PROPOSED AMENDED RECORD OF DECISION

Northrop Grumman Bethpage Facility

Operable Unit Number 02: Off-Site Groundwater
Operable Unit Number 03: Former Grumman Settling Ponds and Adjacent Areas
Off-Site Groundwater

and

Naval Weapons Industrial Reserve Plant

Operable Unit Number 02: Off-Site Groundwater
State Superfund Projects
Bethpage, Nassau County

Site Nos. 130003A & 130003B
May 2019

Prepared by
Division of Environmental Remediation
New York State Department of Environmental Conservation

PROPOSED AMENDED RECORD OF DECISION

Northrop Grumman - Bethpage Facility and Naval Weapons Industrial Reserve Plant Site
Bethpage, Nassau County
Site Nos. 130003A and 130003B
May 2019

SECTION 1: SUMMARY AND PURPOSE OF THE PROPOSED AMENDED RECORD OF DECISION

The New York State Department of Environmental Conservation (the Department), in consultation with the New York State Department of Health (NYSDOH), is proposing an amendment to certain Records of Decision (RODs) for the Northrop Grumman Bethpage Facility and Naval Weapons Industrial Reserve Plant (NWIRP) sites (Figure 1). The disposal of hazardous wastes at these sites, as more fully described in the original RODs and Section 7 of this document, has contaminated various environmental media. The proposed amendment is intended to attain the remedial action objectives identified for these sites for the protection of public health and the environment. This proposed amendment identifies the new information which has led to this proposal and discusses the reasons for the preferred remedy.

The purpose of this proposed Amended ROD (AROD) is to present a preferred remedy to address groundwater contamination, herein referred to as the Navy Grumman groundwater plume, that originated from the Northrop Grumman Bethpage Facility and the Naval Weapons Industrial Reserve Plant and that now extends nearly four miles from these two New York State Inactive Hazardous Waste Disposal Sites. This preferred remedy was not developed to fully replace remedies detailed in existing Records of Decision (RODs). Instead, with data showing that the existing remedies are not fully effective at achieving remedial action objectives, this preferred remedy has been developed to supplement the existing remedies and to address off-site groundwater contamination not adequately addressed under the existing RODs. Specifically, under the existing remedies, not only does groundwater contamination continue to migrate south toward currently unimpacted public water supplies and unimpacted portions of the Long Island Sole Source Aquifer, but this southward migration is causing contaminant concentrations to increase in off-site groundwater. This preferred remedy specifically addresses these threats to public health and the environment associated with this off-site groundwater contamination.

This proposed AROD is based on a Feasibility Study (FS) completed to evaluate remedial alternatives based on new information that are capable of addressing groundwater contaminated with chlorinated solvents (including trichloroethene (TCE)) and 1,4-dioxane originating from the former Northrop Grumman Bethpage Facility and the NWIRP sites. The FS was finalized in April 2019 and expanded on an earlier (August 2016) Remedial Options Report completed to initially evaluate containment options for the off-site groundwater plume. The Remedial Options Report was completed and provided to the New York State Legislature in accordance with A09492 (Saladino) /S07832 (Hannon) that were signed into law in December 2014. In February 2017, following issuance of the Remedial Options Report, the Department initiated an expedited engineering analysis/FS. To complete this engineering analysis/FS, the Department partnered with the United States Geological Survey (USGS) and issued a work assignment to the engineering firm Henningson, Durham, & Richardson Architecture & Engineering, P.C. (HDR).

The New York State Inactive Hazardous Waste Disposal Site Remedial Program (also known as the State Superfund Program) is an enforcement program, the mission of which is to identify and characterize suspected inactive hazardous waste disposal sites and to investigate and remediate those sites found to pose a significant threat to public health and environment.

The Department has issued this document in accordance with the requirements of New York State Environmental Conservation Law and Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York; (6 NYCRR) Part 375, and Guidance Document DER-2 – "Making Changes to Selected Remedies". This document is a summary of the information that can be found in the site-related reports and documents in the document repository identified below.

SECTION 2: CITIZEN PARTICIPATION

The Department seeks input from the community on all proposed remedies. This is an opportunity for public participation in the remedy selection process. The public is encouraged to review the reports and documents, which are available at the following repository:

Bethpage Public Library
47 Powell Avenue
Bethpage, NY 11714
Phone: (516) 931-3907

A public comment period has been set from:

5/23/2019 to 7/7/2019

An availability session and public meeting have been scheduled for the following date and times:

Availability Session Begins at 5:00 PM on 6/10/2019

Public Meeting Begins at 7:00 PM on 6/10/2019

Public meeting and availability session location:

Bethpage High School Auditorium
Bethpage High School
10 Cherry Avenue
Bethpage, NY 11714

At the meeting, the findings of previous remedial investigations (RIs), the current investigation, the USGS groundwater flow modeling, and the feasibility study (FS) will be presented along with a summary of the proposed remedy. After the presentation, a question-and-answer period will be held, during which verbal or written comments may be submitted on the proposed remedy.

Written comments may also be sent through 7/7/2019 to:

Jason Pelton, P.G.
NYS Department of Environmental Conservation
Division of Environmental Remediation
625 Broadway
Albany, NY 12233
jason.pelton@dec.ny.gov

The Department may modify the proposed remedy or select another of the alternatives presented in this proposed amendment based on new information or public comments. Therefore, the public is encouraged to review and comment on the proposed remedy identified herein. Comments will be summarized and addressed in the responsiveness summary section of the AROD. The AROD is the Department's final selection of the remedy for these sites.

Receive Site Citizen Participation Information By Email

Please note that the Department's Division of Environmental Remediation (DER) is "going paperless" relative to citizen participation information. The ultimate goal is to distribute citizen participation information about contaminated sites electronically by way of county email listservs. Information will be distributed for all sites that are being investigated and cleaned up in a particular county under the State Superfund Program, Environmental Restoration Program, Brownfield Cleanup Program, Voluntary Cleanup Program, and Resource Conservation and Recovery Act Program. We encourage the public to sign up for one or more county listservs at http://www.dec.ny.gov/chemical/61092.html

SECTION 3: DETAILS OF NAVY GRUMMAN GROUNDWATER PLUME

This proposed AROD includes a detailed analysis of remedial alternatives to address the Navy Grumman groundwater plume emanating from the Northrop Grumman Bethpage Facility (NYS Inactive Hazardous Waste Disposal Site No. 130003A) and the NWIRP site (NYS Inactive Hazardous Waste Disposal Site No. 130003B). The details of the Navy Grumman groundwater plume are summarized below.

Navy Grumman Groundwater Plume Discovery:
The presence of chlorinated solvents in groundwater collected from industrial water supply wells in the Bethpage area was first identified in October 1975 during a New York State Department of Health sampling program. A subsequent groundwater evaluation completed by the Nassau County Department of Health and the USGS in 1986 identified a groundwater plume that was approximately one-mile wide, two-miles in length, and more than 500-feet thick originating from the industrial area at the Northrop Grumman Bethpage Facility and NWIRP properties.

Navy Grumman Groundwater Plume Location and Characteristics:
Since the discovery of the Navy Grumman groundwater plume in the 1970s, remedial investigation activities completed by Northrup Grumman and the U.S. Navy, along with the recent investigation activities completed by the Department, demonstrate that past disposal practices have

contaminated both on-site and off-site groundwater with chlorinated solvents and that the extent of the groundwater plume has expanded. The investigation results indicate that the primary contaminant of concern in the groundwater is TCE. As shown on Figure 2, there is a western groundwater plume and an eastern groundwater plume that originate from the Northrop Grumman and NWIRP sites. Downgradient of the sites, the two plumes comingle to form one overall groundwater plume that now extends approximately 4.3 miles south toward the Southern State Parkway. At its widest point, the plume is approximately 2.1 miles wide. In most areas, the top of the groundwater plume is over 200 feet beneath the ground surface and extends to depths of approximately 900 feet beneath the ground surface. A three-dimensional illustration of the surface of the Navy Grumman groundwater plume is included as Figure 3.

The Navy Grumman groundwater plume described above has impacted the groundwater resources in the shallow Upper Glacial Aquifer and the deeper Magothy Aquifer that are part of the Environmental Protection Agency-designated Long Island Sole Source Aquifer that underlies the majority of Long Island. The Long Island Sole Source Aquifer is the largest and most productive aquifer in New York State and represents the source of high-quality drinking water for approximately 2.6 million people. In Nassau County, a total of 46 public water suppliers rely on the Long Island Sole Source Aquifer as a source of drinking water. These water suppliers use 360 public water supply wells to withdraw the groundwater from the aquifer system.

There are 11 public water supply wells that have been impacted by the groundwater contamination that has originated from the Northrop Grumman and NWIRP sites, and 16 public water supply wells that are threatened by the Navy Grumman groundwater plume. The 11 impacted public water supply wells have treatment that allows for continued use of these wells for drinking water purposes. Of the 11 public water supply wells that are already impacted, five public supply wells (Bethpage Water District Plants 4, 5, and 6) are immediately downgradient of the NWIRP and Northrop Grumman Bethpage Facility sites and within the central portion of the groundwater plume. These were the first to require wellhead treatment, and groundwater withdrawn from some of these wells has continuously contained increasing concentrations of site-related contaminants over time.

SECTION 4: SITE DESCRIPTIONS AND HISTORY

The Northrop Grumman Bethpage Facility and NWIRP sites are located in the Hamlet of Bethpage, Town of Oyster Bay, New York (Figure 1) and have been associated with the aerospace industry since approximately the 1930s. The facility included a combination of Grumman owned and operated plants and U.S. Navy owned and contractor (Grumman) operated plants. Activities performed at these facilities occurred on an approximately 600-acre area and included administration, engineering, research and development, and manufacturing and testing for the U.S. Navy and the National Aeronautics and Space Administration. All manufacturing ceased at the Northrop Grumman and NWIRP facilities in 1996.

Based on the on-site and off-site presence of chlorinated solvents in groundwater, the Grumman Aerospace-Bethpage Facility was added to the New York State Inactive Hazardous Waste Disposal Site Registry in 1983 and listed as Site No. 130003. Following this site listing, a combination of investigation and remediation activities have been completed and are ongoing to address this contamination. In 1993, the Grumman Aerospace-Bethpage Facility Site (130003) was divided into the Northrop Grumman Bethpage Facility Site (130003A) and the U.S. Navy NWIRP Site (130003B). The Northrop Grumman Bethpage Facility Site (130003A) was further divided in March of 2000 with 26 acres becoming the Northrop Grumman-Steel Los Plant 2 Site (130003C).

Since operations ended, many portions of the Northrop Grumman Bethpage Facility were delisted from the Registry as investigations were completed in different areas of the site and the U.S. Navy transferred most of the property to Nassau County for economic redevelopment. Currently the Northrop Grumman Bethpage Facility site occupies 9-acres and the NWIRP site comprises an 8.7-acre parcel. The current boundaries for the Northrop Grumman Bethpage Facility and the NWIRP site, along with historic property boundaries, are shown on Figure 1. The sites are surrounded by properties that are utilized for a combination of industrial, commercial, and residential purposes.

There were several locations at both the Northrop Grumman Bethpage Facility and the NWIRP site where the storage, treatment, and disposal of various wastes occurred. These areas are described in detail in earlier RI reports and RODs for the two sites. Remedial actions have either been taken to address this site contamination or are underway. This includes the current operation of two on-site groundwater extraction and treatment systems and one off-site groundwater extraction and treatment system. Additionally, two off-site groundwater extraction and treatment systems are under various stages of construction and design to address groundwater hotspots (areas where high concentrations of site contaminants occur in groundwater).

Site Geology and Hydrogeology:
The site is located on the Long Island glacial sand deposits that are part of the Environmental Protection Agency designated Sole Source Aquifer. Depth to groundwater (in the Upper Glacial aquifer) is approximately 50 to 55 feet beneath the ground surface and groundwater flow is generally southward. The upper glacial aquifer is underlain by the Magothy aquifer which is the primary source of drinking water for most parts of Nassau County. Beneath the site, the Magothy aquifer extends to depths of approximately 700 to 900 feet beneath the ground surface. The Magothy aquifer is a complex sequence of gravel, sand, silt, and clay. Within the Magothy aquifer, lenses of low permeability clay, silt, and sand are abundant. These lenses are not necessarily continuous and have a significant influence on the movement of both groundwater and the site contaminants. The Magothy aquifer is underlain by the Raritan clay and the Lloyd Sand of the Raritan Formation. The Raritan clay is approximately 100-feet thick and generally represents an underlying confining unit for the Magothy aquifer. The Lloyd Sand is comprised of fine to coarse sand and gravel and is the lowest of the Long Island aquifers.

Operable Units:
An operable unit (OU) represents a portion of a remedial program that for technical or administrative reasons can be addressed separately to investigate, eliminate, or mitigate a release, threat of release or exposure pathway resulting from contamination. The Northrop Grumman Bethpage Facility and NWIRP sites are divided into four OUs. Soil remediation at the former Northrop Grumman Bethpage Facility and NWIRP manufacturing plants are designated as OU1. Groundwater contamination at and downgradient of the Northrop Grumman Bethpage Facility and NWIRP sites is designated as OU2. An off-site area located immediately east of the Northrop

Grumman-Bethpage Facility Site referred to as the former Grumman Settling Ponds (Figure 2) is identified as OU3. OU3 includes soil and groundwater at and downgradient of the Former Grumman Settling Ponds, adjacent areas of the Bethpage Community Park, and the Northrop Grumman Access Road. OU4 was established by the U.S. Navy to specifically address contaminated soil, soil vapor, and groundwater at a former drum marshaling location in an area referred to as Site 1.

OU2 and OU3 for the Northrop Grumman Bethpage Facility Site (130003A) and OU2 for the NWIRP Site (130003B) are the subject of this proposed AROD. Currently, the off-site groundwater contamination is managed under two separate operable units. The OU2 plume generally corresponds to groundwater contamination that originated from the NWIRP and Northrop Grumman Bethpage Facility while the OU3 groundwater plume originated from the off-site area identified as the Former Grumman Settling Ponds. This proposed AROD evaluates alternatives and identifies a preferred option for addressing the Navy Grumman groundwater plume.

