2016 OU2 GROUNDWATER INVESTIGATION
RE133D1, RE133D2 (VPB167)
INSTALLATION REPORT

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT (NWIRP)
SITE 1 OU2
BETHPAGE, NY

Prepared for:

Department of the Navy
Naval Facilities Engineering Command, Atlantic
9324 Virginia Avenue
Building Z-144
Norfolk, Virginia 23511

April 2017

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9324 Virginia Avenue
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Prepared by:

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Contract Number: N62470-11-D-8013
CTO WE15

April 2017

Brian Caldwell

Brian Caldwell
Contract Task Order Manager

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List of Acronyms and Abbreviations

AOC	Area of Concern
bgs	below ground surface
CSM	Conceptual Site Model
COR	Continuously Operating Reference
DOD	Department of Defense
EPA	Environmental Protection Agency, United States
ESS	Environmental Sequence Stratigraphy
ft	feet
GOCO	Government-Owned Contractor-Operated
GPS	Global Positioning System
IDW	Investigation Derived Waste
IR	Installation Restoration
Katahdin	Katahdin Analytical Services
NAD	North American Datum
NAVD	North American Vertical Datum
NAVFAC	Naval Facilities Engineering Command
NG	Northrop Grumman
NTU	nephelometric turbidity units
NWIRP	Naval Weapons Industrial Reserve Plant
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
OU	Operable Unit
PCBs	Polychlorinated Biphenyls
POTW	Publicly Owned Treatment Works
PPE	Personal Protective Equipment
PVC	Polyvinylchloride
SAP	Sampling and Analysis Plan
SVOC	Semivolatile Organic Compounds
TCE	Trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Total Organic Carbon
UFP	United Federal Programs
US	United States
VOC	Volatile Organic Compounds
VPB	Vertical Profile Boring

1.0 PROJECT BACKGROUND

Resolution Consultants has prepared this Data Summary Report for the Naval Facilities Engineering Command (NAVFAC), Mid-Atlantic under contract task order WE15 Contract N62470-11-D-8013. This report describes the installation of two monitoring wells and one initial groundwater monitoring event (specifically at the Vertical Profile Boring [VPB] 167 location) in 2016 for the Naval Weapons Industrial Reserve Plant (NWIRP) Bethpage Operable Unit (OU) 2 Site 1 offsite plume. NWIRP Bethpage is located in east-central Nassau County, Long Island, New York, approximately 30 miles east of New York City (Figure 1).

1.1 Scope and Objectives

This report provides information on the installation of RE133D1 and RE133D2, monitoring wells associated with VPB167. The purpose of this investigation was to ascertain subsurface conditions and contaminant levels upgradient of the Massapequa Water District. The locations of RE133D1 and RE133D2, as well as other VPBs and monitoring well locations, are shown in Figure 2.

The field investigation included completing two monitoring wells, well development, soil/groundwater analysis, groundwater grab samples, and surveying. Field tasks were conducted in 2016 in accordance with the *United Federal Programs Sampling and Analysis Plan (UFP SAP)*, Bethpage, New York (Resolution, 2013a). In addition, the work adhered to the following UFP SAP Addendums: *Groundwater Sampling Using Low Stress (Low Flow) Purging and Sampling Protocol* (Resolution Consultants, 2013b) and *Installation of Vertical Profile Borings and Monitoring Wells* (Resolution Consultants, 2013c).

Documentation of these activities is included in Appendix A of this report.

1.2 Site History

NWIRP Bethpage is in the Hamlet of Bethpage, Town of Oyster Bay, New York. Since its inception in 1941, the plant's primary mission was the research, prototyping, testing, design, engineering, fabrication, and primary assembly of military aircraft. The facilities at NWIRP included four plants used for assembly and prototype testing, a group of quality control laboratories, two warehouse complexes (north and south), a salvage storage area, water recharge basins, the Industrial Wastewater Treatment Plant, and several smaller support buildings.

The Navy’s property originally totaled 109.5 acres and was formerly a Government-Owned Contractor-Operated (GOCO) facility that was operated by Northrop Grumman (NG) until

September 1998. Prior to 2002, the NWIRP property was bordered on the north, west, and south by current or former NG facilities, and on the east by a residential neighborhood. By March 2008, approximately 100 acres of NWIRP property were transferred to Nassau County in three separate actions. The remaining 9 acres and access easements were retained by the Navy to continue remedial efforts at Installation Restoration (IR) Site 1 – Former Drum Marshalling Area and Site 4 – Former Underground Storage Tanks (Area of Concern [AOC] 22). A parcel of land connecting the two sites was also retained. Currently, the 9-acre parcel of NWIRP is bordered on the east by the residential neighborhood and on the north, south, and west by Steel Equities; however, a small portion is still owned by Nassau County. Access to the NWIRP is from South Oyster Bay Road.

1.3 Geology and Hydrogeology

Overburden at the site consists of well over 1,000 feet (ft) of unconsolidated deposits overlying crystalline bedrock of the Hartland Formation. Overburden is divided into four geologic units: the upper Pleistocene deposits, the Magothy Formation, the clay member of the Raritan Formation ("Raritan Clay") and the Lloyd Sand member of the Raritan Formation ("Lloyd Sand") (Geraghty and Miller, 1994).

The upper Pleistocene ranges in thickness from approximately 50 to 100 ft and consists of till and outwash deposits of medium to coarse sand and gravel with lenses of fine sand, silt and clay (Smolensky and Feldman, 1988); these deposits form the Upper Glacial Aquifer. Directly underlying this unit is the Magothy Formation with a thickness of 650 to 900 ft and lower extent of 700 to 1,000 ft below ground surface (bgs), as observed at the former NWIRP and extending southeast to areas south of Southern State Parkway. Locally at the RE133 locations, the bottom of the Magothy (top of the Raritan Clay) is encountered at approximately 998 feet bgs. The Magothy is characterized by fine to medium sands and silts interbedded with zones of clays, silty sands and sandy clays. Sand and gravel lenses are found in some areas between depths of 600 and 880 ft bgs; these deposits form the main producing zones of the Magothy Aquifer.

Investigations performed by the Navy since 2012 indicate that the bottom of the Magothy (top of the Raritan Clay) can extend to depths of 700 to greater than 1,000 ft bgs. The top of the Raritan Clay deepens to the south-southeast, as evidenced by clay depths of 1,000 ft bgs (or more) in borings installed offsite. The Raritan Clay Unit is of continental origin and consists of clay, silty clay, clayey silt, and fine silty sand. This member acts as a confining layer over the Lloyd Sand Unit. The Lloyd Sand Unit is also of continental origin, having been deposited in a large fresh water lacustrine environment. The material consists of fine to coarse-grained sands, gravel, inter-bedded clay, and silty sand. These deposits form the Lloyd Aquifer.

The Upper Glacial Aquifer and the Magothy Aquifer comprise the aquifers of interest at the NWIRP. Regionally, these formations are generally considered to form a common, interconnected aquifer as the coarse nature of each unit near their contact and the lack of any regionally confining clay unit allows for the unrestricted flow of groundwater between the formations.

The Magothy Aquifer is the major source of public water in Nassau County. The most productive water bearing zones are the discontinuous lenses of sand and gravel that occur within the siltier matrix. The major water-bearing zones are coarse sand and gravel lenses located in the lower portion of the Magothy. The Magothy Aquifer is commonly regarded to function overall as an unconfined aquifer at shallow depths and a confined aquifer at deeper depths. The drilling program at the NWIRP has revealed that clay zones beneath the facility are common but laterally discontinuous. No confining clay units of facility-wide extent have been encountered. This is also the case for borings installed offsite.

Groundwater is encountered at a depth of approximately 50 ft bgs at the facility. Historically, because of pumping and recharge at the facility, groundwater depths have been measured to range from 40 to 60 ft bgs. The groundwater flow in the area is to the south-southeast.

Resolution Consultants reviewed the geologic data and regional literature and developed four representative base-wide cross sections to support development of a Conceptual Site Model (CSM). A description of the application of Environmental Sequence Stratigraphy (ESS) and the results are provided in Appendix B.

2.0 FIELD PROGRAM

Two monitoring wells were installed in the vicinity of VPB167 between May 2016 and July 2016. Field investigation activities consisted of drilling, well installation, well development, sampling, soil/groundwater analysis, and surveying. Drilling during this investigation was performed by Delta Well and Pump Company of Ronkonkoma, New York. A description of these tasks is provided below.

2.1 Drilling and Well Construction

Monitoring wells RE133D1 and RE133D2 were installed using mud rotary drilling techniques (Figure 2). Depths of monitoring wells RE133D1 and RE133D2 were 585 ft and 805 ft respectively. Well construction details are summarized in Table 1. Boring logs with lithologic descriptions of the well screen interval are included in the Appendix A. *2016 OU2 Groundwater Investigation VPB167* (Resolution Consultants, 2017) documents the installation of this VPB including detailed lithologic descriptions, continuous gamma plot and multiple Volatile Organic Compounds (VOC) sample results over the entire boring length. The gamma and TCE/PCE plot for VPB167 along with the well screen intervals at RE133D1 and RE133D2 is included in Appendix A.

Prior to installing each monitoring well, the results of the groundwater samples, the geophysical logs, lithology and field data from the vertical profile borings were analyzed (*2016 OU2 Groundwater Investigation VPB167*, Resolution Consultants, 2017). Screen intervals were determined based on intervals with the highest VOC concentrations as measured in the hydropunch samples and coincident intervals with the highest apparent permeability based on the gamma logs. During the monitoring well installation, split spoon samples were collected every 5 ft in the screen interval. One soil sample per monitoring well was analyzed for Total Organic Carbon (TOC) via United States (US) Environmental Protection Agency (EPA) series SW-846 method 9060A by Katahdin Analytical Services (Katahdin). Data validation of TOC data was performed by Resolution Consultants. Data validation packages and analytical data tables are included in Appendix A.

Wells were constructed of 4-inch diameter, Schedule 80, National Sanitation Foundation-approved polyvinylchloride (PVC) riser pipe and .010-slot well screen. Wells were completed at the surface with a 12-inch diameter steel curb box. Well risers were set below grade and fit with lockable J plugs. Detailed monitoring well construction diagrams are included in Appendix A.

2.2 Well Development

Following installation, all monitoring wells were developed to evacuate silts and other fine-grained materials and to establish the filter pack to promote a hydraulic connection between the well and

the surrounding aquifer. Well development was not initiated until at least 24 hours after well installation.

Monitoring well screens were developed using a combination of air lifting, manual surging, and pumping with a submersible pump. Turbidity was monitored during development to determine stabilization. In compliance with New York State Department of Environmental Conservation (NYSDEC) policy, wells were developed until turbidity was less than 50 nephelometric turbidity units (NTUs) if possible. Table 2 summarizes total pumped volume from air and pump development and final turbidity. Well development logs are included in Appendix A.

2.3 Sampling

Following development, wells were allowed to stabilize for at least 2 weeks prior to groundwater sampling in accordance with low flow sampling procedures. Wells were purged using a bladder pump with a drop tube intake placed at the approximate midpoint of the screened interval. The following water quality parameters were continuously measured: water temperature, pH, conductivity, oxidation-reduction potential, dissolved oxygen and turbidity. Groundwater analytical samples were collected when water quality parameters stabilized. Samples were analyzed for VOCs via method 8260C and 1,4-dioxane via Method 8270D SIM by Katahdin. All development and purge water was managed as investigation derived waste (IDW). Groundwater sample logs and data validation packages are included in Appendix A.

Monitoring wells RE133D1 and RE133D2 were sampled by Resolution Consultants on September 20, 2016. Analytical results and stabilized field parameters for these monitoring wells are summarized in Table 3 and 4, respectively. Data validation is documented in Appendix A. These monitoring wells will be included in quarterly sampling as part of the Navy's ongoing Environmental Restoration Program.

2.4 Decontamination and Investigation Derived Waste

Resolution Consultants utilized dedicated and disposable sampling equipment when possible to avoid the potential for cross-contamination of samples. The sampling equipment included dedicated plastic scoops, disposable polyethylene tubing, disposable gloves, and laboratory supplied sample bottles. Hand held equipment and split spoons were decontaminated using Luminox and water wash, a potable water rinse, followed by a distilled water rinse. Water was collected in 5-gallon pails or 55-gallon drums. Non dedicated sampling equipment was decontaminated as outlined in the UFP SAP Addendum - *Groundwater Sampling Using Low Stress (Low Flow) Purging and Sampling Protocol* (Resolution Consultants, 2013b).

As part of the IDW management practices and in accordance with the SAP, the investigation waste (consisting of soil cuttings, drilling muds, IDW fluids, and personal protective equipment [PPE]) generated during the groundwater monitoring well installation and sampling was containerized and staged at NWIRP Bethpage.

