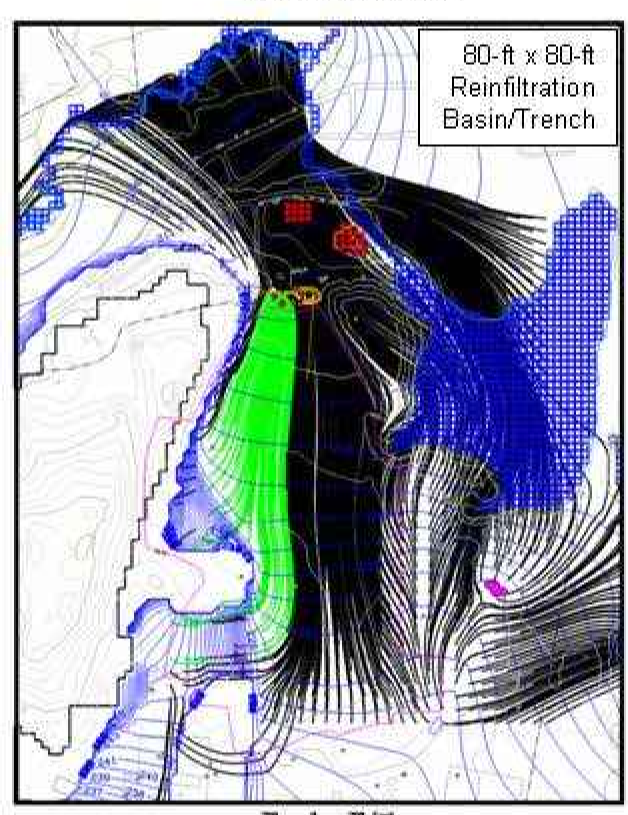


Run S002-2A

Reinfiltration



Run S002-2B



Run S002-2C

LEGEND

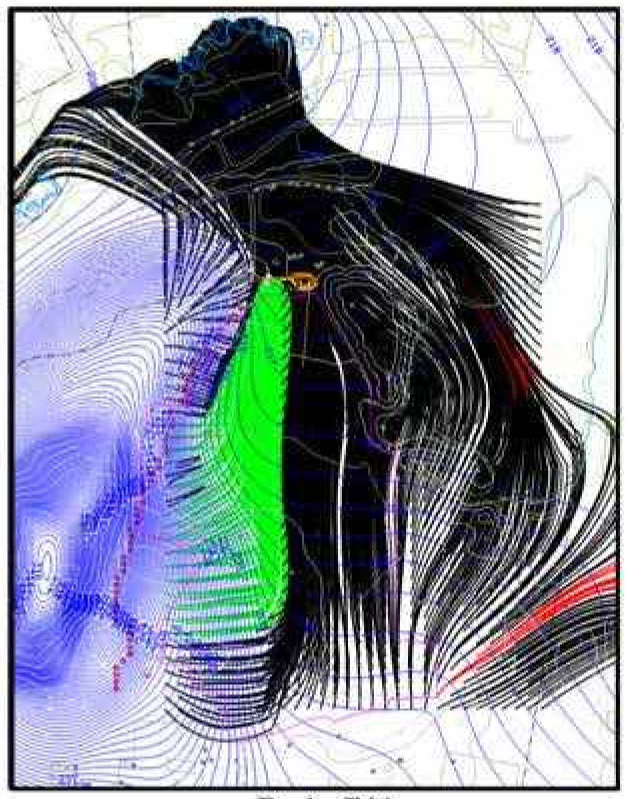
- Reinjection Well in Layer 1
- Extraction Well in Layer 1
- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Wetland
- Surface Water
- Fort Devens Boundary
- Shepley's Hill Landfill Extent
- Approximate Treatment Plant Location
- Reinfiltration Basin/Trench

N

Pathlines for Particles Started in Model Layer 1
S002 Series Simulations with 25 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 at 25 GPM (No Reinjection)
Shepley's Hill Landfill
Fort Devens

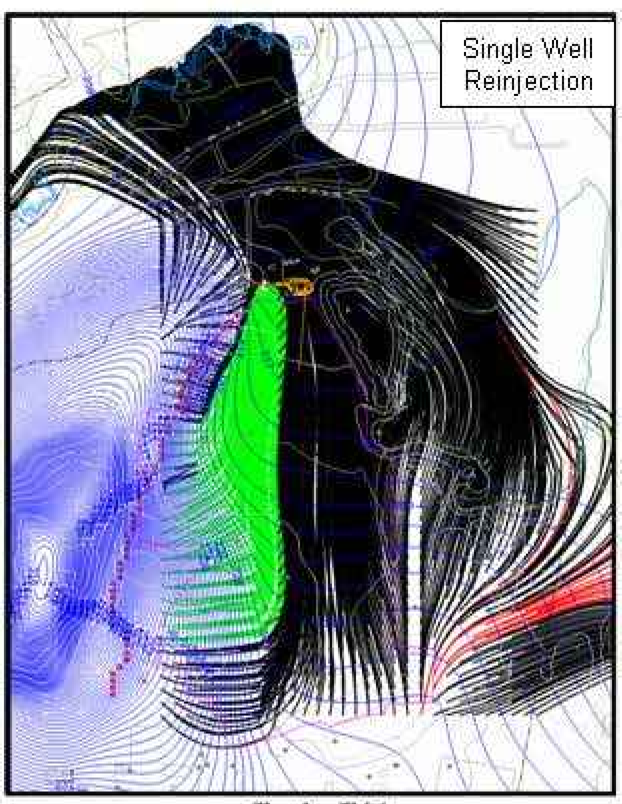
CH2MHILL

No Reinjection

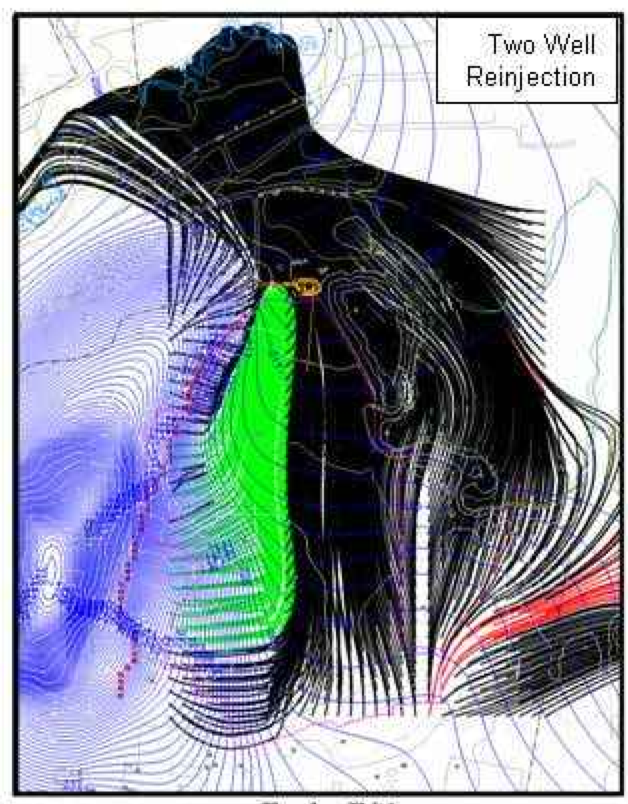


Run 412 at 25 GPM

Reinjection

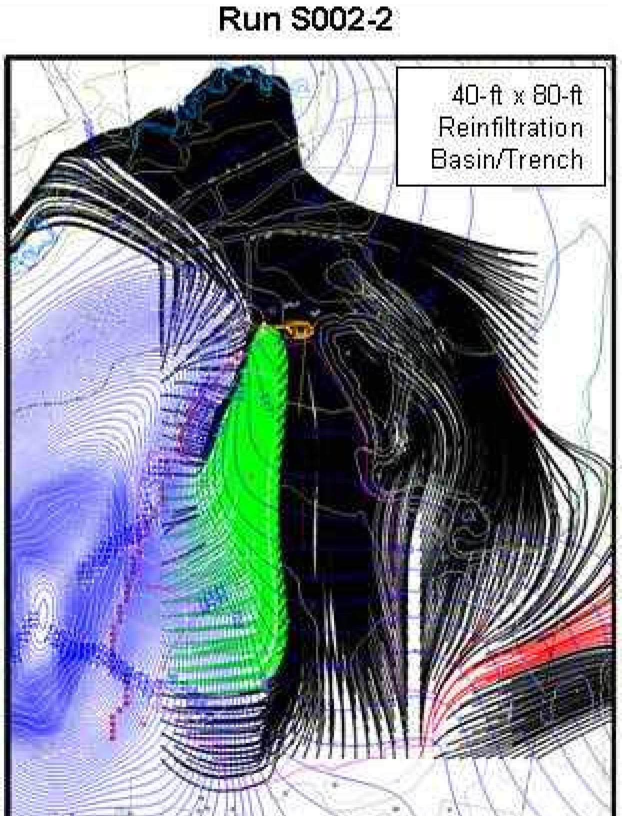


Run S002-2

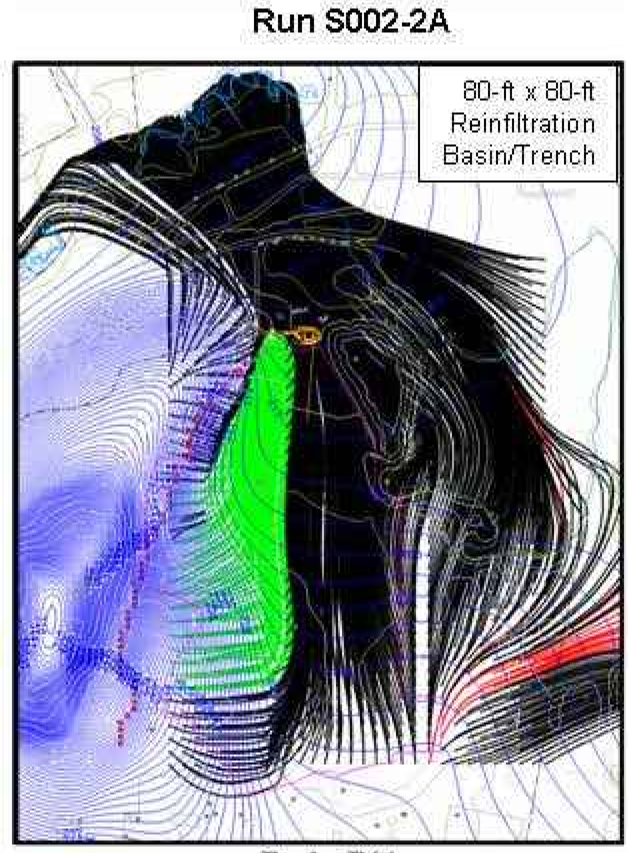


Run S002-2A

Reinfiltration



Run S002-2B



Run S002-2C

LEGEND

- **Particle Captured By Extraction Well**
- **Particle Exiting Through Other Layer 1 Boundaries**
- **Particle Exiting Through Layer 2 Boundaries**
- **Simulated Hydraulic Head Contour**
- **Wetland**
- **Surface Water**
- **Fort Devens Boundary**
- **Shepley's Hill Landfill Extent**
- **Approximate Treatment Plant Location**

N

Pathlines for Particles Started in Model Layer 2
S002 Series Simulations with 25 GPM Total Flow for Reinjection or Reinfiltration as Compared with Design Model Run 412 at 25 GPM (No Reinjection)
Shepley's Hill Landfill
Fort Devens

CH2MHILL

ATTACHMENT B - ARARs

Attachment B -- ARARS

Requirement	Authority	Status	Synopsis	Action to Meet Requirement
Groundwater Discharge -- Chemical Specific				
SDWA –MCLs (40 CFR 141.61-141.63	Federal	Relevant and Appropriate	The purpose of the SDWA is to protect United Stated drinking water resources. MCLs have been promulgated for a number of contaminants (inorganic and organic). These levels regulate the concentration of contaminants in public drinking water supplies, but may also be considered relevant and appropriate for groundwater aquifers used for drinking water.	MCLs will be used as a treatment goal for the treatment system. In other words the system will be designed and operated to treat extracted water to below MCLs prior to discharge to the aquifer.
Massachusetts Drinking Water Standards (310 CMR 22.00)	State	Relevant and Appropriate	Massachusetts Drinking Water Standards establish MMCLs for public drinking water systems. If state MMCLs are more stringent than Federal standards, the state levels must be attained.	MMCLs if more stringent than Federal MCLs will be used as treatment goals for the treatment system.
Massachusetts Groundwater Discharge Permit Program and Groundwater Quality Standards (314 CMR 5.00 and 6.00)	State	Applicable	These standards limit the concentration of certain chemical constituents in Massachusetts waters. The groundwater beneath the area being considered for groundwater discharge is classified as a Class I.	The system will be designed and operated to attain groundwater quality standards prior to discharge of water.
Groundwater Discharge -- Location Specific				
M.G.L. c. 131A: Massachusetts Endangered Species Act; 321 CMR 8.00, List of	State	Applicable	The Commonwealth of Massachusetts has the authority to research, list, and protect any species. The Commonwealth lists species as threatened, endangered, or of	State-listed species have been identified in the vicinity of Shepley's Hill include the Grasshopper

Requirement	Authority	Status	Synopsis	Action to Meet Requirement
Endangered Wildlife and Wild Plants; 321 CMR 10.00, Massachusetts Endangered Species Regulations.			special concern. The state list may differ from the federal list. Actions must be conducted in a manner that minimizes impacts to listed species.	Sparrow which used the capped area as habitat.
Groundwater Discharge -- Action Specific				
RCRA – Identification and Listing of Hazardous Wastes; Toxicity Characteristics (40 CFR 261.24)	Federal	Relevant and Appropriate	These requirements identify the maximum concentrations of contaminants for which the waste would be a RCRA-characteristic hazardous waste for toxicity. The analhtical test given in Appendix II is referred to as the TCLP test.	Process sludge will be analyzed according to TCLP. If TCLP results exceed the standards in 261.24, the material will be disposed of off-site in a RCRA-permitted treatment, storage, and disposal facility.
RCRA Subtitle C, 40 CFR Part 264 – Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.	Federal	Relevant and Appropriate	These standards, which regulate the operation of facilities that treat, store, or dispose of hazardous waste, are implemented through authorized state RCRA program cited below (Massachusetts Hazardous Waste Management Regulations)	See MA haz. waste regulations below.
Underground Injection Control Program, 40 CFR 144, 146, 147, 1000	Federal	Applicable	Minimum performance standards for underground injection wells. Prohibits injection that may cause a violation of primary drinking water standards. Infiltration galleries or trenches fall within the broad definition of Class V wells.	Extracted groundwater will be treated to levels equal to or below federal and state drinking water standards to ensure that discharges to injection wells, infiltration

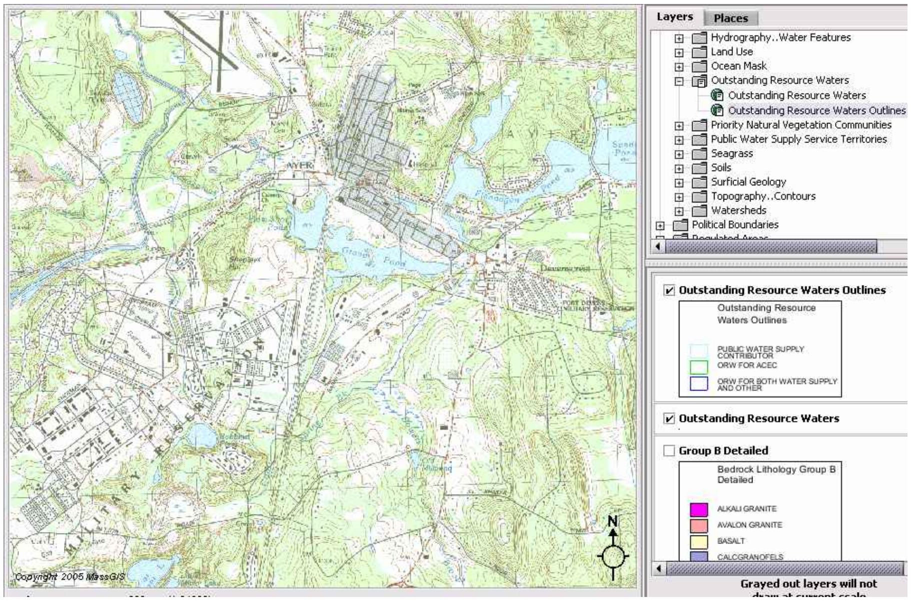
Requirement	Authority	Status	Synopsis	Action to Meet Requirement
				trenches, or galleries will not cause a violation of drinking water standards in the receiving aquifer.
Massachusetts Air Pollution Control Regulations (310 CMR 7.00)	State	Applicable	Regulations set emission limits necessary to attain ambient air quality standards.	The activities of the remedial action (including construction) will be conducted to meet standards. If limits are exceeded, emissions will be managed through engineering controls.
Massachusetts HWMR – Requirements for Generators (310 CMR 30.300-30.371)	State	Relevant and Appropriate	This regulation sets standards for generators of hazardous waste involving waste accumulation, waste shipment, and preparation of the uniform hazardous waste manifest. Massachusetts specifies requirements for very small quantity generators, as well as small and large quantity generators.	If RCRA-characteristic wastes are generated, the material will be managed in accordance with these requirements.
Massachusetts Hazardous Waste Management Regulations – Location Standards for Facilities (310 CMR 30.700 – 30.707)	State	Relevant and Appropriate	There shall be a minimum of 300 feet from the active portion of the facility to the property line.	This Shepley's Hill treatment plant is not currently considered a hazardous waste management facility. Placement of the facility provided few options given the limited space

Requirement	Authority	Status	Synopsis	Action to Meet Requirement
				available north of the landfill off the cap. If it's status changes a waiver may be requested for exemption from the distance requirement.
Massachusetts Underground Water Source Protection, 310 CMR 27.00	State	Applicable	Under these regulations, "no underground injection shall be allowed where a Class V well causes or allows movement of fluid containing any pollutant into underground sources of drinking ater and the presence of such pollutant causes or is likely to cause a violation of any Massachusetts Drinking Water Regulation… or … adversely affects or is likely to adversely affect the health of persons." Class V wells are defined to include "recharge wells used to replenish the water in an aquifer."	Extracted groundwater will be treated to levels at or below federal and state drinking water standards to ensure that discharges to injection wells, trenches, or infiltration galleries will not cause any violation of drinking water standards in the receiving aquifer.
Surface Water Discharge – Chemical Specific				
Federal CWA NPDES Program and State Massachusetts Surface Discharge Permit Progam and Surface Water Quality Standards (314 CMR 3.00 and 4.00)	Federal/State	Applicable	These regulations limit discharges to surface waters to protect surface water quality. Discharges may be limited or prohibited to protect existing uses and not interfere with the attainment of designated uses in downstream and adjacent segments.	Groundwater will be treated to meet specified discharge limiations.

Requirement	Authority	Status	Synopsis	Action to Meet Requirement
Surface Water Discharge – Location-Specific				
Rivers and Harbors Act of 1899 (33 USC 403; 33 CFR Parts 320-323)	Federal	Applicable	Section 10 of the Rivers and Harbors Act of 1899 requires authorization from the Secretary of the Army Corps of Engineers, for the construction of any structure in or over any "navigable water of the U.S." It also requires such authorization for the excavation or deposition of material in such waters, or any obstruction or alteration in such waters.	Although not anticipated, any action within navigable waters will be coordinated with the Army Corp of Engineers.
Protection of Wetlands – Executive Order 11990 (40 CFR 6, Appendix A)	Federal	Applicable	Under this order, federal agencies are required to minimize the degradation, loss, or destruction of wetlands, and to preserve the natural and beneficial values of wetlands. A remedial action should not adversely affect a wetland, if another practicable alternative is available. If no alternative is available, efforts should be made to mitigate the impacts from the remedial action	To the extent possible, wetlands and buffer areas will be avoided. Any action needed within the wetland area will be conducted in a manner to minimize impacts and provide for restoration.
Fish and Wildlife Coordination Act (16 USC 661 et seq., 40 CFR 6.302)	Federal	Applicable	This act requires that any federal agency proposing to modify a body of water must consult with the US Fish and Wildlife Service, National Marine Fisheries Services, and related state agencies to develop measures to prevent, mitigate, or compensate for project-related losses to fish and wildlife. EPA's NPDES permit	The actions to be taken should considered in the overall context of the operation of the Contingency Remedy and anticipated improvements of wetland and riverine resources

Requirement	Authority	Status	Synopsis	Action to Meet Requirement
			regulations (40 CFR 122.49) reference compliance with this act.	
CWA Section 404, 40 CFR Part 230, 33 CFR Parts 320-323	Federal	Applicable	No adverse impacts to wetlands should occur as part of a remedial action if a practicable alternative exists. If no alternative exists the effects must be mitigated.	The extraction wellfield, treatment system, and discharge will be operated to minimize impacts to wetlands.
Floodplain Management Executive Order 11988 (40 CFR part 6, Appendix A)	Federal	Applicable	Requires federal agencies to minimize potential harm to or within floodplains and avoid floodplain development wherever there is a practicable alternative.	Space for development of the remediation system was limited to a small area north of the capped landfill area. The competed plant elevation is above the 100 year flood level.
Massachusetts Wetland Protection Requirements (310 CMR 10.00)	State -	Applicable	Regulates activities in freshwater wetlands, 100-year floodplains, and 100 foot buffer zones beyond such areas. Regulated activities include certain types of construction and excavation activities.	Construction of infiltration galleries, injection wells, or discharge piping to surface water will likely take place within protected resource areas and should meet the protective requirements of this regulation.

ATTACHMENT C – Resource Mapping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Places
Hydrography..Water Features
Land Use
Ocean Mask
Outstanding Resource Waters
Outstanding Resource Waters
Outstanding Resource Waters Outlines
Priority Natural Vegetation Communities
Public Water Supply Service Territories
Seagrass
Soils
Surficial Geology
Topography..Contours
Watersheds
Political Boundaries
Outstanding Resource Waters Outlines
Outstanding Resource Waters Outlines
PUBLIC WATER SUPPLY CONTRIBUTOR
ORW FOR ACEC
ORW FOR BOTH WATER SUPPLY AND OTHER
Outstanding Resource Waters
Group B Detailed
Bedrock Lithology Group B Detailed
ALKALI GRANITE
AVALON GRANITE
BASALT
CALCGRANOFELS
Grayed out layers will not
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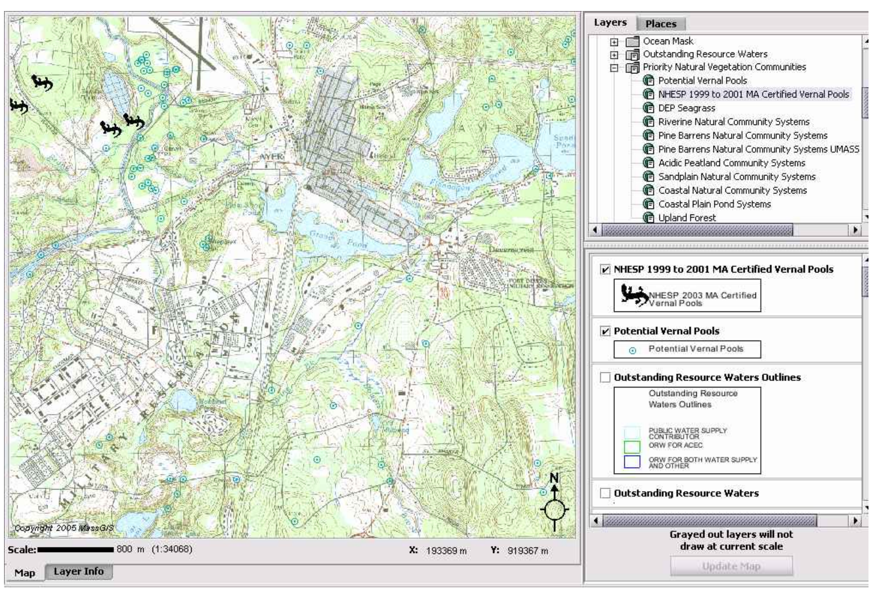
Layers
Places
Ocean Mask
Outstanding Resource Waters
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Potential Vernal Pools
NHESP 1999 to 2001 MA Certified Vernal Pools
DEP Seagrass
Riverine Natural Community Systems
Pine Barrens Natural Community Systems
Pine Barrens Natural Community Systems UMASS
Acidic Peatland Community Systems
Sandplain Natural Community Systems
Coastal Natural Community Systems
Coastal Plain Pond Systems
Upland Forest
NHESP 1999 to 2001 MA Certified Vernal Pools
NHESP 2003 MA Certified Vernal Pools
Potential Vernal Pools
Potential Vernal Pools
Outstanding Resource Waters Outlines
Outstanding Resource Waters Outlines
PUBLIC WATER SUPPLY CONTRIBUTOR
ORW FOR ACEC
ORW FOR BOTH WATER SUPPLY AND OTHER
Outstanding Resource Waters
Grayed out layers will not draw at current scale
Update Map
Copyright 2005 MassGIS
N
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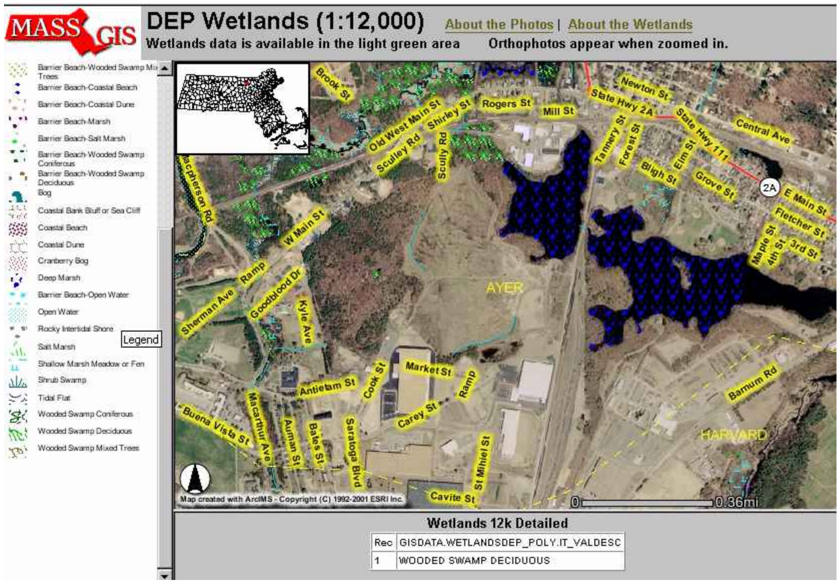
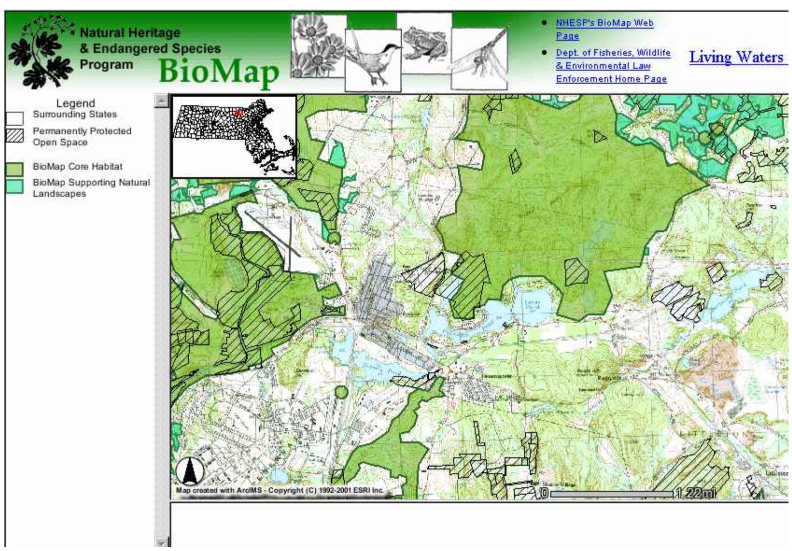
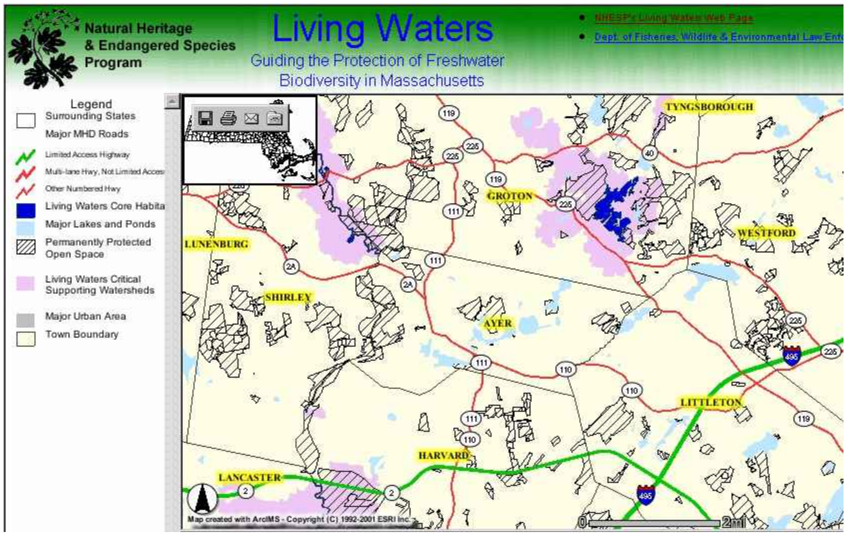
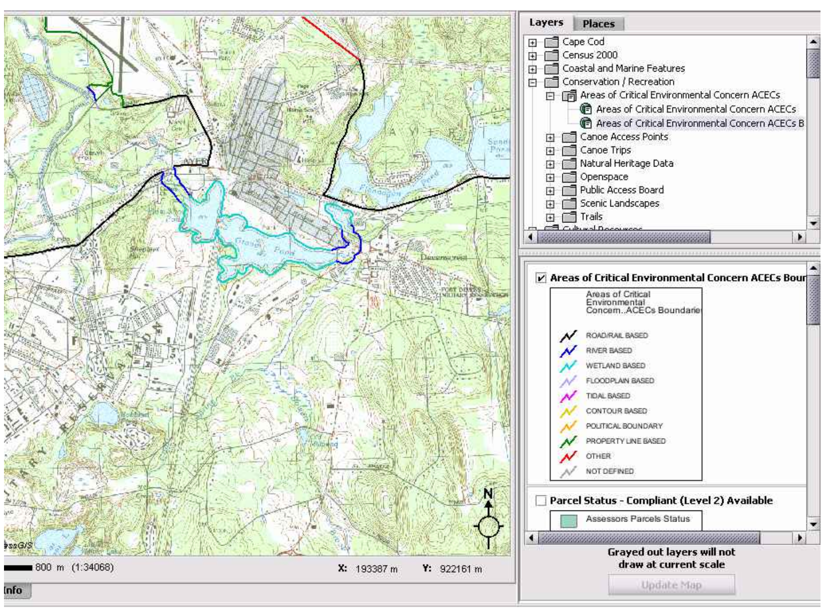
X: 193369 m
Y: 919367 m
Map
Layer Info


MASS GIS
DEP Wetlands (1:12,000)
About the Photos | About the Wetlands
Wetlands data is available in the light green area
Orthophotos appear when zoomed in.
Legend
AYER
HARVARD
Map created with ArcIMS - Copyright (C) 1992-2001 ESRI Inc.
Wetlands 12k Detailed
Rec GISDATA.WETLANDSDEP_POLY.IT_VALDESC
1 WOODED SWAMP DECIDUOUS


Natural Heritage
& Endangered Species
Program
BioMap
NHESP's BioMap Web Page
Dept. of Fisheries, Wildlife & Environmental Law Enforcement Home Page
Living Waters
Legend
Surrounding States
Permanently Protected Open Space
BioMap Core Habitat
BioMap Supporting Natural Landscapes
Map created with ArcIMS - Copyright (C) 1992-2001 ESRI Inc.


Natural Heritage & Endangered Species Program
Living Waters
Guiding the Protection of Freshwater Biodiversity in Massachusetts
NHESP's Living Waters Web Page
Dept. of Fisheries, Wildlife & Environmental Law Enf
Legend
Surrounding States
Major MHD Roads
Limited Access Highway
Multi-lane Hwy, Not Limited Access
Other Numbered Hwy
Living Waters Core Habita
Major Lakes and Ponds
Permanently Protected Open Space
Living Waters Critical Supporting Watersheds
Major Urban Area
Town Boundary
TYNGSBOROUGH
GROTON
WESTFORD
LUNENBURG
SHIRLEY
AYER
LITTLETON
HARVARD
LANCASTER
Map created with ArcIMS - Copyright (C) 1992-2001 ESRI Inc.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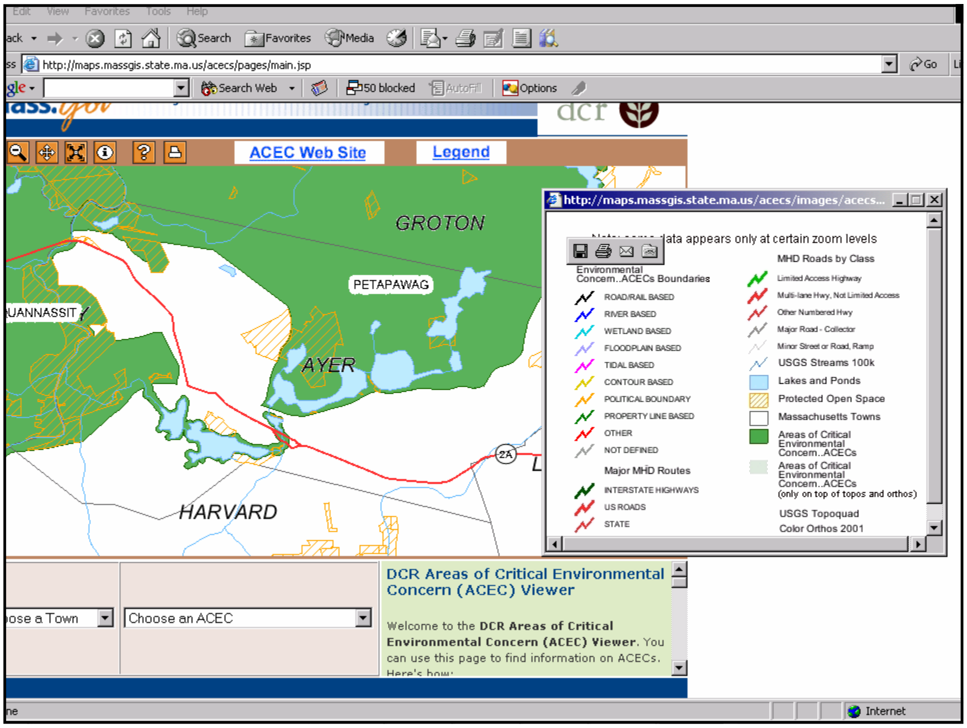
Layers
Places
Cape Cod
Census 2000
Coastal and Marine Features
Conservation / Recreation
Areas of Critical Environmental Concern ACECs
Areas of Critical Environmental Concern ACECs
Areas of Critical Environmental Concern ACECs B
Canoe Access Points
Canoe Trips
Natural Heritage Data
Openspace
Public Access Board
Scenic Landscapes
Trails
Areas of Critical Environmental Concern ACECs Bour
Areas of Critical Environmental Concern..ACECs Boundarie
ROAD/RAIL BASED
RIVER BASED
WETLAND BASED
FLOODPLAIN BASED
TIDAL BASED
CONTOUR BASED
POLITICAL BOUNDARY
PROPERTY LINE BASED
OTHER
NOT DEFINED
Parcel Status - Compliant (Level 2) Available
Assessors Parcels Status
Grayed out layers will not draw at current scale
Update Map



http://maps.massgis.state.ma.us/acecs/pages/main.jsp
ACEC Web Site
Legend
GROTON
PETAPAWAG
AYER
HARVARD
Choose an ACEC
DCR Areas of Critical Environmental Concern (ACEC) Viewer
Welcome to the DCR Areas of Critical Environmental Concern (ACEC) Viewer. You can use this page to find information on ACECs.
MHD Roads by Class
Limited Access Highway
Multi-lane Hwy, Not Limited Access
Other Numbered Hwy
Major Road - Collector
Minor Street or Road, Ramp
USGS Streams 100k
Lakes and Ponds
Protected Open Space
Massachusetts Towns
ROAD/RAIL BASED
RIVER BASED
WETLAND BASED
FLOODPLAIN BASED
TIDAL BASED
CONTOUR BASED
POLITICAL BOUNDARY
PROPERTY LINE BASED
OTHER
NOT DEFINED
Major MHD Routes
INTERSTATE HIGHWAYS
US ROADS
STATE
USGS Topoquad
Color Orthos 2001
Internet

ATTACHMENT D – NHESP Consultation

Commonwealth of Massachusetts

Division of Fisheries & Wildlife

MassWildlife

Wayne F. MacCallum, *Director*

August 11, 2005

Spence Smith
CH2M HILL
25 New Chardon Street, Suite 300
Boston, MA 02114-4770

Re: Nonacoicus Brook and Vicinity Near Plow Shop Pond
Ayer, MA
NHESP Tracking Number: 05-18244

Dear Mr. Smith,

Thank you for contacting the Natural Heritage and Endangered Species Program ("NHESP") of the MA Division of Fisheries & Wildlife for information regarding state-protected rare species in the vicinity of the above referenced site. We have reviewed the site and would like to offer the following comments.

This project site is located near Priority Habitat 300 as indicated in the 11th Edition of the Massachusetts Natural Heritage Atlas. Our database indicates that the following state-listed rare species have been found in the vicinity of the site:

Scientific name	Common Name	Taxonomic Group	State Status
Cyperus houghtonii	Houghton's Flatsedge	Plant	Endangered
Bartramia longicauda	Upland Sandpiper	Bird	Endangered
Ammodramus savannarum	Grasshopper Sparrow	Bird	Threatened

This project site is located near Priority Habitat 269 and Estimated Habitat 567 as indicated in the 11th Edition of the Massachusetts Natural Heritage Atlas. Our database indicates that the following state-listed rare species have been found in the vicinity of the site:

Scientific name	Common Name	Taxonomic Group	State Status
Senna hebecarpa	Wild Senna	Plant	Endangered
Bartramia longicauda	Upland Sandpiper	Bird	Endangered
Emydoidea blandingii	Blanding's Turtle	Reptile	Threatened
Clemmys insculpta	Wood Turtle	Reptile	Special Concern
Ambystoma laterale	Blue-Spotted Salamander	Amphibian	Special Concern

Division of Fisheries and Wildlife
Field Headquarters, One Rabbit Hill Road, Westborough, MA 01581 (508) 792-7270 Fax (508) 792-7275
An Agency of the Department of Fisheries, Wildlife & Environmental Law Enforcement

RECEIVED
AUG 16 2005

This project site is located near Priority Habitat 269 and Estimated Habitat 567 as indicated in the 11th Edition of the Massachusetts Natural Heritage Atlas. Our database indicates that the following state-listed rare species have been found in the vicinity of the site:

Scientific name	**Common Name**	**Taxonomic Group**	**State Status**
Eleocharis ovata	Ovate Spike-Sedge	Plant	Endangered

These species are protected under the Massachusetts Endangered Species Act (M.G.L. c. 131A) and its implementing regulations (321 CMR 10.00). State-listed wildlife are also protected under the state's Wetlands Protection Act (M.G.L. c. 131, s. 40) and its implementing regulations (310 CMR 10.37 and 10.59). Fact sheets for these species can be found on our website http://www.state.ma.us/dfwele/dfw/nhesp/nhfact.htm.

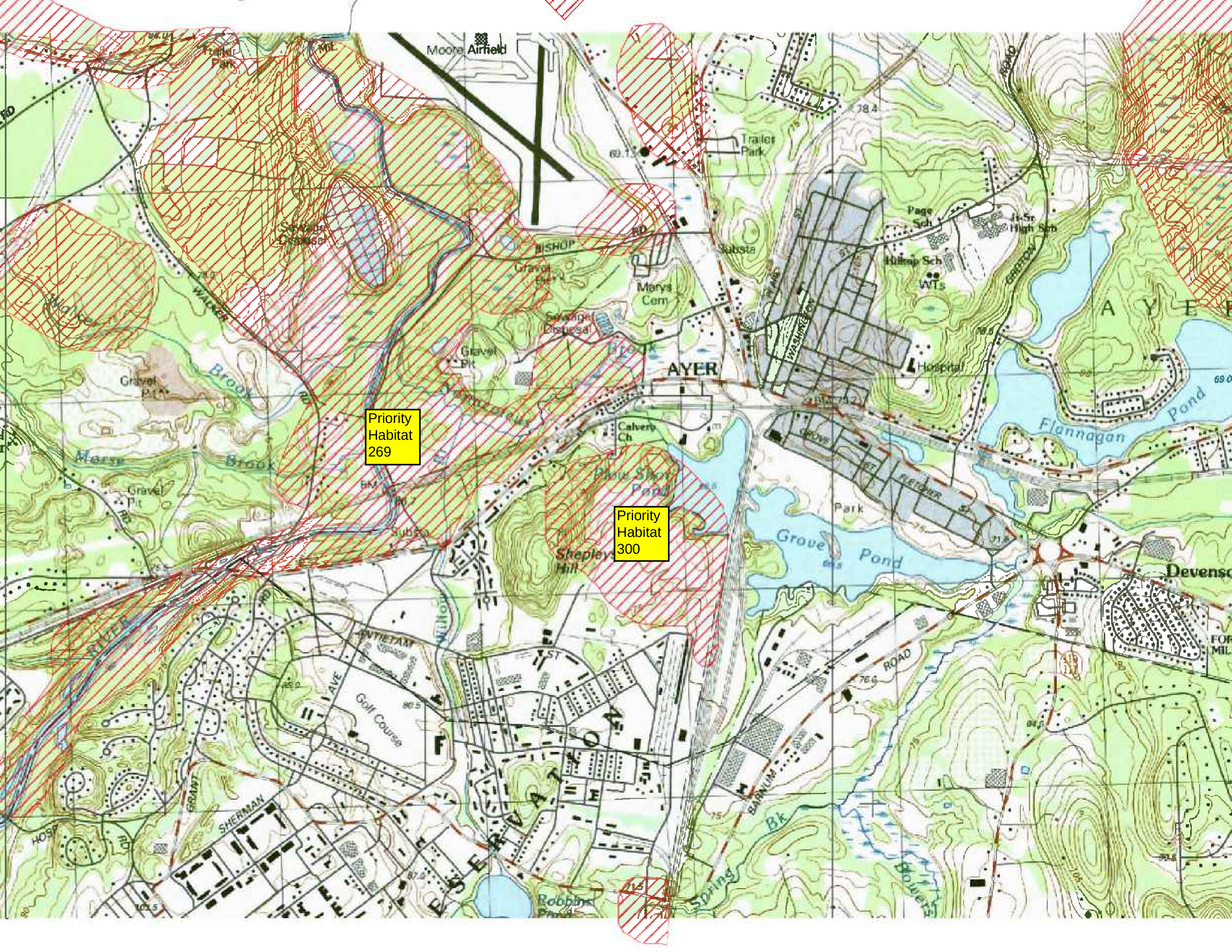
This evaluation is based on the most recent information available in the NHESP database, which is constantly being expanded and updated through ongoing research and inventory. Should your site plans change, or new rare species information become available, this evaluation may be reconsidered.

If you have any questions regarding this review please call Joanne Theriault, Environmental Review Assistant, at ext. 310.

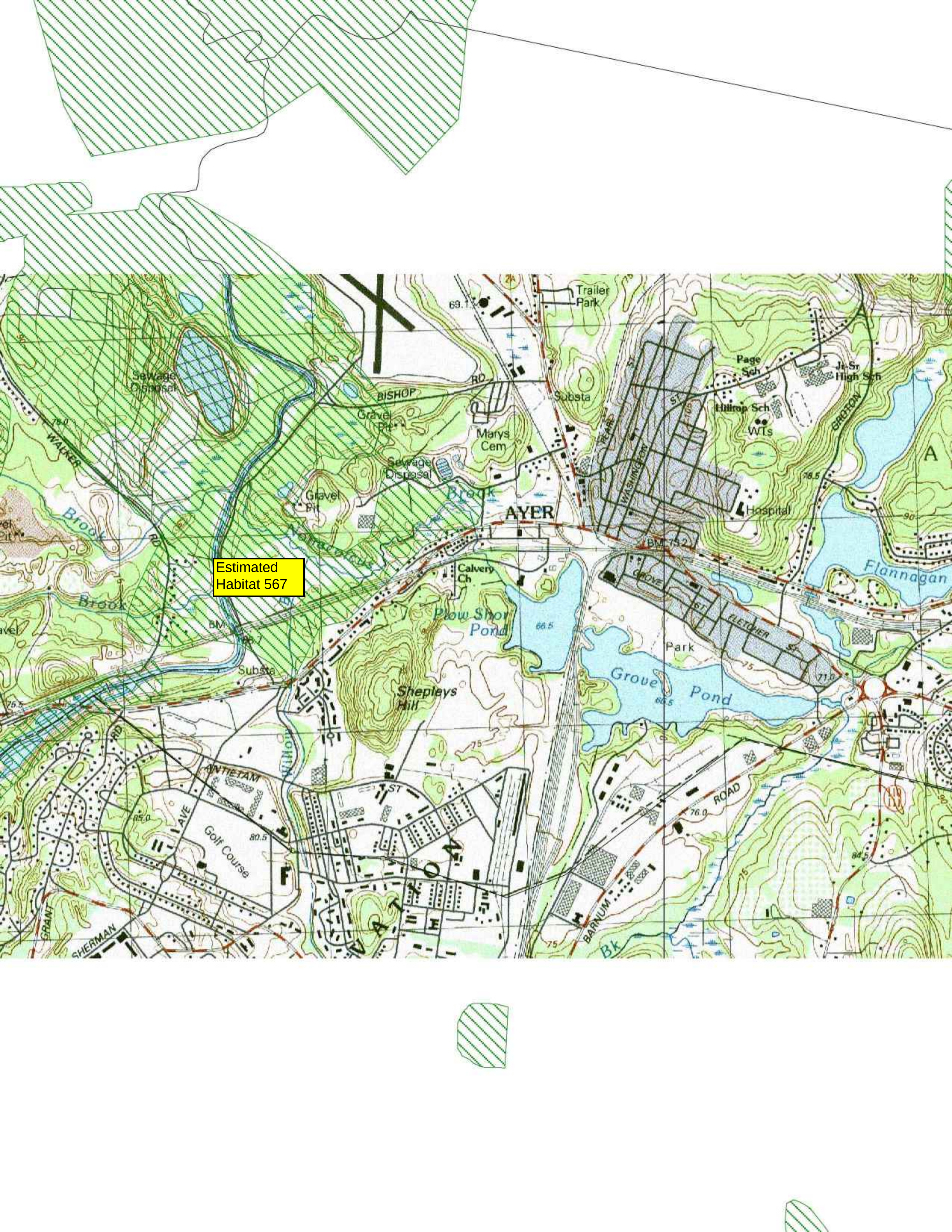
Sincerely,

Thomas W. French

Thomas W. French, Ph.D.
Assistant Director



Priority Habitat 269
Priority Habitat 300
AYER
Moore Airfield
Trailer Park
Flannagan Pond
Grove Pond
Devens
Shepley Hill
Calvary Ch
Marys Cem
Hospital
Page Sch
Golf Course
Spring Bk
Bowers
Robbins Pond



Estimated
Habitat 567
AYER
Trailer
Park
BISHOP
RD
Gravel
Pit
Sewage
Disposal
Marys
Cem
Substa
Page
Sch
Jr-Sr
High Sch
Hilltop Sch
WTs
GROTON
Hospital
WASHINGTON
ST
Brook
Nonacoicus
Calvery
Ch
Plow Shop
Pond
Grove
Pond
Park
GROVE
FLETCHER
ST
Flannagan
Shepleys
Hill
WALKER
RD
ANTIETAM
AVE
Golf Course
ROAD
BARNUM
SHERMAN
GRANT
Bk

ATTACHMENT E – Response to Comments

Draft On-Site Discharge Evaluation –
Shepley's Hill Groundwater Extraction, Treatment,
and Discharge System, June 30, 2005

The following document includes comments and responses on the ***Draft On-Site Discharge Evaluation – Shepley's Hill Groundwater Extraction, Treatment, and Discharge System, June 30, 2005***, prepared on behalf of the Devens BRAC Environmental Office, and provided to the Base Clean-Up Team (BCT). EPA comments were provided in a letter to Robert Simeone, Devens BRAC Environmental Coordinator, dated September 16, 2005.

Environmental Protection Agency, letter dated September 16, 2005

Comment (cover letter):

EPA has reviewed the "Draft On-Site Discharge Evaluation Shepley's Hill Groundwater Extraction, Treatment, and Discharge System" technical memorandum, dated June 30, 2005. The technical memorandum provides an assessment of various options for on-site discharge of treated water from the SHL extraction/treatment system. The primary focus of the document is on the hydraulic impacts of on-site discharge (e.g., changes in the capture zone of the extraction wells, changes in groundwater/surface water interactions, etc.). In addition, it provides a summary of relevant regulations that constrain the discharge options. The memo was prepared by CH2MHill for the Devens BCT.

The document presents an assessment of the "pros and cons" of various discharge options. The advantages of on-site discharge over the present course (i.e., discharge to the Devens POTW) include lower O&M costs and the opportunity to use the discharge flow to achieve positive hydraulic effects. Release of treated water directly to the Nonacoicus Brook, the Army's preferred alternative, would replace volume that otherwise will be lost due to reduced groundwater discharge downgradient of the extraction wells. Also, reinjection or reinfiltration of treated water to the groundwater along the southern part of the landfill, which was considered in the analysis, offers the potential for some mitigation of adverse impacts in the vicinity of Red Cove.

EPA generally concurs with the conclusions drawn from this analysis, primarily that discharge of treated water in the vicinity of the dam appears to be a viable option with potential advantages. However, the EPA has reviewed the MADEP's August 12, 2005 comment letter on this technical memorandum and is aware that the DEP has a number of significant concerns with the Army's on-site discharge proposals. It appears that DEP's Antidegradation Policy would be an ARAR for surface water discharge. The Army will need to satisfy the DEP's concerns prior to implementing an on-site discharge option.

EPA's comments on the technical memorandum are attached. The key comments relate to the need for additional performance monitoring, primarily with respect to hydraulic information, to validate model predictions and further evaluate the potential impacts of on-site discharge options. The chosen discharge scenario will dictate the monitoring needs. Therefore, our comments reflect generally what the additional monitoring needs would be based on whether surface water discharge of reinfiltration/reinjection options are pursued, but details on the monitoring requirements would need to be discussed and agreed upon by the BCT, once decisions are made regarding which option or options will be further investigated.

<u>Response:</u>

Comment noted. Data collected during the early operations of the treatment plant and extraction wellfield, with discharge to the POTW, will be useful for the BCT, supporting decision-making about on-site discharge options to be further investigated. In addition, these data will be helpful in the evaluation and any adjustments to performance monitoring plans for either a surface water or reinfiltration/reinjection option.

General Comments

1. If surface water discharge is pursued, the Army would need to evaluate whether the continuous discharge to the brook would damp out natural cycles of high and low stream flow to a significant and/or deleterious extent. (Estimates presented in the document indicate that 50 gpm discharge to the brook would represent about 1/3 of the 90% prediction-interval minimum ambient stream flow and about 8% of the mean stream flow.)

<u>Response:</u>

The discharge would not be expected to dampen the short-term hydrologic response of Nonacoicus Brook in terms of increased flow. Short-term events such as thunderstorms or rapid spring thaws may induce flooding independent of the controlled discharge of treated groundwater. However, the continuous discharge flow would be expected to dampen low-flows during drought or dry periods.

2. If an on-site discharge scenario is ultimately selected, the modeling analysis highlights the need to expand the performance monitoring program, primarily with respect to hydraulic information, in two key areas: 1) Red Cove; and 2) Nonacoicus brook and wetlands downstream of the dam. Groundwater and surface water monitoring would need to be expanded to be of sufficient density and frequency to validate the model predictions in these areas. The modeling suggests reduced groundwater discharge to each of these areas under the preferred surface water discharge scenario, but the related effects to water levels (groundwater and surface water) and flow rates (groundwater and surface water), particularly in the brook and wetlands, are of equal or perhaps greater relevance. Discharge to surface water may require that the hydraulic monitoring program be expanded in the area downstream of the dam to include synoptic measurement of stream water levels, in-stream flow rates, and water levels in an expanded number of wetland and stream piezometer locations in order that the model-predicted changes to flux and water levels may be identified and resolved at an appropriate scale, and the model validated. BCT discussions are needed on additional hydraulic monitoring needs to further evaluate on-site discharge options.

Response:

Recommended changes to hydraulic monitoring would be developed during final design of a selected on-site discharge option. This monitoring would be designed to evaluate actual performance vs. model predictions.

3. With respect to Red Cove, EPA has noted in previous comments that the Army's groundwater model does not appear to adequately represent "ambient" (i.e., non-pumping) groundwater flow conditions in the Red Cove area. Although the model suggests potential positive benefits to the Red Cove Area (e.g., run 412), since it is not clear that the current monitoring network adequately resolves flow in that area of the site, it is also unclear how the model-predicted changes in that area will be verified. As discussed in EPA's presentation to the BCT on June 9, 2005, and previously, additional monitoring is needed in the Red Cove area, including additional monitoring wells within the landfill footprint, shoreline piezometers, surface water staff gauges, etc. Further discussions are needed. This is particularly important if one of the reinjection or reinfiltration scenarios are pursued.

Response:

Discussions relating to additional monitoring would occur during the final design of a discharge option.

4. If future consideration is given to ground water reinjection scenarios, the scenarios invoking groundwater discharge to the southern part of the landfill are interesting in that they appear to offer the potential for some mitigation in the vicinity of Red Cove. If these scenarios are investigated further, the monitoring issues/needs identified in the Red Cove area (see previous comment) should be carefully considered.

Response:

Monitoring needs in the area of Red Cove will be considered as an on-site discharge option is further developed during the final design process.

Specific Comments

1. Page 2, 1st Para, and Figure C.1-1: Once a final discharge scenario decision is reached, the BCT should review the adequacy of the current monitoring network and determine any necessary changes and/or additions.