The following Records of Decision (RODs) have been issued for the Northrop Grumman Bethpage Facility site and the NWIRP site:

1. 130003A, Operable Unit 1 On-Site Soil Source Area, March 1995;
2. 130003A and 130003B, Operable Unit 2 Groundwater, March 2001;
3. 130003A, Operable Unit 3, Former Grumman Settling Ponds and Associated Groundwater, March 2013;
4. 130003B, Operable Unit 1 On-Site Soils Source Areas, May 1995;
5. 130003B, Operable Unit 2, Groundwater, Department of the Navy, January 2003; and
6. 130003B, Operable Unit 4, Site 1 – Former Drum Marshaling Area Contaminated Soil, Soil Vapor, and Groundwater, Department of the Navy, September 2018.

SECTION 5: LAND USE AND PHYSICAL SETTING

The Department may consider the current, intended, and reasonably anticipated future land use of the site and its surroundings when evaluating a remedy for soil remediation. This proposed AROD evaluates remedial options for addressing the off-site portions of the groundwater plume and does not address on-site soil remediation. On-site soil contamination is addressed under the existing RODs for the NWIRP site and the Northrop Grumman Bethpage Facility site. Land use is one of the eight criteria used in evaluating the alternatives in this proposed AROD for addressing the off-site portions of the groundwater plume. Specifically, this criterion evaluates the current, intended, and reasonably anticipated future use of the site and its surroundings, as it relates to an alternative when unrestricted levels are not achieved.

With the size of the off-site groundwater plume and the plume’s location within heavily developed areas in the Towns of Oyster Bay and Hempstead, implementation of each alternative would produce disruptions to nearby land uses. Therefore, this proposed AROD details how the elements of each alternative would impact the nearby communities and the approaches to minimize these disruptions.

SECTION 6: <u>ENFORCEMENT STATUS</u>

Potentially Responsible Parties (PRPs) are those who may be legally liable for contamination at a site. This may include past or present owners and operators, waste generators, and haulers.

The PRPs for the off-site groundwater contamination, documented to date, include:

- Northrop Grumman Corporation
- Department of the Navy
- Covestro (current owner of the RUCO Polymer Corp. (Hooker Chem) site (NYS Inactive Hazardous Waste Disposal Site No. 130004)

Northrop Grumman signed an RI/FS Order on Consent for OU1 (On-Site Soil Source Area) and OU2 (Groundwater) in 1989. Northrop Grumman also signed an RI/FS Order on Consent in July 2005 for the Former Grumman Settling Ponds and Associated Groundwater. In 2014 and 2015, Northrop Grumman entered into Orders on Consent for the OU3 (Former Grumman Settling Ponds and Associated Groundwater) Remedial Design and Remedial Action and the OU2 (Groundwater) remedial program, respectively.

The Navy signed a Federal Facilities Site Remediation Agreement in 2005 for implementation of the OU2 (Groundwater) remedy.

As this proposed AROD supplements and incorporates the elements of the prior OU2 and OU3 RODs, and, pursuant to the Orders and Agreements referenced above, the PRPs will continue to implement the elements of those RODs that are contained in the final amended remedy.

SECTION 7: <u>SITE CONTAMINATION</u>

7.1: <u>Expanded Investigation and Engineering Evaluation of the Navy Grumman Groundwater Plume</u>

In February 2017, the Department commenced an expanded investigation to develop an up-to-date understanding of the Navy Grumman groundwater plume and an engineering analysis to evaluate alternatives to hydraulically contain the Navy Grumman groundwater plume. This investigation and engineering evaluation has been completed by the Department in partnership with the USGS. A description of the tasks included in the investigation and engineering evaluation is included below and in more detail in the Feasibility Study Report (April 2019).

Vertical Profile Boring Drilling, Monitoring Well Installation, and Groundwater Sampling Program

To assist the Department in understanding the southern extent of the Navy Grumman groundwater plume, two vertical profile borings (VPBs) were advanced along the distal end of the plume (DEC-VPB-1 and DEC-VPB-2 on Figure 4). To assess water quality with depth in each of the VPBs, discrete interval groundwater samples were collected at approximately 20-foot intervals to depths of approximately 1,000 feet beneath the ground surface. Following collection, the groundwater samples were submitted for laboratory analysis and the data were used to design three permanent groundwater monitoring wells at these two locations. Two monitoring wells (DEC1D1 and DEC1D2 on Figure 4) were installed adjacent to DEC-VPB-1 while the third well (DEC2D1) was installed near DEC-VPB-2 (Figure 4). The groundwater sampling results from the VPBs and permanent groundwater monitoring wells were used to supplement data collected from previous investigations and long-term groundwater monitoring programs being completed by the U.S. Navy and Northrop Grumman in developing a comprehensive groundwater database.

Comprehensive Groundwater Sampling Results Database Development
Groundwater quality data derived from previous investigations, routine long-term monitoring, Nassau County Department of Health public water supply well sampling, and the Department's drilling program were compiled and incorporated into a single comprehensive groundwater database. The database included over 5,600 groundwater samples collected from over 540 locations for a total of over 200,000 individual records. The database was then used to analyze and evaluate the nature and extent of the Navy Grumman groundwater plume and to prepare three-dimensional (3D) visualizations of the groundwater contamination. The 3D plume representations were then used to compare and evaluate alternatives to extract and manage treated water with the USGS groundwater flow model that was developed for this project, as discussed below.

The contaminants of concern (COCs) included in the groundwater database were identified based on a review of the following four documents:

1. 2001 New York State Department of Environmental Conservation OU2 ROD;
2. 2003 Navy OU2 ROD;
3. 2013 New York State Department of Environmental Conservation OU3 ROD; and
4. 2003 Public Water Supply Contingency Plan

A "contaminant of concern" is a contaminant that is sufficiently present in frequency and concentration in the environment to require evaluation for remedial action. Not all contaminants identified on the property are contaminants of concern. The nature and extent of contamination and environmental media requiring action are summarized in Exhibit A. Additionally, the previously prepared RI reports contain a full discussion of the data. The contaminant(s) of concern identified at the Northrop Grumman Bethpage Facility and NWIRP sites are:

1,1,2,2-Tetrachloroethane
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethene
1,2-Dichloroethane
1,2-Dichloroethene
1,2-Dichloropropane
1,4-Dioxane
Chloroform
cis-1,2-Dichloroethene
Chlorodiflouromethane (Freon 22)
Dichlorodifluoromethane (Freon 12)
Tetrachloroethene
Toluene
trans-1,2-Dichloroethene
Trichloroethene
1,1,2-Trichloro-1,2,2,-trifluoroethane
Vinyl chloride
Carbon disulfide
Carbon tetrachloride
Chlorobenzene
Chromium
Iron
Nickel

Development of Three-Dimensional Navy Grumman Groundwater Plume Representations
The comprehensive groundwater database was used as the source of data for the preparation of a series of 3D visualizations of the Navy Grumman groundwater plume. Specifically, plume visualizations were created for TCE, Toluene, 1,1-DCA, Freon, and Total Chlorinated Volatile Organic Compounds (TCVOCs). Once this was completed, the individual plumes were superimposed to form a 3D visualization of COCs that exceed the respective Standards, Criteria and Guidance (SCGs). This 3D visualization of the contaminant plume is shown on Figure 3. The SCG plume included 1,4-dioxane to a concentration of 0.35 parts per billion (ppb) which is the United States Environmental Protection Agency (USEPA) calculated screening level identified as 0.35 µg/l based on a 10^{-6} lifetime excess cancer risk screening level in tap water (EPA, 2013C). Three-dimensional visualizations were also created for a 50 ppb (Figure 5) and 100 ppb (Figure 6) TCVOC plume.

Groundwater Flow Modeling Program
In partnership with the USGS, a groundwater flow model capable of simulating groundwater flow beneath Long Island was developed. The USGS model was used to evaluate how various groundwater extraction and discharge scenarios influence plume migration and groundwater containment and was a critical component of the Feasibility Study and ultimately in the development of a preferred remedy for addressing the Navy Grumman groundwater plume. Specifically, the modeling was important in quantitatively evaluating the following:

1. Migration and capture of the Navy Grumman groundwater plume;
2. Influence of increased groundwater withdrawal on yield of nearby public water supply wells;
3. Potential for landward movement of the freshwater-saltwater interface; and
4. Possible impacts to nearby surface water streams (e.g., Massapequa Creek) and wetland environments.

The USGS used MODFLOW and MODPATH to complete the groundwater flow modeling. Both of these models are considered industry standard for use in simulating complex groundwater flow systems. MODFLOW is a modular hydrologic model that simulates 3D groundwater flow in aquifers while MODPATH is a particle tracking post processing model that calculates the path lines along which a groundwater particle would travel based on the MODFLOW results. The model contained 25 layers, 250 columns, and 346 rows of 100–foot square cells.

The 3D plume representations were provided to the USGS for use in the groundwater flow modeling. As part of this process, MODPATH was used to assign particles at the centroid of each model cell within the entire plume representation. MODPATH then calculated the forward path along which each particle within the plume travels from its origin to its ultimate discharge location.

The USGS groundwater flow model was then used to develop remedial alternatives and to better understand zones of contribution to extraction wells, possible movement of existing hotspots, potential influence on or by the public water supply wells and existing groundwater recovery systems, the return of treated water to the aquifer system (i.e., recharge basins and injection wells), and the influence on the environmental parameters (surface water stream flow, wetland water levels, and freshwater-saltwater interface).

Engineering Evaluation Included in a Feasibility Study

The engineering analysis and FS relied on the results of the groundwater flow modeling to compare groundwater extraction alternatives and quantify the volume of groundwater requiring extraction, treatment, and discharge to achieve the remedial action objectives. The primary objective of the engineering evaluation included in the FS is to present technically feasible options to hydraulically contain the Navy Grumman groundwater plume, reduce its volume and contaminant concentrations, and prevent its further expansion and migration. The FS represents the technical basis for the preferred remedy detailed in this proposed AROD.

There is also other significant new information (in addition to that which resulted from the investigation and engineering evaluation) that is now available, that did not exist at the time that the earlier RODs were issued. A summary of this new information is provided below.

Groundwater flow modeling performed in the 2000 Feasibility Study that was prepared by Arcadis/Geraghty Miller on behalf of Northrop Grumman and formed the basis of the NYSDEC OU2 ROD, indicated that the selected remedy would not result in exposures to site related VOCs in downgradient public water supply wells. At that time, all water supply wells that were affected had treatment for VOCs, and the modeling indicated that no other public supply wells would be affected, based on 30-year predictive simulations. Contrary to the modeling results, due to plume migration that has occurred since then, the addition of wellhead treatment has been necessary to address site related VOCs at several previously un-impacted public water supply wells at three separate well fields.

The 2000 FS stated that the off-site portion of the plume that would not be captured by the active pump and treatment systems would undergo natural attenuation. However, based on a review of the available information, it is clear that natural attenuation alone in these areas would not significantly contribute to attaining groundwater quality standards in the offsite portion of the plume, as defined in the 2000 FS.

In the 2000 FS, the modeling for the alternative that was selected in the ROD predicted that SCGs would be attained at Bethpage Water District Well 4-2 in 11 years. In 2012 (11 years after the issuance of the ROD), the average TCE concentration in Bethpage Water District Well 4-2 raw water was 83 ppb and has since increased to an average of 221 ppb (2017 annual average). Similarly, the groundwater flow modeling performed as part of the 2000 FS predicted that SCGs would not be exceeded in Bethpage Water District Well 4-1 under the selected alternative. However, groundwater quality monitoring has shown that TCE, cis-1,2-DCE, and 1,1-DCA have exceeded their respective SCGs in raw water samples collected from Bethpage Water District Well 4-1. Specifically, in 2017, TCE, cis-1,2-DCE, and 1,1-DCA were detected at maximum concentrations 183 ppb, 53 ppb, and 6 ppb respectively. Furthermore, the groundwater flow modeling performed as part of the 2000 FS simulated a peak influent total VOC concentration of 11 ppb at Bethpage Water District Well 6-2 under the selected remedy. Monthly sampling of raw, untreated water from Bethpage Water District Well 6-2 shows a continuous increase of TCE concentrations over time since the 2001 ROD with a maximum concentration of 1,940 ppb in March 2017.

The 2000 FS included a figure which indicated that the downgradient edge (5 ppb total volatile organic compounds) of the plume was located north of Hempstead Turnpike. Based on groundwater quality data that was collected subsequent to the OU2 ROD, it is now known that the 5 ppb plume extends to the vicinity of Southern State Parkway, in excess of 8,000 feet further downgradient.

Based on the results of the NYSDEC investigation and engineering evaluation, the Navy Grumman groundwater plume continues to migrate south toward currently unimpacted public water supplies and unimpacted portions of the Long Island Sole Source Aquifer, and this southward migration is causing contaminant concentrations to increase in off-site groundwater. This is also evident based on the information provided above, which demonstrates that some of the conclusions regarding plume migration in the 2000 Feasibility Study are not supported by groundwater monitoring data that have since been collected. Based on the above, the NYSDEC has determined that the existing remedies are not fully effective in achieving the remedial action objectives for the site and in addressing the threats to public health and the environment.

As a result, the NYSDEC conducted an engineering evaluation and related groundwater modeling to develop additional remedial alternatives to address the Navy Grumman groundwater contaminant plume.

7.2: <u>Summary of Actions Under Public Water Supply Protection Program</u>

The 2001 New York State Department of Environmental Conservation ROD for OU2 (Groundwater) and the U.S. Navy 2003 ROD for OU2 (Groundwater) recognized the importance of the continued provision of potable water to those communities/populations served by water supply wells that are, or that may become, impacted by site-related contamination. Based on this, the 2001 and 2003 RODs required that a Public Water Supply Protection Program be implemented. The components of this program continue to be implemented and include the following:

1. Continued public water supply wellhead treatment to meet appropriate drinking water quality performance objectives at wellfields already affected by the groundwater contaminant plume for as long as these affected wellfields are used as community water supply sources;
2. Public water supply wellhead treatment or comparable alternative measures, as necessary, for wellfields that become affected in the future; and
3. Long-term monitoring of the groundwater contaminant plume including outpost monitoring wells upgradient of potentially affected water supply wells.