IDW solids were containerized in roll offs. Representative samples from each roll off were submitted to Katahdin for analysis of:

- Target Compound List (TCL) VOCs
- TCL Semi-volatile Organic Compounds (SVOCs)
- Toxicity Characteristic Leaching Procedure (TCLP) Metals
- Polychlorinated Biphenyls (PCBs)
- Total petroleum hydrocarbons
- Corrosivity
- Ignitability
- Reactive Cyanide
- Reactive Sulfide
- Paint Filter

IDW fluid generated during well development and purging was containerized in frac tanks and stored at NWIRP Bethpage for characterization and ultimate disposal to the Publicly Owned Treatment Works (POTW), in accordance with the facilities existing discharge permit. A representative water sample was collected from each frac tank and submitted to Katahdin for analysis of VOCs via Method SW 624, pH via Method SW 9040B, PCBs via Method 8082 and Total Metals via Method SW 846. All analytical criteria were met for disposal of water.

2.5 Surveying

A survey of the monitoring well locations was conducted at the end of fieldwork by C. T. Male, Inc., of Latham, NY, under the direct supervision of Resolution Consultants. The locations were tied into the existing base map developed for this investigation. The survey elevation is referenced to the North American Vertical Datum (NAVD) 1988 and has a vertical accuracy of 0.01 foot. Vertical control is based on observations of the Continuously Operating Reference (COR) Stations Queens and Central Islip. The horizontal location is referenced to the North American Datum (NAD) 1983 (2011) NY. Long Island Zone 3104 and has an accuracy of 0.1 foot. Local horizontal and vertical

control is based on Global Positioning System (GPS) observations using the NYSNet Real Time Network.

A table of survey data (latitude/longitude, northing/easting, elevations of ground, rim and PVC) and a survey map is included in Appendix A.

3.0 REFERENCES

Geraghty and Miller, Inc., 1994. *Remedial Investigation Report, Grumman Aerospace Corporation, Bethpage, New York*. Revised September 1994.

Resolution Consultants, 2013a. *United Federal Programs Sampling and Analysis Plan*, *Site OU-2 Offsite Trichloroethene (TCE) Groundwater Plume Investigation, Bethpage, New York*. April 2013.

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Resolution Consultants, 2017. *2016 OU2 Groundwater Investigation VPB167, Bethpage, NY.* March 2017.

Smolensky, D., and Feldman, S., 1988. *Geohydrology of the Bethpage-Hicksville-Levittown Area, Long Island, New York, U.S*. Geological Survey Water-Resourced Investigations Report 88-4135, 25 pp.

Tables

TABLE 1
MONITORING WELL CONSTRUCTION SUMMARY
2016 OU2 GROUNDWATER INVESTIGATION
NWIRP BETHPAGE, NY

MONITORING WELL	WELL COMPLETION DATE	GROUND ELEVATION (MSL)	PVC ELEVATION (INNER CASING) (MSL)	WELL DEPTH (ft bgs)	CASING DEPTH (ft bgs)	SCREEN INTERVAL (ft bgs)	SUMP DEPTH INTERVAL (ft bgs)	BORING DEPTH (ft bgs)
RE133D1	7/8/2016	48.89	48.38	585	53.5	560 - 580	580 - 585	598
RE133D2	6/15/2016	48.91	48.72	805	53.5	780 - 800	800 - 805	818

MSL - mean sea level
ft bgs - feet below ground surface

TABLE 2
MONITORING WELL DEVELOPMENT SUMMARY
2016 OU2 GROUNDWATER INVESTIGATION
NWIRP BETHPAGE, NY

MONITORING WELL	AIR DEVELOPMENT		PUMP DEVELOPMENT			APPROX. TOTAL DEVELOPMENT VOLUME (GAL)	FINAL TURBIDITY (NTUs)
	DATE	APPROX. VOLUME (GAL)	DATE	FINAL PUMP DEPTH (FT BGS)	APPROX. VOLUME (GAL)		
RE133D1	7/14/2016	5,000	7/19/2016	560-580	4,300	9,300	0.87
RE133D2	7/15/2016; 7/18/2016	9,000	7/20/2016 - 7/21/2016	780-800	9,000	18,000	48.3

GAL - gallon
FT BGS - feet below ground surface
NTUs - Nephelometric Turbidity Units

TABLE 3. ANALYTICAL DATA SUMMARY
2016 OU2 GROUNDWATER INVESTIGATION
NWIRP BETHPAGE, NY

Location	NYSDEC Groundwater Guidance or Standard Value (Note 1)	RE133D1	RE133D2
Sample Date		9/20/2016	9/20/2016
Sample ID		RE133D1-GW-092016	RE133D2-GW-092016
Sample type code		Groundwater	Groundwater
VOC 8260C (ug/L)			
1,1,1-TRICHLOROETHANE	5	<0.50 U	<0.50 U
1,1,2,2-TETRACHLOROETHANE	5	<0.50 U	<0.50 U
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	5	<0.50 U	<0.50 U
1,1,2-TRICHLOROETHANE	1	<0.50 U	<0.50 U
1,1-DICHLOROETHANE	5	<0.50 U	<0.50 U
1,1-DICHLOROETHENE	5	<0.50 U	<0.50 U
1,2,4-TRICHLOROBENZENE	5	<0.50 U	<0.50 U
1,2-DIBROMO-3-CHLOROPROPANE	0.04	***<0.75 U***	***<0.75 U***
1,2-DIBROMOETHANE	NL	<0.50 U	<0.50 U
1,2-DICHLOROBENZENE	3	<0.50 U	<0.50 U
1,2-DICHLOROETHANE	5	<0.50 U	<0.50 U
1,2-DICHLOROETHENE, TOTAL	5	<1.0 U	<1.0 U
1,2-DICHLOROPROPANE	1	<0.50 U	<0.50 U
1,3-DICHLOROBENZENE	3	<0.50 U	<0.50 U
1,4-DICHLOROBENZENE	3	<0.50 U	<0.50 U
1,4-DIOXANE (Method 8270D_SIM)	NL	**0.16 J**	<0.17 U
2-BUTANONE	50	<2.5 U	<2.5 U
2-HEXANONE	50	<2.5 U	<2.5 U
4-METHYL-2-PENTANONE	NL	<2.5 U	<2.5 U
ACETONE	50	**4.1 J**	<2.5 UJ
BENZENE	1	<0.50 U	<0.50 U
BROMODICHLOROMETHANE	50	<0.50 U	<0.50 U
BROMOFORM	50	<0.50 U	<0.50 U
BROMOMETHANE	5	<1.0 U	<1.0 U
CARBON DISULFIDE	60	<0.50 UJ	<0.50 UJ
CARBON TETRACHLORIDE	5	<0.50 U	<0.50 U
CHLOROBENZENE	5	<0.50 U	<0.50 U
CHLOROETHANE	5	<1.0 UJ	<1.0 UJ
CHLOROFORM	7	<0.50 U	<0.50 U
CHLOROMETHANE	5	<1.0 U	<1.0 U
CIS-1,2-DICHLOROETHENE	5	<0.50 U	<0.50 U
CIS-1,3-DICHLOROPROPENE	0.4	***<0.50 U***	***<0.50 U***
CYCLOHEXANE	NL	<0.50 U	<0.50 U
DIBROMOCHLOROMETHANE	5	<0.50 U	<0.50 U
DICHLORODIFLUOROMETHANE	5	<1.0 U	<1.0 U
ETHYLBENZENE	5	<0.50 U	<0.50 U
ISOPROPYLBENZENE	5	<0.50 U	<0.50 U
M- AND P-XYLENE	NL	<1.0 U	<1.0 U
METHYL ACETATE	NL	<0.75 UJ	<0.75 UJ
METHYL CYCLOHEXANE	NL	<0.50 U	<0.50 U
METHYL TERT-BUTYL ETHER	10	<0.50 U	<0.50 U
METHYLENE CHLORIDE	5	<2.5 U	<2.5 U
O-XYLENE	NL	<0.50 U	<0.50 U
STYRENE	5	<0.50 U	<0.50 U
TETRACHLOROETHENE	5	<0.50 U	<0.50 U
TOLUENE	5	<0.50 U	<0.50 U
TRANS-1,2-DICHLOROETHENE	5	<0.50 U	<0.50 U
TRANS-1,3-DICHLOROPROPENE	0.4	***<0.50 U***	***<0.50 U***
TRICHLOROETHENE	5	<0.50 U	<0.50 U
TRICHLOROFLUOROMETHANE	5	<1.0 U	<1.0 U
VINYL CHLORIDE	2	<1.0 U	<1.0 U
XYLENES, TOTAL	5	<1.5 U	<1.5 U
1,4-DIOXANE (Method 522)	NL	NA	NA

Notes:

1 New York State Department of Environmental Conservation Division of Water Technical and Operation Guidance series (6 NYCRR 700-706, Part 703.5 summarized in TOGS 1.1.1)
Ambient water quality standards and groundwater effluent limitations, class GA; NL = Not Listed

Bold = Detected; ***Bold and Italics*** =Not detected exceeds NYS Groundwater Standards or guidance value
Yellow highlighted values exceed Groundwater Standards or guidance value

Sample type codes: N - normal environmental sample, FD - field duplicate

U = Nondetected result. The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
UJ = The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte.
J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
M = the matrix spike or matrix spike duplicate did not meet recovery or precision requirements.

TABLE 4
STABILIZED FIELD PARAMETERS
2016 OU2 GROUNDWATER INVESTIGATION
NWIRP BETHPAGE, NY

Well	Date	Temperature (°C)	pH	Specific Conductance (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Depth to water (ft bgs)	Flow rate (ml/min)
RE133D1	9/20/2016	15.60	4.84	0.132	0.32	105.9	26.3	25.86	650
RE133D2	9/20/2016	17.69	4.72	0.037	0.79	136.9	83.0	26.94	600

°C - degrees Celsius
µS/cm - Microsiemens per Centimeter
mg/L - milligrams per liter
mV - Millivolts
NTU - Nephelometric Turbidity Unit
ft bgs - feet below ground surface
ml/min - mililiters per minute

Figures

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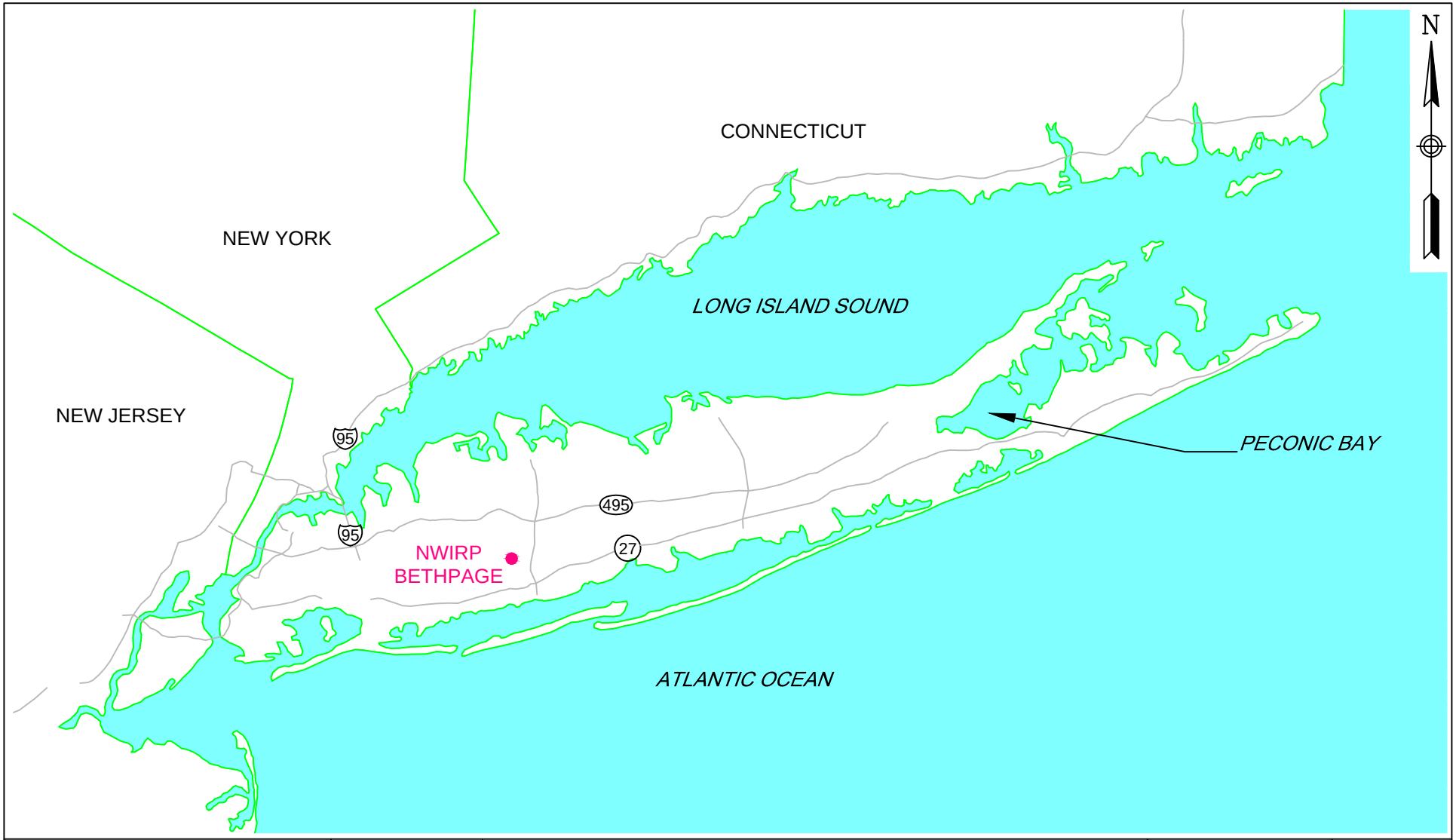


