DEPARTMENT OF THE NAVY
ENGINEERING FIELD ACTIVITY, NORTHEAST
NAVAL FACILITIES ENGINEERING COMMAND
10 INDUSTRIAL HIGHWAY
MAIL STOP, #82
LESTER, PA 19113-2090

IN REPLY REFER TO

5090
Code EV21/JLC

24 JULY 2003

Mr. Steve Scharf
Project Engineer
New York State Department of Environmental Conservation
Bureau of Eastern Remedial Action
Division of Environmental Remediation
625 Broadway
Albany, NY 12233-7015

Dear Steve:

Subj: Final Public Water Supply Contingency Plan and Comment Response Letter - Operable Unit (OU) 2 - Groundwater at NWIRP Bethpage, New York and Northrop Grumman Corporation, New York; NYS Registry #1-30-003 A & B

Enclosed, please find a copy of the Revised Final Public Water Supply Contingency Plan (PWSCP) that is being forwarded for your information. Also enclosed is a Comment Letter that responds to various comments submitted by the members of the Bethpage Technical Advisory Committee (TAC) regarding the PWSCP, the GM-38 Remedy, and various modeling issues. Both of these documents were developed on behalf of the Department of Navy by ARCADIS Geraghty & Miller and Tetra Tech NUS.

If you have any questions regarding the enclosed documents, please give me a call at (610) 595-0567, extension 163.

Sincerely,

JAMES L. COLTER
Remedial Project Manager
By direction of the
Commanding Officer

Enclosures: (1) Revised Final Public Water Supply Contingency Plan
(2) Comment Response Letter

Distribution:
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Rob Burns - Dvirka & Bartilucci
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Carl Hoffman - NYSDEC (Albany)
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Ken Bishop - Town of Oyster Bay
Darrol Lopez - Town of Hempstead
Arnold Palleschi - Hempstead Water District
Ron Krumholtz - Bethpage Water District
Frank Flood - Massapequa Water District
Matt Snyder - New York Water Service
Edoardo Licci - South Farmingdale Water District
Anthony Sabino, Esq. - Counsel for Bethpage Water District
W. Carmen, Esq. - Counsel for South Farmingdale Water District
Joe Kaminski - NAVAIR
Al Taormina - J.A. Jones
Ed Mangano - Nassau County Legislator
Jim McBride - RAB Community Co-Chair

Public Water Supply Contingency Plan

Prepared for:
Engineering Field Activities Northeast (EFANE)

Naval Facilities Engineering Command

Reference:
Tetra Tech NUS Contract No. GCMP-02-011-0888

ARCADIS

Infrastructure, buildings, environment, communications

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Public Water Supply
Contingency Plan

Prepared for:
Engineering Field Activities Northeast (EFANE)

Naval Facilities Engineering Command

Reference:
Tetra Tech NUS Contract No.
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Date:
22 July 2003

Introduction

The March 2001 Record of Decision (ROD) issued by the New York State Department of Environmental Conservation (NYSDEC) for Operable Unit 2 (OU2) (Groundwater) for the Northrop Grumman Corporation (NGC) and Naval Weapons Industrial Reserve Plant (NWIRP) Sites in Bethpage, Nassau County, New York (NYSDEC Site Numbers 1-30-003A and B, respectively) requires that as part of the selected remedy (i.e., Remedial Alternative 3), that a public water supply contingency plan for the design, construction, operation and maintenance of wellhead treatment systems and/or the evaluation of comparable alternative measures, if necessary, be developed. The April 2003 ROD issued by the Navy for OU2 contains similar language in this regard. This plan was prepared to satisfy this ROD requirement.

Public Water Supply Contingency Plan Elements

This Public Water Supply Contingency Plan (PWSCP) consists of five main elements, as follows:

- Groundwater Modeling
- Trigger Values
- Outpost (Early Warning) Monitoring Wells
- Groundwater Monitoring of Outpost Monitoring Wells
- Wellhead Treatment/Comparable Alternative Measures

These plan elements are discussed in detail below.

Groundwater Modeling

A groundwater flow and solute transport model was constructed and used by ARCADIS G&M, Inc. (ARCADIS) to estimate the future migration of the groundwater contaminant plume attributable to the NGC and NWIRP sites. Specifically, the model was used to: (1) evaluate the approximate timing of plume arrival at public supply wells that are located downgradient of the lower portion of the plume's leading edge that is anticipated to impact the public supply wells, (2) determine the approximate total volatile organic compound (TVOC) concentrations

anticipated to impact the public supply wells, (3) establish trigger values for initiating remedial measures, and (4) establish the horizontal location of each proposed outpost monitoring well along with its' screen setting. The model was developed using hydrogeologic and water quality data collected from existing monitoring wells and vertical profile borings (VPBs) drilled in the vicinity, and also accounts for the effects of public supply well pumpage in evaluating plume migration. Appendix A summarizes the methodologies used and results of the groundwater modeling performed.

Pumpage data and information related to the future plans of the water districts for expansion or modification of wellfield pumping rates (if any) will be requested from the potentially affected water districts and will be evaluated on an annual basis. This evaluation will determine whether an update to the existing model to reflect the modified pumping scheme and an additional modeling run(s) is required to assess the effect, if any, of the modified pumping scheme on contaminant flow paths. If such modeling efforts suggest that a water supply well may be impacted within five years and it has been further determined that the projected contaminant flow path will not intercept an existing outpost monitoring well, then an additional outpost monitoring well(s) would be designed, installed, and monitored. The evaluation of the future pumpage plans, decision on remodeling, and any remodeling results will be presented in the annual groundwater monitoring report submitted to the NYSDEC and TAC group.

Trigger Values

Based on the groundwater modeling conducted, trigger values have been established for each outpost (early warning) monitoring well (see Table A-3 in Appendix A). A trigger value is defined as a specific, site-related VOC concentration detected in a groundwater sample collected from an outpost monitoring well (the list of site-related VOCs are provided in Table 1 of this plan). If groundwater sampling indicates that a trigger value has been reached (and this result is confirmed, as defined in this plan), this signifies that wellhead treatment, or comparable alternative measures, is required and it is time to begin planning wellhead treatment or comparable alternative measures to address the potential for a specific public supply well or well field to be impacted. This process would not preclude the water district(s) from taking any action they deem appropriate. Trigger values have been developed to provide for approximately five years early warning prior to VOCs being detected in the downgradient supply well.

Outpost (Early Warning) Monitoring Wells

Outpost (early warning) monitoring wells will be installed generally south (downgradient) of the delineated lower portion of the TVOC groundwater plume attributable to the NGC and NWIRP sites that is anticipated to impact public supply wells. Ideally these wells, when first installed, will have non-detect results for site related VOCs in groundwater samples collected from them.

By locating the outpost wells between the leading edge of the lower portion of the plume that is anticipated to impact public supply wells and the downgradient public supply wells, regular sampling and analysis of these wells for VOCs will provide early warning of plume migration toward one or more of the public supply wells. The outpost wells will be clustered at specific locations (i.e., several wells of different depths at essentially the same location) to account for the plume thickness, and to be sure that plume migration will be detected. Table A-2 of Appendix A provides details on the screen zones of the proposed outpost monitoring wells and the screen zones of the associated public supply wells. The modeling discussed in Appendix A focused on developing outpost monitoring well locations and trigger values for the first public supply well in each well field to be potentially affected by the plume and, therefore, as shown in Table A-2 of Appendix A, the proposed outpost monitoring well cluster for each well field is intended to monitor potential impacts to one public supply well in each well field. Review of this table shows that some of the outpost monitoring well screens are shallower than the screens of the public supply wells they are intended to monitor. Because the VOC plume is relatively thick and different vertical plume segments are migrating at different velocities, the modeling discussed in Appendix A focused on the fastest moving plume segment near each potentially impacted public supply well field that could result in VOC detections in the public supply well(s).

The fastest moving plume segment near each public supply well field, at a five-year groundwater travel time distance upgradient from each potentially affected public supply well field, was selected as the proposed screen zone for one of the outpost monitoring wells for each wellfield as it would provide the earliest warning of the advancement of the plume. As a conservative measure, an outpost well was also proposed for the second fastest moving segment of the plume. Because of the complexities of the three-dimensional migration of the plume and the five-year groundwater travel time distance of the outpost monitoring wells from the public supply wells, it does not necessarily hold that an outpost monitoring well would be screened at the same depth horizon as the corresponding public supply well, and as can

be seen from Table 2 of Appendix A; only some of the outpost well screens overlap the same screen zone depth horizon as the public supply wells they will monitor.

Figures A-2 through A-5 of Appendix A provide the locations of the proposed outpost monitoring wells and the associated public supply wells. The outpost wells are to be located generally north of the public supply well fields to be monitored, which is intuitive as the lower portion of the plume's leading edge that is anticipated to impact public supply wells is currently located north of the well fields and is migrating generally to the south/southeast (the regional groundwater flow direction). However, as shown on Figure A-2, Outpost Well Cluster 1 is proposed to be located due west of the South Farmingdale Water District (SFWD) Well Field 1 and specifically, west/northwest of Well 4043, the first well expected to be impacted in the well field. At this location, modeling indicates that the relative position of the plume and local stresses imposed on the groundwater flow field by pumping the SFWD Well Field 1 supply wells will result in plume impacts to the well field from the west.

Currently, outpost monitoring wells are planned for SFWD Well Fields 1 and 3, New York Water Service (NYWS) Wells 3S and 4S, and Town of Hempstead (TOH) Water District Well 13 (total of 4 outpost well locations; total of 9 outpost wells). Modeling does not predict an impact to occur at Well 5303, however as a conservative measure an outpost well cluster will be installed for this well. Water quality data collected from the proposed outpost wells, as well as data collected from public supply wells they specifically monitor, will also provide very early warning of the advancement of the plume toward the supply wells operated by the Massapequa Water District (MWD); although groundwater modeling does not predict an impact to the MWD wells within the next 30 years. If the outpost monitoring wells and the wells/well fields they will monitor become impacted by site-related VOCs, the need for MWD specific outpost monitoring wells will then be assessed. This assessment will be carried out by entering water quality data from the impacted outpost wells and public supply wells into the model and then carrying out model runs to determine if the MWD wells will be impacted. If an impact is predicted then locations and screen intervals for MWD specific outpost wells will be developed and the timing of outpost well installation will be determined.

Appendix B contains the work plan that covers installation of the proposed outpost monitoring wells.

Groundwater Monitoring of Outpost Monitoring Wells

The nine proposed outpost monitoring wells (see Table A-2 of Appendix A) will be sampled on a quarterly basis as part of the NYSDEC-approved OU2 Groundwater Monitoring Plan, Northrop Grumman Corporation, Bethpage, New York (ARCADIS, 2001). The nine wells will be sampled for VOCs using dedicated submersible pumps and inflatable packers. The groundwater samples will be analyzed in the laboratory for the Target Compound List (TCL) of VOCs using United States Environmental Protection Agency (USEPA) Method 502.2. In addition to the outpost monitoring well data, VOC water quality information from the four public supply well fields being monitored will be requested from the water districts, and these data will be reviewed and used to complement the outpost monitoring well data developed.

Wellhead Treatment/Comparable Alternative Measures

Wellhead treatment, or comparable alternative measures, for a public supply well or well field will be required and provided if trigger values for individual site specific compounds (see Table 1) are reached (and confirmed as described in this plan – see Figure 1).

Plan Implementation

Some of the tasks that comprise this plan have already been completed (i.e., groundwater modeling to determine outpost well locations, screen settings, and trigger values) while others have yet to occur (i.e., installation and monitoring of outpost wells).

Once this plan has been reviewed and approved by the NYSDEC, the following steps will occur:

- Installation of the nine proposed outpost monitoring wells (see Figures A-2 through A-5 of Appendix A for proposed outpost well locations).
- Initiation of quarterly sampling of the outpost wells and obtain public supply well VOC data.
- The sequence of sampling, data review, and wellhead treatment will proceed as detailed on Figure 1.

- If a trigger value(s) is met or exceeded in one or more outpost wells then the well(s) where the trigger value has been reached will be resampled two additional times for confirmation, as the trigger values are very close to the analytical method detection limit and there is an approximate five-year travel time between the outpost well and the public supply well. The first re-sampling will occur within approximately one week of the determination that the trigger value was reached. The second resampling will occur approximately one week after the first re-sampling.

- Based on the analytical results of the initial and confirmation samples described above, if all three samples indicate that the trigger value(s) has been reached for site specific compounds, (as described below) then negotiations with the potentially affected water district(s) will commence.

Reaching or exceeding a trigger value is defined as follows:

- Only validated analytical results for site specific compounds (see Table 1) will be considered in the determination as to whether a trigger value has been reached or exceeded.

- Estimated values (i.e., "J" qualified data) will not be counted toward the trigger value. Site specific VOCs that individually equal or exceed a trigger value, will be confirmed to have met/exceeded the trigger value if, after two resamplings, site specific compounds individually equal/exceed the trigger value.

- The same compound must meet/exceed the trigger value in all three samples for the result to be confirmed.

Reporting

All analytical testing results will be provided on a two-week turnaround following submission of the samples to the laboratory. Following receipt of analytical results from the lab, the data will be validated. If, following data validation, it is determined that the trigger value(s) is reached, then re-sampling will be carried out as discussed above and notification will be provided to NGC, the Navy, and the NYSDEC. Subsequently, within two weeks of receipt of complete sample results for all sampling rounds, if it has been confirmed that a trigger value(s) has been reached than a data report (validated data) will be prepared and submitted to NGC, the Navy, the NYSDEC and the potentially affected water district(s) informing them of the results.

If the quarterly sampling of the outpost wells does not indicate that a trigger value has been reached, then the data will be reported in the regular quarterly reports and not as a special data report.