Based on the Public Water Supply Protection Program, the U.S. Navy and Northrop Grumman provided wellhead treatment at six separate water plants (Figure 2) operated by three nearby water districts. The U.S. Navy and Northrop Grumman also continue to implement a long-term groundwater monitoring program to assess the need for future wellhead treatment at 16 additional public water supply wells that are threatened by continued migration of the Navy Grumman groundwater plume. The wellhead treatment actions are summarized below.

1) <u>Bethpage Water District</u>

Under the Public Water Supply Protection Program, three separate air stripping treatment systems were constructed for five public supply wells at Bethpage Water District Plants 4, 5, and 6. These three public water supply well fields are immediately downgradient of the NWIRP and Northrop Grumman Bethpage Facility sites and within the central portion of the groundwater plume. These were the first to require wellhead treatment, and groundwater withdrawn from some of these wells has experienced continuous increases in concentrations of the site contaminants over time. The Bethpage Water District continues to provide treatment at Plants 4, 5, and 6 prior to distribution of water to customers.

Bethpage Water District Plant 6

Bethpage Water District Plant 6 relies on two public water supply wells (Well 6-1 and Well 6-2). Sampling of raw, untreated water between November and December of 1976 detected TCE in Well 6-1 at concentrations of 28, 26 and 60 ppb during three separate sampling events. Based on these TCE detections, Bethpage Water District removed Well 6-1 from service in December 1976.

In February 1985, TCE was first detected in raw, untreated water from Well Number 6-2 at a concentration of 1 ppb. In February 1987, TCE was detected at a maximum concentration of 5 ppb in the raw, untreated water and Bethpage Water District removed Well 6-2 from service in November 1988.

A treatment system was installed at the Bethpage Water District Plant 6 in 1990 to address the TCE contamination. The District returned Well 6-1 into service in June of 1990 and returned Well 6-2 into service in December 1990. Since this time, water from both wells has been treated and routine monitoring is conducted to verify that the water meets NYS drinking water standards prior to distribution. The cost for constructing the treatment system at Bethpage Water District Plant 6 was reimbursed by Northrop Grumman.

Bethpage Water District Plant 4

Bethpage Water District Plant 4 relies on two public water supply wells (Well 4-1 and Well 4-2). TCE was detected in raw, untreated water from Well 4-1 between September 7, 1988 and July 30, 1990 at concentrations (0.5 to 2.6 ppb) below the drinking water maximum contaminant level of 5 ppb. TCE and other site-related contaminants originating from the NWIRP and Northrop Grumman Bethpage Facility sites were not detected in routine monitoring samples again until October of 1992 when TCE was detected in raw, untreated water from Well 4-1 at a concentration of 1.2 ppb. After October 1992, TCE was detected in Well 4-1 at or above the reporting limit during four sampling events between 1993 and 1995.

TCE was detected occasionally at low levels in raw, untreated water from Well 4-2 between January 7, 1993 and October 3, 1994. Treatment equipment (air stripper) was installed on wells at the Bethpage Water District Plant 4 (Wells 4-1 and 4-2) in 1995 to treat the raw water prior to its distribution to customers. Routine monitoring is performed to verify that the water meets NYS drinking water standards prior to distribution. The cost for constructing the treatment system at Bethpage Water District Plant 4 was reimbursed by Northrop Grumman. Unrelated to the presence of TCE, Bethpage Water District removed Well 4-1 from service in February 2013 because of the periodic detection of radium.

Bethpage Water District Plant 5
Bethpage Water District Plant 5 relies on a single public water supply well (Well 5-1). A treatment system was installed at the Bethpage Water District Plant 5 (Well 5-1) in October of 1995 prior to the detection of site contaminants in raw, untreated water as a precautionary measure. The cost for constructing the treatment system at Bethpage Water District Plant 5 was reimbursed by the U.S. Navy. This treatment system was constructed in anticipation of site contaminants originating from the NWIRP and Northrop Grumman Bethpage Facility sites ultimately impacting the quality of water at Well 5-1. The first detection of site contaminants in the raw, untreated water at Well 5-1 did not occur until 2007, when TCE was detected at 0.6 ppb.

No other Bethpage Water District public water supply wells have been threatened or impacted by contamination from the Northrop Grumman Bethpage Facility and NWIRP sites.

2) South Farmingdale Water District
Under the Public Water Supply Protection Program, two separate air stripping treatment systems were constructed for the public supply wells at South Farmingdale Water District Plants 1 and 3. These treatment systems were installed prior to the detection of site contaminants in raw, untreated water as a precautionary measure. The treatment system was installed at Plant 1 in 2011 and at Plant 3 in 2013. The cost for constructing the treatment systems at South Farmingdale Water District Plants 1 and 3 was reimbursed by the U.S. Navy. No other South Farmingdale Water District public water supply wells are impacted by contamination from the NWIRP and Northrop Grumman sites.

3) New York American Water Company – Seamans Neck Road Water Plant
The New York American Water Company – Seamans Neck Road Water Plant relies on two supply wells (Well Number 3 and Well Number 4). Both wells have been impacted by contaminants originating from the NWIRP and Northrop Grumman Bethpage Facility sites. However, no detections in the raw, untreated water exceeded the drinking water maximum contaminant level of 5 ppb. Specifically, in 2006, TCE was detected in raw, untreated water at a concentration of 0.6 ppb in Well Number 3. Subsequently, TCE concentrations gradually increased to a maximum concentration of 3.3 ppb on October 18, 2011. TCE was detected at low concentrations (approximately 0.5 ppb) in Well Number 4 in early 2008. The highest TCE concentration of 0.9 ppb was detected in Well Number 4 in February of 2011.

In response to the presence of TCE in the raw, untreated water, the U.S. Navy installed an interim treatment system at the Seaman's Neck Road Water Plant in July 2012. A permanent, full scale wellhead treatment system for the Seaman's Neck Road wells went on line in February of 2015 to address the TCE groundwater contamination. No other New York American Water Company public water supply wells have been impacted by contamination from the NWIRP and Northrop Grumman Bethpage Facility sites.

7.3: Summary of Previous Remedial Investigations at NWIRP and Northrop Grumman Sites

Since its listing on the New York State Registry of Inactive Hazardous Waste Disposal Sites in

1983, data relative to the Northrop Grumman Bethpage Facility and NWIRP contamination has been collected on an on-going basis that continues today. The previous Remedial Investigations (RIs) associated with the groundwater plume have generally established the nature and extent of contamination resulting from former activities at the sites. The field activities and findings of the investigations are described in the earlier RI Reports. The previously completed RIs, and the ongoing groundwater monitoring programs performed by the U.S. Navy and Northrop Grumman, were supplemented by data collected by the Department as part of this expanded investigation.

7.3.1: Standards, Criteria, and Guidance (SCGs)

The remedy must conform to promulgated standards and criteria that are directly applicable or that are relevant and appropriate. The selection of a remedy must also take into consideration guidance, as appropriate. Standards, Criteria and Guidance are hereafter called SCGs.

To determine whether the contaminants identified in various media are present at levels of concern, the data from this investigation were compared to media-specific SCGs. The Department has developed SCGs for groundwater, surface water, sediments, and soil. The NYSDOH has developed SCGs for drinking water and soil vapor intrusion. The tables found in Exhibit A list the applicable SCGs in the footnotes. For a full listing of all SCGs see: http://www.dec.ny.gov/regulations/61794.html

As contaminants of concern exceeding SCGs in OU2 and OU3 on-site soil, groundwater, and on and off-site soil vapor, are being addressed in accordance with separate RODs, this proposed AROD focuses on contaminants of concern that exceed SCGs in off-site groundwater.

7.3.2: Interim Remedial Measures

An interim remedial measure (IRM) is conducted at a site when a source of contamination or exposure pathway can be effectively addressed before issuance of the Record of Decision.

The following IRM(s) have been completed at the Northrop Grumman Bethpage Facility and NWIRP sites and were performed as source control measures to address the off-site migration of contaminated groundwater and soil vapor based on conditions observed during earlier remedial investigations.

1) *Plant 2 Soil Vapor Extraction System* - A soil vapor extraction system was installed and continues to operate adjacent to a former storage tank that was used to store TCE at Plant 2 (Figure 2).

2) *Plant 15 Soil Vapor Extraction System* - A soil vapor extraction system was used to remediate an area of tetrachloroethene (PCE) contamination that was present adjacent to Plant 15 (Figure 2).

3) *On-Site Containment System (ONCT)* – In 1997, Northrop Grumman began operation of five extraction wells that are part of the ONCT (Figure 2). The combined pumping rate from the

five wells is approximately 3,800 gallons per minute (5.5 million gallons per day (MGD)). Following withdrawal, the contaminated groundwater is treated with two separate air stripping treatment systems to remove the contaminants. Once treated, the water is returned to the aquifer through a series of on-site recharge basins. Since operation of the ONCT IRM began in late 1997, nearly 200,000 pounds of contamination has been removed and an area of clean groundwater has developed downgradient of the remediation system. The ONCT system continues to operate.

4) *Site 1, Former Drum Marshaling Yard Soil Vapor Extraction Containment System* - To address high concentrations of site-related chlorinated solvent contamination in soil vapor present in the Former Drum Marshaling Area located in Site 1 (Figure 2), the U.S. Navy installed and began operation of an on-site soil vapor extraction and treatment system in 2010. The system continues to operate and relies on 17 soil vapor extraction wells designed to prevent off-site migration of soil vapor contamination and eliminate potential impacts to off-site structures.

5) *Bethpage Community Park On-Site Groundwater Extraction and Treatment System* – In 2009, Northrop Grumman began operation of a groundwater extraction and treatment system along the former Grumman access road to address groundwater contamination originating from the Former Grumman Settling Ponds area (Figure 2). The system includes four groundwater extraction wells that remove contaminated water at a combined rate of approximately 250 gpm (0.36 MGD). Once treated, the water is returned to the aquifer system through discharge to a nearby recharge basin. Since operation of the IRM began in 2009, approximately 2,200 pounds of contamination has been removed and an area of clean groundwater has developed downgradient of the remediation system. The groundwater extraction and treatment system continues to operate.

6) *Bethpage Community Park On-Site Soil Vapor Extraction and Treatment System* - To address high concentrations of site-related chlorinated solvent contamination in soil vapor present in the Former Grumman Settling Ponds area, Northrop Grumman installed and began operation of a soil vapor extraction and treatment system along the southern and western boundary of the Bethpage Community Park. The system continues to operate and relies on 18 soil vapor extraction wells to prevent off-site migration of soil vapor contamination and eliminate potential impacts to off-site structures. Prior to the start of the soil vapor extraction system, a vapor intrusion sampling program was completed in 2007 at eight off-site properties. This vapor intrusion sampling program confirmed that site contaminants are not migrating off-site in soil vapor and entering into overlying structures.

7) *Bethpage Community Park Soil Excavation* - The Town of Oyster Bay completed a remedial investigation and subsequent remediation as part of an IRM for 7 of the 12 acres comprising Bethpage Community Park. The IRM included the excavation and off-site disposal of approximately 175,000 cubic yards of soil contaminated with chlorinated solvents, PCBs, metals and Freon compounds (dichlorodifloromethane (R-12) and chlorodifloromethane (R-21)) from this seven-acre area. Following removal, the excavation was backfilled with certified clean backfill material.

7.4: <u>Summary of Remedial Actions in Accordance with Earlier RODs</u>

In addition to the IRMs, and in accordance with earlier RODs, the U.S. Navy and Northrop Grumman are currently implementing remedial actions to address on-site soil contamination and off-site groundwater contamination. These remedial actions are described below and shown on Figure 2.

1) *GM-38 Area Groundwater Extraction and Treatment* System - To address off-site groundwater contamination in a portion of the plume identified as the GM-38 Area, the U.S. Navy installed and began operation of a groundwater extraction and treatment system in 2008 (GM-38 Groundwater Extraction and Treatment System on Figure 2). The system continues to operate and withdraws contaminated groundwater at a rate of approximately 1,000 gpm (1.4 MGD) from two extraction wells. Following withdrawal, the contaminated water is treated using air stripping technology combined with granulated activated carbon prior to being returned to the aquifer through discharge to a nearby recharge basin.

2) *RW-21 Area Groundwater Extraction and Treatment System* - To address off-site groundwater contamination in a portion of the plume identified as the RW-21 Area, Northrop Grumman has installed three groundwater extraction wells (Figure 2). Northrop Grumman is currently designing a treatment plant, the underground conveyance piping system, and the approach for managing the treated water. The RW-21 Groundwater Extraction and Treatment System is being designed to withdraw approximately 1,500 gpm (2.2 MGD) of contaminated water from the aquifer. Once treated, the water will be returned to the aquifer using recharge basins and/or injection wells. It is expected that the RW-21 Groundwater Extraction and Treatment System will be operational in 2020.

3) *RE-108 Area Groundwater Extraction and Treatment System* - To address off-site groundwater contamination in a portion of the plume identified as the RE-108 Area, the U.S. Navy is currently designing a groundwater extraction and treatment system. The system is being designed in two phases to include three to five extraction wells (Figure 2) and two separate treatment plants. The first phase will include one extraction well that will withdraw contaminated water from the aquifer at a rate of approximately 400 gpm (0.58 MGD). Once withdrawn, the contaminated water will be conveyed to the existing GM-38 treatment plant for treatment prior to being discharged to a nearby recharge basin. It is expected that the Phase I RE-108 groundwater extraction and treatment system will be operational in 2020. The second phase will include two to four groundwater extraction wells, construction of a treatment plant, and the use of nearby recharge basins to manage the treated water. The U.S. Navy is expecting that the Phase II RE-108 groundwater extraction and treatment system will be operational in 2022.

