2012 - 2013 OU2 GROUNDWATER INVESTIGATION
VPB 137, 138, 139
BETHPAGE, NY

Prepared for:

Department of the Navy
Naval Facilities Engineering Command, Mid-Atlantic
9742 Maryland Ave.
Norfolk, VA 23511-3095

Comprehensive Long-Term Environmental Action Navy
Contract Number N62470-11-D-8013

CTO WE15

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List of Acronyms and Abbreviations

AOC	Area of Concern
bgs	below ground surface
BWD	Bethpage Water District
Delta	Delta Well and Pump, Inc.
DoD	Department of Defense
DOT	Department of Transportation
ELAP	Environmental Laboratory Accreditation Program
EPA	Environmental Protection Agency, United States
ft	feet
GOCO	Government-Owned Contractor-Operated
IDW	Investigation Derived Waste
IR	Installation Restoration
Katahdin	Katahdin Analytical Services, Inc
NAVD	North American Vertical Datum
NAVFAC	Naval Facilities Engineering Command
NG	Northrop Grumman
NTUs	Nephlometric Turbidity Units
NWIRP	Naval Weapons Industrial Reserve Plant
NYSDEC	New York State Department of Environmental Conservation
OU	Operable Unit
PCBs	Polychlorinated Biphenyls
PCE	Tetrachloroethene
PID	Photoionization Detector
POTW	Publicly Owned Treatment Works
PPE	Personal Protective Equipment
PVC	Polyvinylchloride
SVOC	Semivolatile Organic Compounds
TCE	Trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Total Organic Carbon
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
VPB	Vertical Profile Boring

1.0 PROJECT BACKGROUND

Resolution Consultants has prepared this Summary Report for the Naval Facilities Engineering Command, Mid-Atlantic under contract task order WE15 Contract N62470-11-D-8013. The report describes vertical profile boring (VPB) and monitoring well installation activities in 2012 and 2013 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 data summary report provides information on the installation of three VPBs (137, 138, and 139) and eight associated monitoring wells. The purpose of this investigation was to address data gaps south of the On-site Containment Treatment system (ONCT). VPB and monitoring well locations are shown in Figure 2, and TCE concentrations for the shallow (<300 ft bgs) and deep (>300 ft bgs) groundwater incorporating the new data are shown in Figures 3 and 4. Additionally, Figures 5 and 6 present cross sections G-G' and H-H' through the site which incorporate the new lithologic and analytical data. VPBs 137, 138, and 139 were completed to 890, 935 and 965 feet (ft) below ground surface (bgs), respectively. The data from these VPBs provides information on the extent and magnitude of VOCs near Bethpage Water District Plant #6, and to a certain extent helps ascertain the effectiveness of the on-site groundwater treatment system.

Field tasks were conducted between October 2012 and October 2013 in accordance with the *United Federal Programs Sampling and Analysis Plan*, Bethpage, New York (Resolution Consultants, 2013). In addition, the work adhered to the following UFP SAP Addendums: Groundwater Sampling Using Low Stress (Low Flow) Purging and Sampling Protocol (Resolution Consultants, 2013) and Installation of Vertical Profile Borings and Monitoring Wells (Resolution Consultants, 2013). The field investigation included completing three vertical profile borings and eight monitoring wells, groundwater sampling, geophysical logging and surveying.

Documentation of these activities is included in the appendices of this report. Appendix A contains the summary packet for VPB 137 and associated wells RE103D1, RE103D2, RE103D3, Appendix B contains the summary packet for VPB 138 and associated wells RE104D1, RE104D2, RE104D3, Appendix C contains the summary packet for VPB 139 and associated wells RE105D1, RE105D2, and Appendix D contains the summary packet for Investigation Derived Waste (IDW).

1.2 Site History

NWIRP Bethpage is located in east-central Nassau County, Long Island, New York, approximately 30 miles east of New York City (Figure 1).

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 the 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 Nassau County property. Access to the NWIRP is from South Oyster Bay Road.

1.3 Geology and Hydrogeology

Overburden at the site consists of approximately 1,000 ft of glacial 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, 1990); these deposits form the Upper Glacial Aquifer. Directly underlying this unit is the Magothy Formation with a thickness of 650 to 850 ft bgs observed onsite. 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 875 ft bgs; these deposits form the Magothy Aquifer

The Raritan Clay is encountered at NWIRP at a depth of approximately 700 to 900 ft bgs. 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 member 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, and 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 zone is a basal gravel located at or near the contact with the Raritan. 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 on 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.

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 regional groundwater flow in the area is to the south southeast.

2.0 FIELD PROGRAM

Field investigation activities consisted of the drilling, sampling, soil/groundwater analysis, geophysical logging and surveying of three vertical profile borings and eight monitoring wells. Drilling during this investigation was performed by Delta Well and Pump Co., of Ronkonkoma, New York. A description of these tasks is provided below.

2.1 Vertical Profile Borings

Three vertical profile borings (VPB 137, VPB 138 and VPB 139) were completed during this field effort between November 2012 and August 2013. Depths of VPB 137, VPB 138 and VPB 139 were 890 ft, 935 ft and 965 ft, respectively. Locations are shown on Figure 2 and on cross sections GG' and HH' on Figures 5 and 6, respectively. Details are summarized on Table 1.

2.1.1 Drilling

VPBs were installed by drilling an 8-inch diameter hole via a mud rotary drilling techniques. Drilling mud consisted of potable water and polymer-free sodium bentonite or equivalent. Drilling mud was contained and re-circulated in baffled, high capacity mud tubs. A sand separator was used intermittently to remove fines from circulation.

2.1.2 Sampling

For each vertical profile boring, up to 10 split spoon samples were collected from ground surface to a depth of 800 ft when a change in geology was observed. Below 800 ft, confirmation of the Raritan Clay formation was based on five consecutive split spoon samples retrieving clay. Samples were logged by the field geologist and screened for volatile organic compounds (VOCs) utilizing a photoionization detector (PID). Detailed boring logs for each VPB are included in Appendices A, B and C.