0 15 30

SCALE IN MILES

NAVFAC

GENERAL LOCATION MAP
NWIRP BETHPAGE
BETHPAGE, NEW YORK

CONTRACT NUMBER	CTO NUMBER
N62470-11-D-8013	WE15
APPROVED BY --	DATE --
APPROVED BY --	DATE --
FIGURE NO. 1	REV 0

F:\Projects\Navy\Bethpage WXE0817.0 Deliverables\7.2 CADD\GIS_files\Bethpage\MAP DOCS\MXD\MISC\Location Maps\F2 RE133 2016 12 02 R1.mxd

Property Retained by Navy (9-Acres)

Former Naval Weapons Industrial Reserve Plant

Former Northrop Grumman Site

Inset: RE133D1 and RE133D2 Location

RE133D1
RE133D2

RE133D1
RE133D2

BPOW6-1
BPOW6-2

0 375 750 Feet

RE133D1
RE133D2

0 750 1,500 3,000 Feet

Legend

- Monitoring Well
- Vertical Profile Boring
- Vertical Profile Boring - Proposed
- Water Supply Well
- Extraction Well

RE133D1 AND RE133D2 LOCATION MAP
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

CONTRACT NUMBER	CTO NUMBER
N62470-11-D8013	WE15
APPROVED BY: PS	DATE: 12/2/2016
APPROVED BY: —	DATE: —
FIGURE NO.: 2	REV: 0

Appendices

Appendix A

RE133D1, RE133D2

Section 1

Boring Logs

Resolution Consultants

Boring Log

BORING #: **RE133D1**
Sheet 1 of 2

Client: Department of the Navy, Naval Facilities Engineering Command, Mid-Atlantic		**Logged By:** V. Thayer
Location: Howard & Wicks Ave., Town of Hempstead, NY		**Drilling Company:** Delta Well & Pump
Project #: 60266526	**Ground Elevation (msl):** 48.89	**Well Screen Interval (ft):** 560-580
Start Date: 6/27/2016	**Drilling Method:** Auger (0-50' bgs) Mud Rotary (>50' bgs)	**Water Level (ft):**
Finish Date: 7/8/2016	**Northing:** 193975.82 **Easting:** 1126227.64	**Total Depth (ft):** 598.0

DEPTH (ft)	PID (ppm)	Formation	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	Well Completion	Well Construction
0					0-563 ft bgs: See VPB167 for Descriptions		10" Diameter Steel Casing
50							
100							Bentonite Grout
150							
200							
250							
300							
350							
400							4" Diameter Schedule 80 PVC Riser
450							
500							

Resolution Consultants

Boring Log

BORING #: **RE133D1**
Sheet 2 of 2

Client: Department of the Navy, Naval Facilities Engineering Command, Mid-Atlantic		**Logged By:** V. Thayer
Location: Howard & Wicks Ave., Town of Hempstead, NY		**Drilling Company:** Delta Well & Pump
Project #: 60266526	**Ground Elevation (msl):** 48.89	**Well Screen Interval (ft):** 560-580
Start Date: 6/27/2016	**Drilling Method:** Auger (0-50' bgs) Mud Rotary (>50' bgs)	**Water Level (ft):**
Finish Date: 7/8/2016	**Northing:** 193975.82 **Easting:** 1126227.64	**Total Depth (ft):** 598.0

DEPTH (ft)	PID (ppm)	Formation	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	Well Completion	Well Construction
500					0-563 ft bgs: See VPB167 for Descriptions *(continued)*		4" Diameter Schedule 80 PVC Riser *(continued)*
502							
504							
506							
508							
510							
512							
514							
516							
518							
520							
522							
524							
526							
528							
530							
532							
534							
536							
538							
540							
542							#00 Filter Sand
544							
546							
548							
550							
552							
554							
556							#1 Filter Sand
558							
560							
562							
564	0		SP-SM		Gray (10YR 5/1) poorly graded SAND with SILT; subangular medium sand, little fine sand, fines (silt 10%)		
566							
568							
570	0		SP-SM		Gray (10YR 5/1) poorly graded SAND with SILT; fine sand, little medium sand, silty (15%) interbedded with on 3/4" layer of dark gray microlaminated clayey silt		4" Diameter Schedule 80 PVC, 10 Slot Well Screen (560-580 ft bgs)
572							
574	0		SP-SM		Gray (10YR 5/1) poorly graded SAND with SILT, subangular medium Sand, interbedded with on 1/4" layer of clayey silt		
576							
578							
580	0		SP-SM		Gray (10YR 5/1) poorly graded SAND with SILT; subangular medium sand, little fine sand, silt (10-15%), trace coarse sand		
582							Sump
584							
586							
588							
590							
592							#1 Sand to Bottom
594							
596							
598					End of boring at 598.0 ft. bgs.		

Resolution Consultants

Boring Log

BORING #: **RE133D2**
Sheet 1 of 2

Client: Department of the Navy, Naval Facilities Engineering Command, Mid-Atlantic		**Logged By:** V. Thayer
Location: Howard & Wicks Ave., Town of Hempstead, NY		**Drilling Company:** Delta Well & Pump
Project #: 60266526	**Ground Elevation (msl):** 48.91	**Well Screen Interval (ft):** 780-800
Start Date: 6/1/2016	**Drilling Method:** Auger (0-50' bgs) Mud Rotary (>50' bgs)	**Water Level (ft):**
Finish Date: 6/15/2016	**Northing:** 193991.82 **Easting:** 1126227.06	**Total Depth (ft):** 818.0

DEPTH (ft)	PID (ppm)	Formation	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	Well Completion	Well Construction
0					0-783 ft bgs: See VPB167 for Descriptions		10" Diameter Steel Casing
50							
100							
150							
200							Bentonite Grout
250							
300							
350							
400							
450							
500							
550							4" Diameter Schedule 80 PVC Riser
600							
650							
700							

Resolution Consultants

Boring Log

BORING #: **RE133D2**
Sheet 2 of 2

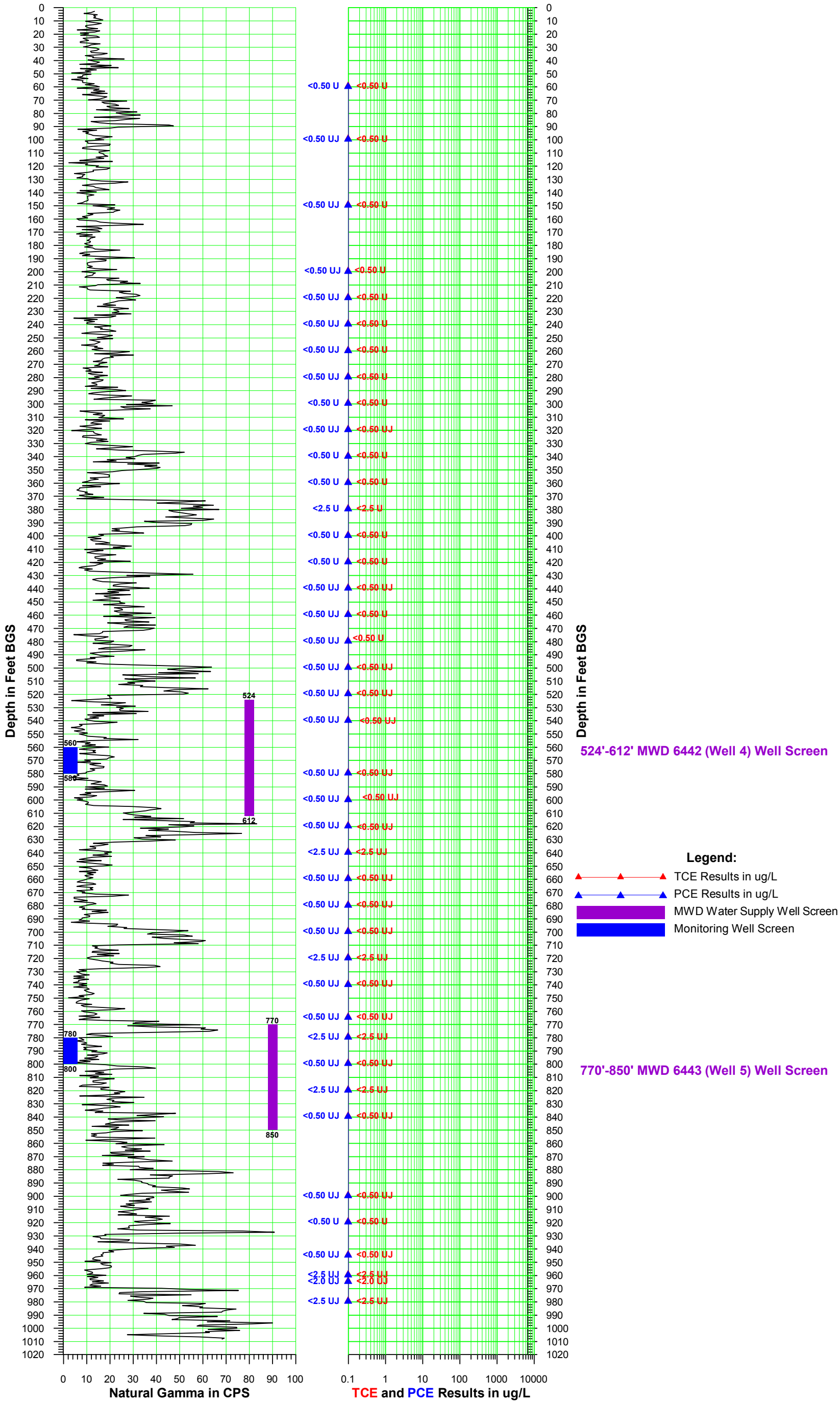
Client: Department of the Navy, Naval Facilities Engineering Command, Mid-Atlantic		**Logged By:** V. Thayer
Location: Howard & Wicks Ave., Town of Hempstead, NY		**Drilling Company:** Delta Well & Pump
Project #: 60266526	**Ground Elevation (msl):** 48.91	**Well Screen Interval (ft):** 780-800
Start Date: 6/1/2016	**Drilling Method:** Auger (0-50' bgs) Mud Rotary (>50' bgs)	**Water Level (ft):**
Finish Date: 6/15/2016	**Northing:** 193991.82 **Easting:** 1126227.06	**Total Depth (ft):** 818.0

DEPTH (ft)	PID (ppm)	Formation	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	Well Completion	Well Construction
740					0-783 ft bgs: See VPB167 for Descriptions *(continued)*		4" Diameter Schedule 80 PVC Riser *(continued)*
742							
744							
746							
748							
750							
752							
754							
756							
758							
760							
762							#00 Filter Sand
764							
766							
768							
770							
772							
774							#1 Filter Sand
776							
778							
780							
782							
784	0		SM		White (10YR 8/1) silty SAND, micaceous fine Sand, 40% silt, trace coarse sand; think layer of subrounded gravel		
786			SM		Pale brown (10YR 6/3) silty SAND, subangular fine to coarse Sand, 15% fines (silt and clay)		
788	0		GP-GM		Gray (10YR 6/2) poorly graded GRAVEL with SILT and SAND, subrounded fine gravel (pea size); little subangular medium sand, few silt		
790			SP-SM				4" Diameter Schedule 80 PVC, 10 Slot Well Screen (780-800 ft bgs)
792					Gray (10YR 6/1) Poorly Graded SAND with SILT, subangular medium Sand, few coarse sand, silt (10%), trace subangular fine gravel		
794	0		GP-GM		Gray (10YR 6/1) Poorly Graded GRAVEL with SILT and SAND, subrounded fine Gravel (pea size); little subangular medium sand, few silt		
796			SP-SM				
798	0		SW-SM		Gray (10YR 6/1) poorly graded SAND with SILT, subangular medium Sand, silt (10%)		
800			SM		Light gray (10YR 7/1) widely graded SAND with SILT, subangular medium Sand, little fine sand, subrounded coarse sand, little subrounded fine gravel, 10-15% fines		Sump
802					White (7.5YR 8/1) SILTY SAND, fine sand, silt		
804							
806							
808							
810							
812							#1 Sand to Bottom
814							
816							
818					End of boring at 818.0 ft. bgs.		