4) *Site 1 – Former Drum Marshaling Area* - To address PCB soil and groundwater contamination, the U.S. Navy is currently implementing an excavation and off-site disposal remedy to address approximately 45,000 cubic yards of PCB contaminated soil. Following excavation, the area will be backfilled and land-use controls will be in-place to prevent possible future disturbance of the remaining contaminated subsurface soil. The U.S. Navy is expecting that the excavation and off-site disposal remedy will be completed in 2020. The U.S. Navy will continue to operate

the existing soil vapor extraction and treatment system and will be supplementing it with additional soil vapor extraction wells.

5) *Former Grumman Settling Ponds* – In the area of the Former Grumman Settling Ponds, Northrop Grumman is currently implementing an in-situ thermal remedy to address residual chlorinated solvent contamination present in soil approximately 40 to 60 feet beneath the ground surface and an excavation and off-site disposal remedy to address soil contaminated with PCBs and metals. Northrop Grumman is expecting that the in-situ thermal and the excavation and off-site disposal remedies will be completed in 2020.

7.5: <u>Summary of Environmental Assessment</u>

This section summarizes the assessment of existing and potential future environmental impacts presented by the Navy Grumman groundwater plume originating from the NWIRP and Northrop Grumman Bethpage Facility sites. Environmental impacts may include existing and potential future exposure pathways to fish and wildlife receptors, wetlands, groundwater resources, and surface water.

Based upon the resources and pathways identified and the toxicity of the contaminants of ecological concern at this site, a Fish and Wildlife Resources Impact Analysis (FWRIA) was deemed not necessary for OU2 and OU3.

In 2017, the Department conducted an expanded investigation to develop an up-to-date understanding of the Navy Grumman groundwater plume and an engineering analysis to evaluate alternatives to address the Navy Grumman groundwater plume. This analysis has confirmed that past disposal practices have contaminated both on-site and off-site groundwater with chlorinated solvents. The investigation results indicate that the primary contaminant of concern in the groundwater is TCE. The TCE contamination has impacted the groundwater resources in the shallow Upper Glacial Aquifer and the deeper Magothy Aquifer. Both aquifers are part of the Environmental Protection Agency designated Sole Source Aquifer that underlies the majority of Long Island.

Groundwater data compiled into a comprehensive database and subsequently used to develop three-dimensional plume representations confirms that there is a western groundwater plume (OU2) and an eastern groundwater plume (OU3) that originated from the NWIRP and Northrop Grumman sites. Downgradient of the on-site areas, the two plumes comingle to form one overall groundwater plume (Navy Grumman groundwater plume). The Navy Grumman groundwater plume is approximately 4.3 miles in length, 2.1 miles wide, and extends to depths of approximately 900 feet beneath the ground surface.

Within the overall plume, TCE concentrations in groundwater exceed the SCG of 5 ppb and range from 0.23 ppb to 11,200 ppb. TCE is present in groundwater at concentrations exceeding SCGs to a maximum depth of 820 feet below ground surface. The highest TCE concentrations occur in groundwater downgradient of the former Northrop Grumman Bethpage Facility and NWIRP sites and in groundwater downgradient of an off-site area referred to as the Former Grumman Settling Ponds (Figure 2). In addition to TCE, TCE degradation products (e.g., cis-DCE), tetrachloroethene

(PCE), 1,1,1-trichloroethane (1,1,1-TCA), and Freon compounds are also present in on-site and off-site groundwater at concentrations that exceed SCGs. The emerging contaminant 1,4-Dioxane is also present in on-site and off-site groundwater at concentrations exceeding SCGs and may be associated with use as a stabilizer for solvents that were historically used on-site. The SCG for 1,4-dioxane is a USEPA calculated screening level identified as 0.35 ppb based on a 10^{-6} lifetime excess cancer risk screening level in tap water (EPA, 2013C).

While there are two on-site groundwater containment systems and one off-site groundwater extraction and treatment system operating and removing significant amounts of groundwater contamination, the Navy Grumman groundwater plume continues to migrate to the south-southeast. This southward migration of the plume is causing contaminant concentrations to increase in off-site groundwater. Based on the presence of site contaminants in off-site groundwater, the U.S. Navy and Northrop Grumman have provided wellhead treatment at six separate water plants operated by three nearby water districts. Additionally, with uncontrolled continued expansion of the off-site groundwater plume, there are an additional 16 downgradient public water supply wells that are considered threatened by the groundwater contamination.

Investigation activities have also identified on-site soils contaminated with volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals and PCBs. These areas have either already been addressed or are currently being addressed under existing RODs to address on-site soil contamination.

7.6: <u>Summary of Human Exposure Pathways</u>

This human exposure assessment identifies ways in which people may be exposed to site-related contaminants. Chemicals can enter the body through three major pathways (breathing, touching or swallowing). This is referred to as *exposure.*

The area is served by multiple public water suppliers, some of which are impacted by site-related contaminants. The currently impacted public water supplies treat the water prior to distribution to consumers. This treated water is in compliance with all current Maximum Contaminant Levels as per NYSDOH Part 5, Subpart 5-1 regulations that apply to Public Water Systems. In addition, a Public Water Supply Protection Plan, as required in previous Records of Decision, will continue to address any future impacts to public water supplies from site related contaminants should they be affected by the expanding groundwater plume.

7.7: <u>Summary of the Remediation Objectives</u>

The objectives for the remedial program have been established through the remedy selection process stated in 6 NYCRR Part 375. The goal of the recently completed expanded investigation and engineering analysis is to identify remedial alternatives to address the Navy Grumman groundwater plume, based on new environmental data and modeling. At a minimum, the remedy shall eliminate or mitigate all significant threats to public health and the environment presented by the contamination identified at the site through the proper application of scientific and engineering principles.

Groundwater RAOs for Public Health Protection:

- Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards; and
- Prevent contact with contaminated groundwater.

Groundwater RAOs for Environmental Protection:

- Hydraulically contain the Navy Grumman groundwater plume, reduce its volume and contaminant concentrations, and prevent its further expansion and migration;
- Restore groundwater aquifer to pre-disposal/pre-release conditions, to the extent practicable;
- Prevent the discharge of contaminants to surface water; and
- Prevent adverse impacts to the quantity or quality of the groundwater resources associated with the Nassau-Suffolk Sole Source Aquifer.

SECTION 8: SUMMARY OF THE PROPOSED AMENDED REMEDY

To be selected, the remedy must be protective of public health and the environment, be cost-effective, comply with other statutory requirements, and utilize permanent solutions, alternative technologies or resource recovery technologies to the maximum extent practicable. The remedy must also attain the remedial action objectives identified for the site, which are presented in Section 7.7. Potential remedial alternatives for the Northrop Grumman Bethpage Facility and NWIRP sites were identified, screened and evaluated in the April 2019 FS report.

A summary of the remedial alternatives that were considered for the Northrop Grumman Bethpage Facility and NWIRP sites is presented in Exhibit B. Cost information is presented in the form of present value, which represents the amount of money invested in the current year that would be sufficient to cover all present and future costs associated with the alternative. This enables the costs of remedial alternatives to be compared on a common basis. As a convention, a time frame of 30 years is used to evaluate present worth costs for alternatives with an indefinite duration. This does not imply that operation, maintenance, or monitoring would cease after 30 years if remediation goals are not achieved. A summary of the Remedial Alternatives Costs is included as Exhibit C.

The basis for the Department's proposed amended remedy is set forth at Exhibit D. For the Navy Grumman groundwater plume, the proposed amended remedy is referred to as the Hydraulic Containment of Site Contaminants above SCGs Combined with Mass Flux Remediation - Centralized Treatment Plant with a Centralized Recharge Basin remedy. The remedy corresponds to groundwater contamination addressed under Operable Units 2 and 3 in previous Records of Decision.

The estimated present worth cost to implement the remedy is $585,000,000. The cost to construct the remedy is estimated to be $241,000,000 and the estimated average annual cost for operation and maintenance of the system is $16,300,000.

The elements of the proposed remedy (which are intended to supplement remedial element(s) previously selected in existing RODs, as described in Section 1) are as follows:

1) A remedial design program would be implemented to provide the details necessary for the construction, operation, optimization, maintenance, and monitoring of the remedial program. Green remediation principles and techniques would be implemented to the extent feasible in the design, implementation, and site management of the remedy as per DER-31. The major green remediation components are as follows:

   - Considering the environmental impacts of treatment technologies and remedy stewardship over the long term;
   - Reducing direct and indirect greenhouse gases and other emissions;
   - Increasing energy efficiency and minimizing use of non-renewable energy;
   - Conserving and efficiently managing resources and materials;
   - Reducing waste, increasing recycling and increasing reuse of materials which would otherwise be considered a waste;
   - Maximizing habitat value and creating habitat when possible;
   - Fostering green and healthy communities and working landscapes which balance ecological, economic and social goals; and
   - Integrating the remedy with the end use where possible and encouraging green and sustainable re-development.

2) Groundwater extraction and treatment would be implemented to treat site contaminants in the off-site groundwater plume. Based on the current groundwater flow modeling, it is expected that approximately eight groundwater extraction wells would be installed and pumped within the interior of the groundwater plume to achieve capture of site contaminants that exceed 50 ppb. These eight wells are positioned as mass flux wells and specifically designed to capture the bulk of the groundwater contamination mass. The mass flux wells would be supplemented with a network of approximately 16 extraction wells located along the margins of the SCG plume (typically 5 ppb TCVOC) to prevent continued migration of the plume. In total, these 24 extraction wells would withdraw contaminated groundwater at an approximate combined rate of 12,100 gallons per minute (17.5 MGD). The exact number and locations of the extraction wells would be determined after pre-design sampling, completion of a full engineering design and continued groundwater modeling. This would also assist in finalizing the well depths and pumping rates.

   The extracted groundwater would be treated at one of five groundwater treatment plants using air stripping technology. This air stripping would be implemented ex-situ to remove volatile contaminants from extracted groundwater. Using this technology, the groundwater would be contacted with an air stream to volatilize contaminants from groundwater to air. Following air stripping, the water would be secondarily treated with liquid-phase granulated active carbon (GAC). The GAC would be used to remove dissolved contaminants from extracted groundwater by adsorption. The GAC system would consist of one or more vessels filled with carbon connected in series and/or parallel. Advanced oxidation process (AOP) technology would be used for 1,4-dioxane removal, if necessary, based on data acquired during the remedial design. The extracted air stream containing the volatile contaminants would be treated prior to discharge to the atmosphere using vapor-phase GAC. The above description of the groundwater treatment processes is based on evaluations in the FS. The details of this treatment process would be fully determined during a remedial design program.

Following withdrawal, contaminated groundwater from 17 of the 24 extraction wells would be pumped to a centralized groundwater treatment plant in the area of the former Northrop Grumman property. This centralized treatment plant would be capable of treating approximately 8,100 gpm (11.7 MGD). Following treatment, this water would be returned to the aquifer via a newly constructed recharge basin located on the public property within Bethpage State Park. It is expected that a recharge basin approximately 10-acres in size would be necessary to manage the treated water. Seasonally, a portion of the treated water would be beneficially re-used for irrigation purposes by the Bethpage State Park.

Contaminated groundwater withdrawn from four of the 24 extraction wells would be pumped to a second centralized treatment plant near the headwaters of Massapequa Creek. This centralized treatment plant would be capable of treating approximately 2,000 gpm (2.8 MGD). Following treatment, this water would be used to augment flow in Massapequa Creek. This streamflow augmentation would provide environmental benefits (e.g., increased steam flows) to the local aquatic habitat within Massapequa Creek.

Contaminated water from the three remaining groundwater extraction wells would be treated at three smaller, individual, treatment plants located south of the Southern State Parkway. Two of these treatment plants would be capable of treating 1,000 gpm (1.4 MGD) each and the third treatment plant would be capable of treating 500 gpm (0.72 MGD). Treated water from these individual treatment plants would be discharged to three existing recharge basins at a total flow rate of approximately 2,000 gpm (2.9 MGD) to mitigate potential environmental impacts to surface water flow, wetland water levels, and subsea discharge (saltwater intrusion) caused by the extraction of approximately 12,100 gallons per minute (17.5 MGD) of groundwater under this alternative.

Groundwater modeling would be performed during the remedial design program to assist in finalizing the number and locations of recharge basins to be used (and the associated discharge rates), and the amount of treated water that would be discharged to Massapequa Creek (to augment flow) and to Bethpage State Park (for irrigation purposes). To convey water from the extraction wells to the five treatment plants and from the treatment plants to the discharge locations, it is estimated that a total of approximately 124,000 feet (23.5 miles) of underground conveyance piping would be installed as part of this remedy.

The operation of the components of the remedy would continue until the remedial objectives have been achieved, or until the Department determines that continued operation is technically impracticable or not feasible.

3) The remedy assumes that the existing and planned groundwater extraction and treatment remedial systems (i.e., GM-38 [existing], RW-21 [under construction], RE108 Phase I (in design] and RE108 Phase II [in design]) are operating and that the existing water district public water supply wells would continue to pump water at rates equivalent to the average rate for those wells (over a representative six-year period (2010-2015)) during operation of the remedy.

4) The Bethpage Water District Plants 4, 5, and 6 pumping wells would be transitioned over time from public water supply wells to remedial wells. To allow Bethpage Water District to

continue to meet municipal demands without these wells, the remedy includes a provision for development of an alternate water supply.

5) Imposition of an institutional control in the form of an environmental easement, deed restriction or an environmental notice on properties where engineering controls (e.g., extraction wells, water treatment plants) are constructed.