Groundwater samples were collected every 50 ft for the first 200 ft of borehole depth. After the first 200 ft, groundwater samples were collected every 20 ft until the boring terminated in the Raritan. Groundwater samples were collected with a hydropunch sampler and analyzed for VOCs by Environmental Protection Agency (EPA) Method 8260B by Katahdin Analytical Services, a Department of Defense Environmental Laboratory Accreditation Program (ELAP) accredited laboratory and NYSDEC-certified laboratory. During the collection of groundwater samples, typical field parameters were measured (pH, temperature, specific conductivity, turbidity etc.). Data validation was performed by Resolution Consultants. Groundwater sample logs, data validation packages and analytical data tables are included in Appendices A, B and C.

One soil sample was collected per VPB for laboratory analysis for total organic carbon (TOC) by EPA series SW-846 method 9060A. All analyses were performed or subcontracted by Katahdin Analytical Services. During drilling, a Community Air Monitoring Program was performed; one air sample was collected per VPB using SUMMA canisters and submitted for laboratory analysis by EPA Method TO-15 by Katahdin Analytical Services, a DoD ELAP accredited laboratory. Data validation of both TOC and air data was performed by Resolution Consultants. Data validation packages and analytical data tables are included in Appendices A, B and C.

2.1.3 Geophysics

Borehole geophysical logs were recorded for each VPB after drilling tools were withdrawn from the borehole. A Mount Sopris Instrument model 2PGA-100 poly gamma was used. Starting at the top of the hole, the probe was advanced at a maximum rate of 15 ft per minute. A copy of the log was printed in the field for review once the probe reached the bottom of the borehole. The instrument was then raised to the top of the boring and a second log was generated and printed in the field. The gamma log sheets and plots comparing the gamma log with trichloroethene (TCE) and tetrachloroethene (PCE) concentrations from hydropunch samples are included in the Summary Packet reports. At the completion of the geophysical logging at each VPB, the geologist log, the geophysical log, and the hydropunch groundwater samples (Appendices A, B, C) were compiled together and optimal well screen intervals were selected for the installation of monitoring wells.

2.2 Monitoring Wells

Eight monitoring wells were installed at the site of the three vertical profile borings between January and September 2013. Depths of monitoring wells ranged from 375 feet to 785 feet. Locations are shown on Figure 2 and on cross sections GG' and HH', Figures 5 and 6, respectively.

2.2.1 Drilling and Well Construction

The wells were installed using mud rotary drilling techniques. Well construction details are summarized Table 2. Boring logs with lithologic descriptions of the well screen interval are included in Appendices A, B and C.

Prior to installing each monitoring well, screen intervals were determined from the results of the groundwater samples, the geophysical logs, lithology and field data from the vertical profile borings. Screens were selected based on several goals: to monitor the depth interval of the highest VOC concentrations observed in hydropunch data and to monitor depths of interest to BWD Plant 6 wells: 6-1 (330 – 380 ft bgs) and 6-2 (700-735 and 750-770 ft bgs).

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 TOC via USEPA series SW-846 method 9060A by Katahdin. Data validation of TOC data was performed by Resolution Consultants. Data validation packages and analytical data tables are included in Appendices A, B and C.

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 Appendices A, B and C.

2.2.2 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, mechanical 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 nephlometric turbidity units (NTUs) if possible. Table 3 summarizes total pumped volume from air and pump development and final turbidity. Well development logs are included in Appendices A, B and C.

2.2.3 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 with a submersible pump with the 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 and turbidity. Groundwater analytical samples were collected when water quality parameters stabilized. Samples were analyzed for VOCs via method 8260B by Katahdin. All development and purge water was managed as investigation derived waste (IDW). Groundwater sample logs, data validation packages and analytical data tables are included in Appendices A, B and C.

2.3 Decontamination and Investigation Derived Waste (IDW)

Resolution Consultants utilized dedicated and disposable sampling equipment when possible to avoid the potential for cross-impacting of samples. The sampling equipment included dedicated plastic scoops, disposable Teflon or polyethylene tubing, disposable gloves, and laboratory supplied sample bottles. Hand held equipment, split spoons and the hydropunch were decontaminated using an alconox and water wash, a potable water rinse followed by a distilled water rinse. Water was collected in 5-gallon pails or 55-gallon drums and transported to the frac tank.

The investigation waste (consisting of soil cuttings, drilling muds, IDW fluids and personal protective equipment (PPE)) generated during the borings and well installations was containerized and staged at NWIRP Bethpage. All IDW was characterized and disposed of properly. The representative samples from each roll off were submitted to Katahdin for analysis of:

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

Purge water and well development water was containerized in frac tanks and stored at NWIRP Bethpage for characterization and ultimate disposal to the 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 and pH via method SW 9040B (all waters); Both water and soil was transported from point of generation to the designated staging area at NWIRP in Department of Transportation (DOT) approved 55-gallon drums or similarly appropriate containers. To the extent feasible, soil and water was not mixed.

All analytical criteria were met for disposal of soil and water. Table 4 provides a summary of IDW management and documentation is included in Appendix D.

2.4 Surveying

A survey of the borings and well locations was conducted at the end of the fieldwork by GEOD Corp of Newfoundland, New Jersey, under the direct supervision of Resolution Consultants. The locations were tied into the existing base map developed for this investigation. The vertical locations were surveyed to a reference point determined in the field with a vertical accuracy of 0.01 foot. All elevations were referenced to the North American Vertical Datum (NAVD) 1988. The horizontal locations of each point were established from directly measuring from fixed Site features (such as curbs, light poles, etc) with an accuracy of 0.1 foot.

A table of survey data (ground, top of casing, PVC, latitude/longitude and northing/easting) and a survey map are included in Appendices A, B and C.