Discussions/Negotiations with Potentially Affected Water District(s)

As indicated on Figure 1, once the trigger value(s) has been reached and confirmed (from three consecutive samples as described above), wellhead treatment or comparable alternative measures, will be required and pre-design discussions/negotiations will commence between NAVY/Northrop Grumman and the potentially affected water district(s) so that funding for wellhead treatment or comparable alternative measures can be negotiated and provided to the water district(s).

Design, Construction, Operation and Maintenance of Wellhead Treatment/Comparable Alternative Measures

Once the negotiations are complete and a financial agreement has been reached by the parties, the potentially affected water district(s) will be responsible for the design, construction, operation and maintenance of wellhead treatment or a comparable alternative measure.

Table 1. List of Volatile Organic Compounds Associated with the Northrop Grumman Corporation and U.S. Navy/NWIRP Facilities, Bethpage, New York.

CAS Number	Compound Name	Common Abbreviation
75-15-0	Carbon disulfide	--
56-23-5	Carbon tetrachloride	--
108-90-7	Chlorobenzene	--
67-66-3	Chloroform	--
79-01-6	Trichloroethene	TCE
156-59-2	cis-1,2-Dichloroethene	cis-1,2-DCE
156-60-5	trans-1,2-Dichloroethene	trans-1,2-DCE
127-18-4	Tetrachloroethene	PCE
76-13-1	1,1,1-Trichloro-2,2,2-trifluoroethane	Freon 113
540-59-0	1,2-Dichloroethene	1,2-DCE
107-06-2	1,2-Dichloroethane	1,2-DCA
75-35-4	1,1-Dichloroethene	1,1-DCE
75-34-3	1,1-Dichloroethane	1,1-DCA
79-00-5	1,1,2-Trichloroethane	--
79-34-5	1,1,2,2-Tetrachloroethane	--
71-55-6	1,1,1-Trichloroethane	1,1,1-TCA

Footnotes:

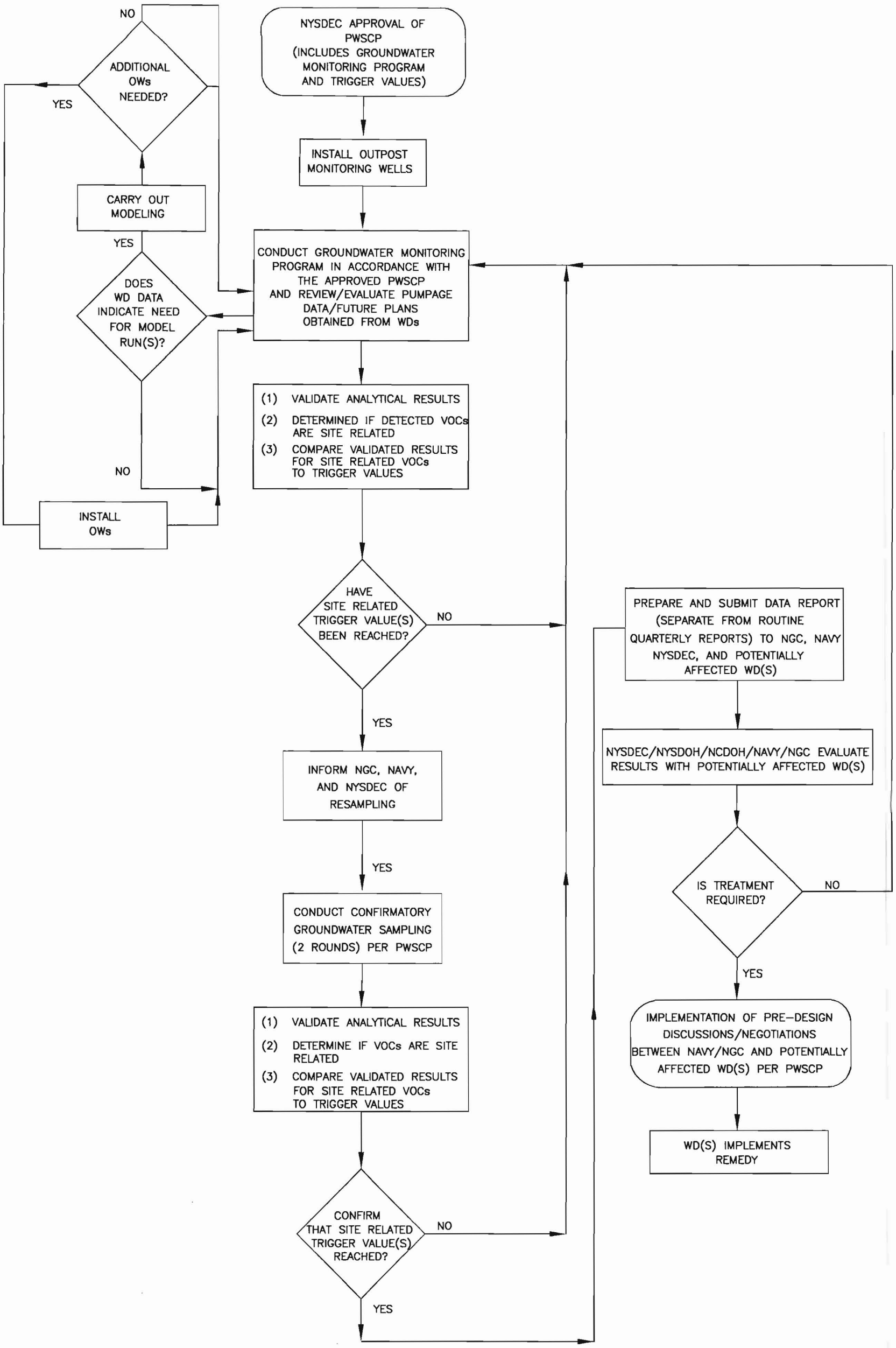
1.) The complete Target Compound List of VOCs will be analyzed during each sampling event.

2.) Compounds identified based on ARCADIS G&M, Inc. GIS/Key database updated through April 11, 2003.

3.) The compounds listed above were selected for inclusion in the list of site-related VOCs based on the following criteria:
- Frequency of detection in valid groundwater samples
- Location of detection (i.e., on-site, off-site, upgradient)
- Known source areas
- Observed biotransformation processes

4.) For the purposes of this table, the term site refers to the Northrop Grumman Corporation and Navy/NWIRP Facilities, Bethpage, New York.

NWIRP Naval Weapons Industrial Reserve Plant
VOC Volatile Organic Compound
CAS Chemical Abstract Service
-- Not Applicable



PWSCP	PUBLIC WATER SUPPLY CONTINGENCY PLAN
NYSDEC	NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
VOCs	VOLATILE ORGANIC COMPOUNDS
NGC	NORTHROP GRUMMAN CORPORATION
NYSDOH	NEW YORK STATE DEPARTMENT OF HEALTH
NCDOH	NASSAU COUNTY DEPARTMENT OF HEALTH
WD	WATER DISTRICT
OW	OUTPOST WELL

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DRAWN	DATE	PROJECT MANAGER	DEPARTMENT MANAGER
AG	3/20/03	C. SAN GIOVANNI	M. WOLFERT
FLOW CHART FOR GROUNDWATER MONITORING AND REPORTING		LEAD DESIGN PROF.	CHECKED DES
		PROJECT NUMBER	DRAWING NUMBER
NORTHROP GRUMMAN CORPORATION AND US NAVY NWIRP FACILITIES, BETHPAGE, NEW YORK		NY001371.0001.00004	1

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Appendix A

Groundwater Modeling in Support of Determining Locations and Screen Zones for Outpost Monitoring Wells Memorandum

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MEMO

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Mike Wolfert
Carlo San Giovanni

Copies:
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From:
Robert Porsche/ Doug Smolensky

Date:
13 December 2002
(revised July 3, 2003)

ARCADIS Project No.:
NY001321.0006.00003

Subject:
Groundwater Modeling in Support of Determining Locations and Screen Zones for Outpost Monitoring Wells, Northrop Grumman Corporation.

Purpose of Outpost Monitoring Wells

The purpose of this memo is to outline the process followed to select potential outpost monitoring well locations for several public water supply wells located south (i.e., downgradient) of the Northrop Grumman Corporation/Naval Weapons Industrial Reserve Plant (NWIRP) sites in Bethpage, New York. The outpost monitoring wells will be used to monitor groundwater quality between the lower portion of the leading edge of the volatile organic compound (VOC) plume this is anticipated to impact the public supply wells and the supply wells potentially in the path of the plume. Outpost Well locations have been chosen to provide approximately 5 years notice to the water districts, specifically, the outpost monitoring well locations developed with this effort will enable detection of the groundwater plume at least 5 years before the supply wells have detections of VOCs.

The updated Northrop Grumman groundwater model (documented in the ARCADIS October 2002 letter report) was used in this evaluation to help identify the outpost monitoring well screen locations in the context of the aforementioned goals.

Determination of Municipal Wells that may have VOC Detections

Groundwater flow modeling with forward particle tracking was used to determine that the following supply wells downgradient of the leading edge of the lower portion of the plume have the potential to have VOC detections related to the plume: N5303 (Town of Hempstead [Levittown] Water District), N8480 and N9338 (New York Water Service), N6150, N4043, and N5148 (South Farmingdale Water District). Travel time from the plumes leading edge to these wells is summarized in Table A-1. Well locations are shown on Figure A-1.

The model predicted time to VOC detections in supply wells resulting from the evaluation summarized in this memo is based on the assumption that the steady state groundwater flow conditions simulated by the model remain constant through time. Therefore, if significant changes to pumping rates are made in the supply wells downgradient of the plume, the flow field would change and the potential for VOC detections would require re-evaluation. Recall that the particle tracking evaluation only indicates the potential for groundwater at the plumes leading edge to reach a downgradient receptor. It does not quantify the concentration of VOCs in the groundwater predicted to reach the well. However, solute transport modeling (conducted by ARCADIS) has predicted that the following supply wells would have influent concentrations above 0.5 µg/L within 30 years as a result of the VOC plume; time to VOC detection is shown in parenthesis: N4043 (11 years), N6150 (4 years), N8480 (18 years), and N9338 (24 years).

Although groundwater flow modeling with forward particle tracking indicated that municipal supply wells N5303 and N5148 were potential receptors of the groundwater plume, solute transport modeling indicates that when the plume reaches these wells, influent concentrations will remain below 0.5 µg/L for the 30 year evaluation period. Nevertheless, to be conservative, ARCADIS has developed an outpost monitoring well cluster location and screen zones for supply well N5303. An outpost monitoring well location was not developed for supply well N5148 because it is located in the same well field as supply well N4043 and model results predict a VOC detection in N4043 approximately 15 years before a detection in N5148 (see Table A-1). For well fields with multiple supply wells (South Farmingdale Well Field 1 and New York Water Service Wells 3S and 4S), locations for outpost monitoring wells were developed for the supply well in the field where the model predicted the first VOC detection to occur.

Selection of Outpost Monitoring Well Locations

Following the identification of supply wells with the potential to have VOC detections from the groundwater plume, and after determining the timing of the VOC detections with the model, the locations for placement of the outpost monitoring wells were defined both horizontally and vertically. In addition to being sufficiently distant from the supply well to provide a 5-year notification period, the wells were screened to detect that portion of the plume that, based on model predictions, had the potential to cause VOC detections in the supply well. In the case of supply well N5303, an outpost monitoring well location was selected in

spite of the uncertainty associated with the limit of the plumes western extent. The following sections describe the procedure used to select the location and screen zone for each of the outpost monitoring wells.

Distance from municipal supply wells

Groundwater flow modeling with reverse particle tracking was used to define the appropriate distance upgradient of each supply well for the installation of the outpost monitoring well. Reverse particle tracking was used to define the capture zone resulting from the operation of each supply well, and to determine the distance from the supply well beyond which a particle of groundwater would travel for at least 5 years before reaching the supply well. As stated above, this evaluation and its results are based on the assumption that the conditions modeled will remain constant through time. If the rate of groundwater production at the supply well in question, or the rate at nearby supply wells is significantly varied from the simulated production rate for extended periods, groundwater velocities near the supply wells will vary and the selected outpost monitoring well location may not provide a 5-year notification period.

Selection of Screen Zones

The results of the groundwater flow modeling with forward particle tracking discussed earlier were used to evaluate which portion of the plume moved fastest as it approached the municipal supply wells. The layer through which the fastest moving portion of the plume traveled as it approached the well was selected as the primary horizon to be monitored for advanced warning of the approaching plume. As a conservative approach, the layer through which the second fastest moving portion of the plume traveled as it approached the well was selected as the secondary horizon to be monitored. At South Farmingdale's Wellfield No. 1 there were two layers that contained the fastest moving portion of the plume, and so three outpost wells are proposed for this wellfield.

Modeling Results

The supply well capture zones were evaluated along with the results of forward particle tracking of the plumes leading edge, to define both the horizontal and vertical location to be monitored to detect the advancing TVOC plume at least five years before VOC detections occur in the supply well. Based on the evaluation of the groundwater modeling described above, ARCADIS recommends the installation of four clusters of outpost monitoring wells. The clusters will consist of two or three monitoring wells, each targeting a specific portion of the aquifer. ARCADIS recommends the installation of a three-well cluster to monitor groundwater upgradient of South Farmingdale's Well Field No. 1 (N4043, N5148, and N7377). Two-well clusters are recommended to monitor groundwater quality upgradient of South Farmingdale's Well Field No. 3 (N6150), the New York Water Service Well Field (N8480, and N9338), and the Town of Hempstead (Levittown) Well Field (N5303). Locations for the outpost monitoring well clusters are shown on Figures A-2 through A-5; screen zones for the proposed outpost monitoring wells are summarized in Table A-2. The distance from the outpost monitoring well clusters to the supply wells, the model predicted

trigger values, time to trigger value at the outpost wells, and time to VOC detection at the supply wells are given in Table A-3, along with the nearest street intersection to the recommended outpost well location. Any differences between Tables A-1 and A-3 (regarding time of travel) are a function of the transport mechanisms simulated. Table A-1 is based on particle tracking (advective transport modeling), while Table A-3 is based on solute transport modeling. When differences are significant, the recommendations are conservative as the shortest time was always used in the decision making process.