Response:

Agreed.

2. Page 2, 1st Bullet: Cost should also be included as a decision-making criterion.

Response:

Cost is a decision-making criterion considered in the evaluation of options. The bullets on Page 2 present overarching considerations (e.g. no consideration given to discharge within the capped area and off-base).

3. Page 9, 1st Para: It should be noted that the potential of a hydraulic connection between groundwater from the Shepley's Hill area and the McPherson Well Zone II will be assessed as part of the CSA/CAAA study.

Response:

Reference to the CSA/CAAA work will be added.

4. Page 9 - 10 and Table 4: The appropriateness of the use of Priest Brook in Winchendon as a suitable analogue for Nonacoicus Brook is in need of additional support/justification. In particular, it is noted that Nonacoicus Brook is essentially located in a semi-urban environment and is influenced by a number of factors such as impoundments, storm drainage, runoff from impervious surfaces, etc. Does Priest Brook share such characteristics? What analysis supports or refutes such comparison? As stated at previous meetings, collection of actual stream flow data in the area of interest, under an appropriate range of conditions, needs to be considered in order to give credence to the flow analysis presented in Table 4.

Response:

Both the Nonacoicus and Priest Brook watersheds are rural/suburban settings. Specific differences in the degree of development between the two have not been evaluated in detail but are not expected to be significant. Differences in infiltration capacity of the watershed dues to development are probably offset by slightly higher detention in the Nonacoicus Brook watershed. The Priest Brook example provides a similar sized watershed in a similar hydrologic setting and, most importantly, has a lengthy record of 86 years. The longer the record is, the better the flow statistics or chance that the gage records have captured a wide range of discharge response. The drainage-area ratio method is commonly used to develop flow statistics for ungaged streams or those having records of short duration. Short-term gaging of the Nonacoicus would provide records of short duration that would not add much additional certainty to the analysis. Longer-term records of other streams would still be required through direct comparison or through regression analyses of data from multiple streams in the region to adequately characterize the magnitude and frequency of lower probability events (ie high and low flows). The Stream Stats analysis provides the regression analytical approach to derive flow statistics for the region. This was utilized to derive the 7Q10 for the Nonacoicus.

5. Page 10, 3rd Para: What is the status of the rare species assessment in the Nonacoicus Brook and Plow Shop Pond area?

Response:

A consult was requested from Natural Heritage Endangered Species program and a response has been received. The findings are summarized in the table below. No habitat polygons have been identified in the reach of the Nonacoicus between the Dam and West Main Street. Due to the types of species and the habitat identified, upland areas near the landfill and wetland areas north of West Main Street, it is not anticipated that on-site discharge would impact these species in their identified habitats.

Common Name	Scientific Name	Taxonomic Group	State Status	Notes/Comment
Plants				
Houghton's Flatsedge	*Cyperus houghtonii*	Plant	Endangered	PH-300; Landfill area/woods; species likely on dry upland areas (Shepley's Hill?)
Ovate Spiked-Sedge	*Eleocharis ovata*	Plant	Endangered	PH-269/EH-567; Area north of West Main Street; wetland species
Wild Senna	*Senna hebecarpa*	Plant	Endangered	PH-269/EH-567; Area north of West Main Street; likely upland areas
Animals				
Upland Sandpiper	*Bartramia longicauda*	Bird	Endangered	PH-300 and PH-269; Landfill area /woods and are north of West Main Street; habitat "open grassy areas, wet meadows, old fields, and pastures"
Grasshopper Sparrow	*Ammodramus savannarum*	Bird	Threatened	PH-300; Landfill Area/woods; habitat "in sandplain grasslands, pastures, hayfields, and airfields characterized by bunch grasses"
Blanding's Turtle	*Emydoidea blandingii*	Reptile	Threatened	PH-269/EH-567; Area north of West Main Street; habitat "primarily aquatic preferring densely vegetated shallow ponds, marshes and small streams."
Wood Turtle	*Clemmys insculpta*	Reptile	Special Concern	PH-269/EH-567; Area north of West Main Street; "The preferred habitat of the Wood Turtle is riparian areas. Slower moving streams are favored, with sandy bottoms and heavily vegetated stream banks."
Blue Spotted Salamander	*Abystoma laterale*	Amphibian	Special Concern	PH-269/EH-567; Area north of West Main Street; "Blue spotted salamanders require moist, moderately shaded environments… having depressions available for seasonal flooding [vernal pools]"

6. <u>Page 12:</u> The discussion of the estimation of surface-water discharge statistics based on drainage-basin area notes that, "... basins of similar size and hydrologic ... characteristics should be used ... ." Are the Priest Brook and Nonacoicus Brook drainages "similar"? The Nonacoicus Brook drainage includes a significant area of relatively static surface water (Plow Shop, Grove, and upstream ponds). These might be expected to affect the gross water balance in the drainage, particularly in the summer months, when the ponds may lose a significant volume of water to evapotranspiration. If the Priest Brook drainage has much less surface water area, the extrapolation to the Nonacoicus drainage may overestimate the stream flow. Does the literature address the comparability of basins with different fractions of surface water cover?

Response:

See response to Specific Comment 4.

7. Page 16, Table 7: An inspection of Table 7 suggests that Scenarios 5 and 6 are almost identical. Scenario 5 (Site East of Landfill (C004)) appears to have one additional disadvantage pertaining to working on steep slopes. Is Scenario 6 (site east of landfill (S002)) therefore considered to be superior?

Response:

Of the two, Scenario 6 appears to be superior due to constructability issues for Scenario 5.

7. Page 19, Water Budget Analysis: The water budget analysis focuses on changes in groundwater flux, expressed in gpm. It would also be useful, however, to estimate reduction/ increase in groundwater levels over relevant sub-areas of the site. For example, it is stated that, "Run 412 reduces the flow of ground water to the Nonacoicus in the area north of the dam to north of West Main Street ("Zone 6") by 18 gpm." What affect will this have on groundwater levels in this area? Will wetland resources be impacted adversely? The hydraulic performance monitoring will need to be reassessed to address this issue if on-site discharge options are pursued. See General Comment 2, above.

Response: **Run 412, the wellfield design run, involves discharge to the POTW. Predicted drawdown maps for Run 412 have been provided to the BCT. The performance monitoring network was developed to assess this drawdown with operation of the system. Drawdown triggers were developed as part of the performance monitoring plan and these triggers were not exceeded during the extraction test. Modeling work demonstrates that on-site discharge to surface water or groundwater in the vicinity of the Nonacoicus is expected to mitigate any drawdown in this area.**

8. Page 20, Conclusions and Recommendations: In addition to defining >capture=, additional hydraulic performance monitoring is needed to verify the various model-predicted changes to groundwater discharge (and related hydraulic effects). Since the predicted changes are spatially variable, a greater density of hydraulic monitoring data will be needed in some areas of the site should an on-site discharge option be adopted. See General Comment 2, above. As noted in General Comment 3 above, the model appears to be somewhat at odds with actual groundwater flow data in the area of Red Cove. In any case (including the present offsite discharge scenario), the model should be verified and updated as necessary in conjunction with the collection and synthesis of performance monitoring data collected as pumping is initiated and a new equilibrium is established.

Response:

See response to General Comment 2.

Draft On-Site Discharge Evaluation –
Shepley's Hill Groundwater Extraction, Treatment,
and Discharge System, June 30, 2005

The following document includes comments and responses to DEP comments on the ***Draft On-Site Discharge Evaluation – Shepley's Hill Groundwater Extraction, Treatment, and Discharge System, June 30, 2005***, prepared on behalf of the Devens BRAC Environmental Office, and provided to the Base Clean-Up Team (BCT). DEP comments were provided in a letter to Robert Simeone, Devens BRAC Environmental Coordinator, dated August 12, 2005.

Massachusetts Department of Environmental Protection, Letter dated August 12, 2005

Comment:

The Massachusetts Department of Environmental Protection (MassDEP) has reviewed the report entitled, "Draft On-Site Discharge Evaluation- Shepley's Hill Landfill Groundwater Extraction, Treatment, and Discharge System," prepared by CH2M Hill, dated June 30, 2005 ("the Report"), which evaluates groundwater and surface water discharge alternatives for the effluent from the Shepley's Hill Landfill Arsenic Treatment Plant (ATP). As explained below, MassDEP is concerned that the groundwater and surface water discharge alternatives identified therein would violate substantive state requirements previously identified as applicable requirements (i.e. ARARs). MassDEP believes that these requirements cannot be waived pursuant to §121(d)(4) of CERCLA under the circumstances.

Response:

The DEP indicates that both the groundwater and surface water alternatives would violate the substantive state requirements previously identified. We believe we have captured and evaluated substantive requirements in the analysis. Operation of the extraction and treatment system with the current discharge to POTW will provide additional field data, supporting further development and design of an on-site discharge approach. Responses below follow specific comments.

Comment:

The Massachusetts Surface Water Quality Standards designate Plow Shop Pond and Nonacoicus Brook as Class B, High Quality Waters. See, 314 CMR 4.06(2). As Class B, High Quality Waters, Plow Shop Pond and Nonacoicus Brook are designated for protection under 314 CMR 4.04. The applicable standards for performance for this project include not only the effluent limitations outlined in the Report but also the Antidegradation Provisions published at 314 CMR 4.04. Plow Shop Pond and Nonacoicus Brook, therefore, must be protected and maintained for their existing level of quality unless limited degradation for a new or increased discharge is authorized by the Department after the Department determines that such discharge "is insignificant because it does not have the potential to impair any existing or designated water use and cause any significant lowering of water quality" under 314 CMR 4.04(2) or the proponent demonstrates to the Department's satisfaction under 314 CMR 4.04(4), after public notice in accordance with 314 CMR 2.06, that no less environmentally damaging alternative site for the activity, source for the disposal, or method of elimination of the discharge is reasonably available or feasible," amongst other things.

Accordingly, MassDEP would consider a discharge to Plow Shop Pond or Nonacoicus Brook consistent with the Antidegradation Provisions only if it is "insignificant" because it does not have the potential to impair any existing or designated water use and cause any significant lowering of water quality or the proponent can satisfactorily demonstrate that no less environmentally damaging alternative site for the activity, source for the disposal, or method of elimination of the discharge is reasonably available or feasible. Because the discharge can be routed through the Devens Regional Wastewater Treatment Facility, it is not readily apparent how the proponent could satisfy the Commonwealth's Antidegradation Provisions.

<u>**Response:**</u>

BRAC is confident that the Class B designated uses of Plow Shop Pond and the Nonacoicus Brook would be maintained and enhanced with surface water discharge. In addition, the discharge of water locally within the pond brook ecosystem offsets the hydraulic stress associated with groundwater capture. Start-up operations for the system, as configured with the POTW discharge, will provide data that further demonstrate that surface water designated uses would not be impaired and may actually be enhanced. This concern will be revisited as these data are collected and shared with the DEP and the other members of the BCT.

<u>**Comment:**</u>

The groundwater discharge alternatives are also problematic. The regulations at 314 CMR 5.00 establish the Commonwealth of Massachusetts' Groundwater Discharge Program under which discharges of pollutants to the ground waters of the Commonwealth are regulated by MassDEP pursuant to M.G.L. c. 21, § 43. In addition to regulating these discharges, M.G.L; c. 21, §§ 26 through 53 also requires that MassDEP regulate the outlets for such discharges and any treatment works associated with these discharges. Through 314 CMR 5.00, MassDEP controls the discharge of pollutants to the ground waters of the Commonwealth to assure that these waters are protected for their highest potential use. See, 314 CMR 5.01. The alternative groundwater discharges identified in the Report would not be allowed under 314 CMR 5.06(3) if a sewer system is reasonably accessible and permission to enter such a sewer system can be obtained from the authority having jurisdiction over it, in accordance with 310 CMR 15.02(12) and M. G .L. c. 83, § 11. Because the discharge can be routed through the Devens Regional Wastewater Treatment Facility, it is not readily apparent how the proponent could satisfy this requirement.

<u>**Response:**</u> **The treated water would meet the substantive standards, water quality based effluent limitations identified in 310 CMR 5.10 (3). The project, as a groundwater remediation project, is intended to improve groundwater quality thus protecting human health and the environment. The treatment plant effluent is not an industrial discharge that may be viewed to further degrade or tax a resource. The project should be viewed more holistically as providing a net benefit to potential human and ecosystem receptors by improving overall water quality in the area downgradient of the landfill. In addition, local hydraulic impacts to the ecosystem are mitigated with groundwater reinjection.**

On-site recharge to groundwater provides an effective means to place treated water back in the aquifer in very close proximity to the area where it is removed for treatment. This is consistent with the spirit of Water Management Act (MGL c. 21G) and implementing regulations (310 CMR 36.00). In addition, 310 CMR 5.05 (2) provides an exemption for "Any recharge well used exclusively to replenish the water in an aquifer with uncontaminated water." Remediation projects are often viewed as exempt since they are undertaken to protect and enhance groundwater resources, differing in that regard from other industrial discharges. The Army's intent to meet the groundwater quality–based discharge limitations at 310 CMR 5.10 (3) would protect groundwater. As a practical matter, POTW treatment plant capacity should be reserved for sewage and industrial process waters from the communities. If remediation projects can meet typically more rigorous discharge limitations of either surface water or ground water discharge, then POTW capacity should not be used.

Comment:

MassDEP offers the following additional comments relative to the ARAR section of the

Report.

1 **Groundwater Discharge -Location-Specific** -First row should specify: Massachusetts Endangered Wildlife and Plants (321 CMR 8.00) and Massachusetts Endangered Species Act (321 CMR 10.00).

Response: This will be corrected to include M.G.L. c. 131A: Massachusetts Endangered Species Act; 321 CMR 8.00, List of Endangered Wildlife and Wild Plants; 321 CMR 10.00, Massachusetts Endangered Species Regulations.

Comment:

2. **Groundwater Discharge -Action-Specific** -Add new ARAR for the following: Massachusetts HWMR Groundwater Protection (310 CMR 30.660-679), State, Relevant and Appropriate, These regulations require groundwater monitoring at specified regulated units that treat, store, or dispose of hazardous waste. Maximum concentration limits for the hazardous' constituents are specified in 310 CMR 30.668

Response: Groundwater monitoring for the landfill as a "regulated unit" is being conducted in accordance the Record of Decision for Shepley's Hill Landfill (1995) and the associated long-term monitoring program. The identified requirements have been previously considered as part of the development of the long-term monitoring program. This program would be modified to incorporate any compliance monitoring should final design and construction of the groundwater discharge option be pursued.

Comment:

3. **Groundwater Discharge -Chemical Specific** -Under 314 CMR 5.10 (inclusive) and 314 CMR 5.19 discharge limits for new discharges are technology based, the ATP was developed to meet a 10 ug/l arsenic discharge limit and that should have been the stated goal of a groundwater [or surface water] discharge.

Response: The treatment plant was initially designed with the objective of meeting the discharge limitations of the Devens Regional Waste Water Treatment Plant, as specified

in the permit issued in July, 2003. The Army further decided that a design goal for the treatment would be 10 ug/l for arsenic.

Comment:

4. **Surface Water Discharge -Location-Specific** -Add new ARAR as follows: - Massachusetts Wetland Protection Requirements (310 CMR 10.00), -State, - Applicable, -Regulates activities in freshwater wetlands, 100-year floodplains, and 100 foot buffer zones beyond such areas: Regulated activities include certain types of construction and excavation activities. Construction of infiltration galleries, injection wells, or discharge piping to surface water will likely take place within protected resource areas and should meet the protective requirements of this regulation.

Response: This will be added.

Comment:

5. Surface Water Discharge -Chemical Specific -Table 5 Surface Water Discharge Standards should include a limit for chlorine/trihalomethane.

Response: We have not identified a surface water effluent limitation for either chlorine or trihalomethane in the NPDES remediation general permit (RGP) administered by EPA Region 1 and the DEP or the State surface water quality regulations that is directly applicable to remediation situations involving metals sites. However, the RGP presents a total residual chlorine (TRC) standard, of 11ug/L intended, as indicated in Table Vof the RGP, for projects involving hydrostatic testing of pipelines and tanks. However, permit guidance indicates that this should apply to all treatment systems by stating "permittees covered by the RGP who submit information in an NOI or an NOC under this permit which indicates that chlorine compounds are used in the activity or treatment systems must dechlorinate and monitor for the TRC in the effluent…this permit sites effluent limits based on the EPA recommended water quality criteria which are 11 ug/L for freshwater (chronic)..."

Comment:

6. Surface Water Discharge -Location Specific and Action Specific -The NPDES program allows for dilution consideration in developing discharge limits for metals but the calculation should only consider the drainage area ~ the proposed discharge location to develop the dilution range. In this draft, the whole watershed is inappropriately considered available for dilution.

Response: The USGS StreamSTATs procedure was utilized, as specified in NPDES and DEM guidance, to calculate the applicable 7Q10 discharge. If a decision is made to pursue surface water discharge further, other drainage area/discharge volume calculations may be discussed with the BCT.

Comment:

Additionally, MassDEP notes the following technical deficiencies in the Options Evaluation:

Feasibility Screening and Modeling Results -The matrix in Table 7 does not include the additional cost or time it will take to address specific technical issues associated with the Discharge Options. It is presumed that these would be addressed in the Comprehensive Site Assessment/Corrective Action Alternative Analysis that will not be completed in the foreseeable future and those results could change this Reports Screening results.

Response: Table 7 is a feasibility screening matrix to support general evaluation of discharge options and identify advantages and disadvantages based on effectiveness, implementability and cost. Costs/time associated with technical issues are included. The evaluation of on-site discharge options for the existing pump and treat system is not dependent upon the CSA/CAAA.

Comment:

2. Feasibility Screening and Modeling Results -Page 17 -Additional groundwater modeling was completed to evaluate the hydraulic impact of alternative discharge locations. However, to appropriately evaluate a groundwater discharge, both a refined hydraulic groundwater model and a detailed geochemical model would need to be developed to accurately predict the impacts of re-injection. At a minimum, the parameters to include would be differing soil types and hydraulics of the injection areas, addition information on soil adsorption, precipitation and dissolution reactions, consideration for non-equilibrium and equilibrium conditions, surface water interactions, and vertical and horizontal gradient influences. This information was not presented in the Report.

Response: On site groundwater recharge was evaluated in the same manner as groundwater extraction, supporting the design of the extraction wellfield. The BCT has defined a monitoring approach, presented elsewhere, to evaluate any changes in geochemical conditions and hydraulics in the aquifer. This monitoring program would be modified to incorporate evaluation of either surface water discharge or groundwater discharge if either of these is selected for implementation.

Comment:

4 Potential Process Needs -Discussion is presented about balancing treatment dosing and arsenic removal/discharge. The process should not trade-off one pollutant for another. The effluent must meet all applicable discharge limits.

Response: The effluent will meet applicable standards.

Comment:

Recommendations and Conclusions -I understand that new information on both the interpretation of groundwater flow data by the groundwater model and present groundwater discharge to Red Cove was presented at the last Restoration Advisory Meeting. This information should be evaluated in the context of the final remedy for the Shepley's Hill Landfill and the other Operable Units associated with Shepley's Hill Site. In addition, the Report focused narrowly on the hydraulics and relative costs of the discharge alternatives identified. It relies on a groundwater model that has not been developed to provide the appropriate level of detail needed to evaluate the hydro-geologic impacts of each alternative and some ARARs were simply not included for consideration. The Conclusions and Recommendations contained in the Report warrant reconsideration.

Response: Comment noted.

Comment:

4 MassDEP remains concerned that high levels of arsenic are continuing to migrate from the landfill and the Contingency Remedy will not adequately address migration of the arsenic plume and other issues at the site associated with possible cap system failure. MassDEP , therefore, requested in August 2004 that the United States Environmental Protection Agency consider re-opening the Record of Decision to allow for additional assessment of the groundwater, including assessing alternative methods to divert groundwater away from the landfill, and consideration of additional alternative remedial actions to address the continuing generation of leachate and containment of the advancing groundwater plume. MassDEP continues to believe that additional assessment of the groundwater, including assessing alternative methods to divert groundwater away from the landfill, and consideration of additional alternative remedial actions to address the continuing generation of leachate and containment of the advancing groundwater plume, and it is looking forward to working with the Army in the implementation of a Comprehensive Site Assessment/Corrective Action Alternative Analysis for Shepley's Hill Landfill per the Massachusetts Solid Waste Program requirements and Landfill Technical Guidance Manual.

Response: Comment noted.

Start-Up Extraction Test – Shepley's Hill Groundwater Extraction, Treatment, and Discharge System

PREPARED FOR: BRAC Clean-Up Team (BCT)

PREPARED BY: CH2M HILL

DATE: February 28, 2006

Introduction

The purpose of this letter report is to provide hydraulic data, results and interpretations from extraction testing work conducted during the start-up of the Shepley's Hill Extraction, Treatment, and Discharge system. The extraction testing was conducted at EW-1 and involved two 24 hr drawdown tests and a recovery test. EW-1 was selected for testing since modeling work conducted during system design activities demonstrated that EW-1 performance and the combined well field, involving EW-01 and EW-04 operating as a pair, would be very similar.

The hydraulic monitoring approach, further described in the Contingency Remedy Performance Monitoring Plan (CH2M HILL, 2005b), involved extensive manual and data logger measurements. These measurements were collected at multiple locations from August 24, 2005 through August 30, 2005. The work was scheduled such that the operating treatment plant would be functioning and available to treat the groundwater effluent during the test, avoiding the need for tank storage. Consequently, the work was conducted following initial start-up/shakedown activities when plant treatment process adjustments were complete. Prior to initiating the test the wellfield and plant remained idle for 5 days, to ensure that the aquifer had returned to steady state conditions.

The objective of the testing was to measure drawdown in the plume capture area with normal operation of the wellfield at 25 gpm and to derive aquifer hydraulic characteristics in the area of the wellfield. In addition to drawdown data, recovery data were also evaluated to characterize aquifer hydraulics through distance-drawdown and time-drawdown analyses. Comparison of these data is made with predictive simulations of the groundwater model involving Runs 401 through 403.

This memo provides well completion and boring logs for wells constructed both on base and off base during the design and construction of the Contingency Remedy (Attachment A). All of these new locations are part of either the hydraulic or geochemical monitoring networks described in the Contingency Remedy Performance Monitoring Plan (CH2M HILL, 2005b).

Hydraulic Monitoring

Figure 1 depicts the location of the wells, piezometers, and surface water stage locations that are included in the geochemical and hydraulic performance monitoring network. All of these locations were occupied prior to, during, and following the extraction test to characterize groundwater elevation and surface water stage under baseline, maximum drawdown, and recovery conditions. Subsets of these monitoring locations were visited frequently throughout the test for manual measurements or were automatically logged with pressure transducers to support estimation of hydraulic parameters through time-drawdown and distance-drawdown analyses.

The wells that were logged with pressure transducers are identified in Figure 1 and Table b-1. Table B-1 and Table B-2 provide lists of wells that are part of the hydraulic and geochemical monitoring networks (CH2M HILL, 2005b). All of these wells were monitored during the extraction test. Attachment B provides two tables, Table B-3 and Table B-4, summarizing water-level measurements collected before and during the tests. Table B-3 includes monitoring well locational coordinates and surveyed reference elevations from Meridian Associates, Inc (2005). The depth-to-water data for pre-extraction test baseline events, maximum drawdown, recovery, and post-extraction are converted to elevations and have been used to develop synoptic water-level plots. Table B-4 contains manual measurements collected regularly throughout the tests. Nearfield wells were monitored roughly every hour during the early stages of the extraction test and those further afield were monitored every 2 to 3 hours.

Chemical Monitoring

During early August 2005 the treatment plant start-up testing was conducted and by August 19, 2005 process adjustments were complete and the system was ready to support the extraction test. The plant and wellfield were shutdown on Friday, August 19th to allow the aquifer to recover over the weekend and the extraction test was scheduled to be begin the following Thursday, August 25th.

During the extraction test, samples were collected for influent and effluent analysis to provide data on expected arsenic concentrations in influent and effectiveness of treatment. These samples were collected on roughly 6 hour intervals throughout the initial drawdown test and daily the following week when the second extraction test was conducted. These data are presented in Table 1 and demonstrate that significant concentrations of arsenic, averaging 3067 ug/l, were present in the influent stream from EW-1 throughout the testing period. The average effluent arsenic concentration during this period was 3.9 ug/l. Concentrations as high as 5910 ug/l were encountered earlier in the month from EW-04 during start-up testing. The treatment goal of 10 ug/l for arsenic was met throughout the test.

Plans to collect total dissolved solid (TDS) data were modified for the extraction test. The Army BRAC had committed to design and construct a treatment plant as part of the contingency remedy so these data were no longer necessary for decision making. However, one influent sample was collected during the first sampling event of the extraction test confirming the expected high total dissolved solids in the influent to the treatment plant, having a result of 350 mg/l.

LEGEND

Hydraulic Monitoring Network

Geochemistry Sentinel Network

Note: New Well Locations Approximate (to be surveyed)

CH2MHILL

FIGURE 1
Performance Monitoring Network

TABLE 1
Chemical Monitoring During the Extraction Test

SAMPLE ID		IN0825050900	EF0825050902	IN0825051500	EF0825051500	IN0825052100	EF0825052100	IN0826050900	EF0826050900	EFFLUENT 0829	EFFLUENT 0830
SAMPLE TYPE (Plant Process)		INFLUENT	EFFLUENT	INFLUENT	EFFLUENT	INFLUENT	EFFLUENT	INFLUENT	EFFLUENT	EFFLUENT	EFFLUENT
SAMPLING DATE		25-AUG-05	25-AUG-05	25-AUG-05	25-AUG-05	25-AUG-05	25-AUG-05	26-AUG-05	26-AUG-05	29-AUG-05	30-AUG-05
SAMPLE TIME		9:00	9:02	15:00	15:00	21:00	21:00	9:00	9:00	14:00	14:30
LAB SAMPLE ID		L0509870-01	L0509870-02	L0509870-03	L0509870-04	L0509870-05	L0509870-06	L0509870-07	L0509870-08	L0510043-01	L0510043-02
	Units										
Solids, Total Dissolved	ug/l	350000	NS	NS	NS	NS	NS	NS	NS	NS	NS
Arsenic, Total	ug/l	3152 [1]	7.9	3045 [1]	5.6	3025 [1]	2.9	3044 [1]	4	1.5	1.2

[1] Influent values data. Average influent concentration 3067 ug/l and average effluent concentration 3.9 ug/l during extraction tests.

Hydraulic Testing and Analysis

Construction of the two extraction wells was completed in early 2005. Figure 2 provides an extraction well schematic drawing of each of the extraction wells that were installed. Attachment A provides boring logs and well completion diagrams for both extraction wells locations. Shortly after installation of the extraction wellfield was complete, both wells were developed and step tests were completed. The section that follows describes the step tests and the extraction tests and analyses in further detail.

Step-Drawdown Tests

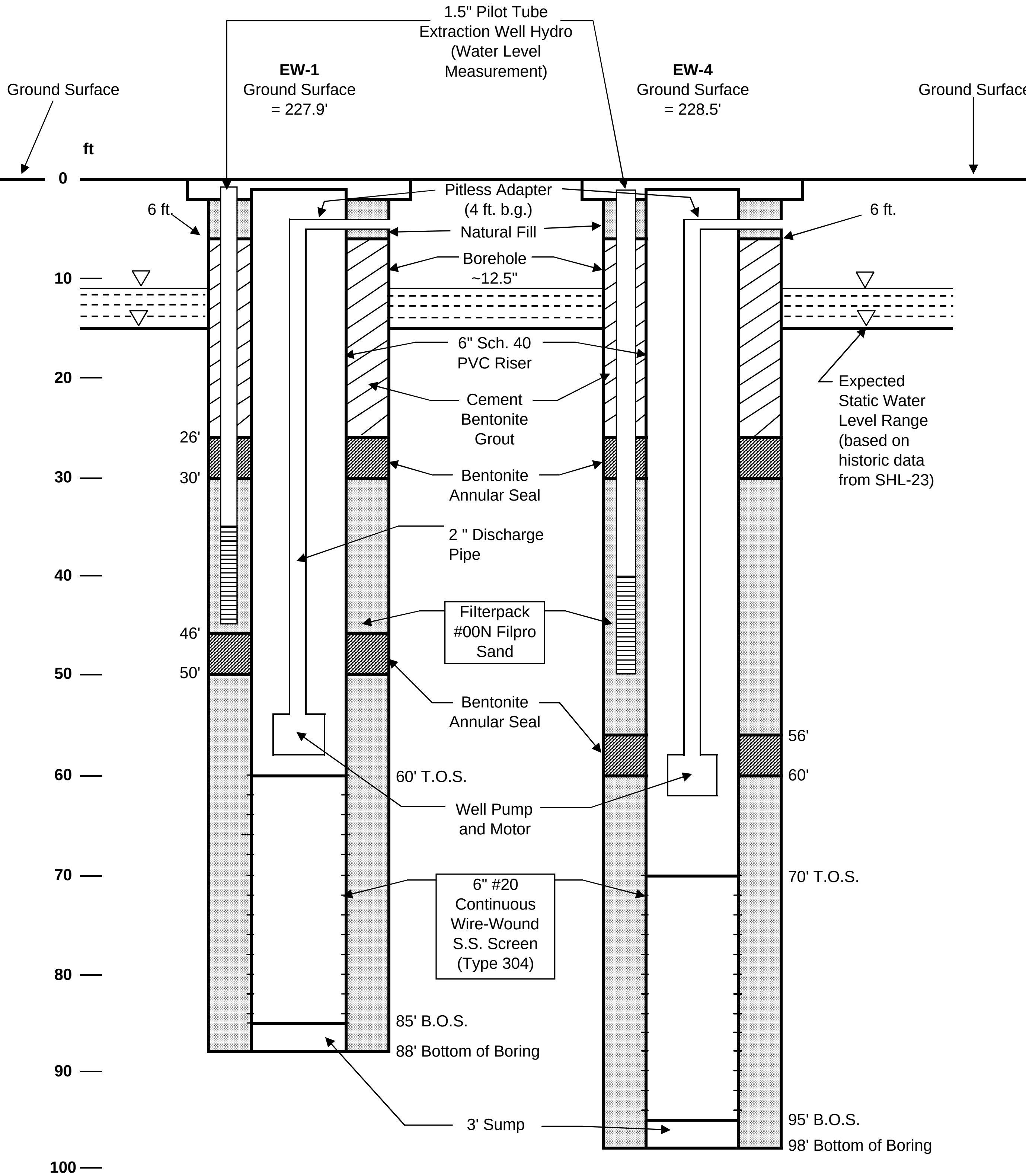
Step-drawdown tests of extraction wells EW-01 and EW-04 were conducted on February 15, 2005. Each well was pumped at 5, 15, and 25 gallons per minute (gpm) successively for 25 to 30 minutes at each rate, and the resulting drawdown was measured in each extraction well. In addition, new monitoring wells SHM-05-45A, SHM-05-45B, SHM-05-46A, and SHM-05-46B, approximately 50 and 100 feet east of the EW-01, were monitored. This was done to develop a sense of expected drawdown in the nearfield area. This information was utilized to further evaluate the planned monitoring network for the extraction test, such that adjustments could be made in this network, if needed.

Prior to initiating pumping for each step-drawdown test, static water levels in the extraction wells and the monitoring wells were collected manually. As the test progressed, water levels in the wells were collected at intervals between two and five minutes. These water levels are provided in Table 2. Pumped water was stored in a frac tank. Although the tests occurred on the same day, the first test (EW-01) was expected to have had a negligible effect on the second test (EW-04), since the volume of water associated with these short duration tests was relatively small (~1500 gallons).

Table 3 presents the cumulative drawdown at the end of each pumping interval for the test well and four monitoring wells. From this drawdown information and the pumping rate, the specific capacity of a well, a measure of yield or productivity, may be calculated. Specific capacity (C_s) is equal to the pumping rate (Q) divided by the drawdown (Δh_w). In other words, the specific capacity is a measure of the yield, usually represented in gallons per minute, of the saturated aquifer per foot of drawdown. Specific capacity is easily measured and provides an effective means to evaluate well production potential and track changes over time as a well is operated.

Specific capacities for EW-01 ranged from 2.1 to 3.1 gpm/ft and for EW-04 from 2.7 to 3.1 gpm/ft. These data indicate that on average EW-01 produces 2.8 gpm/ft and EW-04 produced 2.9 gpm/ft. It should be noted that specific capacities may change with pumping, increasing with well development or decreasing if fouling of screens occurs as a production well is operated. Improved specific capacities with increased pumping during the test at EW-01 suggest that the well development may have been enhanced through the test. In addition, specific capacities generally decrease with higher pumping rates due to well screen inefficiency becoming more prevalent at higher rates.

EW-01 and EW-04 each have approximately 50 and 60 ft of saturated thickness above the tops of the screened intervals, respectively (See Figure 2). This roughly calculates to a potential yield for EW-01 of 142 gpm and 174 gpm for EW-04, if operated independently, before the watertable would be drawn down to the screened depth. This simply gives a



Note: Wells to be completed with a pitless adapter connection and housed within a 24" square by 12" deep vault with water-tight bolt-down cover.

FIGURE 2
Well Construction Schematic Drawing

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TABLE 2
Extraction Well Step Tests

Δt (min)	EW-01	SHM-05-45A (CS-50)	SHM-05-45B (CD-50)	SHM-05-46A (CS-100)	SHM-05-46B (CD-100)
5 GPM					
0	12.28	14.35	14.91	13.92	13.31
2	13.48	14.41	14.98	13.96	13.34
4	14.41	14.42	14.99	13.98	13.37
7	14.48	14.44	15.00	13.97	13.35
10	14.48	14.43	15.00	13.98	13.35
15	14.48	14.43	15.00	13.98	13.35
20	14.48	14.43	15.00	13.98	13.35
25	14.48	14.43	15.00	13.98	13.35
15 GPM					
27	17.12	14.51	15.15	14.00	13.43
29	17.15	14.54	15.17	14.00	13.46
31	17.15	14.54	15.17	14.01	13.45
33	17.15	14.57	15.17	14.02	13.47
35	17.15	14.57	15.18	14.02	13.47
40	17.15	14.57	15.18	14.02	13.47
45	17.15	14.57	15.18	14.02	13.47
50	17.15	14.57	15.18	14.02	13.47
25 GPM					
52	18.31	14.67	15.33	14.15	13.56
54	20.31	14.68	15.34	14.13	13.58
56	20.35	14.70	15.34	14.16	13.59
58	20.31	14.71	15.35	14.17	13.57
60	20.31	14.71	15.36	14.17	13.61
65	20.31	14.71	15.36	14.17	13.61
70	20.31	14.71	15.36	14.17	13.61
75	20.31	14.71	15.36	14.17	13.61

Δt (min)	EW-04	SHM-05-45A (CS-50)	SHM-05-45B (CD-50)	SHM-05-46A (CS-100)	SHM-05-46B (CD-100)
5 GPM					
0	13.41	14.20	14.80	13.81	13.18
2	14.98	14.24	14.84	13.82	13.21
4	15.02	14.24	14.85	13.81	13.20
6	15.02	14.25	14.84	13.82	13.21
8	15.02	14.27	14.85	13.84	13.23
13	15.02	14.27	14.85	13.84	13.23
18	15.02	14.27	14.85	13.84	13.23
23	15.02	14.27	14.85	13.84	13.23
28	15.02	14.27	14.85	13.84	13.23
15 GPM					
30	18.84	14.31	14.90	13.85	13.25
32	18.87	14.33	14.92	13.85	13.28
34	18.89	14.34	14.95	13.86	13.28
36	18.89	14.37	14.99	13.89	13.29
38	19.00	14.39	14.99	13.91	13.31
43	19.01	14.39	14.99	13.92	13.32
48	19.01	14.39	14.99	13.92	13.32
53	19.01	14.39	14.99	13.92	13.32
58	19.01	14.39	14.99	13.92	13.32
25 GPM					
60	21.97	14.43	15.01	13.93	13.34
62	21.98	14.43	15.01	13.95	13.34
64	22.00	14.44	15.01	13.95	13.35
66	22.01	14.45	15.02	13.96	13.35
68	22.01	14.45	15.02	13.96	13.36
73	22.01	14.46	15.02	13.97	13.35
78	22.01	14.46	15.02	13.97	13.36
83	22.01	14.46	15.02	13.97	13.36
88	22.01	14.46	15.02	13.97	13.36

TABLE 3
Summary of Step-Drawdown Test Results

	EW-01 Step-Drawdown Test						
	EW-01			SHM-05-45A	SHM-05-45B	SHM-05-46A	SHM-05-46B
Discharge (gpm)	**Duration (min)**	**Cumulative Drawdown (ft)**	**Specific Capacity (gpm/ft)**	**Cumulative Drawdown (ft)**	**Cumulative Drawdown (ft)**	**Cumulative Drawdown (ft)**	**Cumulative Drawdown (ft)**
5	25	2.20	2.3	0.08	0.09	0.06	0.04
15	25	4.87	3.1	0.22	0.27	0.10	0.16
25	25	8.03	3.1	0.36	0.45	0.25	0.30
	EW-04 Step-Drawdown Test						
	EW-04			**SHM-05-45A**	**SHM-05-45B**	**SHM-05-46A**	**SHM-05-46B**
Discharge (gpm)	**Duration (min)**	**Cumulative Drawdown (ft)**	**Specific Capacity (gpm/ft)**	**Cumulative Drawdown (ft)**	**Cumulative Drawdown (ft)**	**Cumulative Drawdown (ft)**	**Cumulative Drawdown (ft)**
5	28	1.61	3.1	0.07	0.05	0.03	0.05
15	30	5.60	2.7	0.19	0.19	0.11	0.14
25	30	8.60	2.9	0.26	0.22	0.16	0.18

gpm = gallons per minute
ft = feet
d = day
min = minute

sense of potential yields for these extraction wells though they would have to be outfitted with higher capacity pumps to achieve these flows. In addition, the inlets for the current pumps are located in the interval approximately 3 to 5 feet above the top of screen to ensure uniform flow across the screen and motor cooling.

In summary, step test data indicate that the extraction wells are appropriately constructed to support the cumulative wellfield design flow rate of 50 gpm during normal operations, should it be increased from the current rate of 25 gpm agreed upon by the BCT. In addition, each individual extraction well will support a rate of 50 gpm while the other well is down for maintenance. Grundfos 40S30-9 (3 hp) well pumps were selected for these extraction wells to provide for pumping at lower rates while still allowing individual wells to achieve 50 gpm, if needed.

Constant Rate Pumping and Recovery Tests

Two constant-rate aquifer pumping tests were conducted with extraction well EW-01 as the test well. For the first test, EW-01 was pumped at a target rate of 25 gallons per minute (gpm) for 27.8 hours starting on August 25, 2005 at 6:54 AM. Water levels were allowed to recover over approximately 72 hours prior to the second test. Following the recovery period, a second test was conducted to enhance the data set available for analysis, addressing concerns relating to potential slippage of transducer cables during the first test. The second test was conducted, with EW-01 pumping at a target rate of 25 gpm for 24.5 hours starting on August 29, 2005, at 11:07 AM. Both drawdown and the recovery data sets are evaluated below.

Field Approach

Prior to each aquifer pumping test, static water levels were collected manually from the test well, 13 near-field observation wells with pressure transducers, and other monitoring wells and piezometers. Manual water levels were also collected periodically throughout the tests from these wells. Although manual measurements are collected with precision reported in hundredths, these data are rounded to tenths when used for groundwater contouring or other analyses. The accuracy is less than the precision due to inherent ground survey error for each well or reference point. The accuracy of the ground survey measurements is expected to be +/- .05 feet vertical and the error associated with manual water-level measurements is also estimated to be +/- .05 feet vertical. All manual water levels are provided in Table B-4 in Attachment B. Table B-3 presents a summary of baseline data, maximum drawdown, recovery, and operational waterlevel snapshots. This summary was developed primarily from manual water-level data but has been supplemented with water levels from data loggers for some locations.

During each test, water levels were recorded automatically using two In Situ Hermit 3000 data loggers connected to 15 and 20 psi pressure transducers in the 13 near-field observation wells (EW-04, SHM-05-45A, SHM-05-45B, SHM-05-46A, SHM-05-46B, SHL-5, SHM-96-5B, SHM-96-5C, SHL-9, SHL-22, SHM-96-22B, SHL-22C, and SHL-23) and the test well EW-01, respectively. Logarithmic testing for all tests and loggers was selected with a maximum time between readings equal to 10 minutes. This provided for frequent readings on a 2-3 second basis early in the test and a number of readings throughout the duration of the tests.

Both drawdown and recovery were recorded during the first aquifer pumping test, while only drawdown was recorded during the second test (extraction well EW-01 continued normal operation at the target rate of 25 gpm following this test). The raw displacement data were downloaded from the dataloggers to a laptop computer in the field and subsequently backed up to network drives for subsequent analysis.

Data Analysis

The aquifer test data collected were analyzed using AQTESOLV for Windows (HydroSOLVE, Inc., 2003) to process data logger data and aid in curve matching to obtain estimates of transmissivity/hydraulic conductivity, storativity, and specific yield. Analytical methods available for unconfined aquifers were evaluated and the mathematical solution first developed by Neuman (1974) and enhanced by Moench (1993, 1993) was determined to provide the best means, through curve-matching, for estimating hydraulic properties from drawdown and recovery data for the unconfined aquifer. This solution accounts for delayed gravity response and partial penetration. The assumptions inherent in the Neuman solution are as follows:

- The aquifer is homogeneous, isotropic and of uniform thickness and of infinite areal extent;
- The aquifer is unconfined;
- Flow is unsteady; and
- Diameter of pumping well is very small so that storage in the well can be neglected.

These assumptions, as with any mathematical solution, are never fully met in natural settings and the degree of agreement with each of these assumptions varies from location to location within the aquifer. However, curve matching with theoretical solutions still provides a powerful means to evaluate aquifer response and estimate aquifer properties. Evaluation of drawdown and recovery data from multiple tests and locations provides a means to develop a range of estimates representative of aquifer-wide properties and to converge on average values for aquifer parameters. The time-drawdown and recovery (residual) data from both pump tests and the recovery test as matched with Neuman solutions are provided in Attachment C and summarized later. In addition, to time drawdown analyses conducted at each of the nearfield wells, semilog plots of distance-drawdown (Cooper-Jacob 1946), were developed to provide another method for estimating transmissivity and storativity.

A uniform saturated thickness of 109 feet was assumed for the unconsolidated aquifer based upon aquifer characteristics observed at SHL-22, which terminates at the bottom of the unconsolidated aquifer (top of bedrock), and static water level measured prior to the tests. The saturated thickness thins toward the landfill and likely thickens north of SHL-22, so this thickness was assumed to best represent average conditions in the area of the test. A horizontal-to-vertical anisotropy factor of 10:1 was assumed. The effects of partial penetration by test well EW-01 and the 13 observation wells were also accounted for in the data analyses. Table 4 summarizes the well information used in the data analyses.

Some water-level observations from the first aquifer pumping test (8/25 through 8/26) required adjustment during data analysis due to apparent transducer cable slippage. These locations included SHL-5, SHM-96-5C, SHL-9, SHM-96-22B, SHM-05-45B, and SHM-05-46A. The slippage of these transducers is believed to have been related to disturbance of the transducers by ground survey crews. This was recognized during the test and each

TABLE 4
Summary of Well Information

Well ID	Easting (ft)	Northing (ft)	Distance from Pumping Well (ft)	Top of Screen Depth (ft bgs)	Bottom of Screen Depth (ft bgs)	Finish Length (stickup or flush) (ft)	Inner Casing Diameter (in)	Borehole Diameter (in)
EW-1	629942.7	3027959.9	0.0	60	85	-0.5	6	18
EW-4	629894.9	3027990.9	57.0	70	95	-0.5	6	18
SHL-9	630009.4	3028147.0	198.6	15	25	1.8	2	6
SHL-5	630191.8	3028124.9	298.8	3	13	1	2	6
SHM-96-5B	630158.2	3028112.7	264.2	80	90	1.7	4	10
SHM-96-5C	630173.5	3028106.1	273.2	50	60	0.9	4	8
SHL-22	630056.4	3028162.8	232.6	105	115	1.4	4	10
SHM-96-22B	630071.9	3028169.8	246.5	82	92	1.7	4	10
SHM-93-22C	630045.9	3028158.2	223.5	124.3	134.3	1.7	4	6
SHL-23	629712.7	3027916.7	234.0	23	33	2.1	2	6
SHM-05-45A	629995.4	3027962.0	52.7	20	25	2.4	2	6
SHM-05-45B	629995.2	3027956.7	52.6	65	75	2.6	2	6
SHM-05-46A	630041.7	3027946.5	99.9	20	25	2.1	2	6
SHM-05-46B	630041.2	3027941.1	100.3	65	75	1.7	2	6

ft = feet
ft bgs = feet below ground surface
in = inches

transducer was re-secured to ensure they did not move during the remainder of the test. In addition, a decision was made to conduct a second drawdown test following completion of the recovery test to ensure that good data were available. Shifts in the data related to transducer slippage were observable, enabling adjustments to be made prior to analysis. The raw and corrected water-level data are provided on CD (see Attachment D).

Pumping rates used in the aquifer test analyses were based on actual influent flow rates recorded every 15 seconds at the treatment plant. These flow rates were averaged over the individual backwash cycles, as well as over the intervals between the backwash cycles. The backwash cycles typically occur approximately every 45 minutes and last a little over two minutes at an average flow rate of approximately 10 gpm. The intervals between the backwash cycles lasted approximately 42 minutes at an average flow rate of 27.7 gpm. For the first test, EW-01 was pumped at an average rate of 26.8 gallons per minute (gpm) and for the second test, EW-01 was pumped at an average rate of 26.6 gpm. The influent flow rates recorded by the treatment plant, as well as the averages calculated from this data, are provided on the CD in Attachment D.

Attachment E provides daily and hourly precipitation data for Hanscom Field (Bedford), elevation 166 ft above mean sea level (amsl) east of the site and Fitchburg Municipal Airport, elevation 339 feet amsl west of Devens. Devens has an elevation of 215 feet amsl. Bedford is considered to provide the most representative record of conditions present at Devens during the tests. These daily and hourly data generally agree with what was observed by field staff during the extraction test. Table 5 presents a brief summary relating precipitation data from Bedford to the observations at Devens for the period August 24 through August 30.

TABLE 5
Precipitation Summary (Bedford and Shepley's Hill)

Date/Day	Test	Bedford Precipitation	Devens Observation/Comment
Aug 24/Wed.	Baseline monitoring	Trace, .12 inch	Brief isolated thunderstorms around 6:00 pm during completion of pre-test manual waterlevel survey.
Aug 25/Thurs.	Drawdown	Dry, .00 inch	Dry at SHL. Drawdown test initiated at 6:54 AM.
Aug 26/Fri.	Drawdown and Recovery	Dry, .00 inch	Dry at SHL. Drawdown test terminated at 10:33 AM.
Aug 27/Sat.	Recovery	Dry, .01 inch	Recovery continues and largely complete. No field staff on site
Aug 28/Sun.	Recovery	.16 inch	Recovery data collection continues through weekend. No field staff on site. Rainstorms widespread throughout the state.
Aug 29/ Mon.	Recovery and Drawdown	Trace, .01 inch	Second drawdown test initiated at 11:07 AM.
Aug 30/ Tues.	Drawdown	.16", 900-1000; .19" 1000-1100; .15" 1100-1200; .01" 1200-1300	Strong rain in early morning hours as 24 hr test is completed. Field staff observed continued rain throughout morning. Drawdown test terminated at 11:37 AM.

Given the timing and duration of rainfall, the effects are expected to have had negligible impact on the tests. In general, the full water-level data set indicates a slight declining water-level trend throughout the period of the tests (8/24 through 8/29). This likely relates to longer term trends (seasonality) and the short duration precipitation events were not significant enough to measurably affect this overall groundwater trend during the period of the test.

Hydraulic Triggers

Manual water-level readings were collected continuously by two field teams during the first 10 hours of the tests. These readings provided areal coverage supplementing the intensive data collected with data loggers and provide the opportunity to specifically observe wells along Molumco Road and Nonacoicus Brook and within the wetland identified to evaluate hydrology in the brook/wetland environment. These wells, in addition to a stage board in the wetland, are designed to evaluate hydraulic triggers as specified in the Performance Monitoring Plan (CH2M HILL, 2005).

At the time of the test, the hand-installed piezometers SHP-05-47A; SHP-05-48A, B; SHP-05-49A were dry. In addition, the wetland area identified for location of a stage board (WP-01) was dry. This was due to the generally low water conditions in the area at the end of the summer. The deeper B screens at SHP-05-47B (downstream of the dam) and SHP-05-49B (downstream of Molumco Road), however, provided the opportunity to monitor shallow water table conditions near the brook throughout the duration of the test. The data at SHP-05-49B indicate that the shallow installations are very responsive to changes in surface water levels. The data from SHP-05-49B and observations of the brook during the extraction test indicated that the stage of Nonacoicus Brook was dropping throughout the day on August 25th. This surface water response or hydrograph is likely the short duration response to the storms in the Nonacoicus Basin that occurred the previous evening on August 24th. Consequently, these shallow installations in close proximity to the brook probably best reflect surface water stage and are susceptible to short-term changes that mask the trends in groundwater stage over the larger area. Stresses influencing groundwater levels at a larger scale, such as would be expected from a pumping well are likely better evaluated with wells located further from the Brook.

The hydraulic triggers specified in the Performance Monitoring Plan (CH2M HILL, 2005b) for the start-up period (including extraction test) are as follows:

> *Start-up Period: If during start-up operations either >.2 feet of drawdown is observed at the SHP-05-47A,B and SHP-05-49A,B locations or >.4 feet is observed at the locations along Molumco Road, consistently over three measurements, and this drawdown is clearly associated with the operation of the extraction system (ie. not associated with sudden changes in brook water levels due to beaver dam breaches or other factors), the system will be temporarily shutdown while the BCT reviews the complete hydraulic dataset.*

Data for wells along Molumco Road, including SHP-99-34 A, B, SHM-99-32X, SHM-99-31 A,B,C, and SHP-99-33A, B; the wetland area SHM-05-42 A,B; up Scully Road, including SHM-05-41 A,B,C; and between the plant and Plow Shop Pond, including 8 S,D and SHL-13, provide excellent additional locations to evaluate the response of groundwater to the 25 gpm stress applied at EW-01 during the extraction test. These data (see Table B-3 and B-4) suggest that drawdown response is on the order of hundredths and likely less than a tenth of a foot within a few hundred feet of EW-01 pumping at 25 gpm.

The dataset suggests that the drawndown triggers established for the project (CH2M HILL, 2005) were not exceeded during the test and are not expected to be exceeded if the pumping rate is doubled in the future to the design rate of 50 gpm. With these small changes in waterlevels, it becomes difficult to resolve what may be induced by pumping vs. fluctuations or continuous changes in water elevations associated with seasonal climatic adjustments.

Hydraulic Parameters

Neuman (1974) solutions were fitted to data plotted as time versus drawdown on log-log plots and the ratio of total pumping time to time since pumping ceased versus residual drawdown (recovery) on semi-log plots (see Attachment C). Table 6 presents a summary of the estimates of aquifer parameters from this time-drawdown analysis for both drawdown tests and recovery tests. In addition, Table 6 presents estimates of transmissivity and storativity derived from a distance-drawdown analysis (Cooper-Jacob 1946). Figures 3 and 4 provide the distance-drawdown plots.

Time-drawdown analyses indicate average transmissivity of 6172 ft^2/d and specific yield of .027. Distance-drawdown tests indicate an average transmissivity of 2906 ft^2/d. The previous pump test conducted at SHM-96-5C, to the northeast of EW-1 yielded a similar transmissivity of 1.9 ft^2/min or 2736 ft^2/d (SWET, 1998).