6) A Site Management Plan is required, which includes the following:
   - An Institutional and Engineering Control Plan that identifies all use restrictions and engineering controls for the Northrop Grumman Bethpage Facility and NWIRP sites and details the steps and media-specific requirements necessary to ensure the following institutional and/or engineering controls remain in place and effective:
     - Institutional Controls: The Institutional Control/s discussed in Paragraph 5 above.
     - Engineering Controls: The extraction wells, underground conveyance piping, treatment plants, and recharge basins discussed in Paragraphs 2 and 3 above.
   - A Monitoring Plan to assess the performance and effectiveness of the remedy. The plan includes, but may not be limited to:
     - monitoring of groundwater to assess the performance and effectiveness of the remedy; and
     - a schedule of monitoring and frequency of submittals to the Department.
   - An Operation and Maintenance (O&M) Plan to ensure continued operation, maintenance, optimization, monitoring, inspection, and reporting of any mechanical or physical components of the remedy. The plan includes, but is not limited to:
     - procedures for operating and maintaining the remedy;
     - compliance monitoring of treatment systems to ensure proper O&M as well as providing the data for any necessary permit or permit equivalent reporting;
     - maintaining site access controls and Department notification; and
     - providing the Department access to the site and O&M records.

Exhibit A

Nature and Extent of Contamination

This section describes the findings of the Remedial Investigation for all environmental media that were evaluated. As described in Section 7, samples were collected from various environmental media to characterize the nature and extent of contamination.

This document evaluates remedial options for addressing the off-site portions of the groundwater plume originating from the NWIRP site and the Northrop Grumman Bethpage Facility site. On-site waste/source areas, soil contamination, and on and off-site soil vapor is addressed under the existing RODs for the NWIRP site and the Northrop Grumman Bethpage Facility site. Each of the existing RODs includes tables summarizing findings of the investigations for each medium for which contamination was identified. This document includes tables to present the range of contamination found in on-site and off-site groundwater and compares the data with the applicable SCGs for the site.

Waste/Source Areas

As described in the RI reports, waste/source materials were identified at the site and are impacting groundwater, soil, and soil vapor.

Wastes are defined in 6 NYCRR Part 375-1.2 and include solid, industrial and/or hazardous wastes. Source areas are defined in 6 NYCRR Part 375. Source areas are areas of concern at a site where substantial quantities of contaminants are found which can migrate and release significant levels of contaminants to another environmental medium. Wastes and source areas were identified at the site and include a former drum marshaling area, areas where above-ground and underground storage tanks were located, recharge basins that received process water, sludge drying beds, and a salvage storage area.

The waste/source areas identified at the sites were addressed/will be addressed by the IRM(s), by remedial actions completed in accordance with earlier RODs; and by remedial actions that will be completed in accordance with IRMs and RODs described in Sections 7.3.2 and 7.4 respectively.

Groundwater

Remedial investigations completed by Northrup Grumman (Geraghty & Miller and Arcadis) and the U.S. Navy (TetraTech) over the last few decades, demonstrate that past disposal practices contaminated the groundwater in both the upper glacial and Magothy aquifers. The western (OU2) and eastern plumes (OU3) originated from the sites, and the two plumes comingle downgradient of the on-site areas to form one overall groundwater plume (Figure 2).

The groundwater plume is a three-dimensional volume of contaminated groundwater in the subsurface that varies by location and depth within its overall limits (Figure 3). The length of the groundwater plume that contains site contaminants exceeding the respective Standards, Criteria and Guidance (SCGs) is approximately 4.3 miles. As shown on Figure 3, the SCG groundwater plume extends from the NWIRP and Northrop Grumman properties to the distal edge near the Southern State Parkway. The overall width of the plume is approximately 2.1 miles wide at its widest point.

The assessment of the existing groundwater quality data conducted in support of this proposed AROD confirmed that TCE is the primary contaminant in the overall groundwater plume. TCE has the highest number of detections and the highest number of measured sample concentrations that exceed applicable standards (Table 1). Specifically, TCE was detected in 3,172 of the 5,545 groundwater samples analyzed for TCE (57% of samples). As summarized in Table 1, the TCE concentrations in groundwater ranged from 0.23 parts per billion (ppb) to 11,200 ppb and exceeded the SCG of 5 ppb in 2,257 of the 5,545 samples. TCE was found to exceed the SCG to a maximum depth of 820 feet below ground surface. TCE was detected at the highest concentration in a monitoring well located in the RW-21 Area south of the Former Grumman Settling Ponds area (Figure 2).

As summarized in Table 1, cis-DCE and PCE were the next most frequently detected site contaminants in groundwater. Specifically, cis-DCE was detected in 494 of 4,243 groundwater samples at concentrations that exceeded the 5 ppb SCG. The highest cis-DCE concentration was 210,000 ppb and this sample was collected from a vertical profile boring (VP-27) completed in 2005 during the investigation of the Former Grumman Settling Ponds area (Figure 2). The deepest groundwater sample that exceeded the standard for cis-DCE was collected from a monitoring well screened from 716 to 726 feet (MW-13 in the RW-21 area). PCE was detected in 890 of 5,447 groundwater samples at concentrations exceeding the SCG of 5 ppb. The highest PCE concentration (940 ppb) occurred in a groundwater sample collected at a depth of 640 feet beneath the ground surface in a monitoring well (MW-87D2) located south of the former RUCO Polymer Corp (Hooker Chemical site on Figure 2) site (Site No. 130004) and immediately west of the NWIRP and Northrop Grumman Bethpage Facility sites.

Additional chlorinated volatile organic compounds (CVOCs), Freon compounds, toluene and 1,4-dioxane were also detected at concentrations exceeding their respective standards and are generally found comingled with the TCE, PCE, and cis-DCE groundwater plume. The deepest groundwater sample that was found to be above standards was 980 feet below ground surface where toluene was measured at 5.8 ppb in a vertical profile boring (VPB-167) immediately south of the Southern State Parkway. The emerging contaminant 1,4-dioxane was detected in approximately 50% of the 634 groundwater samples in the database at concentrations exceeding the EPA health-based guidance value 0.35 ppb. The detected concentrations for 1,4-dioxane ranged from 0.046 ppb to 190 ppb, and 1,4-dioxane was detected in samples as deep as 750 feet below ground surface.

Site contaminants have been detected in raw, untreated groundwater used as drinking water in six different well fields operated by the Bethpage Water District, South Farmingdale Water District, and New York American Water Company (Figure 2). The Bethpage Water District operates three of the six well fields. These three well fields are immediately downgradient of the NWIRP and Northrop Grumman Bethpage Facility sites and within the central portion of the groundwater plume. Due to their proximity to the sites, these Bethpage Water District well fields were the first to require wellhead treatment to address site related VOC contamination present in off-site groundwater. Based on sampling completed in in 2017, the average TCE concentrations in raw, untreated groundwater exceeded the SCG of 5 ppb for TCE in the three Bethpage Water District well fields and ranged from 30.87 ppb to 1,940 ppb. With the exception of Bethpage Water District Well 6-1, the TCE concentrations in raw, untreated groundwater have increased over time in each of the Bethpage Water District wells. Raw, untreated water from Bethpage Water District Well 6-2 has consistently contained the highest TCE concentrations. In 2017, TCE concentrations in raw, untreated water from Well 6-2 ranged from 844 ppb to 1,940 ppb with an average of 1,362 ppb. The average annual TCE concentration in raw, untreated groundwater from

Well 6-2 increased over 700 percent from 2008 (161 ppb) to 2017 (1,362 ppb). In 2017, TCE concentrations in raw, untreated water from Bethpage Water District Well 4-1 ranged from 85 ppb to 183 ppb with an average of 143 ppb. The average annual TCE concentration in raw, untreated groundwater from Well 4-1 increased nearly 300 percent from 2008 (36 ppb) to 2017 (143 ppb). The Bethpage Water District provides treatment at each of its wells prior to distribution of water to customers.

Table 1 - Groundwater

Detected Constituents	Concentration Range Detected (ppb)[a]	SCG[b] (ppb)	Frequency Exceeding SCG
VOCs			
1,1,1-Trichloroethane	0.1 - 110	5	31 of 4,618
1,1,2,2-Tetrachloroethane	0.2 - 0.25	5	0 of 4,596
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	0.22 - 250	5	335 of 4,107
1,1,2-Trichloroethane	0.21 - 5	1	83 of 4,604
1,1-Dichloroethane	0.16 - 110	5	205 of 4,615
1,1-Dichloroethene	0.19 - 110	5	195 of 4,618
1,2-Dichloroethane	0.14 - 39.9	0.6	133 of 4,616
1,2-Dichloroethene	0.21 – 1,100	5	43 of 1,843
1,2-Dichloropropane	0.28 - 32.7	1	38 of 4,433
1,4-Dioxane	0.046 - 190	0.35	306 of 634
Carbon Disulfide	0.089 - 18	60	0 of 4,231
Carbon Tetrachloride	0.09 - 8	5	3 of 4,605
Chlorobenzene	0.3 - 7	5	2 of 4,605
Chlorodifluoromethane (Freon 22)	0.21 - 400	5	22 of 1,276
Chloroform	0.11 - 110	7	100 of 4,550
Chromium, Total	0.4 - 804	5	56 of 113
Cis-1,2-Dichloroethylene	0.19 – 210,000	5	494 of 4,243
Dichlorodifluoromethane (Freon 12)	0.2 - 32	5	5 of 3,767
Tetrachloroethylene (PCE)	0.2 - 940	5	890 of 5,447
Toluene	0.06 – 84,000	5	59 of 4,441
Trans-1,2-Dichloroethene	0.23 - 95	5	23 of 4,238
Trichloroethylene (TCE)	0.23 – 11,200	5	2,257 of 5,545
Vinyl Chloride	0 – 6,300	2	568 of 5,403
Inorganics			
Iron	120 – 1,700	300	11 of 15
Nickel	30.6 - 30.6	100	0 of 15

a - ppb: parts per billion, which is equivalent to micrograms per liter, ug/L, in water.
b - SCG: Standard Criteria or Guidance - Ambient Water Quality Standards and Guidance Values (TOGs 1.1.1), 6 NYCRR Part 703, Surface water and Groundwater Quality Standards, and Part 5 of the New York State Sanitary Code (10 NYCRR Part 5).

Based on the findings of the expanded investigation combined with earlier RIs, the past disposal of hazardous waste has resulted in the contamination of on-site and off-site groundwater. While on-site groundwater contamination identified during the previous RIs was addressed during the IRMs described in Section 7.3.2 and will be further addressed in accordance with existing RODs, contaminant concentrations in off-site groundwater continue to increase and the plume continues to migrate to the south-southeast. The site contaminants that are considered to be the primary contaminants of concern which will drive the remediation of groundwater to be addressed by the remedy selection process are: TCE, and TCE breakdown products, PCE, and 1,4-dioxane.

Soil

Based on the findings of the earlier Remedial Investigations, the past disposal of hazardous waste has resulted in the contamination of soil. The site contaminants identified in soil which are considered to be the primary contaminants of concern are TCE and TCE breakdown products, PCE, PCBs, and metals. These contaminants have been addressed by IRMs and the existing RODs, or will be addressed by the existing RODs.

Soil Vapor

The evaluation of the potential for soil vapor intrusion resulting from the presence of site related soil or groundwater contamination was evaluated by the sampling of soil vapor, sub-slab soil vapor under structures, and indoor air inside structures. At this site due to the presence of buildings in the impacted area a full suite of samples were collected to evaluate whether soil vapor intrusion was occurring.

To assess the potential for soil vapor intrusion, sub-slab and indoor air samples were collected from a total of 26 homes located immediately south of the former NWIRP and Northrop Grumman Bethpage Facility sites. This sampling identified elevated concentrations of site-related VOCs in soil vapor and in the indoor air of six residential structures. Granular activated carbon (GAC)-based air purification units (APUs) were initially installed to remove site-related VOC vapors from indoor air of the affected structures and then slab-slab depressurization systems (SSDs) were installed to mitigate the potential for soil vapor intrusion to occur.

Based on the concentrations detected, and in comparison with the NYSDOH Soil Vapor Intrusion Guidance, soil vapor contamination identified during the RI was addressed during the IRM described in Section 7.3.2. Specifically, the Bethpage Community Park On-Site Soil Vapor Extraction and Treatment System operated by Northrop Grumman and the Site 1, Former Drum Marshaling Yard Soil Vapor Extraction Containment System operated by the U.S. Navy, prevent off-site migration of VOC contaminated soil vapor.

Exhibit B

<u>Description of Remedial Alternatives</u>

The following alternatives were considered based on the remedial action objectives (see Section 7.7) to address the off-site groundwater plume originating from the Northrop Grumman Bethpage Facility and NWIRP sites as described in Exhibit A.

With the exception of the No Further Action Alternative, the following common elements are included in each of the remedial alternatives evaluated:

- **<u>Groundwater Extraction</u>**: Contaminated groundwater would be withdrawn from the subsurface using high capacity extraction wells. The total number of extraction wells, along with the approximate locations, pumping rates, and depths for each alternative was determined based on groundwater flow modeling completed in cooperation with the USGS. The final locations, depths, and flow rates for each of the extraction wells would be further refined during a remedial design program.
- **<u>Treatment of Contaminated Water</u>**: The typical treatment process would include filtration, removal of VOCs using air stripping technology, vapor-phase granulated active carbon (GAC), liquid-phase GAC, and advanced oxidation process (AOP) for 1,4-dioxane. Depending on the alternative, the contaminated groundwater from each extraction well would either be treated utilizing one or two large centralized treatment plants or multiple decentralized groundwater treatment plants near the extraction wells. The details for the centralized treatment plant and decentralized treatment plant options are summarized below.
    1) <u>Decentralized Treatment Plants</u>: Under this treatment option, multiple decentralized treatment plants are proposed near the extraction wells (either individually or in a group) based on the locations and flow rates of the respective extraction wells. Alternatives including decentralized treatment plants are identified with the "A" suffix. The property acquisition costs for sufficient acreage for constructing the decentralized treatment plants is included within the cost estimates for each of the decentralized treatment plant alternatives. For the purpose of this analysis, it is assumed that an approximately 2,000 to 4,000-square foot groundwater treatment plant building is required adjacent to each extraction well. To the maximum extent practicable, public ROWs, existing state/county/town-owned recharge basins, and publicly-available real estate would be utilized when evaluating possible locations for the decentralized treatment plants.
    2) <u>Centralized Treatment Plants</u>: Under this treatment option, one large centralized treatment plant would be located within the area of the former Northrop Grumman Bethpage Facility and NWIRP site property boundaries (herein referred to as north treatment plant); and a second treatment plant would be located along the Southern State Parkway near Massapequa Creek (herein referred to as south treatment plant). To the maximum extent practicable, public ROWs, existing state/county/town-owned recharge basins, and publicly-available real estate would be utilized when evaluating possible locations for the extraction well houses and pump stations.
- **<u>Management of Treated Water</u>**: Each alternative includes options for managing treated water by either beneficially re-using the water and/or returning the treated water to the surface water and/or groundwater systems. Specifically, treated water would be managed using a combination of existing recharge basins, constructed recharge basins, surface water streams (e.g., Massapequa Creek), injection wells or irrigation at the Bethpage State Park.