Table A-1. Groundwater travel time (in years) from the plumes leading edge in each model layer to municipal supply wells, Northrop Grumman Corporation - Bethpage, New York.

	Model Layer									
Well ID	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
South Farmingdale Well Field 1										
4043	21	22	12	12	12	--	--	--	--	--
5148	27	--	--	--	--	--	--	--	--	--
7377	--	--	--	--	--	--	--	--	--	--
South Farmingdale Well Field 3										
6150	--	--	--	12	8	>30	>30	>30	>30	--
New York Water Service Wells 3S and 4S										
8480	23	25	17	24	24	>30	>30	>30	>30	>30
9338	--	30	23	27	24	>30	>30	>30	>30	>30
Town of Hempstead (Levittown) Well 13										
5303	--	--	--	--	>30	--	>30	--	--	--

-- No model predicted detection of TVOCs.
>30 Model predicts detection of TVOCs after 30 years.

ARCADIS

Table A-2. Municipal Supply Well Data and Screen Zones of Proposed Outpost Monitoring Well Clusters, Northrop Grumman Corporation - Bethpage, New York.

Outpost	Model Layer				Proposed Outpost Wells Screen Zones						
Wells ID	Number	Top Elevation	Bottom Elevation	Middle Elevation	Top Elevation	Bottom Elevation	Length Feet	Screened Interval feet bls	Municipal Well Field Monitored	Municipal Supply Well Nos.	Screened Interval of Municipal Supply Well feet bls
OW1-1	4	-114	-170	-142	-122	-162	40	196-236	South Farmingdale Well Field 1	4043[1], 5148, 7377	312-372 (4043); 309-369 (5148); 607-758 (7377)
OW1-2	5	-170	-270	-220	-200	-240	40	274-314	South Farmingdale Well Field 1	4043[1], 5148, 7377	312-372 (4043); 309-369 (5148); 607-758 (7377)
OW1-3	6	-270	-360	-315	-295	-335	40	369-409	South Farmingdale Well Field 1	4043[1], 5148, 7377	312-372 (4043); 309-369 (5148); 607-758 (7377)
OW2-1	6	-265	-355	-310	-290	-330	40	350-390	South Farmingdale Well Field 3	6150	545-612
OW2-2	7	-355	-437	-396	-376	-416	40	436-476	South Farmingdale Well Field 3	6150	545-612
OW3-1	7	-354	-435	-394.5	-374.5	-414.5	40	436.5-476.5	New York Water Service 3S and 4S	8480[1], 9338	570-665 (8480); 585-646 (9338)
OW3-2	9	-524	-601	-562.5	-542.5	-582.5	40	604.5-644.5	New York Water Service 3S and 4S	8480[1], 9338	570-665 (8480); 585-646 (9338)
OW4-1	10	-583	-630	-606.5	-586.5	-626.5	40	652-692	TOH Water District (Levittown) 13	5303	602-736
OW4-2	11	-630	-740	-685	-665	-705	40	730-770	TOH Water District (Levittown) 13	5303	602-736
									Massapequa Water District, Northwest Wellfield	6442, 6443	524-612, 770-850
									Massapequa Water District, Northeast Wellfield	4602, 5703, 8214, 9173	381-445, 382-458, 606-686, 764-845

Outpost monitoring wells are not planned for the Massapequa Water District at this time as modeling does not predict impacts at these wells in the 30-year modeling time period.

Elevations are given in feet relative to mean sea level.

(1) First well in well field predicted by modeling to be potentially impacted with VOCs; monitoring well cluster designed to monitor potential impacts at this well.

BLS Below landsurface
TOH Town of Hempstead
VOCs Volatile Organic Compounds

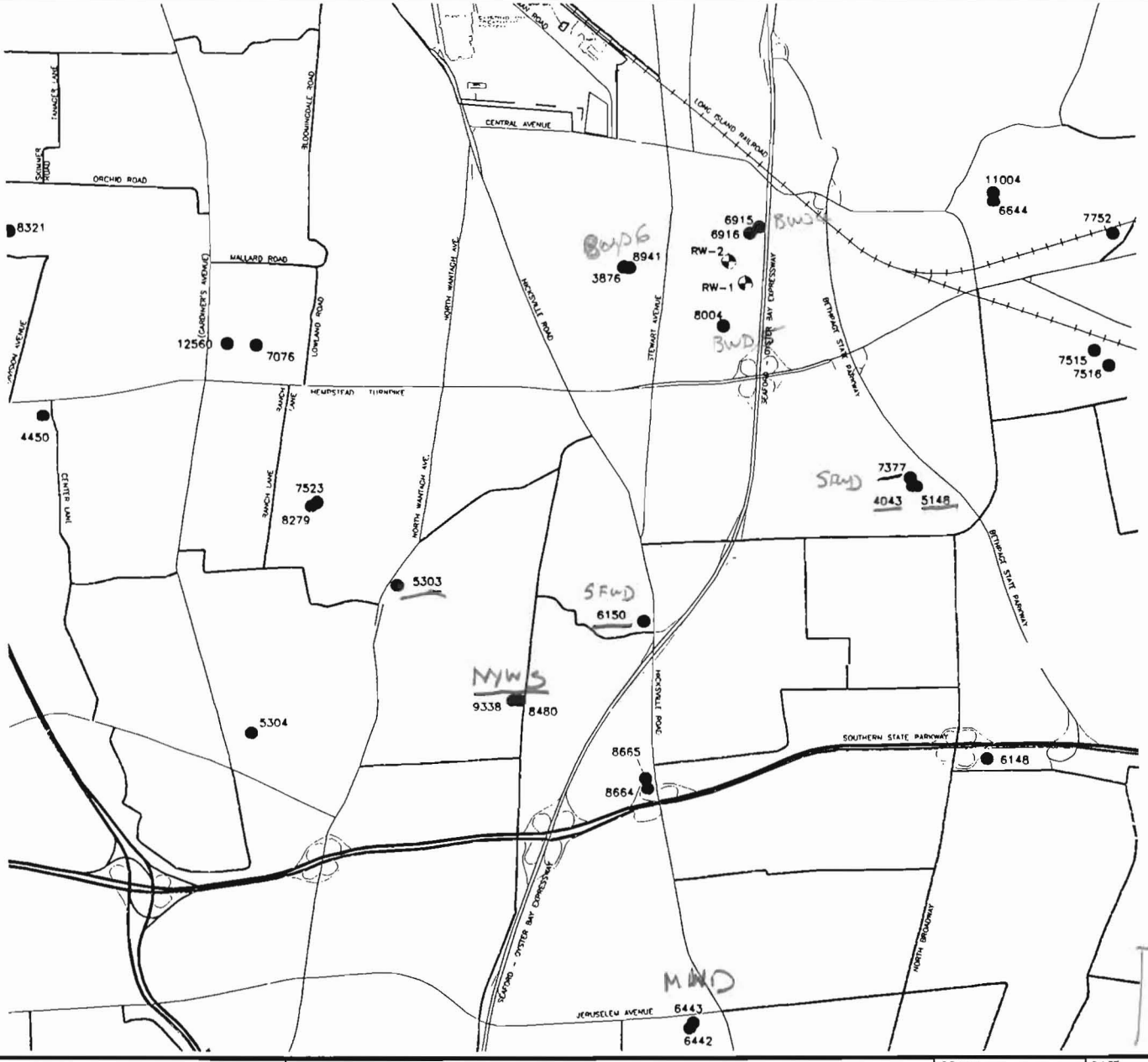
G:\TECHNICL\Porsche\NGModel\outpost wells\outpost location memo tables 1 and 2.xls- screen zones

Table A-3. Outpost Monitoring Well Trigger Values, Northrop Grumman Corporation - Bethpage, New York.

Outpost Well ID	Nearest Street Intersection of Outpost Well Location	Distance from Outpost Well to Municipal Supply Well (feet)	Municipal Supply Well ID	Outpost Well Trigger Value (ppb)	Time to Reach Trigger Value in Outpost Well (years)	Time to Detection in Municipal Supply Well (years)
OW1-1, OW1-2, OW1-3	Lawrence Street & Bruce Drive	625	4043	0.6	6	11
OW-2-1, OW-2-2	Harriet Road & Gloria Road	320	6150	--	--	4
OW3-1, OW3-2	Red Maple Drive East & Red Maple Drive North	975	8480	1.5	13	18
OW4-1, OW4-2	Elm Drive West & Elm Drive North	850	5303	1.5	--	--

Time to detection is number of years before detection of 0.5 ppb total volatile organic compounds (TVOC) in municipal supply well.
Trigger Value is TVOC concentration at outpost well 5 years before model predicted detection of 0.5 ppb at municipal supply well.
For Well 6150, travel time is too brief to determine trigger value, detection will occur in less than 5 years.
For Well 5303 trigger value and time to detection cannot be determined because the model does not predict a detection to occur at Well 5303 based on current plume delineation, however, as a conservative measure a trigger value of 1.5 ppb has been selected (same as for Outpost Wells OW2-1, OW3-2). The highest of the calculated trigger values was selected because a trigger value for a well where there is no prediction of impact should not be lower than for a well where there is a prediction of impact.

ppb parts per billion



LEGEND

- PROPOSED REMEDIAL WELL
- SUPPLY WELL

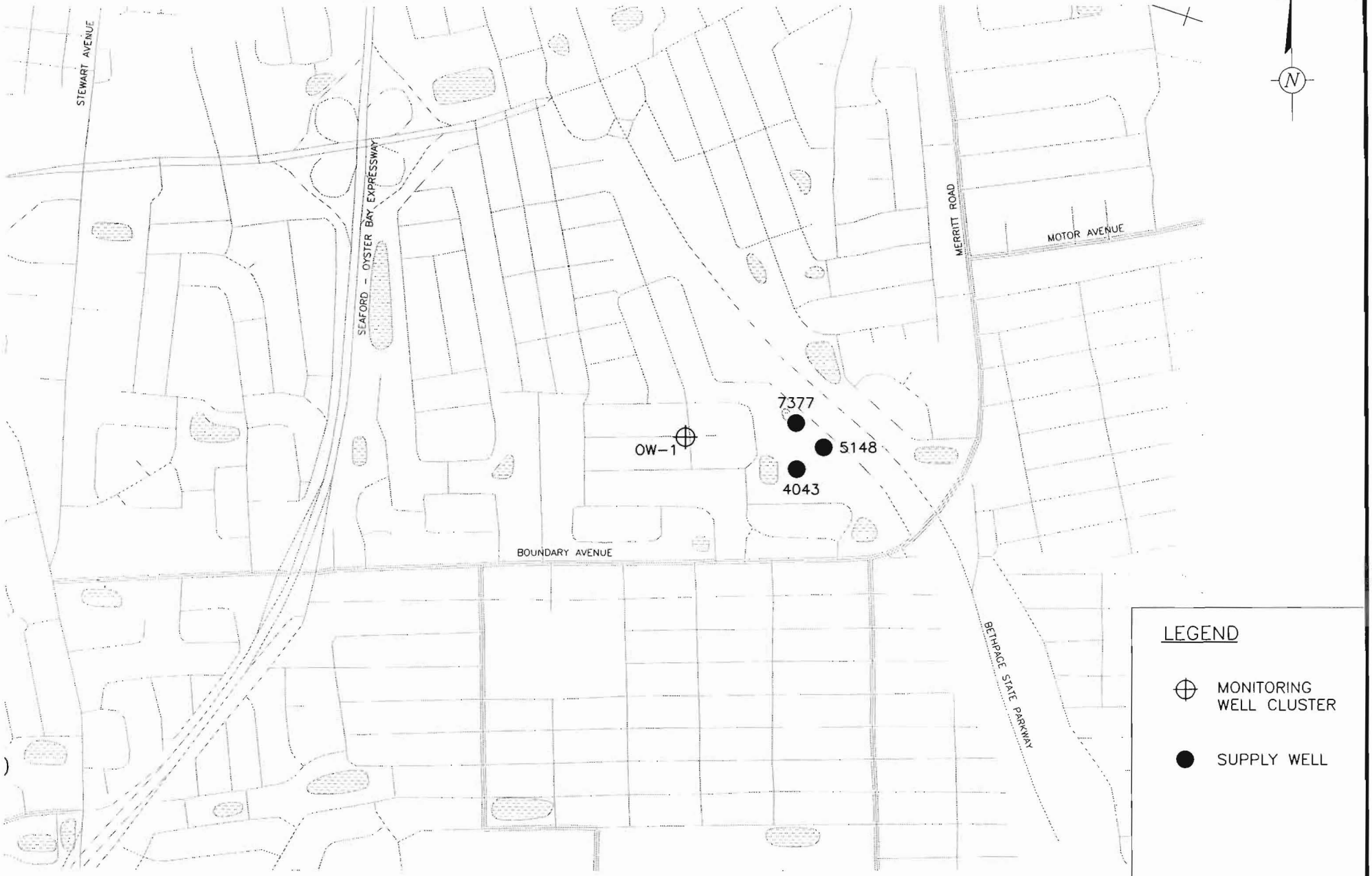
NOTES:
MASSAPEQUA WATER DISTRICT PUBLIC SUPPLY WELLS 4602, 5703, 8214, AND 9173 LOCATED APPROXIMETLY 7,000 FT EAST OF NORTH BROADWAY AND 1,600 FT SOUTH OF SOUTHERN STATE PARKWAY.