TABLE 6
Summary of Estimated Aquifer Parameters (Drawdown and Recovery Analyses)

Well ID --	Radius From Pumping Well (ft)	Maximum Drawdown (ft)	Neuman Solution				Cooper-Jacob Distance-Drawdown	
			Transmissivity (ft^2/d)	Storativity --	Specific Yield --	Beta --	Transmissivity (ft^2/d)	Storativity --
Drawdown & Recovery Analysis - 8/25-8/26/05								
Shallow (screened less than 35 ft bgs)							2736	4.0E-02
SHM-05-45A	49.76	0.50	731	6.3E-05	7.7E-02	3.4E-03		
SHM-05-46A	99.79	0.47	824	6.2E-06	2.4E-03	1E-03		
SHL-9	207.22	0.12	6,170	5E-05	6.2E-03	3.6E-03		
Intermediate (generally screened between 35 and 75 ft bgs)								
SHM-05-45B	51.51	0.78	4,670	1.4E-03	4.7E-03	3.8E-02		
SHM-05-46B	98.71	0.45	3,356	1.7E-03	7E-02	8.6E-02		
SHM-96-5C	273.54	0.14	16,140	2.1E-03	2.6E-02	2.6E-02		
Deep (generally screened between 75 and 115 ft bgs)								
EW-04	56.57	0.55	7,324	1.2E-03	2.9E-02	1.3E-02		
SHM-96-22B	247.58	0.18	12,370	7E-04	4.7E-03	3.1E-02		
SHM-96-5B	266.30	0.18	6,713	1.3E-03	2.4E-02	1.6E-01		
Recovery Analysis 8/26-8/29/2005								
Shallow (screened less than 35 ft bgs)							NA	NA
SHM-05-45A	49.76	0.47	552	6.5E-05	9.2E-02	3.6E-03		
SHM-05-46A	99.79	0.37	555	1.1E-04	6.8E-02	3E-02		
SHL-9	207.22	0.1	4,096	4.6E-05	6.1E-03	3.1E-03		
Intermediate (generally screened between 35 and 75 ft bgs)								
SHM-05-45B	51.51	0.45	4,460	2.9E-03	4.2E-03	1.6E-02		
SHM-05-46B	98.71	0.38	9,482	3.2E-03	1E-02	6E-03		
SHM-96-5C	273.54	0.13	15,810	1.5E-03	3.1E-02	2.3E-02		

Well ID	Radius From Pumping Well	Maximum Drawdown	Neuman Solution				Cooper-Jacob Distance-Drawdown	
			Transmissivity (ft^2/d)	Storativity	Specific Yield	Beta	Transmissivity (ft^2/d)	Storativity
--	(ft)	(ft)		--	--	--		--
Deep (generally screened between 75 and 115 ft bgs)								
EW-04	56.57	0.45	6,238	1.9E-03	3.5E-02	1E-02		
SHM-96-22B	247.58	0.15	7,958	7E-04	2.1E-02	8.7E-02		
SHM-96-5B	266.30	0.15	5,307	9.6E-04	3.8E-02	2E-01		
Drawdown Analysis - 8/29-8/30/2005								
Shallow (screened less than 35 ft bgs)							3075	3.3E-02
SHM-05-45A	49.76	0.49	616	1.7E-04	6.6E-02	8.8E-03		
SHM-05-46A	99.79	0.40	720	4.1E-05	1.8E-02	8.4E-03		
SHL-9	207.22	0.15	4,992	2.5E-05	1.1E-03	2.3E-03		
Intermediate (generally screened between 35 and 75 ft bgs)								
SHM-05-45B	51.51	0.76	2,145	5.3E-04	6.6E-02	6.1E-02		
SHM-05-46B	98.71	0.41	8,973	2.6E-03	4.1E-03	1E-02		
SHM-96-5C	273.54	0.18	13,270	1.4E-03	1.9E-03	4.6E-02		
Deep (generally screened between 75 and 115 ft bgs)								
EW-04	56.57	0.47	5,097	1.2E-03	1.9E-02	3.2E-02		
SHM-96-22B	247.58	0.20	10,580	6.3E-04	2.1E-03	7.9E-02		
SHM-96-5B	266.30	0.19	7,505	7.9E-04	7.9E-03	1.4E-01		
AVERAGE (all tests)			6,172	1.0E-03	2.7E-02	4.2E-02	2,906	3.7E-02

Figure 3
Distance Drawdown- First Extraction Test

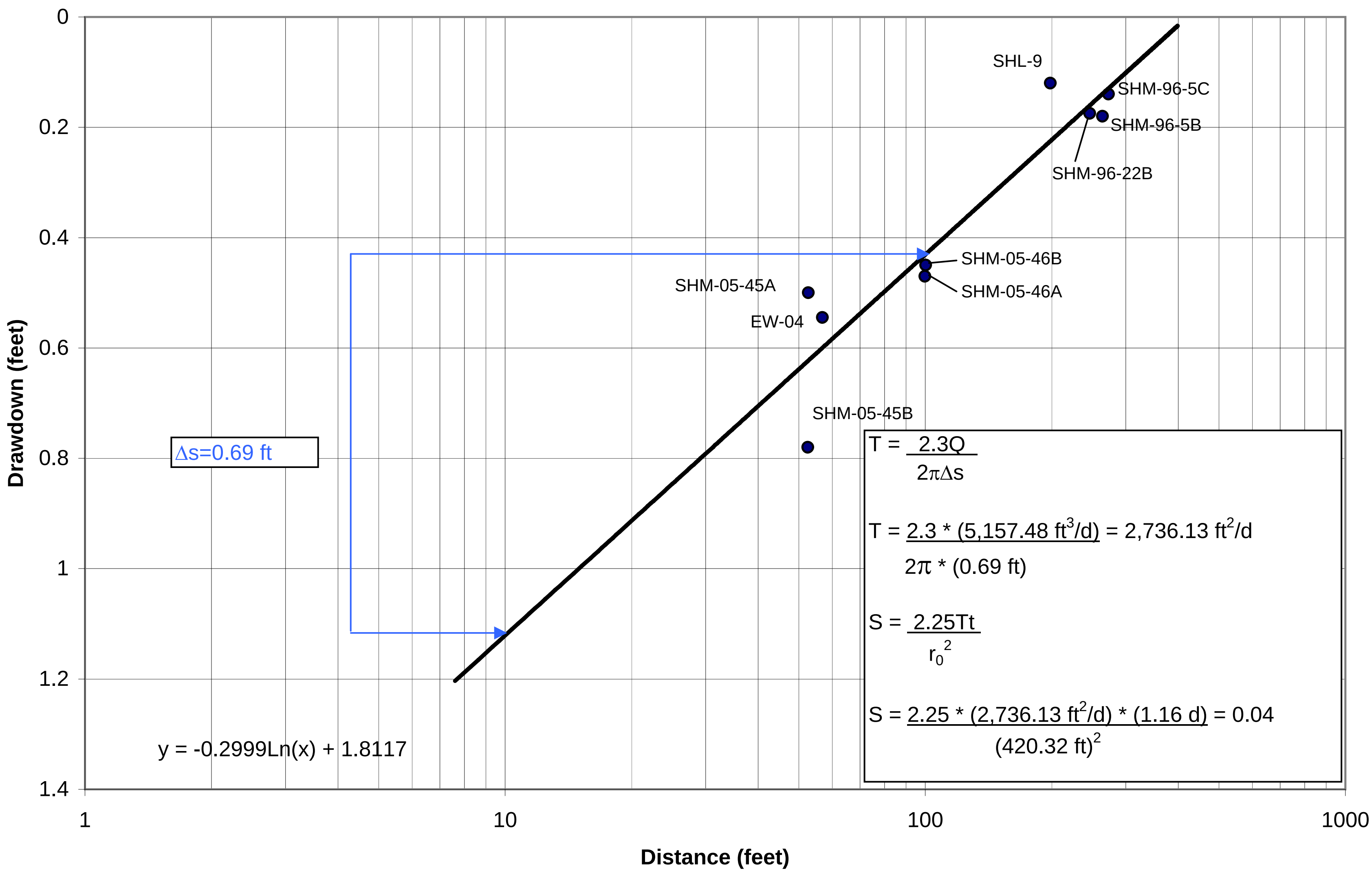
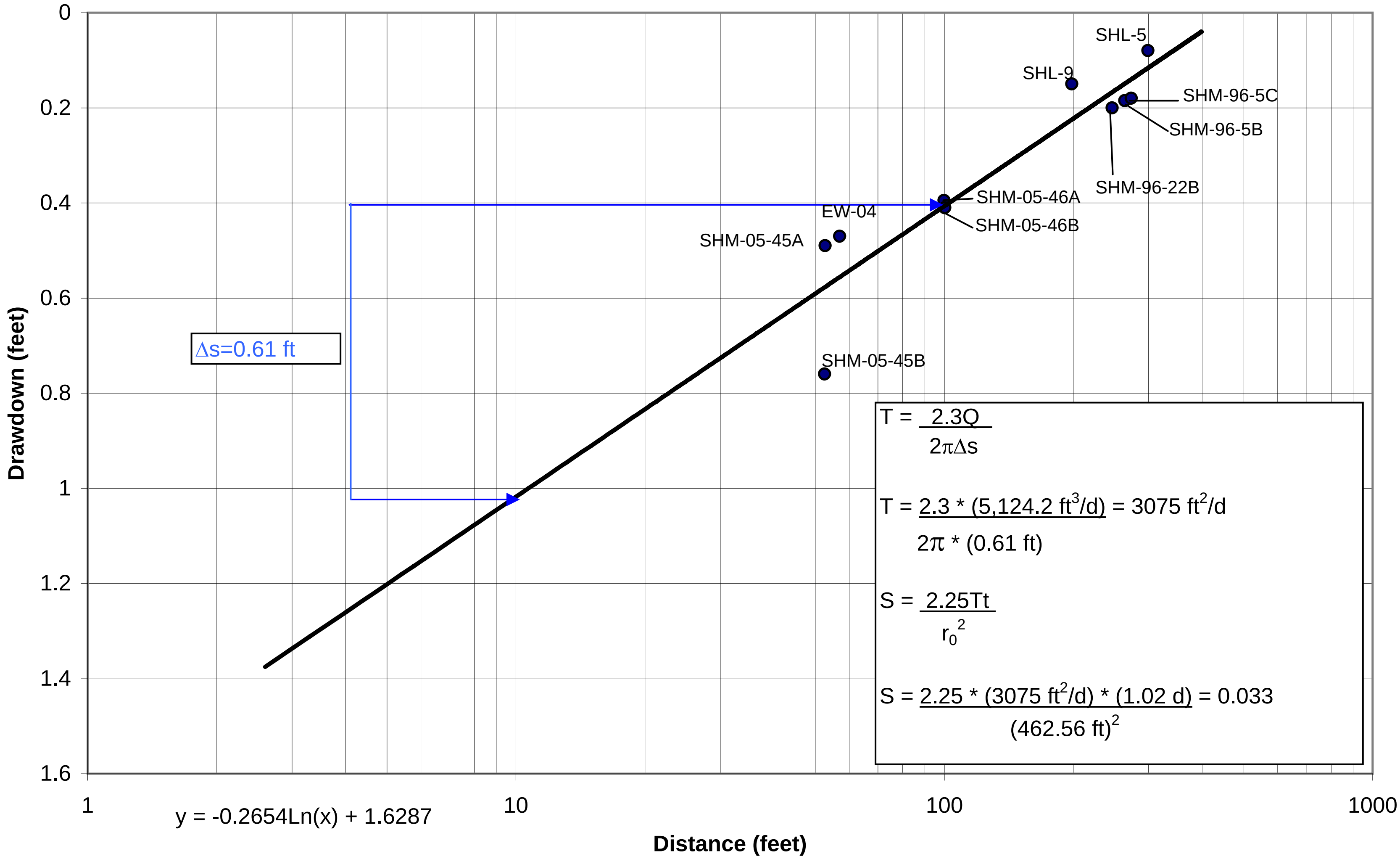


Figure 4
Distance Drawdown- Second Extraction Test



Assuming roughly a saturated thickness of approximately 100 feet, then the average transmissivities derived from the time-drawdown analyses of 6172 ft^2/d and the distance-drawdown analyses of 2972 ft^2/d yield average hydraulic conductivities of 61.72 ft/d and 29.72 ft/d, respectively. Converted to metric units these are equivalent to 2.18E-02 cm/s and 1.05E-02 cm/s. These values are characteristic for glacial outwash deposits (involving dominantly fine sands with little silt).

Groundwater Flow

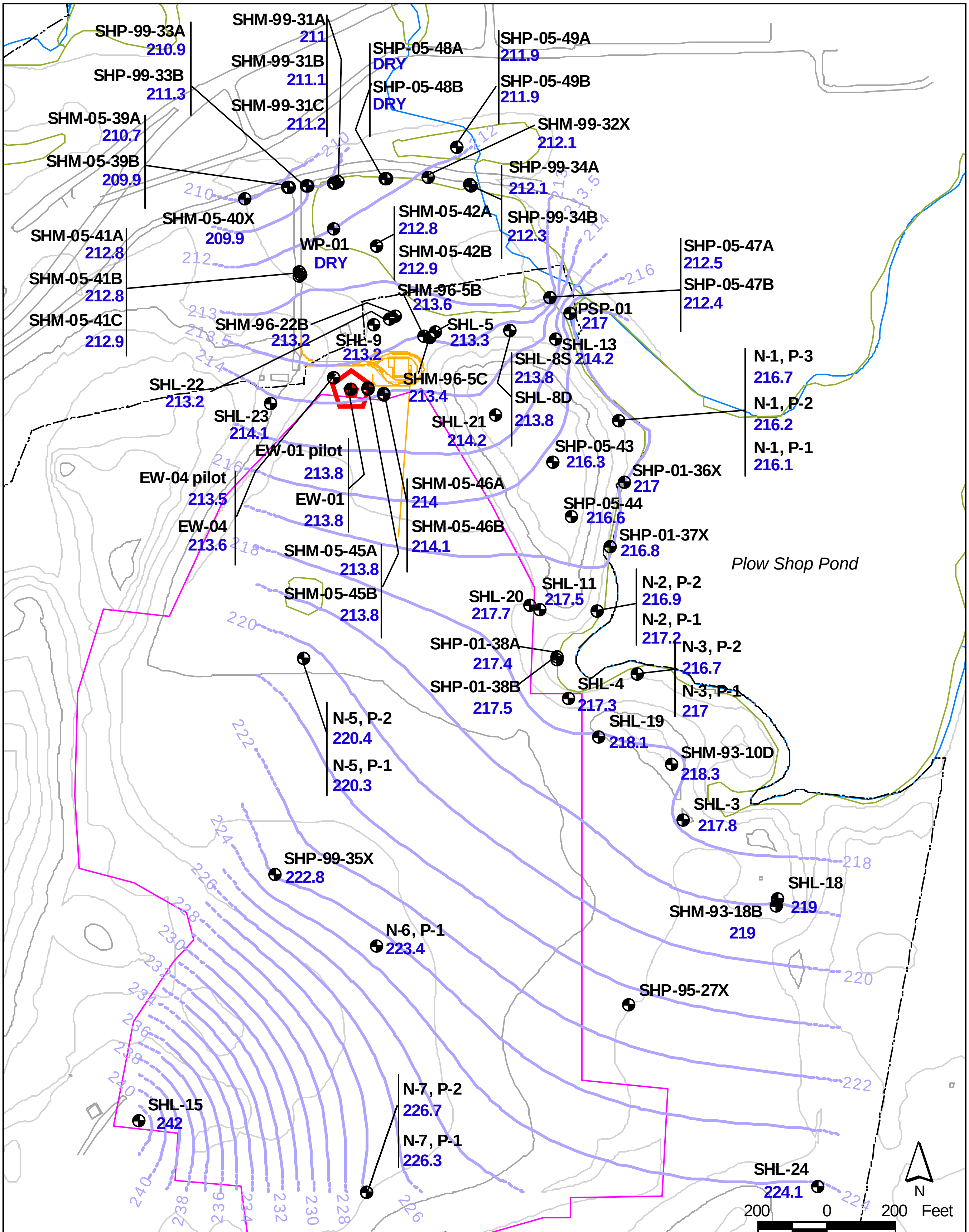
Data collected prior to and during the extraction test were compared with the summary of synoptic water level elevations collected historically and presented in the Supplemental Groundwater Investigation (Harding ESE, 2003, Appendix C). This comparison indicates that the water elevations during the test were similar to "average" water level conditions.

The synoptic groundwater data collected prior to and during the extraction tests (see Table B-3) has been contoured to depict conditions prior to pumping (Figure 5) and immediately prior to termination of pumping at 25 gpm (Figure 6). To develop the plots, the data from wells nested in the unsaturated zone were averaged, due to generally minor vertical gradients observed throughout the area. This produces average head conditions across the thickness of the unconsolidated aquifer.

Figure 5 presents the pretest groundwater table from the synoptic dataset collected on the evening of August 24th and Figure 6 presents the watertable on August 26th immediately prior to the termination of the first extraction test. These two figures illustrate the effect of the operating system on the watertable in the vicinity of EW-01, particularly the shift of the 213 – 215 foot groundwater elevation contours. A 213.5 ft groundwater elevation contour has been added to further describe the drawdown in the area around the wellfield.

Figure 7 presents particle track simulations for EW-01 operating at 50, 40, and 30 gpm. These are from simulation runs 401, 402, and 403, respectively that are provided in the *Final One Hundred Percent (100%) Submittal, Remedial Design and Remedial Action Workplan* (CH2M HILL, 2005a). The original design demonstrated that EW-01 operating alone at a pumping rate of 50 gpm (Run 401) would meet design objectives. However, a decision was made to move forward with Run 412, an EW-01/EW-04 combination operated at a cumulative rate of 50 gpm, since it would provide similar performance to EW-01 operated alone while providing redundancy with a two-well scheme. Subsequently, the BCT decided that initial operations of the system would be at target rate of 25 gpm rather than 50 gpm.

Runs 401, 402, and 403 in Figure 7 illustrate what might be expected from EW-01 at 50, 40, and 30 gpm. Particle tracks for Run 403 generally agree with the configuration of the watertable developed with pumping of EW-01 during the extraction test at 25 gpm. This indicates that the extraction wellfield is having the hydraulic effect on the aquifer that is expected based on the predictions of the groundwater model. It is expected that at 50 gpm the actual observations vs. predicted would be similar. Further monitoring of the system during operation of both EW-01 and EW-04 at 25 gpm will confirm that the dual-well extraction well configuration provides capture equivalent to EW-01 operating alone.



LEGEND

Estimated Groundwater Elevation Contour (dashed where inferred; in feet above mean sea level)

SHL-15 ← Location ID
242 ← Groundwater Elevation
Well, Piezometer, or Stage Board

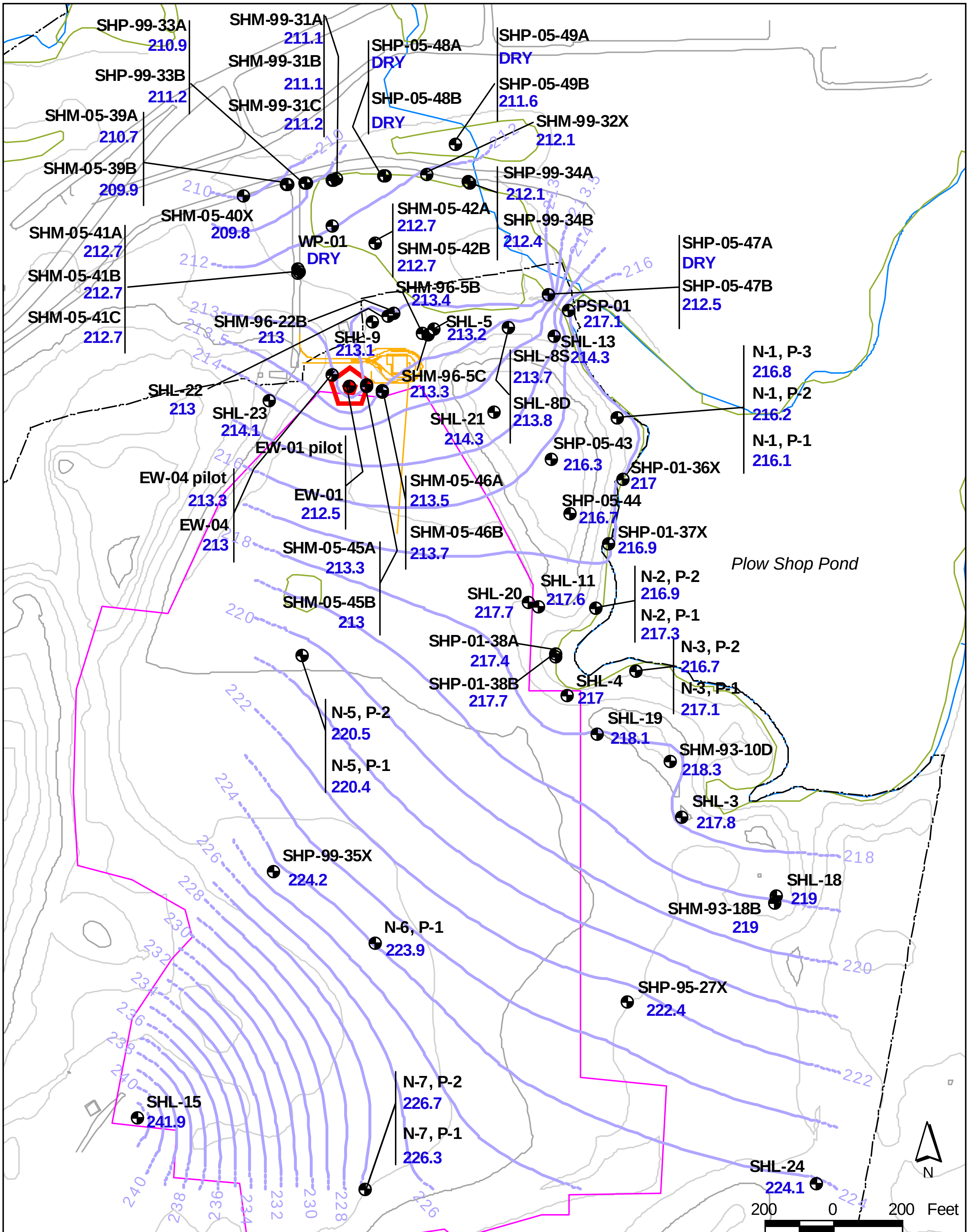
Test Well EW-01

Figure 5
Contour Map of Baseline (Pre-Test) Groundwater Elevations
Measured on August 24, 2005

Shepley's Hill Landfill, Fort Devens, MA

Contour Interval = 1 foot (except where noted)

CH2MHILL



LEGEND

Estimated Groundwater Elevation Contour
(dashed where inferred; in feet above mean sea level)

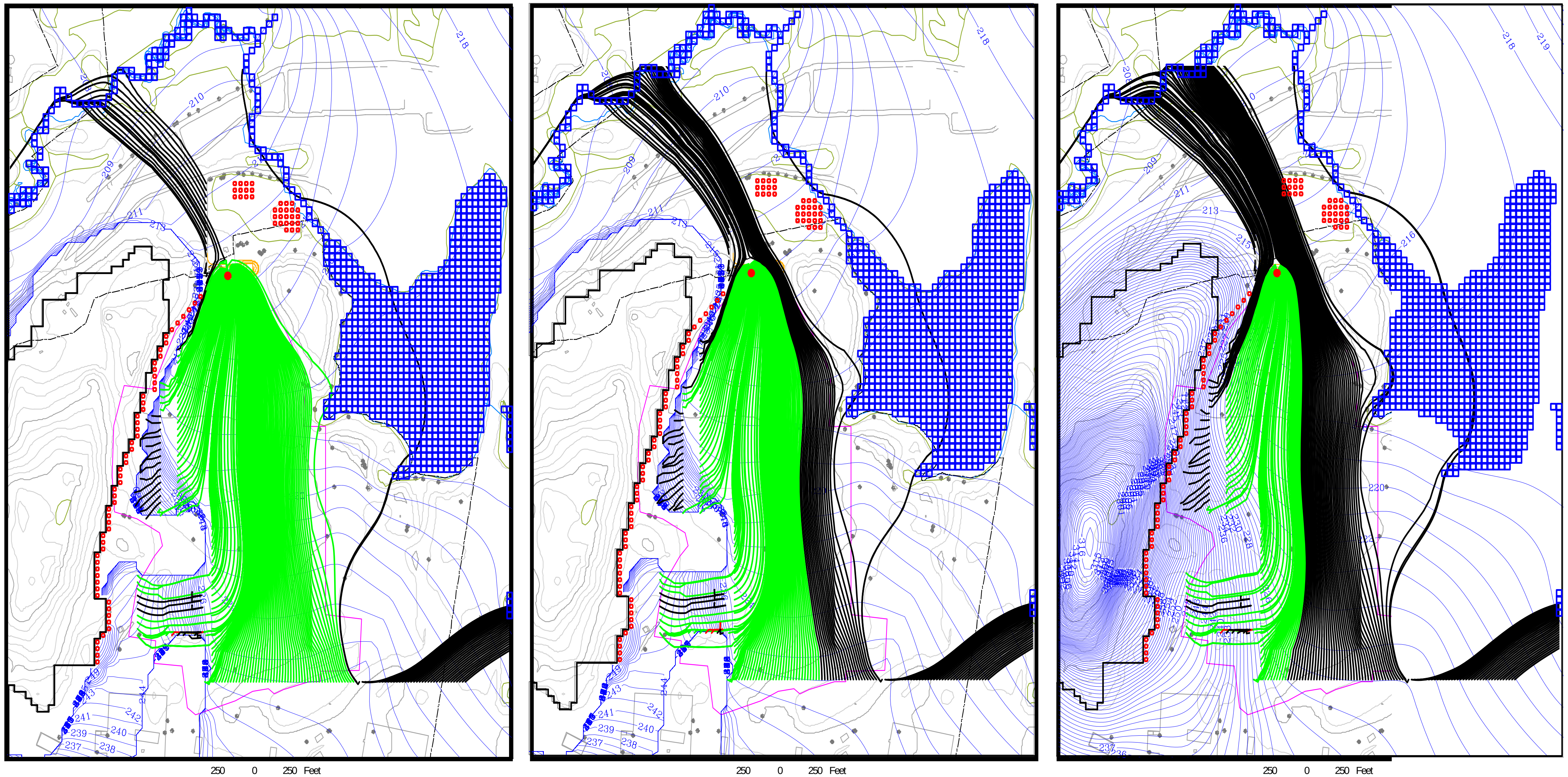
SHL-15 ← Location ID
242 ← Groundwater Elevation
Well, Piezometer, or Stage Board

Test Well EW-01

Figure 6
Contour Map of Groundwater Elevations at Maximum Drawdown
Measured on August 26, 2005
August 25, 2005 Aquifer Pumping Test
Shepley's Hill Landfill, Fort Devens, MA

Contour Interval = 1 foot (except where noted)

CH2MHILL



Run 401 - EW-01 Pumping at 50 GPM

Run 402 - EW-01 Pumping at 40 GPM

Run 403 - EW-01 Pumping at 30 GPM

Notes:
1. Simulated hydraulic head contour interval is equal to 1 foot.

LEGEND

- Extraction Well in Layer 1
- Particle Captured By Extraction Well
- Particle Exiting Through Other Layer 1 Boundaries
- Particle Exiting Through Layer 2 Boundaries
- Simulated Hydraulic Head Contour
- Proposed Treatment Plant
- Shepley's Hill Landfill Extent
- Fort Devens Boundary
- Surface Water
- Wetland

N

Figure 7
Pathlines for Particles Started in Model Layer 1
Scenario 1 - Single Well Pumping at 50, 40, and 30 GPM
Runs 401 through 403
Adapted from - Remedial Design and Remedial Action Workplan
Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL

Conclusions and Recommendations

The extraction tests provide baseline data for evaluation of extraction well/wellfield performance during operation of the system. Hydraulic monitoring data collected during regular monitoring events throughout routine operation of the system will provide additional synoptic water level datasets for evalutation. The following are conclusions and recommendations from the extraction well step tests, extraction test, and other monitoring:

- Specific capacities for EW-1 and EW-4 average 2.8 and 2.9 gpm/ft of drawdown, respectively. These results indicate that the wells are appropriately designed to support the design pumping rate of 50 gpm either split between them or with either well operating alone (during maintenance). The design assumes that 50 gpm is the maximum cumulative flow for the wellfield.
- Time-drawdown analyses indicate an average transmissivity of 6172 ft^2/d, specific yield of .027. Distance-drawdown tests indicate an average transmissivity of 2906 ft^2/d. These values are representative for glacial outwash deposits involving dominantly fine sands. The previous pump test conducted at SHM-96-5C, to the northeast of EW-1 yielded a similar transmissivity of 1.9 ft^2/min or 2736 ft^2/d (SWET, 1998).
- Assuming an average saturated thickness of approximately 100 feet, the average transmissivities derived from the time-drawdown analyses of 6172 ft^2/d and the distance-drawdown analyses of 2972 ft^2/d yield average hydraulic conductivities of 61.72 ft/d and 29.72 ft/d, respectively or 2.18E-02 cm/s and 1.05E-02 cm/s, expressed in metric units.
- The comprehensive synoptic water level datasets collected during the extraction test indicate that the drawndown triggers established for the project (CH2M HILL, 2005) were not exceeded during the test and are not expected to be exceeded if the pumping rate is doubled in the future to the design rate of 50 gpm.
- Influent arsenic data collected during the extraction test (EW-01 operating) indicate that this constituent averaged 3067 ug/l. Concentrations as high as 5910 ug/l were encountered prior to the extraction test when EW-04 was operated at 25 gpm during process start-up testing. Test data suggest that the extraction wells are appropriately located.
- The average treatment plant effluent arsenic concentration during the test period was 3.9 ug/l, indicating that the treatment process is capable of meeting the design treatment goal of 10 ug/l, with the influent characteristics encountered under full pumping stress.
- Ongoing hydraulic monitoring during the completion of start-up activities and operation of the system will provide data concerning performance of the system during normal seasonal watertable fluctuation.

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Attachment A

Boring and Well Completion Logs

	PROJECT NUMBER	BORING NUMBER
CH2MHILL	284350.SC.01	**SHM-05-39** SHEET 1 OF 2

SOIL BORING LOG

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA

ELEVATION : 222.9' DRILLING CONTRACTOR : Dragin Drilling

DRILLING METHOD AND EQUIPMENT USED : Geoprobe and Hollow Stem Auger

WATER LEVELS : START : 12/03/2004 & 02/01/2005 END : 12/03/2004 & 02/02/2005 LOGGER : Tseng

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
						Note: Geoprobe water profiling followed by HSA soil sampling and well installations.
5						
						No water sample collected - dry
10						
	12-14					Water sample OBSB0114W Screen depth 12-14 ft bgs
15						
	19-21			9-11-11-12	Dark brown fine to course SAND, trace gravel	Soil sample OBSB0119S
20						
25						
	27-29					Water sample OBSB0129W Screen depth 27-29 ft bgs
	29-31			4-5-7-9	Light brown medium SAND, trace gravel	Soil sample OBSB0129S
30						
35						
	37-39					Water sample OBSB0139W Screen depth 37-39 ft bgs
	39-41			4-6-7-7	Greyish brown fine to medium SAND, trace pebbles	Soil sample OBSB0139S
40						

PROJECT NUMBER	BORING NUMBER
284350.SC.01	SHM-05-39 SHEET 2 OF 2

SOIL BORING LOG

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
ELEVATION : 222.9' DRILLING CONTRACTOR Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Geoprobe and Hollow Stem Auger
WATER LEVELS : START : 12/03/2004 & 02/01/2005 END : 12/03/2004 & 02/02/2005 LOGGER : Tseng

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
45						
	47-49					Water sample OBSB0149W and duplicate Screen depth 47-49 ft bgs
	49-51			3-4-5-8	Greyish brown fine SAND, poorly graded	Soil sample OBSB0149S
50						
55						
	59-61			6-9-5-7	Grey fine SAND, trace silt, poorly graded	Water sample OBSB0161W
60						Screen depth 59-61 ft bgs Soil sample OBSB0159S
65						
	67-69					Water sample OBSB0169W Screen depth 67-69 ft bgs Refusal at 69 ft bgs
70						
75						
80						

	PROJECT NUMBER	BORING NUMBER
CH2MHILL	284350.SC.01	**SHM-05-40X** SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA

ELEVATION : 224.6' DRILLING CONTRACTOR Dragin Drilling

DRILLING METHOD AND EQUIPMENT USED : Geoprobe and Hollow Stem Auger

WATER LEVELS : START : 12/03/2004 & 02/02/2005 END : 12/06/2004 & 02/02/2005 LOGGER : Tseng

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
						Note: Geoprobe water profiling followed by HSA soil sampling and well installations.
5						
						No water sample collected - dry
10						
	12-14					Water sample OBSB0214W Screen depth 12-14 ft bgs
	14-16	24"		2-3-4-6	Brown fine to medium SAND, trace pebbles	Soil sample OBSB0214S
15						
20						
	22-24					Water sample OBSB0224W and MS/MSD Screen depth 22-24 ft bgs
25						
30						
	32-34	24"		5-11-14-51	Medium to course SAND, some rounded gravel (Gravel up to 3/4" in size)	Water sample OBSB0234W Screen depth 32-34 ft bgs Soil sample OBSB0232S
35						
	36-38					Water sample OBSB0238W Screen depth 36-38 ft bgs Refusal at 38 ft bgs
40						

PROJECT NUMBER	BORING NUMBER	
284350.SC.01	SB03	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA

ELEVATION : approx. 224' DRILLING CONTRACTOR : Dragin Drilling

DRILLING METHOD AND EQUIPMENT USED : Geoprobe

WATER LEVELS : START : 12/6/2004 END : 12/06/2004 LOGGER : Tseng

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
5						
						No water sample collected - dry
10						
						No water sample collected - damp
15						
	17-19					Water sample OBSB0319W and duplicate Screen depth 17-19 ft bgs
20						
25						
	27-29					Water sample OBSB0329W Screen depth 27-29 ft bgs
30						
35						
	37-39					Water sample OBSB0339W Screen depth 37-39 ft bgs
40						
						Refusal at 41 ft bgs

PROJECT NUMBER	BORING NUMBER
284350.SC.01	SHM-05-41 SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
ELEVATION : 223.8' (A), 223.6 (B), 224.0 (C) DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Geoprobe and Hollow Stem Auger
WATER LEVELS : START : 12/06/2004 & 02/03/2005 END : 12/07/2004 & 02/02/2005 LOGGER : Tseng/Bakey

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
						Note: Geoprobe water profiling followed by HSA soil sampling and well installations.
5						
10						
						No water sample collected - field param or
15						
	19-21	24"		4-5-6-6	2" wet dark brown GRAVEL with fine sand and silt. 10" moist yellow-orange poorly graded fine to course SAND.	Soil sample SB04-20-22
20						
	22-24					Water sample OBSB0424W Screen depth 22-24 ft bgs
25						
	29-31	17"		2-2-3-2	15" yellow-orange wet poorly graded fine to course SAND.	Soil sample SB04-29-31
30					2" yellow-orange GRAVEL with poorly graded fine to course sand.	
	32-34					Water sample OBSB0434W and MS/MSD Screen depth 32-34 ft bgs
35						
	39-41	11"		7-7-8-9	8" light brown moist well graded silty fine SAND with some gravel. 3" moist GRAVEL with fine to medium sand and silt.	Soil sample SB04-39-41
40						

CH2MHILL	PROJECT NUMBER 284350.SC.01	BORING NUMBER **SHM-05-41** SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
ELEVATION : 223.8' (A), 223.6 (B), 224.0 (C) DRILLING CONTRACTOR Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Geoprobe and Hollow Stem Auger
WATER LEVELS : START : 12/03/2005 & 02/01/2005 END : 12/03/2005 & 02/02/2005 LOGGER : Tseng/Bakey

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
	42-44					Water sample OBSB0444W Screen depth 42-44 ft bgs
45						
	49-51	24"		10-16-18-25	7" wet yellow-orange well graded fine SAND with silt. 17" moist dense poorly graded medium to course SAND with approx 30% gravel and silt. 1.5" course GRAVEL in shoe.	Soil sample SB04-49-51
50						
	52-54					Water sample OBSB0454W Screen depth 52-54 ft bgs
55						
60	60-62	8"			8" slough	No soil sample.
	62-64					Water sample OBSB0464W Screen depth 62-64 ft bgs
	64-66	17"		16-19-21-31	7" slough 10" moist grey to yellow-orange poorly graded medium to course SAND with fine gravel. 1.5" GRAVEL in shoe.	
65						
70						
	72-74					Water sample OBSB0474W Screen depth 72-74 ft bgs
	74-76	0"			NR	Geoprobe refusal at 74 ft bgs
75						
80						

CH2MHILL	PROJECT NUMBER 284350.SC.01	BORING NUMBER SHM-05-41 SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
ELEVATION : 223.8' (A), 223.6' (B), 224.0' (C) DRILLING CONTRACTOR Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Geoprobe and Hollow Stem Auger
WATER LEVELS : START : 12/03/2005 & 02/01/2005 END : 12/03/2005 & 02/02/2005 LOGGER : Tseng/Bakey

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
	84-86	18"		16-31-26-19	18" slough	
85	86-88	18"		13-23-30-60	15" slough 3" wet dense SILT with fine gravel and course sand GRAVEL in shoe.	
90						Hollow stem auger refusal at 92'
	94-96	18"		14-22-59-71	13" slough 3" dense SILT with iron precipitate 2" weathered bedrock	
95						
100						
105						
110						
115						
120						

PROJECT NUMBER	BORING NUMBER	
284350.SC.01	SB05	SHEET 1 OF 2

SOIL BORING LOG

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
ELEVATION : approx. 222' DRILLING CONTRACTOR Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Geoprobe
WATER LEVELS : START : 12/8/2004 END : 12/07/2004 LOGGER : Tseng

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
5						
10						
15						
20						
25						
	27-29					Water sample OBSB0529W Screen depth 27-29 ft bgs
30						
35						
	37-39					Water sample OBSB0539W Screen depth 37-39 ft bgs
40						

PROJECT NUMBER	BORING NUMBER	
284350.SC.01	SB05	SHEET 2 OF 2

SOIL BORING LOG

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
ELEVATION : approx. 222' DRILLING CONTRACTOR Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Geoprobe
WATER LEVELS : START : 12/6/2004 END : 12/07/2004 LOGGER : Tseng

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
45						
	47-49					Water sample OBSB0549W Screen depth 47-49 ft bgs
50						
55						
	57-59					Water sample OBSB0559W Screen depth 57-59 ft bgs
60						
65						
	67-69					Water sample OBSB0569W Screen depth 67-69 ft bgs Refusal at 69 ft bgs
70						
75						
80						

PROJECT NUMBER	BORING NUMBER		
284350.SC.01	SHM-05-42	SHEET 1	OF 2

SOIL BORING LOG

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA

ELEVATION : 214.5' DRILLING CONTRACTOF Dragin Drilling

DRILLING METHOD AND EQUIPMENT USED : Geoprobe

WATER LEVELS : START : 12/8/2004 END : 12/09/2004 LOGGER : Bakey/Tseng

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
						Note: Wells SHM-05-42A and SHM-05-42I were installed approx. 100 ft north of origir soil boring.
5						
10						
15						
20						
25						
	27-29					Water sample OBSB0629W Screen depth 27-29 ft bgs
30						
35						
	37-39					Water sample OBSB0639W Screen depth 37-39 ft bgs
40						

CH2MHILL	PROJECT NUMBER 284350.SC.01	BORING NUMBER SHM-05-42 SHEET 2 OF 2

SOIL BORING LOG

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
ELEVATION : 214.5' DRILLING CONTRACTOR Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Geoprobe/Hollow Stem Auger
WATER LEVELS : START : 12/6/2004 END : 12/07/2004 LOGGER : Bakey/Tseng

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
45						
						Water sample OBSB0649W
	47-50			111-45-26-12		Screen depth 47-49 ft bgs
						Soil sample PZNSB064750
50	50-55			4-4-7-8		Soil sample PZNSB065053 empty
						Collected sleeve 50-55
						Water sample 50-55
55	55-60					Collected sleeve 55-60
						Water sample 55-60
	57-59					Water sample OBSB0659W
						Screen depth 57-59 ft bgs
60						Water sample 60-65
65						
	67-69					Water sample OBSB0669W
						Screen depth 67-69 ft bgs
70						Water sample 70-75
						Refusal at 74 ft bgs - Geoprobe
75						
80						Water sample 80-85

CH2MHILL	PROJECT NUMBER **284350.SC.01**	BORING NUMBER **EW-01** SHEET 1 OF 3
	SOIL BORING LOG	

PROJECT : Fort Devens LOCATION : Ayer, MA
ELEVATION : approx 227.9' DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : HSA/CME 95
START : 9/30/2004 END : 10/01/04 LOGGER : C.DiSante/T.Bakey

DEPTH BELOW SURFACE (FT)	INTERVAL (FT BGS)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
	0-1		1/cuttings		Dark brown fine SAND mixed with leaves/roots	
	1-5		2/cuttings		Well-graded yellowish brown fine SAND with trace gravel	
5						
10						
15			3/cuttings		Light brown fine SAND, trace gravel	
20						
25						
			4/cuttings		Light brown fine SAND, trace gravel, wet	
30	30-32	18"	5/ss	2-2-2-2	Medium brown fine SAND with angular gravel (15%), loose	Soil sample collected at 30-32 ft bgs Sample ID: SIEW0130S Water sample collected at 33-37 ft bgs. Sample ID: SIEW0130W
35						
	37-39	12"	6/ss	4-4-4-4	Greyish brown medium SAND, well graded with some coarse sand and some gravel, subangular	
40						

	PROJECT NUMBER	BORING NUMBER	
CH2MHILL	284350.SC.01	EW-01	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Fort Devens LOCATION : Ayer, MA
ELEVATION : approx. 227.9' DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : HSA/CME 95
START : 9/30/2004 END : 10/01/04 LOGGER : C.DiSante/T.Bakey

DEPTH BELOW SURFACE (FT)	INTERVAL (FT BGS)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
40	40-42	8"	7/ss	4-5-5-6	Medium to coarse olive grey SAND, well graded with same gravel (20%) subangular, loose	Soil sample collected from 40-42 ft bgs Sample ID: SIEW0140S
						Water sample collected from 45-49 ft bgs. Sample ID: SIEW0140W
45						
50						Water sample collected from 50-54 ft bgs. Sample ID: SIEW0150W
55	55-57	24"	8/ss	2-3-3-2	Olive grey fine SAND, well sorted	Soil sample collected from 55-57 ft bgs Sample ID: SIEW0150S
60						Water sample collected from 60-64 ft bgs. Sample ID: SIEW0160W
65	65-67	18"	9/ss	9-14-15-16	Very dense fine grey SAND and trace grey angular gravel	Soil sample collected from 65-67 ft bgs Sample ID: SIEW0160S
70			10/cuttings		Augering through yellowish orange to greenish grey moist well graded fine SAND with subangular fine gravel	No water sample collected from 70-74 ft bgs due to low water level pump could not overcome
	74-76	12"	11/ss	5-5-5-5	2" well graded medium to coarse greenish grey SAND	Soil sample collected from 74-76 ft bgs Sample ID: SIEW0170S
75	76-78	24"	12/ss	5-5-5-5	10" poorly graded fine greenish grey SAND 6" poorly graded fine greenish grey SAND 10" Well graded medium to coarse SAND 8" poorly graded fine greenish grey SAND	
80						

CH2MHILL	PROJECT NUMBER 284350.SC.01	BORING NUMBER EW-01	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Fort Devens LOCATION : Ayer, MA
ELEVATION : approx 227.9' DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : HSA/CME 95
START : 9/30/2004 END : 10/01/04 LOGGER : C.DiSante/T.Bakey

DEPTH BELOW SURFACE (FT)	INTERVAL (FT BGS)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
80						Water sample collected from 80-84 ft bgs. Sample ID: SIEW0180W
	84-86	10"	13/ss	22-60/4"	8" Moist greenish grey fine SAND 2" Yellowish orange gravelly SILT	Soil sample collected from 84-86 ft bgs Sample ID: SIEW0180S Augering through gravelly material 85-89 ft bgs
85						
	89-91	10"	14/ss	15-22-34-22	6" well graded g.g. fine SAND 4" Weathered bedrock subangular-angular fine to coarse GRAVEL, well graded gravel with sand	
90						
95					Auger refusal at 96 ft bgs	End of borehole
100						
105						
110						
115						
120						

	PROJECT NUMBER 284350.SC.01	BORING NUMBER **EW-04** SHEET 1 OF 3
CH2MHILL	**SOIL BORING LOG**	

PROJECT : Fort Devens LOCATION : Ayer, MA
ELEVATION : approx.228.5' DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : HSA/CME 95
START : 10/5/2004 END : 10/06/04 LOGGER : C.DiSante/T.Bakey

DEPTH BELOW SURFACE (FT)	INTERVAL (FT BGS)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
			1/cuttings		Medium brown fine SAND, loose; trace coarse sand	
5						
10						
15						
20						
25						
30						Collected water sample at 30-34 ft bgs Sample ID: SIEW0430W Collect MS, MSD
35	35-37	24"	2/ss	2-2-2-2	Medium brown fine SAND, loose; trace coarse sand	
40						

CH2MHILL	PROJECT NUMBER 284350.SC.01	BORING NUMBER EW-04	SHEET 2 OF 3
	SOIL BORING LOG		

PROJECT : Fort Devens LOCATION : Ayer, MA
ELEVATION : approx. 228.5' DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : HSA/CME 95
START : 10/5/2004 END : 10/06/04 LOGGER : C.DiSante/T.Bakey

DEPTH BELOW SURFACE (FT)	INTERVAL (FT BGS)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
40						Water sample collected at 40-44 ft bgs. Sample ID: SIEW0440W
45	45-47	18"	3/ss	3-3-3-3	12" Very fine light brown poorly graded SAND 6" Medium grey mottled medium to coarse SAND	Soil sample collected from 45-47 ft bgs Sample ID: SIEW0440S
50						Water sample collected at 50-54 ft bgs. Sample ID: SIEW0450W
55	55-57	12"	4/ss	5-5-5-6	6" Very fine light brown SAND 6" fine light brown SAND	Soil sample collected from 55-57 ft bgs Sample ID: SIEW0450S
60						Water sample collected at 60-64 ft bgs. Sample ID: SIEW0460W
65	65-67	4"	5/ss	3-3-4-4	Olive grey wet poorly graded fine SAND	Soil sample collected from 65-67 ft bgs Sample ID: SIEW0460S
	67-69	19"	6/ss	3-4-3-4	10" Olive grey wet poorly graded fine SAND 9" Wet olive grey and black well graded fine to medium SAND with silt	
70						Water sample collected at 70-74 ft bgs. Sample ID: SIEW0470W
	74-76	21"	7/ss	5-5-11-7	Wet olive grey well graded fine to medium SAND with silt	
75						Soil sample collected from 75-77 ft bgs Sample ID: SIEW0470S
80						

CH2MHILL	PROJECT NUMBER 284350.SC.01	BORING NUMBER EW-04	SHEET 3 OF 3

SOIL BORING LOG

PROJECT : Fort Devens LOCATION : Ayer, MA
ELEVATION : approx. 228.5' DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : HSA/CME 95
START : 10/5/2004 END : 10/06/04 LOGGER : C.DiSante/T.Bakey

DEPTH BELOW SURFACE (FT)	INTERVAL (FT BGS)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
80						Water sample collected from 80-84 ft bgs. Sample ID: SIEW0480W
	84-86	15"	8/ss	4-5-6-6	6" Wet olive grey well graded fine to medium SAND with silt	
85					9" Wet olive grey poorly graded fine SAND	Soil sample collected from 85-87 ft bgs Sample ID: SIEW0480S
90					Auger through wet olive grey and black poorly graded fine SAND with silt	
95	95-97	16"	9/ss	9-17-30-50/4"	4" Wet olive grey and black poorly graded fine SAND with silt 12" Moist olive grey well graded silty SAND with gravel	No sample
100						
105					Auger Refusal at 107 ft bgs	End of borehole
110						
115						
120						

	PROJECT NUMBER	BORING NUMBER
CH2MHILL	284350.SC.01	**SB-03 (on base)** SHEET 1 OF 3

SOIL BORING LOG

PROJECT : Fort Devens LOCATION : Ayer, MA
ELEVATION : approx. 235.3' DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : HSA/CME 95
START : 10/1/2004 END : 10/04/04 LOGGER : C.DiSante/T.Bakey

DEPTH BELOW SURFACE (FT)	INTERVAL (FT BGS)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
			1/cuttings		Dry yellowish orange well graded fine SAND with silt; Little (5-10%) fine gravel	
5						
10						
15						
20			2/cuttings		Dry yellowish orange well graded fine SAND with silt; Trace (0-5%) silt, trace fine gravel	
25			3/cuttings		Dry yellowish orange well graded fine SAND with silt; Trace (10-15%) silt, trace fine gravel	
30						Water sample collected at 30-34 ft bgs. Sample ID: SISB0330W
35	35-37	24"	4/ss	2-2-2-2	Medium brown medium to coarse SAND and some dark grey fine gravel	
40						

CH2MHILL	PROJECT NUMBER 284350.SC.01	BORING NUMBER SB-03 (on-base)	SHEET 2 OF 3

SOIL BORING LOG

PROJECT : Fort Devens LOCATION : Ayer, MA
ELEVATION : approx 235.3' DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : HSA/CME 95
START : 10/1/2004 END : 10/04/04 LOGGER : C.DiSante/T.Bakey

DEPTH BELOW SURFACE (FT)	INTERVAL (FT BGS)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
40						Water sample collected at 40-44 ft bgs. Sample ID: SISB0340W
45	45-47	2"	5/ss	2-3-3-3	Medium brown fine silty SAND	
	47-49	5"	6/ss	3-3-3-4	Medium to coarse grey SAND (brown) and GRAVEL (dark grey); traces of fine grey sand mixed with medium grey and black sand	
50						Water sample collected at 50-54 ft bgs. Sample ID: SISB0350W
	54-56	20"	7/ss	3-4-5-6	Medium to coarse grey SAND and medium grey and black sand	
55						
60						Water sample collected at 60-64 ft bgs. Sample ID: SISB0360W
65	65-67	24"	8/ss	3-4-5-5	Fine light grey silty SAND, well sorted medium dense	
70						Water sample collected at 70-74 ft bgs. Sample ID: SISB0370W
75	75-77	24"	9/ss		(75-76.1 ft bgs) Fine light grey silty SAND (76.1-77 ft bgs) Medium loose grey SAND and trace fine silt	
80						

PROJECT NUMBER	BORING NUMBER
284350.SC.01	SB-03 (on base) SHEET 3 OF 3

CH2MHILL

SOIL BORING LOG

PROJECT : Fort Devens LOCATION : Ayer, MA

ELEVATION : 235.3' DRILLING CONTRACTOR : Dragin Drilling

DRILLING METHOD AND EQUIPMENT USED : HSA/CME 95

START : 10/1/2004 END : 10/04/04 LOGGER : C.DiSante/T.Bakey

DEPTH BELOW SURFACE (FT)	INTERVAL (FT BGS)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	CORE DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION.
80						Water sample collected from 80-84 ft bgs. Sample ID: SISB0380W
85	85-87	14"	10/ss	3-3-3-3	Fine to medium light grey SAND	Soil sample collected from 85-87 ft bgs Sample ID: SISB0380S
90					Auger through gravelly layer at 90-92 ft bgs	
95						
100						
105					Weathered bedrock material from 105-108 ft bgs	
					Auger Refusal at 108 ft bgs	End of borehole
110						
115						
120						

	PROJECT NUMBER	WELL NUMBER
CH2MHILL	284350.SC.01	**EW-01** SHEET 1 OF 1

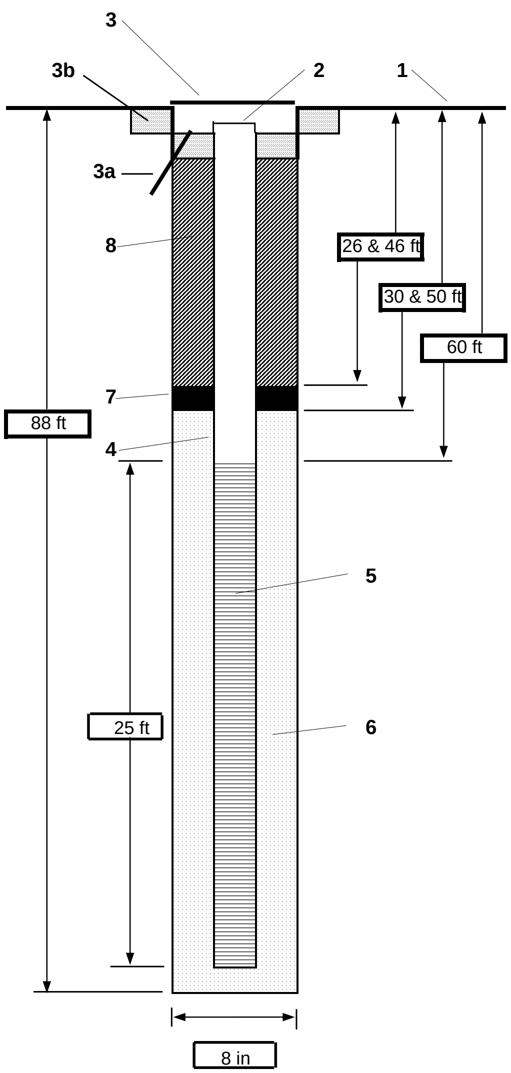
WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA

DRILLING CONTRACTOR : Dragin Drilling

DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger (18.25 " OD)

WATER LEVELS : START : 1/4/2005 END : 1/7/2005 LOGGER : C.DiSante/T.Bakey



1-	Ground elevation at well	228.2
2-	Top of casing elevation	228.0
3-	Wellhead protection cover type	Bolt-down vault
	a) drain tube?	No
	b) concrete pad dimensions	Approx. 5 ft square
4-	Dia./type of well casing	6" diameter sch. 40 PVC
5-	Type/slot size of screen	6" diameter stainless steel, 20-slot
6-	Type screen filter	Filpro sand #00N
	a) Quantity used	
7-	Type of seal	Bentonite chips (Puregold medium)
	a) Quantity used	(Note:Two seals 26-30 and 46-50)
8-	Grout	
	a) Grout mix used	Cement-bentonite
		See notes below - pitot tube installed in
		this area - completion details provided
	Development method	Grundfos pump

Comments

1.5" diameter PVC pitot tube installed with screen from 34 ft bgs to 44 ft bgs

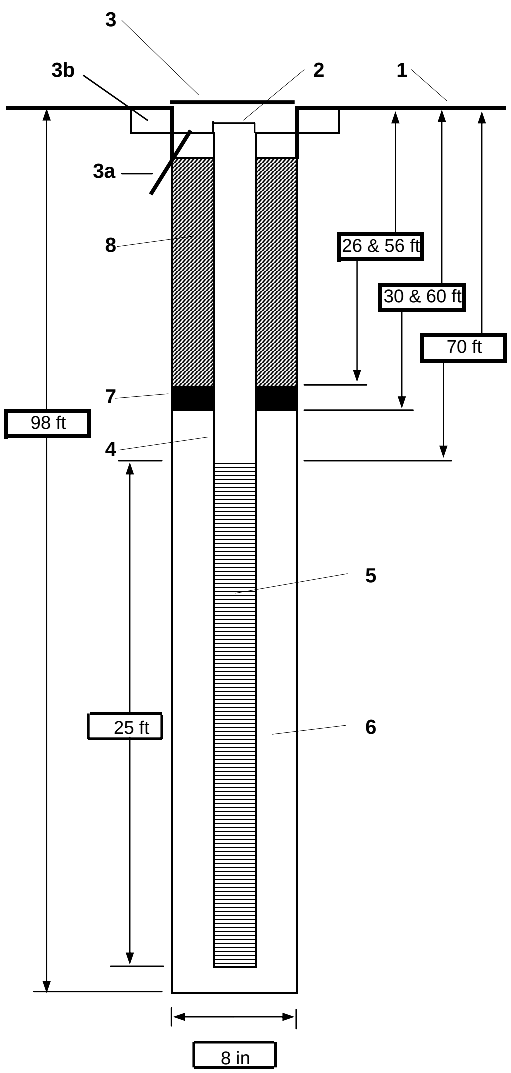
Sand from 30 ft bgs to 46 ft bgs. Bentonite seal from 26 ft bgs to 30 ft bgs.

