2016-2017 OU2 GROUNDWATER INVESTIGATION
RE115D1, RE115D2 (VPB149)
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

August 2017

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NWIRP BETHPAGE
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

Prepared by:

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

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Brian Caldwell
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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
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
PCE	Tetrachloroethene
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 in 2017 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 RE115D1 and RE115D2 monitoring wells associated with Vertical Profile Boring (VPB) 149. The purpose of this investigation was to ascertain contaminant levels and depths in the offsite plume area south of Hempstead Turnpike and west of Hicksville Road. The locations of RE115D1 and RE115D2 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 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 VPB149, the bottom of the Magothy (top of the Raritan Clay) is encountered at approximately 938 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 VPB149 between October 2016 and January 2017. 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 RE115D1 and RE115D2 installed using mud rotary drilling techniques (Figure 2). Depths of monitoring wells RE115D1 and RE115D2 were 660 ft and 755 ft respectively. Well construction details are summarized in Table 1. Boring logs with lithologic descriptions of the well screen interval are included in Appendix A. *2014 OU2 Groundwater Investigation VPB149* (Resolution Consultants, 2015) 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 trichloroethene (TCE) tetrachloroethene (PCE) plot for VPB149 along with the well screen intervals at RE115D1 and RE115D2 are included in Appendix A.

Prior to installing each monitoring well, screen intervals were determined based on intervals with the highest VOC concentrations as measured in the VPB149 hydropunch samples and coincident intervals with the highest apparent permeability based on the VPB149 gamma logs and geologist 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 0.010-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. Flow rate for sample collection was 200 mL/minute. 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 RE115D1 and RE115D2 were sampled by Resolution Consultants on March 16, 2017. 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, 2015. *2014 OU2 Groundwater Investigation VPB149, Bethpage, NY.* March 2015.

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
2016-2017 OU2 GROUNDWATER INVESTIGATION
NWIRP BETHPAGE, NY

MONITORING WELL	WELL COMPLETION DATE	GROUND ELEVATION (MSL)	PVC ELEVATION (INNER CASING) (MSL)	WELL DEPTH (ft bgs)	SURFACE CASING DEPTH (ft bgs)	SCREEN INTERVAL (ft bgs)	SUMP DEPTH INTERVAL (ft bgs)	BORING DEPTH (ft bgs)
RE115D1	1/21/2017	69.45	69.01	660	53	640 - 655	655 - 660	670
RE115D2	12/7/2016	69.51	69.01	755	53	730 - 750	750 - 755	768

MSL - mean sea level

ft bgs - feet below ground surface

TABLE 2
MONITORING WELL DEVELOPMENT SUMMARY
2016-2017 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)		
RE115D1	2/7/2017	3,700	2/8/2017	640-655	4,800	8,500	1.08
RE115D2	2/6/2017	5,700	2/13/2017; 2/14/2017	730-750	7,500	13,200	32.14

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

TABLE 3
ANALYTICAL DATA SUMMARY
2016-2017 OU2 GROUNDWATER INVESTIGATION
NWIRP BETHPAGE, NY

Location	NYSDEC Groundwater Guidance or Standard Value (Note 1)	RE115D1	RE115D2
Sample Date		3/16/2017	3/16/2017
Sample ID		RE115D1-GW-031617	RE115D2-GW-031617
Sample type code		N	N
VOC 8260C (ug/L)			
1,1,1-TRICHLOROETHANE	5	<0.50 U	**0.64 J**
1,1,2,2-TETRACHLOROETHANE	5	<0.50 U	<0.50 U
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	5	**6.1**	**18**
1,1,2-TRICHLOROETHANE	1	**0.55 J**	**0.75 J**
1,1-DICHLOROETHANE	5	<0.50 U	**0.75 J**
1,1-DICHLOROETHENE	5	**2.2**	**5.5**
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	**1.3 J**	**2.4**
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	**8.2 J**	**6.8**
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	**10**	**8.9**
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 U	<0.50 U
CARBON TETRACHLORIDE	5	**1.8**	**1.5**
CHLOROBENZENE	5	<0.50 U	<0.50 U
CHLOROETHANE	5	<1.0 U	<1.0 U
CHLOROFORM	7	**1.3**	**0.90 J**
CHLOROMETHANE	5	**0.88 J**	**0.40 J**
CIS-1,2-DICHLOROETHENE	5	**1.3**	**2.4**
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	**1.4 J**	<1.0 UJ
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 U	<0.75 U
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	**0.27 J**
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	**86**	**230**
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

TABLE 3
ANALYTICAL DATA SUMMARY
2016-2017 OU2 GROUNDWATER INVESTIGATION
NWIRP BETHPAGE, NY

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
2016-2017 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)	Purge Flow rate (ml/min)
RE115D1	3/16/2017	12.33	6.47	0.132	1.73	119.0	4.16	30.01	600
RE115D2	3/16/2017	12.12	6.18	0.523	4.86	-39.1	4.5	30.85	550

°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
NM - not measured

Figures

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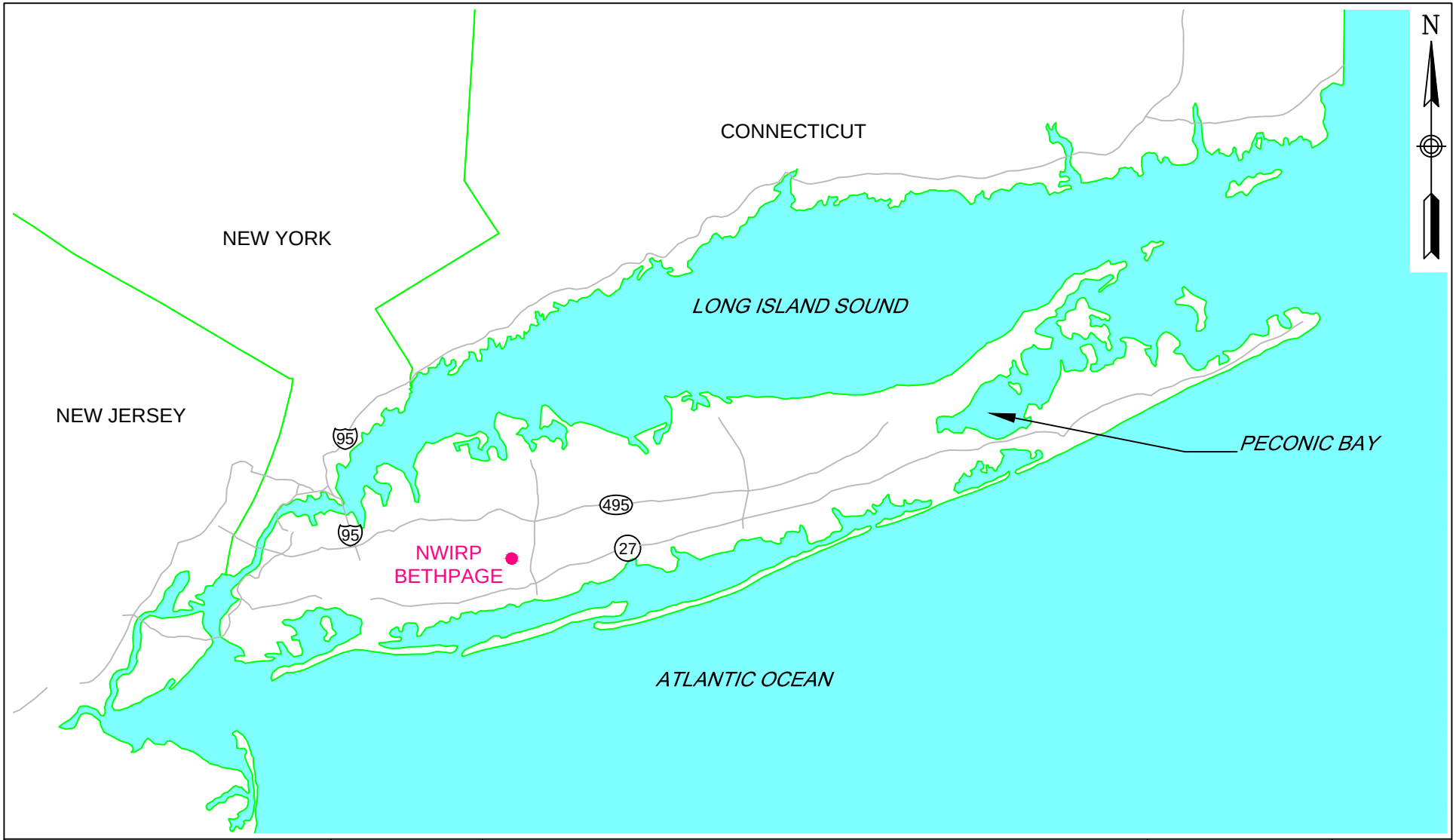