Section 2

VPB167 Gamma and TCE/PCE Plot

Vertical Profile Boring VPB-167
Downward Run - May 9, 2016
Validated Analytical Data



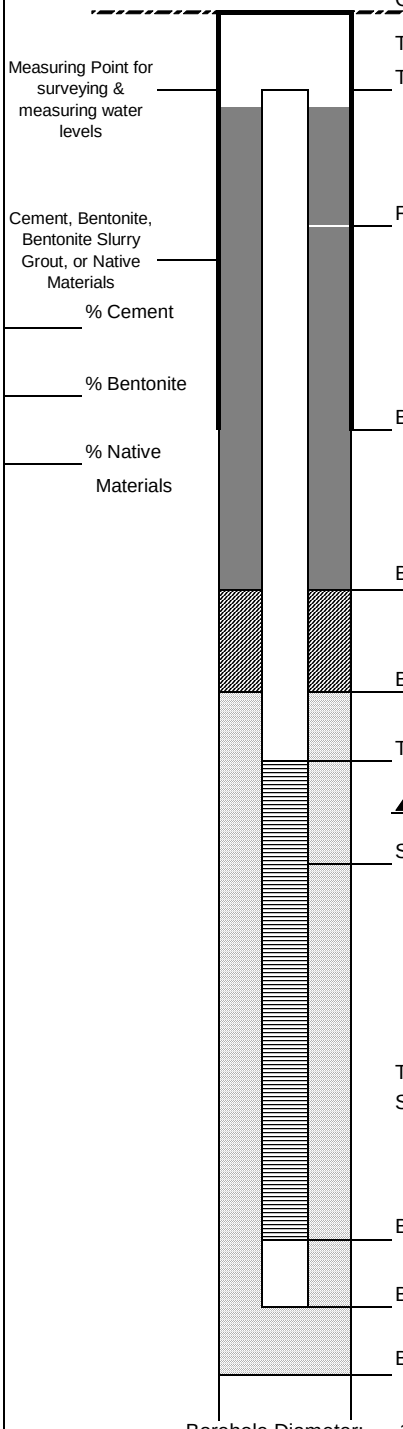
Section 3

Monitoring Well Construction Logs

RESOLUTION CONSULTANTS	Client: NAVFAC	Project Number: 60266526	***WELL ID: RE133D1***	
	Site Location: NWIRP BETHPAGE, NY			
	Well Location: Howard & Wicks Ave., Town of Hempstead, NY		Date Installed:	6/27/2016 - 7/8/2016*
	Method: MUD ROTARY		Inspector:	V. Thayer
	Coords: Northing: 193975.82	Easting: 1126227.64	Contractor:	DELTA WELL & PUMP

MONITORING WELL CONSTRUCTION DETAIL

* Casing installed with Auger rig 5/23/16 - 5/24/16



	Depth from G.S. (feet)	Elevation(feet) Datum
Ground Surface (G.S.)	0.00	48.89
Top of 12 inch diameter Steel Curb Box		
Top of Riser Pipe fit with locking j-plug	0.51	48.38
Riser Pipe:		
Length: 560		
Inside Diameter (ID): 4 inch		
Type of Material: PVC		
Bottom of 10 inch diameter Steel Surface Casing	53.5	-4.6
Bottom of Bentonite Grout	533.0	-484.1
Bottom of #00 Filter Sand/Top of #1 Filter Sand	550	-501.1
Top of Screen	560	-511.1
▲ Stabilized Water Level		
Screen:		
Length: 20		
Inside Diameter (ID): 4 inch		
Slot Size: 10		
Type of Material: PVC		
Type/Size of Sand: #1		
Sand Pack Thickness: 48		
Bottom of Screen	580	-531.1
Bottom of Sump:	585	-536.1
Bottom of Borehole	598	-549.1

Borehole Diameter: 10 inch

Approved:

Describe Measuring Point:

Ground Surface

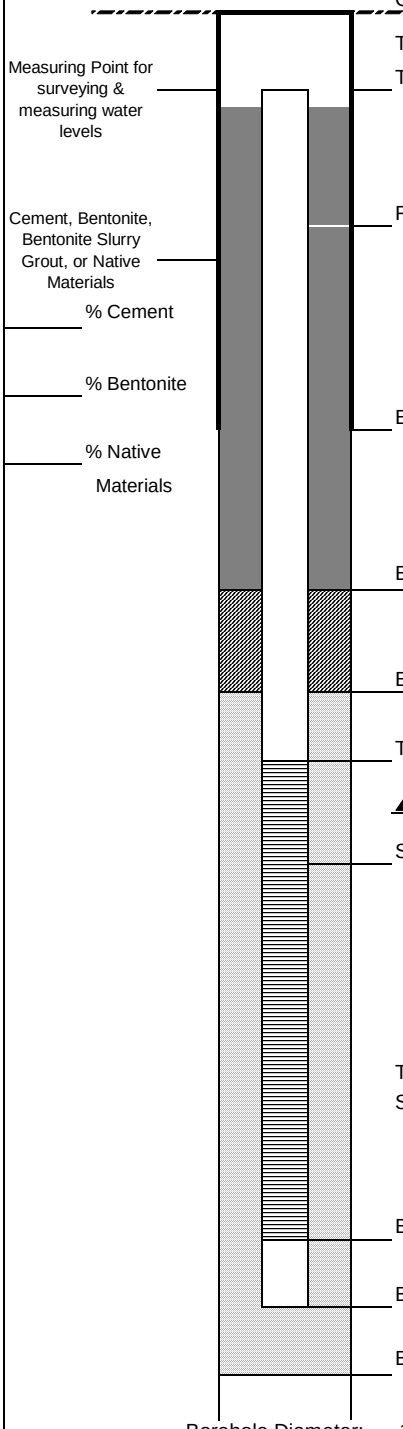
Valerie Thayer
Signature

7/8/2016
Date

RESOLUTION CONSULTANTS	Client: NAVFAC	Project Number: 60266526	***WELL ID: RE133D2***
	Site Location: NWIRP BETHPAGE, NY		
	Well Location: Howard & Wicks Ave., Town of Hempstead, NY		Date Installed: 6/1- 6/15/2016 *
	Method: MUD ROTARY		Inspector: V. Thayer
	Coords: Northing: 193991.82	Easting: 1126227.06	Contractor: DELTA WELL & PUMP

MONITORING WELL CONSTRUCTION DETAIL

* Casing installed with Auger rig 5/19/16 - 5/20/16



	Depth from G.S. (feet)	Elevation(feet) Datum
Ground Surface (G.S.)	0.00	48.91
Top of 12 inch diameter Steel Curb Box		
Top of Riser Pipe fit with locking j-plug	0.19	48.72
Riser Pipe:		
Length: 780		
Inside Diameter (ID): 4 inch		
Type of Material: PVC		
Bottom of 10 inch diameter Steel Surface Casing	53.5	-4.6
Bottom of Bentonite Grout	755.0	-706.1
Bottom of #00 Filter Sand/Top of #1 Filter Sand	770	-721.1
Top of Screen	780	-731.1
▲ Stabilized Water Level		48.9
Screen:		
Length: 20		
Inside Diameter (ID): 4 inch		
Slot Size: 10		
Type of Material: PVC		
Type/Size of Sand: #1		
Sand Pack Thickness: 48		
Bottom of Screen	800	-751.1
Bottom of Sump:	805	-756.1
Bottom of Borehole	818	-769.1

Borehole Diameter: 10 inch

Approved: Valerie Thayer (Signature) 6/14/2016 (Date)

Describe Measuring Point: Ground Surface

Section 4

Groundwater Sample Log Sheets

Well ID: RE 133D1

RESOLUTION CONSULTANTS

Low Flow Ground Water Sample Collection Record

Client: Navy NWIRP Bethpage Date: 9/20/16 Time: Start 840 am/pm
Project No: 60266526 Finish 1160 am/pm
Site Location: Wicks & Howard
Weather Conds: Cloudy, 70° Collector(s): Paul Kaneth

1. WATER LEVEL DATA: (measured from Top of Casing)

a. Total Well Length 598 c. Length of Water Column _____ (a-b) Casing Diameter/Material 4-inch PVC

b. Water Table Depth 25.87 d. Calculated System Volume (see back) 13.1 gal. 20 screen length (ft)

2. WELL PURGE DATA

a. Purge Method: Geotech bladder pump with drop tube assembly

b. Acceptance Criteria defined (see workplan)

- Temperature ± 3%
- pH ± 0.1 unit
- Conductivity ± 3%
- Turbidity ± 10%
- ORP ± 10mV
- Drawdown < 0.3'
- D.O. ± 10% (values >0.5 mg/L)

Remove a minimum 1 screen volume

c. Field Testing Equipment used:

Make	Model	Serial Number
YSI	556	RFW24697

Time (24hr)	Volume Removed (gallons)	Temp. (°C)	Conduct. (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Depth to water (ft)	Color/Odor
930								650		OH
940		15.66	0.104	2.61	2.60	271.3	1.25		25.82	
945		15.50	0.121	1.42	3.51	190.5	82.3		25.83	
950										
955	5 Gal	15.64	0.130	0.69	4.37	137.4	25.2	650	25.84	
1000	—	15.62	0.133	0.54	4.76	115.0				

d. Acceptance criteria pass/fail

	Yes	No	N/A
Has required volume been removed	☑	☐	☐
Has required turbidity been reached	☑	☐	☐
Have parameters stabilized	☑	☐	☐

If no or N/A - Explain below.

(continued on back)

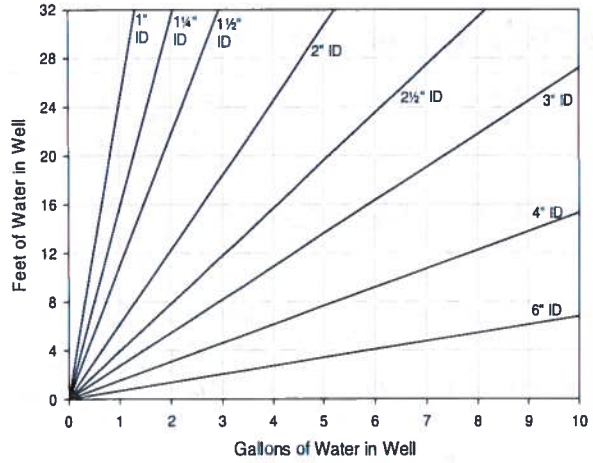
3. SAMPLE COLLECTION: Method: Geotech bladder pump with drop tube assembly

Sample ID	Container Type	No. of Containers	Preservation	Analysis Req.	Time
RE 133D1	40-mL vials	3	HCl	VOCs	1045
	1-L amber	2	none	1,4-Dioxane	1045

Comments hit bottom, stirred up the water column, high turbidity readings
splits with Nassau WD

Signature Paul Kaneth Date 9/20/16

Purge Volume Calculation



Volume / Linear Ft. of Pipe		
ID (in)	Gallon	Liter
0.25	0.0025	0.0097
0.375	0.0057	0.0217
0.5	0.0102	0.0386
0.75	0.0229	0.0869
1	0.0408	0.1544
1.25	0.0637	0.2413
1.5	0.0918	0.3475
2	0.1632	0.6178
2.5	0.2550	0.9653
3	0.3672	1.3900
4	0.6528	2.4711
6	1.4688	5.5600

One screen volume (4-inch well)

15 ft = 37.1 L / 9.8 G
20 ft = 49.4 L / 13.1 G
25 ft = 61.8 L / 16.3 G
30 ft = 74.3 L / 19.6 G
40 ft = 99.2 L / 26.1 G
50 ft = 123.6 L / 32.6 G

Well ID: RE 13301

(continued from front)

Time (24 hr)	Volume Removed (Liters)	Temp (°C)	pH	Conduct. (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Depth to water (ft)	Color/Odor
1005		15.67	4.66	0.134	0.50	118.0				
1010	1.5	15.59	4.71	0.134	0.47	116.7	37.4	650	25.86	
1015	10gal	15.50	4.79	0.133	0.42	110.4	39.4			
1020		15.56	4.76	0.133	0.39	110.0	29.8			
1025		15.52	4.94	0.133	0.37	101.3	26.7			
1030		15.54	4.79	0.132	0.34	106.7	27.6			
1035	15gal	15.60	4.84	0.132	0.32	105.9	26.3			
1045								200		Sample

Well ID: RE133D2

Low Flow Ground Water Sample Collection Record

Client: Navy NWIRP Bethpage Date: 9/20/16 Time: Start 840 am/pm
Project No: 60266526 Finish _____ am/pm
Site Location: Wicks & Howard
Weather Conds: cloudy 70° Collector(s): F. Bell, Paeck, Soby C.

1. WATER LEVEL DATA: (measured from Top of Casing)

a. Total Well Length 818 c. Length of Water Column _____ (a-b) Casing Diameter/Material 4-inch PVC

b. Water Table Depth 47.25 d. Calculated System Volume (see back) 131 gal. 20 screen length (ft)

2. WELL PURGE DATA

a. Purge Method: Geotech bladder pump with drop tube assembly

b. Acceptance Criteria defined (see workplan)

- Temperature ± 3%
- pH ± 0.1 unit
- Conductivity ± 3%
- Turbidity ± 10%
- ORP ± 10mV
- Drawdown < 0.3'
- D.O. ± 10% (values >0.5 mg/L)

Remove a minimum 1 screen volume

c. Field Testing Equipment used:

Make	Model	Serial Number
YSI	556	14G103484
La Motte	2020we	3674-3813

Time (24hr)	Volume Removed (gallons)	Temp. (°C)	Conduct. (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Depth to water (ft)	Color/Odor
1000								600	26.46	ON
1005		17.34	0.043	2.12	4.83	126.7			26.49	cloudy
1010		17.33	0.042	2.07	4.54	141.7	49.9			
1015		17.09	0.041	1.66	4.26	152.2		~600	26.51	
1020		17.02	0.041	1.17	4.31	148.4	86.7			
1025	5G	16.97	0.037	0.96	4.30	139.4		600	26.52	

d. Acceptance criteria pass/fail

	Yes	No	N/A
Has required volume been removed	☑	☐	☐
Has required turbidity been reached	☑	☐	☐
Have parameters stabilized	☑	☐	☐

If no or N/A - Explain below.

