OU III
BUILDING 96
RECOMMENDATION FOR SOURCE AREA REMEDIATION

FINAL

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FOR

U.S. Department of Energy

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FIGURES

TABLES

Executive Summary

The Building 96 area was identified and characterized as a source area for Volatile Organic Compound (VOC) groundwater contamination (primarily tetrachloroethylene or PCE) as part of the 1999 Operable Unit (OU) III Remedial Investigation/Feasibility Study (RI/FS) and was designated as Area of Concern (AOC) 26B. Subsurface investigation including geophysical surveys, trenching and soil borings did not identify any buried drums, cesspools, dry-wells or other obvious source for the PCE contamination in groundwater. This area was historically used as a drum storage and truck washing facility. The data indicated that the source of the PCE was a zone in the shallow Upper Glacial aquifer containing numerous thin silt layers located at and below the water table, which is approximately 17 to 20 feet below land surface (bls).The silt layers were present at depths up to approximately 40 feet bls.

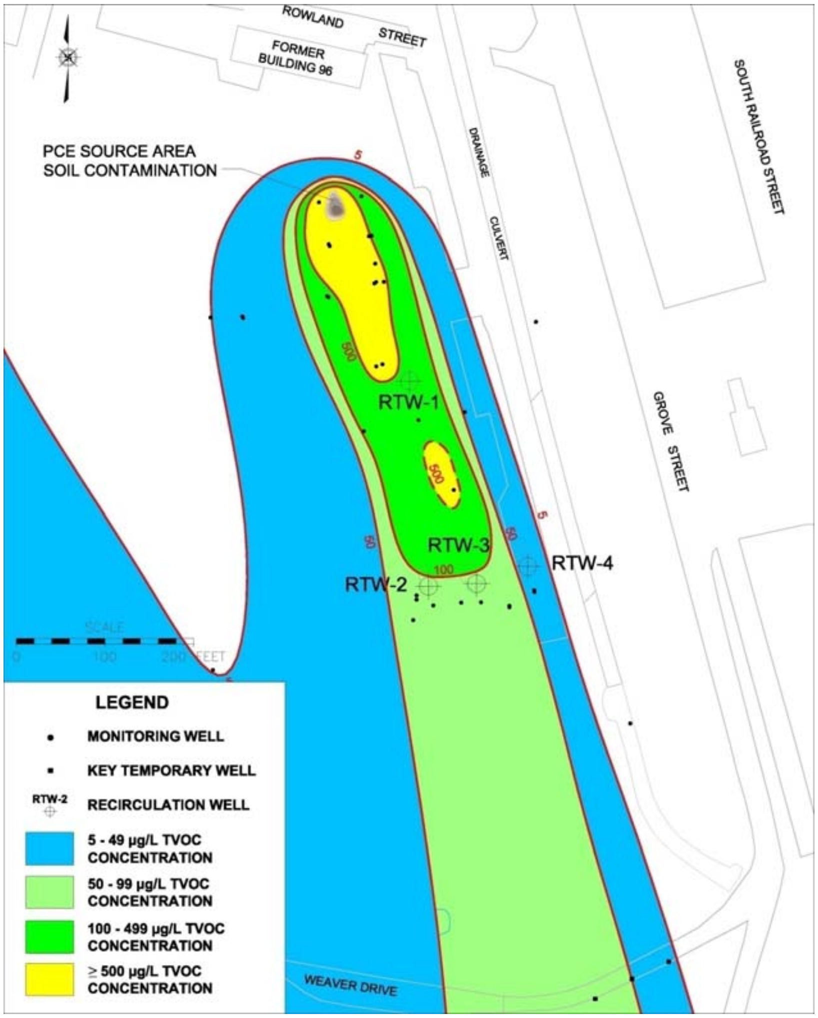
A source removal system consisting of four re-circulation wells with air-stripping was designed and installed in 2001 to reduce VOC concentrations in this area and achieve the overall OU III Record of Decision (ROD) cleanup goal of VOCs meeting drinking water standards in the Upper Glacial aquifer by 2030.

In 2005, BNL determined that the system was no longer effectively reducing VOC concentrations from what appeared to be a continuing source in the shallow Upper Glacial aquifer. A Petition for Shutdown of the system was submitted to the Interagency Agreement (IAG) members and approved. This petition called for the placement of the extraction wells on standby with continued monitoring, and source area remediation through the injection of potassium permanganate into the saturated zone between 20 and 40 feet bls. An initial round of potassium permanganate injections had been performed at the time of the submittal of the Petition for Shutdown, and the data showed a reduction of PCE in groundwater associated with the source area. The Petition for Shutdown had provision for additional injections as necessary to reduce PCE to levels that would allow BNL to achieve the OU III ROD cleanup goals.

Two additional injections were performed, one in 2005 and one in 2006, and subsequent groundwater monitoring data indicated that PCE concentrations were rebounding to pre-injection levels. As a result, a recommendation was made in the 2006 BNL Groundwater Status Report to conduct an evaluation of alternatives for addressing the continuing PCE source. Several technologies were reviewed including soil mixing with vapor extraction, electrical resistance heating, and excavation. During the evaluation of alternatives, BNL determined that it would be beneficial to more precisely define the continuing source area. Additional characterization work was performed during 2008 and included soil borings and a soil vapor survey. The newly obtained soil data indicated that the PCE was located in the unsaturated zone from just below the ground surface to a depth of approximately 15 feet bgs and not below the water table as previously thought. The unsaturated zone was also characterized by interbedded thin silt layers. This helps to explain the results of the potassium permanganate injections, as the source of PCE was primarily located above the water table and the mechanism for transport to groundwater is precipitation infiltration to the water table. Detailed soil and soil vapor data has refined the area of soils contaminated with PCE to an approximately 25 by 25 foot square area by 15 feet bls in depth just south of the former Building 96. This general area had been historically utilized for drum storage/rinsing and a truck wash. The delineation of the contaminated soils to a discrete relatively small and shallow area resulted in the focusing of remedial alternatives to excavation due to its implementability and effectiveness in completely removing the contamination.

To optimize the effectiveness of the Building 96 groundwater remedy, BNL is recommending the excavation of contaminated soils with off-site disposal. This is in addition to the continued operation of the groundwater treatment system until the capture goal is attained, which is expected within several years of the soil excavation. Optimization of the remedy by reducing the number of years of treatment will enable BNL to achieve the cleanup goal of the ROD for this groundwater plume (of meeting drinking water standards by 2030). The regulatory approach for this action would be to document the change in an Explanation of Significant Differences (ESD) to the OU III ROD.

Location of Building 96 Groundwater Plume, Treatment Wells,
and Soil Contamination Source Area



1.0 Introduction

This report provides a recommendation to address the continuing source for the Building 96 Volatile Organic Compound (VOC) groundwater plume to optimize the remedy by reducing the number of years of treatment. The cleanup goal outlined in the OU III Record of Decision (ROD) is to remediate groundwater in the Upper Glacial aquifer to drinking water standards by 2030. The Shutdown Petition for the Building 96 Groundwater Treatment System in 2005 called for the placement of all extraction wells on standby and follow-up spot treatment of groundwater with potassium permanganate as necessary. It was presumed at the time, that the first of three permanganate injections had been successful in reducing PCE concentrations to levels that would ultimately allow for the OU III ROD cleanup goals to be met. The presence of a continuing source was evidenced by the rebounding VOC concentrations, primarily tetrachloroethylene (PCE), in area monitoring wells and in extraction well RTW-1, which was subsequently placed back into operation. The currently operating groundwater treatment system is maintaining hydraulic control over the source area while remediating VOCs.

The area initially estimated as the source of high VOC concentrations was approximately 50' by 100' by 40' bls in depth (7,400 cubic yards). Based on this assumption several technologies were originally evaluated to treat the source area including soil mixing with Soil Vapor Extraction (SVE), Electrical Resistance Heating, Air Sparge and SVE, Groundwater Extraction, Groundwater Extraction with SVE, and Hydrogen Release Compound. Additional soil characterization work performed in 2008 has identified a discrete area of PCE soil contamination that is acting as a continuing source for groundwater contamination. The following report briefly summarizes the system and historical information, and provides a recommendation for remediation of the continuing source and future operations of the groundwater treatment system.

2.0 BNL Site Background

BNL is a 5,265 acre site located in Upton, Suffolk County, New York, near the geographic center of Long Island, north of the Long Island Expressway Figure 1. The BNL site was formerly occupied by the U.S. Army as Camp Upton during World Wars I and II. The Civilian Conservation Corps operated BNL between the wars. In 1947, the Atomic Energy Commission established BNL. BNL was transferred to the Energy Research and Development Administration in 1975 and to the United States Department of Energy (DOE) in 1977.

The facility is presently a federally owned and funded international research and learning center managed by Brookhaven Science Associates, under contract with the DOE. As of December 21, 1989, the site was placed on the U.S. Environmental Protection Agency (EPA) National Priorities List , which is a ranking of hazardous waste sites compiled by the federal government as part of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

3.0 Hydrogeology

Various hydrogeologic data collection and summary activities have been conducted in the Building 96 area. Soil boring data has been obtained from numerous locations and the general lithology of the area is depicted on the cross-sections shown in Figures 2, 3, and 4. The subsurface in the northern area of Building 96 from just below ground surface to a depth of approximately forty feet below land surface (bls) is characterized by Upper Glacial fine to coarse sands interbedded with numerous silt layers which range up to several inches in thickness. The presence of the silt layers tends to decrease with distance south of the source area. The silt layers appear to decrease the vertical hydraulic conductivity with respect to the horizontal conductivity where they are present.

BNL routinely monitors horizontal and vertical groundwater flow directions and magnitudes within the Upper Glacial aquifer and uppermost Magothy aquifer by using water level data collected from a large network of on- and off-site monitoring wells. Short-term and long-term seasonal fluctuations of water levels are also evaluated using hydrographs for select wells, and trends in precipitation. These data are summarized in the annual BNL Groundwater Status Reports. In the localized area surrounding Building 96, groundwater flow direction remained consistent over the past several years and is depicted on Figure 5. Groundwater flow direction in this area is southeasterly. The water table elevation in this area is currently about 20 feet bls. Historically, the water table elevation has fluctuated from 16 to 20 feet bls.