3.0 REFERENCES

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

Naval Facilities Engineering Command (NAVFAC), 2003. *Record of Decision Naval Weapons Industrial Reserve Plant Bethpage, New York, Operable Unit 2 – Groundwater*, NYS Registry: 1-30-003B. April.

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Resolution Consultants, 2013. UFP SAP Addendum, *Groundwater Sampling Using Low Stress (Low Flow) Purging and Sampling* Protocol. November.

Resolution Consultants, 2013. UFP SAP Addendum*, Installation of Vertical Profile Borings and Monitoring Wells.* December.

Smolensky, D., and Feldman, S., 1990. *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
VERTICAL PROFILE BORING SUMMARY
2012 TO 2013 OU2 GROUNDWATER INVESTIGATIOIN
NWIRP BETHPAGE, NY

BORING	BORING START DATE	BORING COMPLETION DATE	GROUND ELEVATION (MSL)	TOTAL DEPTH (ft bgs)	SURFACE CASING SET AT (ft bgs)	NO. OF SPOON SAMPLES	GAMMA LOG (ft bgs)	NO. GW SAMPLES COLLECTED/ ATTEMPTED	TOC SAMPLES	DATE OF AIR SAMPLE	MONITORING WELLS INSTALLED AT LOCATION
VPB 137	11/6/2012	12/18/2012	93.77	890	55	18	889	29 / 39	1 (678 - 680 ft bgs)	12/7/2012	RE103D1, RE103D2, RE103D3
VPB 138	3/7/2013	4/26/2013	89.98	935	55	11	935	37 / 45	1 (743 - 745 ft bgs)	4/1/2013	RE104D1, RE104D2, RE104D3
VPB 139	6/26/2013	8/15/2013	87.50	965	55	11	962.7	36 / 43	1 (638 - 640 ft bgs)	7/18/2013	RE105D1, RE105D2

Vertical Profile Borings
137, 138, 139

TABLE 2
MONITORING WELL CONSTRUCTION SUMMARY
2012 TO 2013 OU2 GROUNDWATER INVESTIGATION
NWIRP BETHPAGE, NY

February 2014

MONITORING WELL	ADJACENT VPB	WELL COMPLETION DATE	GROUND ELEVATION (MSL)	WELL DEPTH (ft bgs)	CASING DEPTH (ft bgs)	SCREEN INTERVAL (ft bgs)	SUMP DEPTH INTERVAL (ft bgs)	BORING DEPTH (ft bgs)
RE103D1	VPB 137	2/28/2013	93.80	645	55	625 - 640	640 - 645	647
RE103D2		2/4/2013	93.63	673	55	653 - 673	none	676
RE103D3		1/18/2013	93.74	735	55	715 - 730	730 - 735	743
RE104D1	VPB 138	6/20/2013	90.53	375	55	350 - 370	370 - 375	388
RE104D2		6/6/2013	90.79	735	55	710 - 730	730 - 735	747
RE104D3		5/15/2013	90.87	785	55	760 - 780	780 - 785	801
RE105D1	VPB 139	9/20/2013	87.23	555	55	530 - 550	550 - 555	567
RE105D2		9/5/2013	87.18	755	55	730 - 750	750 - 755	767

TABLE 3
MONITORING WELL DEVELOPMENT SUMMARY
2012 TO 2013 OU2 GROUNDWATER INVESTIGATION
NWIRP BETHPAGE, NY

MONITORING WELL	ADJACENT VPB	AIR DEVELOPMENT		PUMP DEVELOPMENT			APPROX. TOTAL DEVELOPMENT VOLUME (GAL)	FINAL TURBIDITY (NTUs)
		DATE	APPROX. VOLUME (GAL)	DATE	FINAL PUMP DEPTH (FT)	APPROX. VOLUME (GAL)		
RE103D1	VPB 137	3/7/2013	4000	3/8/2013	90	4000	8000	2.17
RE103D2		3/6/2013	4000	3/11/2013	90	4000	8000	7.46
RE103D3		3/5/2013	4000	3/12/2013	90	5000	9000	36.32
RE104D1	VPB 138	7/11/2013	5000	7/12/2013	370	3000	8000	20.2
RE104D2		7/10/2013	4000	7/15/2013	730	4000	8000	39.2
RE104D3		7/9/13, 7/16/13	5500	7/17/2013	780	3500	9000	34.8
RE105D1	VPB 139	9/26/2013	5500	10/1/2013	545	4200	9700	1.05
RE105D2		9/25/2013	5500	9/30/2013	745	3300	8800	3.19

TABLE 4
INVESTIGATION DERIVED WASTE SUMMARY
2012 TO 2013 OU2 GROUNDWATER INVESTIGATIOIN
NWIRP BETHPAGE, NY

Roll off #	Sample date	Sample ID	Lab SDG	Date manifested offsite	Manifest No.
9700	1/18/2013, 4/18/2013	IDWS 011813,IDWS041813-9700	SG0450,SG2572	7/28/2013	16964
0010	1/18/2013, 4/18/2013	IDWS 011813, IDWS041813-0010	SG0450,SG2572	7/29/2013	16963
9607	1/18/2013, 6/27/2013	IDWS 011813, IDWS-062713-9607	SG0450, SG4526	7/30/2013	16965
9650	6/27/2013	IDWS-062713-9650	SG4526	8/1/2013	16966
0417	7/31/2013	IDW-S-073113	SG5569	9/19/2013	16968
0406	7/31/2013	IDW-S-073113	SG5569	9/19/2013	16969
9893	7/31/2013	IDW-S-073113	SG5569	9/20/2013	16967
0812	10/15/2013	IDW-SOIL-20131015	SG8068	11/8/2013	16970
0312	10/15/2013	IDW-SOIL-20131015	SG8068	11/8/2013	20703