(continued on back)

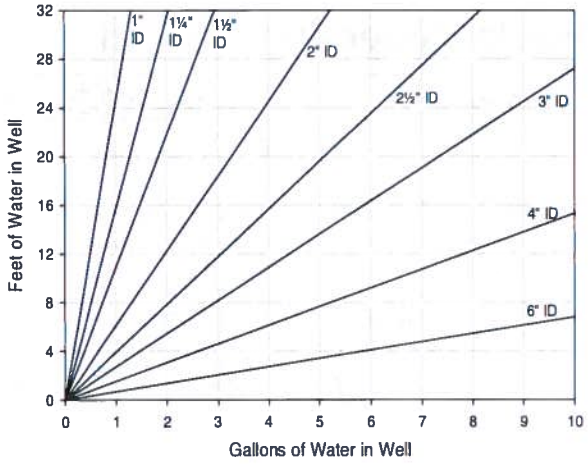
3. SAMPLE COLLECTION: Method: Geotech bladder pump with drop tube assembly

Sample ID	Container Type	No. of Containers	Preservation	Analysis Req.	Time
RE133D2-GW-092016	40-mL vials	3	HCl	VOCs	1130
RE133D2-GW-092016	1-L amber	2	none	1,4-Dioxane	1130

Comments

Signature _____ Date 09-20-16

Purge Volume Calculation



Volume / Linear Ft. of Pipe		
ID (in)	Gallon	Liter
0.25	0.0025	0.0097
0.375	0.0057	0.0217
0.5	0.0102	0.0386
0.75	0.0229	0.0869
1	0.0408	0.1544
1.25	0.0637	0.2413
1.5	0.0918	0.3475
2	0.1632	0.6178
2.5	0.2550	0.9653
3	0.3672	1.3900
4	0.6528	2.4711
6	1.4688	5.5600

One screen volume (4-inch well)

15 ft = 37.1 L / 9.8 G
20 ft = 49.4 L / 13.1 G
25 ft = 61.8 L / 16.3 G
30 ft = 74.3 L / 19.6 G
40 ft = 99.2 L / 26.1 G
50 ft = 123.6 L / 32.6 G

Well ID:

(continued from front)

Time (24 hr)	Volume Removed (Liters)	Temp (°C)	pH	Conduct. (mS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Depth to water (ft)	Color/Odor
1030	–	17.07	4.32	0.037	0.96	139.4	840	650	26.49	Cloudy
1035	–	16.98	4.35	0.036	0.93	138.6	795	700	26.52	Cloudy
1040	–	17.83	4.44	0.037	0.86	137.4	–	600	26.51	Cloudy
1045	–	17.93	4.49	0.037	0.84	135.8	–	600	26.82	clean about flow cell
1050	–	19.11	4.98	0.039	0.33	111.5	607	600	26.84	
1055	–	17.45	4.76	0.038	0.89	125.3	666	600	26.93	
1100	10Gal	17.57	4.73	0.037	0.88	130.5	87	600	26.96	
1105	–	17.78	4.73	0.037	0.83	136.7	78	600	26.94	
1110	–	17.80	4.74	0.037	0.15	133.3	77	600	26.95	
1115	–	17.69	4.72	0.037	0.79	136.9	83	600	26.92	
1130	Sample time							100		

Section 5

Analytical Data Validation

[The Data Validation report included here contains only result tables for RE133D1 and RE133D2; for the complete September 2016 Quarterly Sampling Data Validation report with all well results tables, see September *2016 Groundwater Sampling Data Summary Report, Bethpage, NY*, Resolution Consultants, 2016.]

September 2016
Final Results after Data Review
NWIRP Bethpage OU 2 Regional Groundwater Investigation

		Sample Delivery Group		SJ7597		
		Lab ID		SJ7597-1		
		Sample ID		RE133D1-GW-092016		
		Sample Date		9/20/2016		
		Sample Type		Groundwater		
Method	**Analyte**	**CAS No**	**Units**	Result	Qual	RC
8260C	1,1,1-TRICHLOROETHANE	71-55-6	UG_L	0.5	U	
8260C	1,1,2,2-TETRACHLOROETHANE	79-34-5	UG_L	0.5	U	
8260C	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	76-13-1	UG_L	0.5	U	
8260C	1,1,2-TRICHLOROETHANE	79-00-5	UG_L	0.5	U	
8260C	1,1-DICHLOROETHANE	75-34-3	UG_L	0.5	U	
8260C	1,1-DICHLOROETHENE	75-35-4	UG_L	0.5	U	
8260C	1,2,4-TRICHLOROBENZENE	120-82-1	UG_L	0.5	U	
8260C	1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	UG_L	0.75	U	
8260C	1,2-DIBROMOETHANE	106-93-4	UG_L	0.5	U	
8260C	1,2-DICHLOROBENZENE	95-50-1	UG_L	0.5	U	
8260C	1,2-DICHLOROETHANE	107-06-2	UG_L	0.5	U	
8260C	1,2-DICHLOROETHENE, TOTAL	540-59-0	UG_L	1	U	
8260C	1,2-DICHLOROPROPANE	78-87-5	UG_L	0.5	U	
8260C	1,3-DICHLOROBENZENE	541-73-1	UG_L	0.5	U	
8260C	1,4-DICHLOROBENZENE	106-46-7	UG_L	0.5	U	
8260C	2-BUTANONE	78-93-3	UG_L	2.5	U	
8260C	2-HEXANONE	591-78-6	UG_L	2.5	U	
8260C	4-METHYL-2-PENTANONE	108-10-1	UG_L	2.5	U	
8260C	ACETONE	67-64-1	UG_L	4.1	J	c
8260C	BENZENE	71-43-2	UG_L	0.5	U	
8260C	BROMODICHLOROMETHANE	75-27-4	UG_L	0.5	U	
8260C	BROMOFORM	75-25-2	UG_L	0.5	U	
8260C	BROMOMETHANE	74-83-9	UG_L	1	U	
8260C	CARBON DISULFIDE	75-15-0	UG_L	0.5	UJ	c
8260C	CARBON TETRACHLORIDE	56-23-5	UG_L	0.5	U	
8260C	CHLOROBENZENE	108-90-7	UG_L	0.5	U	
8260C	CHLOROETHANE	75-00-3	UG_L	1	UJ	c
8260C	CHLOROFORM	67-66-3	UG_L	0.5	U	
8260C	CHLOROMETHANE	74-87-3	UG_L	1	U	
8260C	CIS-1,2-DICHLOROETHENE	156-59-2	UG_L	0.5	U	
8260C	CIS-1,3-DICHLOROPROPENE	10061-01-5	UG_L	0.5	U	
8260C	CYCLOHEXANE	110-82-7	UG_L	0.5	U	
8260C	DIBROMOCHLOROMETHANE	124-48-1	UG_L	0.5	U	
8260C	DICHLORODIFLUOROMETHANE	75-71-8	UG_L	1	U	
8260C	ETHYLBENZENE	100-41-4	UG_L	0.5	U	
8260C	ISOPROPYLBENZENE	98-82-8	UG_L	0.5	U	
8260C	M- AND P-XYLENE	108-38-3/106-42	UG_L	1	U	
8260C	METHYL ACETATE	79-20-9	UG_L	0.75	UJ	c
8260C	METHYL CYCLOHEXANE	108-87-2	UG_L	0.5	U	
8260C	METHYL TERT-BUTYL ETHER	1634-04-4	UG_L	0.5	U	
8260C	METHYLENE CHLORIDE	75-09-2	UG_L	2.5	U	
8260C	O-XYLENE	95-47-6	UG_L	0.5	U	
8260C	STYRENE	100-42-5	UG_L	0.5	U	
8260C	TETRACHLOROETHENE	127-18-4	UG_L	0.5	U	
8260C	TOLUENE	108-88-3	UG_L	0.5	U	
8260C	TRANS-1,2-DICHLOROETHENE	156-60-5	UG_L	0.5	U	
8260C	TRANS-1,3-DICHLOROPROPENE	10061-02-6	UG_L	0.5	U	
8260C	TRICHLOROETHENE	79-01-6	UG_L	0.5	U	
8260C	TRICHLOROFLUOROMETHANE	75-69-4	UG_L	1	U	
8260C	VINYL CHLORIDE	75-01-4	UG_L	1	U	
8260C	XYLENES, TOTAL	1330-20-7	UG_L	1.5	U	
8270D_SIM	1,4-DIOXANE	123-91-1	UG_L	0.16	J	

Notes:

UG_L = Micrograms per liter
Qual = Final qualifiers (See Attachment B)
RC = Reason codes (See Attachment C)

September 2016
Final Results after Data Review
NWIRP Bethpage OU 2 Regional Groundwater Investigation

		Sample Delivery Group		SJ7597		
		Lab ID		SJ7597-2		
		Sample ID		RE133D2-GW-092016		
		Sample Date		9/20/2016		
		Sample Type		Groundwater		
Method	**Analyte**	**CAS No**	**Units**	Result	Qual	RC
8260C	1,1,1-TRICHLOROETHANE	71-55-6	UG_L	0.5	U	
8260C	1,1,2,2-TETRACHLOROETHANE	79-34-5	UG_L	0.5	U	
8260C	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	76-13-1	UG_L	0.5	U	
8260C	1,1,2-TRICHLOROETHANE	79-00-5	UG_L	0.5	U	
8260C	1,1-DICHLOROETHANE	75-34-3	UG_L	0.5	U	
8260C	1,1-DICHLOROETHENE	75-35-4	UG_L	0.5	U	
8260C	1,2,4-TRICHLOROBENZENE	120-82-1	UG_L	0.5	U	
8260C	1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	UG_L	0.75	U	
8260C	1,2-DIBROMOETHANE	106-93-4	UG_L	0.5	U	
8260C	1,2-DICHLOROBENZENE	95-50-1	UG_L	0.5	U	
8260C	1,2-DICHLOROETHANE	107-06-2	UG_L	0.5	U	
8260C	1,2-DICHLOROETHENE, TOTAL	540-59-0	UG_L	1	U	
8260C	1,2-DICHLOROPROPANE	78-87-5	UG_L	0.5	U	
8260C	1,3-DICHLOROBENZENE	541-73-1	UG_L	0.5	U	
8260C	1,4-DICHLOROBENZENE	106-46-7	UG_L	0.5	U	
8260C	2-BUTANONE	78-93-3	UG_L	2.5	U	
8260C	2-HEXANONE	591-78-6	UG_L	2.5	U	
8260C	4-METHYL-2-PENTANONE	108-10-1	UG_L	2.5	U	
8260C	ACETONE	67-64-1	UG_L	2.5	UJ	c
8260C	BENZENE	71-43-2	UG_L	0.5	U	
8260C	BROMODICHLOROMETHANE	75-27-4	UG_L	0.5	U	
8260C	BROMOFORM	75-25-2	UG_L	0.5	U	
8260C	BROMOMETHANE	74-83-9	UG_L	1	U	
8260C	CARBON DISULFIDE	75-15-0	UG_L	0.5	UJ	c
8260C	CARBON TETRACHLORIDE	56-23-5	UG_L	0.5	U	
8260C	CHLOROBENZENE	108-90-7	UG_L	0.5	U	
8260C	CHLOROETHANE	75-00-3	UG_L	1	UJ	c
8260C	CHLOROFORM	67-66-3	UG_L	0.5	U	
8260C	CHLOROMETHANE	74-87-3	UG_L	1	U	
8260C	CIS-1,2-DICHLOROETHENE	156-59-2	UG_L	0.5	U	
8260C	CIS-1,3-DICHLOROPROPENE	10061-01-5	UG_L	0.5	U	
8260C	CYCLOHEXANE	110-82-7	UG_L	0.5	U	
8260C	DIBROMOCHLOROMETHANE	124-48-1	UG_L	0.5	U	
8260C	DICHLORODIFLUOROMETHANE	75-71-8	UG_L	1	U	
8260C	ETHYLBENZENE	100-41-4	UG_L	0.5	U	
8260C	ISOPROPYLBENZENE	98-82-8	UG_L	0.5	U	
8260C	M- AND P-XYLENE	108-38-3/106-42	UG_L	1	U	
8260C	METHYL ACETATE	79-20-9	UG_L	0.75	UJ	c
8260C	METHYL CYCLOHEXANE	108-87-2	UG_L	0.5	U	
8260C	METHYL TERT-BUTYL ETHER	1634-04-4	UG_L	0.5	U	
8260C	METHYLENE CHLORIDE	75-09-2	UG_L	2.5	U	
8260C	O-XYLENE	95-47-6	UG_L	0.5	U	
8260C	STYRENE	100-42-5	UG_L	0.5	U	
8260C	TETRACHLOROETHENE	127-18-4	UG_L	0.5	U	
8260C	TOLUENE	108-88-3	UG_L	0.5	U	
8260C	TRANS-1,2-DICHLOROETHENE	156-60-5	UG_L	0.5	U	
8260C	TRANS-1,3-DICHLOROPROPENE	10061-02-6	UG_L	0.5	U	
8260C	TRICHLOROETHENE	79-01-6	UG_L	0.5	U	
8260C	TRICHLOROFLUOROMETHANE	75-69-4	UG_L	1	U	
8260C	VINYL CHLORIDE	75-01-4	UG_L	1	U	
8260C	XYLENES, TOTAL	1330-20-7	UG_L	1.5	U	
8270D_SIM	1,4-DIOXANE	123-91-1	UG_L	0.17	U	