4.0 Building 96 – Operational Background

In accordance with a BNL Plant Engineering report dated June 1997 “Review of Potential Environmental Release Points” the operational chronology of Building 96 is as follows;
Building 96 was constructed in 1941. In 1942, it was shown on a site map as a motor pool. In 1943, drawings show additions to both ends and refer to the facility as a "motor repair shop." The additions are indicated as a "proposed paint shop" on the east end and a "proposed stock warehouse" on the west end of the facility. A drawing in 1960 shows the east end as being used for animal research. Biology Department confirmed that the east end of the facility was used for cattle pancreatic enzyme extraction from 1960-1963. The central heating boiler was decommissioned in 1995 and the above ground 550 gallon fuel oil tank was removed. Past facility uses (i.e., paint shop, motor pool, motor repair facility) may have resulted in environmental releases but records and drawings are non-existent. In addition to the prior uses, the area south of Building 96 was used as a scrapyard until 1999. Used drums were stored in this area in the 1960s and early 1970s. Residual contents from the drums were often emptied onto the open ground of the scrapyard.

5.0 Building 96 Characterization and Remediation Summary

5.1 Geophysical Survey

The initial historic characterization of the Building 96 area was performed in accordance with the *Building 96 Scrapyard Pre-Design Characterization Work Plan,* January 1999, to identify the source of high concentrations of VOCs in the Operable Unit III (OU III) groundwater plume. The area was a suspected source of VOCs within the OU III plume. Building 96 was designated as Area of Concern (AOC) 26B. Soil and ground water samples were analyzed and geophysical surveys were performed to identify any potential buried sources of VOC contamination. Geophysical surveys were performed in February 1999 in three areas in the vicinity of Building 96. Several geophysical anomalies were identified during the pre-design characterization sampling, which is documented in the *Building 96 Pre-Design Report*, June, 1999.

Location	Grid Area
Building 96 and adjacent area	Approximately 15,000 square feet
Building 96 former Scrapyard	Approximately 8,450 square feet
Former Truck Wash area	Approximately 18,000 square feet

Grids representing the surveyed areas are illustrated on Figure 6. Anomalies identified during the geophysical survey were investigated by performing exploratory trenches in March 2004. In summary, the twenty-one exploratory trenches resulted in no conclusive evidence of underground Storage Tanks (USTs), buried drums, sanitary systems or any other structure that could be a potential source of VOC groundwater contamination. Historical information and building records indicated the potential of five cesspools to exist in the Building 96 area (CP-1 through CP-5). Of the five cesspools only one, CP-5, was identified as part of the cesspool investigation. It was determined that this cesspool was associated with former building T-239. In accordance with Suffolk County Department of Health Services closure approval was granted and the Cesspool CP-5 was backfilled in September 2004 with clean fill material to grade.

5.2 Groundwater Treatment System Operational Background

The Building 96 groundwater treatment system began operation in February 2001 and consisted of four recirculation treatment wells (RTW-1 through RTW-4) housed in individual treatment sheds (Figure 5). The wells used in the system are referred to as recirculation treatment wells since water is withdrawn from, and recharged to, the aquifer in the same well. Contaminated groundwater is drawn from the aquifer, via a submersible well pump, into a lower well screen, which is set near the base of the contaminant plume. The groundwater then is pumped into a shallow stripping tray adjacent to the well, and recharged back to the shallow portion of the plume through the upper screen after treatment. The Building 96 system removes contaminants from the groundwater (liquid phase) to the vapor phase via air stripping in a stripping tray adjacent to each wellhead inside the treatment sheds. The combined VOC contaminated vapor stream is passed through a series of Granular Activated Carbon (GAC) filters to remove VOCs. The clean air is discharged to the atmosphere.

5.3 Groundwater Treatment System History

A review of the Building 96 treatment well influent data, monitoring well data, and mass removal data from January 2001 through March 2005, indicated that the remedial effectiveness of RTW-1 had reached a plateau without significant impact on the high concentrations of a continuing source of VOCs located upgradient of RTW-1. In an attempt to reduce the high concentrations of VOCs (primarily PCE) in groundwater in this area, potassium permanganate ($KMnO_4$) was injected to the subsurface in an attempt to chemically oxidize the PCE. The first round of $KMnO_4$ injections was conducted from December 7, 2004 through January 13, 2005 and consisted of 1,000 gallons of a 1.2 percent solution of $KMnO_4$ being injected at 83 temporary well locations from 20 to 40 feet bls (Figure 7). At the time of the injections, it was thought that silt layers present between 20 and 40 feet bls were acting as a source area. Groundwater monitoring data immediately following the first injection of $KMnO_4$ indicated a reduction in PCE concentrations.

A petition to shutdown the system, thereby placing the extraction wells in standby mode with continued monitoring, was submitted to the regulatory agencies and approved in April 2005. The approved petition for shutdown also called for additional spot injections of $KMnO_4$ to address any remaining elevated PCE concentrations in the source area as needed. Two subsequent rounds of $KMnO_4$ injections were conducted in the silt zone area upgradient of extraction well RTW-1 in response to rebounding PCE concentrations in the source area monitoring wells. In addition, extraction well RTW-1 was kept in operation to provide for hydraulic control of the source area (Figure 7). The second round of $KMnO_4$ injections was conducted from April 19, 2005 through April 26, 2005. This round consisted of 600 gallons of a 2.0 percent solution of $KMnO_4$ being injected at 29 temporary well locations from 20 feet to 40 feet bls. Details for the first and second rounds of $KMnO_4$ injections are presented in the *OU III Building 96 Groundwater Treatment System Shutdown Petition (AOC 26B)* (BNL 2005c).

Due to continued elevated levels of PCE concentrations in the Building 96 area upgradient of RTW-1, a third round of $KMnO_4$ injections was conducted January 2006. This round consisted of 330 gallons of a 2.0 percent solution of $KMnO_4$ injected at 22 locations from 20 feet to 30 feet bls.

After three rounds of injections, elevated VOC concentrations were still present in the northern part of the silt zone area upgradient of RTW-1 near wells 085-353 and 085-347. The highest TVOC concentrations in this area in 2006 were 8,754 μg/L and 2,442 μg/L in wells 085-353 and 085-347, respectively. In 2007, well 085-353 was 74 μg/L, 0875-347 was 1,751 μg/L. In the 2nd quarter sampling of 2008, well 085-353 was 692 μg/L and 085-347 was 832 μg/L.

A complete review of the monitoring well data indicates that the $KMnO_4$ injections resulted in some initial success at remediating the PCE concentrations. However, PCE concentrations in most, if not all of the wells in the area rebounded to concentrations at or near those prior to the $KMnO_4$ injections. Wells displaying the most significant rebound included 085-347, 085-353, and 095-84. The 2007 Groundwater Status Report includes historical time vs. concentration trend graphs for the

monitoring wells in this area.
During 2007, hexavalent chromium was detected in the RTW-1 influent at concentrations up to 124 ug/L. Subsequent sampling of all Building 96 area monitoring wells detected elevated levels of hexavalent chromium immediately downgradient of the Building 96 source area and correlated well to areas that were treated with $KMnO_4$. Manganese oxide is one of the byproducts of the $KMnO_4$ treatment process, which oxidizes trivalent chromium to hexavalent chromium. It is expected that over time, the hexavalent chromium will revert back to trivalent chromium (the less toxic form), which is supported by the latest groundwater monitoring data.

RTW-1 was placed back on standby in June 2006 in order to eliminate any hydraulic impact that the discharge may have been having on the shallow portion of the VOC plume in the immediate vicinity. RTW-1 was modified in May 2008 from a recirculation well to a pump and treat well discharging to a nearby drainage culvert and ultimately recharge basin HS. The well was modified and treatment was augmented at RTW-1 with an ion exchange resin to remove hexavalent chromium. During the time that RTW-1 was on standby, hydraulic control was not maintained at the source area and VOCs were able to migrate south towards the remaining three extraction wells RTW-2, RTW-3, and RTW-4. These wells are located approximately 300 feet downgradient of RTW-1. Due to increasing VOC concentrations in the downgradient extraction wells and adjacent monitoring wells, RTW-2 was placed back in operation in October 2007, and RTW-3 and RTW-4 were placed back in operation in March 2008. It is anticipated that VOC concentrations will decrease to levels allowing these wells to be placed back in standby mode.

5.4 2008 Soil Investigations

As noted above, it was previously estimated that a much larger and deeper volume of contaminated soils were present at this location. The area initially estimated in need of treatment and or excavation was approximately 7,400 cubic yards. The areal size combined with the vertical extent of the contamination to a depth of 20 feet below the water table (total of 40 feet bls) posed significant complexity regarding potential remedial alternatives.

Prior to BNL and DOE making a selection and commitment to a supplemental remediation effort that will have the greatest impact towards groundwater cleanup efforts, further soil characterization was needed to better define the source. The area where the highest levels of groundwater contamination continued to occur was chosen as an area of focus for obtaining soil data, see Figure 5. As detailed below in Section 5.4.1, the results from the soil characterization samples indicated that the source area was above the water table and was smaller than originally believed. A subsequent soil gas survey, detailed in Section 5.4.2, covering much of the remainder of the Building 96 area did not detect any additional source areas.

5.4.1 Soil Characterization

Soil sampling between wells 085-353, 085-354, 085-349 and 085-347 was performed by using a Geoprobe. For most locations, soil samples were collected continuously from land surface to the base of the silt unit, (typically 20-30 feet bgs). Select samples were screened using a photoionization detector (PID) and visually characterized. Soil samples of the silt unit (and any samples with elevated PID readings) were analyzed for VOCs using EPA Method 8260. See Table 1 for 2008 soil boring results and Figure 8 for boring locations.

The following is a summary of key information related to the 2008 soil borings. Six soil borings were drilled (via auger and split spoon) between April 15, 2008 and April 23, 2008 for a total of 39 silt layer soil samples sent for VOC analysis. Sampling began at 16 feet bls. The maximum concentration of PCE detected was 5,100 µg/kg in boring B-2 in the shallowest sample from 16-18 feet bls. This sample was from the vadose zone since the water table elevation is approximately 19 feet bls at this location. Boring B-2 is the most northwest of the six locations. The PCE concentrations in boring B-2 quickly dropped off to 180 µg/kg at 18-20 feet bls then to less then 9 µg/kg for the remaining five samples. The second highest PCE detection was in boring B-1, the most southwest location, with a concentration of 130 µg/kg at 29-31 feet bls. The remaining four borings did not detect PCE above 47 µg/kg.