0 3000
SCALE IN FEET

G:\APROJECT\Northrop Grumman\Cadd\GW-38\WELL_LOCATIONS.dwg

ARCADIS

DRAWN: LMC	DATE: 11/26/02	PROJECT MANAGER: R. PORSCHE	DEPARTMENT MANAGER: N. VALKENBURG
LOCATIONS OF SELECT MUNICIPAL SUPPLY WELLS AND PROPOSED REMEDIAL WELLS NORTHROP GRUMMAN CORPORATION		LEAD DESIGN PROF.	CHECKED: R. PORSCHE
		PROJECT NUMBER: NY001321.0006.00003	DRAWING NUMBER: A-1



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SCALE IN FEET

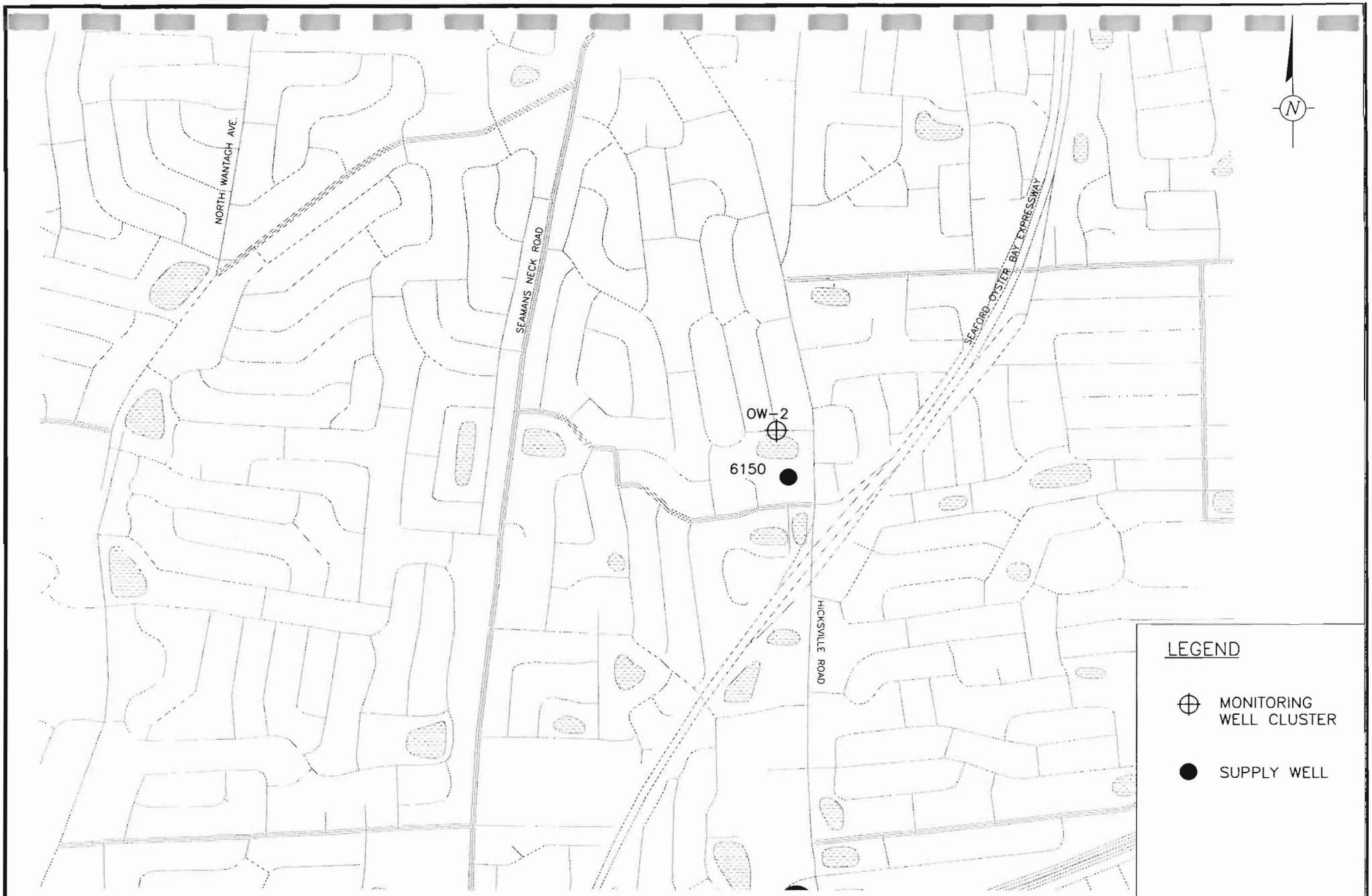
G:\APROJECT\Northrop Grumman\Cadd\GW-38\OW-FIELD1A-R1.dwg

ARCADIS

DRAWN: LMC	DATE: 11/26/02	PROJECT MANAGER: R. PORSCHE	DEPARTMENT MANAGER: N. VALKENBURG
		LEAD DESIGN PROF.	CHECKED: R. PORSCHE
		PROJECT NUMBER: NY001321.0006.00003	DRAWING NUMBER: A-2

OUTPOST MONITORING WELL CLUSTER LOCATION FOR SOUTH FARMINGDALE'S WELL FIELD NO. 1

NORTHROP GRUMMAN CORPORATION



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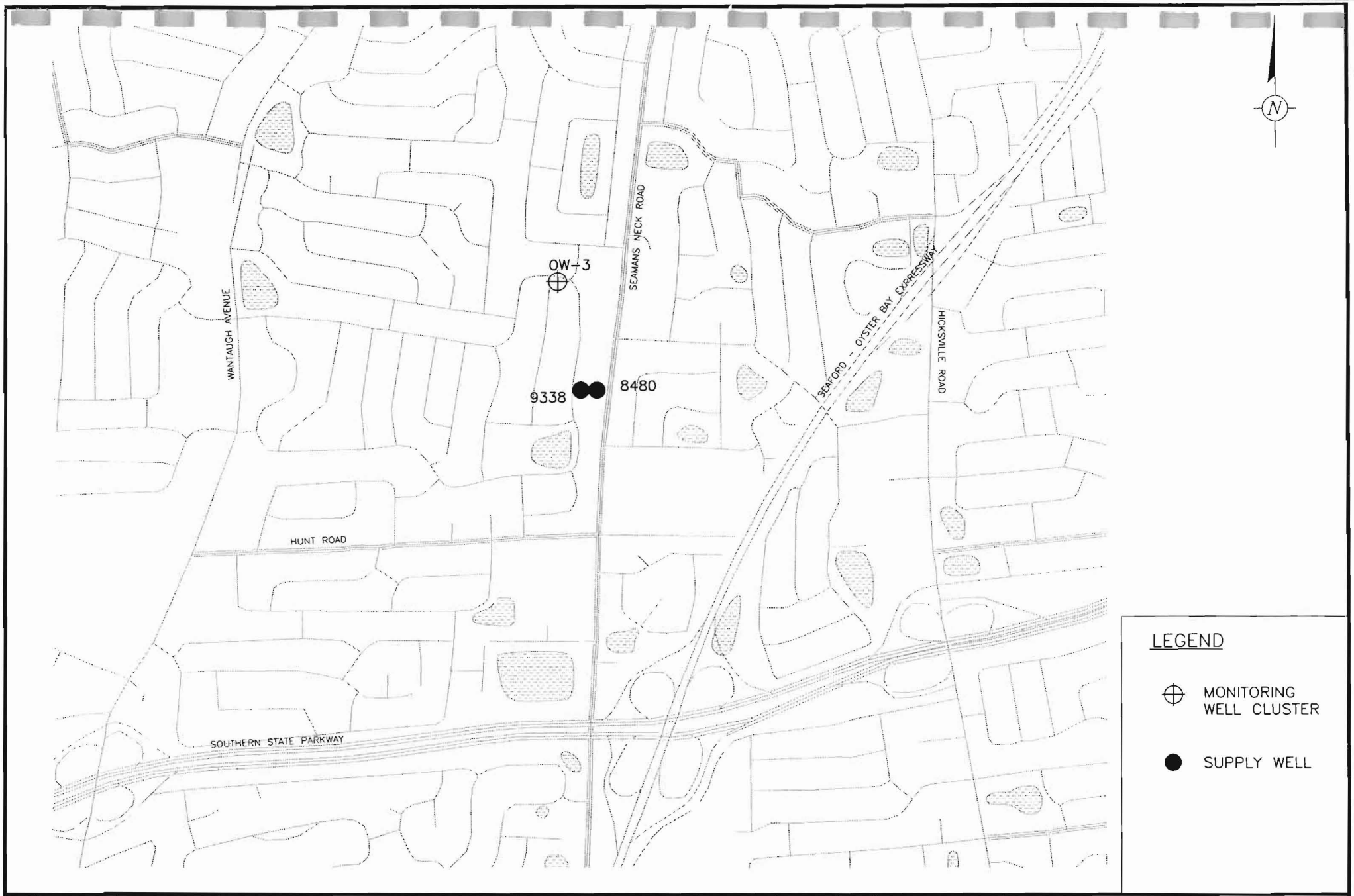
ARCADIS

DRAWN: LMC	DATE: 11/26/02	PROJECT MANAGER: R. PORSCHE	DEPARTMENT MANAGER: N. VALKENBURG
OUTPOST MONITORING WELL CLUSTER LOCATION FOR SOUTH FARMINGDALE WELL FIELD NO. 3 NORTHROP GRUMMAN CORPORATION		LEAD DESIGN PROF.	CHECKED: R. PORSCHE
		PROJECT NUMBER: NY001321.0006.00003	DRAWING NUMBER: A-3



0 1000
SCALE IN FEET

G:\PROJECT\Northrop Grumman\Cadd\GW-38\OW-NYWS-R1.dwg

ARCADIS

DRAWN: LMC	DATE: 11/26/02	PROJECT MANAGER: R. PORSCHE	DEPARTMENT MANAGER: N. VALKENBURG
OUTPOST MONITORING WELL CLUSTER LOCATION FOR THE NEW NEW YORK WATER SERVICE WELL FIELD (WELLS 8480 AND 9338) NORTHROP GRUMMAN CORPORATION		LEAD DESIGN PROF.	CHECKED: R. PORSCHE
		PROJECT NUMBER: NY001321.0006.00003	DRAWING NUMBER: A-4

0 1000
SCALE IN FEET

G:\APROJECT\Northrop Grumman\Cadd\GM-38\OW-LEVITTOWN-R1.dwg

ARCADIS

DRAWN LMC	DATE 7/22/03	PROJECT MANAGER R. PORSCHE	DEPARTMENT MANAGER N. VALKENBURG
OUTPOST MONITORING WELL CLUSTER LOCATION FOR THE TOWN OF HEMPSTEAD WATER DISTRICT (LEVITTOWN) WELL FIELD NO. 13		LEAD DESIGN PROF.	CHECKED R. PORSCHE
NORTHROP GRUMMAN CORPORATION		PROJECT NUMBER NY001321.0006.00003	DRAWING NUMBER A-5

ARCADIS

Appendix B

Work Plan for Outpost Monitoring Well Installation

Work Plan Addendum

for

Outpost Monitoring Well Installation Program

Naval Weapons Industrial Reserve Plant

Bethpage, New York

Engineering Field Activity Northeast
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0812

February 2003

Revision 2 - July 2003

TETRA TECH NUS, INC.

WORK PLAN ADDENDUM
FOR
OUTPOST MONITORING WELL INSTALLATION PROGRAM

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Northeast
Environmental Branch Code EV2
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop #82
Lester, Pennsylvania 19113-2090

Submitted by:
Tetra Tech NUS, Inc.
600 Clark Avenue, Suite 3
King of Prussia, Pennsylvania 19406-1433

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0812

JULY 2003

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1.0 INTRODUCTION AND OVERVIEW

Tetra Tech NUS, Inc. (TtNUS) has been contracted to perform a subsurface investigation for the Department of Navy, Engineering Field Activity Northeast (EFANE) at and near the Naval Weapons Industrial Reserve Plant (NWIRP) in Bethpage New York (hereinafter referred to as the site). Since 1994, Northrop Grumman, the U.S. Navy, and the New York State Department of Environmental Conservation (NYSDEC) have been working together to address the regional groundwater contamination issues associated with historic NWIRP Bethpage and Northrop Grumman Corporation operations.

A Record of Decision (ROD) was published by the Navy in April 2003 that identified a series of actions be taken by the Navy to address groundwater contamination that lies beneath and to the south of their respective properties.

As a result, several vertical profile borings were installed to delineate the southern boundary of a groundwater contaminant plume. The sampling data from these borings were used to locate the proposed well clusters to be installed as part of this program. This document is the work plan for the outpost monitoring well program, which will include the drilling and installation of 9 monitoring wells at 4 locations off the Navy property. The drilling locations are shown on Figure 1 and are further detailed in Figures 2 and 3. A summary of the drilling program is included in Table 1. Figures and tables are provided at the end of the document.

This section provides an introduction and overview of the program. Section 2 describes the necessary tasks to complete the fieldwork activities.

Monitoring wells will be installed to different depths, which are classified as Deep (D), Deep 2 (D2), and Deep 3 (D3), as defined below.

- Deep (D) zone -50 to -365 ft msl.
- Deep 2 (D2) zone -365 to -530 ft msl.
- Deep 3 (D3) zone -530 to -680 ft msl.