Grout above bentonite seal = cement-bentonite

	PROJECT NUMBER	WELL NUMBER
CH2MHILL	284350.SC.01	EW-04 SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger (18.25 " OD)
WATER LEVELS : START : 1/10/2005 END : 2/11/2005 LOGGER : C.DiSante/T.Bakey



1- Ground elevation at well: 228.5

2- Top of casing elevation: 228.1

3- Wellhead protection cover type: Bolt-down vault
- a) drain tube? No
- b) concrete pad dimensions: Approx. 5 ft square

4- Dia./type of well casing: 6" diameter sch. 40 PVC

5- Type/slot size of screen: 6" diameter stainless steel, 20-slot

6- Type screen filter: Filpro sand #00N
- a) Quantity used:

7- Type of seal: Bentonite chips (Puregold medium)
- a) Quantity used: (Note:Two seals 26-30 and 56-60)

8- Grout
- a) Grout mix used: Cement-bentonite
  See notes below - pitot tube installed in
  this area - completion details provided

Development method: Grundfos pump

Comments

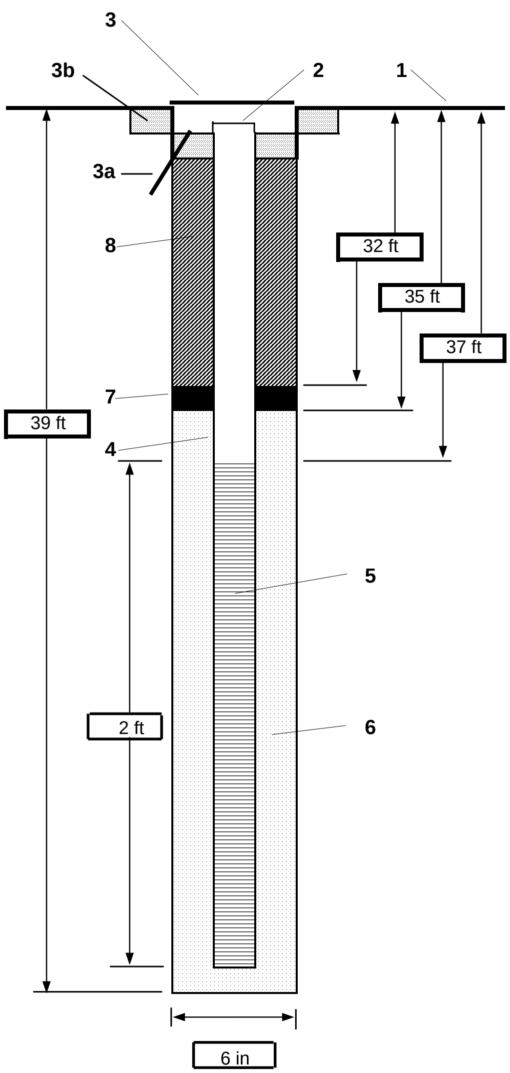
1.5" diameter PVC pitot tube installed with screen from 40 ft bgs to 50 ft bgs
Sand from 30 ft bgs to 46 ft bgs. Bentonite seal from 26 ft bgs to 30 ft bgs.
Grout above bentonite seal = cement-bentonite

PROJECT NUMBER	WELL NUMBER
284350.SC.01	SHM-05-39A SHEET 1 OF 1

CH2MHILL

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger
WATER LEVELS : START : 2/1/2005 END : 2/1/2005 LOGGER : Tseng



1- Ground elevation at well 222.9

2- Top of casing elevation 222.6

3- Wellhead protection cover type Flush 6" diameter road box with bolt-down cov
a) drain tube? No - Road box has rubber seal
b) concrete pad dimensions Approx. 2 ft square

4- Dia./type of well casing 2" diameter sch. 40 PVC

5- Type/slot size of screen 2" diameter sch. 40 PVC, 10-slot

6- Type screen filter Filpro sand
a) Quantity used

7- Type of seal Bentonite chips
a) Quantity used

8- Grout
a) Grout mix used Cement-bentonite

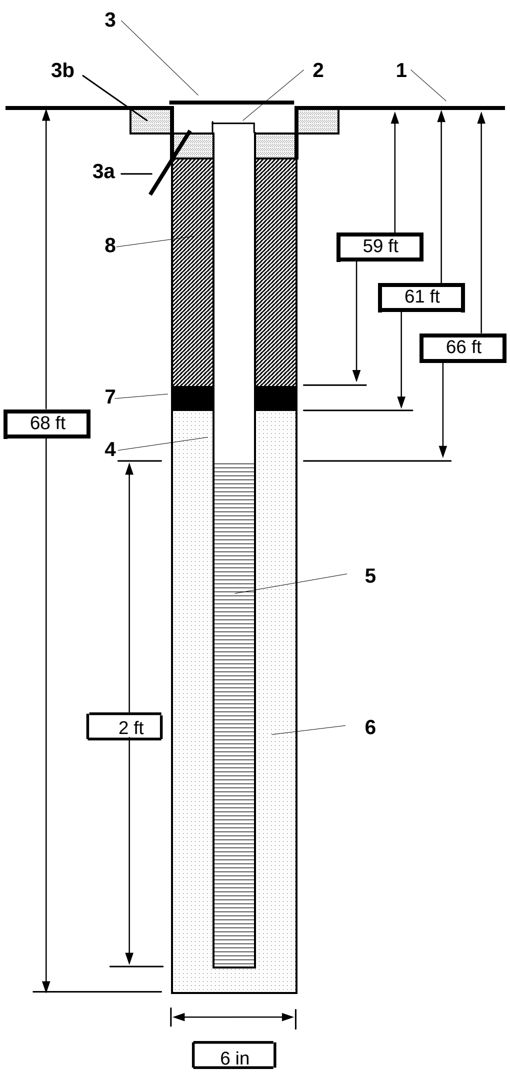
Development method Grundfos pump

Comments

	PROJECT NUMBER	WELL NUMBER
CH2MHILL	284350.SC.01	SHM-05-39B SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger
WATER LEVELS : START : 2/1/2005 END : 2/1/2005 LOGGER : Tseng



1- Ground elevation at well 222.9

2- Top of casing elevation 222.6

3- Wellhead protection cover type Flush 6" diameter road box with bolt-down cove
 a) drain tube? No - Road box has rubber seal
 b) concrete pad dimensions Approx. 2 ft square

4- Dia./type of well casing 2" diameter sch. 40 PVC

5- Type/slot size of screen 2" diameter sch. 40 PVC, 10-slot

6- Type screen filter Filpro sand
 a) Quantity used

7- Type of seal Bentonite chips
 a) Quantity used

8- Grout
 a) Grout mix used Cement-bentonite
 b) Method of placement
 c) Vol. of well casing grout

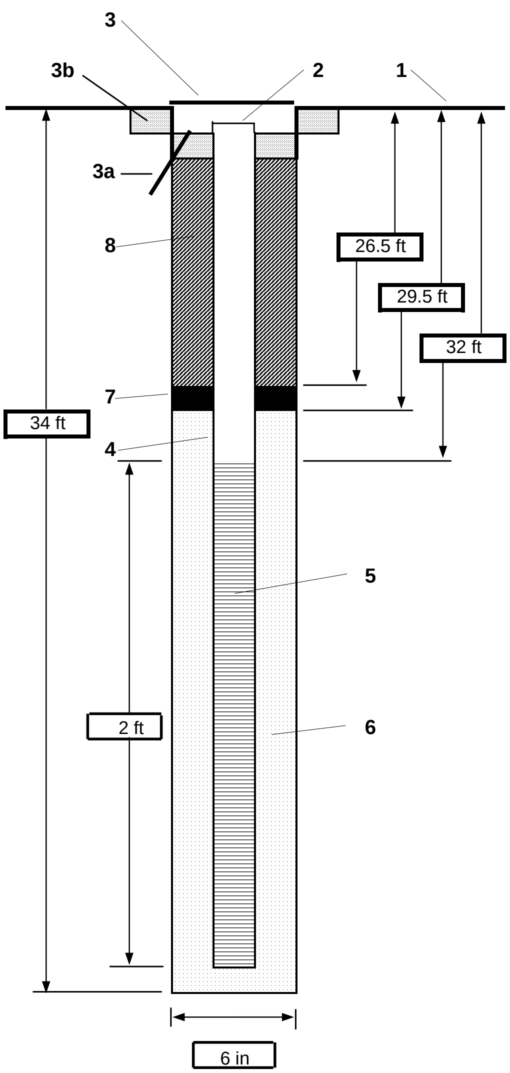
Development method Grundfos pump

Comments

	PROJECT NUMBER	WELL NUMBER
CH2MHILL	284350.SC.01	**SHM-05-40X** SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger
WATER LEVELS : START : 2/2/2005 END : 2/2/2005 LOGGER : Tseng



1- Ground elevation at well: 224.6

2- Top of casing elevation: 224.4

3- Wellhead protection cover type: Flush 6" diameter road box with bolt-down cove
  a) drain tube?: No - Road box has rubber seal
  b) concrete pad dimensions: Approx. 2 ft square

4- Dia./type of well casing: 2" diameter sch. 40 PVC

5- Type/slot size of screen: 2" diameter sch. 40 PVC, 10-slot

6- Type screen filter: Filpro sand
  a) Quantity used:

7- Type of seal: Bentonite chips
  a) Quantity used:

8- Grout
  a) Grout mix used: Cement-bentonite
  b) Method of placement:
  c) Vol. of well casing grout:

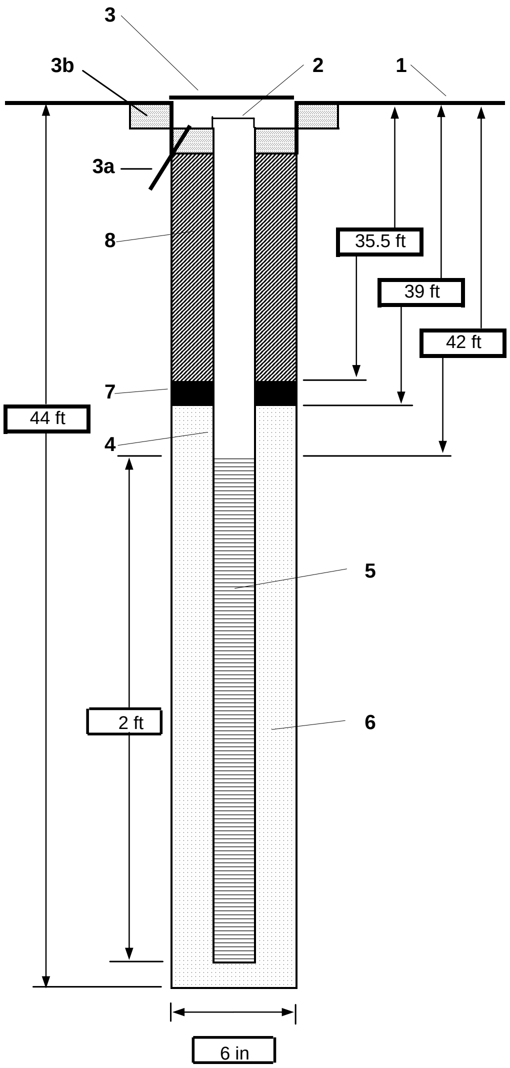
Development method: Grundfos pump

Comments

	PROJECT NUMBER	WELL NUMBER
CH2MHILL	284350.SC.01	**SHM-05-41A** SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger
WATER LEVELS : START : 2/7/2005 END : 2/7/2005 LOGGER : Tseng/Bakey



1- Ground elevation at well: 223.8

2- Top of casing elevation: 223.5

3- Wellhead protection cover type: Flush 6" diameter road box with bolt-down cove
- a) drain tube?: No - Road box has rubber seal
- b) concrete pad dimensions: Approx. 2 ft square

4- Dia./type of well casing: 2" diameter sch. 40 PVC

5- Type/slot size of screen: 2" diameter sch. 40 PVC, 10-slot

6- Type screen filter: Filpro sand
- a) Quantity used:

7- Type of seal: Bentonite chips
- a) Quantity used:

8- Grout
- a) Grout mix used: Cement-bentonite
- b) Method of placement:
- c) Vol. of well casing grout:

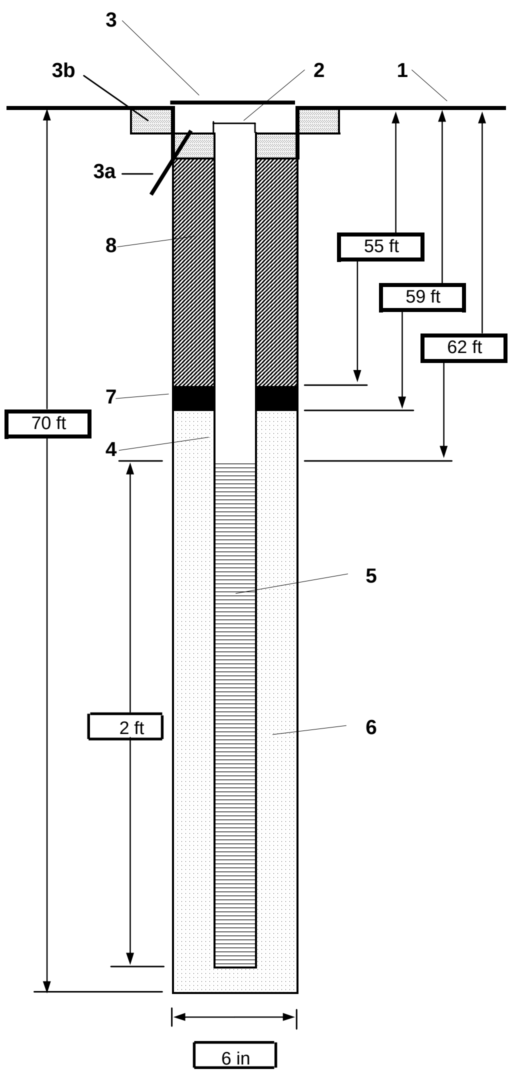
Development method: Grundfos pump

Comments

CH2MHILL	PROJECT NUMBER 284350.SC.01	WELL NUMBER SHM-05-41B SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger
WATER LEVELS : START : 3/30/2005 END : 3/30/2005 LOGGER : Tseng/Bakey



1- Ground elevation at well: 223.6

2- Top of casing elevation: 223.3

3- Wellhead protection cover type: Flush 6" diameter road box with bolt-down cover
 a) drain tube?: No - Road box has rubber seal
 b) concrete pad dimensions: Approx. 2 ft square

4- Dia./type of well casing: 2" diameter sch. 40 PVC

5- Type/slot size of screen: 2" diameter sch. 40 PVC, 10-slot

6- Type screen filter: Filpro sand
 a) Quantity used:

7- Type of seal: Bentonite chips
 a) Quantity used:

8- Grout
 a) Grout mix used: Cement-bentonite
 b) Method of placement:
 c) Vol. of well casing grout:

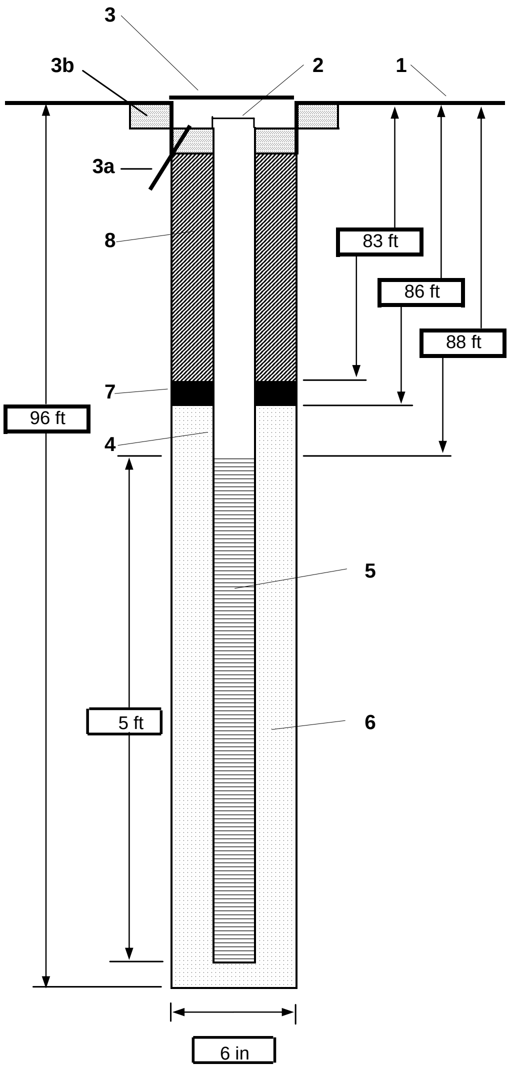
Development method: Grundfos pump

Comments

CH2MHILL	PROJECT NUMBER 284350.SC.01	WELL NUMBER **SHM-05-41C** SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger
WATER LEVELS : START : 2/4/2005 END : 2/4/2005 LOGGER : Tseng/Bakey



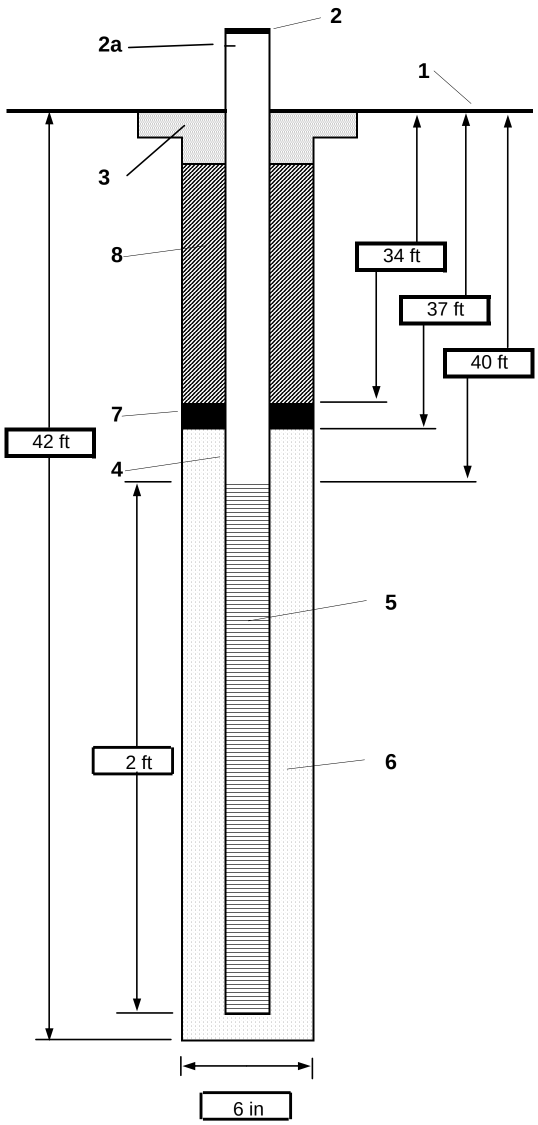
1- Ground elevation at well	224.0
2- Top of casing elevation	223.6
3- Wellhead protection cover type	Flush 6" diameter road box with bolt-down cove
a) drain tube?	No - Road box has rubber seal
b) concrete pad dimensions	Approx. 2 ft square
4- Dia./type of well casing	2" diameter sch. 40 PVC
5- Type/slot size of screen	2" diameter sch. 40 PVC, 10-slot
6- Type screen filter	Filpro sand
a) Quantity used	
7- Type of seal	Bentonite chips
a) Quantity used	
8- Grout	
a) Grout mix used	Cement-bentonite
b) Method of placement	
c) Vol. of well casing grout	
Development method	Grundfos pump

Comments

CH2MHILL	PROJECT NUMBER 284350.SC.01	WELL NUMBER **SHM-05-42A** SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger
WATER LEVELS : START : 3/29/2005 END : 03/29/2005 LOGGER : Tseng



1- Ground elevation at well 214.5

2- Top of casing elevation 217.9
a) vent hole? No

3- concrete pad dimensions None

4- Dia./type of well casing 1" schedule 40 PVC

5- Type/slot size of screen 1" diameter sch. 40 PVC, 10-slot

6- Type screen filter Backfill - let hole collapse
a) Quantity used

7- Type of seal Bentonite powder
a) Quantity used 10 lbs powder for 10 gallons slurry

8- Grout
a) Grout mix used None - native material
b) Method of placement
c) Vol. of well casing grout

Estimated purge volume N/A

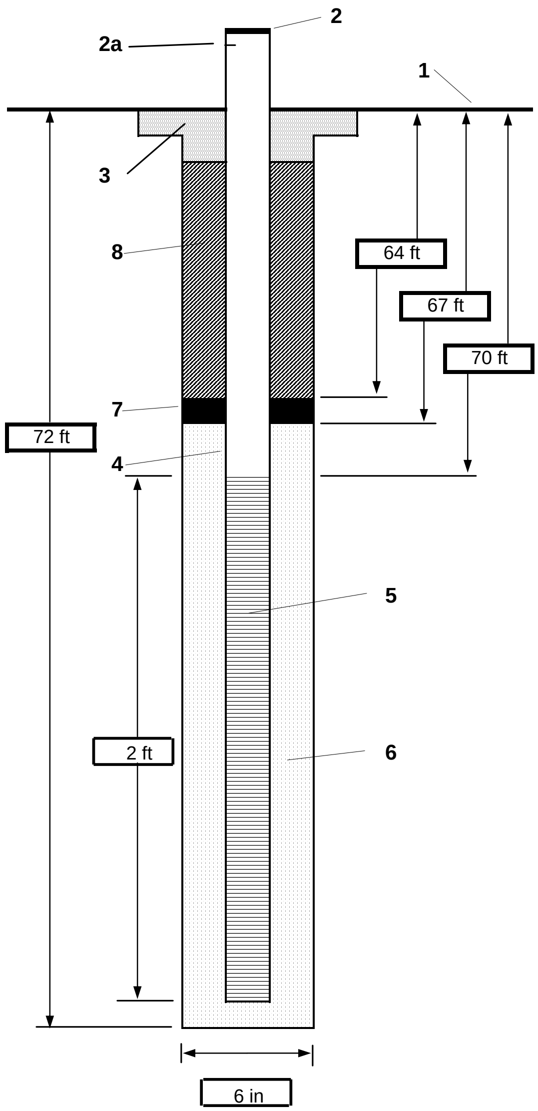
Comments

Note SHM-05-42A and SHM-05-42B are microwells completed in the same borehole.

CH2MHILL	PROJECT NUMBER 284350.SC.01	WELL NUMBER **SHM-05-42B** SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger
WATER LEVELS : START : 3/29/2005 END : 03/29/2005 LOGGER : Tseng



1- Ground elevation at well: 214.5

2- Top of casing elevation: 217.9
a) vent hole?: No

3- concrete pad dimensions: None

4- Dia./type of well casing: 1" schedule 40 PVC

5- Type/slot size of screen: 1" diameter sch. 40 PVC, 10-slot

6- Type screen filter: Backfill - let hole collapse
a) Quantity used:

7- Type of seal: Bentonite powder
a) Quantity used: 10 lbs powder for 10 gallons slurry

8- Grout
a) Grout mix used: None - native material
b) Method of placement:
c) Vol. of well casing grout:

Estimated purge volume: N/A

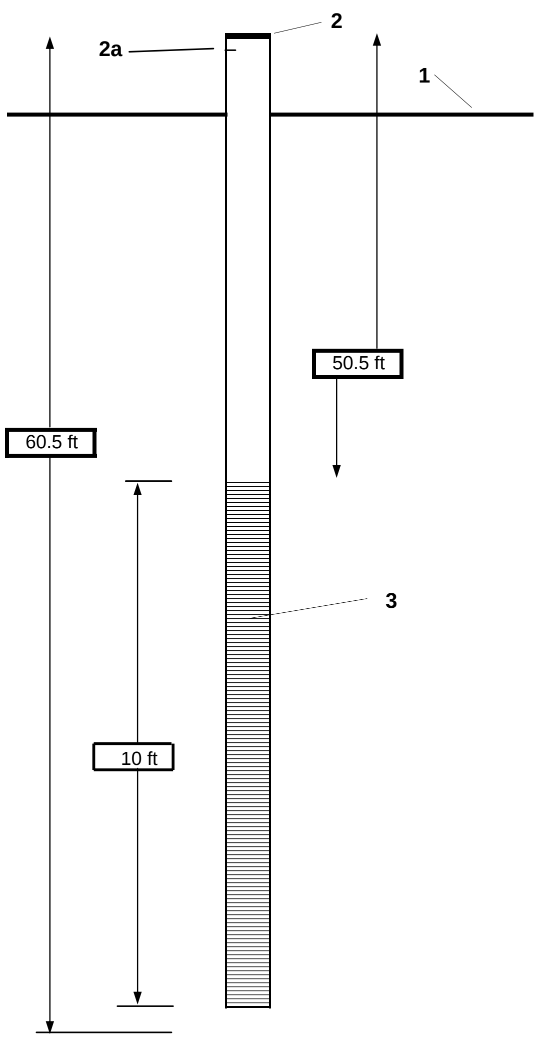
Comments

Note SHM-05-42A and SHM-05-42B are microwells completed in the same borehole.

	PROJECT NUMBER	WELL NUMBER
CH2MHILL	284350.SC.01	SHP-05-43 SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : DPT (Geoprobe 6620DT)
WATER LEVELS : START : 12/10/2004 END : 12-10-2004 LOGGER : Bakey



1- Ground elevation at well 259.4

2- Top of casing elevation 262.4
a) vent hole? No

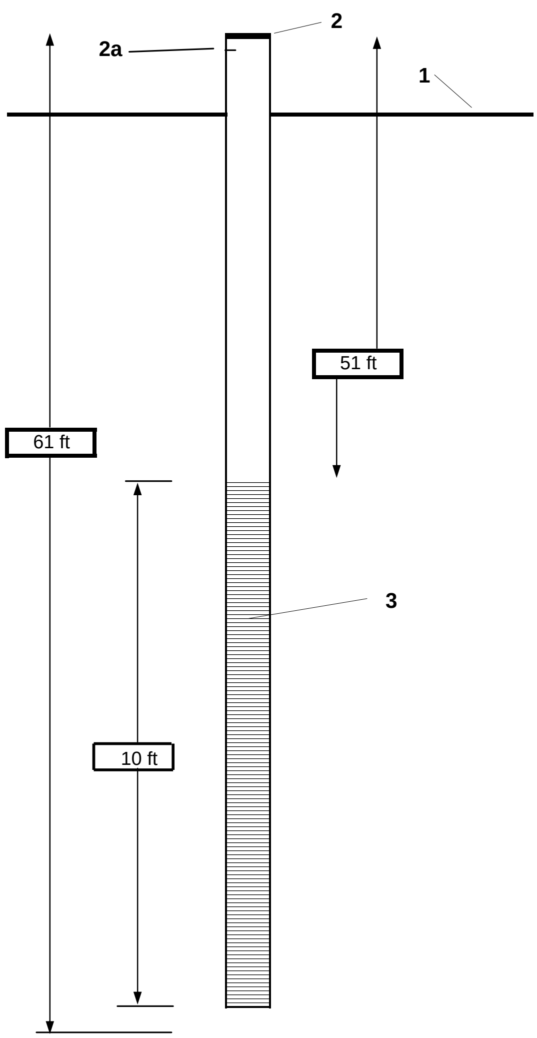
3- Type/slot size of screen 1" diameter sch. 40 PVC, 10-slot

Comments

	PROJECT NUMBER	WELL NUMBER
CH2MHILL	284350.SC.01	SHP-05-44 SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : DPT (Geoprobe 6620DT)
WATER LEVELS : START : 12/10/2004 END : 12-10-2004 LOGGER : Bakey



1- Ground elevation at well 256.4

2- Top of casing elevation 259.5
a) vent hole? No

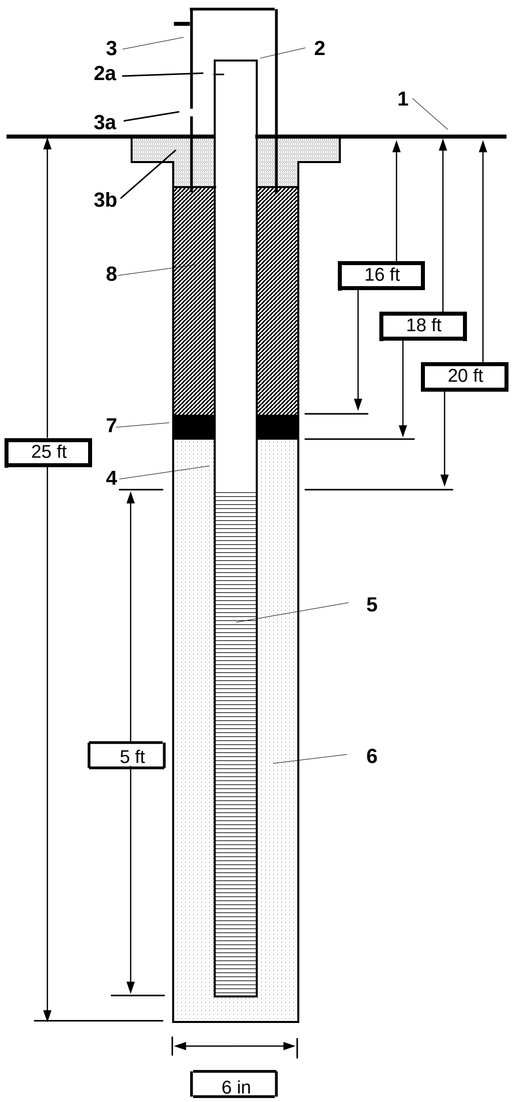
3- Type/slot size of screen 1" diameter sch. 40 PVC, 10-slot

Comments

	PROJECT NUMBER	WELL NUMBER
CH2MHILL	284350.SC.01	SHM-05-45A SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger
WATER LEVELS : START : 1/28/2005 END : 01/28/2005 LOGGER : Bakey



1- Ground elevation at well: 227.3

2- Top of casing elevation: 229.7
a) vent hole?: No

3- Wellhead protection cover type: 4" diameter steel casing with locking cap
a) weep hole?: No
b) concrete pad dimensions: Approx. 3 ft square

4- Dia./type of well casing: 2" diameter sch. 40 PVC

5- Type/slot size of screen: 2" diameter sch. 40 PVC, 10-slot

6- Type screen filter: Filpro sand
a) Quantity used:

7- Type of seal: Bentonite chips
a) Quantity used:

8- Grout
a) Grout mix used: Cement-bentonite
b) Method of placement:
c) Vol. of well casing grout:

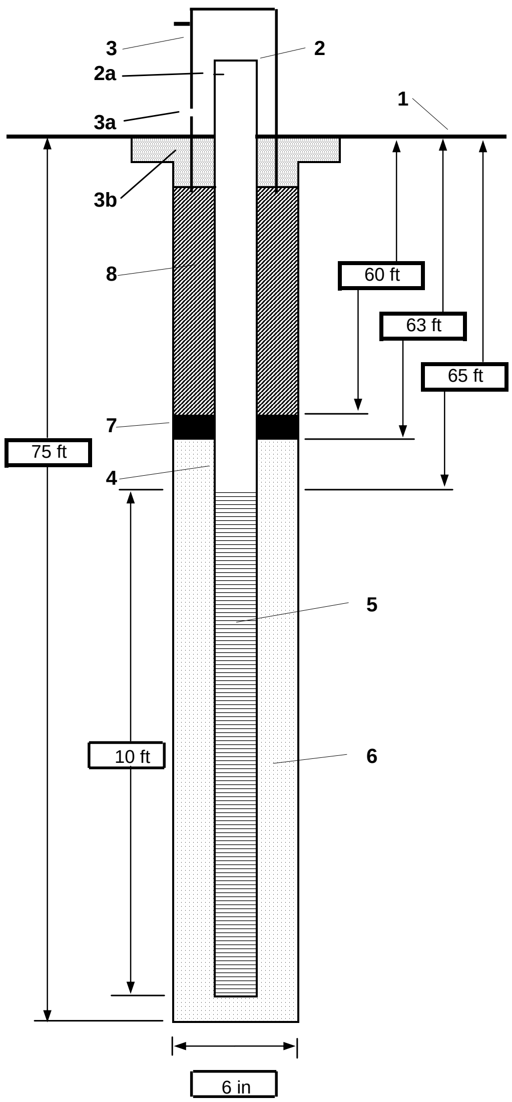
Development method: Grundfos pump

Comments

PROJECT NUMBER	WELL NUMBER
284350.SC.01	SHM-05-45B SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger
WATER LEVELS : START : 1/31/2005 END : 01/31/2005 LOGGER : Bakey



1- Ground elevation at well: 227.7

2- Top of casing elevation: 230.3
a) vent hole?: No

3- Wellhead protection cover type: 4" diameter steel casing with locking cap
a) weep hole?: No
b) concrete pad dimensions: Approx. 3 ft square

4- Dia./type of well casing: 2" diameter sch. 40 PVC

5- Type/slot size of screen: 2" diameter sch. 40 PVC, 10-slot

6- Type screen filter: Filpro sand
a) Quantity used:

7- Type of seal: Bentonite chips
a) Quantity used:

8- Grout
a) Grout mix used: Cement-bentonite

Development method: Grundfos pump

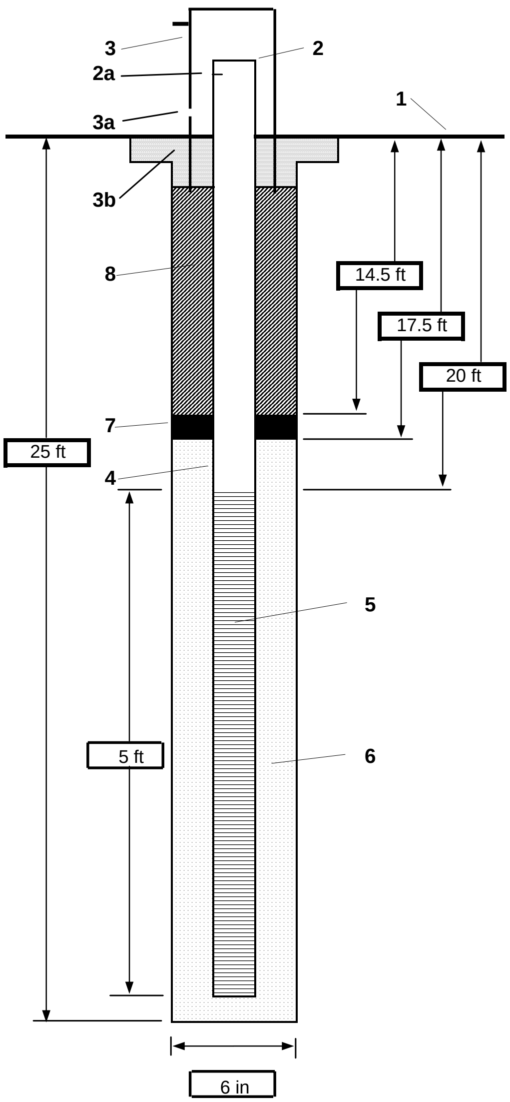
Comments

PROJECT NUMBER	WELL NUMBER
284350.SC.01	**SHM-05-46A** SHEET 1 OF 1

CH2MHILL

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger
WATER LEVELS : START : 1/27/2005 END : 01/27/2005 LOGGER : Bakey



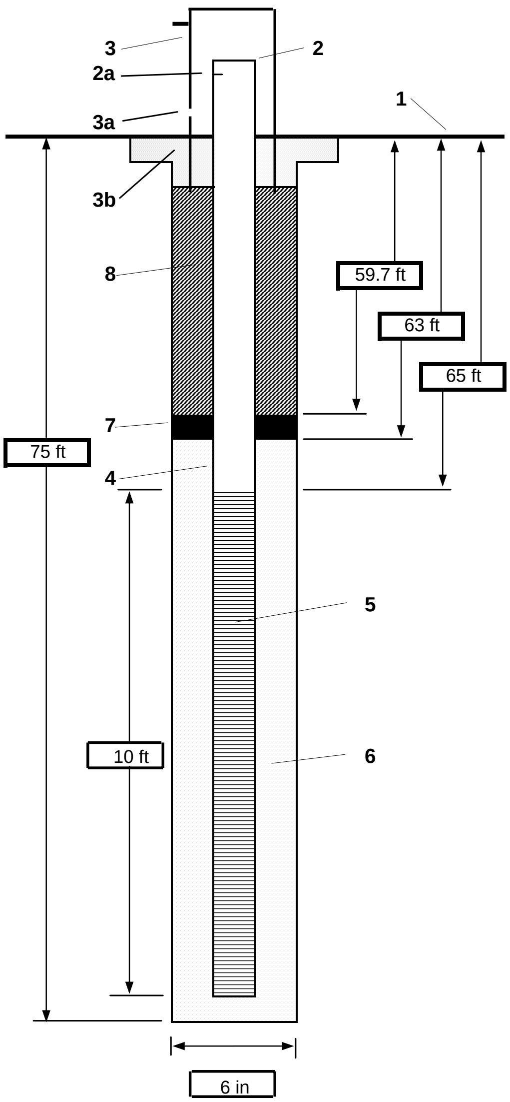
1- Ground elevation at well	227.3
2- Top of casing elevation	229.4
a) vent hole?	No
3- Wellhead protection cover type	4" diameter steel casing with locking cap
a) weep hole?	No
b) concrete pad dimensions	Approx. 3 ft square
4- Dia./type of well casing	2" diameter sch. 40 PVC
5- Type/slot size of screen	2" diameter sch. 40 PVC, 10-slot
6- Type screen filter	Filpro sand
a) Quantity used	
7- Type of seal	Bentonite chips
a) Quantity used	
8- Grout	
a) Grout mix used	Cement-bentonite
b) Method of placement	
c) Vol. of well casing grout	
Development method	Grundfos pump

Comments

	PROJECT NUMBER	WELL NUMBER
CH2MHILL	284350.SC.01	SHM-05-46B SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR : Dragin Drilling
DRILLING METHOD AND EQUIPMENT USED : Hollow Stem Auger
WATER LEVELS : START : 1/27/2005 END : 01/27/2005 LOGGER : Bakey



1- Ground elevation at well: 227.1

2- Top of casing elevation: 228.8
a) vent hole?: No

3- Wellhead protection cover type: 4" diameter steel casing with locking cap
a) weep hole?: No
b) concrete pad dimensions: Approx. 3 ft square

4- Dia./type of well casing: 2" diameter sch. 40 PVC

5- Type/slot size of screen: 2" diameter sch. 40 PVC, 10-slot

6- Type screen filter: Filpro sand
a) Quantity used:

7- Type of seal: Bentonite chips
a) Quantity used:

8- Grout
a) Grout mix used: Cement-bentonite
b) Method of placement:
c) Vol. of well casing grout:

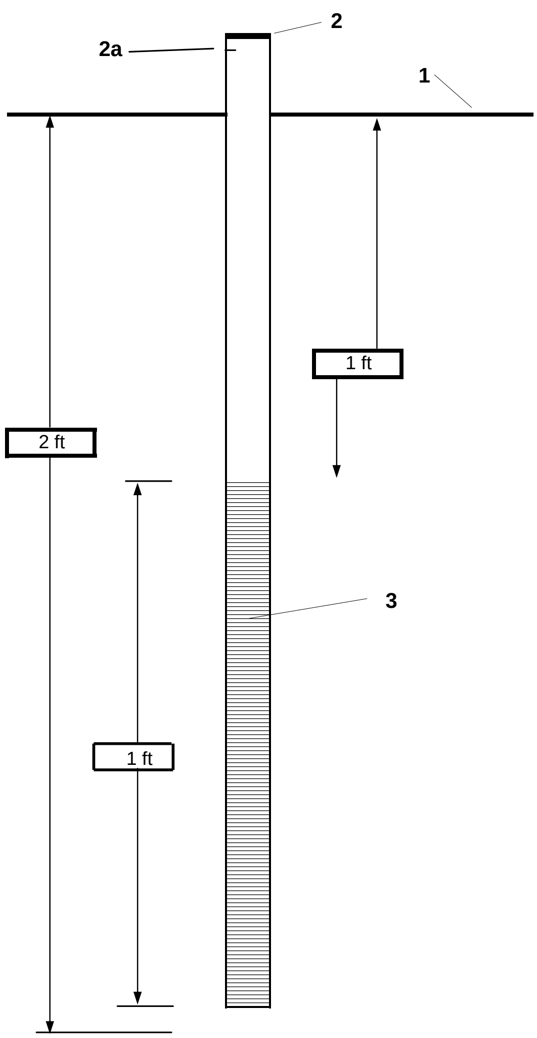
Development method: Grundfos pump

Comments

	PROJECT NUMBER	WELL NUMBER
CH2MHILL	284350.SC.01	SHM-05-47A SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR :
DRILLING METHOD AND EQUIPMENT USED : Hand-driven
WATER LEVELS : START : 2/18/2005 END : 02/18/2005 LOGGER : Tseng



1- Ground elevation at well 214.4

2- Top of casing elevation 218.5
a) vent hole? No

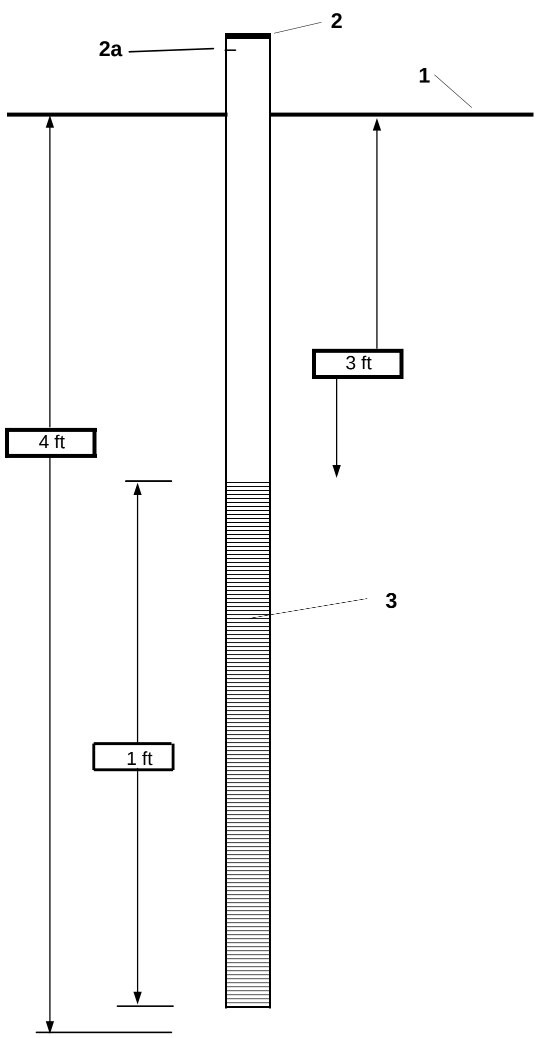
3- Type/slot size of screen 1" diameter sch. 40 PVC, 10-slot

Comments

	PROJECT NUMBER	WELL NUMBER
CH2MHILL	284350.SC.01	**SHM-05-47B** SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR :
DRILLING METHOD AND EQUIPMENT USED : Hand-driven
WATER LEVELS : START : 2/18/2005 END : 02/18/2005 LOGGER : Tseng



1- Ground elevation at well 214.4

2- Top of casing elevation 216.3
a) vent hole? No

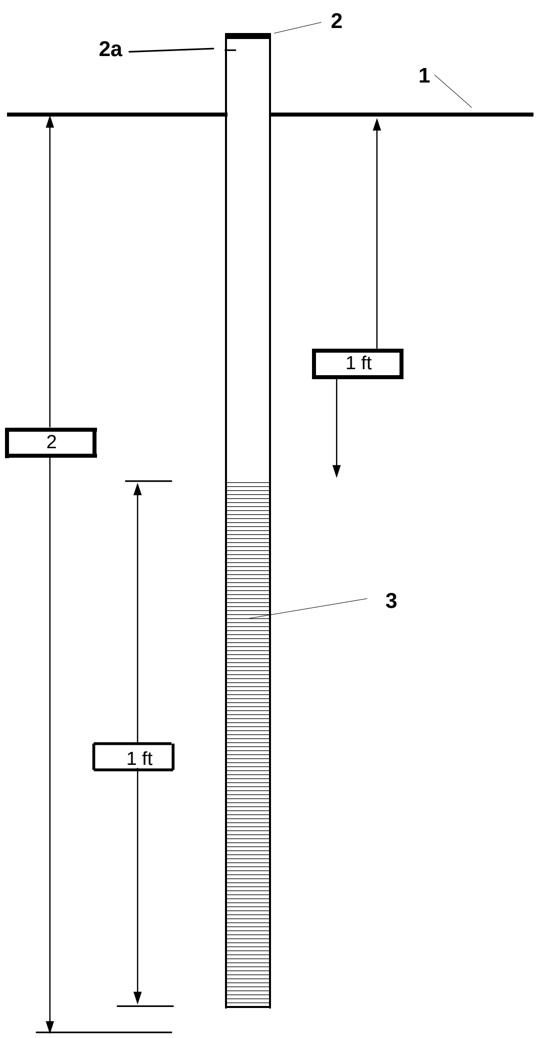
3- Type/slot size of screen 1" diameter sch. 40 PVC, 10-slot

Comments

	PROJECT NUMBER	WELL NUMBER
CH2MHILL	284350.SC.01	SHM-05-48A SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR :
DRILLING METHOD AND EQUIPMENT USED : Hand-driven
WATER LEVELS : START : 2/17/2005 END : 02/17/2005 LOGGER : Tseng



1- Ground elevation at well 213.9

2- Top of casing elevation 217
a) vent hole? No

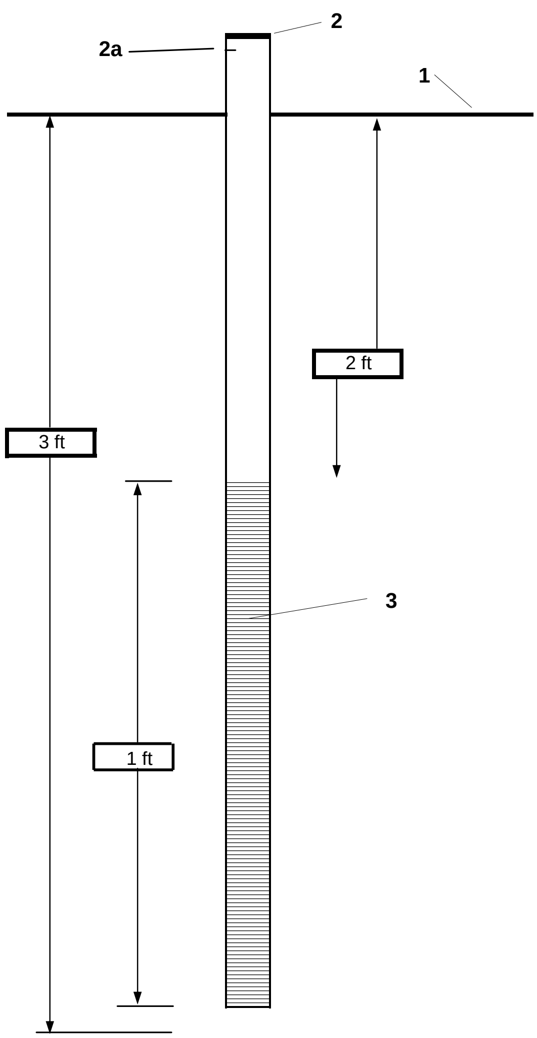
3- Type/slot size of screen 1" diameter sch. 40 PVC, 10-slot

Comments

CH2MHILL	PROJECT NUMBER 284350.SC.01	WELL NUMBER **SHM-05-48B** SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR :
DRILLING METHOD AND EQUIPMENT USED : Hand-driven
WATER LEVELS : START : 2/17/2005 END : 02/17/2005 LOGGER : Tseng



1- Ground elevation at well 213.8

2- Top of casing elevation 218.4
a) vent hole? No

3- Type/slot size of screen 1" diameter sch. 40 PVC, 10-slot

Comments

CH2MHILL	PROJECT NUMBER 284350.SC.01	WELL NUMBER **SHM-05-49A** SHEET 1 OF 1

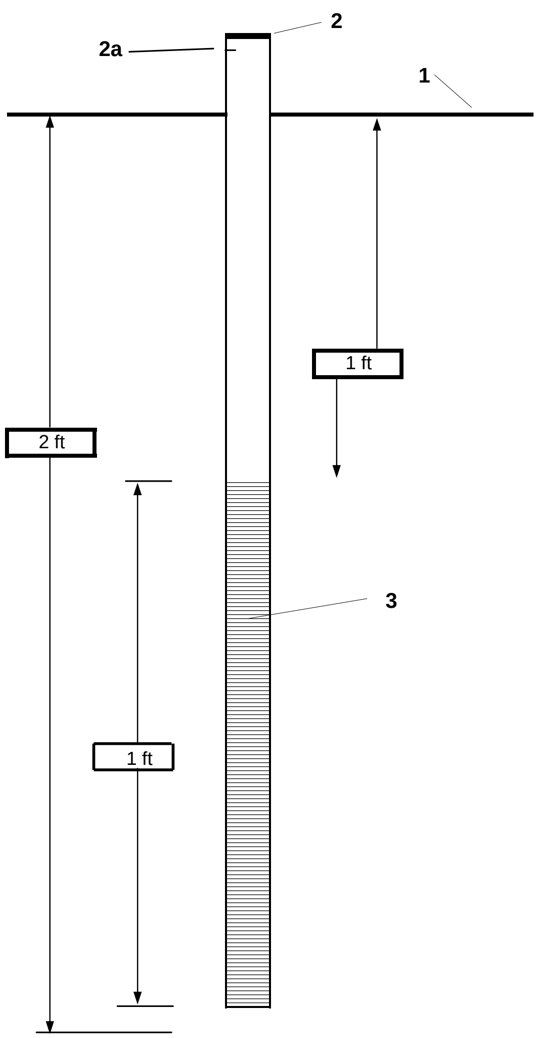
WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA

DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT USED : Hand-driven

WATER LEVELS : START : 2/17/2005 END : 02/17/2005 LOGGER : Tseng



1- Ground elevation at well 213.3

2- Top of casing elevation 217.8
a) vent hole? No

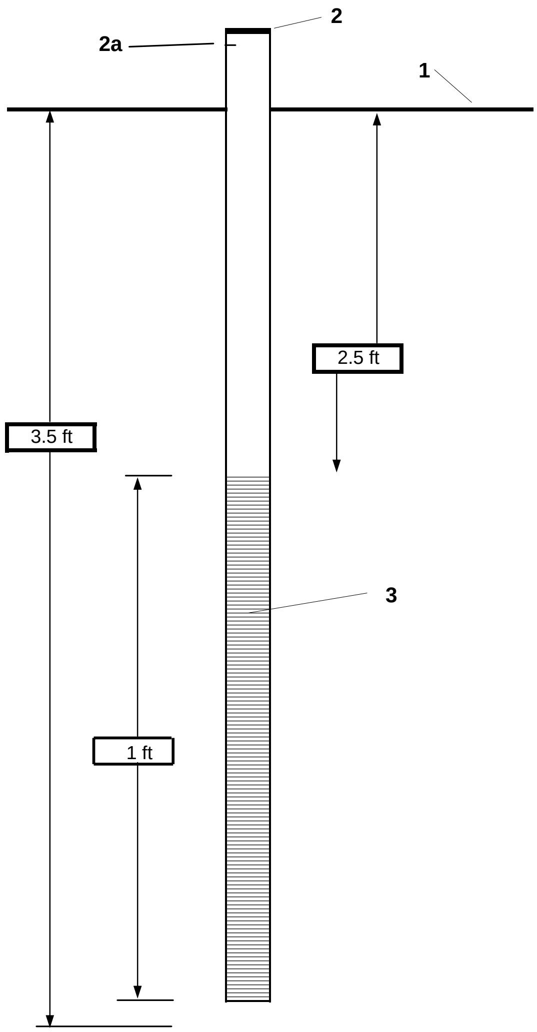
3- Type/slot size of screen 1" diameter sch. 40 PVC, 10-slot

Comments

	PROJECT NUMBER	WELL NUMBER	
CH2MHILL	284350.SC.01	SHM-05-49B	SHEET 1 OF 1

WELL COMPLETION DIAGRAM

PROJECT : Shepley's Hill Landfill LOCATION : Ayer, MA
DRILLING CONTRACTOR :
DRILLING METHOD AND EQUIPMENT USED : Hand-driven
WATER LEVELS : START : 2/17/2005 END : 02/17/2005 LOGGER : Tseng



1- Ground elevation at well 213.3

2- Top of casing elevation 216.2
a) vent hole? No

3- Type/slot size of screen 1" diameter sch. 40 PVC, 10-slot

Comments

Attachment B

Synoptic Water-Level Data
Baseline and Extraction/Recovery Test

TABLE B-1
Hydraulic Monitoring Network
Shepley's Hill Landfill, Fort Devens, MA

Well Identifier	Monitoring Method [1]	Comment
Near Field		
SHL-21	Manual	
SHL-13	Manual	
SHM-96-22B	Datalogger	
SHL-22	Datalogger	
SHM-93-22C	Datalogger	
SHL-5	Datalogger	
SHM-96-5C	Datalogger	
SHM-96-5B	Datalogger	
SHL-9	Datalogger	
SHL-23	Datalogger	
SHM-05-45A,B	Datalogger	~50 ft east of EW-1.
SHM-05-46A,B	Datalogger	~100 ft east of EW-1.
SHP-05-43	Manual	
SHP-05-44	Manual	
EW-01 pilot tube	Manual	Extraction well pilot tube.
EW-04 pilot tube	Manual	Extraction well pilot tube.
Pond Area		
PSP-01	Manual	Stage board near Pond outlet
SHP-01-38A,B	Manual	
N2-P1,P2	Manual	
SHP-01-37X	Manual	
SHP-01-36X	Manual	
N1-P1,P2,P3	Manual	
SHL-20	Manual	
SHL-11	Manual	
SHL-4	Manual	
Downgradient Area		
SHM-05-41A,B,C	Manual	MW triplet on Scully Road
SHM-05-42A,B	Manual	Microwell couplet in wooded area east of Scully Road

Well Identifier	Monitoring Method [1]	Comment
SHP-99-33A, B	Manual	Molumco Road
SHP-99-31A, B, C	Manual	Molumco Road
SHP-99-34A,B	Manual	Molumco Road
SHP-05-47A,B	Manual	Piezometer couplet hand installed, 80' N. of Spillway, west bank.
SHP-05-48A,B	Manual	Piezometer couplet hand installed, S. of Molumco Rd. in wetland channel.
SHP-05-49A,B	Manual	Piezometer couplet hand installed, 40' N. of Molumco Rd. Culvert, West Bank.
WP-01	Manual	Stage board - wetland pool area southwest of SHP-05-48A,B.
Upgradient Area		
SHL-10D	Manual	
SHL-15	Manual	
N5-P1,P2	Manual	
N3-P1,P2	Manual	
SHL-19	Manual	
SHL-10, C, E	Manual	
SHL-3	Manual	
N4-P1,P2,P3	Manual	
SHP-99-35X	Manual	
SHL-18	Manual	
SHM-93-18B	Manual	
N6-P1	Manual	
SHP-95-27X	Manual	
N7-P1,P2	Manual	
SHL-24	Manual	

[1] Wells identified to be monitored with data loggers are monitored manually except during the extraction test.