Gamma logs and geologic logs were obtained at each boring. Both the gamma logs and visual observations show interbedded sand and silt were present in all borings from 10 to 15 feet bls (above the water table). Another prominent silt layer exists at most locations between 20 and 25 feet bls.

As a result of the high concentrations of PCE detected at the most shallow interval of boring B-2, six more soil borings were drilled (via Geoprobe and macro core tube) between May 27, 2008 and May 29, 2008 for a total of 25 silt layer soil samples sent for VOC analysis. The maximum concentration of PCE detected was 1,800,000 µg/kg in boring B-2 in the shallowest sample from 8.5-9 feet bls. The PCE concentrations in boring B-2 quickly dropped off from 210,000 µg/kg at 12-13 feet bls then to 79 µg/kg for the remaining three samples. The second highest PCE detection was in Boring B-7, approximately 15 feet north of boring B-2, with a concentration of 110,000 µg/kg. Boring B-10, approximately 15 feet west of Boring B-2, detected 480 µg/kg at 17-21 feet bls. The remaining three borings did not detect PCE above 80 µg/kg. PCE was the most prominent VOC detected in soil samples with other compounds such as 1,1,1-trichloroethane found at ranges from 1800 µg/kg to 0.47 µg/kg.

During June and July 2008 soil borings B-11 through B-15 and B-17 through B-22 were completed and a detailed contaminated soil source area was defined as shown in Figures 2, 3, 4, and 8. The most substantial concentrations of PCE were in Boring B-19, with a maximum concentration of 1,100,000 µg/kg at 8-10 feet bls, which is located 7 feet north of Boring B-2, and Boring B-20 with a concentration of 1,100,000 µg/kg at 0-2 feet bls, which is located 7 feet east of Boring B-2. The only other July boring which exhibited high concentrations was Boring B-22 at 9 feet west of Boring B-2 with PCE concentrations of 15,000 µg/kg between 10-12 feet bls. Based on the detailed soil characterization there is an area of highly contaminated PCE soil contamination located from just below ground surface to a depth at or just above the water table. This area is approximately 25’ by 25’ by 15’ bls in depth (about 350 cubic yards). It appears that precipitation events continue to mobilize this contamination and transport it to the water table where it is providing for a continuing source to groundwater. In November 2008, BNL placed a plastic impermeable liner over this area to minimize infiltration from precipitation and thereby reduce the likelihood of PCE being transported to the water table. See Figure 8 for the location and dimensions of the proposed soil excavation. A temporary vertical profile well was installed as Boring B-16 to check for the presence of dense non-aqueous phase liquid (DNAPL) in a location immediately downgradient of the highest soil PCE concentrations at B-2. This boring encountered a clay at 175 feet bls and samples were obtained at 10 foot intervals from just above the top of the clay to the water table. PCE was detected at a concentration of 80 µg/kg just below the water table. The remainder of the sample intervals revealed little or no PCE and therefore no DNAPL immediately downgradient of the source area.

5.4.2 Soil Vapor Survey

A soil vapor screening survey was conducted in September 2008 to supplement the soil boring data and identify whether or not there may be additional high concentration soil contamination areas outside of the area identified from the soil borings. Although direct correlation between contaminated soil and soil vapor VOC concentrations can vary greatly, the results of soil vapor surveys are useful in providing a qualitative indicator of soil contaminated by VOCs. The area chosen for the soil vapor survey was isolated to a grid area totaling approximately 260 square yards.

The soil vapor survey elements included the installation of soil vapor sampling points, collection of soil vapor samples in Tedlar ^{TM} bags, and analysis of the vapor samples using a Photovac Voyager^{TM} portable gas chromatograph (GC). A total of 58 locations were sampled, spaced at 25-foot increments.

The sampling points consist of small-diameter polyethylene tubing with a vapor collection tip, and were installed using a hand-operated “drive bar”. The sampling depth was approximately five feet below grade for all points. Samples were analyzed daily using the portable GC on-site.

The soil vapor results confirmed that the area previously identified in the vicinity of soil boring B-2 appears to be the only location containing soil highly contaminated with PCE. Figure 9 shows the soil vapor locations and PCE concentrations. PCE concentrations in soil vapor were 1 to 2 orders of magnitude higher in the vicinity of B-2. The remaining locations exhibiting PCE concentrations above background are associated with the shallow groundwater plume. PCE results were also observed to drop off to low levels along the perimeters of the study area. The nearest occupied building from the plume is Bldg. 452, Utilities Maintenance. This building is approximately 300 feet northwest of the plume and does not have a basement. The low soil gas levels from perimeter locations indicated that additional sampling closer to Building 452 was not needed.

6.0 Supplemental Remedial Action Recommendations

The delineation of the contaminated soils to a discrete relatively small and shallow area resulted in the focusing of remedial alternatives to excavation due to its implementability and effectiveness in completely removing the contamination. BNL is recommending that the Building 96 remedy be optimized through the excavation of contaminated soils with off-site disposal. This is in addition to the continued operation of the groundwater treatment system until the capture goal is attained, which is expected within several years of the soil excavation. Optimization of the remedy by reducing the number of years of treatment will enable BNL to achieve the cleanup goal of the OU III ROD for this groundwater plume (of meeting drinking water standards by 2030).

Approximately 350 cubic yards of contaminated soil would be removed, characterized for proper disposal, and transported to the off-site disposal facility. This area closely encompasses the area identified in the soil characterization with concentrations exceeding 1,400 µg/kg of PCE. This level, based on NYSDEC TAGM 4046, is a soil cleanup objective to protect groundwater. Endpoint samples will be taken from the bottom of the excavation for confirmation and if necessary additional excavation on the bottom of the excavation will be made.

Excavation will made utilizing shoring to support the sides of the excavation. Typical shoring would be sheet piling or a trench box. The top fifteen feet of unsaturated zone soils above the water table would be excavated and transported from the site. Soil contamination identified at the water table in several of the soil borings correlates with areas previously identified as having high concentrations of groundwater contamination and although in several instances these levels were above the TAGM value they should dissipate once the source area above is removed. The excavation of contaminated soil and stockpiling of clean fill would be performed by a qualified contractor. The material will be placed in covered roll off containers and analyzed for proper disposal.

Hydraulic control over the plume will continue to be maintained by running RTW-1 through RTW-4. Based on 2008 first and second quarter groundwater monitoring results (Figure 5) the highest contaminant concentrations are within the capture zone of the extraction wells. It is expected that with the source area removed this area should show relatively quick and significant improvement in groundwater quality. A capture goal of 50 µg/L for TVOCs will be utilized to determine when to shutdown individual extraction wells. This will be based upon the individual monitoring wells within the capture zone of each extraction well and the extraction well data. This value of 50 µg/L TVOC is consistent with the operation and maintenance manual exit strategy criteria used for most of the other on site treatment systems at BNL. By operating the groundwater extraction wells, hydraulic control will be maintained in this area and treatment of elevated PCE concentrations in groundwater will be continued. Groundwater modeling will be performed to more accurately evaluate the cleanup time frame.

The Building 96 Groundwater Remediation System extraction wells and monitoring wells should continue to be monitored quarterly after the supplemental source area remediation is performed. It would be expected that the wells closest to the source area should show improvement in groundwater quality first and then wells further downgradient would show this same trend several years later. Following the excavation, it is recommended that three additional monitoring wells be installed, one immediately upgradient of the excavation for background water quality, one within the excavated area, and one immediately downgradient of it to monitor progress of the cleanup.

The locations of the three monitoring wells should be as follows: One well will be installed approximately 100 feet north and upgradient to groundwater flow of the center of the area recommended for excavation, one well at the southern extent of the excavation, and one well 25 feet south or downgradient of the center of excavation. The wells will be installed with 15 feet of screen each, with five feet of screen above normal water table or the top of the screen at the peak height documented water table elevation.

Implementation of this recommendation is crucial to optimize the Building 96 remedy and to meet the groundwater cleanup objectives outlined in the OU III ROD.

7.0 Recommendation on Regulatory Approach for Change to ROD

The OU III ROD identifies the selected remedy, Alternative V10C, as active remediation of on-site and off-site VOC groundwater contamination. It also discusses the need for a source removal system using re-circulation wells with air stripping treatment near Building 96. Consequently, a groundwater remediation system consisting of four treatment wells was constructed for the Building 96 plume and has been operating since 2001. Optimization of the Building 96 remedy by reducing the number of years of treatment, and ultimately achievement of the cleanup goal as stated in the ROD for this groundwater plume (of meeting drinking water standards within 30 years or less), will require excavation of the source area.

Under CERCLA, there are three methods for making changes to approved cleanup decisions in RODs:

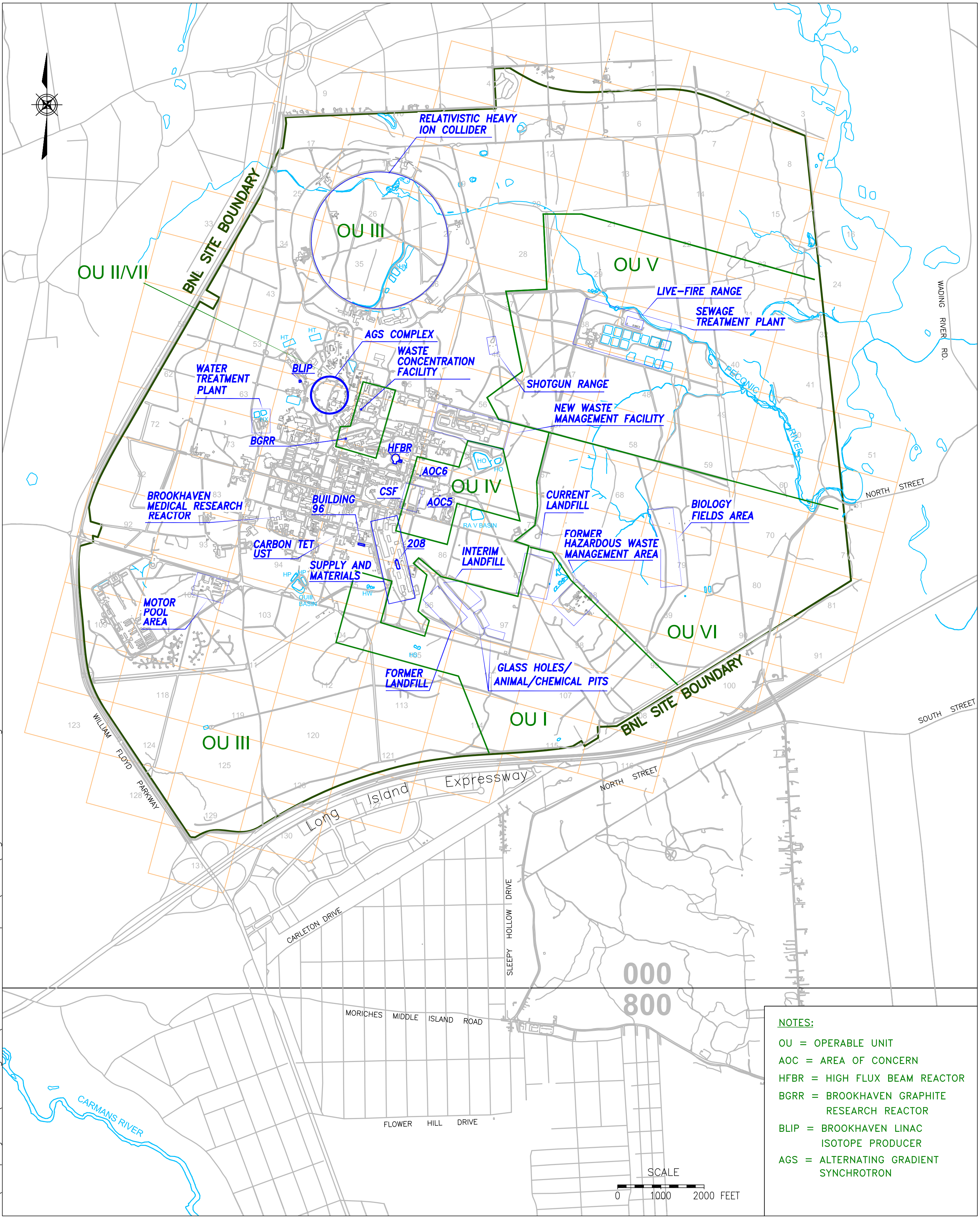
- Non-significant or minor changes (documented via a letter to the involved agencies)
- Significant changes (documented via an Explanation of Significant Differences)
- Fundamental changes (documented via a Proposed Plan and a ROD Amendment)

The categorization of the type of change is a site-specific determination and must consider the potential impact of scope/performance and cost. BNL and DOE have evaluated the change recommended in this report in accordance with Section 117 (c) of CERCLA and Section 300.435 (c)(2)(i) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and EPA guidance (EPA 540-R-98-031) on post-ROD changes, and recommend that an Explanation of Significant Differences (ESD) is the appropriate procedural pathway.

- <u>Potential Scope/Performance Impact</u>: An ESD generally involves a change to a component of a remedy that does not fundamentally alter the overall cleanup approach of the ROD. The recommended soil excavation of the high VOC contamination is consistent with this type of change. The overall cleanup approach of treating the on-site groundwater will continue, and the localized soil removal would help optimize the remedy by reducing the number of years of treatment. As a result, the time to achieve the cleanup goals at this portion of the site will be reduced.

- Potential Cost Impact: The estimated cost for soil excavation and off-site disposal of $414,000 is not a significant change/increase from what the overall VOC remedy in the OU III ROD identified for capital cost of approximately $10,500,000. This change would represent less than a 5% increase to the original remedy.

The fact that the Building 96 area is located within the central portion of the BNL site, and that the contamination originating from this source is hydraulically controlled both at the Building 96 Treatment System and the Middle Road Treatment System results in no direct risk to the public. Therefore, BNL and DOE do not recommend a 30-day public comment period prior to submission of the ESD for NYSDEC concurrence and EPA approval. However, the Community Advisory Council for the BNL site was briefed on the recommendation and will be briefed on the status of this project in the future. In addition, the approved ESD will be made available to the public via the BNL website. The ESD and other relevant documents such as this Report will become part of the Administrative Record file for the BNL site.



NOTES:

OU = OPERABLE UNIT
AOC = AREA OF CONCERN
HFBR = HIGH FLUX BEAM REACTOR
BGRR = BROOKHAVEN GRAPHITE RESEARCH REACTOR
BLIP = BROOKHAVEN LINAC ISOTOPE PRODUCER
AGS = ALTERNATING GRADIENT SYNCHROTRON

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BROOKHAVEN
NATIONAL LABORATORY

EWMS DIVISION

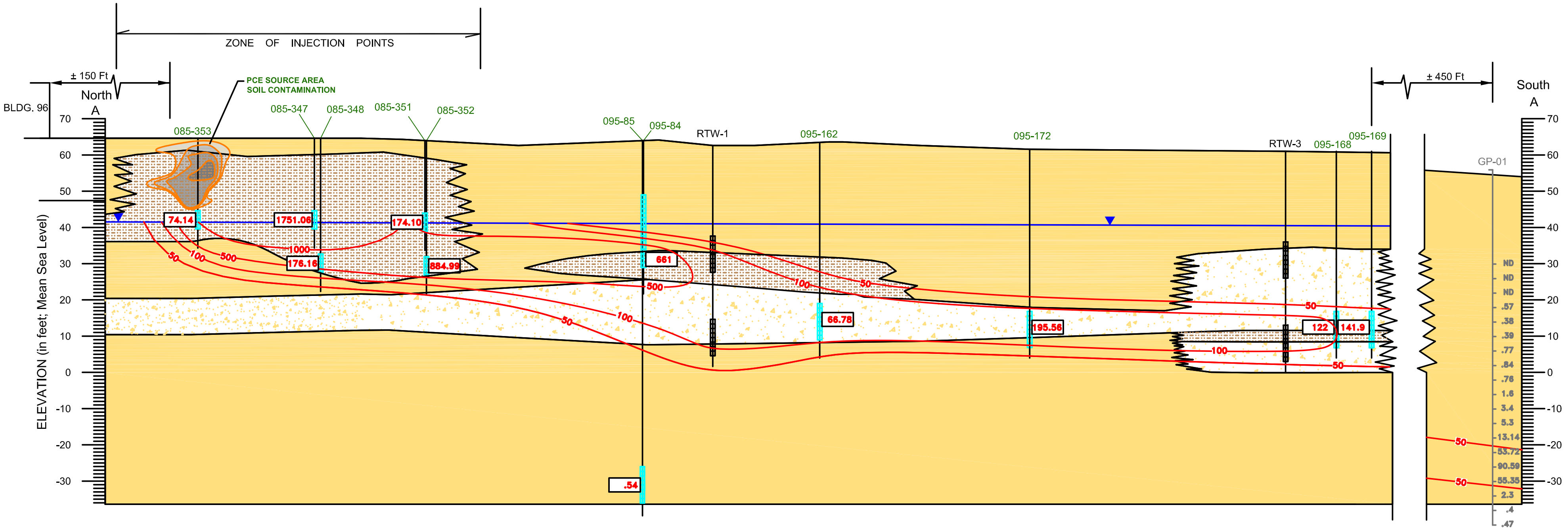
TITLE:

BNL SITE AND
SURROUNDING AREA

OU III BUILDING 96
RECOMMENDATION FOR SOURCE AREA REMEDIATION

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
AJZ	–	11/10/08	–
CHKD:	APPD:	REV.:	NOTES:
–	–	–	–

FIGURE NO.: 1



LEGEND

Upper Glacial aquifer

🟨	Fine to coarse sand, trace to little silt and/or fine to medium gravel.
▨	Very fine sand and/or silt, with silt and sand lenses interbedded.
░	Coarse to very coarse sand, with or without gravel or gravel with sand.

095-85	BNL Monitoring Well ID
104.94	TVOC Concentration (µg/L)
—50—	TVOC Contour (µg/L) (Dashed Where Inferred)
GP-01 .57 .38	Geoprobe Borings
RTW–1	Recirculation Well

▼	Water Table As Of December 3–6, 2007
▯	Monitoring Well Screen
▮	Extraction Well Screen With Blank

HORIZONTAL SCALE
0 30 60
FEET

NOTES:

1) GEOLOGIC INFORMATION SHOWN IS BASED ON LITHOLOGIC DATA COLLECTED JUNE 2004 FOR GP BORING DESIGNATIONS AND NOV. 2004 FOR S BORING DESIGNATIONS SUPPLEMENTED WITH GEOLOGIC DATA FROM 1999.

2) PLUME DISTRIBUTION BASED ON THIRD AND FOURTH QUARTER 2007 BLDG 96 SAMPLING EVENT.

3) CONTOUR INTERVAL IS AS SHOWN.

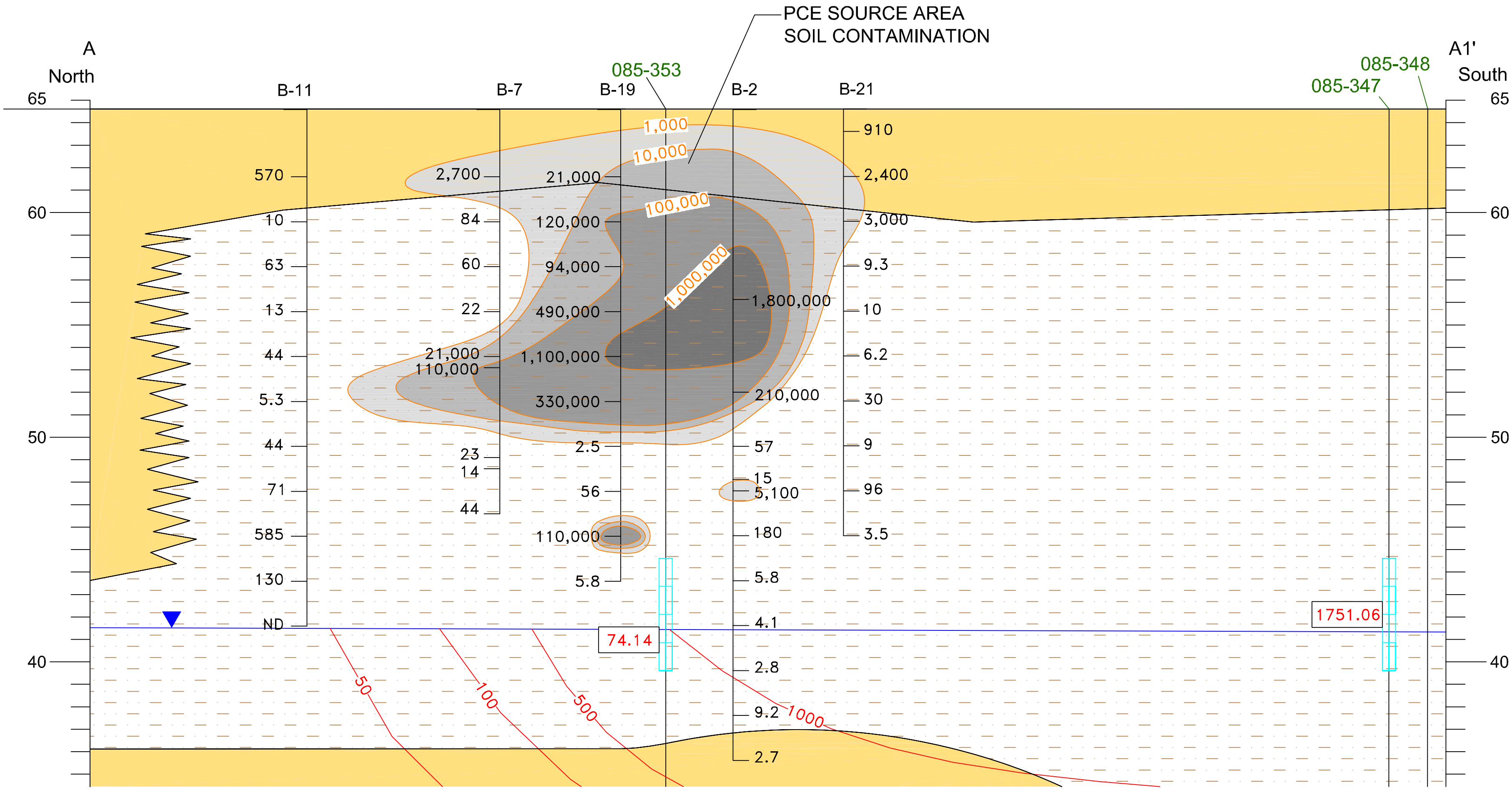
4) BNL WELL ID COLOR CORRESPONDS TO LONG–TERM MONITORING PROGRAM WELL LOCATION MAP.