The wells will be installed in clusters, and drilled, installed, and developed in the following general order, however, site-specific conditions may cause the sequence to be modified:

1. Drill the deepest boring and collect split-spoon samples.

2. Gamma Log the deepest boring.

3. Install the deepest well (includes setting the screen and installing the backfill materials, seals, and locking protective casing), see Attachment 1.

4. Drill and install the remaining shallow wells in the cluster, collecting split spoon samples as described in Section 2.

5. Develop wells.

2.0 FIELD INVESTIGATION TASKS

The tasks that are necessary to complete the field activities are described in this section.

2.1 MOBILIZATION/DEMOBILIZATION

The subsurface investigation will be performed by TtNUS, with support from subcontractors for drilling, investigation derived waste (IDW) disposal, and surveying activities. The supervisor of the team will be a TtNUS representative, who will be identified as the Field Operations Leader (FOL). Additional TtNUS staff will be on-site as needed, and the subcontractor staff will vary from one individual for IDW activities upwards to several people for drilling activities.

It should be noted that the drilling sites are on publicly owned property lots. Access to the lots will be obtained and coordinated by the Navy.

The TtNUS FOL will obtain the necessary equipment for completion of the fieldwork, including setting up the command post. Health and Safety training will be conducted for all site personnel, including maintaining all necessary documentation and ensuring compliance in accordance with the Health and Safety Plan and the subcontract documents. Locations will be cleared of utilities prior to drilling.

2.2 DRILLING ACTIVITIES

Drilling activities will be performed using mud rotary drilling techniques. A boring log will be maintained for each boring drilled.

2.2.1 Mud Rotary Drilling

The well boring diameters will be at least 8 inches to provide sufficient annular space for the installation of 4 inch-diameter wells. A smaller diameter pilot hole can be drilled during soil sampling, however, the boring must be reamed with a larger drill bit prior to well installation. The drill bit and drill rods shall be the type to accommodate split spoon sampling through the drill string. A multi-baffle chamber, high capacity mud pan or dug mud pit will be used to hold drilling mud during the drilling activity. The injection of water and polymer-free bentonite drilling mud is allowed. All lubricants that will potentially come in contact with the drilling mud will be of food grade quality. The use of any other types of additives is prohibited without prior approval of the TtNUS Project Manager.

2.3 SOIL/GROUNDWATER SAMPLING

Soil samples will be collected from the each of the well borings for lithologic descriptive purposes. The soil samples will be collected using split spoon samplers according to American Society for Testing and Materials (ASTM) D-1586 methods. In the deepest boring at each cluster soil samples will be collected at 100 foot intervals throughout the boring. For the other borings in each cluster soil samples will not be collected. Since drilling techniques for the permanent monitoring wells are different than for profile borings, vertical profile boring-type groundwater samples will normally not be collected during the installation of the outpost monitoring wells. However, if based on the boring lithology data, a target screen interval is determined to consist primarily of fine-grained material not appropriate for setting a well screen, then groundwater samples will be collected, in accordance with the Outpost Monitoring Well Drilling Contingency Procedures presented in Attachment 1, to aid in the selection of an alternative screen zone.

A groundwater sample will be collected during the final purge of each outpost monitoring well. This sample will be collected by reducing the discharge rate of the submersible pump to a minimum and then directly filling sample vials from the tubing discharge. The sample will be analyzed for VOCs. This data is considered to be semi-quantitative and will only be used as an initial screen of the quality of the water in the well.

2.4 NATURAL GAMMA LOGGING

Downhole natural gamma logging will be performed by the drilling subcontractor in the Outpost Well borings as shown on Table 1. Upon reaching the final depth of the boring, the downhole drilling equipment will be removed, and gamma logging will be performed from the land surface to the total depth of the boring. The results of the logging will be evaluated by TtNUS and Arcadis Geraghty and Miller (Northrop Grumman) and will be used in combination with split spoon sample observations to determine exact well screen placements.

2.5 MONITORING WELL INSTALLATION

Monitoring wells will be installed with the screen intervals shown on Table 1. A typical well construction detail is provided in Figure 4. The well screen and riser pipe will be lowered into the open hole after the drilling mud is thinned to the fullest extent possible without resulting in excessive caving. The mud rotary borings will also be reamed along the screened interval, prior to well installation to remove as much drilling mud as possible. The depths of all backfilled materials will be constantly monitored during the well installation process by means of a wire-line measuring device.

The outpost wells will be constructed of 4-inch diameter, schedule 80 National Sanitation Foundation (NSF)-grade Polyvinyl Chloride (PVC) well casing and screen. Only materials meeting American Petroleum Institute (API) and ASTM water well standards will be used. All well screens (slotted construction) will be 10 slot (0.010 inches). A vented PVC well cap and threaded PVC bottom cap will be installed on each well. All riser and screen sections will be flush-joint, internally-threaded. Joints will be made up so that when tight, all threads are buried within the riser walls. No couplings, solvents, glues, or chemical cleaners will be used in well construction.

After setting the well screen and casing, the gravel pack (W.G. No. 1) will be placed within the boring annulus, to a depth as identified in Table 1. The well gravel will be placed as follows:

- Deep (D) Wells: to a minimum of 10 feet above the top of the screen.
- Deep 2 (D2) Wells: to a minimum of 20 feet above the top of the screen.
- Deep 3 (D3) Wells: to a minimum of 25 feet above the top of the screen.

The gravel pack will be carefully placed into the annulus through a tremie pipe and its depth will be carefully checked during placement to be sure that it has not bridged. A fine sand layer (finer than gravel pack) will be placed in the annulus on top of the gravel pack in the same manner as the gravel pack, as follows:

- Deep (D) Wells: 5 feet thick above the top of the gravel pack.
- Deep 2 (D2) Wells: 10 feet thick above the top of the gravel pack.
- Deep 3 (D3) Wells: 15 feet thick above the top of the gravel pack.

The gravel pack and fine sand thickness may be changed based on subsurface conditions. A 4- to 8-foot thick bentonite seal will be installed above the fine sand layer using a tremie pipe. The seal will consist of approximately 1.25 pounds of pure bentonite per gallon of water. A Volclay® bentonite slurry will be installed within the annular space above the bentonite seal using a tremie pipe. In all wells, the slurry will be installed to approximately 3 feet below land surface in one continuous operation. The tremie pipe will be gradually removed from the annular space as the slurry is added from the bottom up. Upon approval by the TtNUS representative a cement-bentonite slurry may also be used within the annular space at depths no deeper than 100 feet below ground surface.

Wells will be completed at grade by cementing a 12-inch diameter, locking curb box in place over the wells. A fine sand will be installed above the top of the bentonite slurry and inside the curb box to permit any water which may accumulate inside the curb box to drain. A 0.5 foot thick concrete apron measuring

2 feet by 2 feet square will be placed around each well. Keyed alike well locks will be used to secure the wells. A typical well detail is provided on Figure 4.

2.6 MONITORING WELL DEVELOPMENT

The monitoring wells will be developed no sooner than 24 hours after installation to remove fine materials and sediments from the area around the well screens, and to remove drill cuttings and residual fluids from the area around the monitored interval of the boring.

Monitoring wells will be developed using a combination of air lift and mechanical surging. A threaded, 2-inch diameter steel eductor pipe with a dual surge block assembly (i.e., two rubber swabs set 3 feet apart along a length of perforated steel pipe) will be installed in the well with the surge block set at the base of the well screen. A 3/4-inch diameter polyethylene airline will then be inserted in the eductor pipe to a depth above the top of the well screen. The well will be developed using the combination of air lift pumping and surging (vertical movement of the surge block in the screen zone) at 2-foot discrete intervals upwards along the entire length of the well screen. Field parameters, including pH (standard units), specific conductance [millisiemen per centimeter (mS/cm)], temperature (degrees in centigrade), and turbidity [nephelometric turbidity units (NTU)] will be monitored and recorded periodically throughout well development.

Well development will also include purging stagnant water from the well above the screen interval and rinsing the interior well casing above the water table by using only water from that well. The well will be covered with a clean well cap, which will be rinsed with distilled water prior to installation. The result of this operation will be a well casing free of extraneous materials (grout, bentonite, sand, etc.). At the end of the purging stage, the water extraction rate will be decreased and a groundwater sample will be collected from each well.

Development will continue until all traces of drilling mud are removed, and the well produces clear, sediment-free water, to the extent practical. In compliance with NYSDEC policy, every effort will be made to develop wells until turbidity (as measured in the field) is less than 50 NTUs. However, in some instances, the 50 NTU standard may not be attainable, if the observed turbidity is the result of the formation screened and not related to well design, installation, or development. Therefore, if after a "best well development effort," the 50 NTU standard cannot be attained and turbidity stabilizes (above the 50 NTU standard), the well will be considered acceptable, provided the integrity of the well is satisfactorily proven.

The development fluid will be containerized and transported to the decontamination area where it will be stored in a tank.

2.7 INVESTIGATIVE DERIVED WASTE HANDLING

All Investigative Derived Waste (IDW) accumulated during drilling activities will be collected, accumulated at the NWIRP Bethpage, and eventually disposed off site. These materials include soil cuttings, drilling mud, discharge water, development water, and decontamination water. The soil cuttings and drilling mud will be collected in 55 gallon drums by the drilling subcontractor and will be transferred to a rolloff container that is capable of separating liquids from solid materials. The separated liquids will be pumped from the rolloff container to a holding tank. The discharge waters and decontamination waters will be collected by the drilling contractor and will be transferred to the holding tank. All wastes will be staged for future characterization and disposal.

2.8 DECONTAMINATION

A centrally located decontamination pad on the NWIRP Bethpage will be used for the collection of all decontamination-generated fluids. All decontamination fluids will be collected and staged for characterization and subsequent disposal.

The decontamination operations will consist of washing drilling equipment using a high-pressure potable steam wash. The spilt spoons and the downhole groundwater sampling equipment will be decontaminated with a detergent wash, a potable water rinse, and a deionized water rinse.

2.9 SURVEYING

All newly installed monitoring wells will be surveyed by a New York State-licensed surveyor for both horizontal and vertical control. A total of three monitoring well reference points will be surveyed for vertical control, including the top of the protective casing, the top of the riser pipe, and the ground surface. The center of the well cap will be surveyed for horizontal control.

2.10 DOCUMENTATION

Documentation required to support this project will consist of the following items:

- Field Notebook
- Boring log for each boring
- Well completion form for each well
- Well development record

2.11 SPILL CONTROL MEASURES

Spills will be controlled using the measures that are defined in the Heath and Safety Plan. The general process will include immediate response to contain the spill and subsequent cleanup measures to prevent any further impact to the environment.

2.12 REPORTING

A monitoring well installation summary report will be prepared and submitted as before. This report will include geologic logs, well construction diagrams, gamma logs, sample results and development data.

TABLE 1

OUTPOST MONITORING WELL
PROPOSED DRILLING AND SAMPLING SPECIFICATIONS
NWIRP BETHPAGE, NEW YORK

Outpost Well Designation	Screened Interval (ft bgs)[1]	Total Well Depth (ft bgs)[1]	Height Gravel Pack (ft bgs)[1]	Height Fine Sand (ft bgs)[1]	Number of Split Spoons[2]	Gamma Log	Municipal Supply Well Nos.	Municipal Well Field Monitored
OW1-1(D)	196 to 236	236	186	181	0	No	4043[3], 5148, 7377	South Farmingdale Well Field 1
OW1-2(D)	274 to 314	314	264	259	0	No	4043[3], 5148, 7377	South Farmingdale Well Field 1
OW1-3(D)	369 to 409	409	359	354	3	Yes	4043[3], 5148, 7377	South Farmingdale Well Field 1
OW2-1(D)	305 to 390	390	340	335	0	No	6150	South Farmingdale Well Field 3
OW2-2(D2)	436 to 476	476	416	406	4	Yes	6150	South Farmingdale Well field 3
OW3-1(D2)	437 to 477	477	417	407	0	No	8480[3], 9338	New York Water Service 3S and 4S
OW3-2(D3)	605 to 645	645	580	565	5	Yes	8480[3], 9338	New York Water Service 3S and 4S
OW4-1(D3)	652 to 692	692	627	612	0	No	5303	TOH Water District (Levittown) 13
OW4-2(D3)	730 to 770	770	705	690	13	Yes	5303	TOH Water District (Levittown) 13