TABLE B-2
Geochemistry Sentinel Monitoring
Shepley's Hill Landfill, Fort Devens, MA

Monitoring Well/Piezometer Identification	Comment
SHL-23	West Peripheral
SHL-22	LTM downstream
SHL-9	LTM downstream
SHM-96-22B	LTM downstream
SHM-96-5B	LTM downstream
SHM-96-05C	LTM downstream
SHL-8S,D	East peripheral
SHL-13	East peripheral
SHL-21	East peripheral
PSP-01	East peripheral (Plow Shop Pond – surface water)
SHP-01-36X	East peripheral (near Plow Shop)
SHP-01-37X	East peripheral (near Plow Shop)
SHP-1-38A	East peripheral (near Plow Shop)
SHL-10D	East peripheral
SHL-15	Upgradient
N5-P1,P2	Upgradient
SHM-05-39A,B	New downgradient
SHM-05-40X	New downgradient
SHM-05-41A,B,C	New downgradient
SHM-05-42A,B	New downgradient
SHM-99-31A, B,C	Downgradient
SHM-99-32X	Downgradient

Table B-3 Water Level Summary

Well ID	Northing[1,2] (ft)	Easting[1,2] (ft)	Ground Surface Elevation[1,3] (ft msl)	Outer Casing Elevation[1,3] (ft msl)	Reference Elevation[1,3] (ft msl)	*Baseline* Date DTW Measured	DTW (TOC) (ft)	Elevation (ft msl)	*Baseline* Date DTW Measured	DTW (TOC) (ft)	Elevation (ft msl)	*Max Drawdown* Date DTW Measured	DTW (TOC) (ft)	Elevation (ft msl)	*Recovery* Date DTW Measured	DTW (TOC) (ft)	Elevation (ft msl)	*Max Drawdown* Date DTW Measured	DTW (TOC) (ft)	Elevation (ft msl)	*Operations 1* Date DTW Measured	Time DTW Measured	DTW (TOC) (ft)	Elevation (ft msl)	*Operations 2* Date DTW Measured	Time DTW Measured	DTW (TOC) (ft)	Elevation (ft msl)
SHM-05-39A	3028544.3	629761.4	222.9	222.9	222.6	8/4/2005	11.51	211.1	8/24/2005	11.93	210.7	8/26/2005	11.88	210.7	8/29/2005	12.00	210.6	--	--	--	9/6/2005	933	11.95	210.7	9/21/2005	756	12.03	210.6
SHM-05-39B	3028543.7	629765.5	222.9	222.9	222.6	8/4/2005	12.28	210.3	8/24/2005	12.70	209.9	8/26/2005	12.66	209.9	8/29/2005	12.75	209.9	--	--	--	9/6/2005	932	12.65	210.0	9/21/2005	754	12.80	209.8
SHM-05-40X	3028514.3	629636.9	224.6	224.6	224.4	8/4/2005	14.25	210.2	8/24/2005	14.55	209.9	8/26/2005	14.56	209.8	8/29/2005	14.66	209.7	--	--	--	9/6/2005	1016	14.52	209.9	9/21/2005	800	14.68	209.7
SHM-05-41A	3028290.9	629796.2	223.8	223.8	223.5	8/4/2005	10.21	213.3	8/24/2005	10.71	212.8	8/26/2005	10.82	212.7	8/29/2005	10.83	212.7	--	--	--	9/6/2005	1048	10.78	212.7	9/21/2005	811	10.96	212.5
SHM-05-41B	3028299.2	629796.1	223.6	223.6	223.3	8/4/2005	10.00	213.3	8/24/2005	10.53	212.8	8/26/2005	10.63	212.7	8/29/2005	10.63	212.7	--	--	--	9/6/2005	1042	10.61	212.7	9/21/2005	809	10.79	212.5
SHM-05-41C	3028285.4	629795.9	224.0	224.0	223.6	8/4/2005	10.30	213.3	8/24/2005	10.75	212.9	8/26/2005	10.86	212.7	8/29/2005	10.81	212.8	--	--	--	9/6/2005	1049	10.83	212.8	9/21/2005	813	11.00	212.6
SHM-05-42A	3028375.7	630018.4	214.5	217.9	217.8	8/3/2005	4.47	213.3	8/24/2005	4.98	212.8	8/26/2005	5.10	212.7	8/29/2005	5.03	212.8	--	--	--	9/6/2005	1216	5.11	212.7	9/21/2005	804	5.21	212.6
SHM-05-42B	3028375.7	630018.4	214.5	217.9	217.8	8/3/2005	4.38	213.4	8/24/2005	4.93	212.9	8/26/2005	5.07	212.7	8/29/2005	4.98	212.8	--	--	--	9/6/2005	1217	5.10	212.7	9/21/2005	805	5.20	212.6
SHM-99-31A	3028558.1	629894.9	213.9	215.7	215.4	8/3/2005	3.50	211.9	8/24/2005	4.40	211.0	8/26/2005	4.28	211.1	8/29/2005	4.42	211.0	--	--	--	9/6/2005	823	4.58	210.8	9/21/2005	746	4.35	211.1
SHM-99-31B	3028560.0	629899.9	213.7	215.5	215.4	8/3/2005	3.88	211.5	8/24/2005	4.32	211.1	8/26/2005	4.35	211.1	8/29/2005	4.41	211.0	--	--	--	9/6/2005	824	4.30	211.1	9/21/2005	746	4.47	210.9
SHM-99-31C	3028561.1	629908.5	213.7	215.9	215.8	8/3/2005	4.19	211.6	8/24/2005	4.59	211.2	8/26/2005	4.63	211.2	8/29/2005	4.71	211.1	--	--	--	9/6/2005	824	4.06	211.7	9/21/2005	745	4.75	211.1
SHM-99-32X	3028574.6	630170.1	220.2	222.5	222.3	8/5/2005	9.75	212.6	8/24/2005	10.17	212.1	8/26/2005	10.24	212.1	8/29/2005	10.29	212.0	--	--	--	9/6/2005	716	10.19	212.1	9/21/2005	736	10.36	211.9
SHP-05-47A	3028226.7	630522.8	214.4	NA	218.5	8/2/2005	4.61	213.9	8/24/2005	5.97	212.5	8/26/2005	Dry	Dry	8/29/2005		218.5	--	--	--	9/7/2005	728	5.68	212.8	9/21/2005	836	Dry	Dry
SHP-05-47B	3028226.2	630523.8	214.4	NA	216.3	8/2/2005	1.22	215.1	8/24/2005	3.93	212.4	8/26/2005	3.81	212.5	8/29/2005	3.87	212.4	--	--	--	9/7/2005	727	3.60	212.7	9/21/2005	836	3.91	212.4
SHP-05-48A	3028570.0	630046.0	213.9	NA	217.0	8/5/2005	5.50	211.5	8/24/2005	Dry	Dry	8/26/2005	Dry	Dry	8/29/2005	Dry	Dry	--	--	--	9/6/2005	1303	Dry	Dry	9/21/2005	741	Dry	Dry
SHP-05-48B	3028569.4	630046.3	213.8	NA	218.4	8/5/2005	4.67	213.7	8/24/2005	Dry	Dry	8/26/2005	Dry	Dry	8/29/2005	Dry	Dry	--	--	--	9/6/2005	1303	4.95	213.5	9/21/2005	740	4.93	213.5
SHP-05-49A	3028664.2	630250.6	213.3	NA	217.8	8/5/2005	Dry	Dry	8/24/2005	5.93	211.9	8/26/2005	Dry	Dry	8/29/2005	Dry	Dry	--	--	--	9/6/2005	810	5.89	211.9	9/21/2005	734	Dry	Dry
SHP-05-49B	3028663.6	630250.7	213.3	NA	216.2	8/5/2005	4.35	211.9	8/24/2005	4.28	211.9	8/26/2005	4.65	211.6	8/29/2005	4.90	211.3	--	--	--	9/6/2005	809	4.66	211.5	9/21/2005	733	4.92	211.3
SHP-99-33A	3028551.6	629818.5	222.1	NA	224.1	8/4/2005	12.76	211.3	8/24/2005	13.17	210.9	8/26/2005	13.19	210.9	--	--	--	--	--	--	9/6/2005	925	12.47	211.6	9/21/2005	749	13.12	211.0
SHP-99-33B	3028550.7	629815.5	222.2	NA	223.7	8/4/2005	12.31	211.4	8/24/2005	12.42	211.3	8/26/2005	12.55	211.2	--	--	--	--	--	--	9/6/2005	927	11.20	212.5	9/21/2005	750	12.59	211.1
SHP-99-34A	3028551.5	630294.9	223.6	NA	225.7	8/4/2005	13.46	212.2	8/24/2005	13.65	212.1	8/26/2005	13.56	212.1	8/29/2005	13.67	212.0	--	--	--	9/6/2005	759	12.65	213.1	9/21/2005	730	12.99	212.7
SHP-99-34B	3028552.3	630291.0	223.6	NA	225.6	8/4/2005	13.47	212.1	8/24/2005	13.33	212.3	8/26/2005	13.25	212.4	8/29/2005	13.95	211.7	--	--	--	9/6/2005	805	13.33	212.3	9/21/2005	731	12.52	213.1
WP-01	3028426.8	629893.7	213.3	NA	213.4	8/5/2005	Dry	Dry	8/24/2005	Dry	Dry	8/26/2005	Dry	Dry	8/29/2005	Dry	Dry	--	--	--	9/6/2005	1220	Dry	Dry	9/21/2005	807	Dry	Dry
EW-01	3027959.9	629942.7	NA	228.2	228.0	--	--	--	8/24/2005	14.22	213.8	8/26/2005	24.18	203.8	8/29/2005	14.32	213.7	8/30/2005	24.00	204.0	--	--	--	--	--	--	--	--
EW-01 pilot	3027959.9	629942.7	NA	228.2	228.0	8/2/2005	13.92	214.1	8/24/2005	14.22	213.8	8/26/2005	14.84	213.2	8/29/2005	14.34	213.7	8/30/2005	14.93	213.1	9/7/2005	1020	14.98	228.0	9/21/2005	1059	14.54	213.5
EW-04	3027990.9	629894.9	NA	228.5	228.1	--	--	--	8/24/2005	14.53	213.6	--	--	--	8/29/2005	14.61	213.5	8/30/2005	15.14	213.0	9/7/2005	1018	14.95	228.1	9/21/2005	1105	14.96	213.1
EW-04 pilot	3027990.9	629894.9	NA	228.5	228.1	8/2/2005	13.60	214.5	8/24/2005	14.62	213.5	8/26/2005	14.82	213.3	8/29/2005	14.75	213.4	8/30/2005	15.00	213.1	--	--	--	--	--	--	--	--
SHL-13	3028105.8	630539.8	220.1	222.3	221.8	8/2/2005	7.00	214.8	8/24/2005	7.59	214.2	8/26/2005	7.52	214.3	8/29/2005	7.58	214.2	8/30/2005	7.54	214.3	9/7/2005	703	7.47	214.3	9/21/2005	832	7.67	214.1
SHL-21	3027884.4	630363.4	258.7	261.2	260.0	8/3/2005	45.20	214.8	8/24/2005	45.81	214.2	8/26/2005	45.75	214.3	8/29/2005	45.90	214.1	8/30/2005	45.92	214.1	9/7/2005	828	45.94	214.1	9/21/2005	842	46.14	213.9
SHL-22	3028162.8	630056.4	220.0	221.4	220.6	8/2/2005	6.82	213.8	8/24/2005	7.36	213.2	8/26/2005	7.57	213.0	8/29/2005	7.53	213.1	8/30/2005	7.70	212.9	9/7/2005	1034	7.65	213.0	9/21/2005	817	7.64	213.0
SHL-23	3027916.7	629712.7	240.5	242.6	242.3	8/5/2005	27.42	214.9	8/24/2005	28.16	214.1	8/26/2005	28.17	214.1	8/29/2005	28.32	214.0	8/30/2005	28.39	213.9	9/7/2005	958	28.49	213.8	9/21/2005	1520	28.67	213.6
SHL-5	3028124.9	630191.8	217.9	218.9	218.6	8/3/2005	4.50	214.1	8/24/2005	5.32	213.3	8/26/2005	5.38	213.2	8/29/2005	5.48	213.1	8/30/2005	5.54	213.1	9/7/2005	1210	5.48	213.1	9/21/2005	828	5.58	213.0
SHL-8D	3028127.6	630406.7	220.1	222.3	221.8	8/2/2005	7.46	214.3	8/24/2005	8.03	213.8	8/26/2005	8.04	213.8	8/29/2005	8.02	213.8	--	--	--	9/7/2005	731	8.14	213.7	9/21/2005	830	8.33	213.5
SHL-8S	3028127.6	630406.7	220.1	222.3	222.0	8/2/2005	7.68	214.3	8/24/2005	8.22	213.8	8/26/2005	8.27	213.7	8/29/2005	8.28	213.7	--	--	--	9/7/2005	730	8.52	213.5	9/21/2005	830	8.45	213.6
SHL-9	3028147.0	630009.4	221.7	223.5	223.0	8/2/2005	9.23	213.8	8/24/2005	9.83	213.2	8/26/2005	9.95	213.1	8/29/2005	9.97	213.2	8/30/2005	10.14	213.0	9/7/2005	1021	10.12	212.9	9/21/2005	816	10.11	212.9
SHM-05-45A	3027962.0	629995.4	227.3	229.7	229.5	8/2/2005	15.06	214.4	8/24/2005	15.69	213.8	8/26/2005	16.09	213.3	8/29/2005	15.82	213.7	8/30/2005	16.30	213.2	9/7/2005	951	16.27	213.2	9/21/2005	1053	16.03	213.5
SHM-05-45X	3027956.7	629995.2	227.7	230.3	230.1	8/2/2005	15.62	214.5	8/24/2005	16.29	213.8	8/26/2005	16.61	213.0	8/29/2005	16.35	213.8	8/30/2005	16.93	213.0	9/7/2005	950	16.86	213.2	9/21/2005	1052	16.60	213.5
SHM-05-46A	3027946.5	630041.7	227.3	229.4	229.3	8/2/2005	14.67	214.6	8/24/2005	15.32	214.0	8/26/2005	15.49	213.5	8/29/2005	15.41	213.9	8/30/2005	15.81	213.5	9/7/2005	946	15.82	213.5	9/21/2005	1050	15.65	213.7
SHM-05-46B	3027941.1	630041.2	227.1	228.8	228.7	8/2/2005	13.96	214.7	8/24/2005	14.60	214.1	8/26/2005	14.76	213.7	8/29/2005	14.71	214.0	8/30/2005	15.11	213.6	9/7/2005	948	15.13	213.6	9/21/2005	1051	14.94	213.8
SHM-93-22C	3028158.2	630045.9	220.0	221.7	221.7	8/3/2005	7.89	213.8	8/24/2005	8.45	213.3	8/26/2005	8.65	213.1	8/29/2005	8.62	213.1	8/30/2005	8.81	212.9	9/7/2005	1033	8.69	213.0	9/21/2005	817	8.75	213.0
SHM-96-22B	3028169.8	630071.9	219.9	221.6	220.4	8/2/2005	6.66	213.7	8/24/2005	7.23	213.2	8/26/2005	7.42	213.0	8/29/2005	7.38	213.0	8/30/2005	7.54	212.9	9/7/2005	1104	7.41	213.0	9/21/2005	820	7.49	212.9
SHM-96-5B	3028112.7	630158.2	218.5	220.2	220.0	8/2/2005	5.81	214.2	8/24/2005	6.39	213.6	8/26/2005	6.65	213.4	8/29/2005	9.61	213.6	8/30/2005	6.66	213.3	9/7/2005	1135	6.63	213.4	9/21/2005	825	6.74	213.3
SHM-96-5C	3028106.1	630173.5	218.7	219.6	219.4	8/3/2005	5.40	214.0	8/24/2005	5.98	213.4	8/26/2005	6.12	213.3	8/29/2005	6.12	213.3	8/30/2005	6.23	213.2	9/7/2005	1136	6.07	213.3	9/21/2005	827	6.22	213.2
SHP-05-43	3027747.1	630532.5	259.4	262.4	261.7	8/3/2005	45.06	216.6	8/24/2005	45.45	216.3	8/26/2005	45.36	216.3	8/29/2005	45.48	216.2	--	--	--	9/7/2005	940	45.43	216.3	9/21/2005	846	45.89	215.8
SHP-05-44	3027588.9	630586.4	256.4	259.5	259.1	8/3/2005	42.21	216.9	8/24/2005	42.46	216.6	8/26/2005	42.40	216.7	8/29/2005	42.50	216.6	--	--	--	9/7/2005	935	42.41	216.7	9/21/2005	849	42.53	216.6
N-1, P-1	3027867.9	630723.3	228.8	231.5	231.0	8/3/2005	14.81	216.2	8/24/2005	14.93	216.1	8/26/2005	14.86	216.1	8/29/2005	14.94	216.1	--	--	--	9/7/2005	841	14.84	216.2	9/21/2005	855	14.93	216.1
N-1, P-2	3027867.9	630723.3	228.8	231.5	231.0	8/3/2005	14.54	216.5	8/24/2005	14.80	216.2	8/26/2005	14.77	216.2	8/29/2005	14.80	216.2	--	--	--	9/7/2005	842	14.70	216.3	9/21/2005	852	14.83	216.2
N-1, P-3	3027867.9	630723.3	228.8	231.5	231.2	8/3/2005	14.33	216.9	8/24/2005	14.46	216.7	8/26/2005	14.40	216.8	8/29/2005	14.46	216.7	--	--	--	9/7/2005	842	14.33	216.9	9/21/2005	856	14.50	216.7
N-2, P-1	3027311.3	630658.7	221.6	223.8	223.1	8/1/2005	5.81	217.3	8/24/2005	5.92	217.2	8/26/2005	5.85	217.3	8/29/2005	5.84	217.3	--	--	--	9/7/2005	859	6.67	216.4	9/21/2005	906	5.91	217.2
N-2, P-2	3027311.3	630658.7	221.6	223.8	223.0	8/1/2005	6.02	217.0	8/24/2005	6.14	216.9	8/26/2005	6.08	216.9	8/29/2005	6.04	217.0	--	--	--	9/7/2005	900	6.05	217.0	9/21/2005	907	6.09	216.9
PSP-01	3028179.0	630581.0	NA	NA	216.1	8/5/2005	0.98	217.1	8/24/2005	0.94	217.0	8/26/2005	0.97	217.1	8/29/2005	0.96	217.1	--	--	--	9/7/2005	725	1.00	217.1	9/21/2005	832	0.95	217.1
SHL-11	3027316.1	630496.1	235.0	237.0	236.5	8/1/2005	18.80	217.7	8/24/2005	18.98	217.5	8/26/2005	18.91	217.6	8/29/2005	18.91	217.6	--	--	--	9/7/2005	918	18.91	217.6	9/21/2005	921	19.02	217.5
SHL-20	3027329.4	630463.1	235.4	237.0	237.0	8/1/2005	19.15	217.9	8/24/2005	19.33	217.7	8/26/2005	19.30	217.7	8/29/2005	19.23	217.8	--	--	--	9/7/2005	919	19.30	217.7	9/21/2005	925	19.41	217.6
SHL-4	3027057.2	630575.7	226.4	228.4	228.1	8/1/2005	10.63	217.5	8/24/2005	10.77	217.3	8/26/2005	11.07	217.0	8/29/2005	10.78	217.3	--	--	--	9/7/2005	922	10.77	217.3	9/21/2005	927	10.86	217.2
SHP-01-36X	3027688.5	630738.3	221.1	NA	225.1	8/3/2005	7.99	217.1	8/24/2005	7.16	217.9	8/26/2005	8.11	217.0	8/29/2005	7.72	217.4	--	--	--	9/7/2005	847	8.00	217.1	9/21/2005	902	8.04	217.1
SHP-01-37X	3027498.6	630696.6	219.5	NA	223.7	8/3/2005	6.80	216.9	8/24/2005	6.91	216.8	8/26/2005	6.53	217.2	8/29/2005	6.85	216.9	--	--	--	9/7/2005	855	6.68	217.0	9/21/2005	904	6.80	216.9
SHP-01-38A	3027178.3	630544.0	219.8	NA	221.8	8/1/2005	4.26	217.5	8/24/2005	4.39	217.4	8/26/2005	4.36	217.4	8/29/2005	4.37	217.4	--	--	--	9/7/2005	904	5.74	216.1	9/21/2005	916	4.12	217.7
SHP-01-38B	3027171.8	630545.1	219.9	NA	222.0	8/1/2005	4.33	217.7	8/24/2005	4.49	217.5	8/26/2005	4.34	217.7	8/29/2005	4.42	217.6	--	--	--	9/7/2005	910	4.61	217.4	9/21/2005	917	4.41	217.6
N-3, P-1	3027130.2	630777.8	219.8	222.5	221.8	8/1/2005	4.67	217.1	8/24/2005	4.76	217.0	8/26/2005	4.71	217.1	8/29/2005	4.68	217.1	--	--	--	9/7/2005	925	4.70	217.1	9/21/2005	929	4.77	217.0
N-3, P-2	3027130.2	630777.8	219.8	222.5	221.5	8/1/2005	4.78	216.7	8/24/2005	4.78	216.7	8/26/2005	4.76	216.7	8/29/2005	4.76	216.7	--	--	--	9/7/2005	927	4.70	216.8	9/21/2005	929	4.78	216.7
N-4, P-1[4]	3026762.2	631241.7	218.3	219.9	219.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N-4, P-2[4]	3026762.2	631241.7	218.3	219.9	219.2	8/1/2005	1.99	217.2	8/24/2005	2.10	217.1	8/26/2005	2.09	217.1	8/29/2005	2.02	217.2	--	--	--	9/6/2005	1350	2.02	217.2	9/21/2005	945	2.05	217.2
N-4, P-3[4]	3026762.2	631241.7	218.3	219.9	219.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N-5, P-1	3027173.0	629805.6	241.7	244.9	243.7	8/5/2005	22.93	220.8	8/25/2005	23.38	220.3	8/26/2005	23.35	220.4	8/29/2005	23.48	220.2	--	--	--	9/6/2005	1458	23.59	220.1	9/21/2005	1044	23.83	219.9
N-5, P-2	3027173.0	629805.6	241.7	244.9	243.7	8/5/2005	22.74	221.0	8/25/2005	23.27	220.4	8/26/2005	23.22	220.5	8/29/2005	23.22	220.5	--	--	--	9/6/2005	1457	23.46	220.2	9/21/2005	1045	23.67	220.0

Well ID	Northing[1,2]	Easting[1,2]	Ground Surface Elevation[1,3]	Outer Casing Elevation[1,3]	Reference Elevation[1,3]	Date DTW Measured	DTW (TOC)	Elevation	Date DTW Measured	DTW (TOC)	Elevation	Date DTW Measured	DTW (TOC)	Elevation	Date DTW Measured	DTW (TOC)	Elevation	Date DTW Measured	DTW (TOC)	Elevation	Date DTW Measured	Time DTW Measured	DTW (TOC)	Elevation	Date DTW Measured	Time DTW Measured	DTW (TOC)	Elevation
N-6, P-1	3026338.7	630017.1	257.1	259.9	259.9	8/1/2005	36.13	223.8	8/24/2005	36.51	223.4	8/26/2005	36.05	223.9	8/29/2005	36.63	223.3	--	--	--	9/6/2005	1444	36.74	223.2	9/21/2005	1016	37.00	222.9
N-7, P-1	3025618.6	629991.0	254.4	257.7	256.6	8/1/2005	29.88	226.7	8/24/2005	30.35	226.3	8/26/2005	30.34	226.3	8/29/2005	30.46	226.1	--	--	--	9/6/2005	1513	30.53	226.1	9/21/2005	1025	30.98	225.6
N-7, P-2	3025618.6	629991.0	254.4	257.7	257.1	8/1/2005	29.96	227.1	8/24/2005	30.43	226.7	8/26/2005	30.44	226.7	8/29/2005	30.57	226.5	--	--	--	9/6/2005	1512	30.62	226.5	9/21/2005	1029	30.98	226.1
SHL-15	3025829.5	629326.4	260.1	261.2	260.9	8/1/2005	18.17	242.7	8/24/2005	18.93	242.0	8/26/2005	18.98	241.9	8/29/2005	19.10	241.8	--	--	--	9/6/2005	1520	19.22	241.7	9/21/2005	1034	18.69	242.2
SHL-18	3026474.8	631186.3	236.8	238.8	238.6	8/5/2005	19.27	219.3	8/24/2005	19.60	219.0	8/26/2005	19.62	219.0	8/29/2005	19.67	218.9	--	--	--	9/6/2005	1355	19.65	219.0	9/21/2005	950	19.77	218.8
SHL-19	3026946.0	630664.9	239.5	241.8	241.5	8/1/2005	23.14	218.4	8/24/2005	23.38	218.1	8/26/2005	23.40	218.1	8/29/2005	22.43	219.1	--	--	--	9/7/2005	931	23.44	218.1	9/21/2005	933	23.53	218.0
SHL-3	3026705.6	630910.8	247.4	248.6	248.6	8/1/2005	30.50	218.1	8/24/2005	30.77	217.8	8/26/2005	30.80	217.8	8/29/2005	30.82	217.8	--	--	--	9/6/2005	1337	30.74	217.9	9/21/2005	940	30.84	217.8
SHM-93-10C	3026846.1	630886.0	247.1	249.1	248.6	8/1/2005	29.71	218.9	8/24/2005	29.92	218.7	8/26/2005	23.93	224.7	8/29/2005	30.02	218.6	--	--	--	9/6/2005	1328	29.98	218.6	9/21/2005	952	29.95	218.7
SHM-93-10D	3026867.8	630876.9	246.5	249.1	248.9	8/1/2005	30.43	218.5	8/24/2005	30.63	218.3	8/26/2005	30.64	218.3	8/29/2005	30.61	218.3	--	--	--	9/6/2005	1318	30.62	218.3	9/21/2005	937	30.65	218.3
SHM-93-10E	3026841.5	630878.1	246.6	248.8	248.5	8/1/2005	29.54	219.0	8/24/2005	29.73	218.8	8/26/2005	29.64	218.9	8/29/2005	28.76	219.7	--	--	--	9/6/2005	1333	29.83	218.7	9/21/2005	935	29.38	219.1
SHM-93-18B	3026453.1	631180.4	236.3	238.7	238.3	8/1/2005	18.95	219.4	8/24/2005	19.29	219.0	8/26/2005	19.30	219.0	8/29/2005	19.38	218.9	--	--	--	9/6/2005	1402	19.33	219.0	9/21/2005	936	19.43	218.9
SHL-24	3025635.8	631303.4	237.8	239.9	239.8	--	--	--	8/24/2005	15.69	224.1	8/26/2005	15.72	224.1	8/29/2005	15.83	224.0	--	--	--	9/6/2005	1412	15.80	224.0	9/21/2005	1001	15.96	223.8
SHP-95-27X	3026164.7	630753.2	236.3	238.7	238.5	8/1/2005	15.36	223.1	8/24/2005	33.02	205.5	8/26/2005	16.14	222.4	8/29/2005	16.25	222.3	--	--	--	9/6/2005	1420	16.36	222.1	9/21/2005	1008	16.61	221.9
SHP-99-35X	3026547.3	629722.7	257.5	259.3	259.2	8/1/2005	36.19	223.0	8/24/2005	36.39	222.8	8/26/2005	35.05	224.2	8/29/2005	36.44	222.8	--	--	--	9/6/2005	1450	36.52	222.7	9/21/2005	1036	36.59	222.6

NA=Not Available (survey data not available)

	Corrections made to manual measurement errors identified in Table B-1 based on other readings or response of locations nearby.
9.61	=Suspect measurement.
213.5	=Correction based on water level changes observed via data loggers.

Notes:

1. Field survey performed by Meridian Associates, Inc. between July and August 2005.
2. Northing and easting coordinates based upon project system, reported to be North American Datum of 1983 (NAD83).
3. Elevations based upon project system, reported to be National Geodetic Vertical Datum of 1929 (NGVD29).
4. N-4 ice damaged. P-2 measurement approx.

Table B -4 Manual Water Level Measurements

Water Level Location	24-Aug Time	Baseline Depth	25-Aug Time	Extraction Depth	26-Aug Time	Extraction Depth	29-Aug Time	Recharge Depth	30-Aug Time	Extraction Depth
EW-01		14.22	1758	17.05	758	24.18	747	14.32	1020	22-24'
EW-04		14.53					742	14.61	1103	15.14
EW1 Piezometer		14.22	1800	14.56	756	14.84	748	14.34	1020	14.93
EW4 Piezometer		14.62	1752	14.75	754	14.82	740	14.75	1102	15.00
N-1, P-1		14.93	704	14.84	845	14.86	817	14.94		
N-1, P-1			804	14.84						
N-1, P-1			906	14.84						
N-1, P-1			1002	14.84						
N-1, P-1			1116	14.85						
N-1, P-1			1250	14.85						
N-1, P-1			1349	14.88						
N-1, P-1			1648	14.86						
N-1, P-2		14.80	705	14.75	846	14.77	817	14.80		
N-1, P-2			805	14.75						
N-1, P-2			907	14.75						
N-1, P-2			1003	14.74						
N-1, P-2			1117	14.77						
N-1, P-2			1250	14.77						
N-1, P-2			1349	14.77						
N-1, P-2			1649	14.76						
N-1, P-3		14.46	705	14.41	847	14.40	818	14.46		
N-1, P-3			806	14.41						
N-1, P-3			907	14.42						
N-1, P-3			1003	14.41						
N-1, P-3			1118	14.41						
N-1, P-3			1251	14.43						
N-1, P-3			1350	14.43						
N-1, P-3			1650	14.44						
N-2, P-1		5.92	716	5.88	857	5.85	831	5.84		
N-2, P-1			818	5.85						
N-2, P-1			916	5.85						
N-2, P-1			1014	5.89						
N-2, P-1			1128	5.86						
N-2, P-1			1301	5.87						
N-2, P-1			1403	5.93						
N-2, P-1			1702	5.90						
N-2, P-2		6.14	717	6.07	858	6.08	830	6.04		
N-2, P-2			819	6.06						
N-2, P-2			917	6.07						
N-2, P-2			1014	6.08						
N-2, P-2			1129	6.09						
N-2, P-2			1303	6.08						
N-2, P-2			1403	6.08						
N-2, P-2			1703	6.08						
N-3, P-1	1747	4.76	1054	5.82	907	4.71	842	4.68		
N-3, P-1			1340	4.73						
N-3, P-1			1740	4.74						
N-3, P-2	1747	4.78	1056	4.71	909	4.76	843	4.76		
N-3, P-2			1341	4.74						
N-3, P-2			1743	4.73						
N-4, P-2	1718	2.10	1034	2.07	935	2.09	900	2.02		
N-4, P-2			1323	2.07						
N-4, P-2			1728	2.08						
N-5, P-1			754	23.38	1018	23.35	941	23.48		
N-5, P-1			834	23.36						
N-5, P-1			935	23.34						
N-5, P-1			1031	23.39						
N-5, P-1			1143	23.33						
N-5, P-1			1319	23.35						
N-5, P-1			1421	23.35						
N-5, P-2			755	23.27	1020	23.22	940	23.22		
N-5, P-2			835	23.26						
N-5, P-2			936	23.23						
N-5, P-2			1034	23.24						
N-5, P-2			1144	23.23						
N-5, P-2			1320	23.21						
N-5, P-2			1425	23.20						
N-5, P-2			1727	23.19						
N-6, P-1	1652	36.51	1013	36.50	1013	36.50	915	36.63		
N-6, P-1			1256	36.51						
N-6, P-1			1702	36.50						
N-7, P-1	1628	30.35	956	30.34	950	30.34	920	30.46		
N-7, P-1			1246	30.33						
N-7, P-1			1653	30.35						
N-7, P-2	1628	30.43	954	30.45	953	30.44	920	30.57		
N-7, P-2			1245	30.93						
N-7, P-2			1652	30.43						
PSP-01		0.94	740	0.96	821	0.97	805	0.96		
PSP-01			859	0.96						
PSP-01			956	0.96						
PSP-01			1050	0.96						
PSP-01			1338	0.96						
PSP-01			1442	0.96						
PSP-01			1745	0.96						

Water Level Location	24-Aug Time	Baseline Depth	25-Aug Time	Extraction Depth	26-Aug Time	Extraction Depth	29-Aug Time	Recharge Depth	30-Aug Time	Extraction Depth
SHL-11		18.98	727	18.94	902	18.91	835	18.91		
SHL-11			827	18.90						
SHL-11			925	18.89						
SHL-11			1023	18.91						
SHL-11			1134	18.90						
SHL-11			1309	18.91						
SHL-11			1411	18.90						
SHL-11			1711	18.90						
SHL-13		7.59	738	7.51	817	7.52	804	7.58	1125	7.54
SHL-13			855	7.48						
SHL-13			953	7.49						
SHL-13			1048	7.51						
SHL-13			1336	7.55						
SHL-13			1441	7.54						
SHL-13			1742	7.59						
SHL-15	1619	18.93	949	18.97	1003	18.98	926	19.10		
SHL-15			1239	18.97						
SHL-15			1647	18.98						
SHL-18	1714	19.60	1030	19.62	930	19.62	857	19.67		
SHL-18			1320	19.63						
SHL-18			1724	19.63						
SHL-19	1743	23.38	1049	23.40	920	23.40	845	22.43		
SHL-19			1335	23.41						
SHL-19			1738	23.42						
SHL-19										
SHL-20		19.33	728	19.31	903	19.30	837	19.23		
SHL-20			828	19.30						
SHL-20			927	19.29						
SHL-20			1024	19.28						
SHL-20			1136	19.28						
SHL-20			1310	19.28						
SHL-20			1412	19.26						
SHL-20			1712	19.29						
SHL-21		45.81	734	45.76	830	45.75	810	45.90	1130	45.92
SHL-21			850	45.73						
SHL-21			949	45.73						
SHL-21			1046	45.73						
SHL-21			1332	45.73						
SHL-21			1434	45.74						
SHL-21			1737	45.74						
SHL-22		7.36	1812	7.53	618	7.57	756	7.53	1115	7.70
SHL-23		28.16	1750	28.13	752	28.17	745	28.32	1106	28.39
SHL-24	1704	15.69	1025	15.71	943	15.72	905	15.83		
SHL-24			1310	15.72						
SHL-24			1714	15.72						
SHL-3	1724	30.77	1037	30.80	927	30.80	855	30.82		
SHL-3			1328	30.75						
SHL-3			1730	30.80						
SHL-4	1746	10.77	747	10.77	905	11.07	840	10.78		
SHL-4			829	10.77						
SHL-4			930	10.76						
SHL-4			1026	10.75						
SHL-4			1052	10.77						
SHL-4			1137	10.78						
SHL-4			1313	10.77						
SHL-4			1338	10.80						
SHL-4			1415	10.75						
SHL-4			1715	10.77						
SHL-4			1740	10.80						
SHL-5		5.32	1815	5.36	629	5.38	801	5.48	1120	5.54
SHL-8D		8.03			816	8.04	802	8.02		
SHL-8S		8.22			815	8.27	802	8.28		
SHL-9		9.83	1808	9.91	613	9.95	752	9.97	1112	10.14
SHM-05-39A		11.93			655	11.88	721	12.00		
SHM-05-39B		18.13			654	12.66	722	12.75		
SHM-05-40X		14.55			700	14.56	726	14.66		
SHM-05-41A		10.71	824	10.75	645	10.82	730	10.83		
SHM-05-41A			919	10.73						
SHM-05-41A			1142	10.75						
SHM-05-41A			1416	10.75						
SHM-05-41A			1623	10.77						
SHM-05-41A			1828	10.78						
SHM-05-41B		10.53	825	10.55	647	10.63	729	10.63		
SHM-05-41B			920	10.55						
SHM-05-41B			1144	10.58						
SHM-05-41B			1418	10.57						
SHM-05-41B			1625	10.58						
SHM-05-41B			1829	10.59						
SHM-05-41C		10.75	819	10.80	644	10.86	731	10.81		
SHM-05-41C			921	10.77						
SHM-05-41C			1137	10.81						
SHM-05-41C			1415	10.80						
SHM-05-41C			1622	10.81						
SHM-05-41C			1827	10.82						
SHM-05-42A	1831	4.98	925	5.05	741	5.10	734	5.03		
SHM-05-42A			1133	5.05						

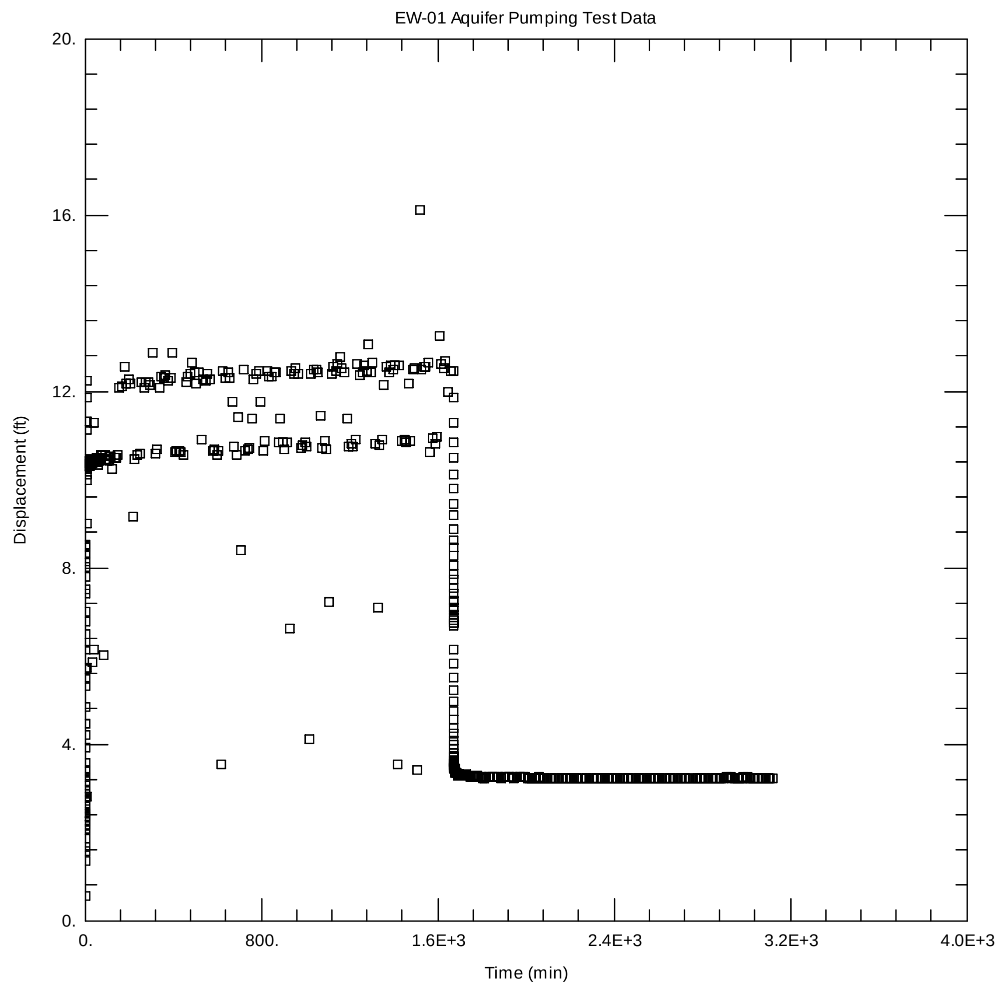
Water Level Location	24-Aug Time	Baseline Depth	25-Aug Time	Extraction Depth	26-Aug Time	Extraction Depth	29-Aug Time	Recharge Depth	30-Aug Time	Extraction Depth
SHM-05-42A			1411	5.07						
SHM-05-42A			1619	5.07						
SHM-05-42A			1824	5.09						
SHM-05-42B	1831	4.93	926	5.02	743	5.07	735	4.98		
SHM-05-42B			1130	5.02						
SHM-05-42B			1412	5.02						
SHM-05-42B			1620	5.03						
SHM-05-42B			1824	5.04						
SHM-05-45A		15.69	1803	16.11	810	16.09	749	15.82	1018	16.30
SHM-05-45B		16.29	1804	16.76	804	15.61	749	16.35	1018	16.93
SHM-05-46A		16.32	1805	15.62	812	15.49	750	15.41	1013	15.81
SHM-05-46B		14.60	1805	14.93	813	14.76	750	14.71	1015	15.11
SHM-93-10C	1728	29.92	1042	29.93	923	23.93	848	30.02		
SHM-93-10C			1332	29.95						
SHM-93-10C			1733	29.92						
SHM-93-10D	1728	30.63	1039	30.68	925	30.64	851	30.61		
SHM-93-10D			1330	30.65						
SHM-93-10D			1730	30.65						
SHM-93-10E	1728	29.73	1044	29.76	924	29.64	850	28.76		
SHM-93-10E			1333	29.80						
SHM-93-10E			1736	29.76						
SHM-93-18B	1711	19.29	1020	19.30	931	19.30	859	19.38		
SHM-93-18B			1319	19.30						
SHM-93-18B			1723	19.29						
SHM-93-22C		8.45	1811	8.60	614	8.65	755	8.62	1114	8.81
SHM-96-22B		7.23	1813	7.41	620	7.42	758	7.38	1117	7.54
SHM-96-5B		6.39	1814	6.62	625	6.65	800	9.61	1117	8.66
SHM-96-5C		4.83	1814	6.05	627	6.12	800	9.12	1119	6.23
SHM-99-31A	1804	4.40	738	4.26	713	4.28	719	4.42		
SHM-99-31A			909	4.21						
SHM-99-31A			1126	4.29						
SHM-99-31A			1404	4.38						
SHM-99-31A			1609	4.40						
SHM-99-31A			1817	4.41						
SHM-99-31B	1804	4.32	740	4.35	712	4.35	718	4.41		
SHM-99-31B			909	4.33						
SHM-99-31B			1127	4.32						
SHM-99-31B			1405	4.34						
SHM-99-31B			1610	4.34						
SHM-99-31B			1818	4.35						
SHM-99-31C	1804	4.59	742	4.64	711	4.63	718	4.71		
SHM-99-31C			909	4.60						
SHM-99-31C			1128	4.60						
SHM-99-31C			1406	4.61						
SHM-99-31C			1611	4.61						
SHM-99-31C			1819	4.62						
SHM-99-32X	1810	10.17	904	10.22	723	10.24	715	10.29		
SHM-99-32X			1123	10.22						
SHM-99-32X			1359	10.23						
SHM-99-32X			1607	10.23						
SHM-99-32X			1814	10.25						
SHP-01-36X		7.16	710	8.07	852	8.11	825	7.72		
SHP-01-36X			810	8.08						
SHP-01-36X			911	8.07						
SHP-01-36X			1006	8.07						
SHP-01-36X			1121	8.07						
SHP-01-36X			1254	8.08						
SHP-01-36X			1357	8.08						
SHP-01-36X			1656	8.08						
SHP-01-37X		6.91	714	6.55	855	6.53	828	6.85		
SHP-01-37X			815	6.77						
SHP-01-37X			914	6.35						
SHP-01-37X			1011	6.80						
SHP-01-37X			1123	6.75						
SHP-01-37X			1300	6.75						
SHP-01-37X			1400	6.79						
SHP-01-37X			1700	6.79						
SHP-01-38A		4.39	725	4.38	901	4.36	834	4.37		
SHP-01-38A			827	4.34						
SHP-01-38A			921	4.34						
SHP-01-38A			1021	4.26						
SHP-01-38A			1132	4.38						
SHP-01-38A			1307	4.39						
SHP-01-38A			1408	4.38						
SHP-01-38A			1707	4.35						
SHP-01-38B		4.49	726	3.65	900	4.34	833	4.42		
SHP-01-38B			826	4.18						
SHP-01-38B			919	4.11						
SHP-01-38B			1016	4.44						
SHP-01-38B			1131	4.30						
SHP-01-38B			1306	4.46						
SHP-01-38B			1407	4.35						
SHP-01-38B			1706	4.34						
SHP-05-43		45.45	731	45.32	835	45.36	812	45.48		
SHP-05-43			848	45.38						
SHP-05-43			946	45.36						

Water Level Location	24-Aug Time	Baseline Depth	25-Aug Time	Extraction Depth	26-Aug Time	Extraction Depth	29-Aug Time	Recharge Depth	30-Aug Time	Extraction Depth
SHP-05-43			1043	45.34						
SHP-05-43			1151	45.36						
SHP-05-43			1328	45.34						
SHP-05-43			1433	45.34						
SHP-05-43			1734	45.35						
SHP-05-44		42.46	729	42.41	839	42.40	813	42.50		
SHP-05-44			844	42.38						
SHP-05-44			945	42.39						
SHP-05-44			1039	42.44						
SHP-05-44			1147	42.43						
SHP-05-44			1325	42.40						
SHP-05-44			1431	42.44						
SHP-05-44			1733	42.40						
SHP-05-47A		5.97	742	Dry	821	Dry	806	Dry		
SHP-05-47A			858	Dry						
SHP-05-47A			957	Dry						
SHP-05-47A			1050	Dry						
SHP-05-47A			1339	Dry						
SHP-05-47A			1443	Dry						
SHP-05-47A			1745	Dry						
SHP-05-47B		3.93	742	3.84	821	3.81	806	3.87		
SHP-05-47B			859	3.83						
SHP-05-47B			957	3.86						
SHP-05-47B			1051	3.83						
SHP-05-47B			1339	3.88						
SHP-05-47B			1443	3.90						
SHP-05-47B			1745	3.87						
SHP-05-48A		Dry	734	Dry	719	Dry	716	Dry		
SHP-05-48A			906	Dry						
SHP-05-48A			1124	Dry						
SHP-05-48A			1401	Dry						
SHP-05-48A			1608	Dry						
SHP-05-48A			1815	Dry						
SHP-05-48B		Dry	734	Dry	720	Dry	716	Dry		
SHP-05-48B			906	Dry						
SHP-05-48B			1124	Dry						
SHP-05-48B			1401	Dry						
SHP-05-48B			1608	Dry						
SHP-05-48B			1815	Dry						
SHP-05-49A	1823	5.93	901	Dry	734	Dry	713	Dry		
SHP-05-49A			1118	Dry						
SHP-05-49A			1355	Dry						
SHP-05-49B	1823	4.28	901	4.31	733	4.65	714	4.90		
SHP-05-49B			1118	4.35						
SHP-05-49B			1355	4.38						
SHP-05-49B			1600	4.42						
SHP-05-49B			1808	6.08						
SHP-95-27X	1700	33.02	1020	33.05	947	16.14	910	16.25		
SHP-95-27X			1306	32.95						
SHP-95-27X			1709	nr						
SHP-99-33A	1800	13.17	744	13.15	704	10.92				
SHP-99-33A			912	13.13						
SHP-99-33A			1130	13.13						
SHP-99-33A			1408	13.17						
SHP-99-33A			1613	13.19						
SHP-99-33A			1820	13.19						
SHP-99-33B	1800	12.42	744	9.25	702	12.55				
SHP-99-33B			913	12.65						
SHP-99-33B			1131	12.65						
SHP-99-33B			1409	12.65						
SHP-99-33B			1614	12.65						
SHP-99-33B			1821	12.67						
SHP-99-34A	1812	13.65	726	13.73	729	13.56	706	13.67		
SHP-99-34A			857	13.67						
SHP-99-34A			1121	13.68						
SHP-99-34A			1357	13.67						
SHP-99-34A			1603	13.71						
SHP-99-34A			1812	13.71						
SHP-99-34B	1812	13.33	726	13.43	726	13.25	707	13.95		
SHP-99-34B			858	13.40						
SHP-99-34B			1122	13.40						
SHP-99-34B			1358	13.40						
SHP-99-34B			1604	13.40						
SHP-99-34B			1813	13.38						
SHP-99-35X	1635	36.39	1007	36.40	1009	35.05	930	36.44		
SHP-99-35X			1250	36.42						
SHP-99-35X			1658	36.39						
WP-01		Dry		Dry			736	Dry		

(shaded) Measurement error or data collected during reduced pumping related to system backwash (short duration effect on near field monitoring).

nr No reading.