\\OERNT\RemedialRecommendations\Report\Figures\FIG_2.DWG

BROOKHAVEN
NATIONAL LABORATORY
EWMS DIVISION

TITLE:
BUILDING 96 AREA
HYDROGEOLOGIC CROSS SECTION (A–A')
OU III BUILDING 96
RECOMMENDATION FOR SOURCE AREA REMEDIATION

DWN: AJZ	VT:HZ.: 1.5:1	DATE: 11/18/08	PROJECT NO.: –
CHKD: JEB	APPD: WRD	REV.: –	NOTES: –
FIGURE NO.: 2			



LEGEND

Upper Glacial aquifer

🟨	Fine to coarse sand, trace to little silt and/or fine to medium gravel.
▤	Very fine sand and/or silt, with silt and sand lenses interbedded.
●	Isoconcentration Contour representing line of equal PCE concentration in (µg/kg) in soil.
095-85	BNL Monitoring Well ID
104.94	TVOC Concentration (µg/L) in Groundwater
—50—	TVOC Contour (µg/L) (Dashed Where Inferred)
B-11 .57 .38	Soil Borings with PCE results (µg/kg)
▼	Water Table As Of December 3–6, 2007
▯	Monitoring Well Screen

HORIZONTAL SCALE

0 15 FEET

NOTES:

1) GEOLOGIC INFORMATION SHOWN IS BASED ON LITHOLOGIC DATA COLLECTED JUNE 2004 FOR GP BORING DESIGNATIONS AND NOV. 2004 FOR S BORING DESIGNATIONS SUPPLEMENTED WITH GEOLOGIC DATA FROM 2008 SOIL BORINGS.

2) GROUNDWATER PLUME DISTRIBUTION BASED ON THIRD AND FOURTH QUARTER 2007 BLDG 96 SAMPLING EVENT.

3) CONTOUR INTERVAL IS AS SHOWN.

4) BNL WELL ID COLOR CORRESPONDS TO LONG–TERM MONITORING PROGRAM WELL LOCATION MAP.

\\OERNT\RemedialRecommendations\Report\Figures\FIG_3.DWG

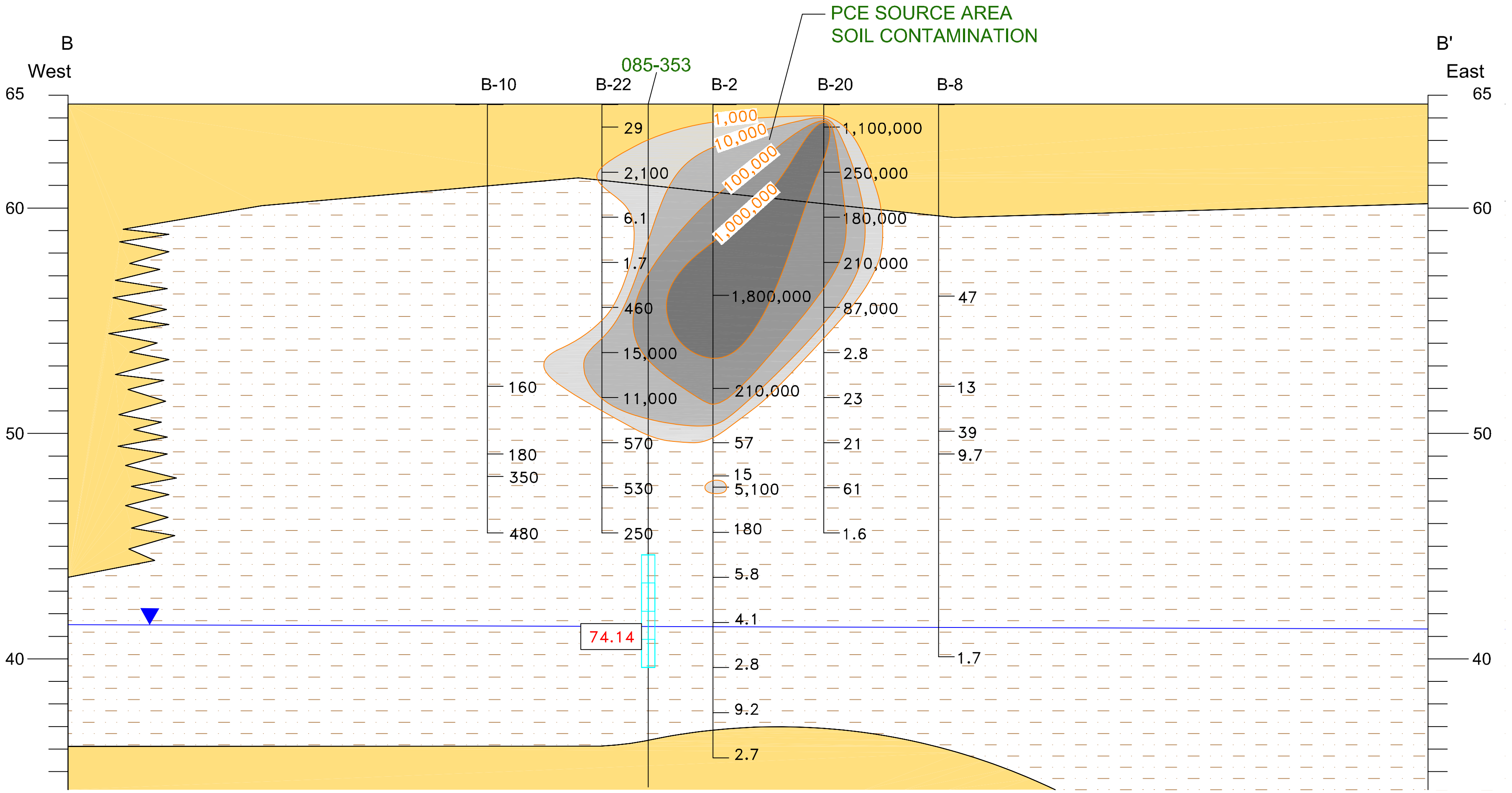
BROOKHAVEN
NATIONAL LABORATORY
ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU III BUILDING 96 AREA
HYDROGEOLOGIC CROSS SECTION (A–A1')

OU III BUILDING 96
RECOMMENDATION FOR SOURCE AREA REMEDIATION

DWN: AJZ	VT:HZ.: 1.5:1	DATE: 03/25/09	PROJECT NO.: –
CHKD: JEB	APPD: WRD	REV.: –	NOTES: –
FIGURE NO.: 3			



\\OERNT\RemedialRecommendations\Report\Figures\FIG_4.DWG

LEGEND

Upper Glacial aquifer

🟨 Fine to coarse sand, trace to little silt and/or fine to medium gravel.

▤ Very fine sand and/or silt, with silt and sand lenses interbedded.

Isoconcentration Contour representing line of equal PCE concentration in (µg/kg) in soil.

095-85 BNL Monitoring Well ID

B-11 .57 .38 Soil Borings with PCE results (µg/kg)

▼ Water Table As Of December 3–6, 2007

Monitoring Well Screen

HORIZONTAL SCALE

0 15
FEET

NOTES:

1) GEOLOGIC INFORMATION SHOWN IS BASED ON LITHOLOGIC DATA COLLECTED JUNE 2004 FOR GP BORING DESIGNATIONS AND NOV. 2004 FOR S BORING DESIGNATIONS SUPPLEMENTED WITH GEOLOGIC DATA FROM 2008 SOIL BORINGS.

2) CONTOUR INTERVAL IS AS SHOWN.

3) BNL WELL ID COLOR CORRESPONDS TO LONG–TERM MONITORING PROGRAM WELL LOCATION MAP.