0 15 30

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

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Former Naval Weapons Industrial Reserve Plant

Former Northrop Grumman Site

RE115D1
RE115D2

Inset: RE115D1 and RE115D2 Location

VPB148
RE114D1
RE114D2
RE114D3

VPB149

RE115D1
RE115D2

VPB50

VPB128

BPOW3-3

0 375 750 Feet

N

PWD-7438

Bethpage

Plainedge

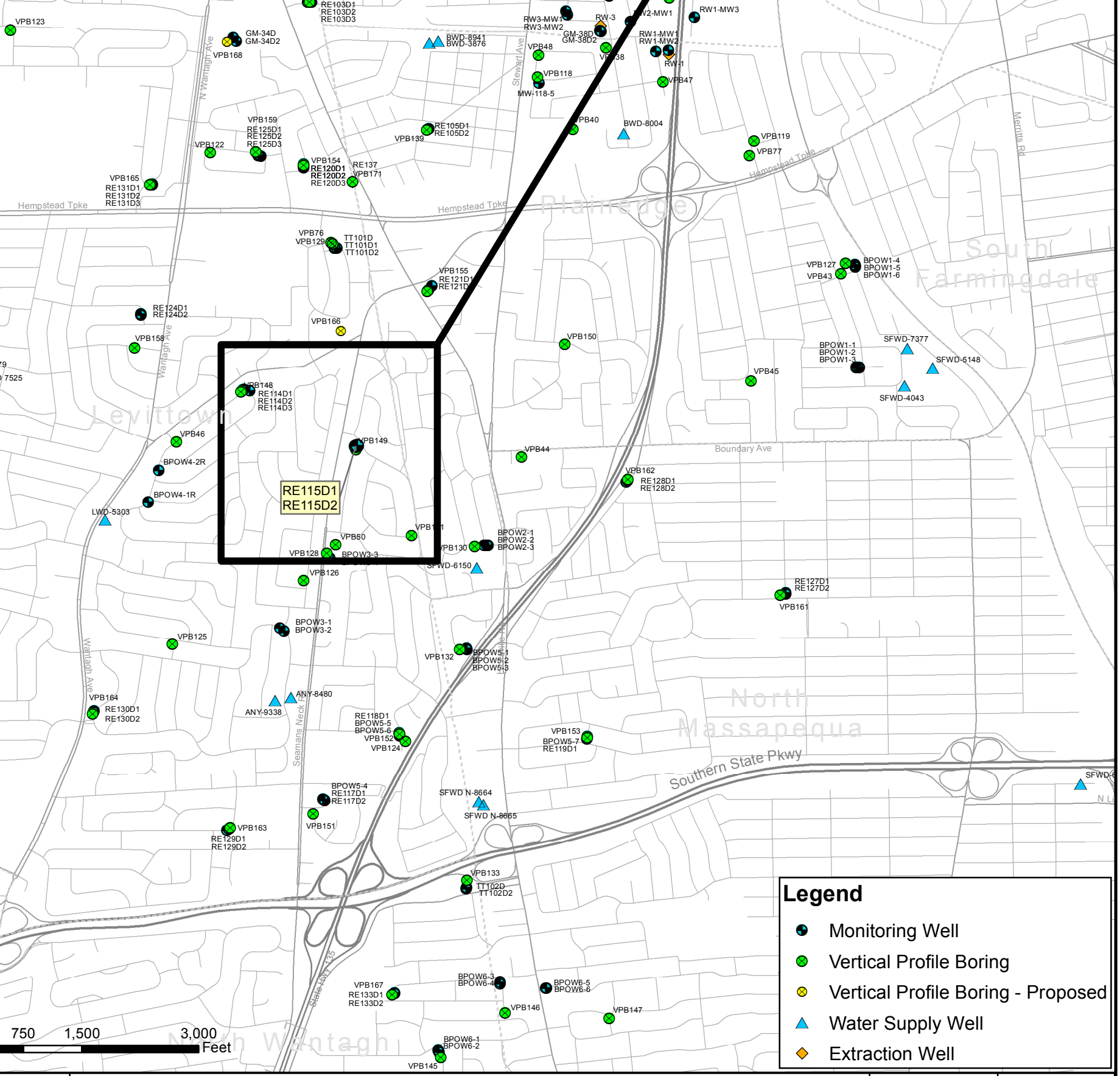
South Farmingdale

Levittown

North Massapequa

North Wantagh

Cherry Ave
Stewart Ave
Powell Ave
Hempstead Tpke
Boundary Ave
Southern State Pkwy
Seamans Neck Rd
Wantagh Ave
N Wantagh Ave
S Oyster Bay Rd
S Broadway
Whitney Rd
Merritts Rd
State HWY 135
Gilling Rd
Ava Rd
Elaine Dr
Daisy Rd
Hillcrest Dr
Knollwood Ln
Swansdowne Dr
Bryant Ave
Taylor Ave
Whittier Ave
Ferris Rd
Wellwood Rd
Maywood Dr
Florence Rd
Piping Rock Rd
Kingsberry Rd
Holmes St
Coleridge St
Parker Ave
Echo Ln
Elm Dr E
Elm Dr N
Elbow Ln
End Ln
Epic Ln
Eve Ln
Pope St
Elm Dr
Mansfield Ave



NAVFAC

RE115D1 AND RE115D2 LOCATION MAP
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

CONTRACT NUMBER	CTO NUMBER
N62470-11-D8013	WE15
APPROVED BY: PS	DATE: 6/14/2017
APPROVED BY: —	DATE: —
FIGURE NO.: 2	REV: 0

Appendices

Appendix A

RE115D1, RE115D2

Section 1

Boring Logs

Resolution Consultants

Boring Log

BORING #: **RE115D1**
Sheet 1 of 2

Client: Department of the Navy, Naval Facilities Engineering Command, Mid-Atlantic		**Logged By:** V. Thayer
Location: Ferris Rd & Maywood Dr, Seaford, NY		**Drilling Company:** Delta Well & Pump
Project #: 60266526	**Ground Elevation (msl):** 69.45	**Well Screen Interval (ft):** 640-655
Start Date: 1/3/2017	**Drilling Method:** Auger (0-50' bgs) Mud Rotary (>50' bgs)	**Water Level (ft):**
Finish Date: 1/21/2017	**Northing:** 200995.46 **Easting:** 1125727.35	**Total Depth (ft):** 670.0