Notes:

UG_L = Micrograms per liter
Qual = Final qualifiers (See Attachment B)
RC = Reason codes (See Attachment C)

DATA VALIDATION REPORT

Project:	Regional Groundwater Investigation — NWIRP Bethpage	
Laboratory:	Katahdin Analytical	
Sample Delivery Groups:	SJ5057	
Analyses/Method:	Total Organic Carbon (TOC) by U.S. EPA SW-846 Method 9060A and Standard Method 5310B for Total Organic Carbon by High-Temperature Combustion	
Validation Level:	2	
Project Number:	0888812477.SA.DV	
Prepared by:	Dana Miller/Resolution Consultants	Completed on: 08/01/2016
Reviewed by:	Tina Cantwell/Resolution Consultants	File Name: SJ5057_ 9060A_5310B

SUMMARY

This report summarizes data review findings for samples listed below, collected by Resolution Consultants from the Regional Groundwater Investigation — NWIRP Bethpage site on 5 July 2016 in accordance with the following Sampling and Analysis Plans:

- *Sampling and Analysis Plan, Bethpage, New York.* (Resolution Consultants April 2013).
- *UFP SAP Addendum, Installation of Vertical Profile Borings and Monitoring Wells, Operable Unit 2, NWIRP Bethpage, New York.* (Resolution Consultants November 2013).
- *UFP SAP Addendum, Inclusion of Additional Target Analytes for Volatile Organics Analyses, NWIRP Bethpage OU2, Bethpage, New York*. (Resolution Consultants August 2014).

Sample ID	Lab ID	Matrix/Sample Type	Analysis
RE133D1-SO-070516-568-570	SJ5057-1	Soil	9060A, 2540G
RE133D1-EB-070516	SJ5057-2	Equipment Blank	5310B

Data validation activities were conducted using the following guidance documents: *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846, specifically Method 9060A, Total Organic Carbon* (U.S. EPA, 1996), *Method SM5310B, Total Organic Carbon by High-Temperature Combustion, U.S. Environmental Protection Agency (U.S. EPA) Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review* (NFG, January 2010, and Department of Defense (DoD) Quality Systems Manual (QSM) for Environmental Laboratories, Version 4.2 (October 2010). In

the absence of method-specific information, laboratory quality control (QC) limits, project-specific requirements and/or professional judgment were used as appropriate.

REVIEW ELEMENTS

The data were evaluated based on the following parameters (where applicable to the method):

✓	Data completeness (chain-of-custody)/sample integrity
✓	Holding times and sample preservation
NA	Gas chromatography/Mass spectrometer performance checks
NA	Initial calibration/continuing calibration verification
✗	Laboratory blanks/equipment blanks
NA	Surrogate spike recoveries
NA	Matrix spike and/or matrix spike duplicate results
✓	Laboratory control sample / laboratory control sample duplicate results
NA	Field duplicates
NA	Internal standards
✓	Sample results/reporting issues

The symbol (✓) indicates that no validation qualifiers were applied based on this parameter. NA indicates that the parameter was not included as part of this data set or was not applicable to this validation and therefore not reviewed. The symbol (X) indicates that a QC non-conformance resulted in the qualification of data. Acceptable data parameters for which all criteria were met and no qualification was performed, and non-conformance or other issues that were noted during validation, but did not result in qualification of data are not discussed further.

RESULTS

Laboratory Blanks/ Equipment Blanks

Laboratory blanks and equipment blanks were analyzed with samples to assess contamination imparted by sample preparation and/or analysis. All results associated with a particular blank were evaluated to determine whether there was an inherent variability in the data, or if a problem was an isolated occurrence that did not affect the data. Samples were flagged in accordance with *Functional Guidelines* (shown below) where detections were not believed to be site-related.

Blank Non-conformance Charts:

For common lab contaminants (methylene chloride, acetone, 2-butanone):			
Blank type	**Blank result**	**Sample result**	**Action for samples**
Method, Storage, Trip, Field, or Equipment	Detects	Not detected	No qualification
	≤ 2x LOQ	< 2x LOQ	Report sample LOQ value with a U
		≥ 2x LOQ and ≤ 4x the LOQ	Report the sample result with a U**
		≥ 4x the LOQ	No qualifications
	> 2x LOQ	< LOD	Report sample LOD value with a U**
		≥ LOD and < 2x LOQ	Report sample LOQ value with a U
		≥ 2x LOQ and < blank contamination	Report the blank result with a U or reject the sample result as unusable R
		≥ 2x LOQ and ≥ blank contamination	If the result is ≤2x blank result, report the sample result U.** If the result is > 2x blank result, no qualification is required. **
****Based on Resolution Consultants professional judgment**			

For all other compounds:			
Blank type	**Blank result**	**Sample result**	**Action for samples**
Method, Storage, Trip, Field, or Equipment	Detects	Not detected	No qualification
	< 2x LOQ	< 2x LOQ	Report sample LOQ value with a U
		≥ 2x LOQ	Use professional judgment
	> 2x LOQ	< 2x LOQ	Report sample LOQ value with a U
		≥ 2x LOQ and < blank contamination	Report the blank result with a U or reject the sample result as unusable R
		≥ 2x LOQ and ≥ blank contamination	If the result is ≤2x blank result, report the sample result U. If the result is > 2x blank result, no qualification is required.
	= 2x LOQ	< 2x LOQ	Report sample LOQ value with a U
		≥ 2x LOQ	Use professional judgment
	Gross contamination	Detects	Qualify results as unusable R

Notes:

LOQ = Limit of quantitation
LOD = Limit of detection
U = Undetected
R = Rejected

The laboratory blank non-conformance is summarized in Attachment A in Table A-1.

Qualifications Actions

The data was reviewed independently from the laboratory to assess data quality. TOC was detected in the equipment blank but professional judgement was used not to qualify the associated sample as undetected. All analytes detected at concentrations less than the limit of quantitation but greater than the method detection limit were qualified by the laboratory as estimated (J). This "J" qualifier was retained during data validation.

No results were rejected; therefore, analytical completeness was calculated to be 100 percent. Data not qualified during data review are considered usable by the project. The remaining results qualified as estimated may be high or low, but the data are usable for their intended purpose, according to U.S. EPA and Department of Defense guidelines. Final data review qualifiers used to describe results and how they should be interpreted by the end data user are provided in Attachment B, Table B-1.

ATTACHMENTS

Attachment A: Table A-1, Non-Conformance Summary Tables
Attachment B: Table B-1, Final Results after Data Review

Attachment A
Non-Conformance Summary Table

Table A-1
Laboratory Blank Non-Conformance
Regional Groundwater Investigation NWIRP Bethpage

Blank ID	Batches	Method	Analyte	Blank Result (MG_L)	LOQ	Detected Associated Samples	Qualifier
WG186943-1	WG186943	5310B	Total Organic Carbon	0.19	1	RE133D1-EB-070516	U

Notes:

ID = Identification
MG_L = Milligrams per liter
LOQ = Limit of quantitation
U = Undetected value

Attachment B
Final Results after Data Review

Table B-1
Final Results after Data Review
Regional Groundwater Investigation NWIRP Bethpage

		Sample Delivery Group		SJ5057			SJ5057		
		Lab ID		SJ5057-1			SJ5057-2		
		Sample ID		RE133D1-SO-070516-568-570			RE133D1-EB-070516		
		Sample Date		7/5/2016			7/5/2016		
		Sample Type		Soil			Equipment Blank		
Method	**Analyte**	**CAS No**	**Units**	Result	Qual	RC	Result	Qual	RC
2540G	TOTAL SOLIDS	-29	PCT	82			NA		
5310B	TOTAL ORGANIC CARBON	-28	MG_L	NA			0.5	UJ	bl
9060A	TOTAL ORGANIC CARBON	-28	UG_G	720			NA		

Notes:

ID = Identification
PCT = Percent
MG_L = Milligrams per liter
UG_G = Micrograms per gram
NA = Not analyzed

Final Qualifier:

UJ = Undetected and estimated – The parameter was analyzed but not detected at concentrations above the listed sample detection limit; the sample detection limit is estimated because one quality control parameter was outside of control limits.

Reason Code:

bl = Qualified undetected and estimated due to lab blank contamination.

DATA VALIDATION REPORT

Project:	Regional Groundwater Investigation — NWIRP Bethpage	
Laboratory:	Katahdin Analytical	
Sample Delivery Groups:	SJ4357	
Analyses/Method:	Total Organic Carbon (TOC) by U.S. EPA SW-846 Method 9060A and Standard Method 5310B for Total Organic Carbon by High-Temperature Combustion	
Validation Level:	2	
Project Number:	0888812477.SA.DV	
Prepared by:	Dana Miller/Resolution Consultants	Completed on: 08/01/2016
Reviewed by:	Tina Cantwell/Resolution Consultants	File Name: SJ4357_ 9060A_5310B

SUMMARY

This report summarizes data review findings for samples listed below, collected by Resolution Consultants from the Regional Groundwater Investigation — NWIRP Bethpage site on 10 June 2016 in accordance with the following Sampling and Analysis Plans:

- *Sampling and Analysis Plan, Bethpage, New York.* (Resolution Consultants April 2013).
- *UFP SAP Addendum, Installation of Vertical Profile Borings and Monitoring Wells, Operable Unit 2, NWIRP Bethpage, New York.* (Resolution Consultants November 2013).
- *UFP SAP Addendum, Inclusion of Additional Target Analytes for Volatile Organics Analyses, NWIRP Bethpage OU2, Bethpage, New York*. (Resolution Consultants August 2014).

Sample ID	Lab ID	Matrix/Sample Type	Analysis
RE133D2-EB-061016	SJ4357-1	Equipment Blank	5310B
RE133D2-SO-0610-783-785	SJ4357-2	Soil	9060A, 2540G

Data validation activities were conducted using the following guidance documents: *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846, specifically Method 9060A, Total Organic Carbon* (U.S. EPA, 1996), *Method SM5310B, Total Organic Carbon by High-Temperature Combustion, U.S. Environmental Protection Agency (U.S. EPA) Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review* (NFG, January 2010, and Department of Defense

(DoD) Quality Systems Manual (QSM) for Environmental Laboratories, Version 4.2 (October 2010). In the absence of method-specific information, laboratory quality control (QC) limits, project-specific requirements and/or professional judgment were used as appropriate.

REVIEW ELEMENTS

The data were evaluated based on the following parameters (where applicable to the method):

✓	Data completeness (chain-of-custody)/sample integrity
✓	Holding times and sample preservation
NA	Gas chromatography/Mass spectrometer performance checks
NA	Initial calibration/continuing calibration verification
✓	Laboratory blanks/equipment blanks/field blanks/trip blanks
NA	Surrogate spike recoveries
NA	Matrix spike and/or matrix spike duplicate results
✓	Laboratory control sample / laboratory control sample duplicate results
NA	Field duplicates
NA	Internal standards
✓	Sample results/reporting issues

The symbol (✓) indicates that no validation qualifiers were applied based on this parameter. NA indicates that the parameter was not included as part of this data set or was not applicable to this validation and therefore not reviewed. Acceptable data parameters for which all criteria were met and no qualification was performed, and non-conformance or other issues that were noted during validation, but did not result in qualification of data are not discussed further.

Qualifications Actions

The data was reviewed independently from the laboratory to assess data quality. TOC was detected in the equipment blank but professional judgement was used not to qualify the associated sample as undetected. All analytes detected at concentrations less than the limit of quantitation but greater than the method detection limit were qualified by the laboratory as estimated (J). This "J" qualifier was retained during data validation. No results were qualified during this review and are considered usable by the project for their intended purpose, according to U.S. Environmental Protection Agency and Department of Defense guidelines. Attachment A, Table A-1 provides final results after data review.