Container type	Sample date	Sample ID	Lab SDG	Date discharged to WWTP	Volume discharged (gal)	Source of water
Frac tank 1	3/6/2013	IDWGW-030613	SG1506	3/14/2013	21000	drilling water
Tanker	3/12/2013	IDWGW-031213	SG1611	3/14/2013	6000	development water
Drums	3/6/2013	IDWGW-030613	SG1506	3/14/2013	1000	rolloff water
Frac tank 2	3/12/2013	IDWGW-031213	SG1611	3/20/2013	19000	development water
Frac tank 1	6/12/2013, 6/28/2013	IDWGW-061213, IDWGW-062813-FRAC TANK1	SG4081, SG4591	7/8/2013	21600	drilling water
Frac tank 2	6/27/2013	IDWGW-062713-FRAC TANK #2	SG4526	7/8/2013	14600	development water
Frac tank 2	7/17/2013	IDW-GW-7-17-13	SG5068	7/24/2013	19500	development water
Frac tank 1	8/19/2013	IDWGW-081913-FRACTANK1	SG6217	9/5/2013	15400	drilling water
Frac tank 1	9/30/2013	IDWGW-093013-FRACTANK1	SG7520	10/9/2013	6500	drilling water
Frac tank 2	10/31/2013	IDWGW-103113-FRACTANK2	SG8534	11/15/2013	11200	development water

Figures

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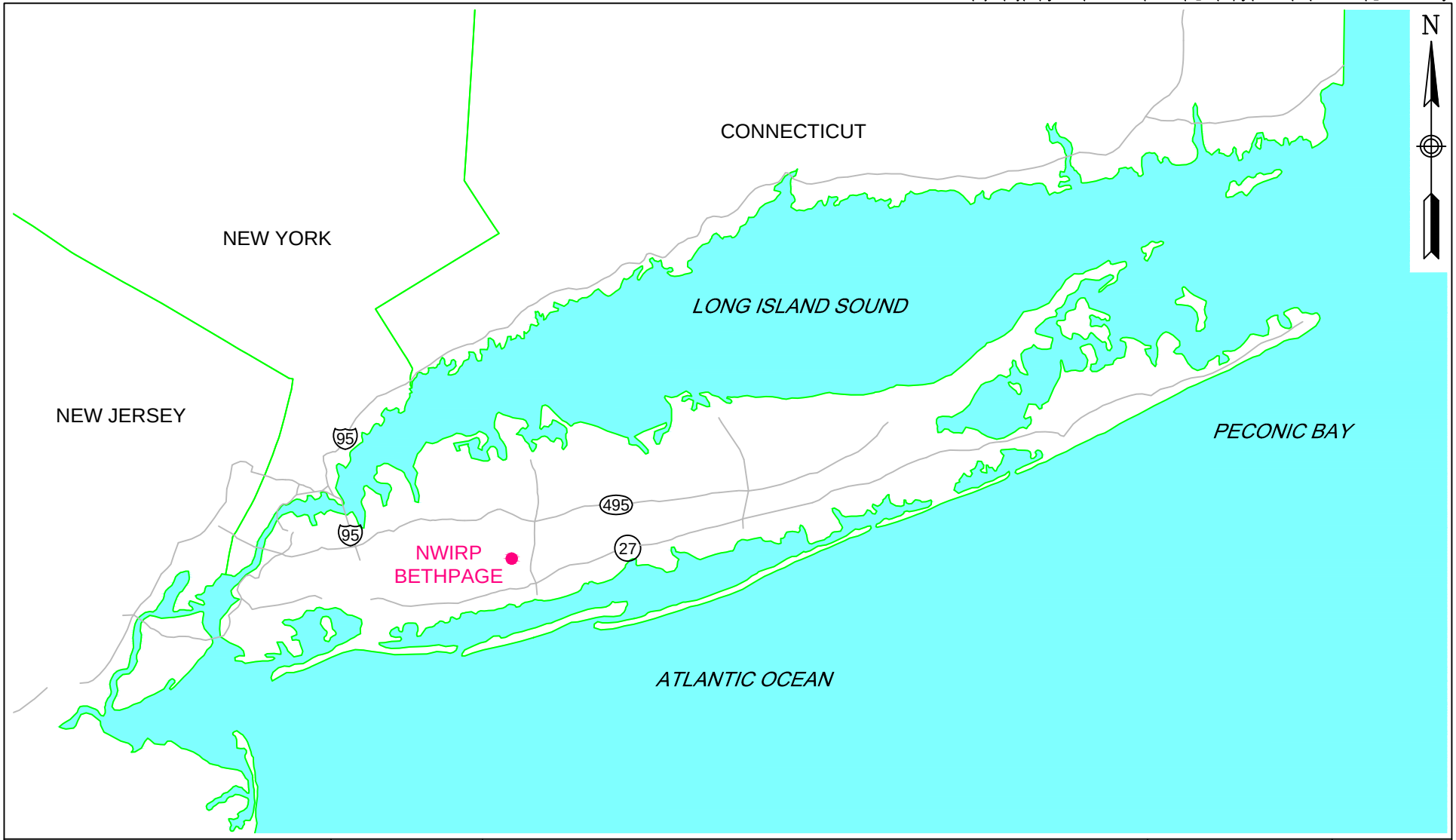

0 15 30

SCALE IN MILES

NAVFAC

GENERAL LOCATION MAP
NWIRP BETHPAGE
BETHPAGE, NEW YORK

CONTRACT NUMBER	CTO NUMBER
N62470-11-D-8018	WXE08
APPROVED BY: EV	DATE: 12/04/2013
APPROVED BY: --	DATE: --
FIGURE NO.: 1	REV: 0