DEPTH (ft)	PID (ppm)	Formation	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	Well Completion	Well Construction
0					0-638 ft bgs: See VB149 for Descriptions.		10" Diameter Steel Casing
50							
100							
150							
200							Bentonite Grout
250							
300							
350							
400							
450							
500							4" Diameter Schedule 80 PVC Riser
550							
600							

Resolution Consultants

Boring Log

BORING #: **RE115D1**
Sheet 2 of 2

Client: Department of the Navy, Naval Facilities Engineering Command, Mid-Atlantic		**Logged By:** V. Thayer
Location: Ferris Rd & Maywood Dr, Seaford, NY		**Drilling Company:** Delta Well & Pump
Project #: 60266526	**Ground Elevation (msl):** 69.45	**Well Screen Interval (ft):** 640-655
Start Date: 1/3/2017	**Drilling Method:** Auger (0-50' bgs) Mud Rotary (>50' bgs)	**Water Level (ft):**
Finish Date: 1/21/2017	**Northing:** 200995.46 **Easting:** 1125727.35	**Total Depth (ft):** 670.0

DEPTH (ft)	PID (ppm)	Formation	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	Well Completion	Well Construction
600					0-638 ft bgs: See VB149 for Descriptions. *(continued)*		4" Diameter Schedule 80 PVC Riser *(continued)*
602							
604							
606							
608							
610							
612							
614							
616							
618							
620							
622							
624							
626							
628							
630							#00 Filter Sand
632							
634							
636							
638	0.0		CL		Very dark gray (GLEY1 3/1) lean Clay, laminated		#1 Filter Sand
640							
642							
644	0.0		SP-SC		Light gray (10YR 7/2) poorly graded SAND with Clay, subangular to subrounded medium sand, 2 bands of brownish yellow (10YR 6/6) sand 1/2" and 1/4" wide, trace coarse sand, few fines (10%)		
646							
648	0.0		SP-SC		Gray (7.5YR 6/1) poorly graded SAND with Clay, subrounded to subangular medium sand, few fines (10%)		4" Diameter Schedule 80 PVC, 10 Slot Well Screen (640-655 ft bgs)
650							
652							
654	0.0		SP-CL		Very pale brown (10YR 7/4) poorly graded SAND with Clay, subangular fine to medium sand, few clay; 654-655 very pale brown (10YR 8/2) lean clay		
656							
658							Sump
660							
662							
664							
666							#1 Sand to Bottom
668							
670					End of boring at 670.0 ft. bgs.		

Resolution Consultants

Boring Log

BORING #: **RE115D2**
Sheet 1 of 2

Client: Department of the Navy, Naval Facilities Engineering Command, Mid-Atlantic		**Logged By:** G. Hicks
Location: Ferris Rd & Maywood Dr, Seaford, NY		**Drilling Company:** Delta Well & Pump
Project #: 60266526	**Ground Elevation (msl):** 69.51	**Well Screen Interval (ft):** 730-750
Start Date: 11/17/2016	**Drilling Method:** Auger (0-50' bgs) Mud Rotary (>50' bgs)	**Water Level (ft):**
Finish Date: 12/7/2016	**Northing:** 201006.44 **Easting:** 1125743.71	**Total Depth (ft):** 768.0

DEPTH (ft)	PID (ppm)	Formation	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	Well Completion	Well Construction
0					0-733 ft bgs: See VB149 for Descriptions.		10" Diameter Steel Casing
50							
100							
150							
200							
250							
300							Bentonite Grout
350							
400							
450							
500							
550							
600							
650							4" Diameter Schedule 80 PVC Riser
700							

Resolution Consultants

Boring Log

BORING #: **RE115D2**
Sheet 2 of 2

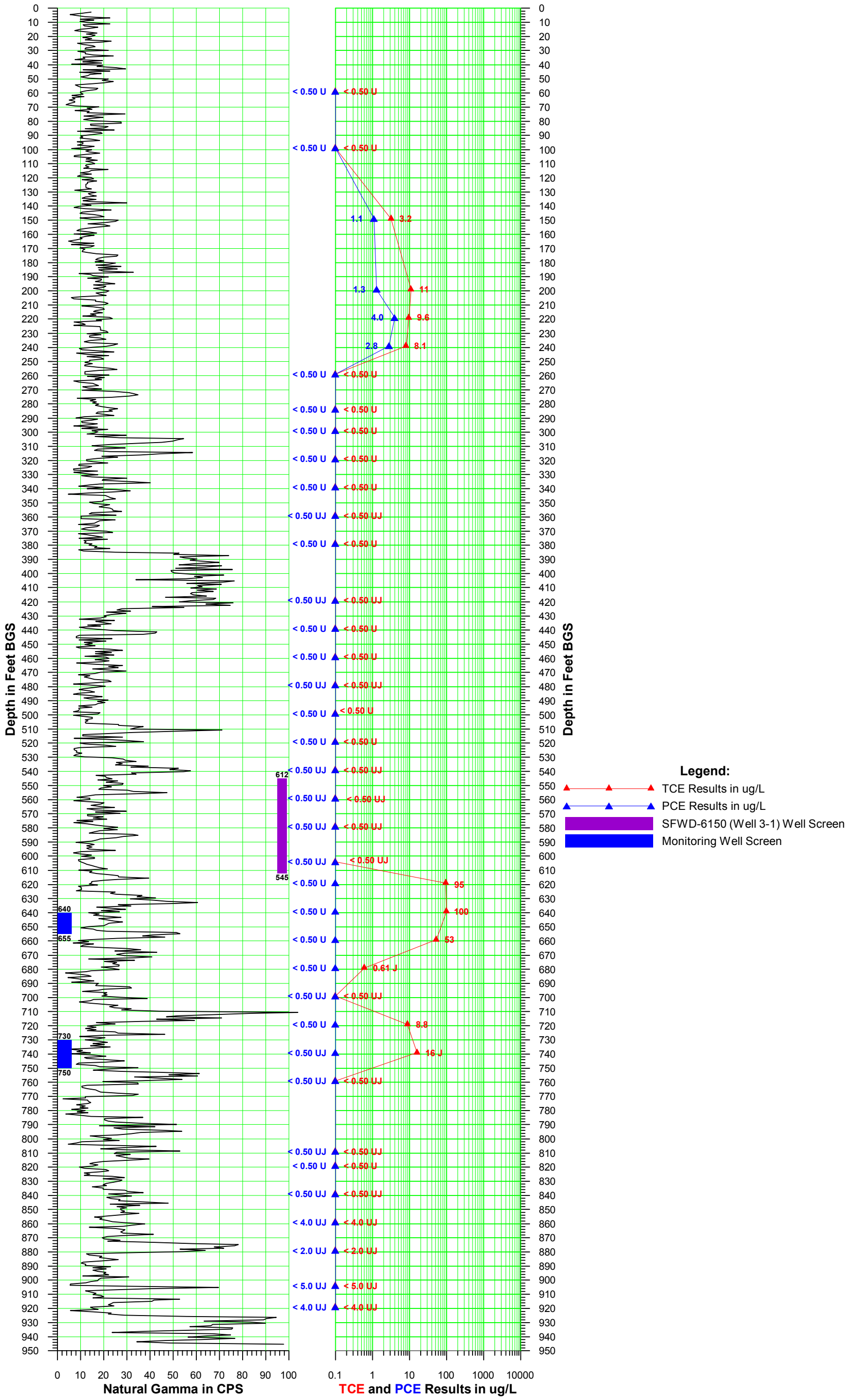
Client: Department of the Navy, Naval Facilities Engineering Command, Mid-Atlantic		**Logged By:** G. Hicks
Location: Ferris Rd & Maywood Dr, Seaford, NY		**Drilling Company:** Delta Well & Pump
Project #: 60266526	**Ground Elevation (msl):** 69.51	**Well Screen Interval (ft):** 730-750
Start Date: 11/17/2016	**Drilling Method:** Auger (0-50' bgs) Mud Rotary (>50' bgs)	**Water Level (ft):**
Finish Date: 12/7/2016	**Northing:** 201006.44 **Easting:** 1125743.71	**Total Depth (ft):** 768.0