ATTACHMENTS

Attachment A: Table A-1, Final Results after Data Review

Attachment A
Final Results after Data Review

Table A-1
Final Results after Data Review
Regional Groundwater Investigation NWIRP Bethpage

			Sample Delivery Group	SJ4357	SJ4357
			Lab ID	SJ4357-1	SJ4357-2
			Sample ID	RE133D2-EB-061016	RE133D2-SO-0610-783-785
			Sample Date	6/10/2016	6/10/2016
			Sample Type	Equipment Blank	Soil
Method	**Analyte**	**CAS No**	**Units**	Result	Result
2540G	TOTAL SOLIDS	-29	PCT	NA	90
5310B	TOTAL ORGANIC CARBON	-28	MG_L	0.35 J	NA
9060A	TOTAL ORGANIC CARBON	-28	UG_G	NA	400 J

Notes:

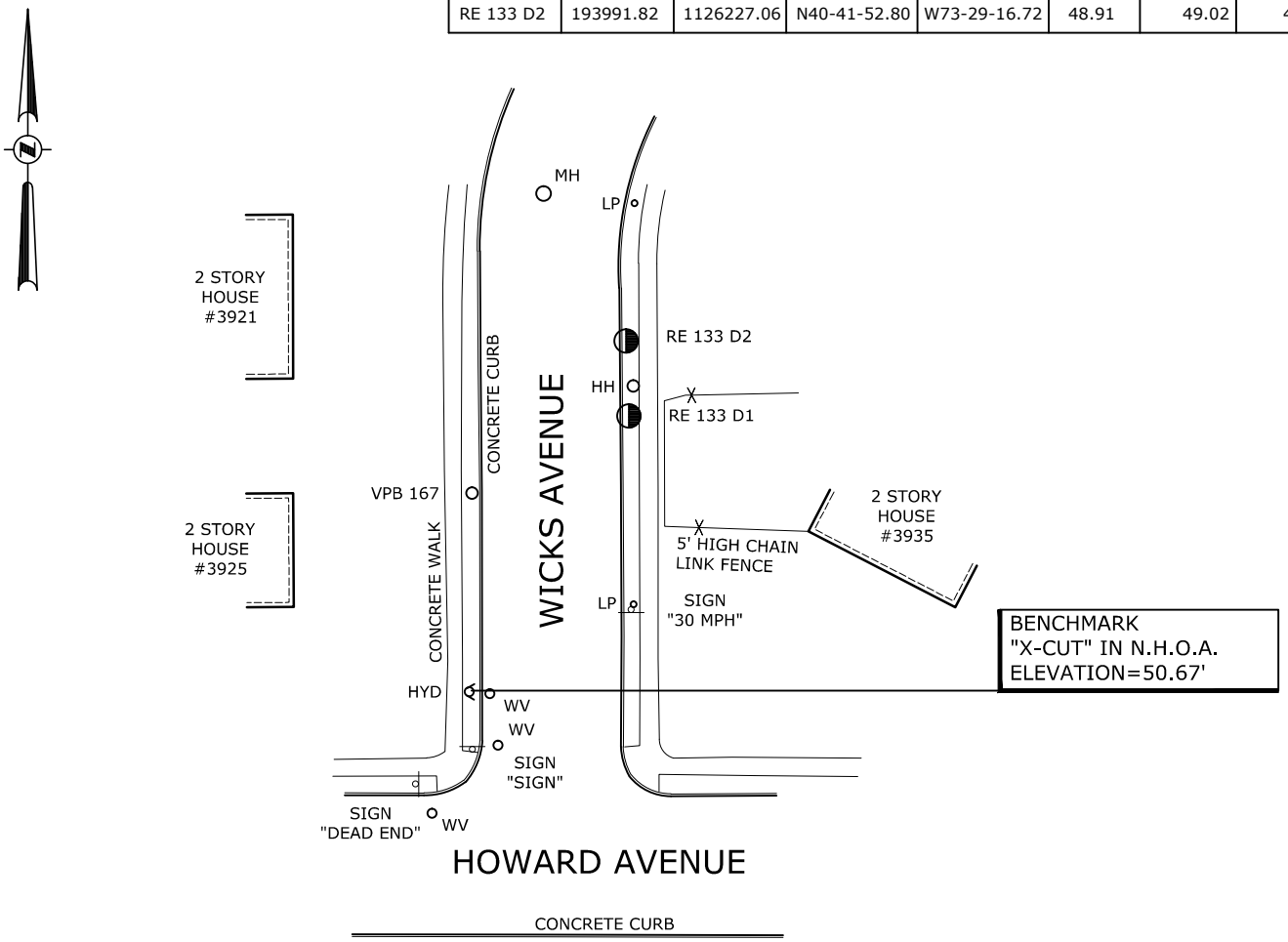
ID = Identification
PCT = Percent
MG_L = Milligrams per liter
UG_G = Micrograms per gram
NA = Not analyzed
J = Estimated value – The reported value is greater than or equal to the method detection limit but less than the limit of quantitation.

Section 6

Survey

NONE :XREFS

Description	Northing	Easting	Latitude	Longitude	Ground	Rim	PVC
VPB 167	193959.30	1126194.17	N40-41-52.48	W73-29-17.15	48.85	NA	NA
RE 133 D1	193975.82	1126227.64	N40-41-52.64	W73-29-16.72	48.89	48.91	48.38
RE 133 D2	193991.82	1126227.06	N40-41-52.80	W73-29-16.72	48.91	49.02	48.72



Legend

HH	Hand Hole
HYD	Hydrant
LP	Light Pole
MW	Monitoring Well
MH	Manhole
VPB 167	Vertical Profile Boring
WV	Water Valve

Map Notes

1. Information shown hereon was compiled from an actual field survey conducted on October 12, 2016.
2. North orientation is Grid North based on the New York State Plane Coordinate System, Long Island Zone, NAD 83 as obtained from GPS observations.
3. Vertical datum shown hereon is NAVD 88 as obtained from GPS observations.

BAR SCALE
40 0 20 40 80
1 inch = 40 ft.

DWG NO. 16-577

Date	RECORD OF WORK	Appr.

VERTICAL PROFILE BORING 167 SURVEY LOCATION
HOWARD AVENUE/WICKS AVENUE

TOWN OF BETHPAGE | NASSAU COUNTY, NEW YORK

C.T. MALE ASSOCIATES
Engineering, Surveying, Architecture & Landscape Architecture, D.P.C.
50 CENTURY HILL DRIVE, LATHAM, NY 12110
518.786.7400 * FAX 518.786.7299

Drafter: GLB	Checker: JFC
Appr. by: JFC	Proj. No. 14.4121
SCALE: 1"=40'	DATE:OCT. 12, 2016

CAD DWG. FILE NAME: K:\Projects\144121\Survey\Drawings and Maps\VPB 167.dwg

Appendix B

Geologic Cross Sections derived from

Environmental Sequence Stratigraphy (ESS)

Appendix B. Geologic Cross Sections derived from Environmental Sequence Stratigraphy

Resolution Consultants reviewed the geologic data and regional literature at the Naval Weapons Industrial Reserve Plant at Bethpage, New York and developed four representative base-wide cross sections to support development of a Conceptual Site Model (CSM). The cross sections are presented in Figure 1 - Figure 4. The cross sections provide geologic context for groundwater and analytical data and can be used as the framework upon which new and existing datasets (groundwater, analytical chemistry, geophysical data, etc.) can be analyzed to better understand groundwater flow-paths and contaminant transport and storage zones. As such, these sections are an integral component of an effective CSM.

The cross sections were developed using Environmental Sequence Stratigraphy (ESS). The ESS approach examines subsurface data in the context of the depositional environments and petroleum industry best practices of sequence stratigraphy and facies models. Shown for each boring included in the stratigraphic analysis are a vertical series of colored blocks which correspond to boring log lithology and a continuous data curve (in red or as a scan of a paper document, which corresponds to the gamma log). These colored blocks represent vertical grain size distribution and are the basis for the correlations between the data points.

The color coded blocks correspond to the graphic grainsize scale as shown in the cross-sections' keys. The width of the block increases with relative grainsize. Block color indicates the textural classification of the sediment (e.g., yellow for sand, green for silt, blue for clay) as written in the field notes of the core logging geologist (see the cross section keys for further definition).

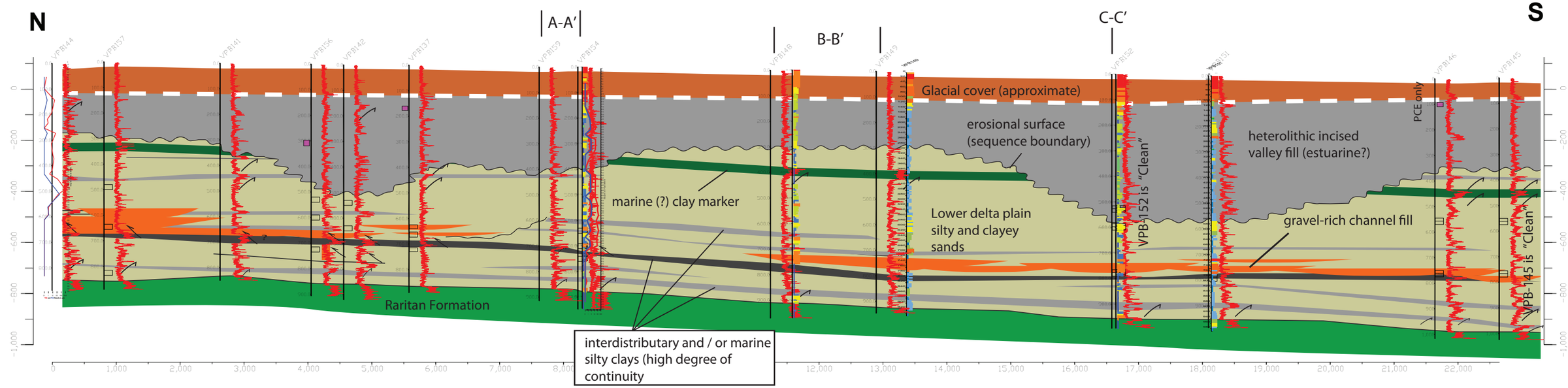
Logs of natural gamma emissions are a common proxy for grainsize. They typically are used as a correlation aide because repetitive spatially extensive trends in grainsize are easily identified visually when curves are examined along a given section. In non-granitic aquifer material, the chemistry of minerals found in clays result in higher concentrations of gamma emitting anions as opposed to the quartz, heavy minerals, and lithic fragments that generally predominate the coarser size fractions. Thus, peaks in the gamma logs can be indicative of clay layers and in general as gamma count per second increases, the grainsize decreases. Gamma logs should always be "calibrated" by comparing side by side with a lithologic log at representative locations. Good agreement between gamma logs and lithology logs were noted in the data points used for the ESS sections at Bethpage.

The previously established general hydrostratigraphy at Bethpage consists of the basal Raritan confining unit, the Magothy aquifer, and the shallow glacial aquifer. The stratigraphy shown in the sections presented in this tech memo is consistent with this general model but additionally shows the Magothy to consist of basal zone gravel-rich channel fills (orange in sections); extensive, planar marine clays (thin units shown in grey and dark green); and silty sands of inter-distributary and delta front origins (shown in tan). Additionally, an erosional incision into the lower delta plain sediments is observed throughout the site (portrayed in sections as a wavy solid black line). Above this, the Magothy sediments are more likely estuarine "incised valley fill" as indicated by the more heterogeneous gamma ray character. In some locations, such as VPB-139 on section A-A', there appears to be clear lithologic control on contaminant distribution within the estuarine facies where the higher TCE and PCE concentrations occur in the coarser lithologic zones.

The depositional axis of the incised valley fill likely trends north-south/southeast. The incision is clearly indicated on all sections via the correlation of a prominent clay layer shown in sections in dark green. Where this clay is missing in the gamma logs, it is likely that it was eroded during a lowstand of sea level. Additionally, while relatively planar in their geometry, the major units dip gently south-south east. This is an important geologic characteristic to consider when comparing analytical results because hydrologic zones separated by thin confining layers within the Magothy may be accessed by screens of similar depth.

One of the most important benefits of the ESS approach is to develop and refine the CSM. ESS facilitates an understanding of the geology governing groundwater occurrence and movement, and provides an element for refining the approaches for assessment and remediation. The ESS results from this effort suggest that a modern analog (a modern geological setting that allows an understanding of the ancient environment) for the Magothy depositional environments is the Mackenzie River Delta, shown in Figure 5. Basal gravel zones are represented by the braided river deposits of the Toklat River, Alaska, in Figure 6.