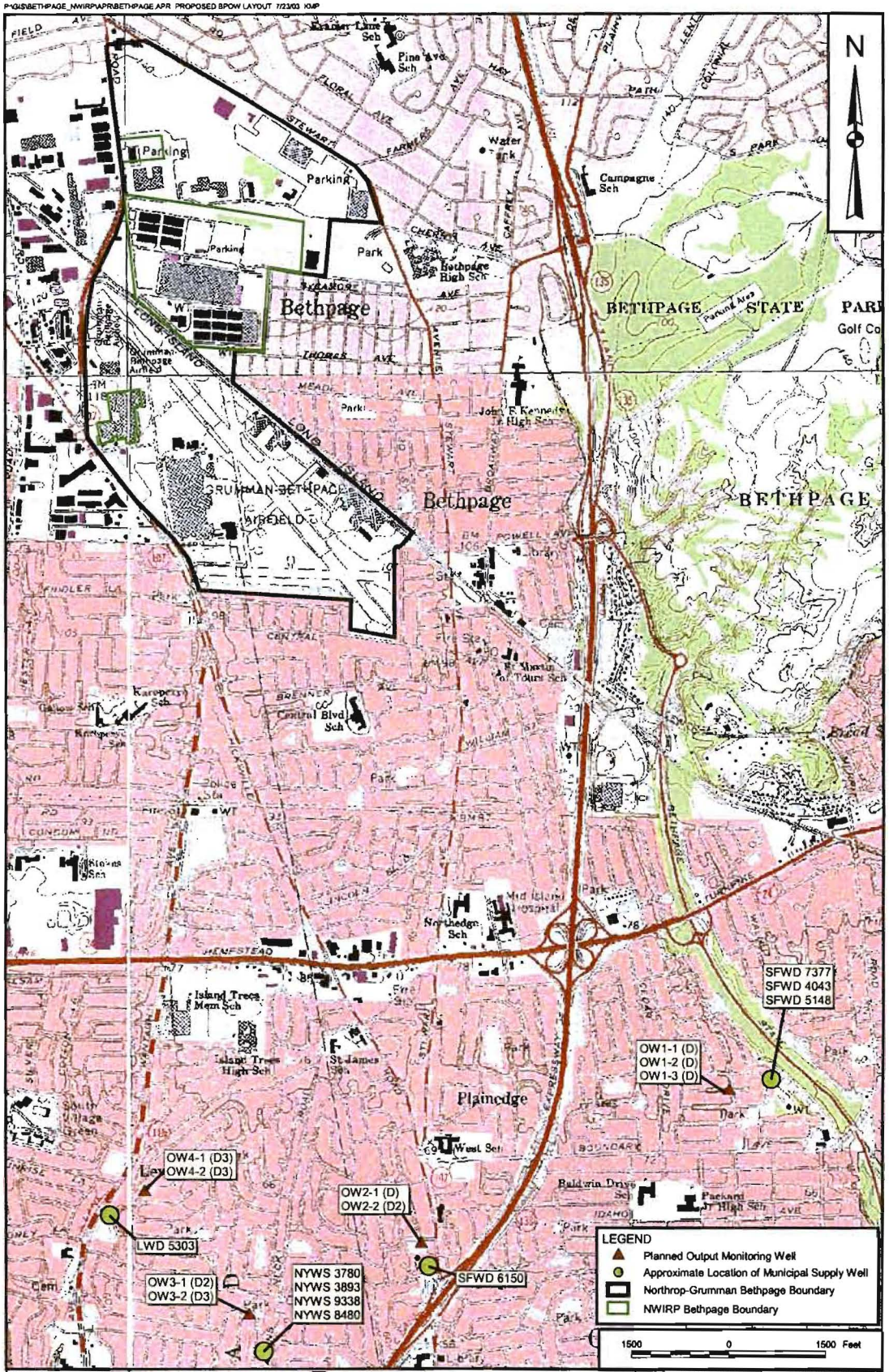
bgs - Below ground surface
ft - feet

1 Based on the local USGS quad sheet, ground surface is assumed to range from 60 to 74 feet above mean sea level. Final screen intervals wil be determined in the field based on boring specific lithology.

2 In the deepest well at each cluster, split spoon samples will be collected at 50-foot intervals to approximately 20-foot above the well screen, then samples will be collected at 5-foot intervals to the bottom of the boring. For the other remaining borings at each cluster, split spoon samples will need only be collected starting at 20-foot above the well screen to the bottom of the boring. Groundwater samples will be collected during the final purge of each outpost monitoring well and analyzed for VOCs. In addition, groundwater samples may be collected during drilling of the boring in accordance with Drilling Contingency Procedures.

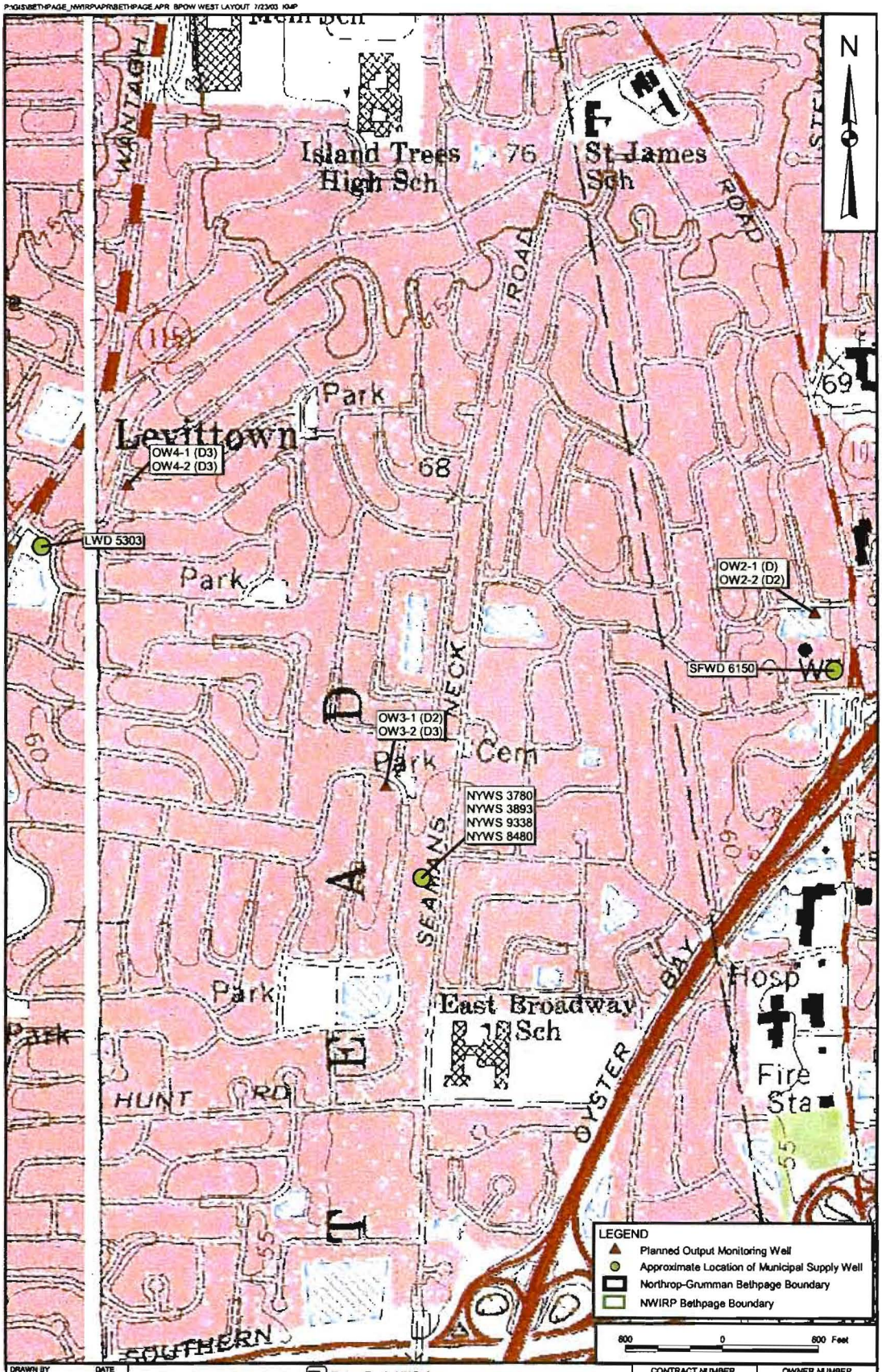
3 Based on modeling efforts, this well will be the first location to be impacted at the well field. The outpost monitoring wells are designed to monitor this well for impact.

P:\GIS\BETHPAGE_NWIRP\APR\BETHPAGE.APR PROPOSED BPOW LAYOUT 7/23/03 KMP



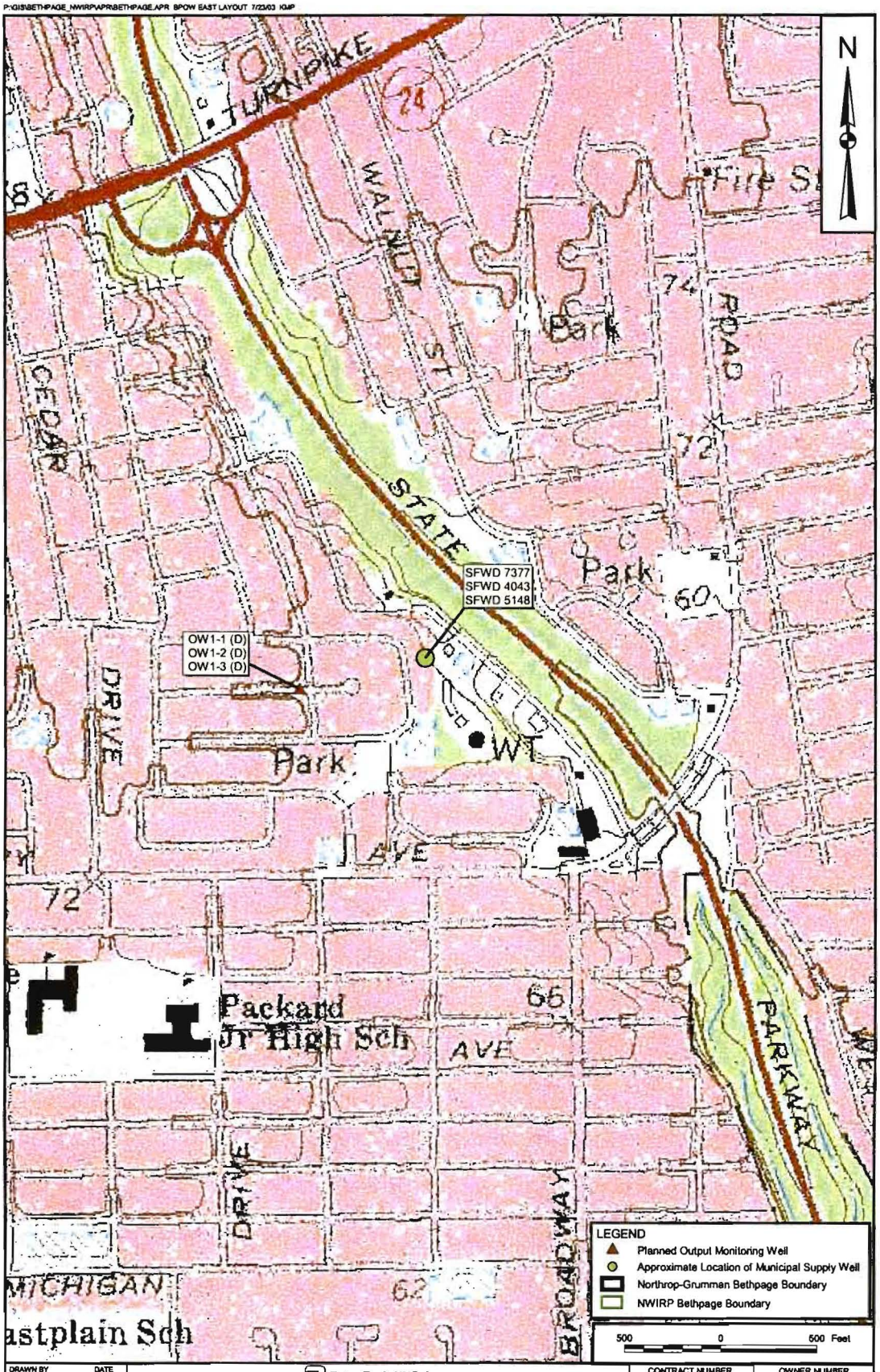
DRAWN BY: J. LAMEY	DATE: 4/28/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER: N4037 / OWNER NUMBER: —
CHECKED BY: D. BRAYACK	DATE: 12/23/02	LOCATION OF OUTPOST MONITORING WELLS NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BETHPAGE, NEW YORK	APPROVED BY: — / DATE: —
COST/SCHEDULE-AREA: —			APPROVED BY: — / DATE: —
SCALE: AS NOTED			DRAWING NO.: FIGURE 1 / REV: 0

P:\GIS\BETHPAGE_NWIRP\APR\BETHPAGE.APR 8POW WEST LAYOUT 7/23/03 KMP



DRAWN BY: A. JANOCHA — DATE: 12/31/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: N4037	OWNER NUMBER:
CHECKED BY: D. BRAYACK — DATE: 12/23/02	LOCATION OF OUTPOST MONITORING WELLS NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BETHPAGE, NEW YORK	APPROVED BY: — DATE: —	
COST/SCHEDULE-AREA: —		APPROVED BY: — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE 2	REV: 0

P:\GIS\BETHPAGE_NWIRP\APR\BETHPAGE.APR 8POW EAST LAYOUT 7/23/03 IGMP



DRAWN BY: A. JANOCHA — DATE: 12/31/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: N4037	OWNER NUMBER: —
CHECKED BY: D. BRAYACK — DATE: 12/31/02	LOCATION OF OUTPOST MONITORING WELLS NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BETHPAGE, NEW YORK	APPROVED BY: — DATE: —	
COST/SCHEDULE-AREA: —		APPROVED BY: — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE 3	REV: 0

FIGURE 4
TYPICAL MONITORING WELL CONSTRUCTION

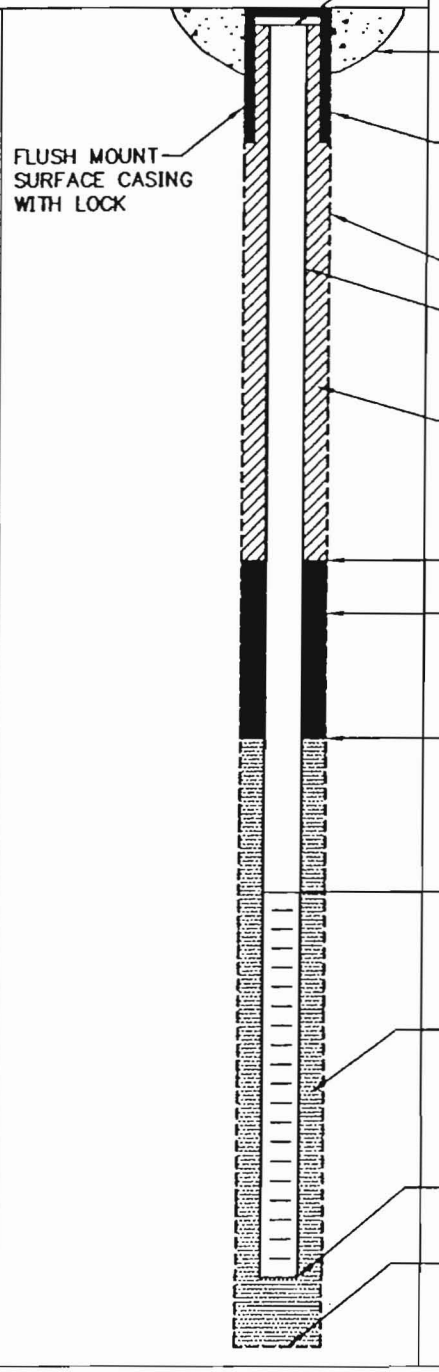
WELL NO.: _____

Tetra Tech NUS, Inc.