DEPTH (ft)	PID (ppm)	Formation	USCS	GRAPHIC LOG	MATERIAL DESCRIPTION	Well Completion	Well Construction
700					0-733 ft bgs: See VB149 for Descriptions. *(continued)*		4" Diameter Schedule 80 PVC Riser *(continued)*
702							
704							
706							
708							
710							
712							
714							
716							
718							#00 Filter Sand
720							
722							
724							
726							#1 Filter Sand
728							
730							
732							
734	0.0		SP		Light gray (5Y 7/2) poorly graded fine SAND, trace Silt		
736							
738	0.0		GW		Light gray (5Y 7/2) well graded fine to coarse subrounded GRAVEL, few medium to coarse subrounded Sand		
740							4" Diameter Schedule 80 PVC, 10 Slot Well Screen (730-750 ft bgs)
742							
744	0.0		SP		Light gray (5Y 7/2) poorly graded medium subrounded SAND, trace Silt, trace coarse subrounded sand		
746							
748	0.0		SC		Light gray (5Y 7/2) soft fat Clayey well graded fine to coarse subrounded SAND, trace fine subrounded gravel, trace silt		
750							
752							Sump
754							
756							
758							
760							
762							#1 Sand to Bottom
764							
766							
768					End of boring at 768.0 ft. bgs.		

Section 2

VPB149 Gamma and TCE/PCE Plot

Vertical Profile Boring VPB-149
Downward Run - October 20, 2014
Validated Analytical Data



Section 3

Monitoring Well Construction Logs

RESOLUTION CONSULTANTS	Client: NAVFAC	Project Number: 60266526	***WELL ID: RE115D1***
	Site Location: NWIRP BETHPAGE, NY		
	Well Location: Ferris Rd. & Maywood Dr, Bethpage, NY		Date Installed: 1/3/2017 - 1/20/2017
	Method: Mud Rotary		Inspector: V. Thayer
	Coords: Northing: 200995.46	Easting: 1125727.35	Contractor: DELTA WELL & PUMP

MONITORING WELL CONSTRUCTION DETAIL

* Casing installed with Auger rig 10/14/16-10/17/16

	Depth from G.S. (feet)	Elevation(feet) Datum
Ground Surface (G.S.)	0.00	69.45
Top of 12 inch diameter Steel Curb Box		
Top of Riser Pipe fit with locking j-plug	0.44	69.01
Riser Pipe:		
Length: 640		
Inside Diameter (ID): 4 inch		
Type of Material: PVC		
Bottom of 10 inch diameter Steel Surface Casing	53	16.5
Bottom of Bentonite Grout	626	-556.6
Bottom of #00 Filter Sand/Top of #1 Filter Sand	635	-565.6
Top of Screen	640	-570.6
▲ Stabilized Water Level		69.5
Screen:		
Length: 15		
Inside Diameter (ID): 4 inch		
Slot Size: 10		
Type of Material: PVC		
Type/Size of Sand: #1		
Sand Pack Thickness: 35		
Bottom of Screen	655	-585.6
Bottom of Sump:	660	-590.6
Bottom of Borehole	670	-600.6

Borehole Diameter: 10 inch

Approved: V. Thayer (Signature) 1/20/2017 (Date)

Describe Measuring Point: Ground Surface

RESOLUTION CONSULTANTS	Client: NAVFAC	Project Number: 60266526	***WELL ID: RE115D2***
	Site Location: NWIRP BETHPAGE, NY		
	Well Location: Ferris Rd. & Maywood Dr, Bethpage, NY		Date Installed: 11/17/2016 - 12/7/2016
	Method: Mud Rotary		Inspector: G. Hicks
	Coords: Northing: 201006.44 Easting: 1125743.71		Contractor: DELTA WELL & PUMP

MONITORING WELL CONSTRUCTION DETAIL

* Casing installed with Auger rig 10/18/16-10/19/16

	Depth from G.S. (feet)	Elevation(feet) Datum
Ground Surface (G.S.)	0.00	69.51
Top of 12 inch diameter Steel Curb Box		
Top of Riser Pipe fit with locking j-plug	0.50	69.01
Riser Pipe:		
Length: 730		
Inside Diameter (ID): 4 inch		
Type of Material: PVC		
Bottom of 10 inch diameter Steel Surface Casing	53	16.5
Bottom of Bentonite Grout	715	-645.5
Bottom of #00 Filter Sand/Top of #1 Filter Sand	720	-650.5
Top of Screen	730	-660.5
▲ 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: 53		
Bottom of Screen	750	-680.5
Bottom of Sump:	755	-685.5
Bottom of Borehole	768	-698.5

Borehole Diameter: 10 inch

Approved:

Describe Measuring Point:

Ground Surface

GORDON L HICKS III
Signature

2/7/2017
Date

Section 4

Groundwater Sample Log Sheets

RESOLUTION CONSULTANTS

Well ID: RE 115D1

Low Flow Ground Water Sample Collection Record

Client: Navy NWIRP Bethpage | Date: 3 / 16 / 17 | Time: Start 800 am/pm | Finish ____ am/pm

Project No: 60266526

Site Location: Ferris & Macwood

Weather Conds: sunny, cold, 25°, icy | Collector(s): Paul Kaneth

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

a. Total Well Length 660 ft | c. Length of Water Column ____ ft (a-b) | Casing Diameter/Material 4-inch PVC

b. Water Table Depth 30.76 ft | d. Calculated System Volume (see back) 9.8 gal. | 15 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	13946
LaMotte	2020	65222

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
915								600		
920		11.75	0.115	5.89	6.16	242				
930		12.11	0.097	2.64	5.81	201.1				
935		12.11	0.097	2.48	5.83	200.0	11.5	600	29.96	
940		11.94	0.123	2.17	6.36	130.2	6.62			
945		11.69	0.126	2.11	6.47	124.5				

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:

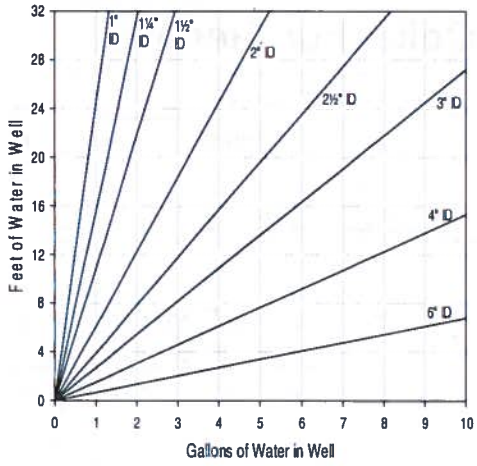
Method: Geotech bladder pump with drop tube assembly

Sample ID	Container Type	No. of Containers	Preservation	Analysis Req.	Time
RE115D1-66-031617	40-mL vials	3	HCl	VOCs	1030
	1-L amber	2	none	1,4-Dioxane	

Comments: MS/MSD

Signature: Paul Kaneth | Date: 3/16/17

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: RE1501 9:15

(continued from front)