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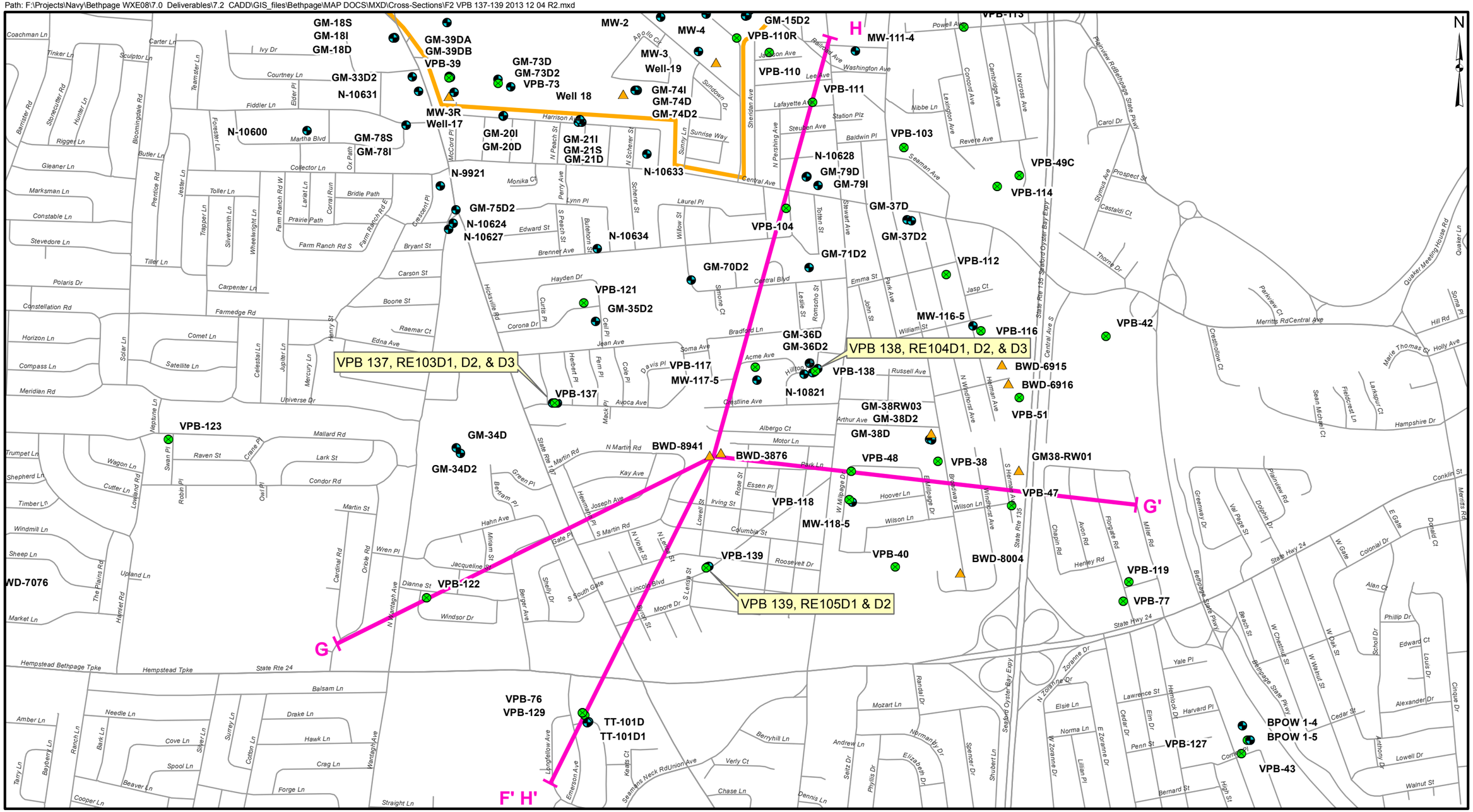

Vertical Profile Boring
Monitoring Well
Water Supply Well
Cross Section
1997 Northrop Grumman
1997 NWIRP Bethpage

VPB 137 and VPB 138 depicted on Cross Section GG'
VPB 138 and VPB 139 depicted on Cross Section HH'

0 312.5 625 1,250 Feet

VPB-137, VPB-138, and VPB-139
CROSS-SECTION AND LOCATION MAP
OPERABLE UNIT 2 (SITE 1)
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

CONTRACT NUMBER	CTO NUMBER
N62470-11-D-8013	WE15
APPROVED BY: PS	DATE: 12/4/2013
APPROVED BY: —	DATE: —
FIGURE NO.: 2	REV: 1

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N

TT-309D: 1.9 2013
TT-309I: ND 2013
TT-309S: 1.5 2013

RW-1: 0.81 J 2013
MW-201-1: 13 2013
RW-3: 4.3 J 2013
RW-4: 0.72 J 2013
RW-2: 16 2013
MW-200-1: 1.3 J 2013
MW-202-1: 1.6 J 2013
MW-203-1: 2.7 J 2013

MW-93D1: < 4.5 2013
MW-93D2: 21 2013
MW-72D1: 1.0 J 2013
MW-72D2: 16 2013
MW-75D2: 87 2013
MW-73D2: 17 2013
MW-77D1: 0.54 J 2013
HN-24I: 16 2013
HN-24S: 0.58 J 2013
FW-03: 3.5 J 2013
TT-303I1: 5.4 2013
VPB-134: 91 2012
HN-42I: 3.0 J 2013
HN-42S: ND 2013
MW-108-1: ND 2013
MW-102-1: ND 2013
MW-86D1: 1.5 J 2013
MW-85I: 0.53 J
VPB-135: 4021 2012
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HN-40S: ND 2013
MW-109-3: 610 2013
GM-17D: 0.34 J 2013
GM-17I: 0.86 J 2013
GM-15I: ND 2013
GM-18D: 0.92 J 2013
GM-18I: ND 2013
GM-39DA: 2.8 J 2013
GM-74I: 0.35 J 2013
N-10631: 0.78 J 2013
GM-21D: 1.8 J 2013
GM-21I: 0.31 J 2013
GM-21S: 0.34 J 2013
GM-20D: 0.32 J 2013
GM-20I: 0.34 J 2013
GM-78I: 0.31 J 2013
GM-78S: ND 2013
GM-79D: 19 2013
GM-79I: 0.23 J 2013
GM-37D: ND 2013
N-10624: ND 2013
N-10627: 0.61 J 2013
GM-36D: ND 2013
VPB-138: 7.8 2013
VPB-137: 4.7 2012
VPB-139: 108 2013
VPB-131: 3.3 2012
BPOW 1-1: 0.82 J 2013