Attachment C
Time-Drawdown and Recovery Data



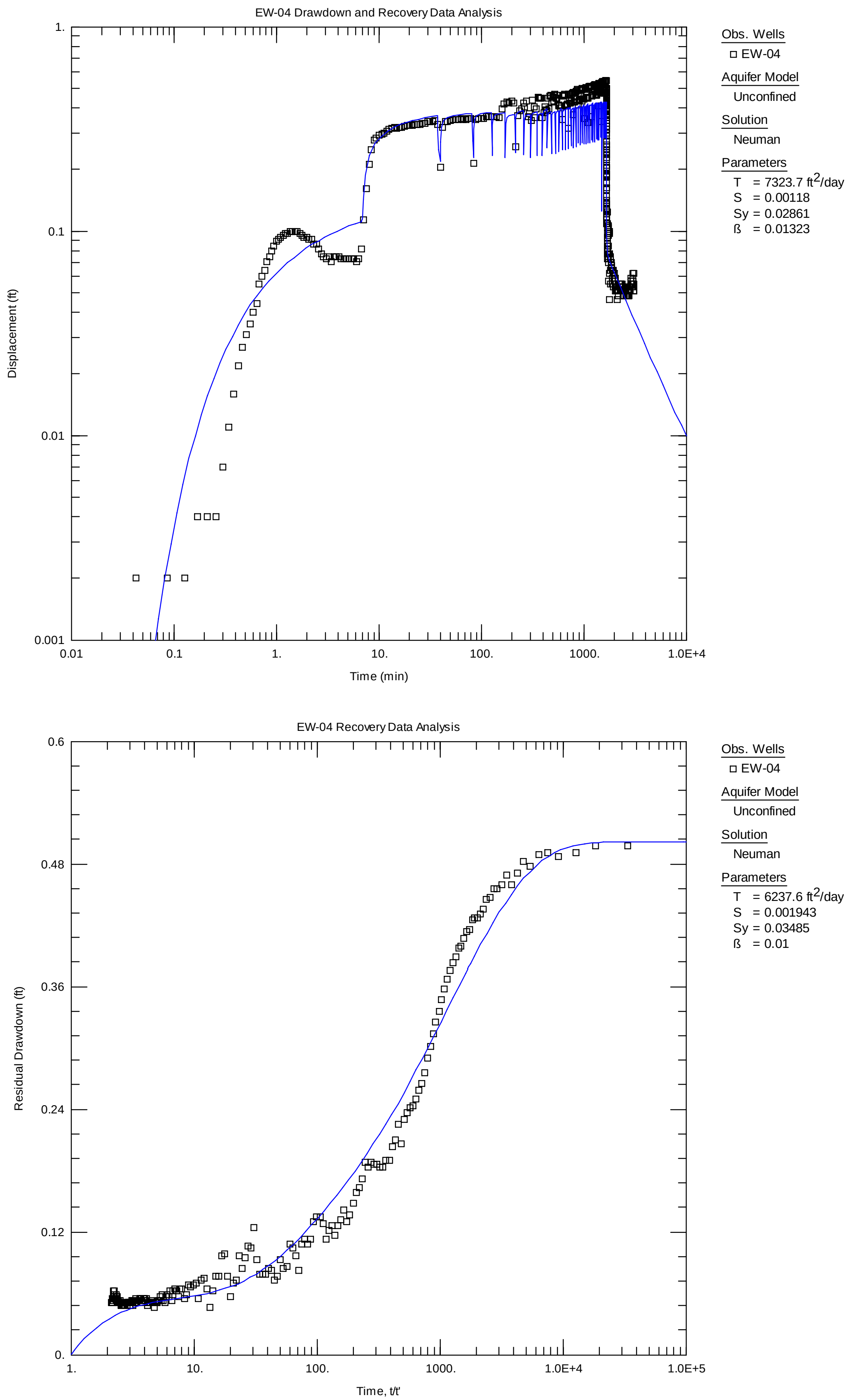
LEGEND

□ Water Level Observation

Figure C-1
Time-Drawdown Plot for EW-01
08/25/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



LEGEND

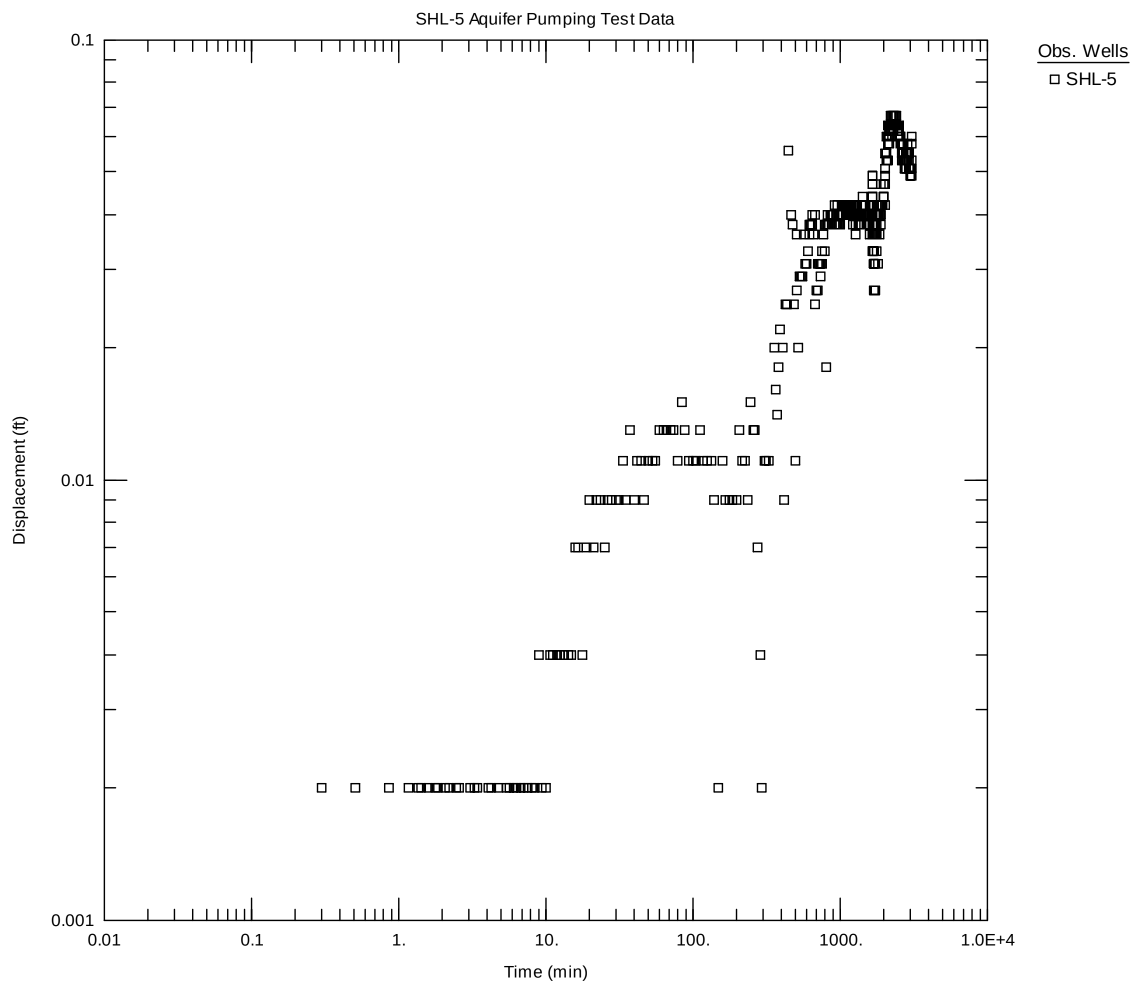
□ Water Level Observation
—— Aquifer Test Solution
T = Transmissivity
S = Storativity
Sy = Specific Yield
β = Neuman's Parameter

t = total pumping time
t′= time since pumping stopped

Figure C-2
Time-Drawdown and Residual Drawdown Plots for EW-04
08/25/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



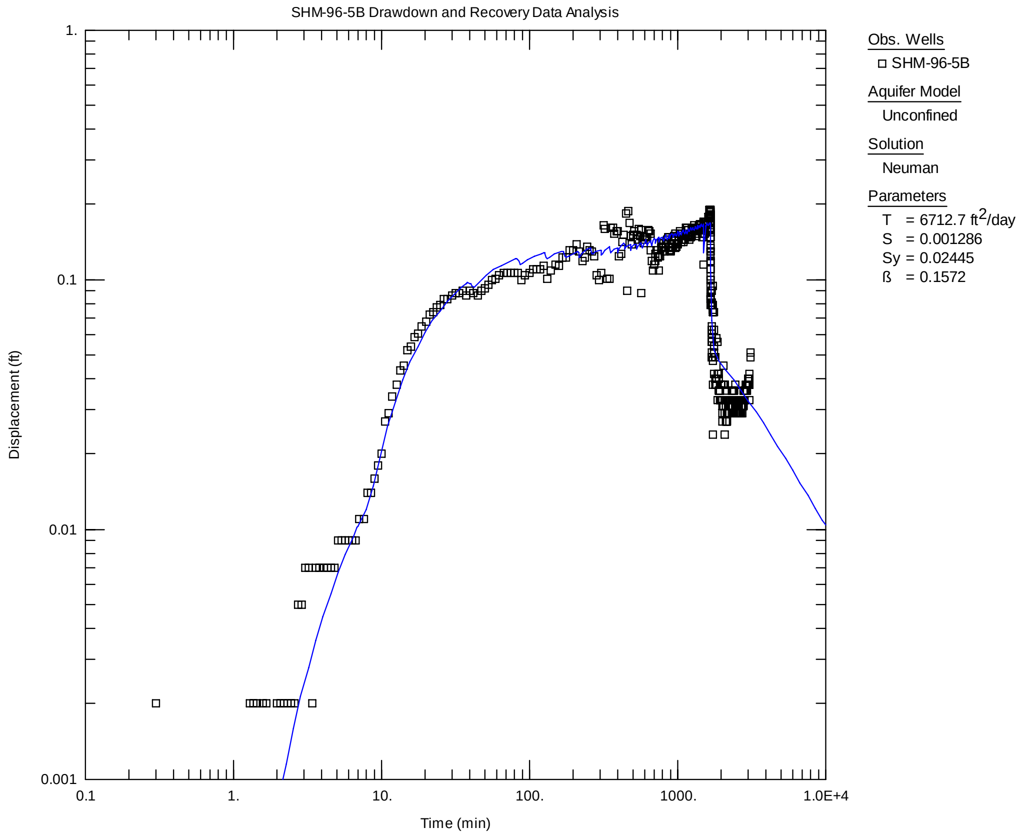
LEGEND

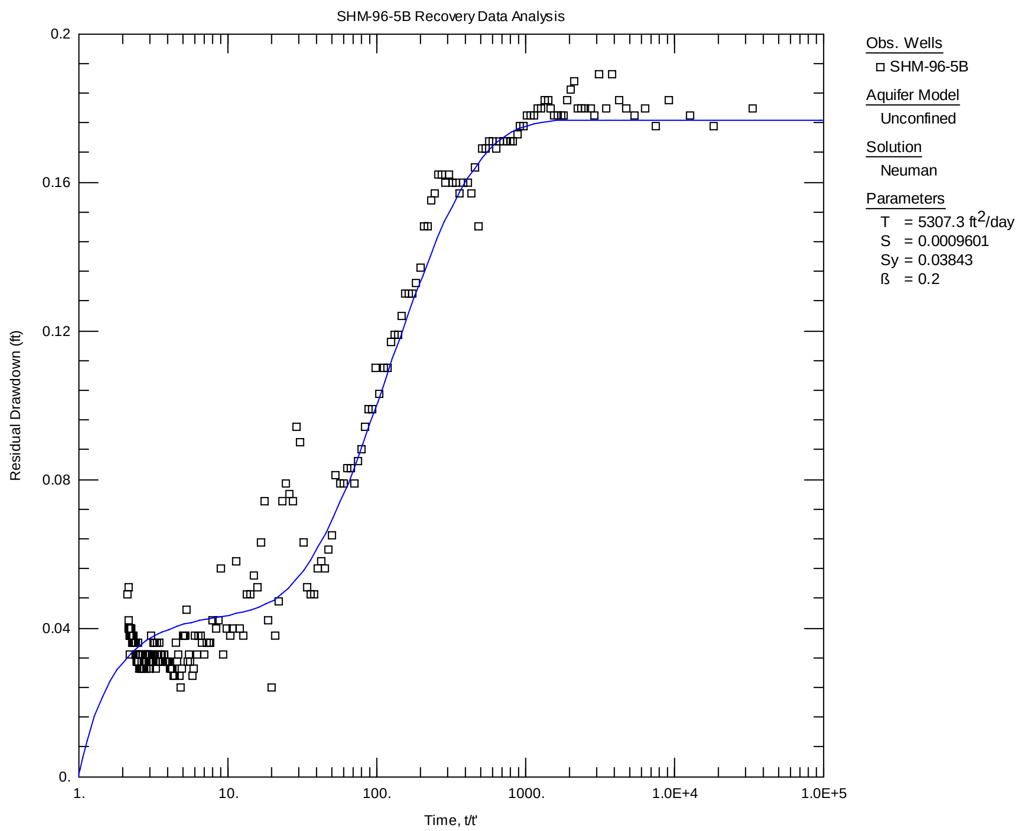
□ Water Level Observation

Figure C-3
Time-Drawdown Plot for SHL-5
08/25/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL





LEGEND

□ Water Level Observation

—— Aquifer Test Solution

T = Transmissivity

S = Storativity

Sy = Specific Yield

β = Neuman's Parameter

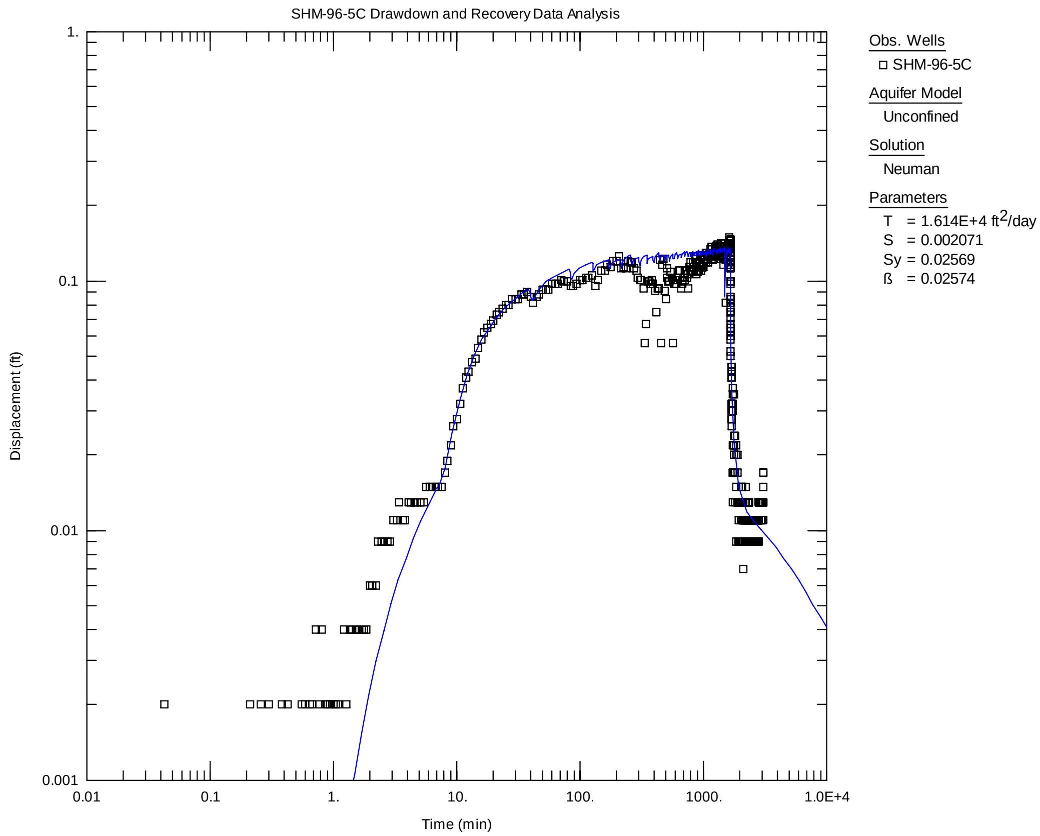
t = total pumping time

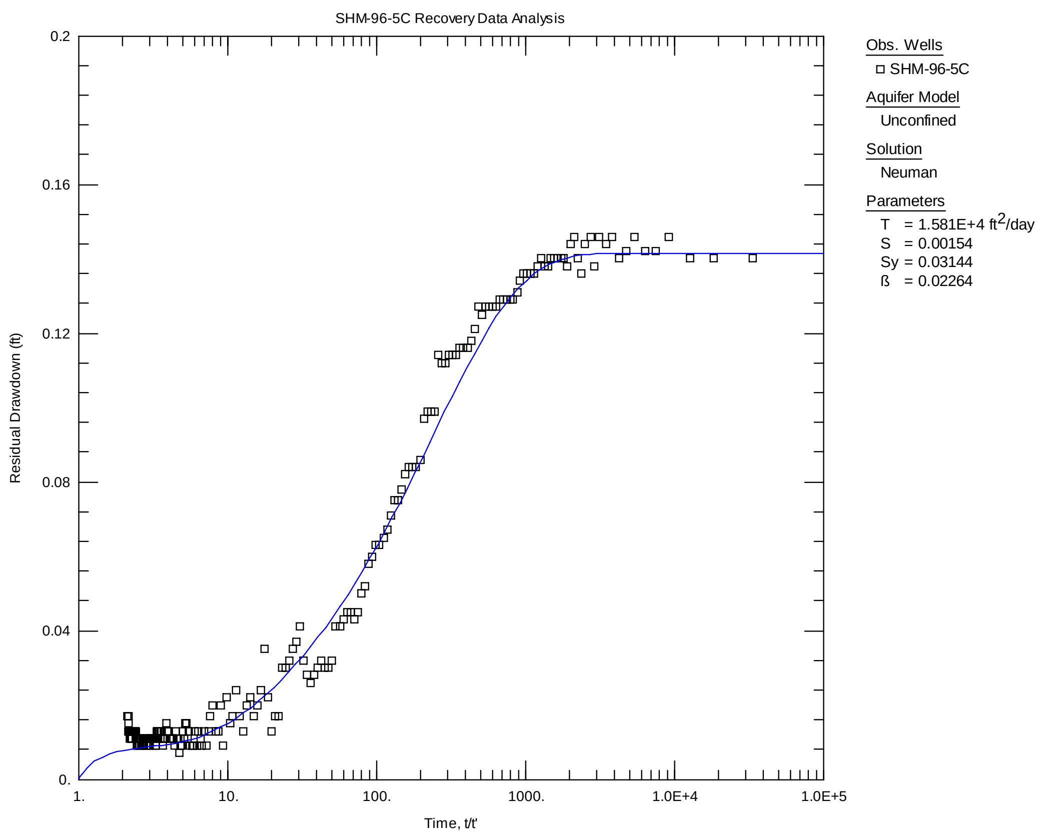
t′= time since pumping stopped

Figure C-4
Time-Drawdown and Residual Drawdown Plots for SHM-96-5B
08/25/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL





LEGEND

□ Water Level Observation

—— Aquifer Test Solution

T = Transmissivity

S = Storativity

Sy = Specific Yield

β = Neuman's Parameter

t = total pumping time

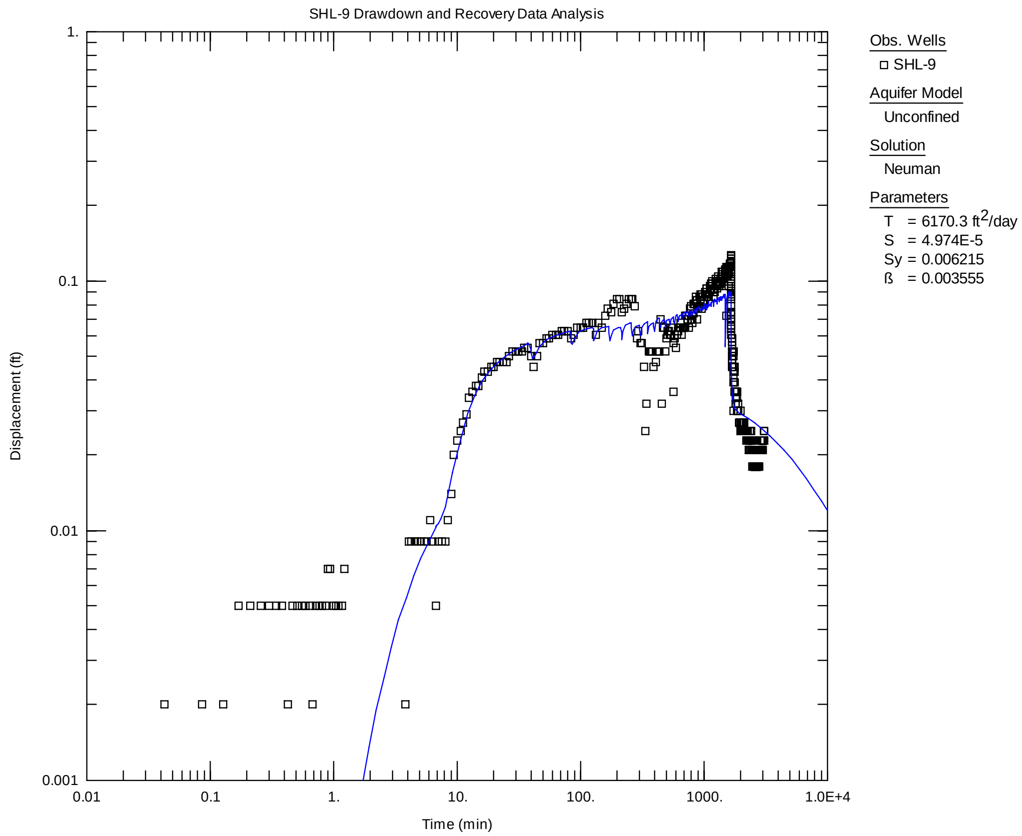
t′= time since pumping stopped

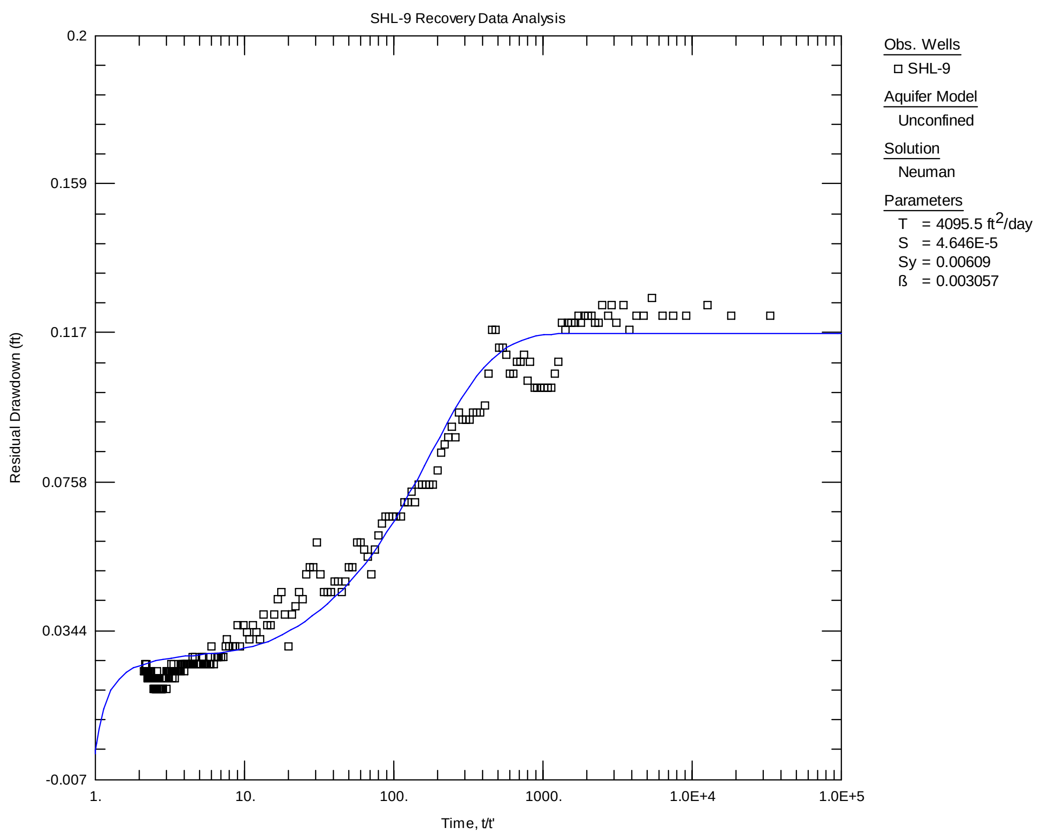
Figure C-5

Time-Drawdown and Residual Drawdown Plots for SHM-96-5C 08/25/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL





LEGEND

□ Water Level Observation

Aquifer Test Solution

T = Transmissivity

S = Storativity

Sy = Specific Yield

β = Neuman's Parameter

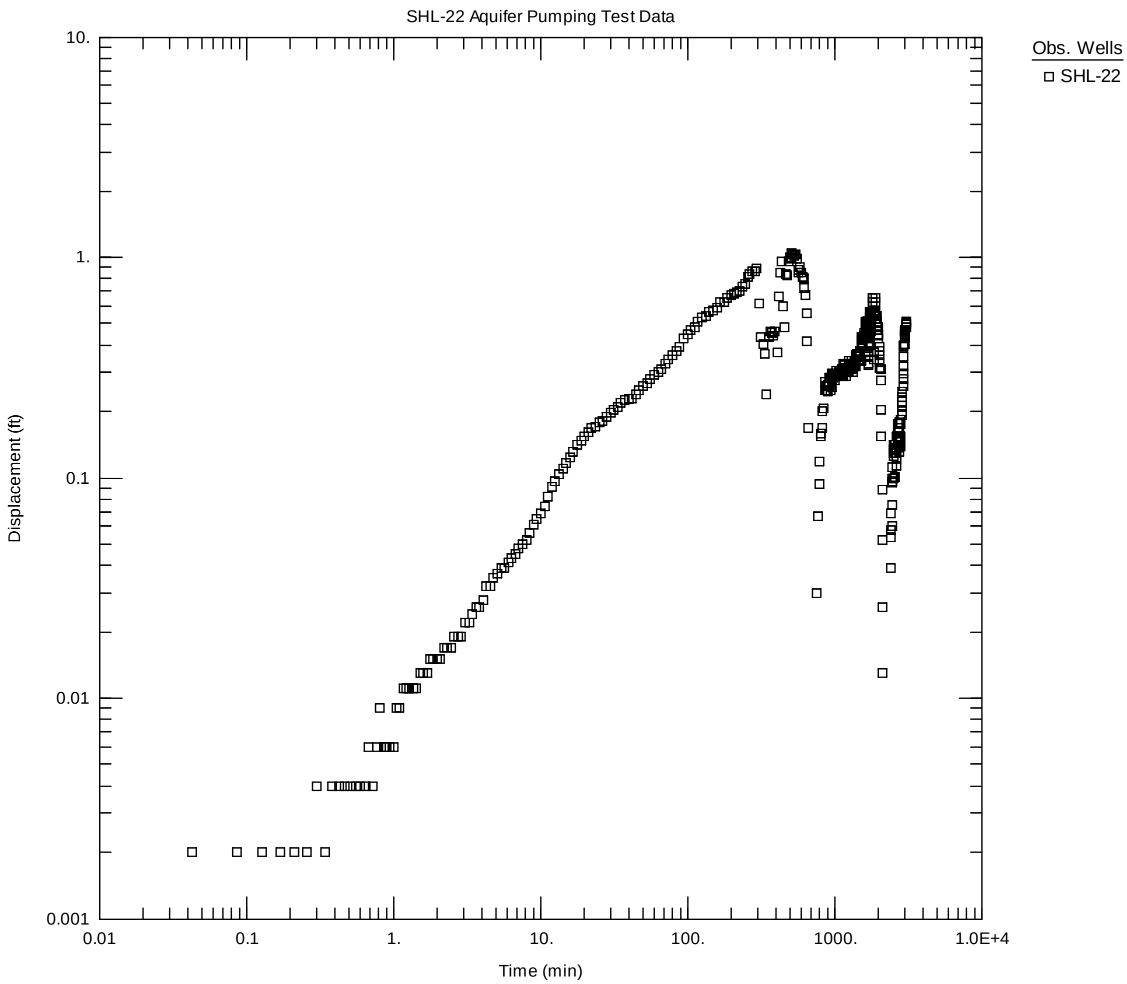
t = total pumping time

t′= time since pumping stopped

Figure C-6
Time-Drawdown and Residual Drawdown Plots for SHL-9
08/25/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL

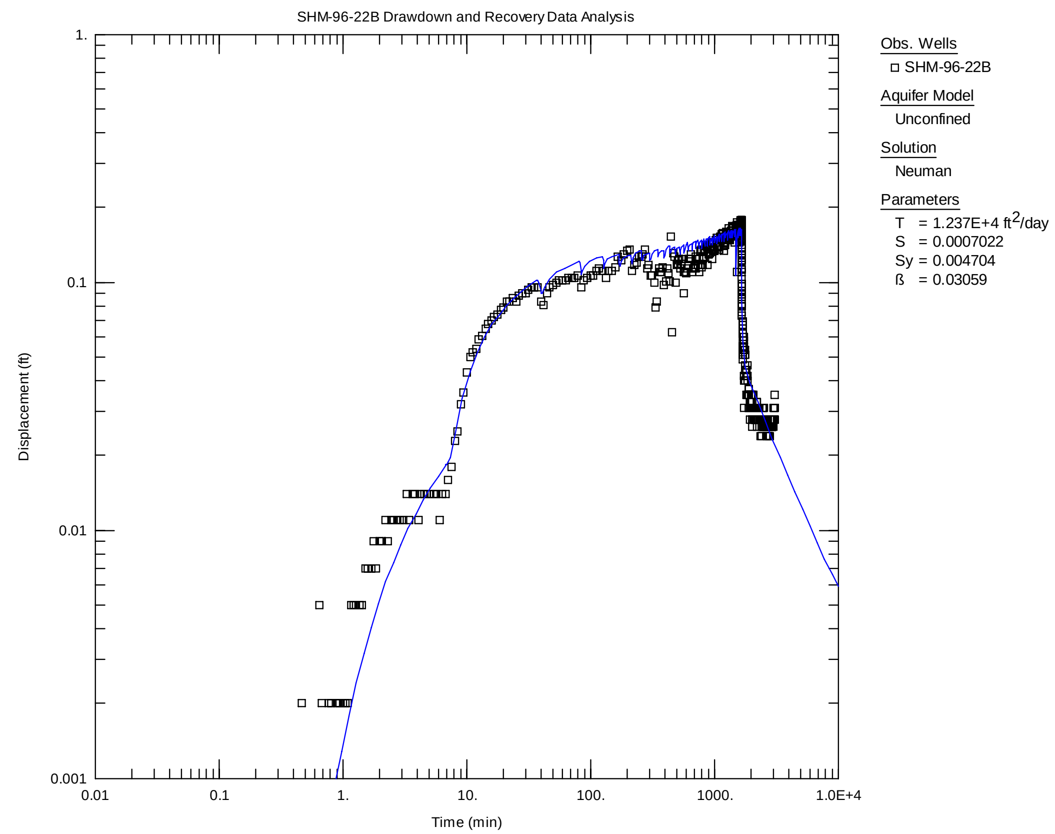


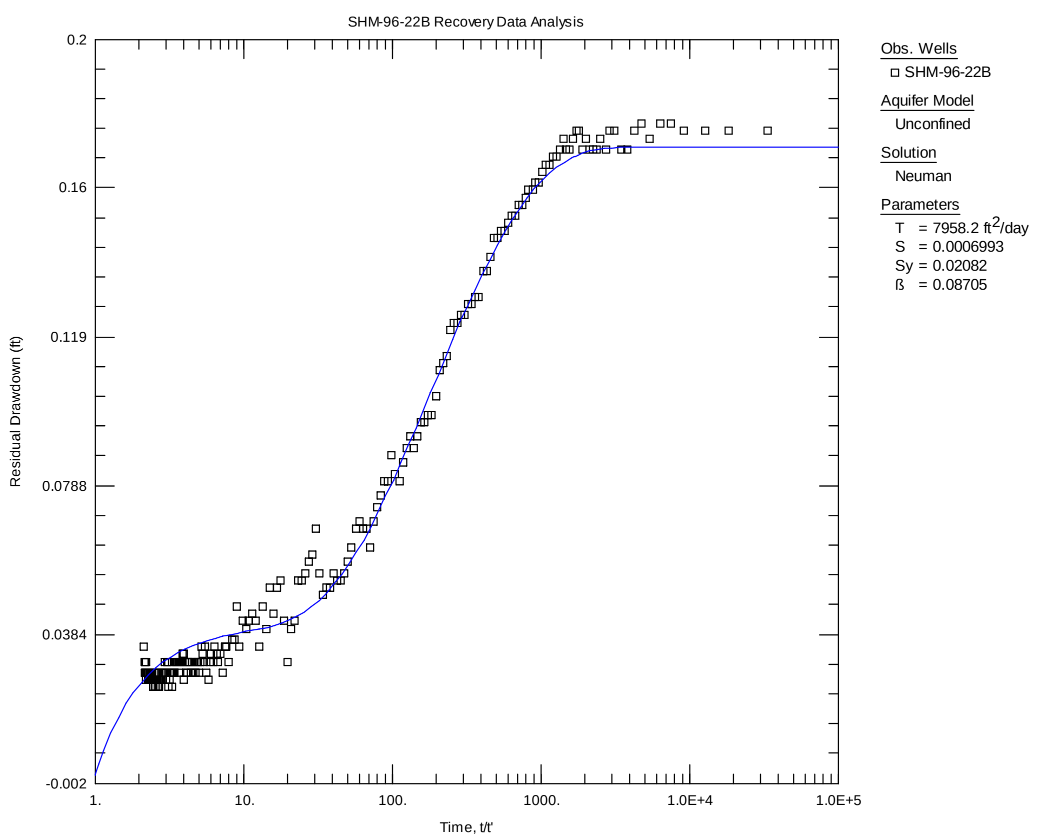
LEGEND
□ Water Level Observation

Figure C-7
Time-Drawdown Plot for SHL-22
08/25/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL





LEGEND

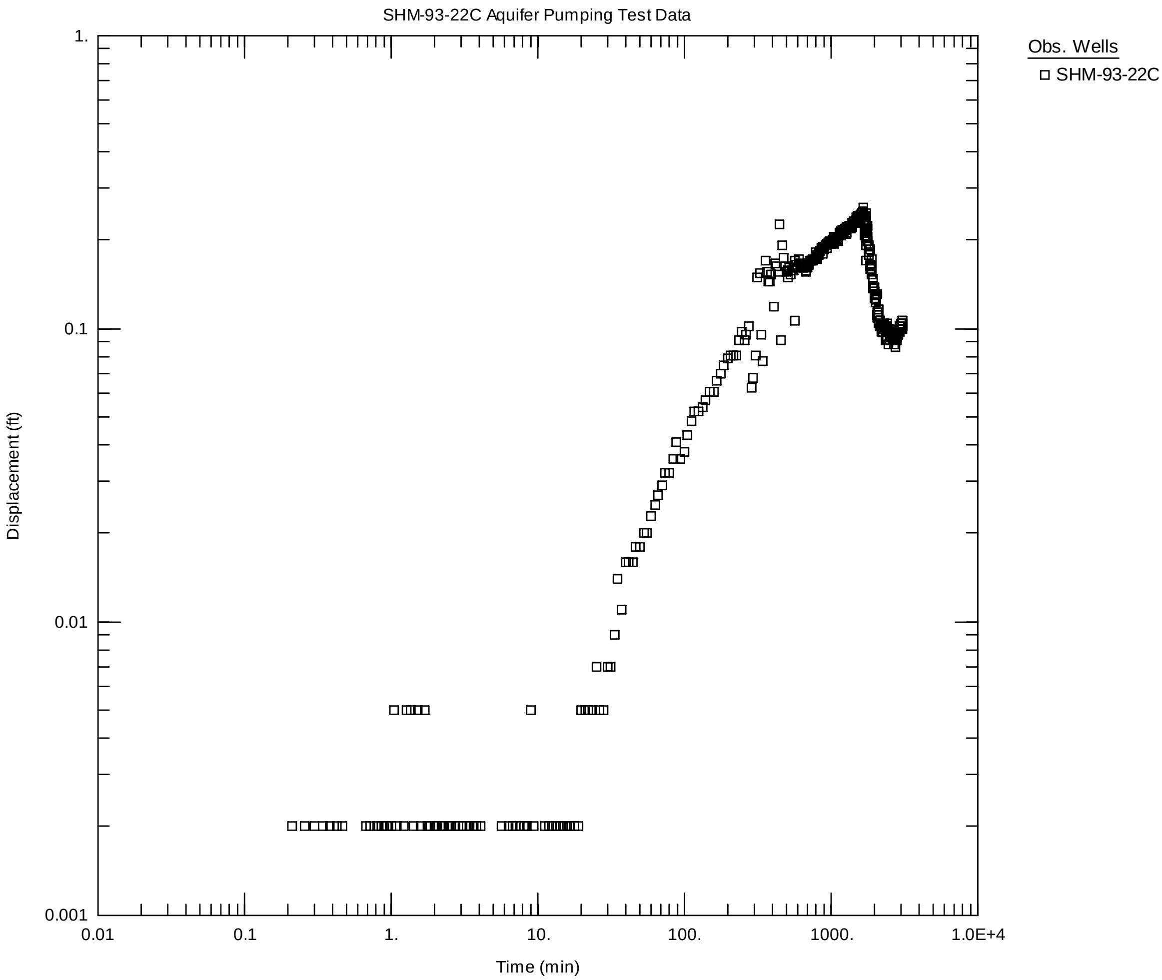
□ Water Level Observation
Aquifer Test Solution
T = Transmissivity
S = Storativity
Sy = Specific Yield
β = Neuman's Parameter

t = total pumping time
t′= time since pumping stopped

Figure C-8
Time-Drawdown and Residual Drawdown Plots for SHM-96-22B
08/25/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



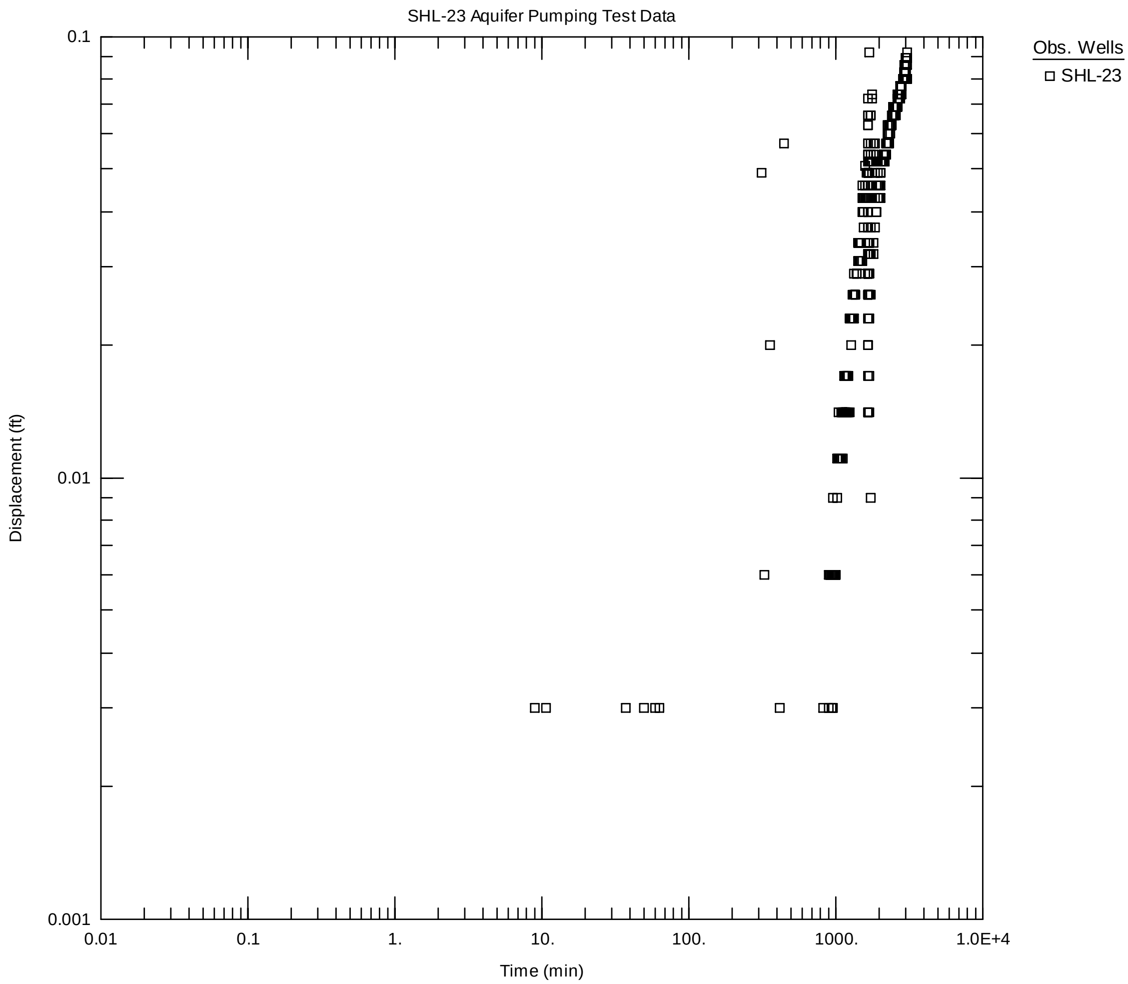
LEGEND

□ Water Level Observation

Figure C-9
Time-Drawdown Plot for SHM-93-22C
08/25/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL

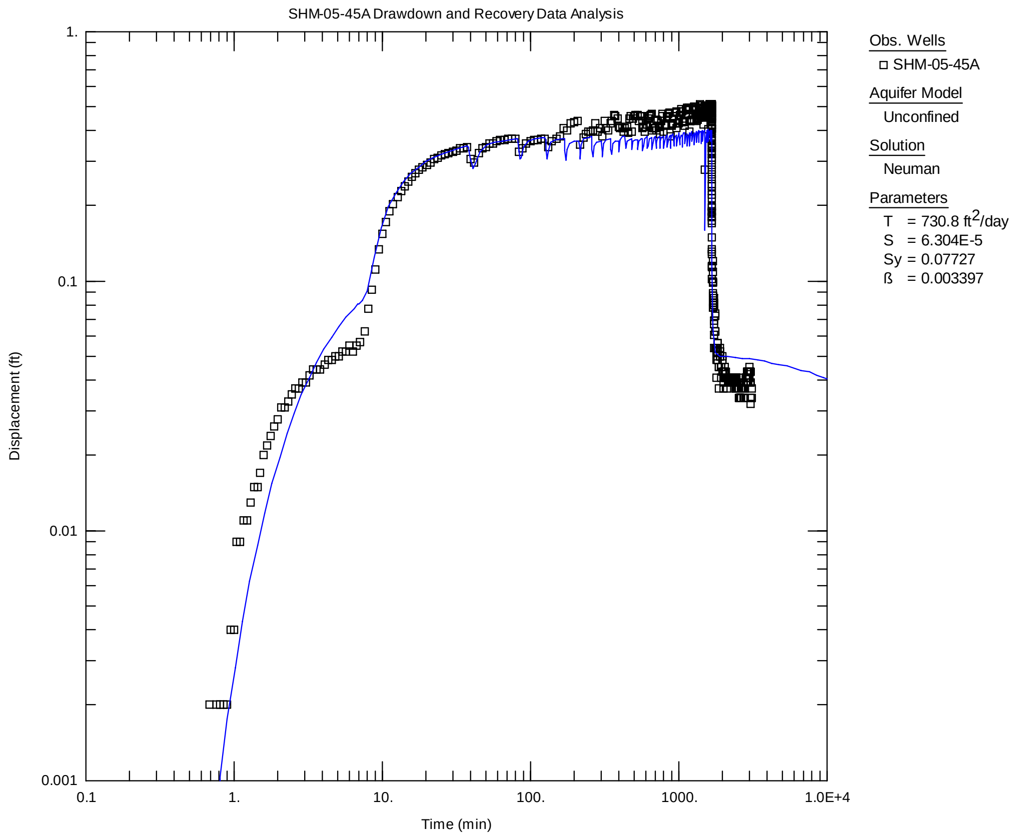


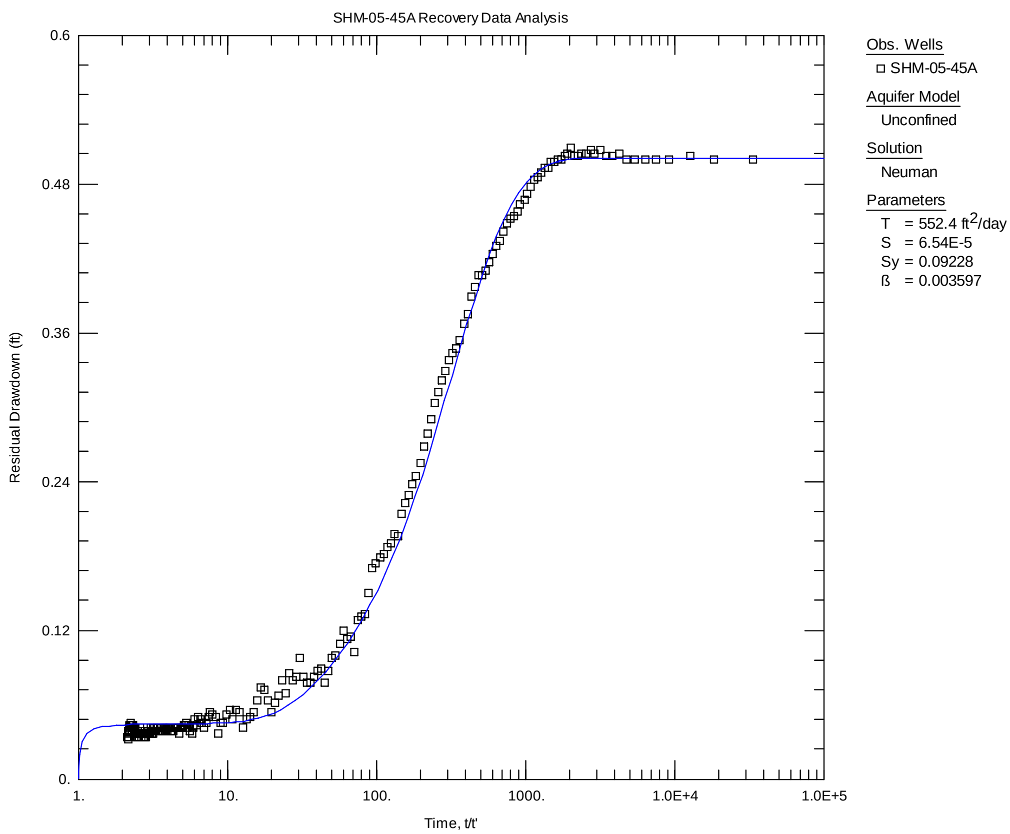
LEGEND
□ Water Level Observation

Figure C-10
Time-Drawdown Plot for SHL-23
08/25/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL





LEGEND

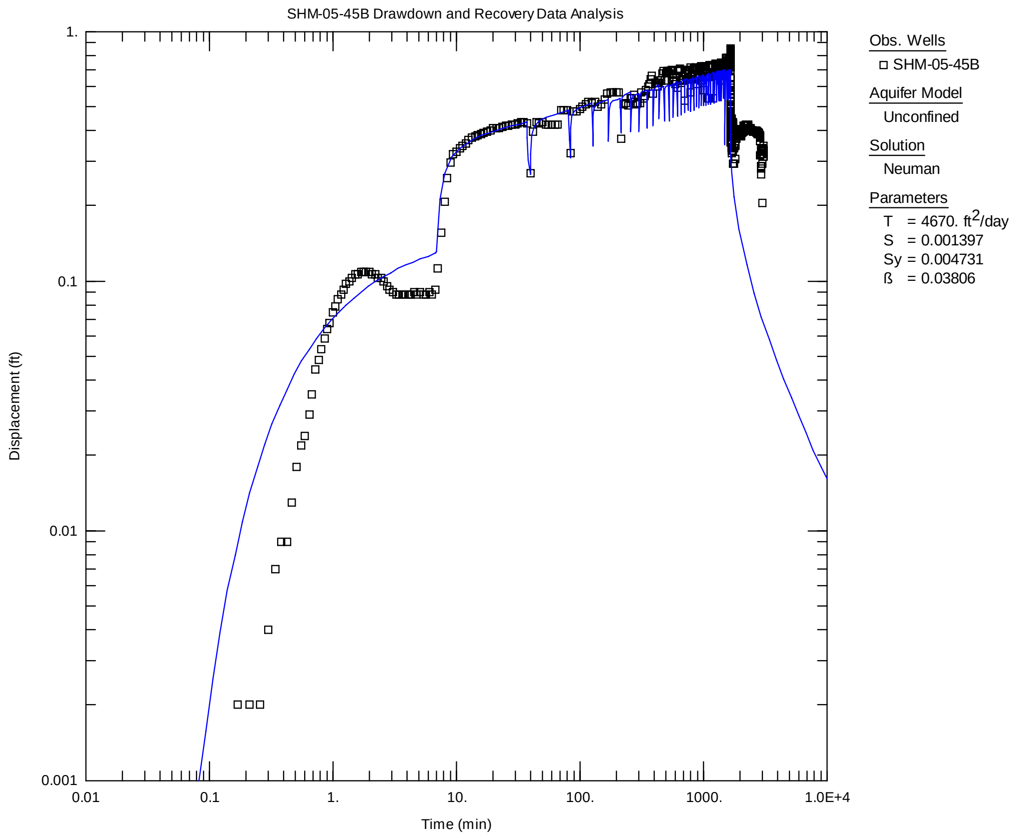
□ Water Level Observation
—— Aquifer Test Solution
T = Transmissivity
S = Storativity
Sy = Specific Yield
β = Neuman's Parameter

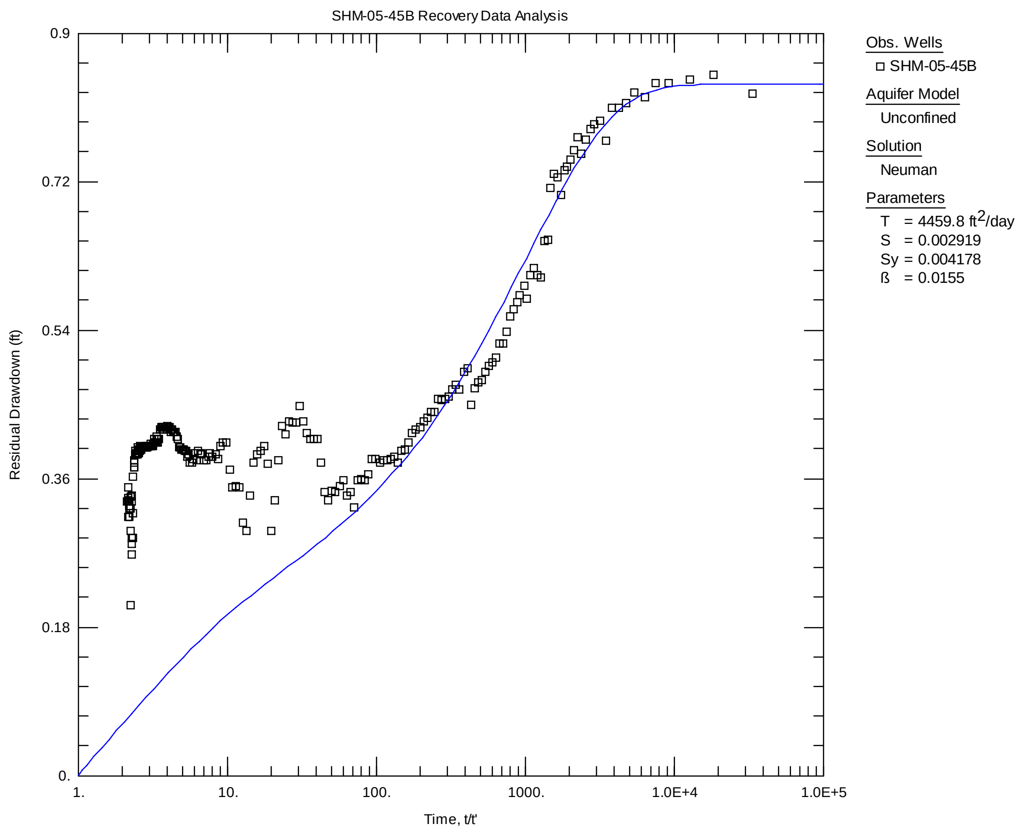
t = total pumping time
t′= time since pumping stopped

Figure C-11
Time-Drawdown and Residual Drawdown Plots for SHM-05-45A
08/25/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL





LEGEND

□ Water Level Observation

Aquifer Test Solution

T = Transmissivity

S = Storativity

Sy = Specific Yield

β = Neuman's Parameter

t = total pumping time

t′= time since pumping stopped

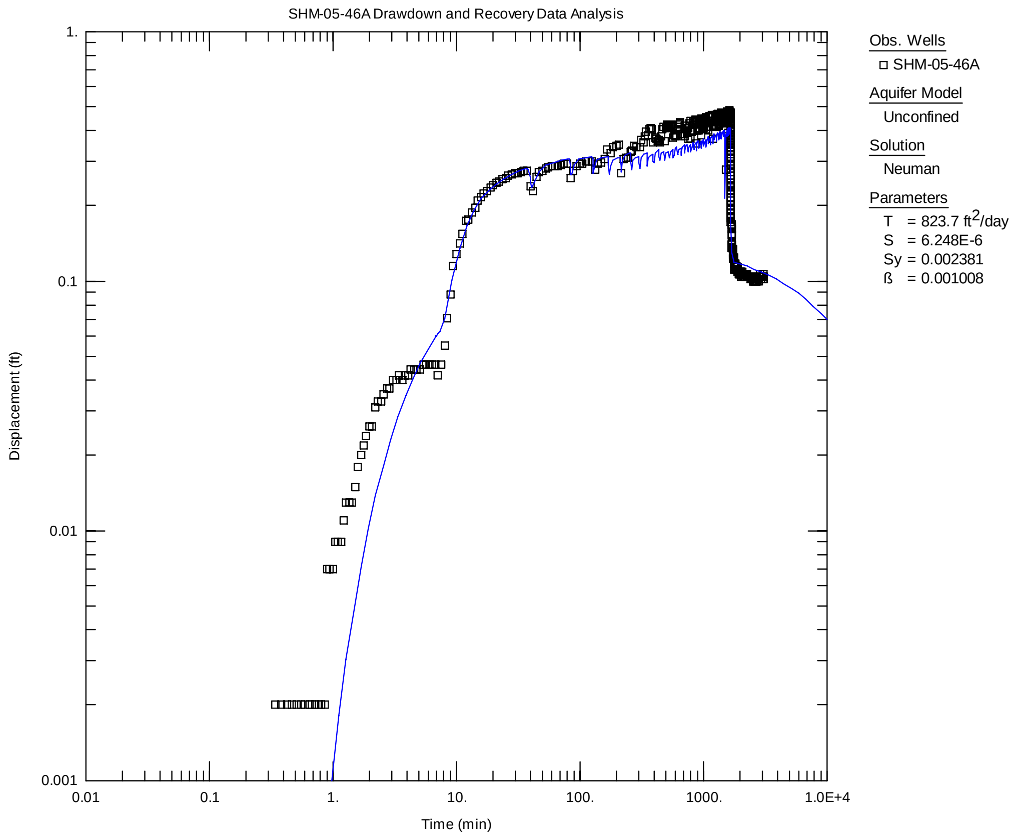
Figure C-12

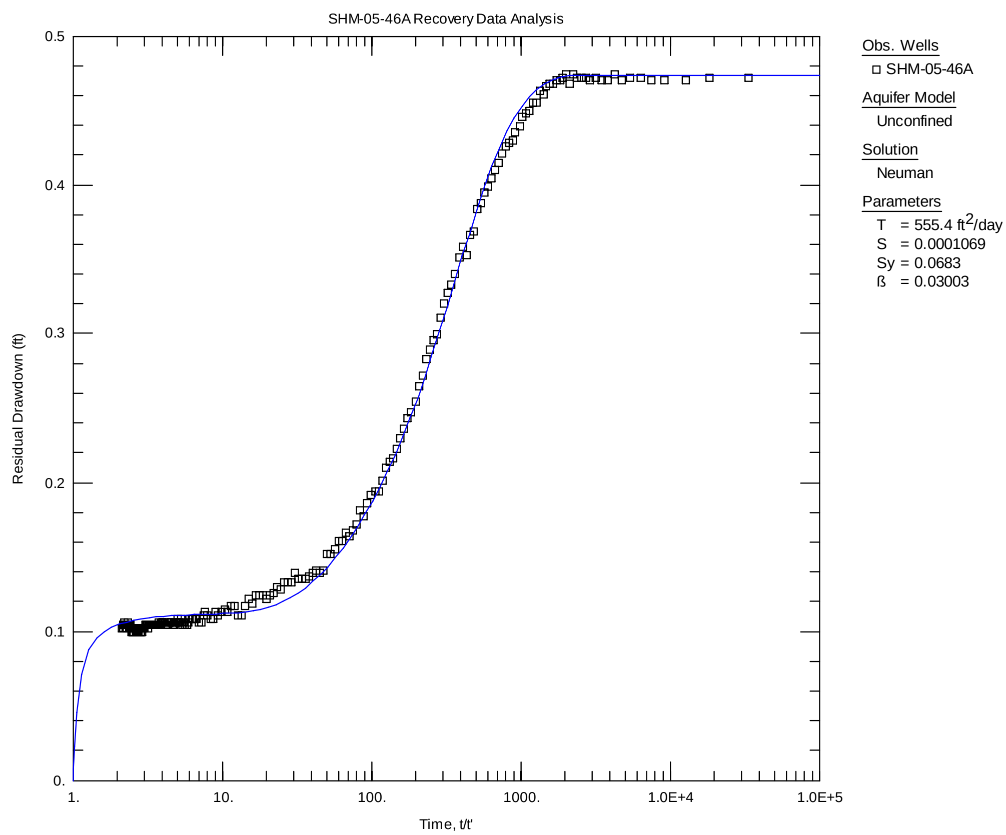
Time-Drawdown and Residual Drawdown Plots for SHM-05-45B