Time (24 hr)	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
950	5gal	11.82	0.126	2.04	6.40	123.4	5.79	500	29.98	pump flow decreased, not sure why
955		12.00	0.129	2.00	6.43	122.4	3.97			
1000		12.20	0.130	2.02	6.41	125.1	3.52			
1005		12.19	0.129	1.92	6.44	119.7	3.84			
1010		12.39	0.132	1.84	6.48	120.7	3.61	600	30.01	
1015		12.35	0.130	1.77	6.48	119.2				
1020	10gal	12.33	0.132	1.73	6.47	119.0	4.16			
1030								260		Sample MS/MSD

RESOLUTION CONSULTANTS

Well ID: RE1502

Low Flow Ground Water Sample Collection Record

Client: Navy NWIRP Bethpage | Date: 3 / 16 / 17 | Time: Start 800 am/pm | Finish 1205 am/pm
Project No: 60266526
Site Location: Ferris & Main road
Weather Conds: Sunny cold, 25° icy | Collector(s): SC

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

a. Total Well Length 75.5 ft | c. Length of Water Column _____ ft (a-b) | Casing Diameter/Material 4-inch PVC
b. Water Table Depth 30.80 ft | 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% | - Turbidity ± 10% | - D.O. ± 10% (values >0.5 mg/L)
- pH ± 0.1 unit | - ORP ± 10mV | Remove a minimum 1 screen volume
- Conductivity ± 3% | - Drawdown < 0.3'

c. Field Testing Equipment used:

Make	Model	Serial Number
YSI	556	49024
Lamotte	2020	65722

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
0930										Start pump
0935		11.12	1.255	15.08	10.02	-102.9	47.8	550		no odor cloudy
0940		11.60	0.788	7.15	7.11	-60.1		550	30.85	cloudy no odor
0945		11.94	0.629	6.38	6.58	-53.3				
0950		11.72	0.611	6.37	6.48	-51.1	37.1	550	30.85	
0955		11.67	0.607	6.35	6.46	-51				

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:

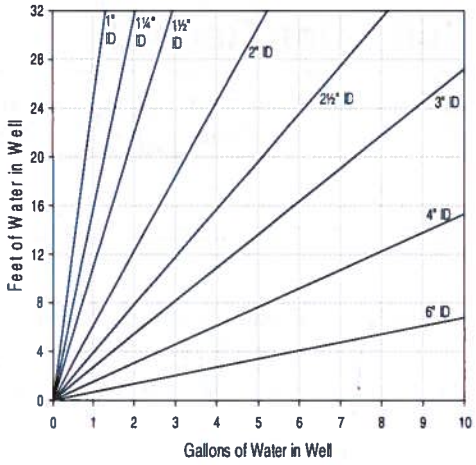
Method: Geotech bladder pump with drop tube assembly

Sample ID	Container Type	No. of Containers	Preservation	Analysis Req.	Time
RE1502-GW031617	40-mL vials	3	HCl	VOCs	1205
RE1502-GW031617	1-L amber	2	none	1,4-Dioxane	1205

Comments: time skip at ~~1100~~ 1005 → 1110 actual finish at 11:00

Signature: Sally Delage | Date: 3/16/17

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: RE115D2

(continued from front)

Time (24 hr)	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		11.91	0.569	6.11	6.32	-49.1	25.3	550	30.85	clear, no odor
1005	5G	11.89	0.546	5.94	6.28	-47.5		550		
1110		11.89	0.537	5.85	6.23	-45.3			30.35	
1115		12.01	0.529	5.55	6.18	-43.0	18.5	550		
1120		12.09	0.528	5.42	6.13	-38		550	30.85	
1125		12.10	0.528	5.15	6.17	-39.7	5.3			
1130		11.95	0.526	5.03	6.17	-39.3		550	30.85	
1135	10G	11.92	0.526	5.01	6.18	-40	4.7			
1140		12.05	0.525	4.93	6.18	-39.8		550		
1145		12.07	0.525	4.89	6.17	-38.9	4.3		30.85	
1150		12.15	0.523	4.88	6.16	-39.0				
1155		12.12	0.522	4.86	6.17	-38.7	4.5	550	30.85	
1200		12.12	0.523	4.86	6.16	-39.1		550	30.85	
1205			Sample time		12.05			200		

Section 5

Analytical Data Validation

[The Data Validation report included here contains only result tables for RE115D1 and RE115D2; for the complete March 2017 Quarterly Sampling Data Validation, see *March 2017 Groundwater Sampling Data Summary Report, Bethpage, NY*, Resolution Consultants, 2017.]

March 2017
Final Results after Data Review
NWIRP Bethpage OU 2 Regional Groundwater Investigation

		Sample Delivery Group		SK2106		
		Lab ID		SK2106-2		
		Sample ID		RE115D1-GW-031617		
		Sample Date		3/16/2017		
		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	6.1		
8260C	1,1,2-TRICHLOROETHANE	79-00-5	UG_L	0.55	J	
8260C	1,1-DICHLOROETHANE	75-34-3	UG_L	0.5	U	
8260C	1,1-DICHLOROETHENE	75-35-4	UG_L	2.2		
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	1.3	J	
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	10		
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	U	
8260C	CARBON TETRACHLORIDE	56-23-5	UG_L	1.8		
8260C	CHLOROBENZENE	108-90-7	UG_L	0.5	U	
8260C	CHLOROETHANE	75-00-3	UG_L	1	U	
8260C	CHLOROFORM	67-66-3	UG_L	1.3		
8260C	CHLOROMETHANE	74-87-3	UG_L	0.88	J	
8260C	CIS-1,2-DICHLOROETHENE	156-59-2	UG_L	1.3		
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	1.4	J	c
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	U	
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	86		
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	8.2	J	m

Notes:

UG_L = Micrograms per liter
NA = Not applicable
Qual = Final qualifiers (See Attachment A)
RC = Reason codes (See Attachment B)

March 2017
Final Results after Data Review
NWIRP Bethpage OU 2 Regional Groundwater Investigation

			Sample Delivery Group	SK2106		
			Lab ID	SK2106-3		
			Sample ID	RE115D2-GW-031617		
			Sample Date	3/16/2017		
			Sample Type	Groundwater		
Method	**Analyte**	**CAS No**	**Units**	Result	Qual	RC
8260C	1,1,1-TRICHLOROETHANE	71-55-6	UG_L	0.64	J	
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	18		
8260C	1,1,2-TRICHLOROETHANE	79-00-5	UG_L	0.75	J	
8260C	1,1-DICHLOROETHANE	75-34-3	UG_L	0.75	J	
8260C	1,1-DICHLOROETHENE	75-35-4	UG_L	5.5		
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	2.4		
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	8.9		
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	U	
8260C	CARBON TETRACHLORIDE	56-23-5	UG_L	1.5		
8260C	CHLOROBENZENE	108-90-7	UG_L	0.5	U	
8260C	CHLOROETHANE	75-00-3	UG_L	1	U	
8260C	CHLOROFORM	67-66-3	UG_L	0.9	J	
8260C	CHLOROMETHANE	74-87-3	UG_L	0.4	J	
8260C	CIS-1,2-DICHLOROETHENE	156-59-2	UG_L	2.4		
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	UJ	c
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	U	
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	0.27	J	
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	230		
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	6.8		

Notes:

UG_L = Micrograms per liter
NA = Not applicable
Qual = Final qualifiers (See Attachment A)
RC = Reason codes (See Attachment B)

Attachment A
Final Qualifier Codes and Explanations

Qualifier	Explanation
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
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 quantitation limit necessary to accurately and precisely measure the analyte in the sample.
U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