Hempstead Tpke
Hicksville Rd
State Hwy 135

Notes:
1. Posted TCE values (µg/L) represent current data from monitoring wells and vertical profile borings. Results shown are for samples collected at depths less than 300 feet below ground surface. Where multiple hydropunch samples were collected above 300 feet at vertical profile borings, the highest concentration is posted.
2. TCE (µg/L) at monitoring wells represents recent data collected by Arcadis in May and June, 2013 with the exception of wells described in notes 3 and 4.
3. TCE (µg/L) at RE103 series, RE104 series and RE105 series monitoring wells represents data collected by Resolution Consultants in October 2013.
4. TCE (ug/L) at monitoring wells MW-73D2, MW-75D2, MW-77D1 and MW-85I (on the Hooker/Ruco site) represents data collected by Oxy Glen Springs Holding, Inc. in July 2013.
5. The colored halos around the symbols identify the concentration ranges: >5 to 50 µg/L - green, >50 to 500 µg/L - blue, and >500 µg/L - brown.

Legend
- Monitoring Well
- Water Supply Well
- Vertical Profile Boring

0 750 1,500 3,000 Feet

DRAWN BY / DATE	TT / 11/22/11
CHECKED BY / DATE	TT / 11/22/11
REVISED BY / DATE	PS / 01/31/14
SCALE	AS NOTED

TCE CONCENTRATIONS
IN SHALLOW (<300 FT BGS)
OU2 GROUNDWATER
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

CONTRACT NUMBER	N62470-11-D8013
CTO NUMBER	WE08
APPROVED BY / DATE	— / —
APPROVED BY / DATE	— / —
FIGURE NO.	3
REV	0

\\uscnr1vfp001\data2\Projects\Navy\Bethpage WXE087.0_Deliverables\7.2_CADD\GIS_files\Bethpage\MAP DOCS\MXD\Cross-Sections\F4 BP_TCE_DEEP_2014 02 03.mxd

MW-77D2: 22 *2013*
VPB-134: 2400 *2012*
MW-53D2: 910 *2013*
MW-86D2: 320 *2013*
MW-85D2: 44 *2013*
MW-89D2: 2.1 J *2013*
VPB-135: 35 *2012*
VPB-136: 15 *2012*
MW-67D: 14 *2013*
MW-67S: 3.6 J *2013*
MW-68D: 66 *2013*
MW-68S: 0.45 J *2013*
MW-3-1: 37 *2013*
WELL 3: 1400 *2013*
WELL 1: 380 *2013*
GM-15D: 0.36 J *2013*
GM-15D2: 11 *2013*
MW-111-4: 2800 *2013*
GM-73D: 23 *2013*
GM-73D2: 44 *2013*
GM-73D3: 1.1 J *2013*
GM-74D: 1.6 J *2013*
GM-74D2: 8.2 *2013*
GM-74D3: 3.0 J *2013*
WELL 19: 180 *2013*
GM-39D2B: 80 *2013*
GM-33D2: 27 *2013*
WELL 17: 190 *2013*
WELL 18: 60 *2013*
GM-75D2: 39 *2013*
GM-37D2: 1.6 J *2013*
GM-71D2: 8 *2013*
GM-70D2: 12 *2013*
GM-35D2: 100 *2013*
GM-36D2: 1.7 J *2013*
VPB-138: ND *2013*
RE104D1: 160 J *2013*
RE104D2: 1.4 J *2013*
RE104D3: ND *2013*
MW-116-5: 1900 *2013*
MW-117-5: 5.1 *2013*
VPB-137: 1820 *2012*
RE103D1: 810 J *2013*
RE103D2: 830 J *2013*
RE103D3: 120 *2013*
RW3-MW3: 410 *2013*
RW3-MW4: 1.8 *2013*
RW3-MW2: 140 *2013*
RW3-MW1: 49 *2013*
RW1-MW3: 1.7 *2013*
RW2-MW1: 14 *2013*
BWD-3876: 57.8 *2013*
BWD-8941: 63.4 *2013*
RW-3: 190 *2013*
GM-38D: 410 *2013*
GM-38D2: 29 *2013*
RW1-MW1: 78 *2013*
RW1-MW2: 64 *2013*
RW-1: 190 *2013*
GM-34D: 330 *2013*
GM-34D2: 180 D *2013*
MW-118-5: 0.33 J *2013*
VPB-139: 1216 *2013*
RE105D1: 75 J *2013*
RE105D2: 1200 J *2013*
Hempstead Tpke
TT-101D: 73 *2013*
TT-101D1: 160 *2013*
TT-101D2: 460 D *2013*
Hicksville Rd
State Hwy 135
BPOW 1-4: ND *2013*
BPOW 1-5: ND *2013*
BPOW 1-6: ND *2013*
BPOW 1-2: 0.33 J *2013*
BPOW 1-3: ND *2013*
BPOW 4-1: ND *2013*
BPOW 4-2: 0.3 J *2013*
VPB-131: 61 *2012*
BPOW 2-1: ND *2013*
BPOW 2-3: 0.3 J *2013*
BPOW 3-3: ND *2013*
BPOW 3-4: 53 *2013*
BPOW 3-1: ND *2013*
BPOW 3-2: ND *2013*
BPOW 5-1: ND *2013*
BPOW 5-2: ND *2013*
BPOW 5-3: ND *2013*
TT-102D: ND *2013*
TT-102D2: ND *2013*