Environmental Sequence Stratigraphy cross section



GRAIN SIZE LOG INDEX*

* not all grainsize categories shown in the comprehensive key are present at the site.
Site sediments are predominatly fine (clays, sandy clays, silts,and fine to medium sand)

- Clay
- Clay with 10% Sand
- Clay with 20% Sand
- Clay with 30% Sand
- Clay with 40% Sand
- Clay with Fine Gravel
- Clay with Medium Gravel
- Clay with Coarse Gravel
- Silt
- Silt with 10% Sand
- Silt with 20% Sand
- Sandy Silt
- Silty Sand
- Clayey Sand
- Silty Sand (Fine Sand with 40% Fines)
- Clayey Sand (Fine Sand with 40% Fines)
- Silty Sand (Fine Sand with 30% Fines)
- Clayey Sand (Fine Sand with 30% Fines)
- Silty Sand (Fine Sand with 10-20% Fines)
- Clayey Sand (Fine Sand with 10-20% Fines)
- Gravelly Silt (Silt with Fine Gravel)
- Gravelly Silt (Silt with Medium Gravel)
- Gravelly Silt (Silt with Coarse Gravel)
- Fine Sand
- Silty Sand (Medium Sand with 50% Fines)
- Clayey Sand (Medium Sand with 50% Fines)
- Silty Sand (Medium Sand with 40% Fines)
- Clayey Sand (Medium Sand with 40% Fines)
- Silty Sand (Medium Sand with 30% Fines)
- Clayey Sand (Medium Sand with 30% Fines)
- Silty Sand (Medium Sand with 10-20% Fines)
- Clayey Sand (Medium Sand with 10-20% Fines)
- Fine Sand with Fine Gravel
- Fine Sand with Medium Gravel
- Fine Sand with Coarse Gravel
- Medium Sand
- Silty Sand (Coarse Sand with 50% Fines)
- Clayey Sand (Coarse Sand with 50% Fines)
- Silty Sand (Coarse Sand with 40% Fines)
- Clayey Sand (Coarse Sand with 40% Fines)
- Silty Sand (Coarse Sand with 30% Fines)
- Clayey Sand (Coarse Sand with 30% Fines)
- Silty Sand (Coarse Sand with 10-20% Fines)
- Clayey Sand (Coarse Sand with 10-20% Fines)
- Medium Sand with Fine Gravel
- Medium Sand with Medium Gravel
- Medium Sand with Coarse Gravel
- Coarse Sand
- Coarse Sand with Fine Gravel
- Coarse Sand with Medium Gravel
- Coarse Sand with Coarse Gravel
- Clayey/Silty Gravel (Fine gravel with clay/silt)
- Clayey/Silty Gravel (Medium gravel with clay/silt)
- Clayey/Silty Gravel (Coarse gravel with clay/silt)
- Sandy Gravel (Fine Gravel with Sand)
- Sandy Gravel (Medium Gravel with Sand)
- Sandy Gravel (Coarse Gravel with Sand)
- Fine Gravel
- Medium Gravel
- Coarse Gravel

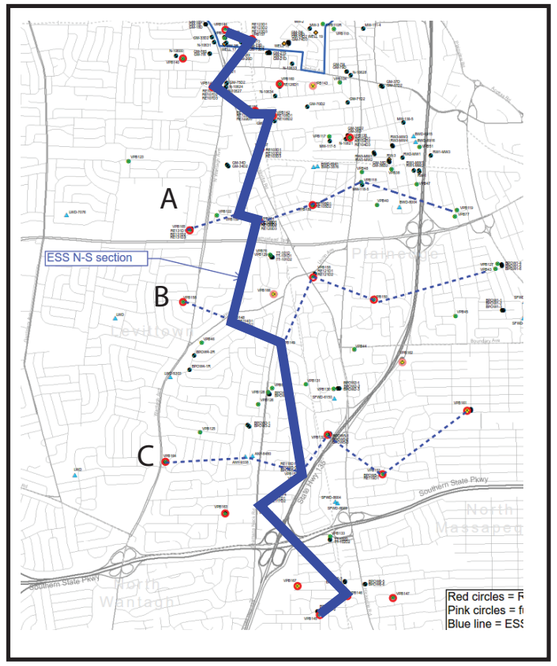


Figure 1. Cross Section N-S

A – A′

West

A

intersection with N-S

VPB-155 VPB-159 VPB-154 VPB-139 BWD 6-1 BWD 6-2 VPB-118 VPB-48 VPB-40 VPB-77 VPB-119

A′

East

Elevation (Ft.)

100 0 -100 -200 -300 -400 -500 -600 -700 -800

Apparent lithologic control on TCE and PCE concentrations

Potentially leaky zone in basal clay here

Raritan Formation

Glacial cover (approximate)

heterolithic incised valley fill (estuarine?)

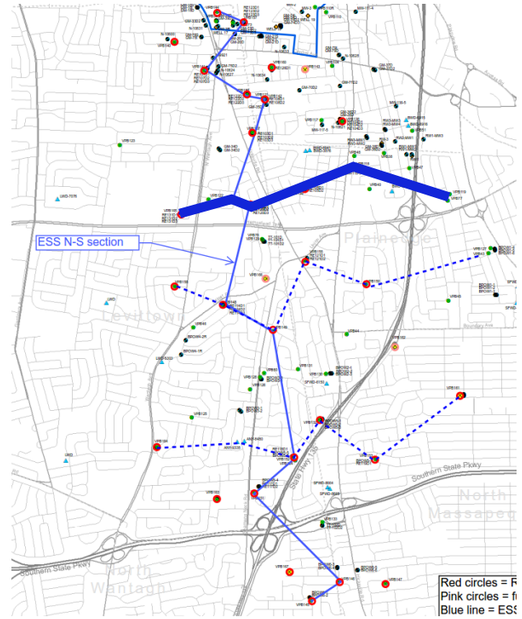
marine (?) clay marker

interdistributary and / or marine silty clays (high degree of continuity (darkest grey clay may serve as base to contaminant)

gravel-rich channel fill

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000 11,000 12,000 13,000 14,000 15,000

Distance



GRAIN SIZE LOG INDEX*

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Site sediments are predominatly fine (clays, sandy clays, silts,and fine to medium sand)

- Clay
- Clay with 10% Sand
- Clay with 20% Sand
- Clay with 30% Sand
- Clay with 40% Sand
- Clay with Fine Gravel
- Clay with Medium Gravel
- Clay with Coarse Gravel
- Silt
- Silt with 10% Sand
- Silt with 20% Sand
- Sandy Silt
- Silty Sand
- Clayey Sand
- Silty Sand (Fine Sand with 40% Fines)
- Clayey Sand (Fine Sand with 40% Fines)
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- Sandy Gravel (Fine Gravel with Sand)
- Sandy Gravel (Medium Gravel with Sand)
- Sandy Gravel (Coarse Gravel with Sand)
- Fine Gravel
- Medium Gravel
- Coarse Gravel

Figure 2. Cross Section A-A’

B

B–B′

B′

West

East

VPB-156

VPB-148

VPB-149

VPB-155

VPB-150

VPB-45

VPB-43

VPB-127

intersection with N-S

Glacial cover (approximate)

heterolithic incised valley fill (estuarine?)

marine (?) clay marker

Lower delta plain silty and clayey sands

gravel-rich channel fill

interdistributary and / or marine silty clays (high degree of continuity (darkest grey clay may serve as base to contaminant)

?

Raritan Formation

100

0

-100

-200

-300

-400

-500

-600

-700

-800

0

1,000

2,000

3,000

4,000

5,000

6,000

7,000

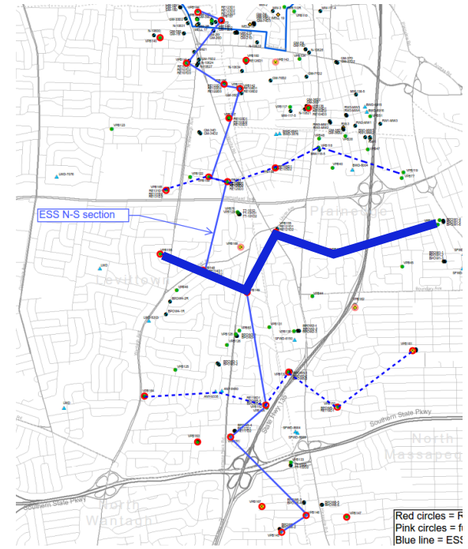
8,000

9,000

10,000

11,000

12,000



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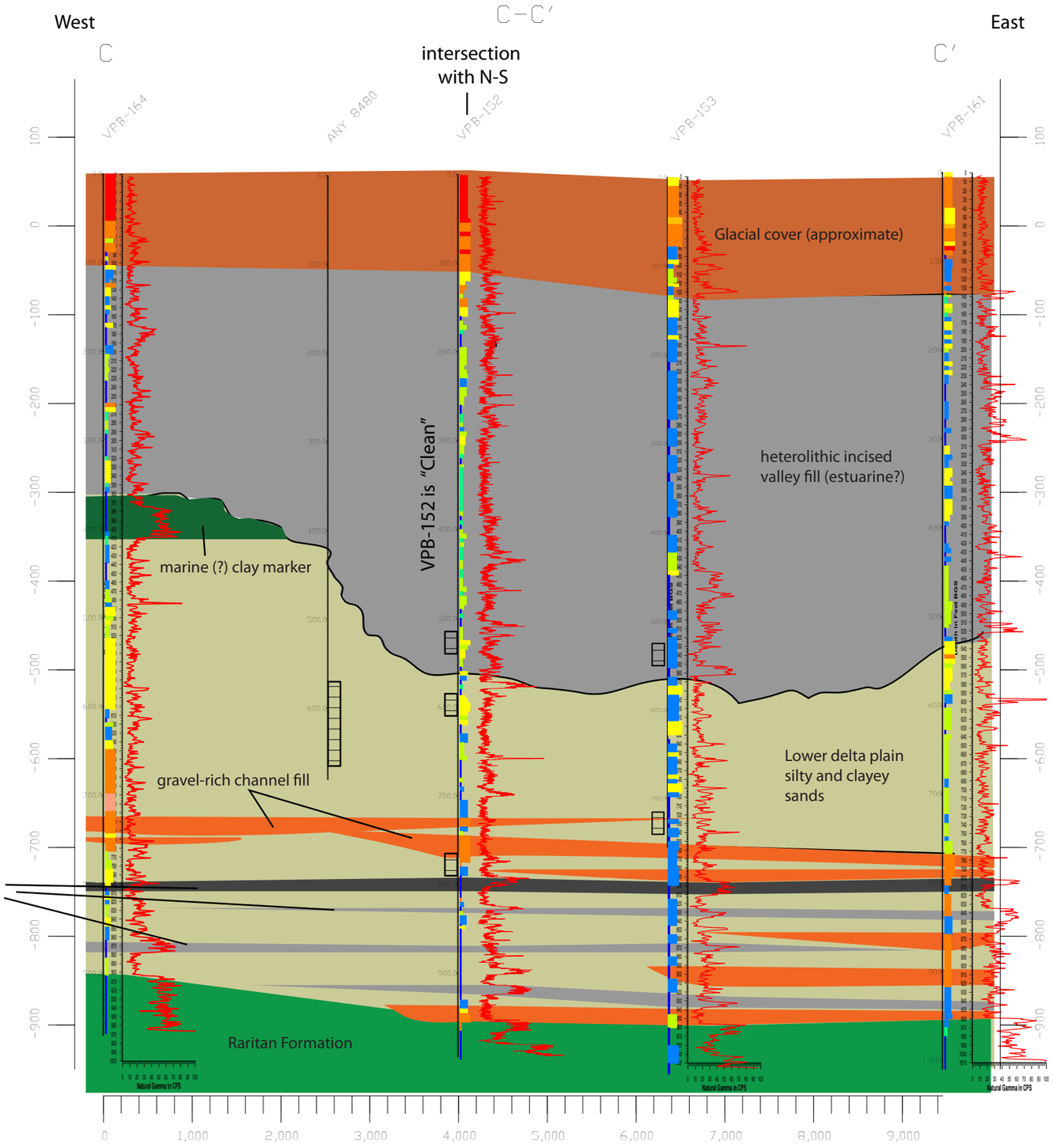
- Coarse Gravel

Figure 3. Cross Section B-B’



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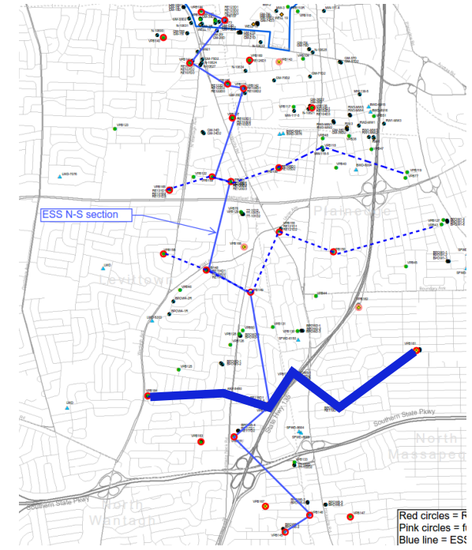

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- Sandy Gravel (Coarse Gravel with Sand)
- Fine Gravel
- Medium Gravel
- Coarse Gravel

Figure 4. Cross Section C-C’

Figure 5. Mackenzie River Delta depositional environment

Source: Thermal Emission and Reflection Radiometer image from NASA's TERRA satellite, August 4, 2005, Mackenzie River, Canada. Image from GSFC/METI/ERSDAC/JAROS and the US/Japan ASTER Science Team. http://earthobservatory.nasa.gov/IOTD/view.php?id=8320

Figure 6. Braided river depositional environment

Source: East Fork Toklat River, Alaska Range, Denali National Park
https://pubs.usgs.gov/of/2004/1216/b/b.html