Attachment B
Reason Codes and Explanations

Reason Code	Explanation
be	Equipment blank contamination
bf	Field blank contamination
bl	Laboratory blank contamination
bm	Missing Blank Information
bt	Trip blank contamination
c	Calibration issue
cr	Chromatographic resolution
d	Reporting limit raised due to chromatographic interference
dt	Dissolved result > total over limit
e	Ether interference
ej	Above calibration range; result estimated.
f	Presumed contamination from FB or ER.
fd	Field duplicate RPDs
h	Holding times
hs	Headspace greater than 6mm in all sample vials
i	Internal standard areas
ii	Injection internal standard area or retention time exceedance
it	Instrument Tune
k	Estimated Maximum Possible Concentrations (EMPC)
l	LCS recoveries
lc	Labeled compound recovery
ld	Laboratory duplicate RPDs (matrix duplicate, MSD, LCSD)
lp	Laboratory control sample/laboratory control sample duplicate RPDs
m	Matrix spike recovery
mc	Deviation from the method
md	MS/MSD precision
nb	Negative laboratory blank contamination
p	Chemical preservation issue
p-h	Uncertainty near detection limit (< Reporting Limit), historical reason code applied.
pe	Post Extraction Spike
q	Quantitation issue
r	Dual column RPD
rt	SIM ions not within + 2 seconds
s	Surrogate recovery
sp	Sample preparation issue
su	Evidence of ion suppression
t	Temperature Preservation Issue
x	Low % solids
y	Serial dilution results
z	ICS results

DATA VALIDATION REPORT

Project:	Regional Groundwater Investigation — NWIRP Bethpage	
Laboratory:	Katahdin Analytical	
Sample Delivery Groups:	SK0515	
Analyses/Method:	Total Organic Carbon (TOC) by U.S. EPA SW-846 Method 9060A	
Validation Level:	2	
Project Number:	0888812477.SA.DV	
Prepared by:	Dana Miller/Resolution Consultants	Completed on: 02/15/2017
Reviewed by:	Tina Clemmey/Resolution Consultants	File Name: SK0515_9060A

SUMMARY

This report summarizes data review findings for samples listed below, collected by Resolution Consultants from the Regional Groundwater Investigation — NWIRP Bethpage site on17 January 2017 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
RE115D1-EB-011717	SK0515-1	Equipment Blank	9060A
RE115D1-SO-011717-643-645	SK0515-2	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), *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
✓	Laboratory Duplicate
NA	Field Duplicate
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

Field blanks help determine how much, if any, contamination was introduced in the field. Laboratory 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. Because blank samples may not be prepared using the same sample weight, volume, or dilution, those variables were considered when using the blank criteria. All field and laboratory blanks were flagged in accordance with *Functional Guidelines* (shown below) where detections were not believed to be site-related.

Blank Non-conformance Charts:

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.

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. 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 Table
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 Sample	Qualifier
WG199332-1SK0515	WG199332	9060A	Total Organic Carbon	0.60	1	RE115D1-EB-011717	U

Notes:
ID = Identification
MG_L = Milligrams per liter
LOQ = Limit of quantitation
U = The analyte was qualified as undetected during data review due to lab blank

Attachment B
Final Results after Data Review

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

		Sample Delivery Group		SK0515			SK0515		
		Lab ID		SK0515-1			SK0515-2		
		Sample ID		RE115D1-EB-011717			RE115D1-SO-011717-643-645		
		Sample Date		1/17/2017			1/17/2017		
		Sample Type		Equipment Blank			Soil		
Method	**Analyte**	**CAS No**	**Units**	Result	Qual	RC	Result	Qual	RC
2540G	TOTAL SOLIDS	-29	PCT	NA			84		
9060A	TOTAL ORGANIC CARBON	-28	MG_L	0.5	U	bl	NA		
9060A	TOTAL ORGANIC CARBON	-28	UG_G	NA			520		

Notes:
ID = Identification
Qual = Final qualifier
RC = Reason code
PCT = Percent
MG_L = Milligrams per liter
UG_G = Micrograms per gram
NA = Not analyzed

Final Qualifier:
U = **Undetected** – The analyte was qualified as undetected during data review due to blank artifacts.

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:	TJ0244	
Analyses/Method:	Total Organic Carbon (TOC) by U.S. EPA SW-846 Method 9060A	
Validation Level:	2	
Project Number:	0888812477.SA.DV	
Prepared by:	Dana Miller/Resolution Consultants	Completed on: 02/15/2017
Reviewed by:	Tina Clemmey/Resolution Consultants	File Name: TJ0244_9060A

SUMMARY

This report summarizes data review findings for samples listed below, collected by Resolution Consultants from the Regional Groundwater Investigation — NWIRP Bethpage site on 2 December 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
RE115D2-SOIL-120216-733-735	TJ0244-1	Soil	9060A, 2540G
RE115D2-EB-120216	TJ0244-2	Equipment Blank	9060A

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), *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

Field blanks help determine how much, if any, contamination was introduced in the field. Laboratory 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. Because blank samples may not be prepared using the same sample weight, volume, or dilution, those variables were considered when using the blank criteria. All field and laboratory blanks were flagged in accordance with *Functional Guidelines* (shown below) where detections were not believed to be site-related.

Blank Non-conformance Charts:

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 Table

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
WG196689-1-TJ0244	WG196689	9060A	Total Organic Carbon	0.19	1	RE115D2-EB-120216	U

Notes:

ID = Identification
MG_L = Milligrams per liter
LOQ = Limit of quantitation
U = The analyte was qualified as undetected during data review due to lab blank

Attachment B
Final Results after Data Review

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

		Sample Delivery Group		TJ0244			TJ0244		
		Lab ID		TJ0244-1			TJ0244-2		
		Sample ID		RE115D2-SOIL-120216-733-735			RE115D2-EB-120216		
		Sample Date		12/2/2016			12/2/2016		
		Sample Type		Soil			Equipment Blank		
Method	**Analyte**	**CAS No**	**Units**	Result	Qual	RC	Result	Qual	RC
2540G	TOTAL SOLIDS	-29	PCT	85			NA		
9060A	TOTAL ORGANIC CARBON	-28	MG_L	NA			0.5	U	bl
9060A	TOTAL ORGANIC CARBON	-28	UG_G	320	J		NA		

Notes:
ID = Identification
Qual = Final qualifier
RC = Reason code
PCT = Percent
MG_L = Milligrams per liter
UG_G = Micrograms per gram
NA = Not analyzed

Final Qualifier:
U = **Undetected** – The analyte was qualified as undetected during data review due to blank artifacts.
J = **Estimated Value** –The analyte concentration was less than the limit of quantitation.