N

Legend

- Monitoring Well
- Water Supply Well
- Vertical Profile Boring

0 750 1,500 3,000 Feet

Notes:

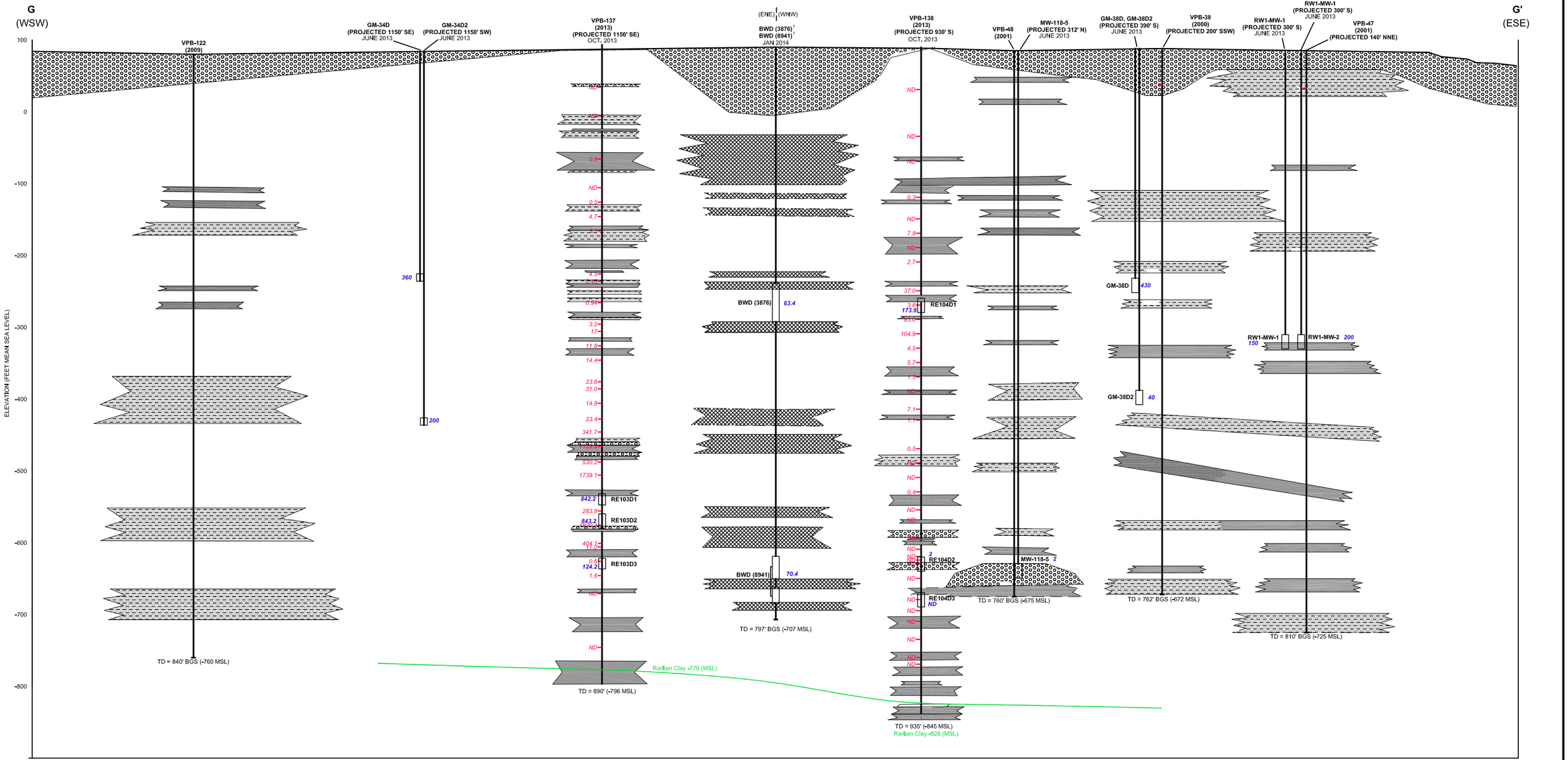
1. Posted TCE values (µg/L) represent current data from monitoring wells and vertical profile borings. Results shown are for samples collected at depths greater than 300 feet below ground surface. Where multiple hydropunch samples were collected below 300 feet at vertical profile borings, the highest concentration is posted.
2. TCE (µg/L) at monitoring wells represents recent data collected by Arcadis in May and June, 2013 with the exception of wells described in notes 3 and 4.
3. TCE (µg/L) at RE103 series, RE104 series and RE105 series monitoring wells represents data collected by Resolution Consultants in October 2013.
4. TCE (ug/L) at monitoring wells MW-77D2, MW-85D2 and MW-89D2 (on the Hooker/Ruco site) represents data collected by Oxy Glen Springs Holding, Inc. in July 2013.
5. The colored halos around the symbols identify the concentration ranges: >5 to 50 µg/L - green, >50 to 500 µg/L - blue, and >500 µg/L - brown.

DRAWN BY	DATE
TT	12/12/11
CHECKED BY	DATE
TT	12/12/11
REVISED BY	DATE
PS	01/31/14
SCALE	
AS NOTED	

NAVFAC

TCE CONCENTRATIONS
IN DEEP (>300 FT BGS)
OU2 GROUNDWATER
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

CONTRACT NUMBER	CTO NUMBER
N62470-11-D8013	WE08
APPROVED BY	DATE
—	—
APPROVED BY	DATE
—	—
FIGURE NO.	REV
4	0



Notes:
1. Adapted from Tetra Tech.
2. Designations on well labels:
   1. From Arcadis Cross Section (2004)
   2. TVOC data from H.M.
   * TVOC from Arcadis
3. Some wells projected into cross section; distance and direction of projection noted under well name.