- **Conveyance of Water**: For the conveyance of contaminated groundwater from mass flux extraction wells, double-walled high-density polyethylene (HDPE) piping would be used. For the conveyance of treated water to the location for management, single-walled HDPE piping would be used.
- **Development of Alternate Water Supply:** Each of the remedial alternatives assume that the currently operating water district pumping wells (e.g., Bethpage Water District Plants 4, 5, and 6; South Farmingdale Water District Plants 1 and 3; and American Water New York – Seamans Neck Road Plant, etc.) would continue to withdraw water during remedy operation. Of these water districts, the three Bethpage water plants have been most impacted by the plume originating from the NWIRP and Northrop Grumman Bethpage Facility sites. Specifically, they are immediately downgradient of the NWIRP and Northrop Grumman Bethpage Facility sites, are within the central portion of the groundwater plume, were the first to require wellhead treatment, and groundwater withdrawn from some of these wells has exhibited continuous increases in contaminant concentrations over time. While these three Bethpage Water District plants are operated to meet municipal demands, they indirectly remove significant amounts of site-related contaminants from the aquifer system through water extraction and treatment. Although this removal provides an added remedial benefit, this dual use of public water supply wells is not a preferred option over the long term. Therefore, it is the intent of the Department and NYSDOH to transition the Bethpage Water District Plants 4, 5, and 6 pumping wells over time from public water supply wells to remedial wells. To allow Bethpage Water District to continue to meet municipal demands without these wells, a provision for development of an alternate water supply in the future is required and included as a common component of each remedial alternative.
- **Long-Term Groundwater Monitoring**: Periodic monitoring of on-site and off-site groundwater quality to assess the performance of the remedial program; and
- **Periodic Reviews**: Periodic reviews would be used to evaluate the proposed remedy and certify that the remedial measures remain in-place.

Alternative 1: No Further Action

The No Further Action Alternative recognizes the remediation of the site completed by the IRM(s) along with on-going and planned remedial actions under existing RODs. The on-going and planned remedial actions are listed below and also described in 7.2 (Summary of Actions Under Public Water Supply Protection Program), Section 7.3.2 (Interim Remedial Measures), and Section 7.4 (Summary of Remedial Actions in Accordance with Earlier RODs). This alternative leaves the site in its present condition and does not provide any additional protection of the environment.

- Operation of the ONCT (five groundwater extraction wells);
- Operation of the Bethpage Community Park Groundwater Containment System (four groundwater extraction wells);
- Operation of the GM-38 Groundwater Extraction and Treatment System (currently two groundwater extraction wells);
- Future operation of the RW-21 Area Groundwater Extraction and Treatment System (three groundwater extraction wells);
- Future operation of the RE-108 Groundwater Extraction and Treatment System (three to five groundwater extraction wells);
- Continued wellhead treatment at six public water supplies; and
- Continued implementation of the Public Water Supply Contingency Plan.

Alternative 2A: Hydraulic Containment of Site Contaminants above Standards, Criteria, and Guidance (SCGs) - Decentralized Treatment Plants with Various Discharge Methods

Under Alternative 2A, a series of groundwater extraction wells would be installed and pumped along the margins of the groundwater plume in order to achieve hydraulic containment of site contaminants that are present at concentrations exceeding SCGs (typically 5 ppb). Once withdrawn, the contaminated water would be treated using multiple, decentralized treatment plants. Alternative 2A assumes that the existing and planned groundwater extraction and treatment remedial systems (i.e., GM-38 [existing], RW-21 [under construction], RE108 Phase I [in design] and RE108 Phase II [in design]) are operating. This alternative also assumes that the existing water district wells would continue to pump water at rates equivalent to the average rate for those wells over a representative six-year period (2010-2015) during operation of the remedy. Alternative 2A is shown conceptually on Figure 7.

Specifically, under Alternative 2A, 16 extraction wells would be installed and pumped at a total rate of 10,400 gallons per minute (gpm) or 15 million gallons per day (MGD) from the aquifer to provide capture of the SCG plume. Extraction wells would be installed to depths ranging from approximately 300-feet below ground surface (bgs) to 950-feet bgs with an estimated screen length of 100 to 200 feet per extraction well. Following withdrawal, the contaminated groundwater from each extraction well would be pumped to a nearby groundwater treatment plant. In total, Alternative 2A includes the construction of six 500-gpm (0.7 MGD) treatment plants, six 1,000-gpm (1.4 MGD) treatment plants, and one 2,250-gpm (3.2 MGD) treatment plant (along the Southern State Parkway near Massapequa Creek).

Once treated, water from 12 of the treatment plants would be returned to the aquifer via 13 existing recharge basins. Three of the 13 recharge basins located beyond the southern edge of the groundwater plume are included under Alternative 2A to manage treated water at a total flow rate of approximately 2,000 gpm (2.9 MGD) to mitigate potential environmental impacts to surface water flow, wetland water levels, and subsea discharge (saltwater intrusion) caused by groundwater extraction under this alternative. Treated water from a single treatment plant near Massapequa Creek would be used to augment flow in Massapequa Creek.

To convey water from point of extraction to treatment and then from the treatment plants to the recharge basins or Massapequa Creek, a total of approximately 82,000 feet (15.5 miles) of underground piping would be installed as part of this remedial alternative. Figure 7 shows the approximate locations of the extraction wells, treatment plants, conveyance piping, and discharge locations.

It is expected that it would take approximately five years to design and implement the remedy. Since Alternative 2A focuses on the area of lowest groundwater VOC concentrations and because of the persistent nature of the contaminants and the length of the groundwater plume, it is not expected that Alternative 2A would achieve the groundwater SCGs within the near future.

Costs are based on completion of remedial design testing, installation of 16 extraction wells, construction and operation of 13 groundwater treatment systems for a 30-year period, installation of 82,000 feet (15.5 miles) of underground piping, development of an alternate water supply, property acquisitions to support the remedy, and long-term groundwater quality monitoring.

Present Worth:..*$553,000,000*
Capital Cost:..*$210,000,000*
Annual Costs:..*$16,700,000*

Alternative 2B: Hydraulic Containment of Site Contaminants above SCGs - Centralized Treatment Plants with a Centralized Recharge Basin

Under Alternative 2B, a series of groundwater extraction wells would be installed and pumped along the margins of the groundwater plume in order to achieve capture of site contaminants that are present at concentrations exceeding SCGs (typically 5 ppb). Once withdrawn, the contaminated water would be treated at one of two centralized treatment plants or one of three decentralized treatment plants. Alternative 2B assumes that the existing and planned groundwater extraction and treatment remedial systems (i.e., GM-38 [existing], RW-21 [under construction], RE108 Phase I [in design] and RE108 Phase II [in design]) are operating. This alternative also assumes that the existing water district wells would continue to pump water at rates equivalent to the average rate for those wells over a representative six-year period (2010-2015) during operation of the remedy. Alternative 2B is shown conceptually on Figure 8.

Specifically, Alternative 2B includes 16 extraction wells that would be installed and pumped at a total rate of 9,200 gpm (13.2 MGD) from the aquifer to provide capture of the SCG plume. Extraction wells would be installed to depths ranging from approximately 300-feet bgs to 950-feet bgs with an estimated screen length of 100 to 200 feet per extraction well. Following withdrawal, the contaminated groundwater from the 16 extraction wells would be pumped to either a north centralized treatment plant capable of treating approximately 5,200 gpm (7.5 MGD), a south centralized treatment plant capable of treating 2,000 gpm (2.9 MGD), two decentralized treatment plants located south of the Southern State Parkway capable of treating 1,000 gpm (1.4 MGD) or a decentralized treatment plant located south of the Southern State Parkway capable of treating 500 gpm (0.72 MGD).

Discharge water from the north centralized treatment plant would be returned to the aquifer via a newly constructed recharge basin located in the public property in the vicinity of the Bethpage State Park. It is expected that a 10-acre recharge basin would be necessary to manage the treated water from the north centralized treatment plant. Approximately 900 gpm (1 MGD) of the treated water would also be beneficially re-used for irrigation purposes by the Bethpage State Park for eight months of the year from the north centralized treatment plant. The discharge water from the south centralized treatment plant would be used to augment flow in Massapequa Creek. Treated water from the three smaller, decentralized treatment plants located near the southern edge of the groundwater plume and near the Southern State Parkway would be discharged to three existing recharge basins to mitigate potential negative environmental impacts to surface water flow, wetland water levels, and subsea discharge (saltwater intrusion) caused by the withdrawal of water from the aquifer under this alternative.

To convey water from the extraction wells to the treatment plants and from the treatment plants to the recharge basins, Massapequa Creek, or Bethpage State Park for irrigation purposes, a total of approximately 108,000 feet (20.4 miles) of underground piping would be installed as part of this remedial alternative. Figure 8 shows the approximate locations of the extraction wells, treatment plants, conveyance piping, and discharge locations.

It is expected that it would take approximately five years to design and implement the remedy. Since Alternative 2B focuses on the area of lowest groundwater VOC concentrations and because of the persistent nature of the contaminants and the length of the groundwater plume, it is not expected that Alternative 2B would achieve the groundwater SCGs within the near future.

Costs are based on completion of remedial design testing, installation of 16 extraction wells, construction and operation of two centralized and three decentralized groundwater treatment systems for a 30-year period, construction of a 10-acre recharge basin, installation of 108,000 feet (20.4 miles) of underground piping, development of an alternate water supply, property acquisitions to support the remedy, and long-term groundwater quality monitoring.

Present Worth: *$485,000,000*
Capital Cost: *$195,000,000*
Annual Costs: *$13,900,000*

Alternative 3A: Plume Mass Flux Remediation - Decentralized Treatment Plants with Various Discharge Methods

Under Alternative 3A, a series of mass flux groundwater extraction wells would be installed and pumped within the interior of the groundwater plume in order to achieve capture of site contaminants that are present at concentrations exceeding 50 ppb. Once withdrawn, the contaminated water would be treated using multiple, decentralized treatment plants. Alternative 3A assumes that the existing and planned groundwater extraction and treatment remedial systems (i.e., GM-38 [existing], RW-21 [under construction], RE108 Phase I [in design] and RE108 Phase II [in design]) are operating. This alternative also assumes that the existing water district wells would continue to pump water at rates equivalent to the average rate for those wells over a representative six-year period (2010-2015) during operation of the remedy. Alternative 3A is shown conceptually on Figure 9.

Specifically, under Alternative 3A, 17 extraction wells would be installed and pumped at a total rate of 9,100 gpm (13.1 MGD) from the aquifer to provide capture of site contaminants at concentrations exceeding 50 ppb. Under Alternative 3A, extraction wells would be installed to depths ranging from 300-feet bgs to 800-feet bgs with an estimated screen length of 100 to 200 feet per extraction well. Following withdrawal, the contaminated groundwater from each extraction well would be pumped to a nearby decentralized groundwater treatment plant. In total, Alternative 3A includes the construction of 12 decentralized treatment plants designed to treat water at flow rates ranging from 500 to 2,250 gpm. Once treated, water would be returned to the aquifer using 12 existing recharge basins. Approximately 900 gpm (1 MGD) of the treated effluent would also be discharged to Bethpage State Park and used for irrigation purposes at the park for eight months of the year.

To convey water from point of extraction to treatment and then from the treatment plants to the recharge basins and Bethpage State Park for irrigation purposes, a total of approximately 118,000 feet (22.4 miles) of underground piping would be installed as part of this remedial alternative. Figure 9 shows the approximate locations of the extraction wells, treatment plants, conveyance piping, and discharge locations.

It is expected that it would take approximately five years to design and implement the remedy. Since Alternative 3A is a mass flux approach that focuses on the area of highest groundwater VOC concentrations and because of the persistent nature of the contaminants and the length of the groundwater plume, it is not expected that Alternative 3A would achieve the groundwater SCGs within the near future.

Costs are based on completion of remedial design testing, installation of 17 extraction wells, construction and operation of 12 groundwater treatment systems for a 30-year period, installation of 118,000 feet (22.4 miles) of underground piping, development of an alternate water supply, property acquisitions to support the remedy, and long-term groundwater quality monitoring.

Present Worth: *$522,000,000*
Capital Cost: *$234,000,000*
Annual Costs: *$17,200,000*

Alternative 3B: Plume Mass Flux Remediation - Centralized Treatment Plant with a Centralized Recharge Basin

Under Alternative 3B, a series of mass flux groundwater extraction wells would be installed and pumped within the interior of the groundwater plume in order to achieve capture of site contaminants that are present at concentrations exceeding 50 ppb. Once withdrawn, the contaminated water would be treated using a single centralized treatment plant. Alternative 3B assumes that the existing and planned groundwater extraction and treatment remedial systems (i.e., GM-38 [existing], RW-21 [under construction], RE108 Phase I (in design] and RE108 Phase II [in design]) are operating. This alternative also assumes that the existing water district wells would continue to pump water at rates equivalent to the average rate for those wells over a representative six-year period (2010-2015) during operation of the remedy. Alternative 3B is shown conceptually on Figure 10.