BROOKHAVEN
NATIONAL LABORATORY

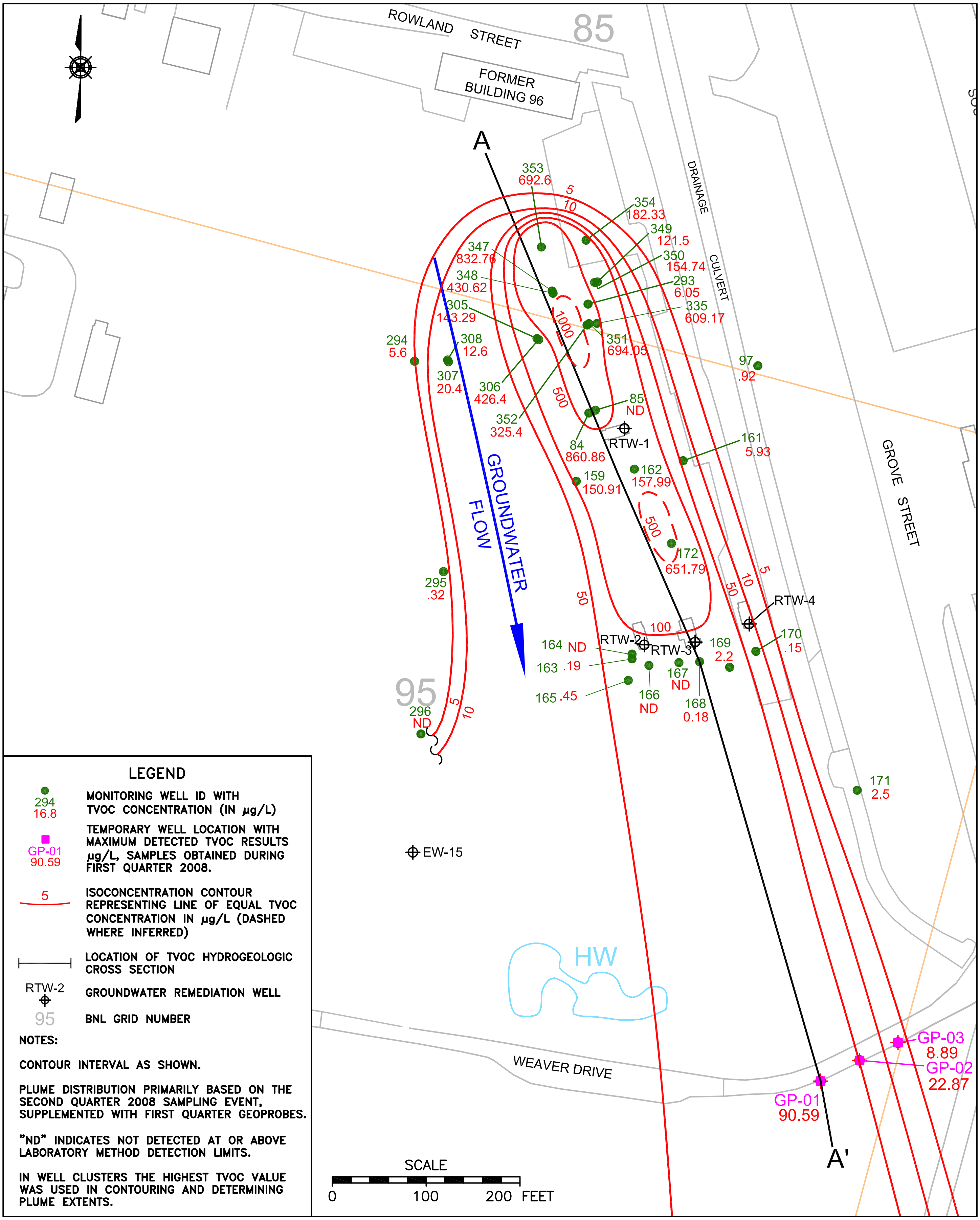
ENVIRONMENTAL PROTECTION DIVISION

TITLE:

OU III BUILDING 96 AREA
HYDROGEOLOGIC CROSS SECTION (B–B')

OU III BUILDING 96
RECOMMENDATION FOR SOURCE AREA REMEDIATION

DWN: AJZ	VT:HZ.: 1.5:1	DATE: 03/25/09	PROJECT NO.: –
CHKD: JEB	APPD: WRD	REV.: –	NOTES: –
FIGURE NO.: 4			



LEGEND

● 294 16.8	MONITORING WELL ID WITH TVOC CONCENTRATION (IN µg/L)
■ GP-01 90.59	TEMPORARY WELL LOCATION WITH MAXIMUM DETECTED TVOC RESULTS µg/L, SAMPLES OBTAINED DURING FIRST QUARTER 2008.
5	ISOCONCENTRATION CONTOUR REPRESENTING LINE OF EQUAL TVOC CONCENTRATION IN µg/L (DASHED WHERE INFERRED)
├──┤	LOCATION OF TVOC HYDROGEOLOGIC CROSS SECTION
RTW-2 ⌖	GROUNDWATER REMEDIATION WELL
95	BNL GRID NUMBER

NOTES:

CONTOUR INTERVAL AS SHOWN.

PLUME DISTRIBUTION PRIMARILY BASED ON THE SECOND QUARTER 2008 SAMPLING EVENT, SUPPLEMENTED WITH FIRST QUARTER GEOPROBES.

"ND" INDICATES NOT DETECTED AT OR ABOVE LABORATORY METHOD DETECTION LIMITS.

IN WELL CLUSTERS THE HIGHEST TVOC VALUE WAS USED IN CONTOURING AND DETERMINING PLUME EXTENTS.

\\OERNT\RemedialRecommendations\Report\Figures\FIG_5.DWG

BROOKHAVEN
NATIONAL LABORATORY

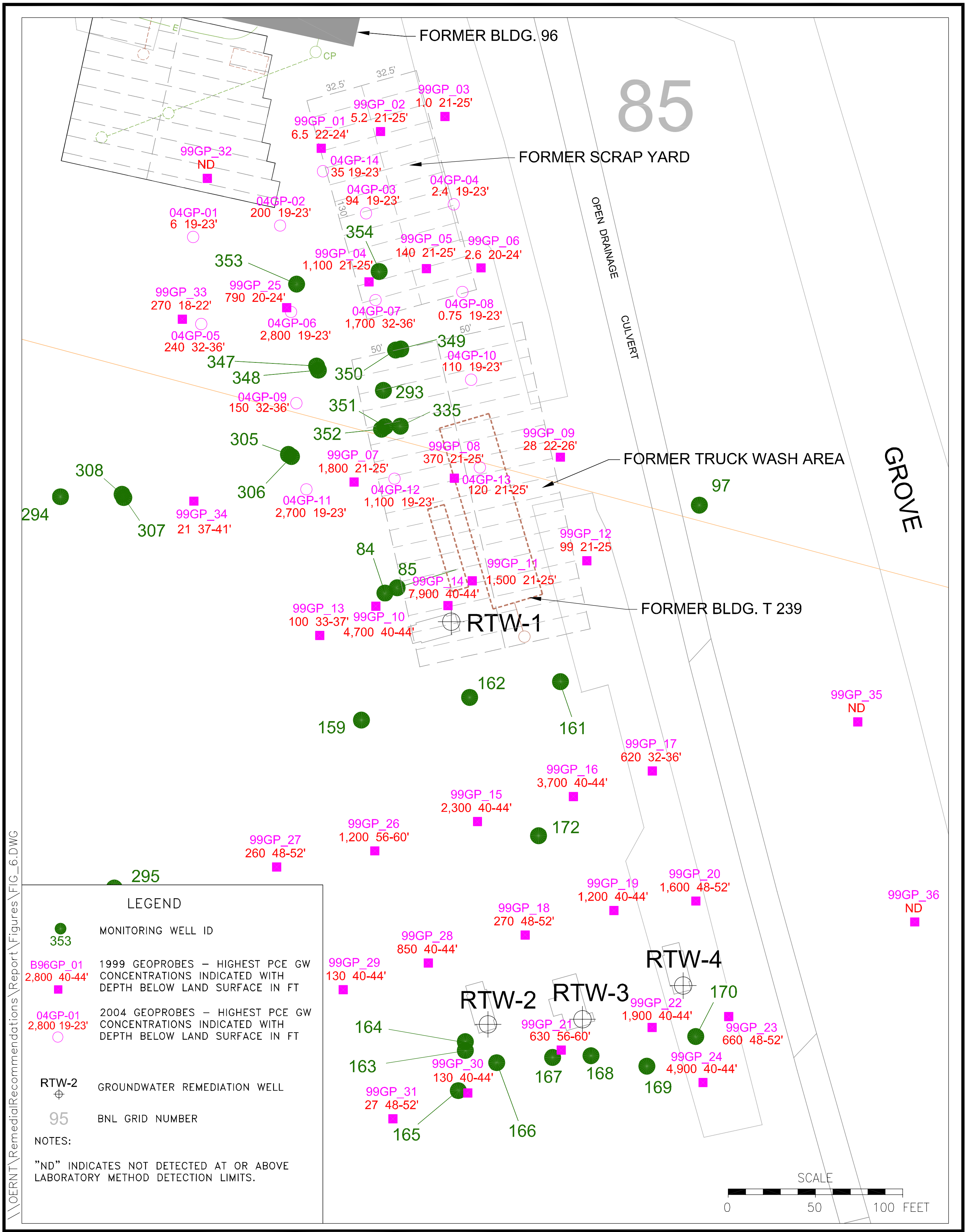
EWMS DIVISION

TITLE:

BUILDING 96 AREA
TVOC PLUME DISTRIBUTION
(2nd QUARTER)