LEGEND

- SAND AND GRAVEL
- F-M SAND WITH VARYING AMOUNTS OF SILT, CLAY, AND C. SAND

CONFINING UNITS

- INTERBEDDED CLAY AND SAND
- SANDY CLAY
- CLAY
- CONFINING UNIT FROM ARCADIS CROSS-SECTION, NO SPECIFIC LITHOLOGY GIVEN
- TOP OF RARITAN CLAY (DASHED WHERE INFERRED)

TT-101D	MONITORING WELL ID
VPB-121	VERICAL PROFILE BORING
(2009)	INSTALLATION YEAR
(PROJECTED 450' ESE)	PROJECTION
MAR 2012	MONITORING WELL SAMPLING DATE
	CONFINING UNIT (DASHED WHERE INFERRED)
TT-101D ND	MONITORING WELL SCREEN WITH TVOC COCENTRATION (ug/L)
374	VERTICAL PROFILE BORING TVOC RESULTS (ug/L)
ND	NON-DETECT
TD = 840' BGS (-735' MSL)	TOTAL DEPTH IN FT BELOW GROUND SURFACE (ELEVATION IN FT ABOVE MEAN SEA LEVEL)

NAVFAC

CROSS SECTION G - G'
OPERABLE UNIT 2 (SITE 1)
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

CONTRACT NUMBER N62470-11-D-8013	CTO NUMBER WE15
APPROVED BY	DATE DECEMBER 2013
APPROVED BY	DATE
FIGURE NUMBER 5	REV 0

H (NNE) — H' (SW)

MW-111-4 (PROJECTED 280' W) JUNE 2013
VPB-111* (2007)
GM-79D (PROJECTED 140' W) JUNE 2013
GM-79I (PROJECTED 295' W) JUNE 2013
VPB-104* (2006) (PROJECTED 40' W)
GM-71D2 (PROJECTED 420' W) JUNE 2013
VPB-138 (2013) (PROJECTED 780' W) Oct. 2013
VPB-117* MW-117-5 (2008) (PROJECTED 180' W)
(SSW) (NE)
BWD (3876)[1] BWD (8941)[1] JAN 2014[1]
VPB-139 (2013) (PROJECTED 75FT NW) OCT. 2013
VPB-129 (2011) TT-101D TT-101D1 TT-101D2 JUNE 2013

ELEVATION (FEET MEAN SEA LEVEL)

100, 0, -100, -200, -300, -400, -500, -600, -700, -800, -900

0, 500, 1,000, 1,500, 2,000, 2,500, 3,000, 3,500, 4,000, 4,500, 5,000, 5,500, 6,000, 6,500, 7,000, 7,500

4100

TD = 631' BGS

0.23

20

20

TD = 887' BGS (-790' MSL)

RARITAN CLAY
(inferred by Arcadis, see section AA')

ND
ND
ND
0.3
ND
7.8
ND
2.7
37.0
RE104D1 3.6
173.9
84.0
104.9
4.5
5.7
1.3
7.1
1.1
0.5
ND
ND
0.4
ND
ND
ND
ND
2 RE104D2
ND
MW-117-5 7
ND RE104D3 ND
ND
ND
ND
ND
ND
ND

TD = 789' BGS (-694 MSL)

TD = 935 ft (-845' MSL)
Raritan Clay -826 MSL

63.4 BWD (3876)

BWD (8941) 70.4

TD = 797' BGS (-707' MSL)

86.6
7.4
1.7
9.5
ND
9.8
ND
108.3
5.6
54.9
99.3
199.3
10.7
23.3
0.5
20.9
62.3
RE105D1 90.4
35.1
ND
1.7
ND
5.0
ND
ND
3.0
92.4
21
1216
RE105D2 1240.4
4.3
ND
ND
ND
ND
ND
ND
ND

RARITAN CLAY -844 MSL

TD = 965 ft (-876 MSL)

TT-101D 95

TT-101D1 180

TT-101D2 480

TD = 851' BGS (-768' MSL)

No clear evidence of RARITAN CLAY
in log or gamma

Notes:
1. Adapted from Tetra Tech.
2. Designations on well labels:
   1. From Arcadis Cross Section (2004)
   2. TVOC data from H.M.
   * TVOC from Arcadis
3. Some wells projected into cross section; distance and direction of projection noted under well name.

LEGEND
- SAND AND GRAVEL
- F-M SAND WITH VARYING AMOUNTS OF SILT, CLAY, AND C. SAND

CONFINING UNITS
- INTERBEDDED CLAY AND SAND
- SANDY CLAY
- CLAY
- CONFINING UNIT FROM ARCADIS CROSS-SECTION, NO SPECIFIC LITHOLOGY GIVEN
- TOP OF RARITAN CLAY (DASHED WHERE INFERRED)

TT-101D	MONITORING WELL ID
VPB-121	VERICAL PROFILE BORING
(2009)	INSTALLATION YEAR
(PROJECTED 450' ESE)	PROJECTION
MAR 2012	MONITORING WELL SAMPLING DATE
	CONFINING UNIT (DASHED WHERE INFERRED)
TT-101D ND	MONITORING WELL SCREEN WITH TVOC COCENTRATION (ug/L)
374	VERTICAL PROFILE BORING TVOC RESULTS (ug/L)
ND	NON-DETECT
TD = 840' BGS (-735' MSL)	TOTAL DEPTH IN FT BELOW GROUND SURFACE (ELEVATION IN FT ABOVE MEAN SEA LEVEL)

NAVFAC

CROSS SECTION H - H'
OPERABLE UNIT 2 (SITE 1)
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

CONTRACT NUMBER N62470–11–D–8013	CTO NUMBER WE15
APPROVED BY	DATE DECEMBER 2013
APPROVED BY	DATE
FIGURE NUMBER 6	REV 0

Appendices

Appendix A

VPB 137 and RE103D1, RE103D2, RE103D3

Appendix B

VPB 138 and RE104D1, RE104D2, RE104D3

Appendix C

VPB 139 and RE105D1, RE105D2

Appendix D

Investigative Derived Waste