Alternative 3B includes 16 extraction wells that would be installed and pumped at a total rate of 7,100 gpm (10.2 MGD) from the aquifer to provide capture of site contaminants at concentrations exceeding 50 ppb. Under Alternative 3B, extraction wells would be installed to depths ranging from 300-feet bgs to 800-feet bgs with an estimated screen length of 100 to 200 feet per extraction well. Following withdrawal, the contaminated groundwater from the 16 extraction wells would be pumped to a centralized groundwater treatment plant located in the vicinity of the former NWIRP and Northrop Grumman property.

Once treated, water would be returned to the aquifer via a newly constructed recharge basin to be located on the public property in the vicinity of the Bethpage State Park. It is expected that an approximate 10-acre recharge basin would be necessary to manage the treated water. Approximately 900 gpm of the treated water would also be beneficially re-used for irrigation purposes by the Bethpage State Park for eight months of the year.

To convey water from the extraction wells to the treatment plant and from the treatment plant to the central recharge basin and Bethpage State Park for irrigation purposes, a total of approximately 82,500 feet (15.6 miles) of underground piping would be installed as part of this remedial alternative. Figure 10 shows the approximate locations of the extraction wells, treatment plants, conveyance piping, and discharge locations.

It is expected that it would take approximately five years to design and implement the remedy. Since Alternative 3B is a mass flux approach that focuses on the area of highest groundwater VOC concentrations and because of the persistent nature of the contaminants and the length of the groundwater plume, it is not expected that Alternative 3B would achieve the groundwater SCGs within the near future.

Costs are based on completion of remedial design testing, installation of 16 extraction wells, construction and operation of a centralized groundwater treatment system for a 30-year period, construction of a 10-acre recharge basin, installation of 82,500 feet (15.6 miles) of underground piping, development of an alternate water supply, property acquisitions to support the remedy, and long-term groundwater quality monitoring.

Present Worth: *$332,000,000*
Capital Cost: *$169,000,000*
Annual Costs: *$8,660,000*

Alternative 4: Aquifer Flushing

Alternative 4 is an aquifer flushing approach that involves the extraction of contaminated groundwater from the aquifer where site contaminant concentrations exceed 100 ppb, ex-situ treatment using multiple decentralized treatment plants, and the re-introduction of the treated water back into the subsurface using injection wells. Under this alternative, the treated water is strategically re-introduced to promote movement of impacted groundwater toward the extraction wells, enhance hydraulic control of the contaminated groundwater, and prevent further migration of the 100 ppb plume. Alternative 4 assumes that the existing and planned groundwater extraction and treatment remedial systems (i.e., GM-38 [existing], RW-21 [under construction], RE108 Phase I (in design] and RE108 Phase II [in design]) are operating. This alternative also assumes that the existing water district wells would continue to pump water at rates equivalent to the average rate for those wells over a representative six-year period (2010-2015) during operation of the remedy. Alternative 4 is shown conceptually on Figure 11.

Under Alternative 4, a total of 23 extraction wells would be installed and pumped at a total rate of 8,700 gpm (12.5 MGD) from the aquifer to provide capture of site contaminants at concentrations exceeding 100 ppb. The extraction wells would be installed to depths ranging from 300-feet bgs to 1,000-feet bgs with an estimated screen length of 100 to 300 feet per extraction well. Following withdrawal, the contaminated groundwater from each extraction well would be pumped to a nearby decentralized groundwater treatment plant. In total, Alternative 4 includes the construction of 23 decentralized treatment plants with capacities ranging from 100 gpm to 1,000 gpm. Once treated, water from the 23 extraction wells would be returned to the aquifer using a network of 43 injection wells. It is expected that each injection well would re-introduce water to the Magothy aquifer at rates ranging from approximately 25 gpm to 700 gpm. The injection wells would be installed to depths ranging from approximately 160 feet bgs to 900 feet bgs.

To convey water from the point of extraction to the point of treatment and then from the treatment plants to the nearby injection wells, a total of approximately 93,000 feet (17.6 miles) of underground piping would be installed as part of this remedial alternative. Figure 11 shows the approximate locations of the extraction wells, treatment plants, conveyance piping, and injection wells.

It is expected that it would take approximately five years to design and implement the remedy. Since Alternative 4 is an approach developed to expedite plume cleanup in the area where the highest groundwater VOC concentrations exist, this alternative may require as little as 20-years to reach completion. This alternative does not however, directly address areas of the plume where site contaminants are less than 100 ppb and above the SCGs. The timeframe to address the remaining portions of the plume necessary to achieve RAOs would likely exceed 30 years.

Costs are based on completion of remedial design testing, installation of 23 extraction wells, 43 injection wells, construction and operation of 23 groundwater treatment systems for a 30-year period, installation of 93,000 feet (17.6 miles) of underground piping, development of an alternate water supply, property acquisitions to support the remedy, and long-term groundwater quality monitoring.

Present Worth:... *$608,000,000*
Capital Cost:.. *$314,000,000*
Annual Costs:... *$21,000,000*

Alternative 5A: Hydraulic Containment of Site Contaminants above SCGs Combined with Mass Flux Remediation - Decentralized Treatment Plants with Various Discharge Methods

Alternative 5A combines Alternatives 2A and 3A and provides an approach to not only capture site contaminants that exceed SCGs but also addresses areas of the plume with high contaminant concentrations using a plume mass flux approach. Under Alternative 5A, a series of groundwater extraction wells would be installed and pumped within the interior of the groundwater plume to achieve capture of site contaminants that are present at concentrations exceeding 50 ppb. These mass flux wells would be supplemented with a network of extraction wells located along the margins of the SCG plume (typically 5 ppb) to prevent continued migration of the plume.

Once withdrawn, the contaminated water would be treated using multiple, decentralized treatment plants. Alternative 5A assumes that the existing and planned groundwater extraction and treatment remedial systems (i.e., GM-38 [existing], RW-21 [under construction], RE108 Phase I [in design] and RE108 Phase II [in design]) are operating. This alternative also assumes that the existing water district wells would continue to pump water at rates equivalent to the average rate for those wells over a representative six-year period (2010-2015) during operation of the remedy. Alternative 5A is shown conceptually on Figure 12.

Specifically, under Alternative 5A, 24 extraction wells would be installed and pumped at a total rate of 13,300 gpm (19.2 MGD) from the aquifer to provide capture of both the 50 ppb plume and the SCG plume. Eight of the extraction wells (square well symbols on Figure 12) would be installed for the purpose of mass flux remediation within the 50 ppb plume and 16 extraction wells (circular well symbols on Figure 12) would be installed for hydraulic containment of the SCG plume. The extraction wells would be installed to depths ranging from approximately 300-feet bgs to 950-feet bgs with an estimated screen length of 100 to 300 feet per extraction well. Following withdrawal, the contaminated groundwater from each extraction well would be pumped to a nearby decentralized groundwater treatment plant. In total, Alternative 5A would include the construction of 17 decentralized treatment plants. Specifically, one treatment plant would be designed for an influent flow rate of approximately 1,250 gpm (1.8 MGD), four treatment plants would be designed for an influent flow rate of approximately 500 gpm (0.72 MGD) gpm, 11 treatment plants would be designed for an influent flow rate of approximately 1,000 gpm (1.4 MGD), and one plant (along the Southern State Parkway near Massapequa Creek) would be designed for an influent rate of approximately 1,500 gpm (2.2 MGD).

Once treated, approximately 10,900 gpm (15.7 MGD) of water from 21 extraction wells would be returned to the aquifer via 16 existing recharge basins. Water from three of the 21 extraction wells would be discharged to an existing recharge basin located to the west of Bethpage State park, but the treated water would also be available for beneficial re-use for irrigation purposes at Bethpage State Park for eight months of the year. Approximately 1,500 gpm (2.2 MGD) of the treated water withdrawn from the three remaining extraction wells would be used to augment flow in Massapequa Creek. Three of the twelve recharge basins located beyond the southern edge of the groundwater plume (south of the Southern State Parkway) are included under Alternative 5A to manage treated water and to mitigate potential environmental impacts to surface water flow, wetland water levels, and subsea discharge (saltwater intrusion) caused by groundwater extraction under this alternative.

To convey water from point of extraction to treatment and then from the treatment plants to the area where the water would be managed (i.e., recharge basins, irrigation, or streamflow augmentation), a total of approximately 131,000 feet (24.8 miles) of underground piping would be installed as part of this remedial alternative. Figure 12 shows the approximate locations of the extraction wells, treatment plants, conveyance piping, and discharge locations.

It is expected that it would take approximately five years to design and implement the remedy. Since Alternative 5A focuses on areas of the plume with the highest concentrations, as well as areas of lower concentrations along the margins of the plume, it is expected that Alternative 5A would be effective at achieving the groundwater SCGs. Because of the persistent nature of the contaminants and the length of the groundwater plume however, it is not expected that Alternative 5A would achieve the groundwater SCGs within the near future.

Costs are based on completion of remedial design testing, installation of 24 extraction wells (8 mass flux and 16 hydraulic containment), construction and operation of 17 treatment plants for a 30-year period, installation of 131,000 feet (24.8 miles) of underground piping, development of an alternate water supply, property acquisitions to support the remedy, and long-term groundwater quality monitoring.

Present Worth: *$748,000,000*
Capital Cost: *$283,000,000*
Annual Costs: *$22,500,000*

Alternative 5B: Hydraulic Containment of Site Contaminants Above SCGs Combined with Mass Flux Remediation - Centralized Treatment Plants with a Centralized Recharge Basin

Similar to Alternative 5A, Alternative 5B combines the approach to capture site contaminants that exceed SCGs (Alternative 2B) with the plume mass flux approach (Alternative 3B). Under Alternative 5B, a series of groundwater extraction wells would be installed and pumped within the interior of the groundwater plume to achieve capture of site contaminants that exceed 50 ppb. These mass flux wells would be supplemented with a network of extraction wells located along the margins of the SCG plume (typically 5 ppb) to prevent continued migration of the plume. Once withdrawn, the contaminated water would be treated using two centralized treatment plants or one of three decentralized treatment plants. Alternative 5B assumes that the existing and planned groundwater extraction and treatment remedial systems (i.e., GM-38 [existing], RW-21 [under construction], RE108 Phase I [in design] and RE108 Phase II [in design]) are operating. This alternative also assumes that the existing water district wells would continue to pump water at rates equivalent to the average rate for those wells over a representative six-year period (2010-2015) during operation of the remedy. Alternative 5B is shown conceptually on Figure 13.

Specifically, under Alternative 5B, eight of the extraction wells would be installed for the purposes of mass flux remediation within the 50 ppb plume and 16 extraction wells would be installed for hydraulic containment of the SCG plume. In total, these 24 extraction wells would be installed and pumped at a total rate of approximately 12,140 gpm (17.5 MGD) from the aquifer to provide capture of both the 50 ppb plume and the SCG plume. Extraction wells would be installed to depths ranging from approximately 300-feet bgs to 950-feet bgs with an estimated screen length of 100 to 200 feet per extraction well. Following withdrawal, contaminated groundwater from 17 of the extraction wells would be pumped to a north centralized groundwater treatment plant capable of treating 8,140 gpm (11.7 MGD) in the area of the former Northrop Grumman and NWIRP property and contaminated water from four of the extraction wells would be pumped to a south centralized treatment plant capable of treating 2,000 gpm (2.8 MGD) near the headwaters of Massapequa Creek. In addition, under Alternative 5B, contaminated water from the three remaining extraction wells would be pumped to individual decentralized treatment plants capable of treating 500 to 1,000 gpm near the southern-most reaches of the groundwater plume.

Discharge water from the north centralized treatment plant would be returned to the aquifer via a newly constructed recharge basin located on the public property in the vicinity of the Bethpage State Park. It is expected that a 10-acre recharge basin would be necessary to manage the treated water from the north centralized treatment plant. Approximately 900 gpm (1 MGD) of the treated water from the north centralized treatment plant would also be beneficially re-used for irrigation purposes by the Bethpage State Park for eight months of the year. The discharge water from the south centralized treatment plant would be used to augment flow in Massapequa Creek. Treated water from the three smaller, decentralized treatment plants located near the southern edge of the groundwater plume would be discharged to three existing recharge basins to mitigate potential negative environmental impacts to surface water flow, wetland water levels, and subsea discharge (saltwater intrusion) caused by the withdrawal of water from the aquifer under this alternative.

To convey water from the extraction wells to the five treatment plants and from the treatment plants to the area where the water would be managed (i.e., recharge basins, irrigation, or streamflow augmentation), a total of approximately 124,000 feet (23.5 miles) of underground piping would be installed as part of this remedial alternative. Figure 13 shows the approximate locations of the extraction wells, treatment plants, conveyance piping, and discharge locations.

It is expected that it would take approximately five years to design and implement the remedy. Since Alternative 5B focuses on areas of the plume with the highest concentrations, as well as areas of lower concentrations along the margins of the plume, it is expected that Alternative 5B would be effective at achieving the groundwater SCGs. Because of the persistent nature of the contaminants and the length of the groundwater plume however, it is not expected that Alternative 5B would achieve the groundwater SCGs within the near future.

Costs are based on completion of remedial design testing, installation of 24 extraction wells (8 mass flux and 16 hydraulic containment), construction and operation of five groundwater treatment systems for a 30-year period, construction of one recharge basin, installation of 124,000 feet (23.5 miles) of underground piping, development of an alternate water supply, property acquisitions to support the remedy, and long-term groundwater quality monitoring.