OU III BUILDING 96
RECOMMENDATION FOR SOURCE AREA REMEDIATION

DWN: AJZ	VT: HZ.: –	DATE: 11/10/08	PROJECT NO.: –
CHKD: JEB	APPD: WRD	REV.: –	NOTES: –
FIGURE NO.: 5			



BROOKHAVEN
NATIONAL LABORATORY

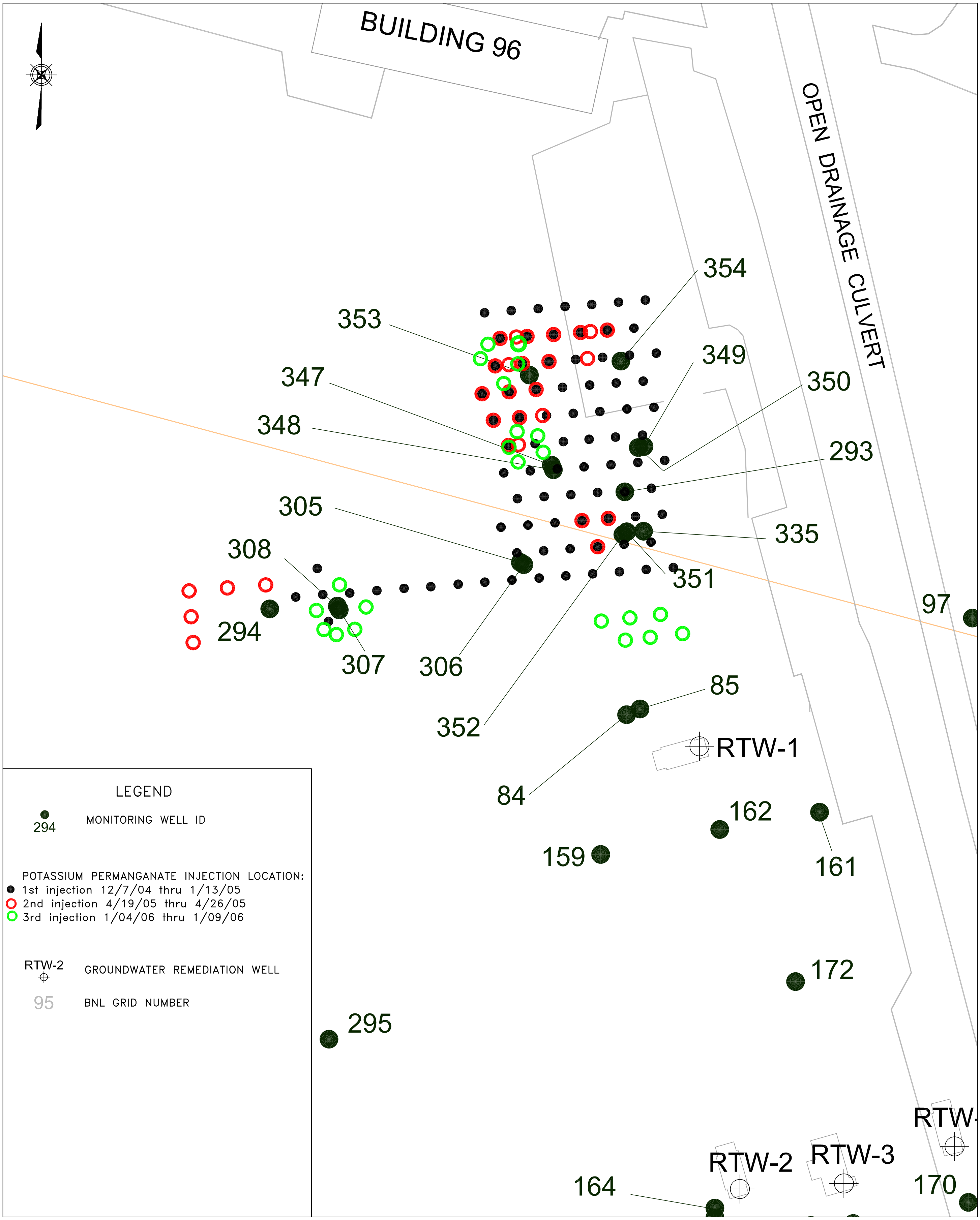
EWMS DIVISION

TITLE:
BUILDING 96 – 1999 AND 2004
GEOPROBE GROUNDWATER DATA

OU III BUILDING 96
RECOMMENDATION FOR SOURCE AREA REMEDIATION

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
AJZ	–	11/18/08	–
CHKD:	APPD:	REV.:	NOTES:
WRD	WRD	–	–

FIGURE NO.: 6



OERNT: \GIS\Gw_projects\Building 96\Source Area Report\Final\Fig_7 11-10-08.dwg

BROOKHAVEN
NATIONAL LABORATORY

EWMS DIVISION

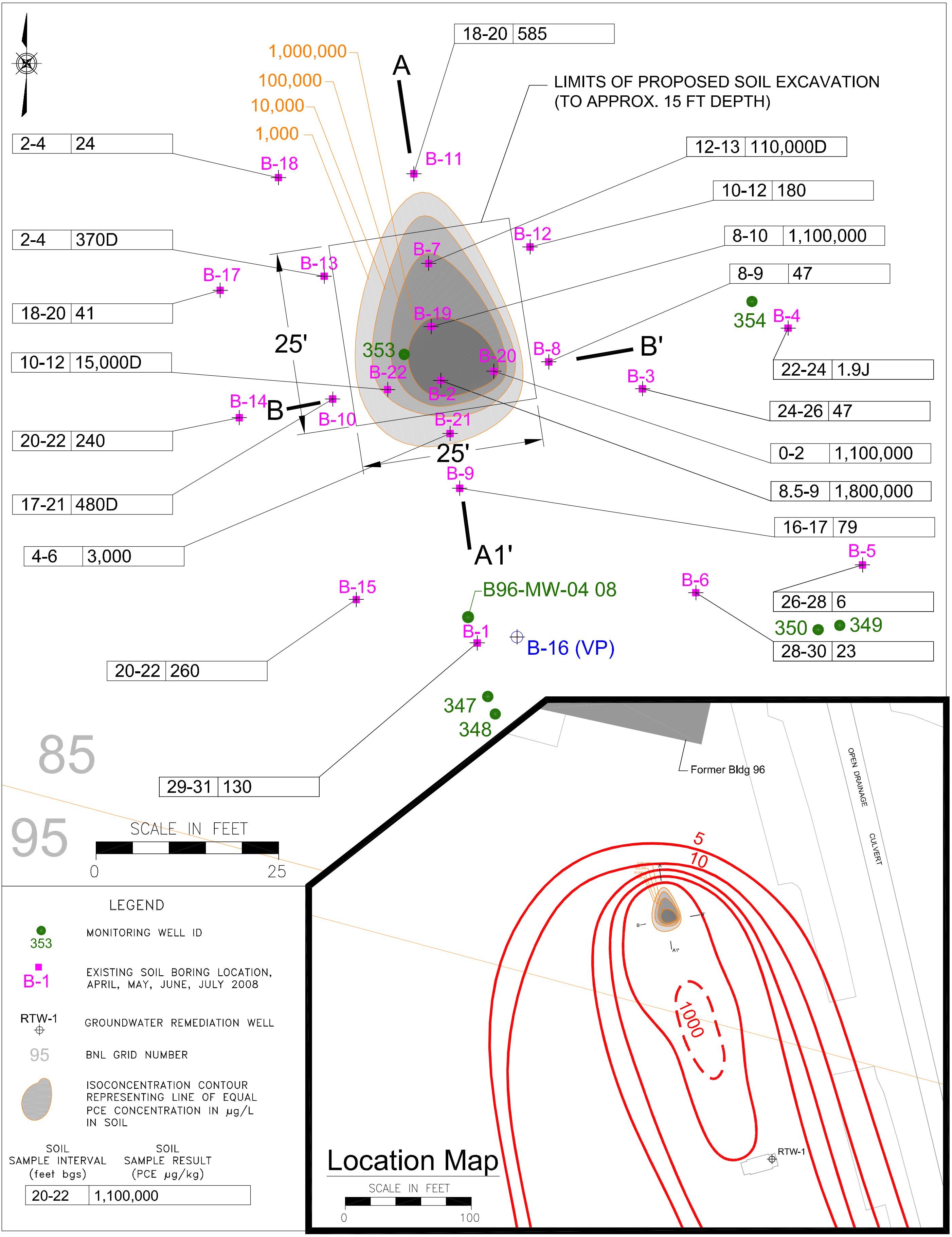
TITLE:

BUILDING 96 AREA POTASSIUM PERMANGANATE INJECTION POINTS

OU III BUILDING 96
RECOMMENDATION FOR SOURCE AREA REMEDIATION

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
AJZ	–	11/13/08	–
CHKD:	APPD:	REV.:	NOTES:
WRD	WRD	–	–

FIGURE NO.: 7



\\OERNT\RemedialRecommendations\Report\Figures\FIG_8.DWG

BROOKHAVEN
NATIONAL LABORATORY

EWMS DIVISION

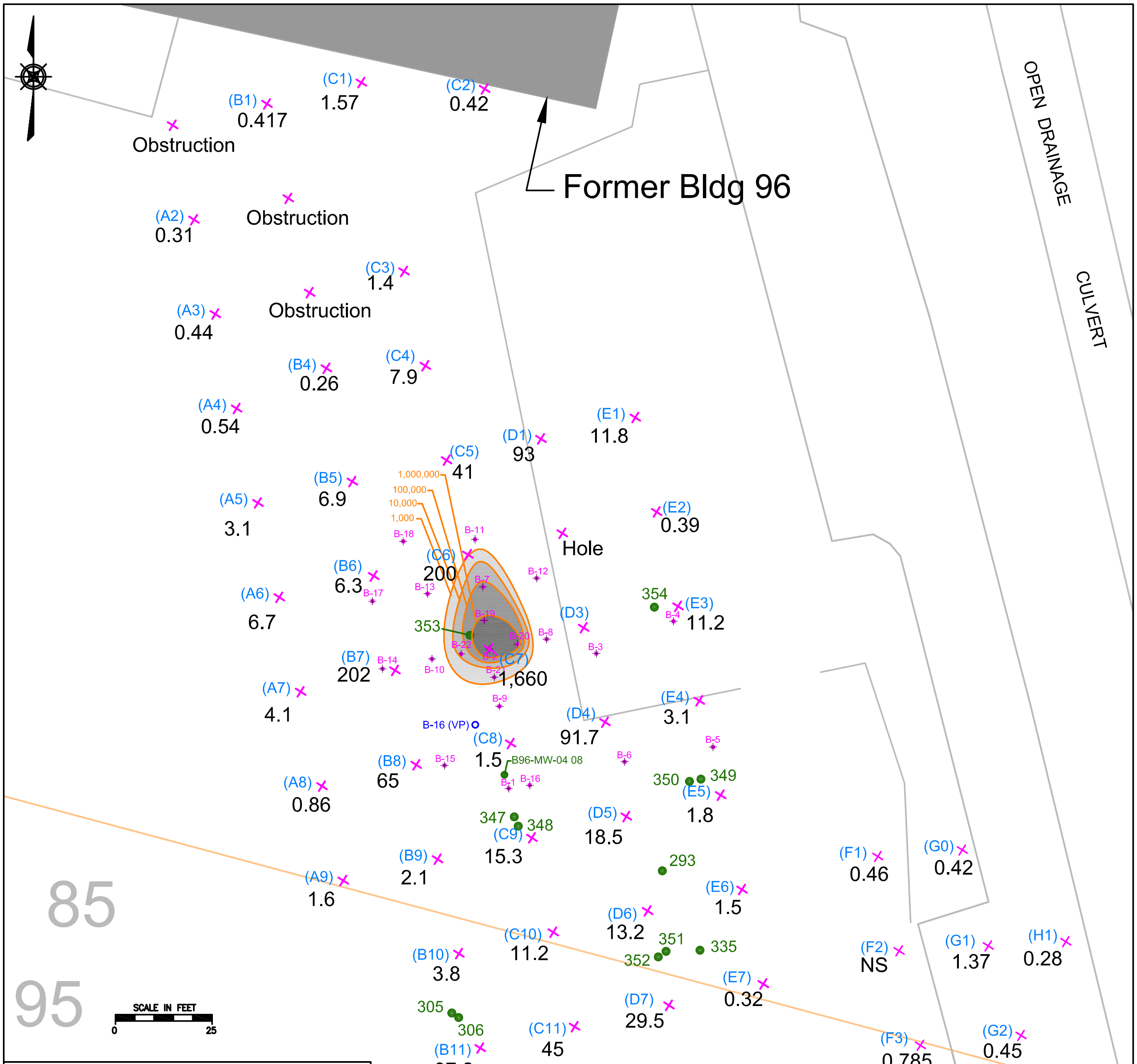
TITLE:

BUILDING 96
2008 BORING LOCATIONS AND PCE RESULTS

OU III BUILDING 96
RECOMMENDATION FOR SOURCE AREA REMEDIATION

DWN:	VT: HZ.:	DATE:	PROJECT NO.:
AJZ	–	02/09/09	–
CHKD:	APPD:	REV.:	NOTES:
–	–	–	–

FIGURE NO.: 8



LEGEND

● 353	MONITORING WELL ID
■ B-1	EXISTING SOIL BORING LOCATION, APRIL, MAY, JUNE, JULY 2008
RTW-1 ⌖	GROUNDWATER REMEDIATION WELL
95	BNL GRID NUMBER
▨	ISOCONCENTRATION CONTOUR REPRESENTING LINE OF EQUAL PCE CONCENTRATION IN µg/L IN SOIL
× 41	Soil Gas Point, Tetrachloroethene Concentration in ppmv
(AX)	Soil Gas Survey (Point Label)
NS	Not Sampled

\\OERNT\RemedialRecommendations\Report\Figures\FIG_9.DWG

BROOKHAVEN
NATIONAL LABORATORY

EWMS DIVISION

TITLE:

BUILDING 96 SOIL VAPOR LOCATIONS AND PCE RESULTS

OU III BUILDING 96
RECOMMENDATION FOR SOURCE AREA REMEDIATION

DWN: AJZ	VT: HZ.: –	DATE: 11/10/08	PROJECT NO.: –
CHKD: WRD	APPD: WRD	REV.: –	NOTES: –
FIGURE NO.: 9			

Table 1
Bldg. 96 Soil Borings April - October 2008

Geoprobe ID	**B96 B-1 (6/16/08)**	
Sample Interval (feet bgs)	**PCE (µg/kg)**	**Percent Moisture (dry weight)**
2-4	33	7
4-6	ND	7
6-8	0.74 J	7
8-10	2.0 J	16
10-12	4.5 J	9
Geoprobe ID	**B96 B-1 (5/29/08)**	
11-12	4 J	17
14-16	8.5	18
Geoprobe ID	**B96 B-1 (4/15/08 - 4/16/08)**	
19-21	35	20
23-25	9	23
25-27	12	20
29-31	130	21
31-33	91	18
Geoprobe ID	**B96 B-2 (5/29/08)**	
8.5-9	1,800,000 D	13
12-13	210,000 D	10
14-16	57	16
16-17	15	15
18-20	79 D	19
Geoprobe ID	**B96 B-2 (4/17/08)**	
16-18	5,100	17
18-20	180	18
20-22	5.8 J	20
22-24	4.1 J	22
24-26	2.8 J	24
26-28	9.2	19
28-30	2.7 J	20
Geoprobe ID	**B96 B-3 (6/16/08)**	
2-4	42	11
4-6	1.4 J	4
6-8	0.94 J	15
8-10	ND	12
10-12	0.94 J	6
12-14	14	16
Geoprobe ID	**B96 B-3 (4/22/08)**	
14-16	20	
16-18	20	
22-24	ND	
24-26	47	
26-28	3	
28-30	ND	
30-32	9	
32-34	ND	
Geoprobe ID	**B96 B-4 (4/18/08)**	
16-18	1.4 J	18
20-22	1.3 J	17
22-24	1.9 J	23
24-26	0.94 J	20
26-28	ND	18
28-30	ND	15

Table 1
Bldg. 96 Soil Borings April - October 2008

Sample Interval (feet bgs)	PCE (µg/kg)	Percent Moisture (dry weight)
Geoprobe ID	**B96 B-5 (4/23/08)**	
18-20	ND	
22-24	ND	
24-26	ND	
26-28	6	
28-30	2	
Geoprobe ID	**B96 B-6 (4/21/08)**	
14-16	ND	19
16-18	ND	18
18-20	2.3	22
20-22	2.7	22
28-30	23	19
30-32	18	20
32-34	16	18
34-36	2.1 J	20
Geoprobe ID	**B96 B-7 (6/17/08)**	
2-4	2,700	10
4-6	84	5
6-8	60	5
8-10	22	4
10-12	21,000	7
Geoprobe ID	**B96 B-7 (5/28/08)**	
12-13	110,000 D	10
16-17	23	17
17-18	14	15
18-21	44	19
Geoprobe ID	**B96 B-8 (5/29/08)**	
8-9	47	15
12-13	13	15
14-15	39	19
15-16	9.7	21
24-25	1.7 J	19
Geoprobe ID	**B96 B-9 (5/27/08)**	
10-11	6.8	13
12-13	13	16
15-16	25	29
16-17	79	19
19-20	8.7	20
Geoprobe ID	**B96 B-10 (5/28/08)**	
12-13	160	13
15-16	180 D	19
16-17	350	20
17-21	480 D	18
Geoprobe ID	**B96 B-11 (6/18/08)**	
2-4	570 D	18
4-6	10	13
6-8	63	14
8-10	13	15
10-12	44	17
12-14	5.3 J	20
14-16	44	8
16-18	71	19
18-20	585	15
20-22	130	20
22-24	ND	14

Table 1
Bldg. 96 Soil Borings April - October 2008

Sample Interval (feet bgs)	PCE (µg/kg)	Percent Moisture (dry weight)
Geoprobe ID	**B96 B-12 (6/18/08)**	
2-4	5.5 J	13
4-6	1.8 J	13
6-8	17	16
8-10	1.9 J	9
10-12	180	12
12-14	4.0 J	13
14-16	110	16
16-18	3.6 J	16
18-20	3.2 J	19
20-22	16	20
22-24	0.64 J	24
Geoprobe ID	**B96 B-13 (6/17/08)**	
2-4	370 D	8
4-6	25	8
6-8	12	4
8-10	3.8 J	7
10-12	2.4 J	8
12-14	140	8
14-16	280 E	18
16-18	92	18
18-20	24	18
20-22	7.8	17
22-24	4.6 J	16
Geoprobe ID	**B96 B-14 (6/16/08)**	
2-4	6.5	5
4-6	0.93 J	4
6-8	11	6
8-10	1.0 J	4
10-12	11	5
12-14	1.4 J	7
14-16	1.7 J	8
16-18	130	19
18-20	89	18
20-22	240	21
22-24	7.1	19
Geoprobe ID	**B96 B-15 (6/16/08)**	
2-4	16	13
4-6	0.99 J	6
6-8	14	12
8-10	43	20
10-12	4.3 J	6
12-14	18	13
14-16	22	14
16-18	140	23
18-20	2.8 J	16
20-22	260	17
22-24	260	20
Geoprobe ID	**B96 B-17 (6/18/08)**	
2-4	19	12
4-6	9.9	11
6-8	1.5	6
8-10	6.4	22
10-12	2.6	19
12-14	10	20
14-16	13	13
16-18	29	21
18-20	6.2	17
20-22	41	18
22-24	23	17

Table 1
Bldg. 96 Soil Borings April - October 2008

Sample Interval (feet bgs)	PCE (µg/kg)	Percent Moisture (dry weight)
Geoprobe ID	**B96 B-18 (6/19/08)**	
2-4	24	8
4-6	2.0 J	5
6-8	.82 J	20
8-10	.67 J	10
10-12	1.6 J	9
12-14	7.6	18
14-16	ND	13
16-18	3.1 J	19
18-20	23	16
20-22	22	21
22-24	1.4 J	20
Geoprobe ID	**B96 B-19 (7.5' N of B-2) (7/30/08)**	
0-2	21,000 D	11
2-4	120,000 D	12
4-6	94,000 D	10
6-8	490,000 D	11
8-10	1100000 D	11
10-12	330,000 D	14
12-14	2.5 J	5
14-16	56	13
16-18	110,000 D	10
18-20	5.8 J	20
Geoprobe ID	**B96 B-20 (7.5' E of B-2) (7/30/08)**	
0-2	1,100,000 D	11
2-4	250,000 D	9
4-6	180,000 D	7
6-8	210,000 D	11
8-10	87,000 D	7
10-12	2.8 J	5
12-14	23	14
14-16	21	17
16-18	61	18
18-20	1.6 J	11
Geoprobe ID	**B96 B-21 (7.5' S of B-2) (7/31/08)**	
0-2	910 D	6
2-4	2,400	8
4-6	3,000	7
6-8	9.3	7
8-10	10	8
10-12	6.2	4
12-14	30	13
14-16	9	17
16-18	96 J,D	9
18-20	3.5 J	17
Geoprobe ID	**B96 B-22 (7.5' W of B-2) (7/31/08)**	
0-2	29	4
2-4	2,100	11
4-6	6.1	4
6-8	1.7 J	3
8-10	460 D	8
10-12	15,000 D	13
12-14	11,000 D	8
14-16	570	16
16-18	530 D	12
18-20	250	18

Table 1
Bldg. 96 Soil Borings April - October 2008

Sample Interval (feet bgs)	PCE (µg/kg)	Percent Moisture (dry weight)
Geoprobe ID	**B96 B-23 (@ location of SV point C12) (10/9/08)**	
0-2	77	10
2-4	27	6
4-6	19	4
6-8	130	6
8-10	290	14
10-12	85	3
12-14	49	10
14-16	0.98 J	3
16-18	1.6 J	3
18-20	0.93 J	3

All units in µg/kg
bgs = below ground surface
J = Estimated result
D = Result was obtained from the analysis of a dilution
E = Estimated result. Result concentration exceeds the calibration
ND = Not detected
Samples analyzed by EPA Method 8260
Note: B-16 not shown since it is a groundwater temporary well