OVERBURDEN
MONITORING WELL SHEET
FLUSH - MOUNT

PROJECT NWIRP Bethpage	LOCATION _____	DRILLER _____
PROJECT NO. N4037	BORING _____	DRILLING METHOD Mud Rotary
DATE BEGUN _____	DATE COMPLETED _____	DEVELOPMENT METHOD Air Lift / Pump
FIELD GEOLOGIST _____		
GROUND ELEVATION _____	DATUM _____	

ACAD:FORM_MWFM.dwg 07/20/99 INL



ELEVATION TOP OF RISER: _____

TYPE OF SURFACE SEAL: 2'x2' Cement Pad

TYPE OF PROTECTIVE CASING: Steel

I.D. OF PROTECTIVE CASING: 12"

DIAMETER OF HOLE: 8"

TYPE OF RISER PIPE: PVC-Sch. 80

RISER PIPE I.D.: 3.8

TYPE OF BACKFILL/SEAL: Bent / Cement to 100' below ground surface

ELEVATION/DEPTH TOP OF SEAL: /

TYPE OF SEAL: Bentonite

ELEVATION/DEPTH TOP OF SAND: /

5' to 15' Fine Sand (WG00)
10' to 25' Coarse Sand (WG#1) above screen

ELEVATION/DEPTH TOP OF SCREEN: /

TYPE OF SCREEN: PVC-Schedule 80

SLOT SIZE x LENGTH: No 10 Slot, ~40'

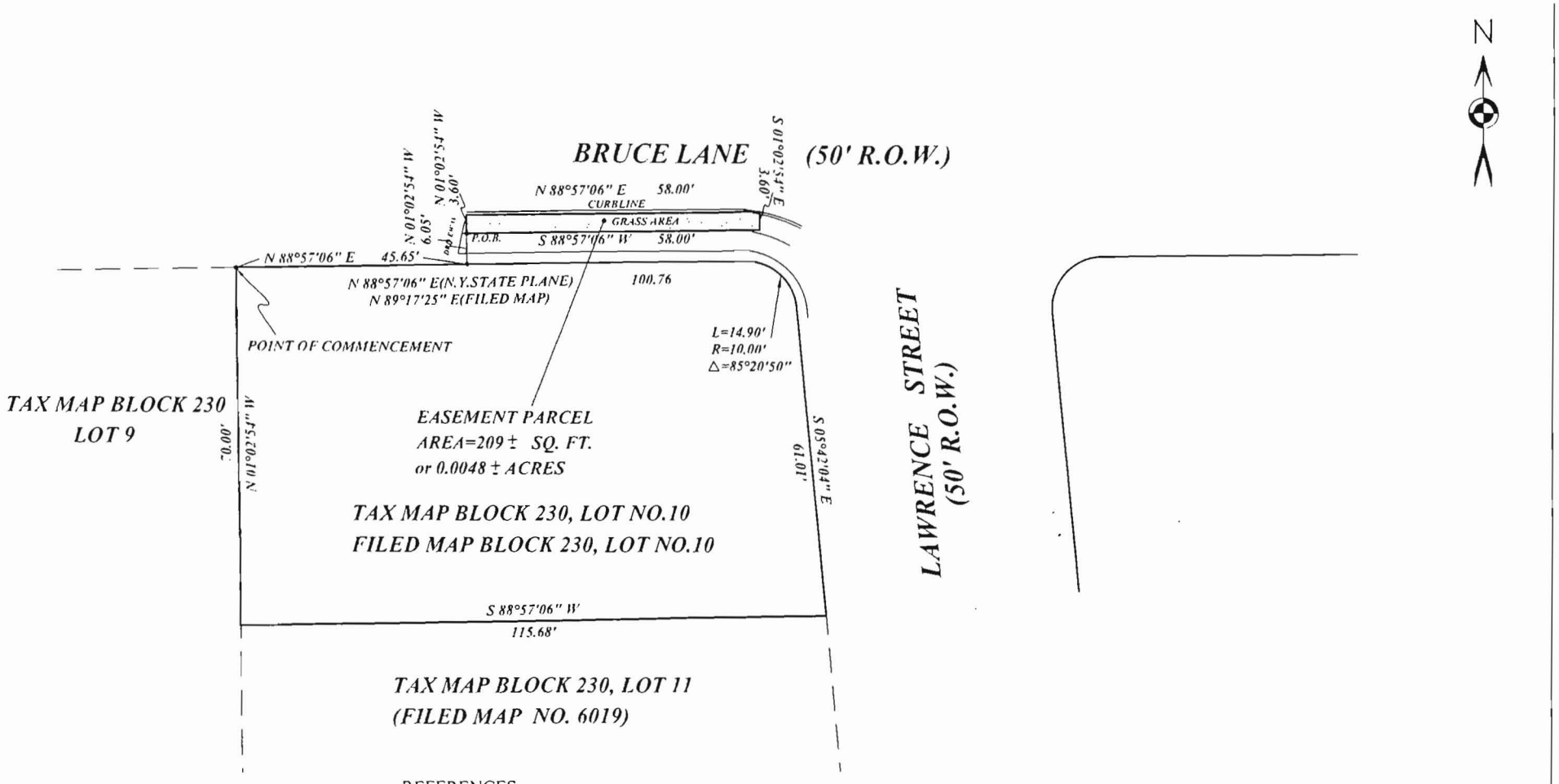
TYPE OF SAND PACK: WG #1 Silica Sand

ELEVATION / DEPTH BOTTOM OF SCREEN: /

ELEVATION / DEPTH BOTTOM OF SAND: /

ELEVATION/DEPTH BOTTOM OF HOLE: /

BACKFILL MATERIAL BELOW SAND: _____



NOTES

1. Tax Map Section 49, Block 230, Lot No.10.
2. Bearings shown in N.Y.State Plane {NAD-83(86)}on the herein Easement Parcel were derived by subtracting 0° 20' 19" from Filed Map azimuth.
3. Any alteration or addition to this survey is a violation of Section 7209 of The New York State Education Law,except as per Section 7209-Subdivision 2.

NTS

REFERENCES:

1. "Map of Pinehurst - Section 1..... Filed in the NCCO, Division of Land Records on September 13, 1951 as Map No. 5308.
2. "Map of Pinehurst-Section-2..." filed in the NCCO, Division of Land Records on Dec. 14, 1953 as Map No.6019.
3. Nassau County Land & Tax Map Block 230, Section 49 Town of Oyster Bay.

NO	DATE	DESCRIPTION REVISIONS	APPR'D.

DRAWN BY: R.C'R
CHECKED BY: N.E.B.

SCALE: 1"=20'

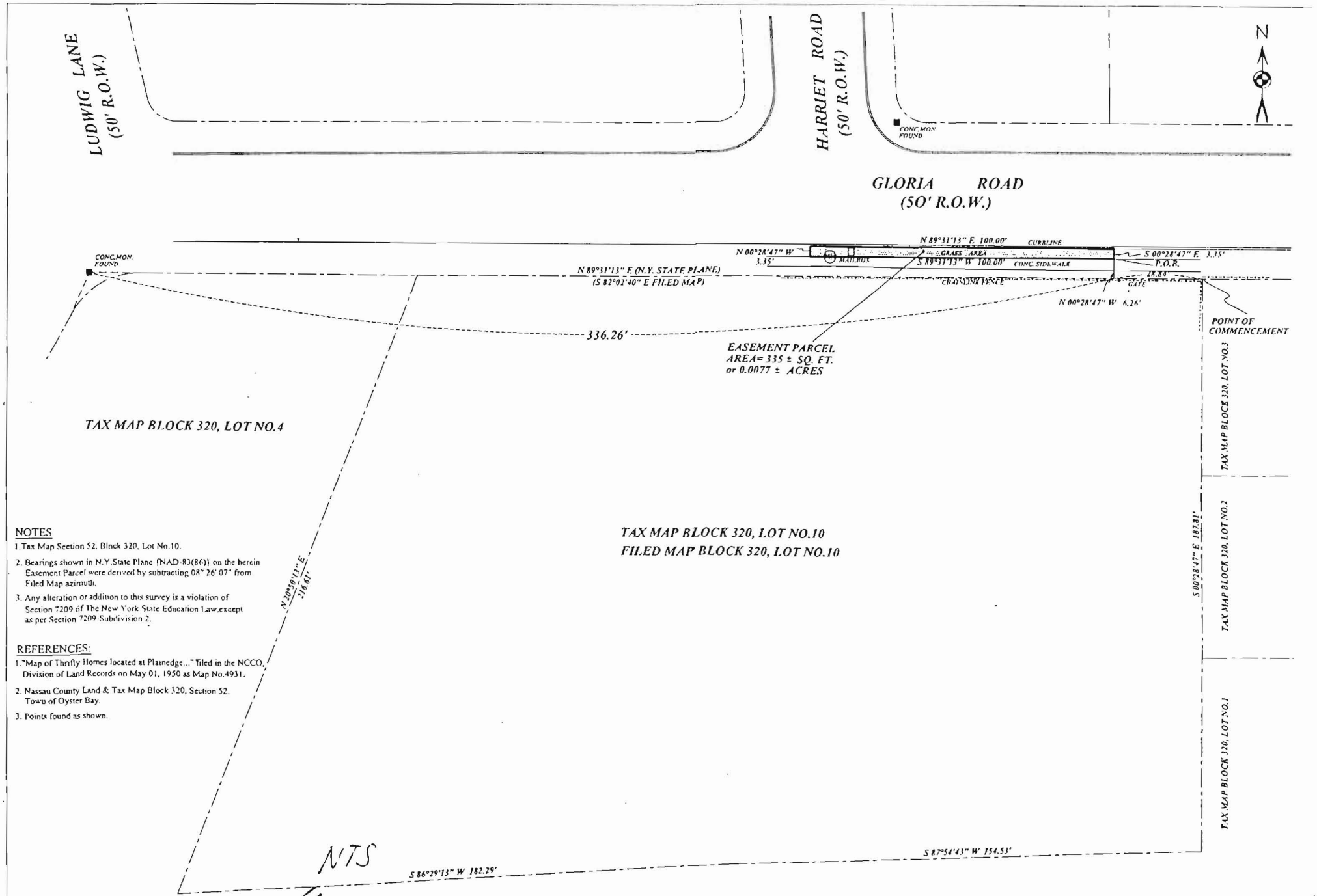
HIRANI ENGINEERING & LAND SURVEYING, P.C.
47 MINEOLA BLVD., 2ND FLOOR
MINEOLA, N.Y. 11501
T (516) 248-1010 F (516) 248-9018
HIRANI

OWNER: **U.S DEPT. OF NAVY**

CONTRACTOR: TETRA TECH NUS

SUBJECT:
EASEMENT FOR OUTPOST MONITORING WELLS BP-OW 1-1 (D),BP-OW 1-2 (D) & BP-OW 1-3(D).

DATE DRAWN: 07/15/03
DATE OF SURVEY: 07/02/2003
CONTRACT# S02-2117
SHEET NO. 1 OF 1



NOTES

1. Tax Map Section 52, Block 320, Lot No.10.
2. Bearings shown in N.Y.State Plane (NAD-83(86)) on the herein Easement Parcel were derived by subtracting 08° 26' 07" from Filed Map azimuth.
3. Any alteration or addition to this survey is a violation of Section 7209 of The New York State Education Law,except as per Section 7209-Subdivision 2.

REFERENCES:

1. "Map of Thrifty Homes located at Plainedge..." Filed in the NCCO, Division of Land Records on May 01, 1950 as Map No.4931.
2. Nassau County Land & Tax Map Block 320, Section 52, Town of Oyster Bay.
3. Points found as shown.

NTS

NO.	DATE	DESCRIPTION	APPR'D.
		REVISIONS	

DRAWN BY: B.C.R.
CHECKED BY: N.E.B.

SCALE: 1"=20'

HIRANI ENGINEERING & LAND SURVEYING, P.C.
47 MINEOLA BLVD., SECOND FLOOR
MINEOLA, NY 11501
T (516) 248-1010 F (516) 248-8981
H I R A N I

OWNER: U.S. DEPT. OF NAVY

CONTRACTOR: TETRA TECH NUS

SUBJECT:
EASEMENT FOR OUTPOST MONITORING WELLS
BP-OW 2-1(D) & BP-OW 2-2 (D2).