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

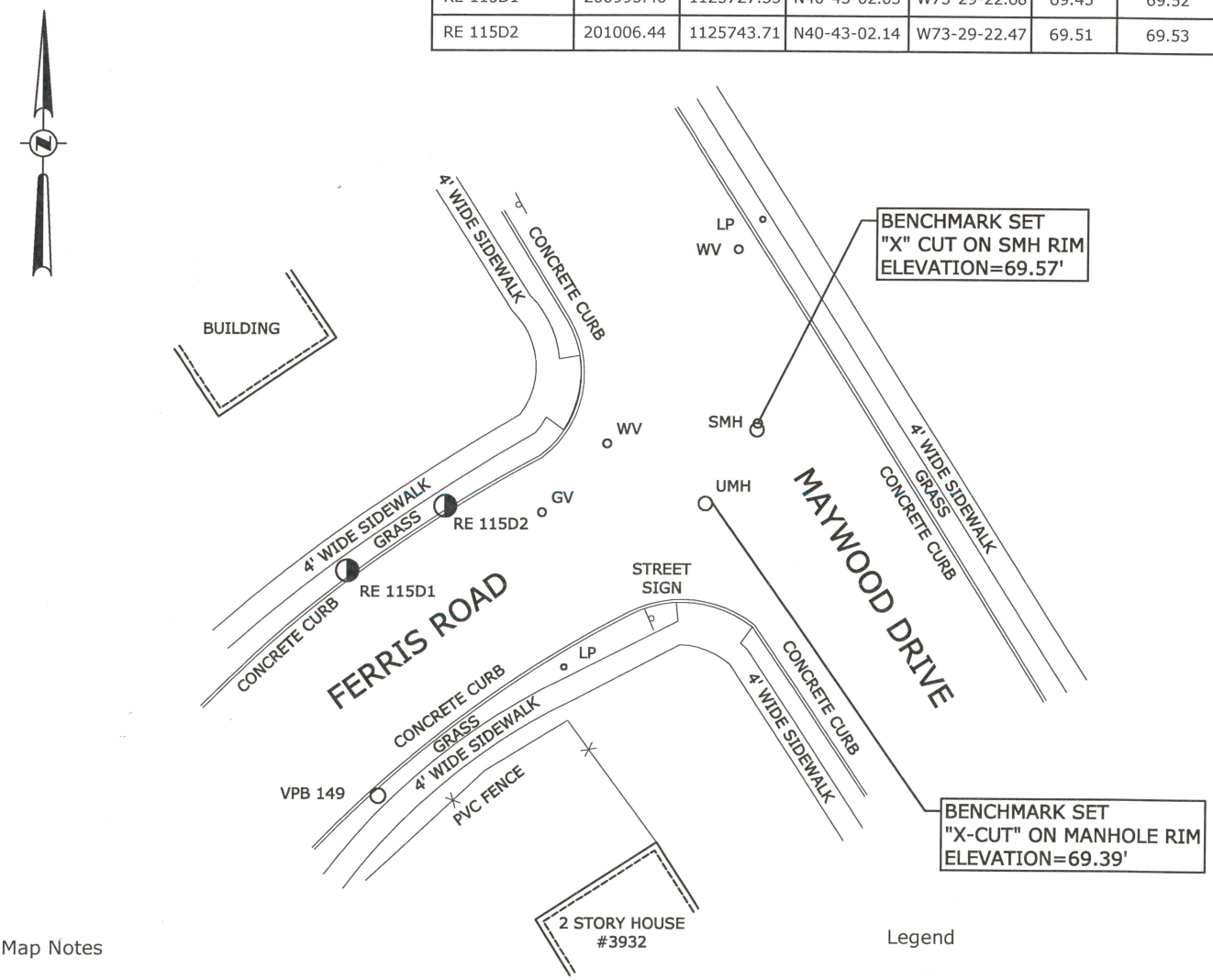
Section 6

Survey

NONE :XREFS

UNAUTHORIZED ALTERATION OR ADDITION TO THIS DOCUMENT IS A VIOLATION OF SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW.

Description	Northing	Easting	Latitude	Longitude	Ground	Top of Casing	PVC
VPB 149	200957.25	1125732.79	N40-43-01.66	W73-29-22.61	69.38	NA	NA
RE 115D1	200995.46	1125727.35	N40-43-02.03	W73-29-22.68	69.45	69.52	69.01
RE 115D2	201006.44	1125743.71	N40-43-02.14	W73-29-22.47	69.51	69.53	69.01



Map Notes

1. Information shown hereon was compiled from an actual field survey conducted from December 9, 2014 and field updated on March 20, 2017.
2. North orientation is Grid North based on the New York State Plane Coordinate System, Long Island Zone, NAD 83(2011) epoch 2010.00 as obtained from GPS observations.
3. Vertical datum shown hereon is NAVD 88(Geoid12A) as obtained from RTK GPS observations using the Queens CORS as a base station.

BAR SCALE

30 0 15 30 60

1 inch = 30 ft.

Legend

o	GV	Gas Valve
o	LP	Light Post
◑	RE 115D2	Monitor Well
	PVC	Poly Vinyl Chloride
		Sign
O	UMH	Unknown Manhole
O	VPB 149	Vertical Profile Boring
o	WV	Water Valve

DWG NO. 14-643

Date	RECORD OF WORK	Appr.
3/20/17	SURVEY UPDATE/NEW MONITOR WELLS ADDED	wjf

STATE OF NEW YORK WILLIAM J. FLYNN 049513 LICENSED LAND SURVEYOR

Drafter: LMK Checker: JFC

Appr. by: JFC Proj. No. 14.4121

VERICAL PROFILE BORING 149 SURVEY LOCATION
FERRIS ROAD

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

SCALE: 1"=30' DATE: DEC. 09, 2014

CAD DWG. FILE NAME: K:\Projects\144121\Survey\Drawings and Maps\2017 DRAWINGS\2017 VPB 149 Elm Dr._Elbow Ln.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 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 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).

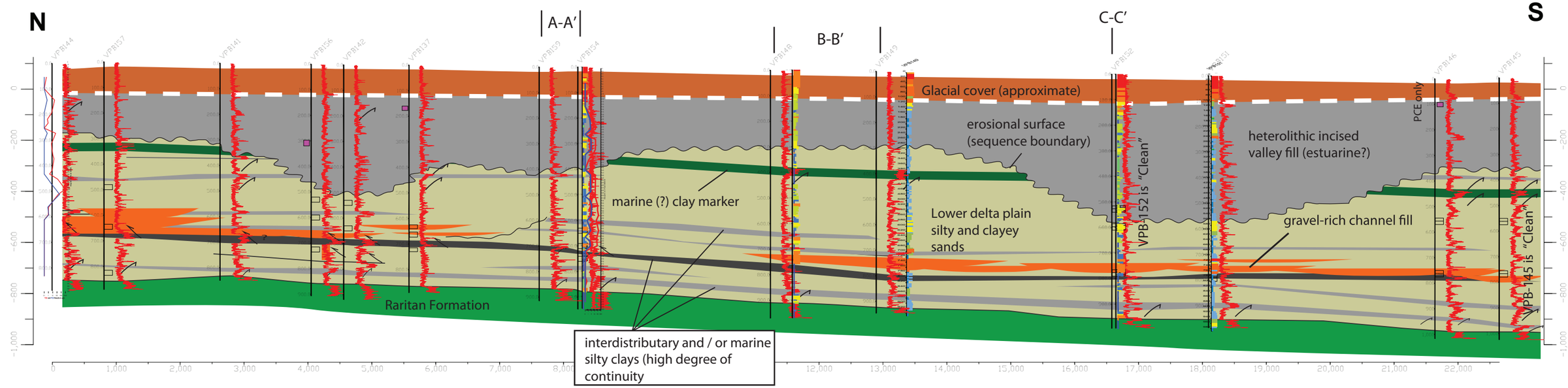
Logs of natural gamma emissions are a common proxy for grainsize. They typically are used as a correlation aide because repetitive spatially extensive trends in grainsize are easily identified visually when curves are examined along a given section. In non-granitic aquifer material, the chemistry of 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 technical 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 VPB139 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