08/25/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL





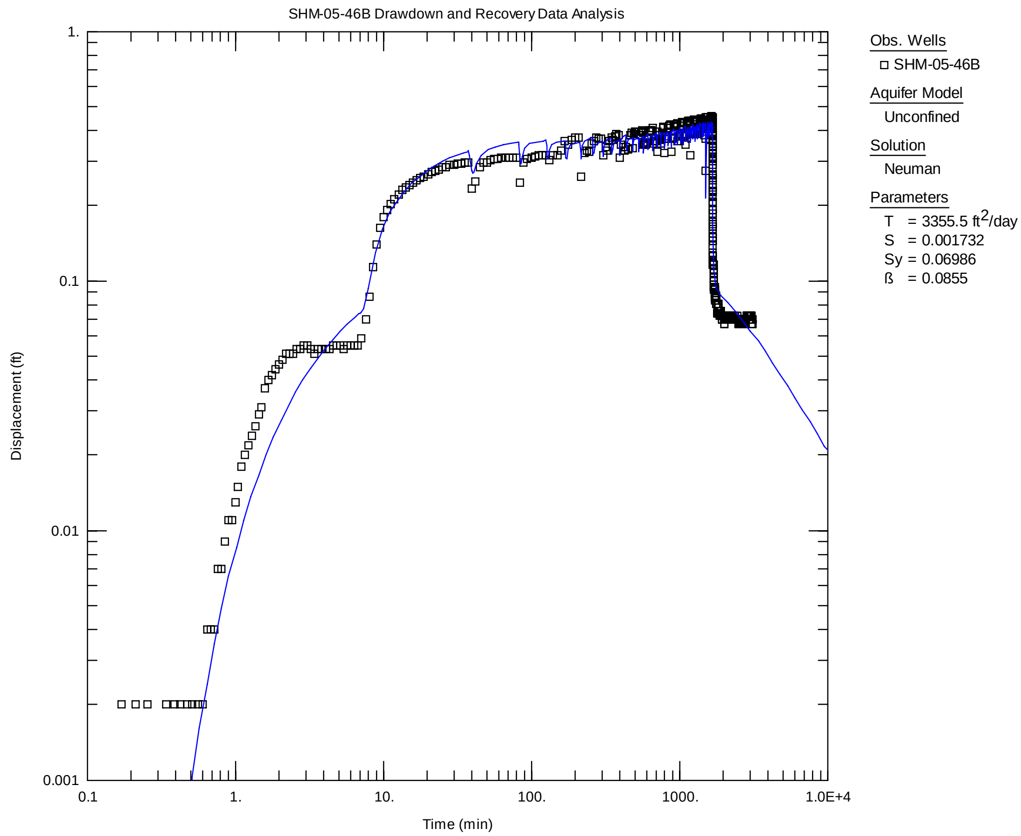
LEGEND

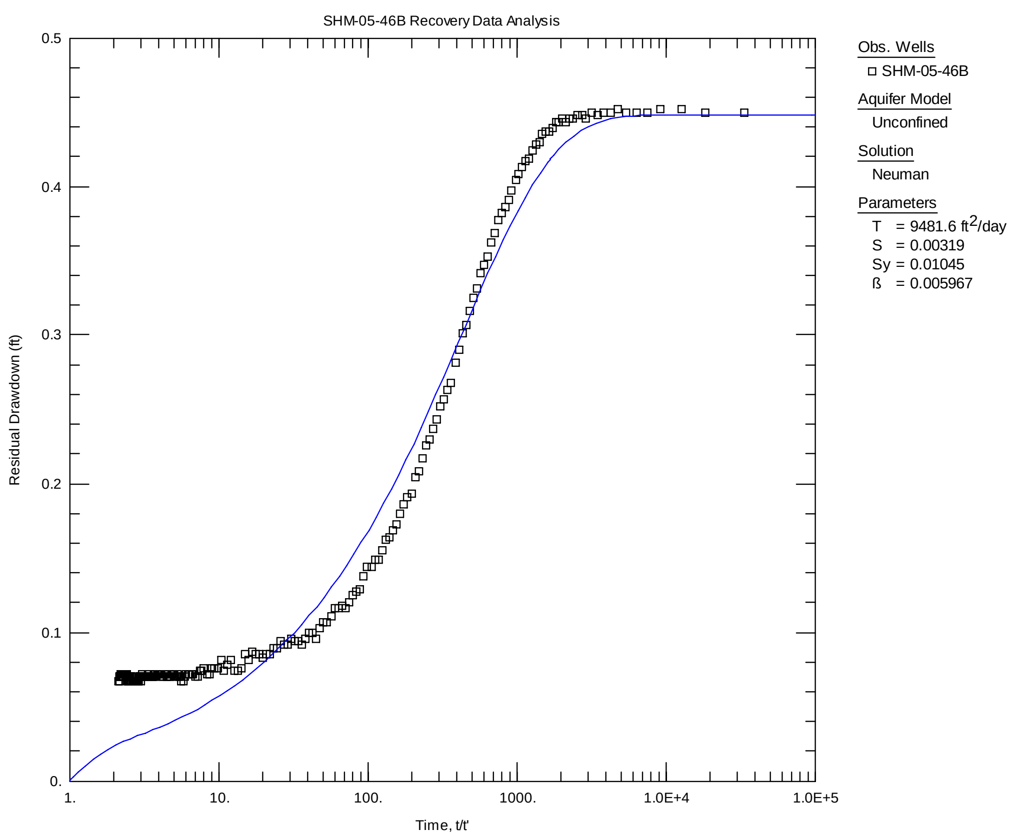
- □ Water Level Observation
- —— Aquifer Test Solution
- T = Transmissivity
- S = Storativity
- Sy = Specific Yield
- β = Neuman's Parameter
- t = total pumping time
- t′= time since pumping stopped

Figure C-13
Time-Drawdown and Residual Drawdown Plots for SHM-05-46A
08/25/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL





LEGEND

□ Water Level Observation

Aquifer Test Solution

T = Transmissivity

S = Storativity

Sy = Specific Yield

β = Neuman's Parameter

t = total pumping time

t′= time since pumping stopped

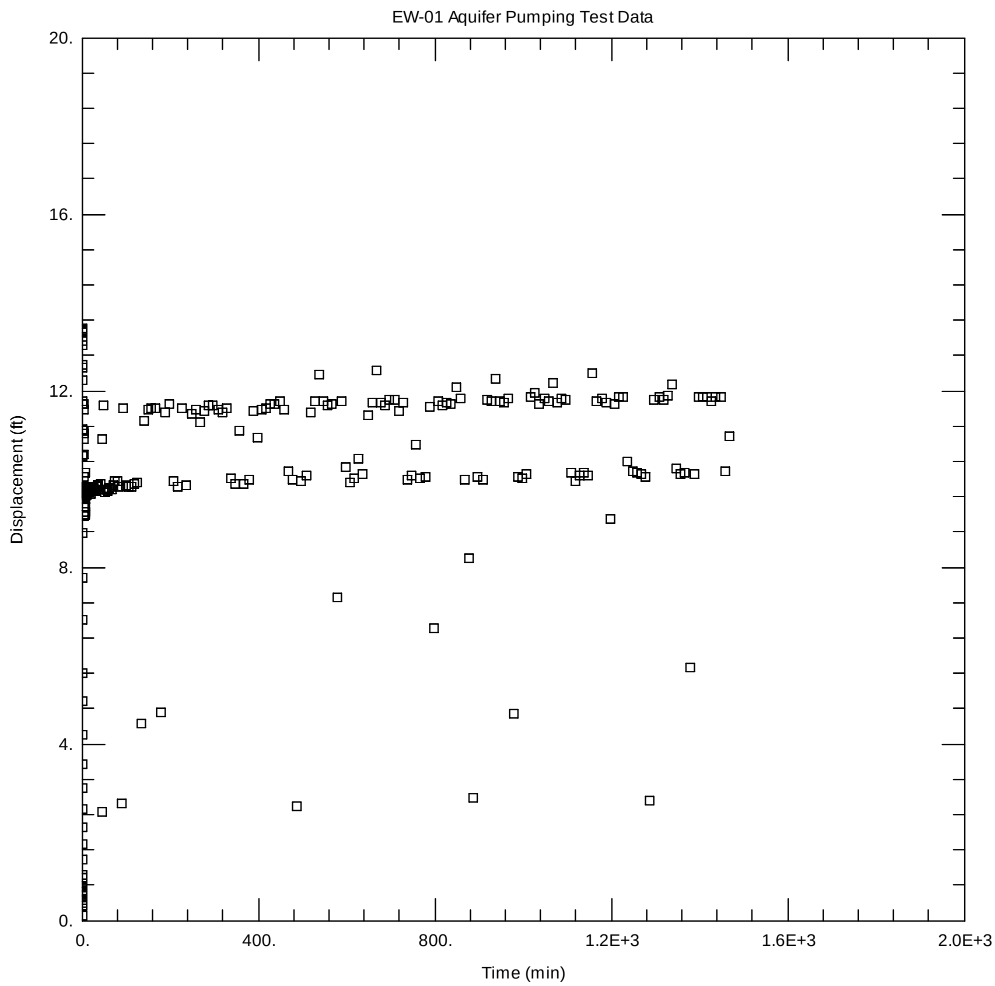
Figure C-14

Time-Drawdown and Residual Drawdown Plots for SHM-05-46B

08/25/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



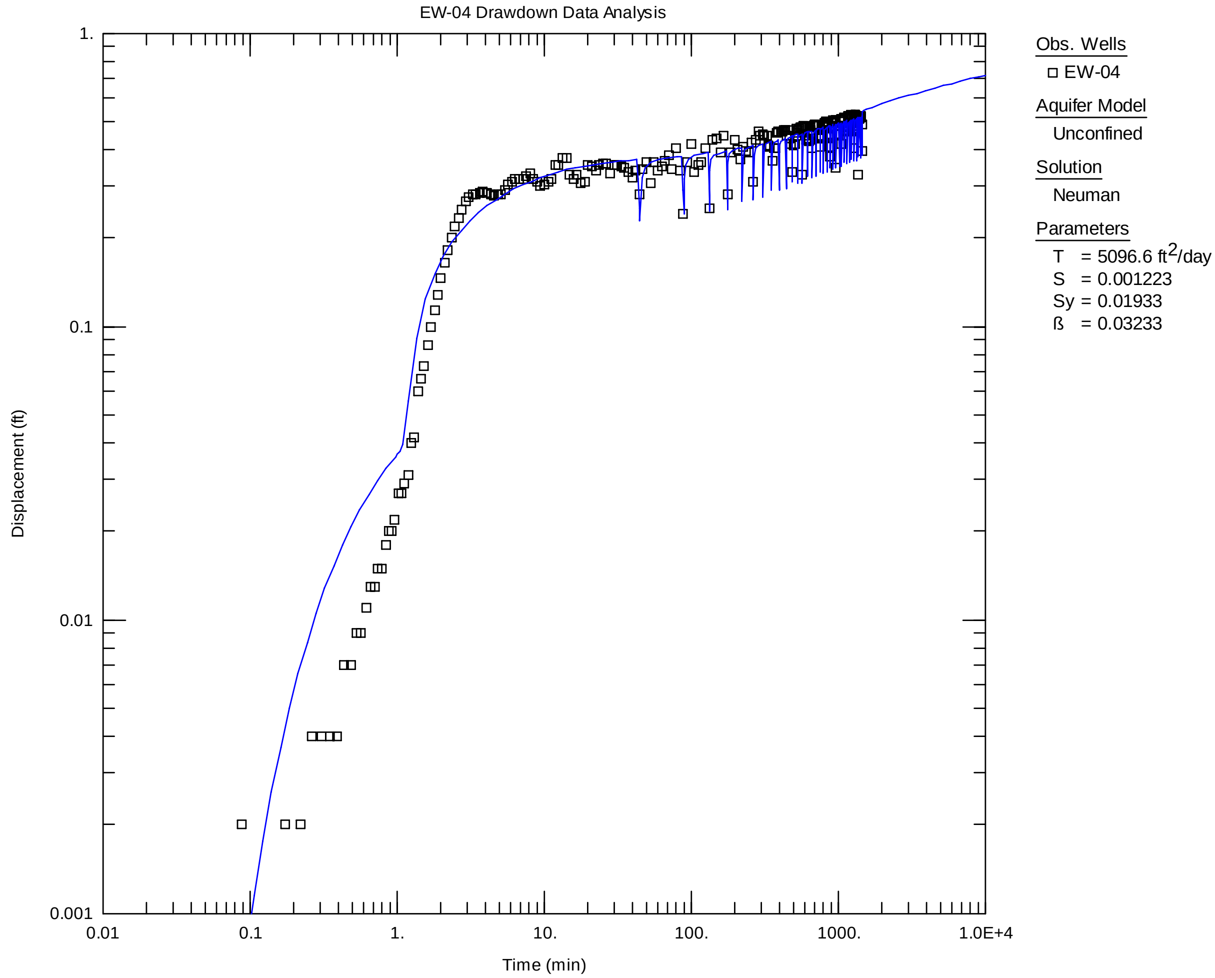
LEGEND

□ Water Level Observation

Figure C-15
Time-Drawdown Plot for EW-01
08/29/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



LEGEND

- □ Water Level Observation
- —— Aquifer Test Solution

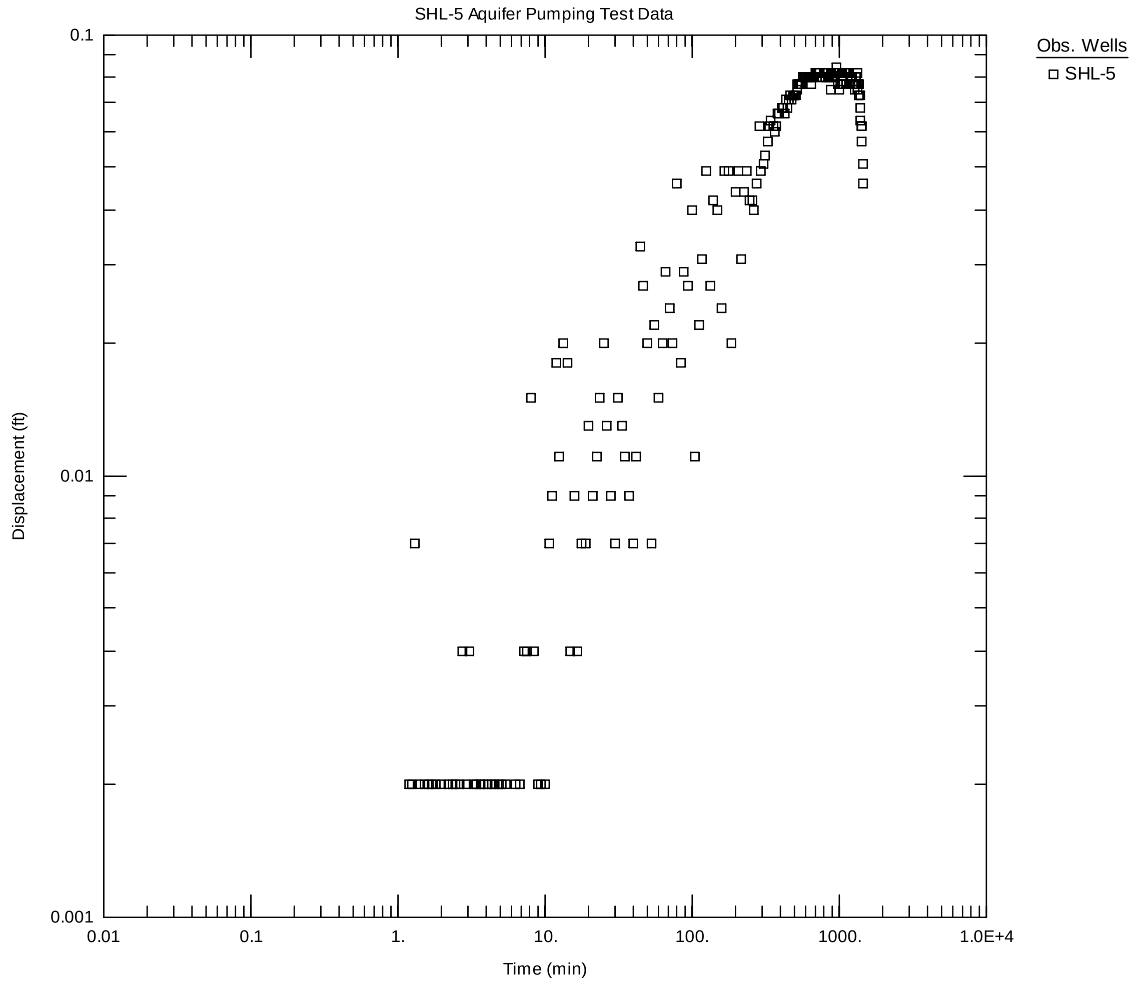
T = Transmissivity
S = Storativity
Sy = Specific Yield
β = Neuman's Parameter

t = total pumping time
t′= time since pumping stopped

Figure C-16
Time-Drawdown Plot for EW-04
08/29/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



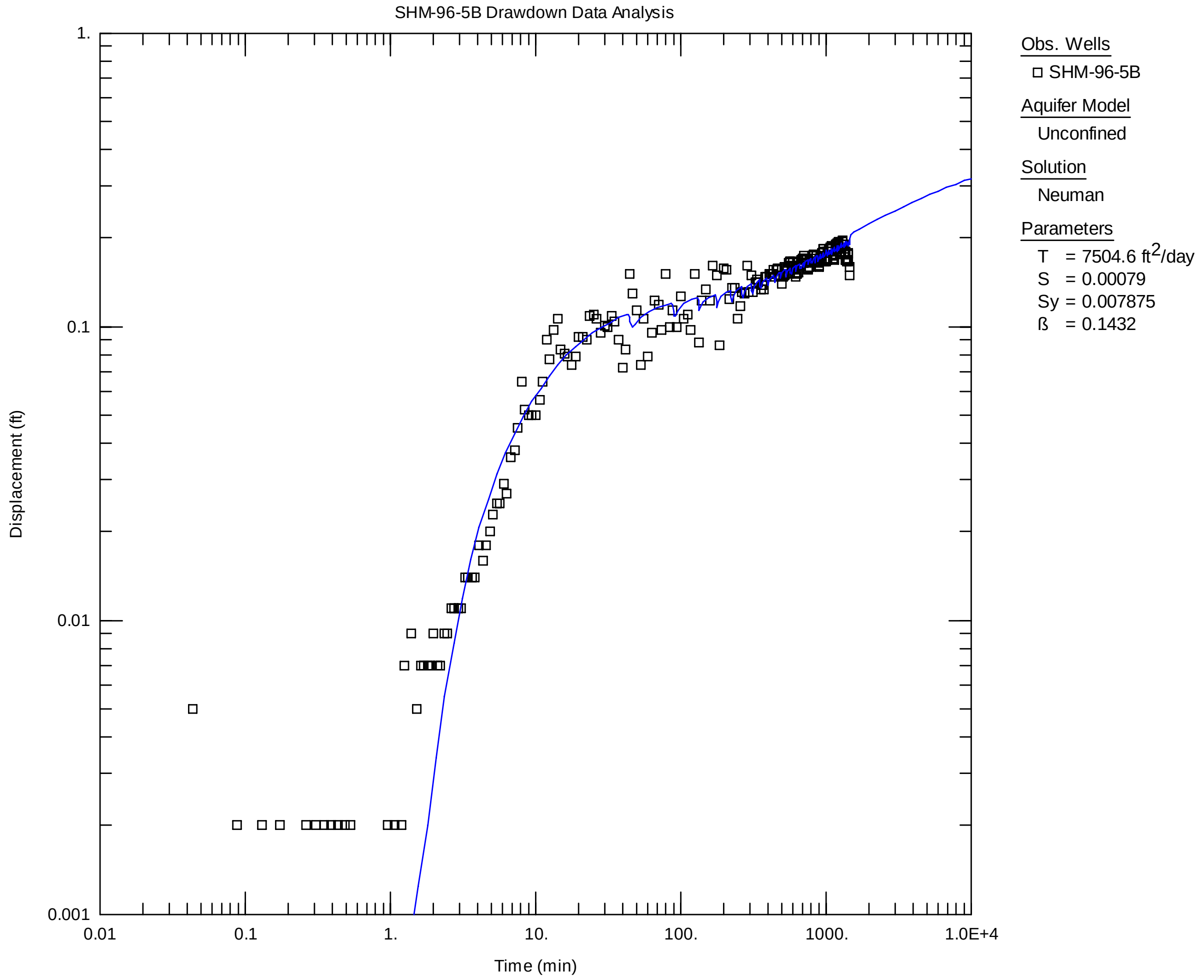
LEGEND

□ Water Level Observation

Figure C-17
Time-Drawdown Plot for SHL-5
08/29/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



LEGEND

□ Water Level Observation

Aquifer Test Solution

T = Transmissivity

S = Storativity

Sy = Specific Yield

β = Neuman's Parameter

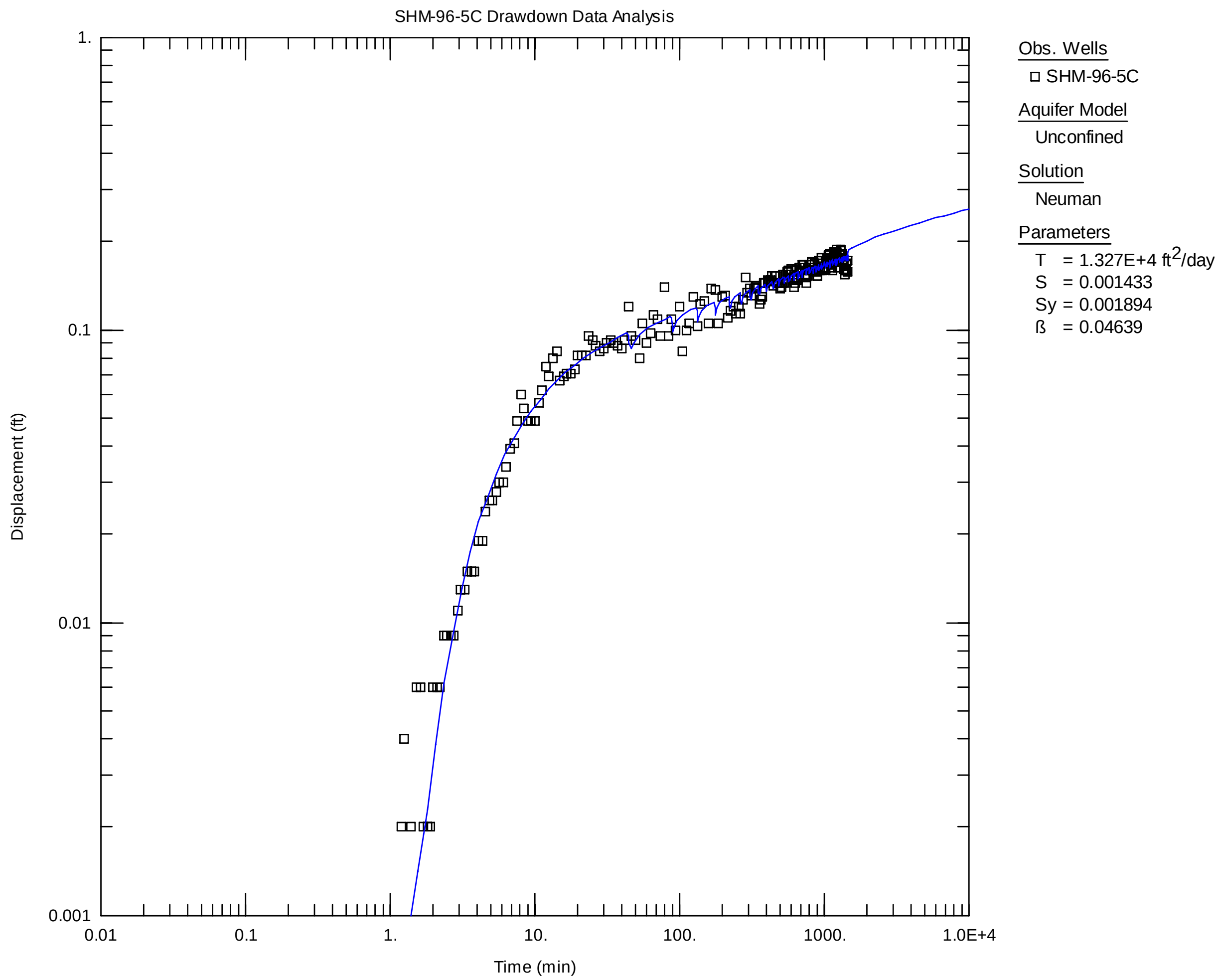
t = total pumping time

t′= time since pumping stopped

Figure C-18
Time-Drawdown Plot for SHM-96-5B
08/29/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



LEGEND

□ Water Level Observation

—— Aquifer Test Solution

T = Transmissivity

S = Storativity

Sy = Specific Yield

β = Neuman's Parameter

t = total pumping time

t′= time since pumping stopped

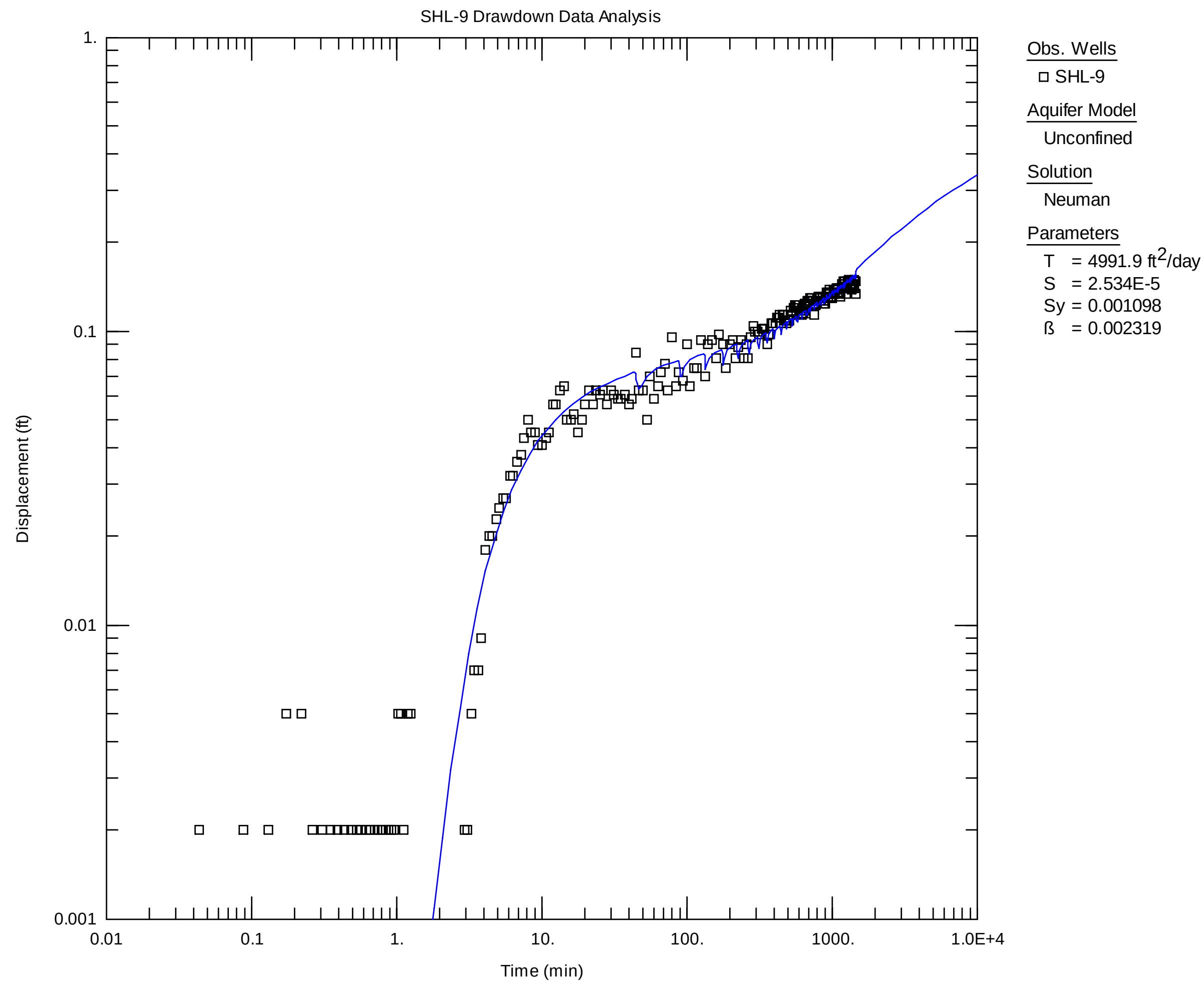
Figure C-19

Time-Drawdown Plot for SHM-96-5C

08/29/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



LEGEND

□ Water Level Observation

Aquifer Test Solution

T = Transmissivity

S = Storativity

Sy = Specific Yield

β = Neuman's Parameter

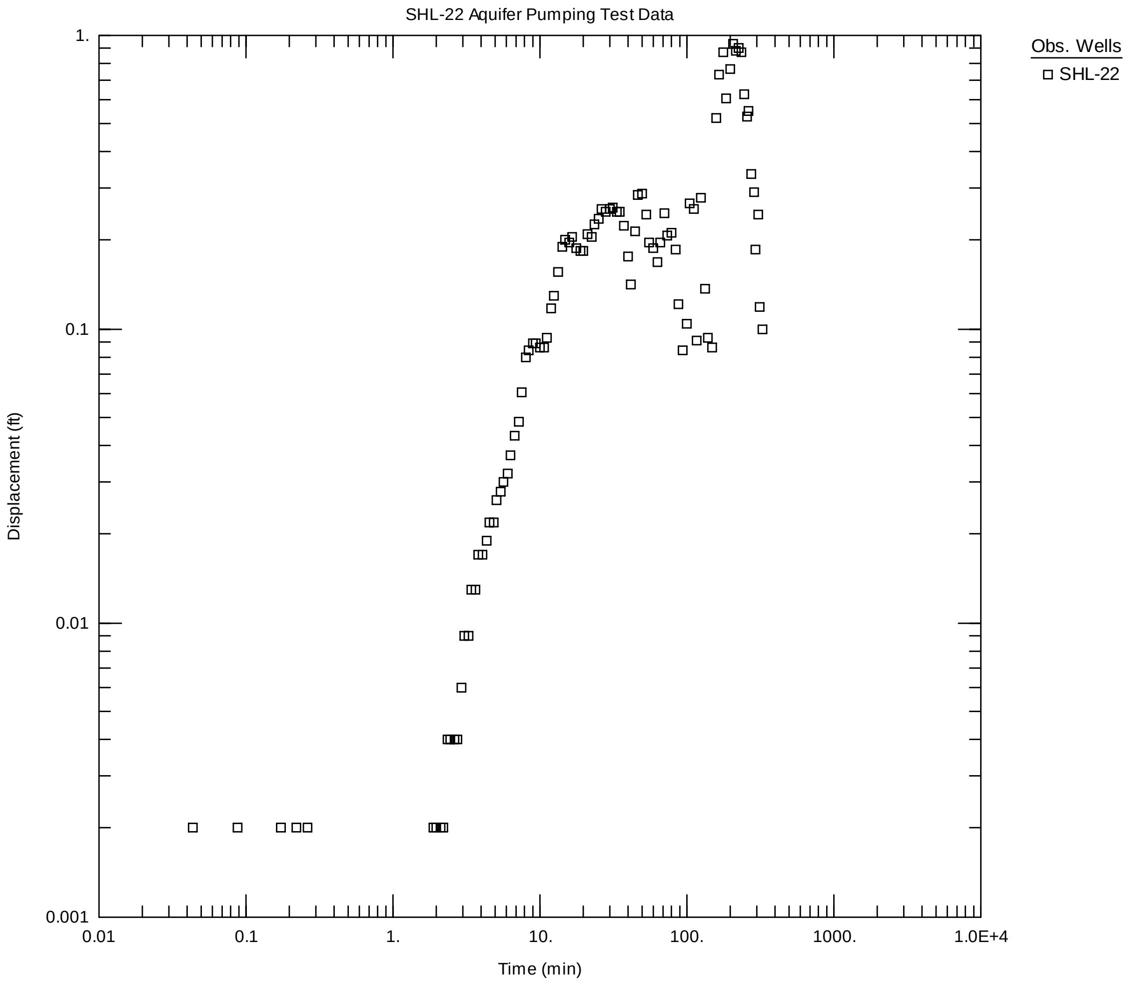
t = total pumping time

t′= time since pumping stopped

Figure C-20
Time-Drawdown Plot for SHL-9
08/29/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL

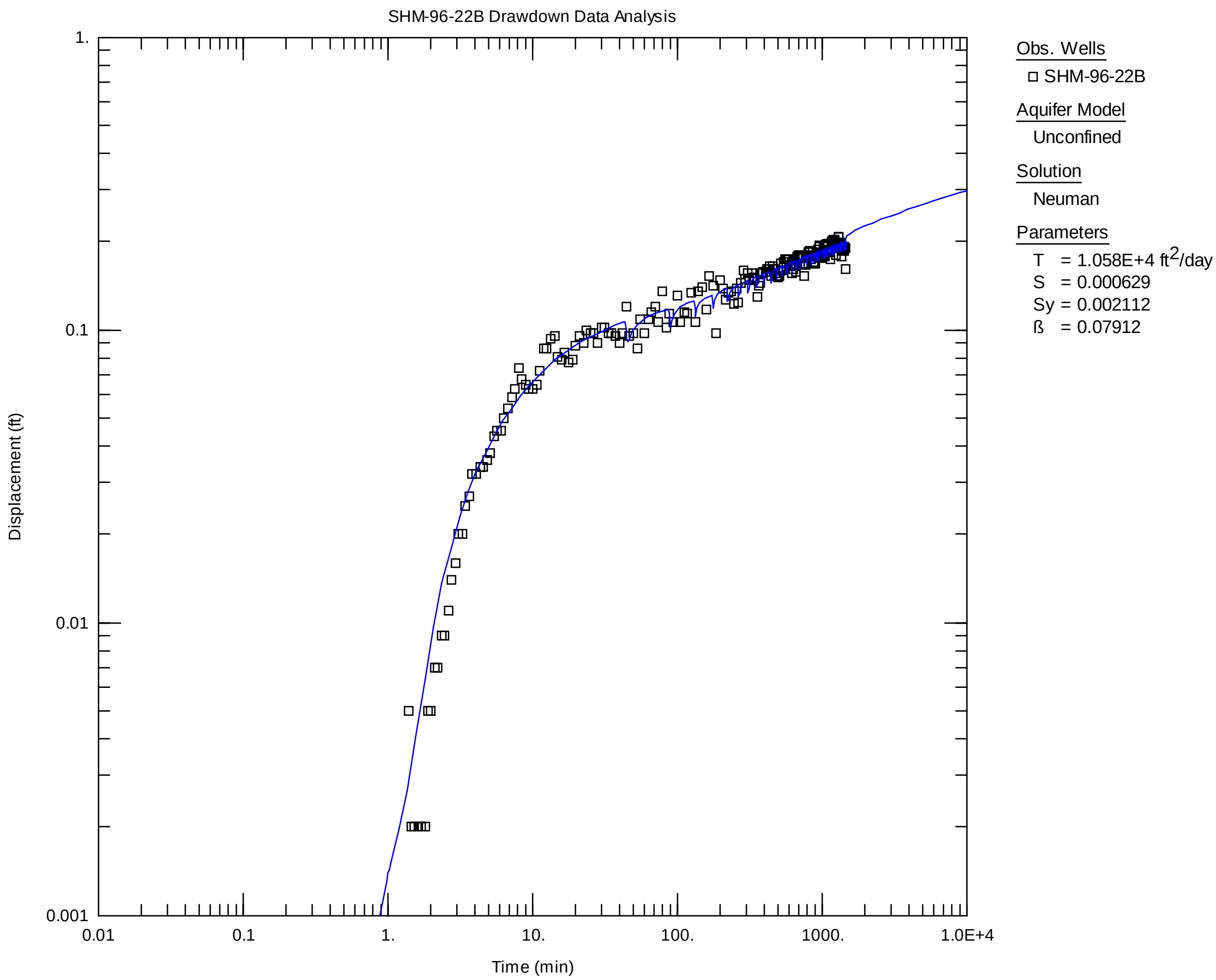


LEGEND
□ Water Level Observation

Figure C-21
Time-Drawdown Plot for SHL-22
08/29/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



LEGEND

□ Water Level Observation

Aquifer Test Solution

T = Transmissivity

S = Storativity

Sy = Specific Yield

β = Neuman's Parameter

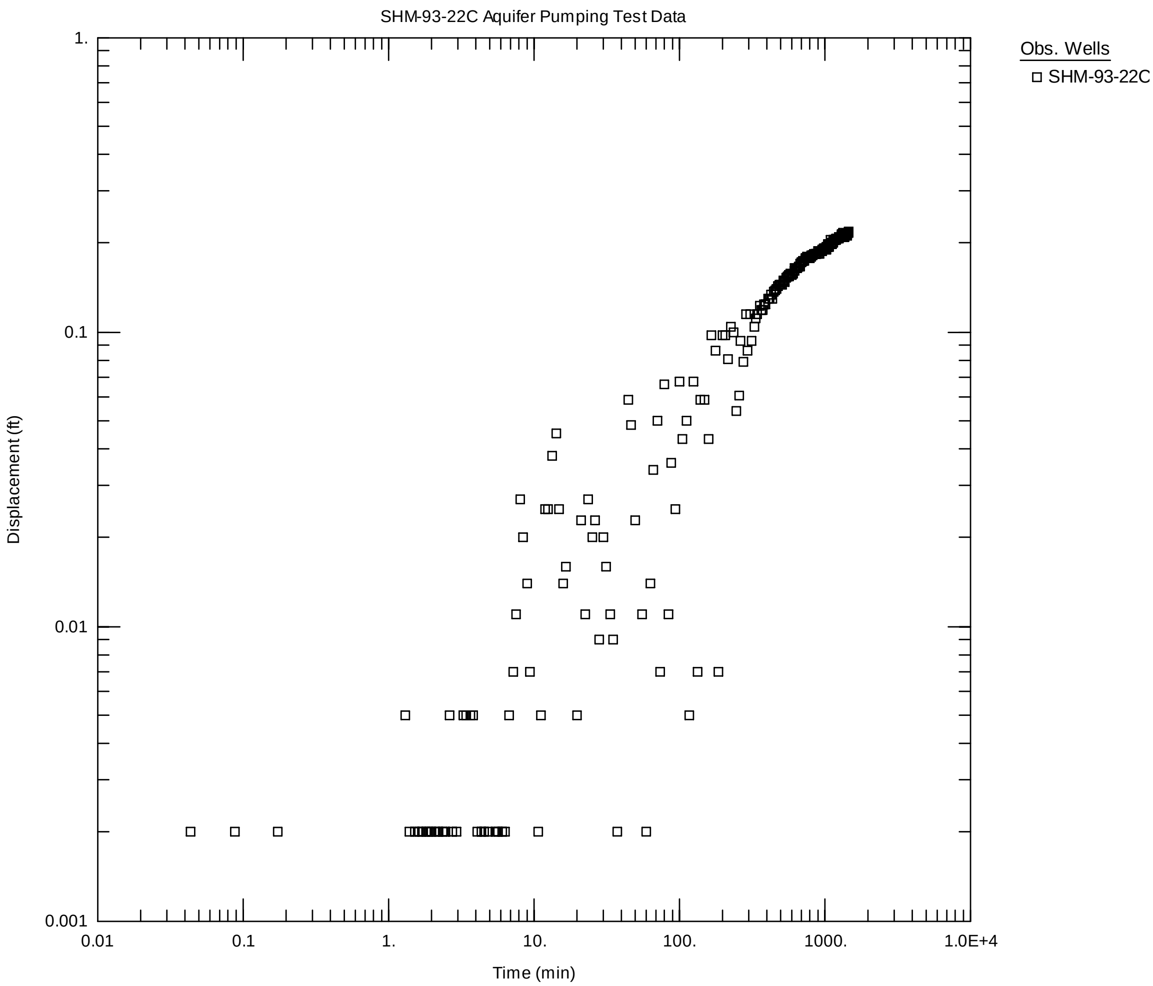
t = total pumping time

t′= time since pumping stopped

Figure C-22
Time-Drawdown Plot for SHM-96-22B
08/29/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL

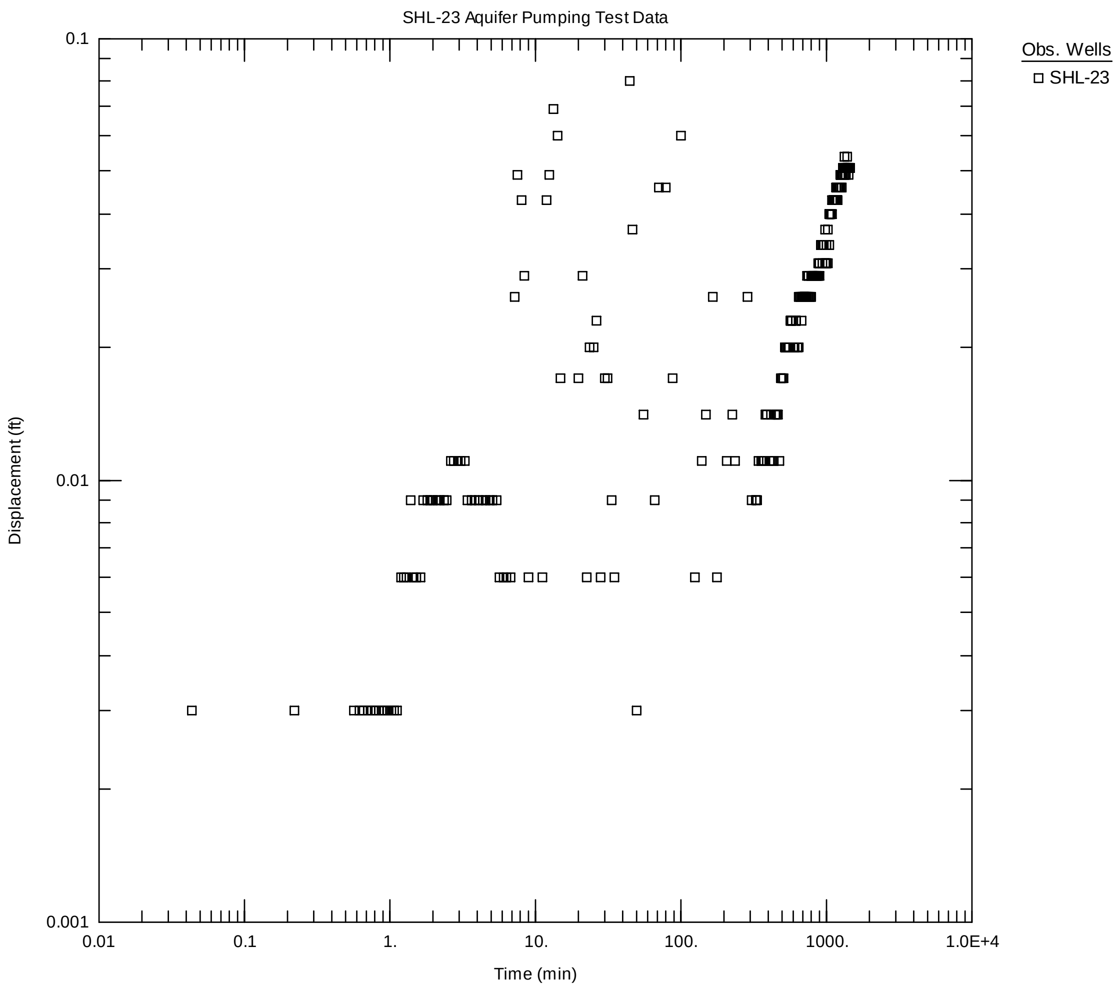


LEGEND
□ Water Level Observation

Figure C-23
Time-Drawdown Plot for SHM-93-22C
08/29/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



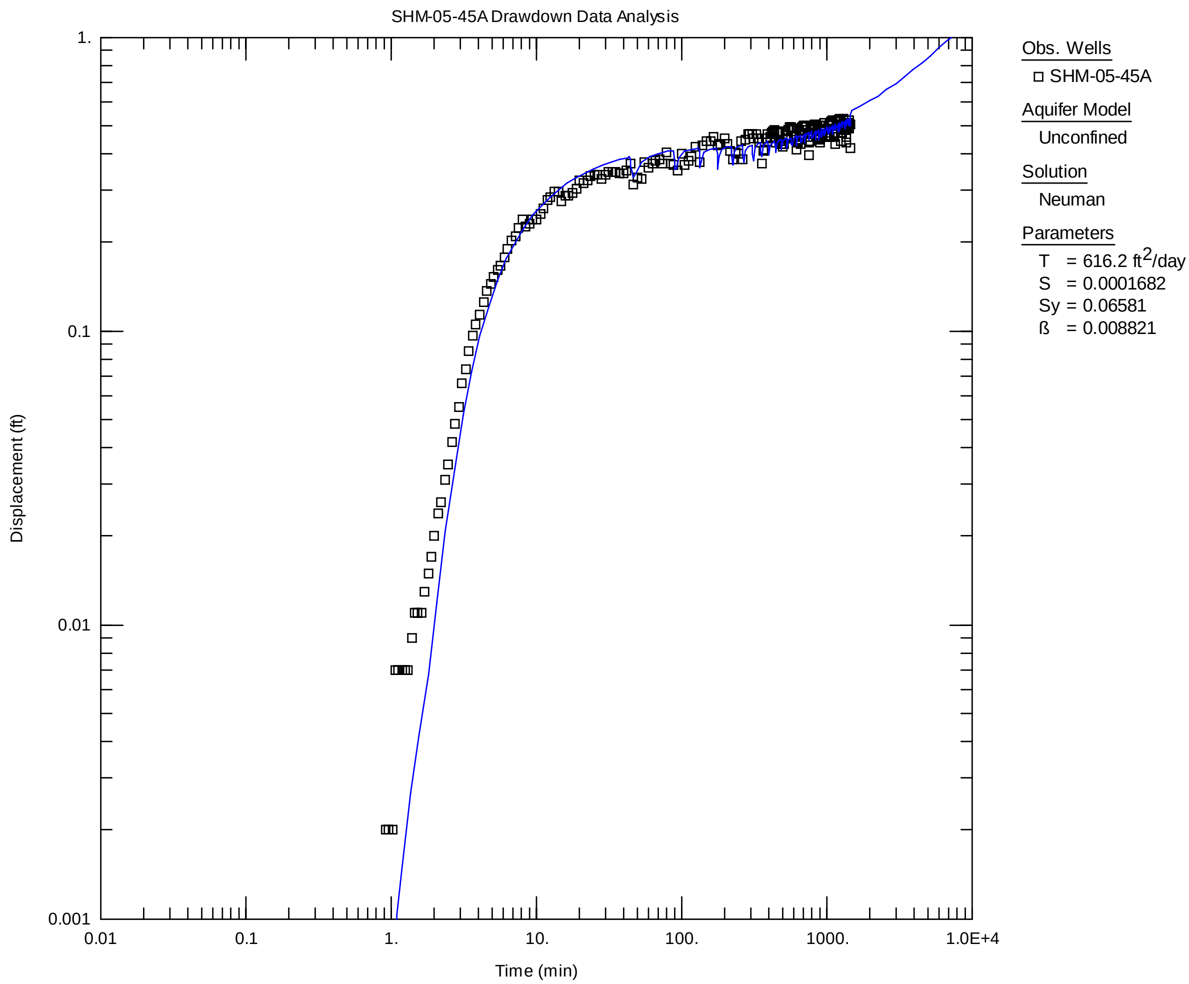
LEGEND

□ Water Level Observation

Figure C-24
Time-Drawdown Plot for SHL-23
08/29/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



LEGEND

□ Water Level Observation

Aquifer Test Solution

T = Transmissivity

S = Storativity

Sy = Specific Yield

β = Neuman's Parameter

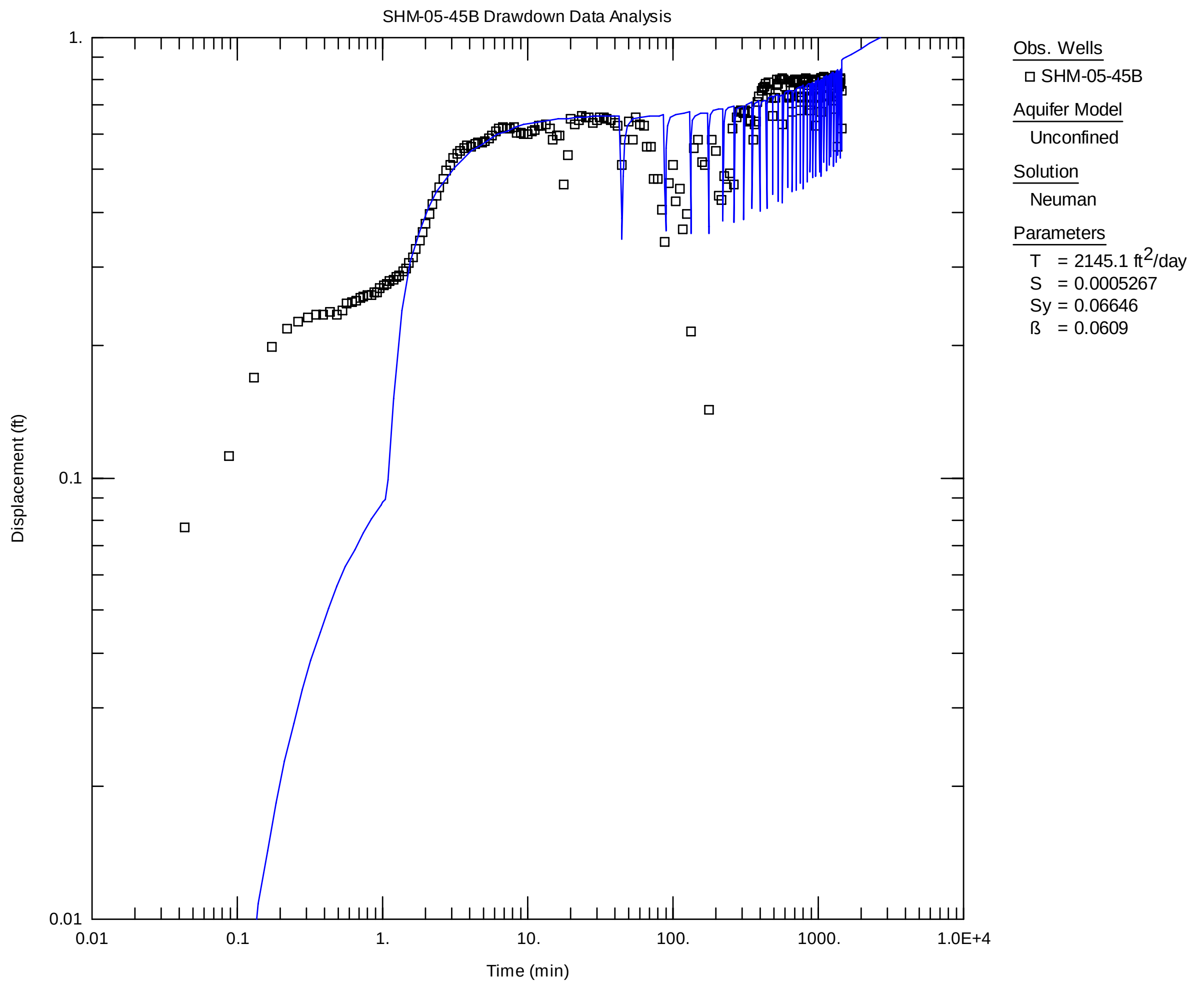
t = total pumping time

t′= time since pumping stopped

Figure C-25
Time-Drawdown Plot for SHM-05-45A
08/29/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



LEGEND

□ Water Level Observation

Aquifer Test Solution

T = Transmissivity

S = Storativity

Sy = Specific Yield

β = Neuman's Parameter

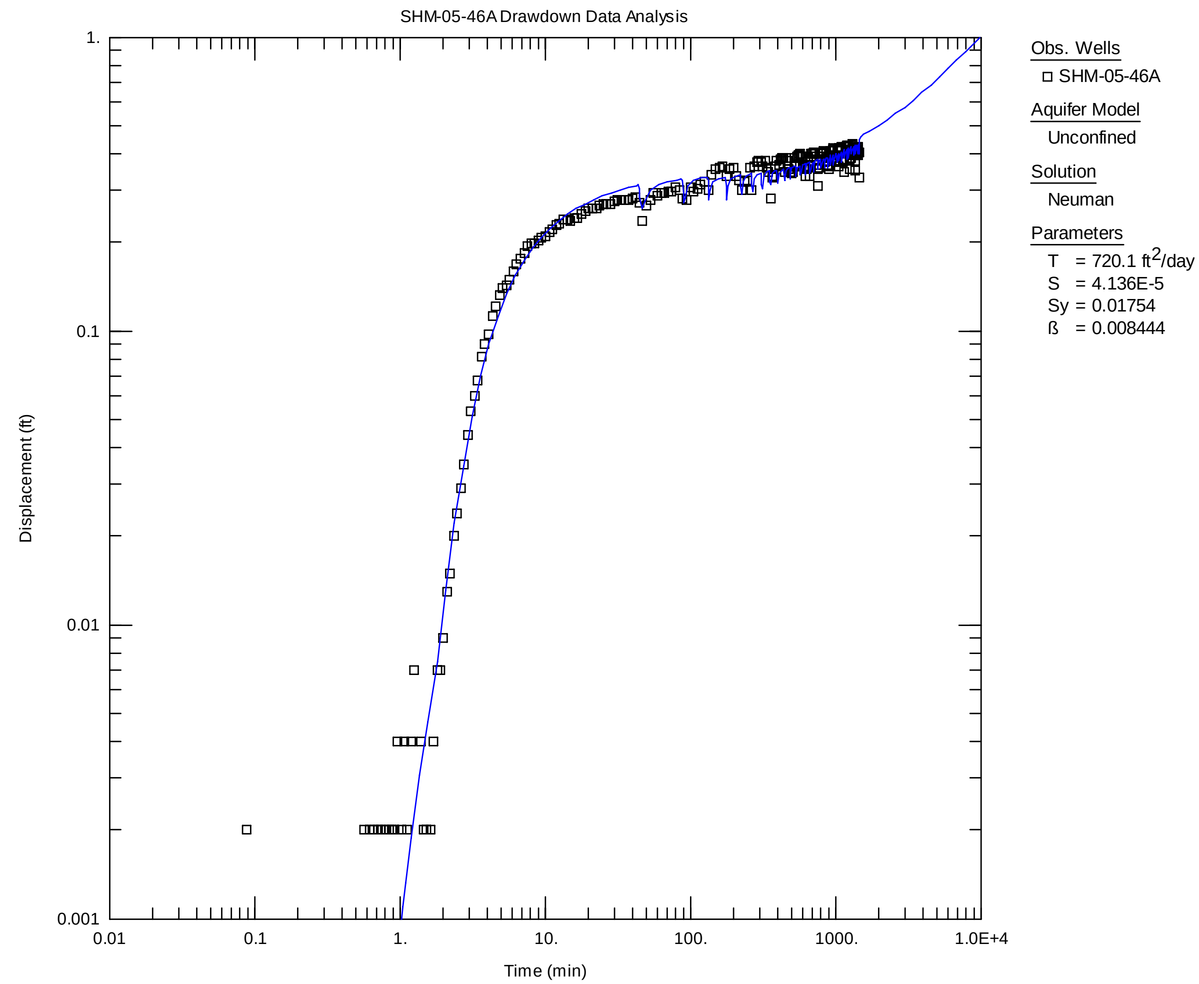
t = total pumping time

t′= time since pumping stopped

Figure C-26
Time-Drawdown Plot for SHM-05-45B
08/29/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