DATE DRAWN: 04/02/03
DATE SURVEYED: 01/09/03 - 01/24/03
CONTRACT # : S02-2117
SHEET NO: 1 OF 1

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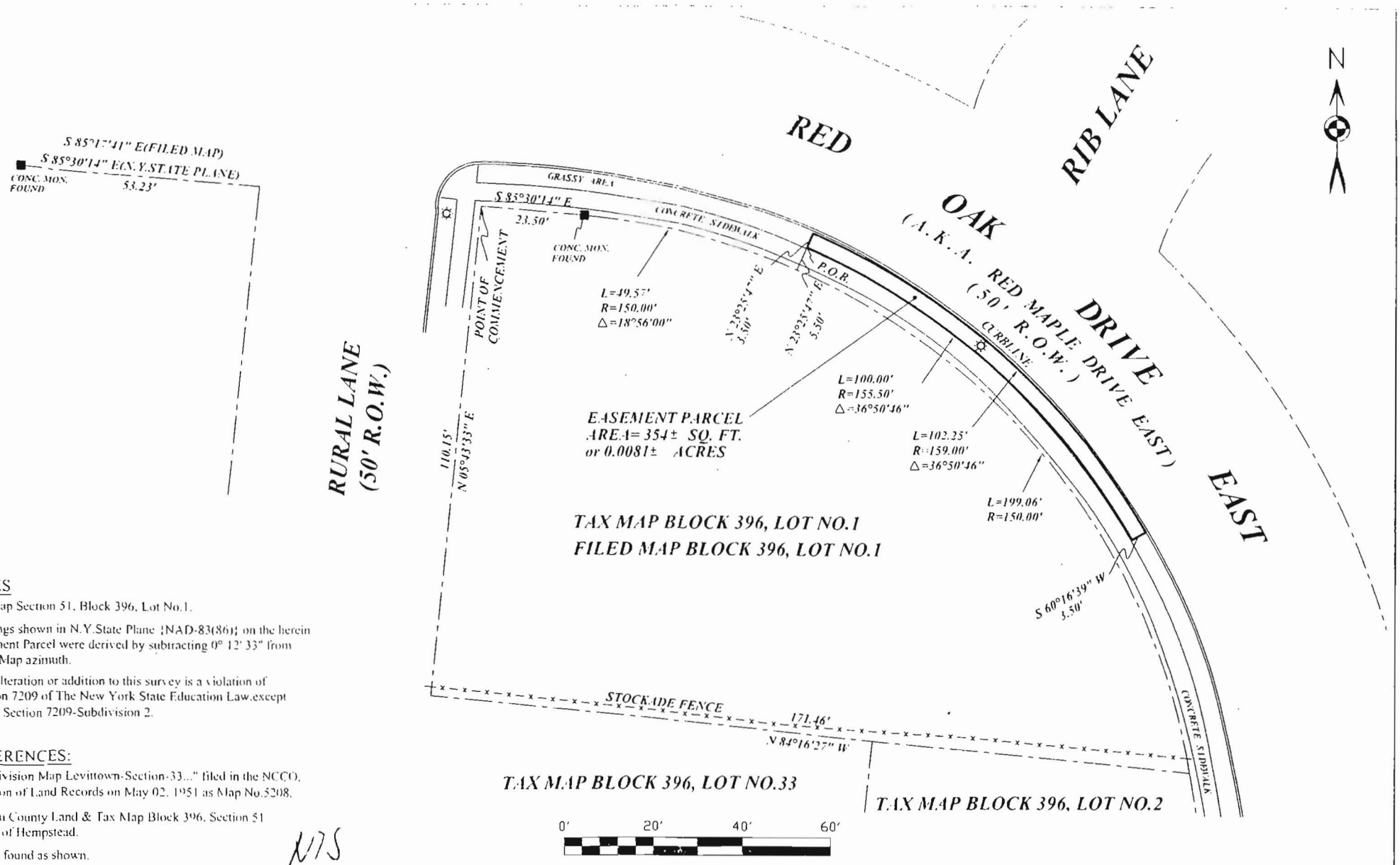


NOTES

1. Tax Map Section 51, Block 396, Lot No.1.
2. Bearings shown in N.Y.State Plane {NAD-83(86)} on the herein Easement Parcel were derived by subtracting 0° 12' 33" from Filed Map azimuth.
3. Any alteration or addition to this survey is a violation of Section 7209 of The New York State Education Law,except as per Section 7209-Subdivision 2.

REFERENCES:

1. "Subdivision Map Levittown-Section-33..." filed in the NCCO, Division of Land Records on May 02, 1951 as Map No.5208.
2. Nassau County Land & Tax Map Block 396, Section 51 Town of Hempstead.
3. Points found as shown.

N/S

NO.	DATE	DESCRIPTION	APPR'D.
		REVISIONS	

DRAWN BY: H.C.R.
CHECKED BY: S.E.D.
SCALE: 1"=20'

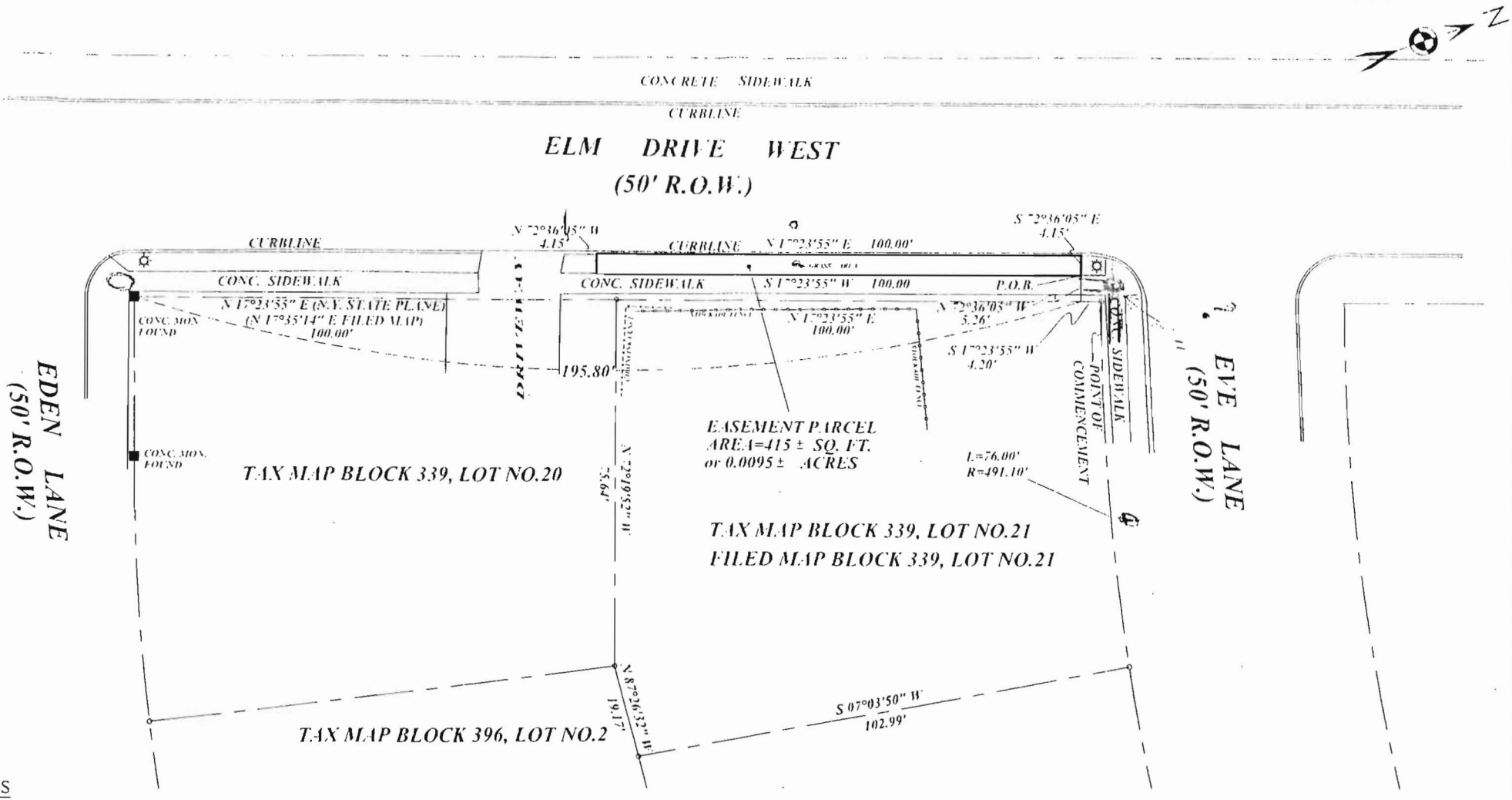
HIRANI ENGINEERING & LAND SURVEYING, P.C.
47 MINEOLA BLVD., 2ND FLOOR
MINEOLA, N.Y. 11501
T (516) 248-1010 F (516) 248-9018
H I R A N I

OWNER: **U.S DEPT. OF NAVY**
CONTRACTOR: TETRA TECH NUS

SUBJECT:
EASEMENT FOR OUTPOST MONITORING WELLS BP-OW 3-1 (D2) & BP-OW 3-2 (D3)

DATE DRAWN: 04/02/03
DATE OF SURVEY: 01/09/03-01/24/03
CONTRACT# S02-2117
SHEET NO: 1 OF 1

G:\PROJECTS\NAVAL TETRA TECH NUS\BP-OW3 EASEMENT.DWG



NOTES

1. Tax Map Section 51, Block 339, Lot No.21
2. Bearings shown in N.Y.State Plane {NAD-83(86)} on the herein Easement Parcel were derived by subtracting 0° 11' 19" from Filed Map azimuth.
3. Any alteration or addition to this survey is a violation of Section 7209 of The New York State Education Law,except as per Section 7209-Subdivision 2.

REFERENCES:

1. "Subdivision Map Levittown-Section-26..." filed in the NCCO. Division of Land Records on Feb. 20, 1951 as Map No.5164.
2. Nassau County Land & Tax Map Block 339, Section 51 Town of Hempstead.
3. Points found as shown.

0' 20' 40' 60'

NO.	DATE	DESCRIPTION REVISIONS	APPR'D

DRAWN BY: BCR
CHECKED BY: S.F.H.

SCALE: 1"=20'

HIRANI ENGINEERING & LAND SURVEYING, P.C.
47 MINEOLA BLVD., 2ND FLOOR
MINEOLA, N.Y. 11501
T (516) 248-1010 F (516) 248-9018 HIRANI

OWNER: **U.S DEPT. OF NAVY**

CONTRACTOR: TETRA TECH NUS

SUBJECT:
EASEMENT FOR OUTPOST MONITORING WELLS BP-OW 4-1 (D-3) & BP-OW 4-2 (D-3)

DATE DRAWN: 04/02-03
DATE OF SURVEY: 01-09/03-01-24/03.
CONTRACT# S02-2117
SHEET NO. 1 OF 1

OUTPOST MONITORING WELL
DRILLING CONTINGENCY PROCEDURES
NWIRP BETHPAGE, NEW YORK

As a normal practice, the deepest well at each cluster will be drilled and installed first. Split spoon samples will collected throughout the boring and across the deepest screen interval as indicated in Table 1. Based on regional data, significant confining unit (fine-grained materials greater than 4 feet thick) should not be present at the planned screen interval and therefore the geophysical log will be conducted to confirm the absence of clay unit across the screened interval, and the screen and well will be installed as planned.

However, if significant clay units are encountered within the planned screen intervals (greater than 20 feet thick), then the following contingencies will be implemented.

Contingencies for the First Monitoring Well Installed in each Cluster

1.0 Based on split spoon sample results, clay and/or clay lenses are prominent throughout the target screen interval (i.e. a 20 foot thick or greater silty/sandy zone is not present within the target screen interval, see Table 1), then

- Continue drilling downward while collecting split spoon samples every five feet, until a minimum of a 20 foot sandy zone is encountered, but proceed no further than 50 feet beyond the bottom of the target screen zone (deepest well only).
- Run geophysical log (deepest well only).
- Screen length is to be a minimum of 20 feet and a maximum of 40 feet, and placed in a sandy zone. The top of the screen shall not be higher than the top of the target screen interval and the bottom of the screen shall not be lower than 50 feet below the bottom of the target screen interval.
- If a screen interval cannot be selected as indicated above, then identify the next deepest well that can be installed in that cluster. Backfill the boring to that depth with bentonite to seal the bottom of the boring and then install the well. The decision on where to place the deepest well will not be made in the field.

2.0 Based on split spoon sample results, a significant clay unit (s) is present in the top half of the target screen interval and 10 to 20 feet of sand is present in the bottom portion of the target screen interval. The screen will be then placed below the clay unit. To determine the screen interval,

- Continue drilling and collecting split spoons to determine if the sandy unit continues downward (deepest well only). Stop when a significant clay unit or the equivalent of sand sufficient for a 40 foot screen interval is encountered.
- Run geophysical log (deepest well only).
- Install well in sandy zone. The screen length may be adjusted to 20 to 40 feet to fit in sandy zone.

3.0 Based on split spoon sample results, a significant clay unit (s) is present in the bottom half of the target screen interval. The well screen will be installed above the clay unit. To determine the screen interval,

- Stop drilling at bottom of target depth.
- Run geophysical log (deepest well only)
- Install well in sandy zone above clay unit, and shorten well screen (but no less than 20 feet) so that the top of the screen is not higher than the top of the target screen interval.

4.0 Based on split spoon sample results, a significant clay unit is present in the middle portion of the target screen interval and a viable sandy unit is present above and below the clay unit, such that the selection of one unit over the other can not be decided with the available data.

- Install next shallowest well as identified under Contingency 1 above.
- Re-drill the boring and collect two temporary monitoring well samples to help determine the screen interval. One water sample will be collected above the clay unit and one water sample will be collected below the clay unit. The screen interval will be placed in the interval with the highest detected site VOC.

If significant clay units are detected in the less deep monitoring well screen intervals, then the contingencies listed above will apply, except that well screens may be shortened so as to not over lap will the deeper well screens. Water samples in the boring will be collected only in the event that geophysical data cannot be used to determine screen intervals.