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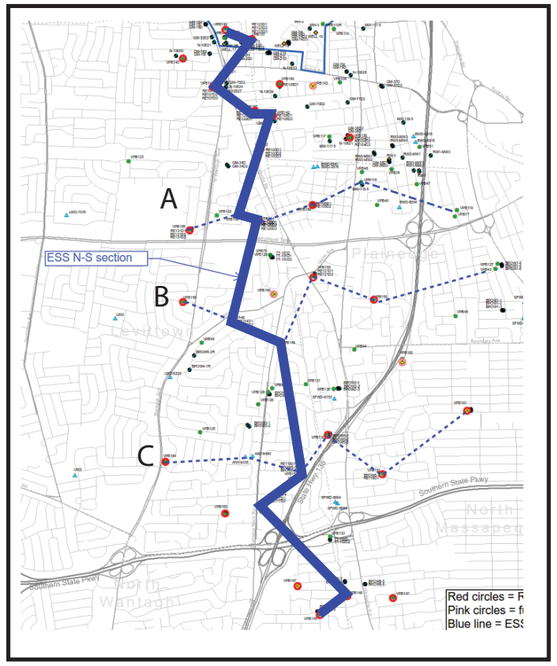


Figure 1. Cross Section N-S

A – A′

West

A

intersection with N-S

VPB-165 VPB-159 VPB-154 VPB-139 BWD 6-1 BWD 6-2 VPB-118 VPB-46 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

Natural Gamma in CPS

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

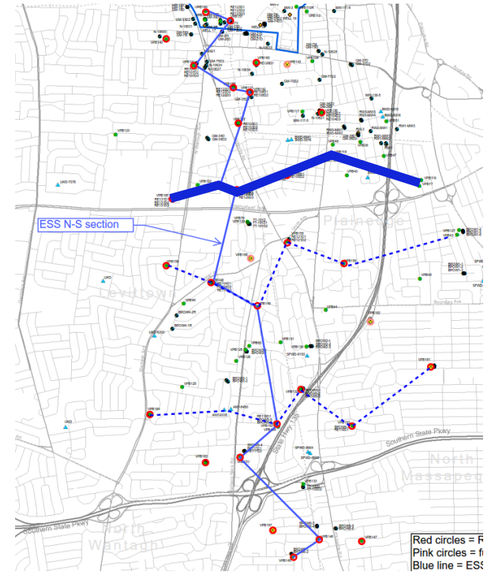
Glacial cover (approximate)

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



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- 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

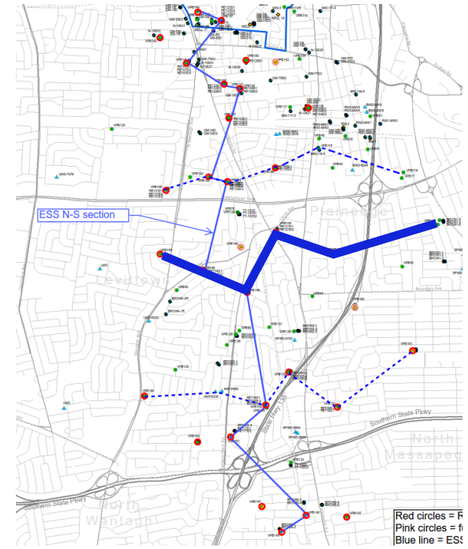

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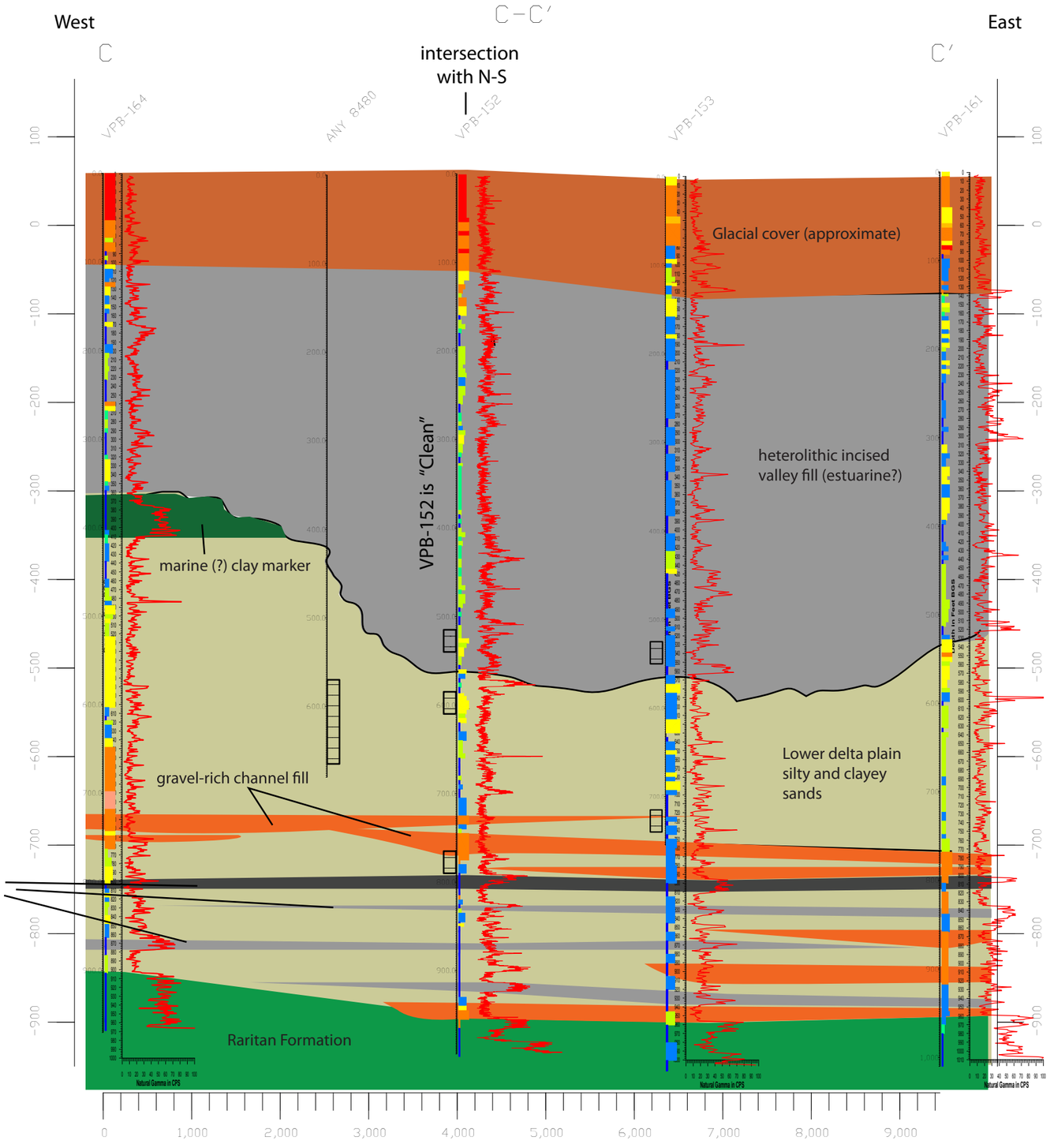
Figure 3. Cross Section B-B’



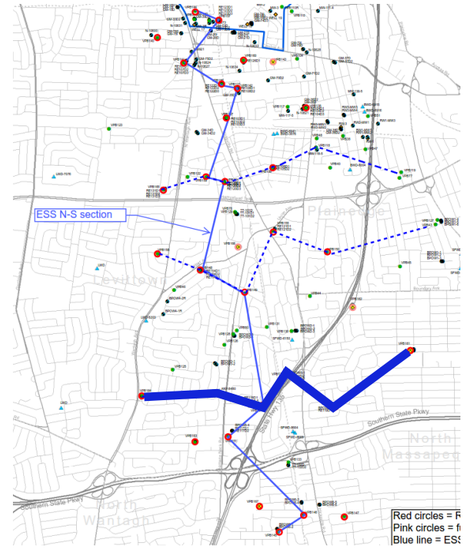


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Figure 4. Cross Section C-C’

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