LEGEND

□ Water Level Observation

—— Aquifer Test Solution

T = Transmissivity

S = Storativity

Sy = Specific Yield

β = Neuman's Parameter

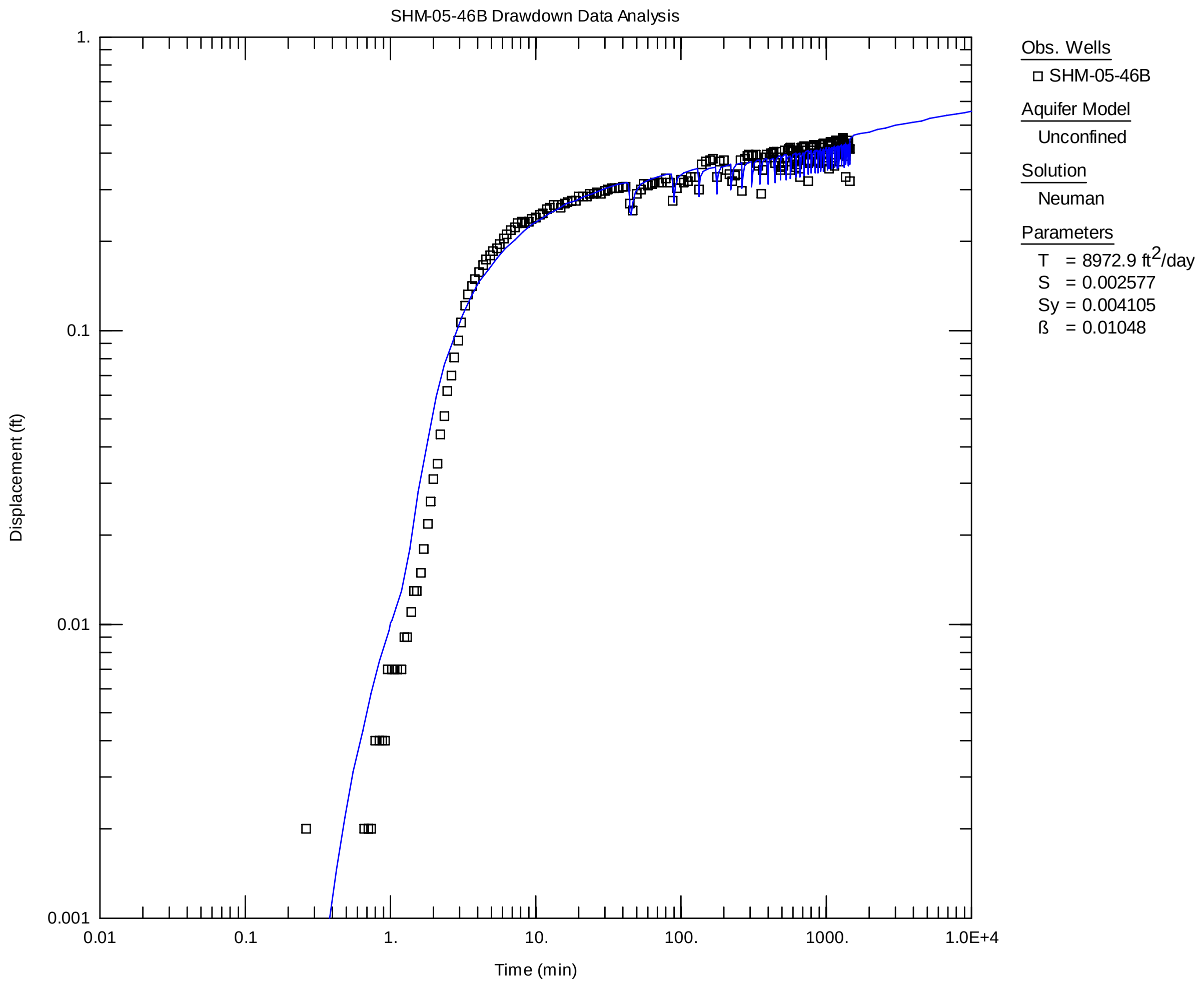
t = total pumping time

t′= time since pumping stopped

Figure C-27
Time-Drawdown Plot for SHM-05-46A
08/29/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL



LEGEND

□ Water Level Observation

Aquifer Test Solution

T = Transmissivity

S = Storativity

Sy = Specific Yield

β = Neuman's Parameter

t = total pumping time

t′= time since pumping stopped

Figure C-28
Time-Drawdown Plot for SHM-05-46B
08/29/2005 Aquifer Pumping Test

Shepley's Hill Landfill, Fort Devens, MA

CH2MHILL

Attachment D
Extraction/Recovery Test
Raw and Corrected Logger and Flow Rate Data

Refer to CD Labeled:

Attachment D
Extraction/Recovery Test
Raw and Corrected Logger and Flow Rate Data

Attachment E

Precipitation Data

UNEDITED LOCAL CLIMATOLOGICAL DATA

NOAA, National Climatic Data Center

Month: 08/2005

Station Location: LAURENCE G HANSCOM FIELD AIRPORT (BED)
BEDFORD , MA

Lat. 42°28'N Lon. 71°17'W

Elevation(Ground): 166 ft. above sea level

Date	Temperature (Fahrenheit) Max.	Min.	Avg.	Dep From Normal	Avg. Dew pt.	Avg Wet Bulb	Degree Days Base 65 Degrees Heating	Cooling	Significant Weather	Snow/Ice on Ground(In) 0600 LST Depth	1200 LST Water Equiv	Precipitation (In) 2400 LST Snow Fall	2400 LST Water Equiv	Pressure(inches of Hg) Avg. Station	Avg. Sea level	Wind: Speed=mph Dir=tens of degrees Resultant Speed	Res Dir	Avg. Speed	max 5-sec Speed	max 5-sec Dir	max 2-min Speed	max 2-min Dir	Date
1	84	64	74	M	64	67	0	9	TS TSRA RA FG HZ VCTS	M	-	M	1.40	29.84	30.10	4.7	22	6.5	18	25	14	35	1
2	88	63	76	M	65	69	0	11	TS FG HZ	M	-	M	0.00	29.69	29.95	3.8	27	5.5	17	30	14	30	2
3	88	63	76	M	65	68	0	11	FG	M	-	M	0.00	29.72	29.96	1.6	35	5.1	17	11	15	11	3
4	87	63	75	M	65	69	0	10	FG	M	-	M	0.00	29.81	30.07	2.9	15	4.7	17	10	15	10	4
5	94	68	81	M	68	71	0	16	TS FG HZ VCTS	M	-	M	0.00	29.73	29.98	6.0	25	7.4	30	30	23	31	5
6	85	60	73	M	58	64	0	8	-	M	-	M	T	29.88	30.14	1.6	8	3.7	15	10	14	10	6
7	87	57	72	M	62	66	0	7	-	M	-	M	0.00	29.90	30.16	3.3	23	5.2	15	22	13	22	7
8	91	64	78	M	67	71	0	13	FG HZ	M	-	M	0.00	29.89	30.14	3.3	23	5.0	13	22	10	23	8
9	86	69	78	M	67	70	0	13	FG HZ	M	-	M	0.02	29.85	30.10	7.3	23	7.4	23	24	16	23	9
10	90	68	79	M	66	70	0	14	HZ	M	-	M	0.00	29.74	29.97	6.9	22	7.4	16	19	14	18	10
11	91	69	80	M	68	71	0	15	FG	M	-	M	T	29.65	29.92	2.2	27	5.3	24	36	18	1	11
12	87	69	78	M	67	71	0	13	FG HZ	M	-	M	T	29.76	30.00	4.0	12	5.9	18	10	15	10	12
13	95*	74	85*	M	71	75	0	20	TS RA FG HZ	M	-	M	0.01	29.61	29.88	5.3	28	6.7	21	26	17	30	13
14	92	66	79	M	69	72	0	14	TS TSRA RA FG HZ VCTS	M	-	M	0.88	29.68	29.94	1.9	7	4.4	21	11	15	11	14
15	69	56	63*	M	62	63	2	0	RA FG+ FG	M	-	M	0.09	29.86	30.12	5.4	5	5.8	17	6	14	6	15
16	79	53	66	M	58	61	0	1	FG+ FG	M	-	M	0.00	29.84	30.10	2.4	15	4.1	15	13	12	13	16
17	86	59	73	M	59	64	0	8	FG HZ	M	-	M	0.01	29.69	29.94	4.1	32	5.3	20	35	15	34	17
18	79	51	65	M	52	58	0	0	-	M	-	M	0.00	29.86	30.12	0.9	28	3.3	16	27	12	26	18
19	79	53	66	M	55	60	0	1	-	M	-	M	0.00	29.91	30.18	5.1	11	5.2	18	11	15	11	19
20	81	65	73	M	65	68	0	8	FG	M	-	M	0.00	29.78	30.05	4.6	10	5.9	16	8	14	9	20
21	89	65	77	M	69	71	0	12	RA FG HZ	M	-	M	0.13	29.57	29.82	6.5	23	6.9	17	24	13	23	21
22	85	59	72	M	57	63	0	7	-	M	-	M	0.00	29.58	29.83	5.3	29	5.9	21	23	15	32	22
23	81	53	67	M	54	59	0	2	-	M	-	M	0.00	29.72	29.98	3.0	30	4.4	20	30	15	29	23
24	78	54	66	M	55	59	0	1	TS FG VCTS	M	-	M	0.01	29.84	30.12	3.2	34	3.7	20	32	16	33	24
25	81	51	66	M	54	59	0	1	FG	M	-	M	0.01	29.93	30.20	2.4	34	4.5	17	1	12	1	25
26	85	50	68	M	53	59	0	3	-	M	-	M	0.00	29.85	30.11	0.7	25	2.4	15	32	12	31	26
27	84	53	69	M	57	62	0	4	FG	M	-	M	0.00	29.83	30.09	3.5	20	5.4	20	19	16	19	27
28	85	62	74	M	65	68	0	9	RA FG	M	-	M	0.05	29.80	30.05	6.2	18	6.9	22	16	17	20	28
29	86	71	79	M	70	72	0	14	RA FG HZ	M	-	M	0.44	29.80	30.04	6.7	19	7.2	26	18	18	19	29
30	76	71	74	M	70	71	0	9	RA FG	M	-	M	0.51	29.70	29.96	3.7	18	4.9	16	19	14	19	30
31	83	73	78	M	73	74	0	13	RA FG	M	-	M	0.14	29.40	30.36	12.5	19	13.6	35	20	26	19	31
	84.9	61.8	73.4	-------	62.9	66.6	.1	8.6	<Monthly Averages	Totals>			3.70	29.77	30.05	1.9	21.6	5.7	<Monthly Average				
			.0	-------					<-----------Departure From Normal----------->				-.05										

Degree Days

	Monthly Total	Monthly Departure	Season to Date Total	Season to Date Departure
Heating:	2	-2	0	0
Cooling:	267	9	680	0

Greatest 24-hr Precipitation: 1.40 Date: 01

Greatest 24-hr Snowfall: Date:

Greatest Snow Depth: 0 Date: -

Sea Level Pressure		Date	Time
Maximum	30.25	25	0827
Minimum	.00	0	0000

Number of Days with -------->

Max Temp >=90: 6	Min Temp <=32: 0	Precipitation >=.01 inch: 13
Max Temp <=32: 0	Min Temp <=0 : 0	Precipitation >=.10 inch: 6
Thunderstorms : 6	Heavy Fog : 2	Snowfall >=1.0 inch : 0

*** EXTREME FOR THE MONTH - LAST OCCURRENCE IF MORE THAN ONE.**

UNEDITED LOCAL CLIMATOLOGICAL DATA

NOAA, National Climatic Data Center

Month: 08/2005

Station Location: FITCHBURG MUNICIPAL AIRPORT (FIT)
FITCHBURG , MA

Lat. 42°33'N Lon. 71°46'W

Elevation(Ground): 339 ft. above sea level

Date	Temperature (Fahrenheit) Max.	Min.	Avg.	Dep From Normal	Avg. Dew pt.	Avg Wet Bulb	Degree Days Base 65 Degrees Heating	Cooling	Significant Weather	Snow/Ice on Ground(In) 0600 LST Depth	1200 LST Water Equiv	Precipitation (In) 2400 LST Snow Fall	2400 LST Water Equiv	Pressure(inches of Hg) Avg. Station	Avg. Sea level	Wind: Speed=mph Dir=tens of degrees Resultant Speed	Res Dir	Avg. Speed	max 5-sec Speed	Dir	max 2-min Speed	Dir	Date
1	81	63	72	M	65	67	0	7	TS TSRA RA FG HZ VCTS	M	-	M	0.54	29.68	30.09	4.1	19	5.2	17	19	13	19	1
2	88	68	78	M	65	69	0	13	TS FG HZ	M	-	M	0.01	29.53	29.94	3.7	27	6.1	16	27	14	26	2
3	88	69	79	M	65	69	0	14	-	M	-	M	0.00	29.54	29.95	3.3	29	5.2	20	27	16	27	3
4	88	65	77	M	66	70	0	12	FG	M	-	M	0.00	29.64	30.06	3.7	16	5.2	15	14	12	14	4
5	91	69	80	M	66	70	0	15	TS FG HZ VCTS	M	-	M	0.02	29.57	29.98	5.5	25	7.1	29	26	20	27	5
6	85	61	73	M	56	63	0	8	-	M	-	M	0.00	29.73	30.14	3.0	34	4.9	16	31	12	23	6
7	85	60	73	M	62	66	0	8	-	M	-	M	0.00	29.74	30.15	3.5	20	4.2	16	24	13	24	7
8	91	69	80	M	66	70	0	15	HZ	M	-	M	0.00	29.70	30.13	1.5	27	4.9	16	22	12	23	8
9	86	69	78	M	64	69	0	13	HZ	M	-	M	T	29.66	30.08	3.8	20	5.4	20	18	15	18	9
10	89	68	79	M	65	70	0	14	-	M	-	M	0.00	29.55	29.96	2.2	20	4.9	15	15	13	15	10
11	90	71	81	M	65	70	0	16	-	M	-	M	0.00	29.52	29.92	3.4	26	6.2	21	32	16	31	11
12	89	68	79	M	64	69	0	14	-	M	-	M	0.00	29.57	29.99	1.1	14	3.2	16	18	13	16	12
13	93*	72	83*	M	70	74	0	18	TS TSRA FG HZ	M	-	M	0.02	29.49	29.87	5.9	25	6.8	25	23	20	28	13
14	90	67	79	M	68	71	0	14	TS TSRA RA FG HZ VCTS	M	-	M	0.93	29.53	29.94	1.2	8	3.6	21	7	16	8	14
15	69	63	66	M	63	64	0	1	RA FG	M	-	M	0.23	29.69	30.11	0.7	2	3.9	15	4	12	3	15
16	78	56	67	M	59	63	0	2	FG	M	-	M	0.01	29.68	30.08	2.1	17	3.7	16	14	13	15	16
17	84	61	73	M	58	64	0	8	-	M	-	M	0.00	29.52	29.94	5.8	29	7.2	22	31	16	33	17
18	77	53	65*	M	51	57	0	0	-	M	-	M	0.00	29.70	30.11	1.8	27	4.1	14	30	12	30	18
19	77	55	66	M	56	60	0	1	-	M	-	M	0.00	29.75	30.16	2.2	12	3.8	15	16	13	17	19
20	78	63	71	M	63	66	0	6	FG	M	-	M	0.00	29.63	30.04	0.6	35	2.1	8	15	7	30	20
21	89	65	77	M	66	69	0	12	FG HZ	M	-	M	0.04	29.42	29.81	3.1	21	5.9	18	28	16	28	21
22	83	58	71	M	56	62	0	6	-	M	-	M	0.00	29.42	29.83	6.2	27	7.0	22	27	18	27	22
23	78	56	67	M	53	59	0	2	HZ	M	-	M	0.00	29.58	29.98	4.1	28	5.3	20	31	16	28	23
24	75	57	66	M	55	59	0	1	TS TSRA VCTS	M	-	M	0.12	29.71	30.12	1.4	30	4.1	22	5	17	4	24
25	80	54	67	M	54	59	0	2	-	M	-	M	0.00	29.78	30.19	2.6	33	5.9	21	31	17	32	25
26	83	54	69	M	53	60	0	4	-	M	-	M	0.00	29.69	30.11	2.7	27	4.5	16	4	12	26	26
27	83	56	70	M	57	62	0	5	-	M	-	M	0.01	29.67	30.07	4.6	17	5.4	24	16	15	18	27
28	82	63	73	M	65	68	0	8	RA FG	M	-	M	0.16	29.61	30.04	4.4	17	5.2	22	16	17	16	28
29	85	68	77	M	68	71	0	12	TS FG+ FG HZ VCTS	M	-	M	0.01	29.60	30.02	6.0	16	6.4	20	15	16	16	29
30	75	71	73	M	69	70	0	8	RA FG	M	-	M	0.23	29.55	29.95	3.7	15	4.2	14	16	10	15	30
31	82	69	76	M	71	73	0	11	RA FG	M	-	M	0.41	29.22	30.57	9.4	17	11.0	31	17	23	17	31
	83.6	63.3	73.5	-------	62.1	66.2	.0	8.7	<Monthly Averages	Totals>			2.74	29.60	30.04	1.9	22.3	5.3	<Monthly Average				
			.0	-------					<-----------Departure From Normal---------->				-1.00										

Degree Days

	Monthly Total	Monthly Departure	Season to Date Total	Season to Date Departure
Heating:	0	-23	0	0
Cooling:	270	81	722	0

Greatest 24-hr Precipitation: 1.16 Date: 14-15

Greatest 24-hr Snowfall: Date:

Greatest Snow Depth: 0 Date: -

Sea Level	Pressure	Date	Time
Maximum	30.25	25	0718
Minimum	.00	0	0000

Number of Days with -------->

Max Temp >=90: 5	Min Temp <=32: 0	Precipitation >=.01 inch: 14
Max Temp <=32: 0	Min Temp <=0 : 0	Precipitation >=.10 inch: 7
Thunderstorms : 7	Heavy Fog : 1	Snowfall >=1.0 inch : 0

*** EXTREME FOR THE MONTH - LAST OCCURRENCE IF MORE THAN ONE.**

U.S. Department of Commerce
National Oceanic & Atmospheric Administration

UNEDITED LOCAL CLIMATOLOGICAL DATA HOURLY PRECIPITATION TABLE LAURENCE G HANSCOM FIELD AIRPORT (BED) BEDFORD , MA (08/2005)

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

	A.M. HOUR(L.S.T) ENDING AT													P.M. HOUR(L.S.T) ENDING AT												
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U.S. Department of Commerce
National Oceanic & Atmospheric Administration

UNEDITED LOCAL CLIMATOLOGICAL DATA
HOURLY PRECIPITATION TABLE
FITCHBURG MUNICIPAL AIRPORT (FIT)
FITCHBURG , MA
(08/2005)

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, North Carolina 28801

	A.M. HOUR(L.S.T) ENDING AT													P.M. HOUR(L.S.T) ENDING AT												
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Startup Testing Report
Groundwater Treatment System
Shepley's Hill Landfill, Devens, MA

Prepared by:

CH2M HILL
25 New Chardon Street, Suite 300
Boston, MA 02114

October 2005

Background

The Shepley's Hill Landfill Arsenic WTP in Devens, Massachusetts was designed to remove arsenic, iron and manganese from groundwater extracted from wells down-gradient of the Shepley's Hill Landfill. The general process design for the facility is to oxidize the iron in the raw water using chlorine dioxide and use the resulting ferric hydroxide formed to coagulate the arsenic in the raw water. The ferric hydroxide is then removed (along with the arsenic) using a microfilter. Chlorine dioxide was chosen as the oxidant for the system because of concerns with high manganese levels in the raw water samples used for the design basis for the facility. The chlorine dioxide is also intended to rapidly oxidize the manganese in the raw water so that it, too, can be removed by the microfilter. Further description of the design parameters for the facility is available in several technical memoranda that were produced during facility design. Start-up testing of the facility was conducted the week of August 15, 2005. The following report summarizes results of the start-up testing and recommends operational parameters and optimization concepts for the full scale operation of the facility.

Trans-membrane Pressure (TMP)

Trans-membrane Pressure (TMP) measures the pressure differential across the microfilter membranes. Prior to beginning treatment of well water, the microfilter was run using potable water to measure the clean water TMP response to increasing flow. Figure 1 summarizes the results of this testing. Following each Clean-in Place (CIP) event, clean water TMP should be measured in response to increasing flow over the capacity range of the system (0-55 gpm with one well running). The resulting flow vs. TMP curve should be compared to the data shown in Figure 1 to observe the overall degradation of the microfilter membranes over time and be able to anticipate when membrane replacement will be required (this is expected to be approximately 7- to 10-years). Also shown in Figure 1, for reference, is the flux associated with the microfilter flowrate in the TMP testing. Flux is measured in gallons per square ft of microfilter membrane per day (gfd). The microfilter for this project is a Pall Aria AP-2 with 10 microza membrane modules. Each module has 538 square feet of media surface area.

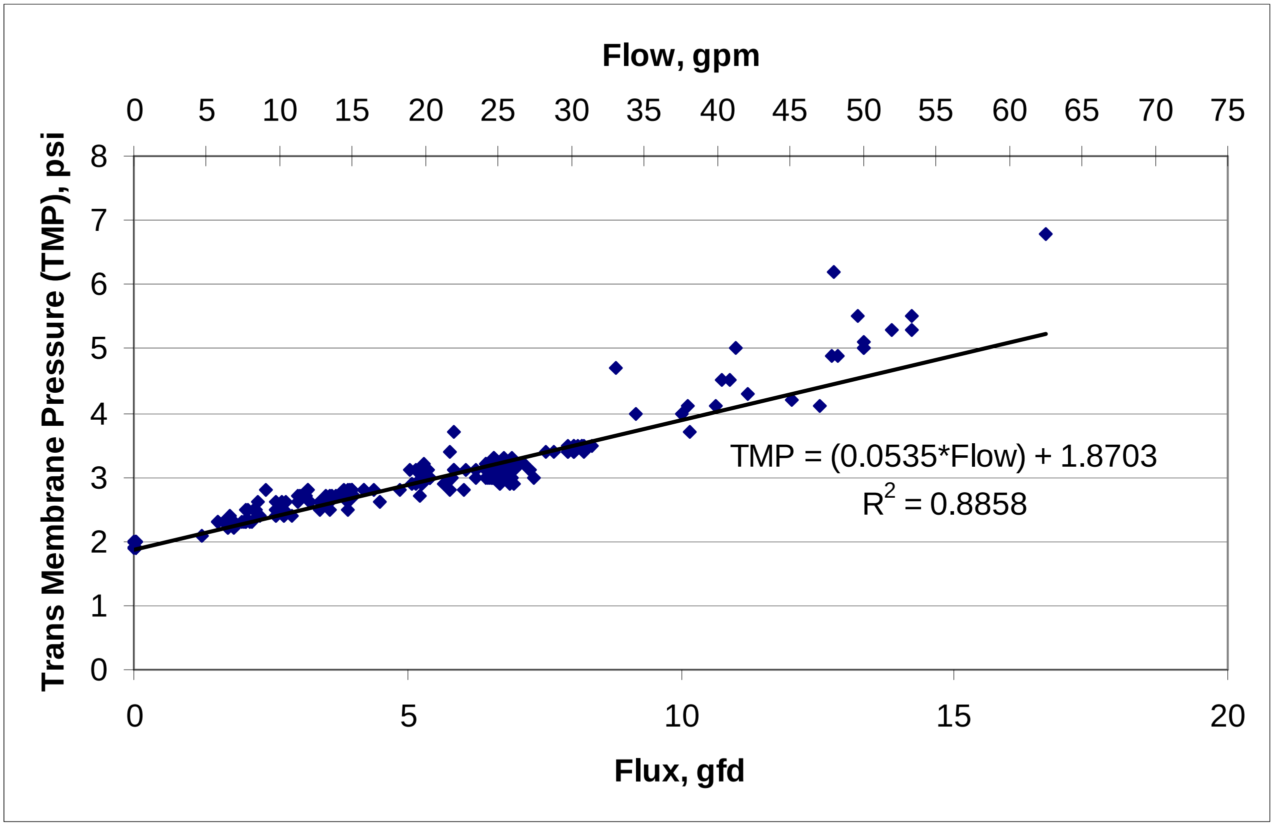

Figure 1
Clean water microfilter TMP response to increasing flow

Raw Water Characteristics

Over the course of system testing, a series of raw water samples were taken from groundwater extraction well no. 2. During start-up, groundwater extraction well no. 1 was not operable, but similar raw water quality can be expected as the wells are quite close to each other. During system operation, it is recommended that a continuous body of data be developed with raw water quality information from both well no. 1 and well no. 2. The data presented in Figures 2 through 4 are, respectively, arsenic, iron and manganese concentrations in the raw water samples taken from well no. 2. From examination of this data, average raw water characteristics are as follows:

Arsenic	5795 ug/L
Iron	76.0 mg/L
Manganese	1.57 mg/L

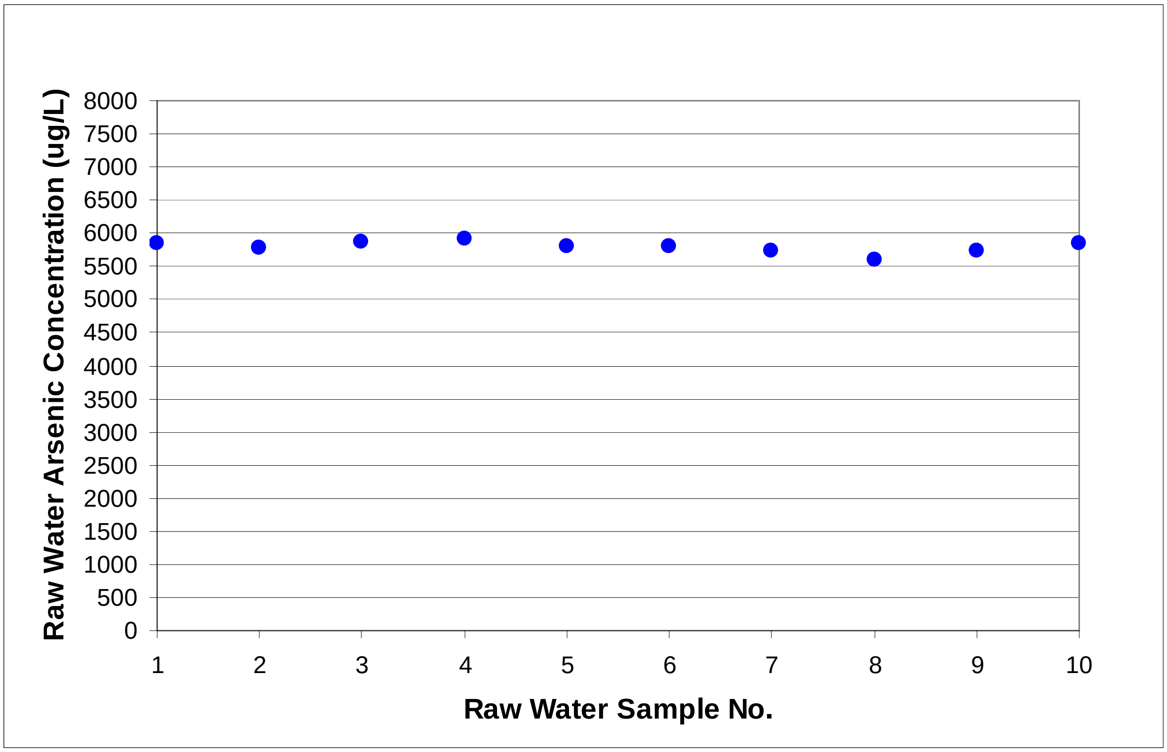

Figure 2
Raw Water Arsenic Concentration

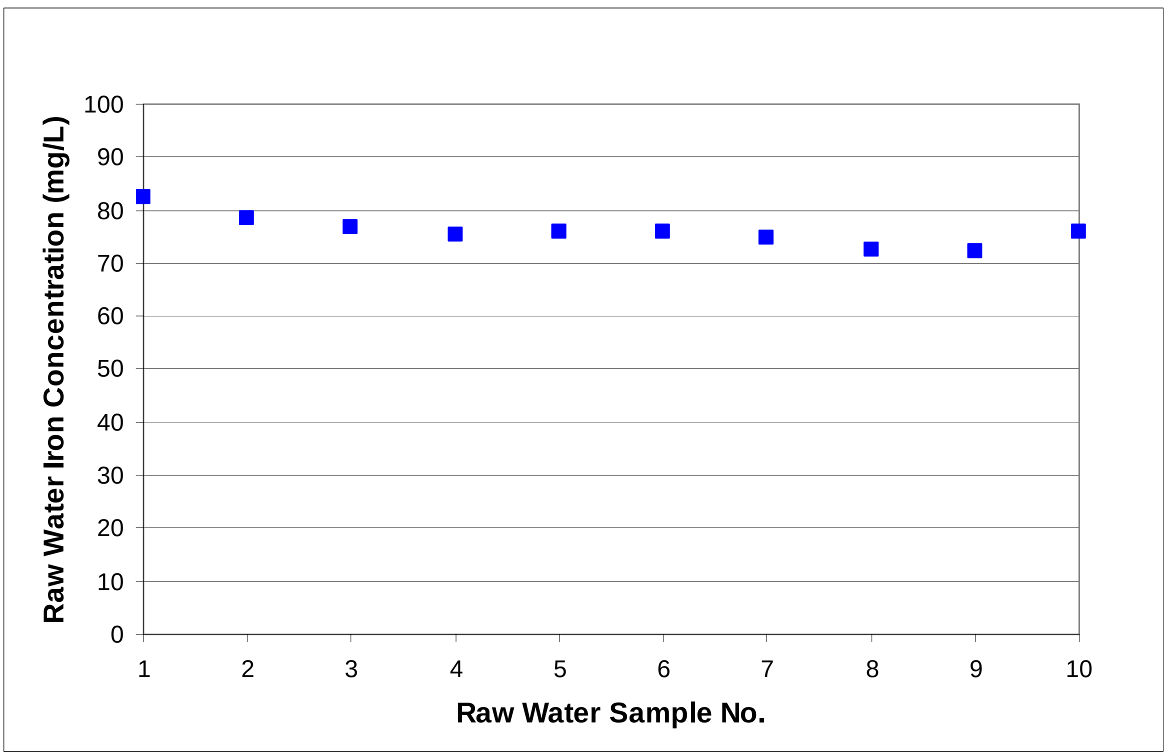

Figure 3
Raw Water Iron Concentration

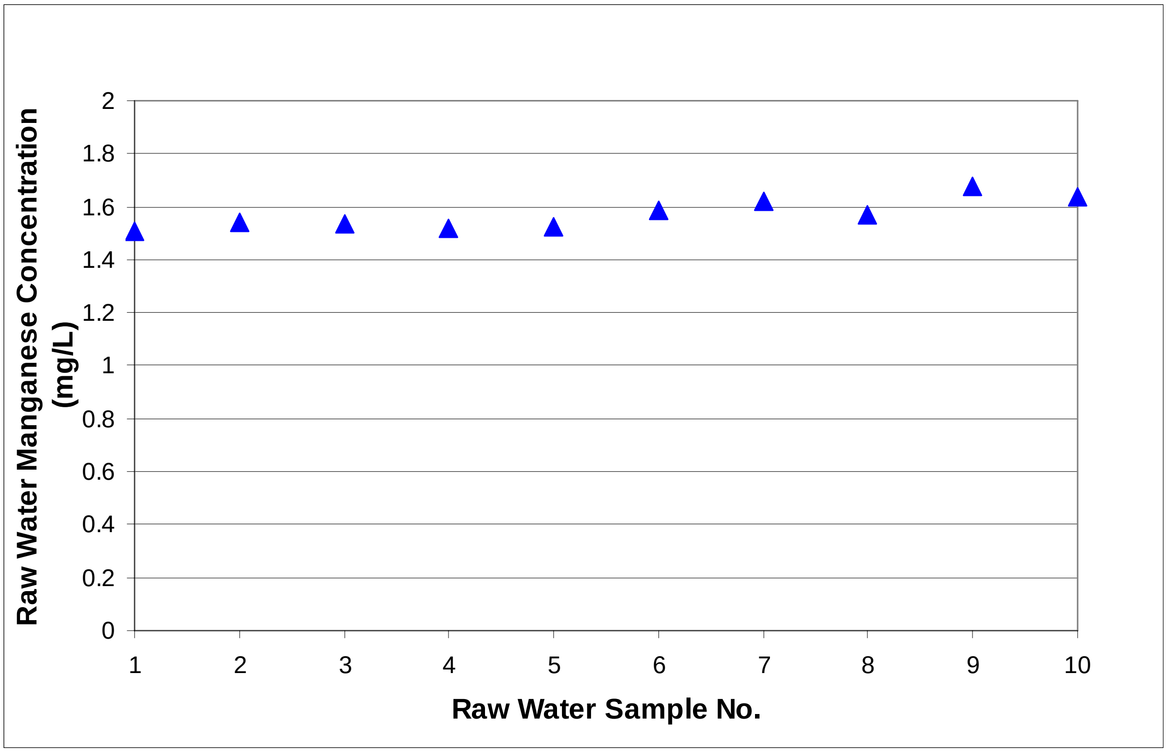

Figure 4
Raw Water Manganese Concentration

Chlorine Dioxide Dose Testing

The principal process being used in the WTP is oxidation of the iron in the raw water and subsequent utilization of the resulting ferric hydroxide (FeOH) to coagulate the arsenic. The FeOH, along with the arsenic, is then removed through the microfiltration process. Several items related to this process are noteworthy:

The relatively low pH of the raw water (approximately pH=6.8) optimizes ferric hydroxide coagulation of the arsenic. Oxidation of the iron in the raw water reduces pH to approximately pH=6.5, further increasing the effectiveness of the ferric hydroxide coagulation process.

Arsenic in the raw water is likely both As(III) and As(V). Only the As(V) has a charge and is able to coagulate with the ferric hydroxide. Any As(III) in the source water must be oxidized to As(V) prior to coagulation with ferric hydroxide being effective. Chlorine dioxide has been shown to not be effective in oxidizing As(III) to As(V), however, free chlorine has. For this reason, the chlorine dioxide generator has been set-up to slightly over-feed chlorine gas and provide some free chlorine residual in the chlorine dioxide feed. The free chlorine residual is intended to oxidize the As(III) in the raw water to As(V).

The results of varying chlorine dioxide dose on finished water arsenic, iron and manganese concentrations is presented in Table 1 and Figures 5 through 8. This is the result of very short-term dose testing during facility start-up. These data points represent 12-minute run times at the indicated conditions. All results should be further confirmed with more long-term testing.

Table 1
Chlorine dioxide dose testing results

Sample Number	Recycle On?	ClO2 Dose	Treated Water Contaminant Concentration			
			Arsenic		Iron	Manganese
		mg/L	ug/L	mg/L	mg/L	mg/L
011	Y	5	1109.0	1.1090	37.1	1.627
018	N	5	1321.0	1.3210	39.1	1.574
033	N	5	796.1	0.7961	27	1.515
017	N	8	1157.0	1.1570	35.9	1.566
032	N	8	613.7	0.6137	24.2	1.698
034	N	8	1190.0	1.1900	35.9	1.732
010	Y	10	554.0	0.5540	26.2	1.833
016	N	10	703.5	0.7035	28.3	1.602
031	N	10	631.2	0.6312	26.9	1.69
035	N	10	506.5	0.5065	21.6	1.816
015	N	12	316.7	0.3167	17.9	1.541
030	N	12	311.3	0.3113	17.2	1.786
036	N	12	471.3	0.4713	19.4	1.663
008	Y	15	20.6	0.0206	0.973	1.599
014	N	15	62.7	0.0627	5.73	1.539
029	N	15	31.7	0.0317	2.68	2.214
037	N	15	162.5	0.1625	7.58	1.593
028	N	18	3.2	0.0032	0.114	0.6802
038	N	18	15.7	0.0157	0.139	1.378
006	Y	20	4.0	0.0040	0.118	1.215
013	N	20	15.1	0.0151	0.144	1.183
027	N	20	2.6	0.0026	0.114	1.18
039	N	20	7.7	0.0077	0.118	1.183
005	Y	25	3.3	0.0033	0.119	0.4098
026	N	25	2.2	0.0022	0.116	1.106
043	N	25	6.2	0.0062	0.115	1.195
004	Y	30	6.1	0.0061	0.151	0.0087
025	N	30	2.1	0.0021	0.122	0.3147
044	N	30	4.6	0.0046	0.108	0.7993
024	N	35	9.2	0.0092	0.435	0.0651
002	Y	40	5.8	0.0058	0.158	0.0059
021	N	40	8.7	0.0087	0.248	1.184
023	N	40	1.7	0.0017	0.122	0.0082
022	N	50	1.9	0.0019	0.116	0.0049

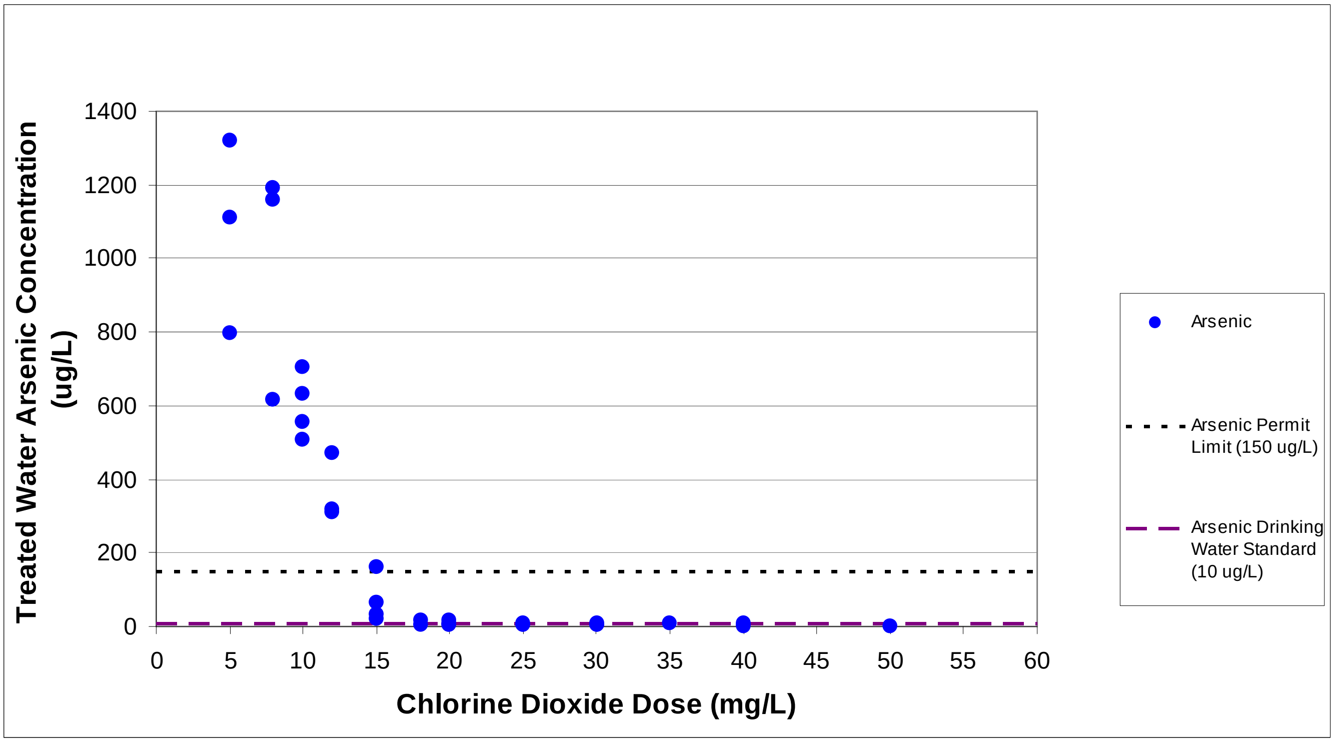

Figure 5
Effects of Varying Chlorine Dioxide Dose on Finished Water Arsenic

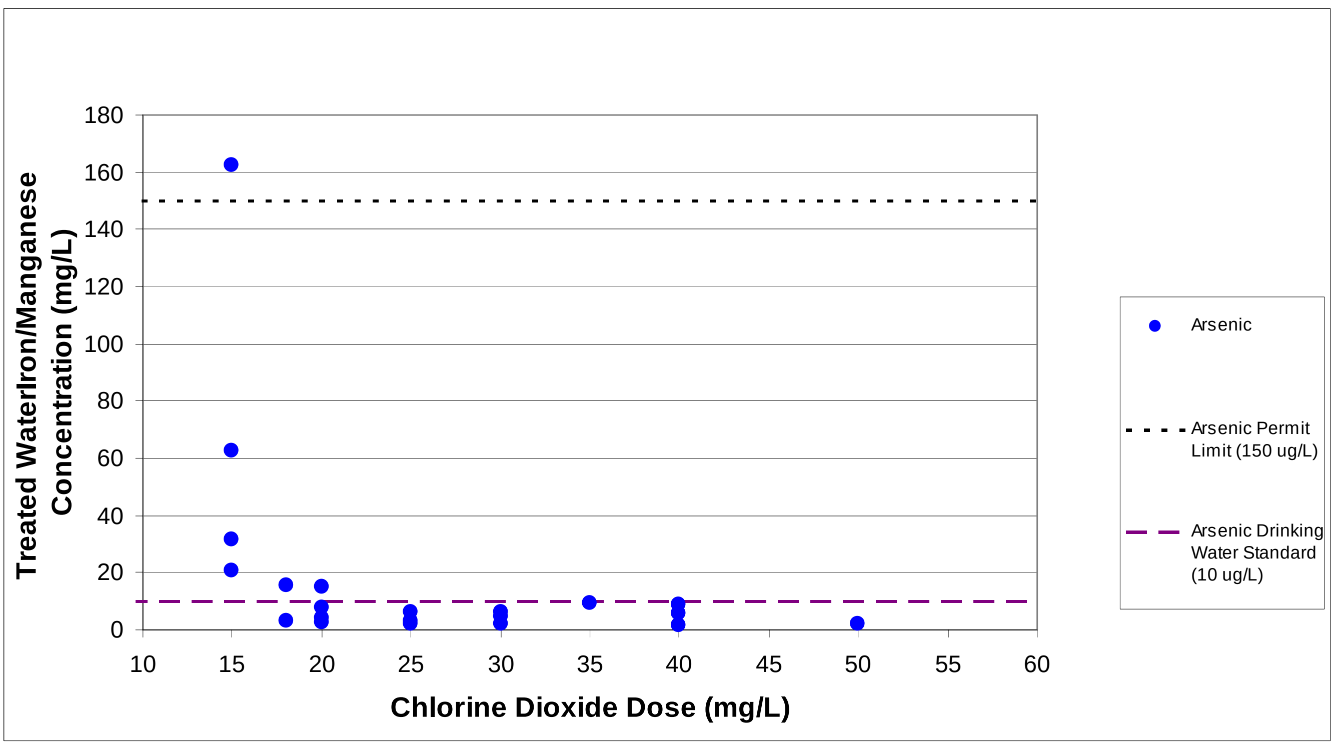

Figure 6
Effects of Varying Chlorine Dioxide Dose on Finished Water Arsenic (Zoom-in)

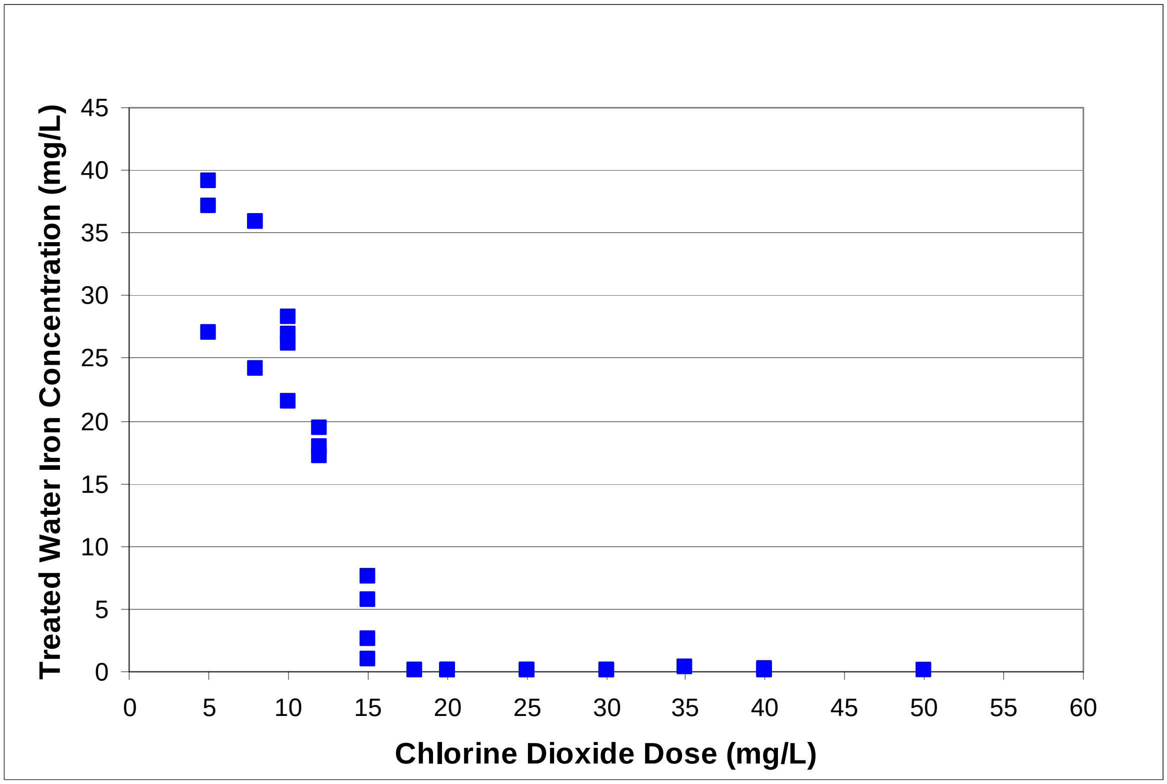

Figure 7
Effects of Varying Chlorine Dioxide Dose on Finished Water Iron

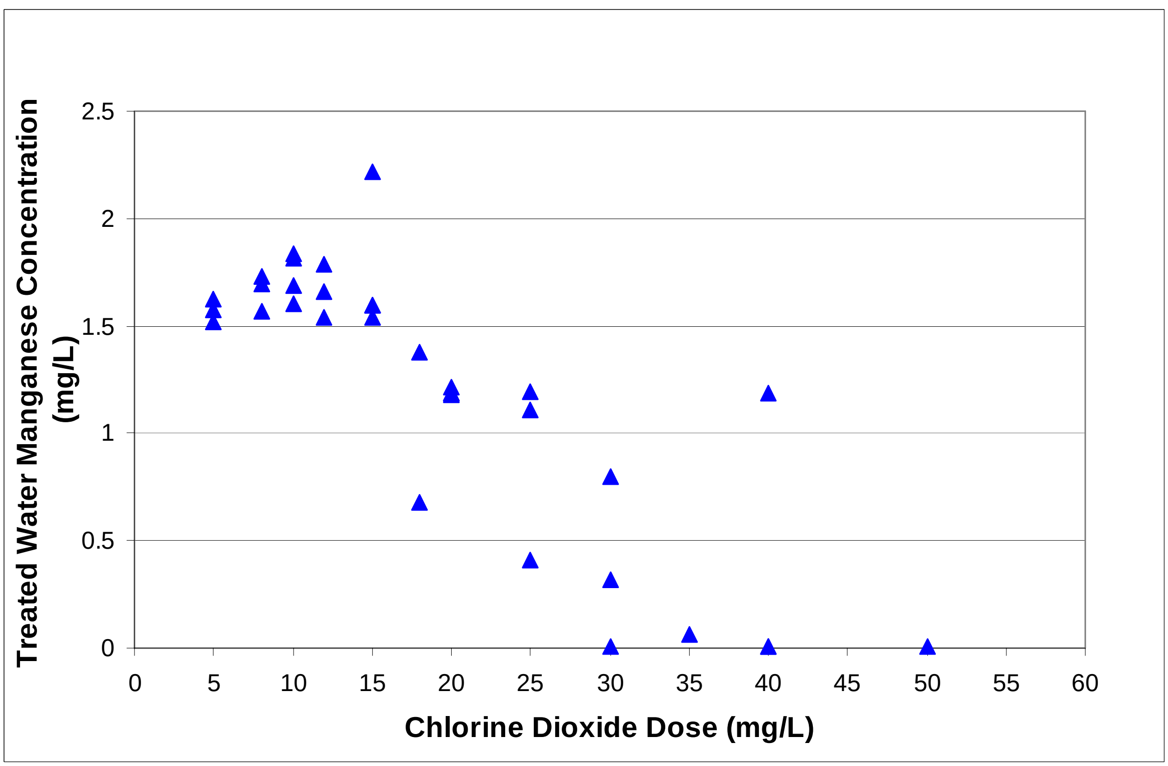

Figure 8
Effects of Varying Chlorine Dioxide Dose on Finished Water Manganese

Discussion of Results

Arsenic Removal. Good arsenic removal to concentrations below 150 ug/L was observed with a chlorine dioxide dose of approximately 15-18 mg/L (reference Figure 6). This corresponds well to the chlorine dioxide dose required to remove the large majority of the iron in the water (reference Figure 7). Increasing chlorine dioxide dose to approximately 25 mg/L consistently resulted in finished water arsenic concentrations below 10 ug/L (reference Figure 6). Because this increased chlorine dioxide dose did not seem to make a significant difference in iron removal (and therefore ferric hydroxide formation), it seems likely that the additional arsenic removal achieved by increasing chlorine dioxide dose from the 15-18 mg/L range to the 25 mg/L range may have more to do with oxidation of the arsenic from As(III) to As (V) than any additional ferric hydroxide formation. Note that even with increasing chlorine dioxide dose, complete removal of arsenic to non-detect levels was not achieved. This may have been due to the arsenic not being completely oxidized from As(III) to As(V).

Manganese. Manganese levels in the raw water are much lower than expected from samples taken during the planning and design phase of this facility (initial samples contained 11 mg/L manganese). The concern regarding manganese is with regards to the effect that partially oxidized manganese may have on long-term microfilter fouling. Manganese oxidation and removal does not appear to be occurring until chlorine dioxide dose is increased to 35-40 mg/L (reference Figure 8).

Recommendation for Operation and Optimization

Raw water chemistry should be monitored during the entire duration of facility operation to observe any changes in arsenic, iron or manganese concentrations. Changes in raw water quality will affect system operation and changes in operational parameters may be necessary in response to significant changes in raw water chemistry.

Initial operation at a chlorine dioxide dose of 25 mg/L is recommended to consistently produce finished water with arsenic concentrations below 10 ug/L. If finished water arsenic concentrations of 150 ug/L are all that is necessary, a chlorine dioxide dose of 18 mg/L appears to be sufficient. Long term observation of finished water arsenic, iron and manganese levels, along with periodic raw water characterization, will confirm the short-term results observed during start-up.

It is recommended that arsenic speciation of raw water and finished water samples be performed to determine the ratio of As(III)/As(V) in both raw water and in the arsenic remaining in the finished water. If the results indicate that As(III) is present in significant quantities in the raw water and that As(III) is also significant in the remaining arsenic in the finished water, increasing the amount of over-feed of chlorine gas in the chlorine dioxide generator may assist in optimizing arsenic removal effectiveness. Should As(III) be significantly present in the raw water, it may be that overall chlorine dioxide dose could be reduced to 18 mg/L or less if sufficient free chlorine was available to oxidize all of the As(III) to As(V). If generation of chlorine dioxide with sufficient free chlorine to oxidize all of the As(III) to As(V) is problematic, sodium hypochlorite could be used in addition to the chlorine dioxide (fed with the chemical metering pumps) to provide for the arsenic oxidation. Further investigation into this issue is recommended.

Because manganese concentrations in the raw water are significantly lower than anticipated, long term manganese fouling of the microfilter may not be an issue. Close tracking of microfilter TMP degradation is recommended and if significant non-recoverable fouling is observed, increased chlorine dioxide dose for manganese oxidation may be necessary. There is no manganese limit in the discharge permit for the facility, so allowing the manganese in the raw water to pass through the system should not be a problem unless it causes issue with long-term microfilter fouling.

Note that, due to time constraints of the field start-up, the residuals handling system was not optimized. Further optimization of the solids transfer pump (removing as much of the solids collected in the bottom of the clarifier as possible before the next reverse flow/air scrub cycle from the microfilter) and the recycle pump (throttling the recycle line such that recycle flow is spread as evenly as possible across each microfilter run between reverse flow/air scrub cycles should continue during system operation. Additionally, the dewatering characteristics of the solids which have been transferred to the filter bottom roll-off container should be examined. Pall should be contacted and can recommend polymers which are compatible with their microfilter modules. Samples of those polymers can be used with solids samples in jar testing to determine which is most effective at flocculating the ferric hydroxide solids. That polymer should be applied using the polymer feed system in order to optimize the operation of the filter bottom roll-off container and reduce residuals volumes which must be disposed of off-site as much as possible.

Overall, the results of testing during start-up of the facility are quite promising. The treatment process appears to be quite effective at arsenic removal at relatively low dose of chlorine dioxide. Continued optimization, as discussed above, is recommended during full-scale, long-term operation.