Present Worth:..........*$585,000,000*
Capital Cost:..........*$241,000,000*
Annual Costs:..........*$16,300,000*

Exhibit C
Remedial Alternative Costs

Remedial Alternative	Capital Cost ($)	Annual Costs ($)	Total Present Worth ($)
No Further Action	0	0	0
Alternative 2A	210,000,000	16,700,000	553,000,000
Alternative 2B	195,000,000	13,900,000	485,000,000
Alternative 3A	234,000,000	17,200,000	522,000,000
Alternative 3B	169,000,000	8,660,000	332,000,000
Alternative 4	314,000,000	21,000,000	608,000,000
Alternative 5A	283,000,000	22,500,000	748,000,000
Alternative 5B	241,000,000	16,300,000	585,000,000

Exhibit D

SUMMARY OF THE PROPOSED REMEDY

The Department is proposing Alternative 5B, Hydraulic Containment of Site Contaminants Above SCGs Combined with Mass Flux Remediation - Centralized Treatment Plants with a Centralized Recharge Basin as the amendment to the previously selected remedies. Alternative 5B would achieve the remediation goals by using 24 extraction wells to capture groundwater with the highest concentrations of site contaminants, as well as lesser contaminated groundwater (which exceeds the SCGs) along the margins of the plume. These extraction wells would allow for an expedited cleanup of the plume while at the same time preventing continued migration to areas that are currently not impacted by site contaminants. Following withdrawal, contaminated groundwater would be transferred via underground conveyance piping to one of two central treatment plants or one of three decentralized treatment plants. Once treated, the water would either be returned to the aquifer system via recharge basins, beneficially re-used at Bethpage State Park, or beneficially used to augment flow in Massapequa Creek. The elements of this remedy are described in Section 8. The proposed remedy is depicted in Figure 13.

Basis for Selection

The proposed amended remedy is based on the results of previous RIs, data collected since the previous RODs were issued and data collected as part of this recent investigation, USGS groundwater flow modeling, and the evaluation of alternatives. Based on the results of the investigation and engineering evaluation, the Navy Grumman plume continues to migrate south toward currently unimpacted public water supplies and unimpacted portions of the Long Island Sole Source Aquifer, and this southward migration is causing contaminant concentrations to increase in off-site groundwater. The criteria to which potential remedial alternatives are compared are defined in 6 NYCRR Part 375. A detailed discussion of the evaluation criteria and comparative analysis is included in the FS report.

The first two evaluation criteria are termed "threshold criteria" and must be satisfied in order for an alternative to be considered for selection.

1. <u>Protection of Human Health and the Environment.</u> This criterion is an overall evaluation of each alternative's ability to protect public health and the environment.

The proposed amended remedy (Alternative 5B) would satisfy this criterion by aggressively removing significant contaminant mass from the groundwater while also establishing hydraulic control of the plume and preventing continued migration of the Navy Grumman groundwater plume to currently un-impacted areas. By using centralized recharge combined with beneficial re-use as irrigation water and Massapequa Creek streamflow augmentation, Alternative 5B provides protection to the Long Island Sole Source Aquifer and the region’s surface water resources.

Full containment of the Navy Grumman groundwater plume would not only provide significant future protections for public health and the environment; it also would avoid long term-costs associated with treatment that may become necessary at currently unimpacted public supply wells.

Similar to Alternative 5B, Alternative 5A (Hydraulic Containment of Site Contaminants above SCGs Combined with Mass Flux Remediation - Decentralized Treatment Plants with Various Discharge Methods) would satisfy this criterion through the removal of significant amounts of contaminant mass from the aquifer while also establishing hydraulic control of the plume. Alternative 5A provides protection to groundwater and surface water resources by discharging the majority of treated water to individual recharge basins and Massapequa Creek. Based on contaminant transport analyses, both Alternatives 5A and 5B may require up to 110 years to fully achieve the remedial action objectives for the SCG plume.

Alternatives 2A and 2B would be considered the next most protective, as both alternatives establish hydraulic control of the aquifer. This hydraulic control would eliminate continued migration of the groundwater plume that has already moved off the former NWIRP and Northrop Grumman Bethpage Facility sites. However, these two alternatives do not remove significant contaminant mass from the most impacted portions of the groundwater plume and are anticipated to require a longer timeframe (more than 30 years longer than Alternatives 5A and 5B) to achieve the RAOs.

Alternatives 3A, 3B and 4 are mass flux approaches that remove significant contaminant mass from the groundwater; but do not provide hydraulic control of the entire SCG plume. These alternatives are considered less protective than the other alternatives because they allow for the continued, uncontrolled migration of the plume beyond its current extent approximately four miles from the NWIRP and Northrop Grumman Bethpage Facility sites. These three alternatives (Alternatives 3A, 3B and 4) are anticipated to achieve RAOs over a longer timeframe (greater than 150 years) through a combination of contaminant mass removal, wellhead treatment, and natural processes. Alternative 1 (No Further Action) relies on the existing remedial actions and allows for continued migration of areas of the plume with high concentrations of site contaminants. As such, Alternative 1 does not provide added protection to public health and the environment and will not be evaluated further.

With the withdrawal of water from the Long Island aquifer at rates ranging from approximately 7,100 gpm (10.2 MGD) to 13,300 gpm (19.2 MGD), under Alternatives 2A, 2B, 3A, 3B, 4, 5A, and 5B, the USGS groundwater flow modeling was used to design these alternatives to minimize possible environmental impacts. Specifically, each alternative included the strategic use of treated water management techniques to minimize possible impacts to stream flow, wetland water levels, public water supply well yield, and saltwater intrusion (i.e., subsea discharge). The use of existing recharge basins, a constructed recharge basin, injection wells, or discharge to Massapequa Creek were used as the approaches to manage treated water.

While the groundwater flow modeling suggests that implementation of Alternatives 2A, 2B, 3A, 3B, 4, 5A, and 5B would result in only very minor environmental impacts; but of these, slightly larger environmental impacts would occur with implementation of Alternatives 2A, 2B, 5A, and 5B. Each of these alternatives include hydraulic containment of the SCG plume and the withdrawal of the largest volumes of water from the aquifer system. In particular, with the withdrawal of groundwater at rates greater than approximately 9,200 gpm (13.2 MGD) under each of these alternatives, the water levels in some surrounding public water supply wells could decrease by approximately 7.3 feet, groundwater levels beneath wetlands could decrease by up to approximately 2.1 feet, and the flow in nearby streams could decrease by up to approximately 1.1 cubic feet per second (cfs). In comparison, under Alternatives 3A, 3B, and 4, water levels in some surrounding public water supply wells could decrease by up to 4.8 feet, groundwater levels beneath wetlands could decrease by up to approximately 1.5 feet, and the flow in nearby streams could decrease by up to approximately 0.8 cfs.

Relative to possible effects on the positioning of the saltwater-freshwater boundary, implementation of Alternatives 4 (Aquifer Flushing) and 3B (Plume Mass Flux Remediation - Decentralized Treatment Plants with Various Discharge Methods), could reduce flow to the freshwater-saltwater boundary the most and therefore are the alternatives that have the greatest potential impact on possible saltwater intrusion. Alternatively, the groundwater flow modeling suggests that Alternatives 3A (Plume Mass Flux Remediation - Decentralized Plants with Various Discharge Methods) and 2A (Hydraulic Containment of Site Contaminants above SCGs - Decentralized Treatment Plants with Various Discharge Methods) would have the lowest potential impact on saltwater intrusion. The groundwater flow modeling suggests that Alternatives 2B, 5A, and 5B have more of an effect on subsea discharge and the freshwater-saltwater boundary than Alternatives 2A and 3A, but less than Alternatives 3B and 4. As stated previously however, the groundwater flow modeling indicates that implementation of each of the alternatives would produce only very minor environmental impacts.

2. Compliance with New York State Standards, Criteria, and Guidance (SCGs). Compliance with SCGs addresses whether a remedy will meet environmental laws, regulations, and other standards and criteria. In addition, this criterion includes the consideration of guidance which the Department has determined to be applicable on a case-specific basis.

Alternatives 2A, 2B, 5A and 5B, each involve groundwater extraction and treatment of the entire area where site contaminants occur in groundwater at concentrations that exceed the SCGs and would be the most effective alternatives in achieving overall compliance with SCGs. By preventing the continued migration of the SCG plume, these four alternatives also eliminate the need for additional public water supplies to require wellhead treatment for the site contaminants. Of these four alternatives, Alternatives 5A and 5B include a mass flux approach to address areas of the plume with high contaminant concentrations while also capturing remaining portions of the plume with contaminant concentrations above the SCGs. Alternatives 5A and 5B would therefore be the most effective at achieving SCGs, followed by Alternatives 2A and 2B.

Alternatives 3A, 3B and 4 are anticipated to effectively achieve SCGs within the most heavily impacted areas of the plume through the extraction and treatment of groundwater where COCs are present at concentrations above 50 ppb, 50 ppb, and 100 ppb, respectively. These alternatives, however, are anticipated to require a much longer timeframe to achieve SCGs within the remainder of the plume where COC concentrations exceed SCGs but are less than 50 ppb and 100 ppb. Instead, Alternatives 3A, 3B and 4 would rely on natural processes and wellhead treatment of public water supplies to achieve SCGs for the areas of the plume where the COC concentrations exceed SCGs but are less than 50 ppb and 100 ppb. These alternatives are therefore less effective at achieving SCGs.

The next six "primary balancing criteria" are used to compare the positive and negative aspects of each of the remedial alternatives.

3. Long-term Effectiveness and Permanence. This criterion evaluates the long-term effectiveness of the remedial alternatives after implementation. If wastes or treated residuals remain on-site after the selected remedy has been implemented, the following items are evaluated: 1) the magnitude of the remaining risks, 2) the adequacy of the engineering and/or institutional controls intended to limit the risk, and 3) the reliability of these controls.

Long-term effectiveness is best accomplished by alternatives involving significant removal of contaminant mass from the aquifer and by preventing further expansion of the groundwater plume to areas that are currently not impacted. Since most of the contaminant mass is present in groundwater located in the central portion of the plume, five of the seven alternatives (Alternatives 3A, 3B, 4, 5A, and 5B) include installation of mass flux wells in areas where site contaminants are present at high concentrations. Alternatives 5A and 5B additionally include groundwater extraction wells along the perimeter of the plume to provide long-term hydraulic control and minimize continued migration of the groundwater plume.

Groundwater extraction and ex-situ treatment under each of the alternatives are considered effective technologies for addressing groundwater contaminated with COCs. Alternatives 5A and 5B are anticipated to achieve RAOs in the shortest remedial timeframe by removing significant contaminant mass from within the most impacted portions of the plume combined with hydraulic control of groundwater with contaminant concentrations exceeding the SCGs along the margins of the plume. Alternatives 2A and 2B provide hydraulic control of groundwater containing site contaminants at concentrations exceeding the SCGs, but these alternatives do not address plume areas with high contaminant concentrations. While Alternatives 2A and 2B would be effective in the long-term in preventing further plume migration, these alternatives are expected to require a significantly greater timeframe to achieve RAOs. Furthermore, since Alternatives 2A and 2B rely on groundwater extraction wells located along the margins of the plume, these alternatives may enhance the southward movement of groundwater with high contaminant concentrations in the center of the plume.

Alternatives 3A, 3B, and 4 would provide significant mass removal of contaminants within the portions of the plume containing site contaminants at concentrations above 50 ppb, 50 ppb, and 100 ppb, respectively, and are expected to require less time to achieve SCGs within the area of active remediation than Alternatives 2A and 2B. These three alternatives would not however be effective over the long-term in reducing contaminant concentrations outside the area of active remediation since they all rely on natural processes in this part of the plume. Achieving SCGs outside the area of active remediation (in the lesser contaminated portions of the SCG plume) is anticipated to require greater time for Alternatives 3A, 3B and 4 than for Alternatives 2A and 2B. Alternatives 3A, 3B, and 4 would also rely on wellhead treatment to prevent exposure to contaminant concentrations above SCGs for public water supply wells that are currently unimpacted and located hydraulically downgradient of the groundwater plume.

4. Reduction of Toxicity, Mobility or Volume. Preference is given to alternatives that permanently and significantly reduce the toxicity, mobility or volume of the wastes at the site.

Alternatives 2A, 2B, 3A, 3B, 4, 5A, and 5B would reduce the toxicity, mobility, and volume of contaminants in the aquifer by using extraction wells to capture contaminated groundwater and providing surface treatment through air stripping, granulated active carbon, and AOP technologies. With extraction wells placed in areas of the plume with high contaminant concentrations along with extraction wells placed along the plume margins, Alternatives 5A and 5B are expected to be the most effective in reducing the toxicity, mobility, and volume of contaminants.

Alternatives 2A and 2B would be effective in reducing toxicity, mobility, and volume of site contaminants by operating extraction wells along the margins of the SCG plume. However, these two alternatives would take a longer timeframe for high COC concentrations in the central portion of the plume to reach the extraction wells located along the perimeter of the plume. By withdrawing contaminated groundwater from only the margins of the plume under Alternatives 2A and 2B, contaminant mass may be allowed to diffuse into fine-grained silts and clays. Therefore, Alternatives 2A and 2B would provide less reduction of toxicity and mobility of the COCs in groundwater than Alternative 5A and 5B.

Alternatives 3A, 3B, and 4 would be effective in reducing the toxicity, mobility, and volume of contaminants in areas of the plume above 50 ppb, 50 ppb and 100 ppb, respectively. However, these alternatives would not actively reduce the toxicity, mobility, and volume in portions of the plume less than 50 ppb and 100 ppb, respectively. Instead, these alternatives would rely on wellhead treatment and natural processes to reduce the toxicity, mobility, and volume of contaminants within these areas of the plume. Therefore, these alternatives would provide less reduction of toxicity, mobility, and volume of the COCs in groundwater than Alternatives 2A, 2B, 5A, or 5B.

Each of the alternatives relies on commonly used treatment technologies to permanently destroy the contaminants once withdrawn from the aquifer. Following air stripping, any remaining contaminants trapped on the GAC adsorption media would be destroyed during regeneration or disposed of in accordance with applicable waste regulations. The AOP technology provides complete destruction and mineralization of many chlorinated solvents, including 1,4-dioxane.

5. Short-term Impacts and Effectiveness. The potential short-term adverse impacts of the remedial action upon the community, the workers, and the environment during the construction and/or implementation are evaluated. The length of time needed to achieve the remedial objectives is also estimated and compared against the other alternatives.

Each of the alternatives would be effective in the short-term at controlling the migration of groundwater containing COCs above the SCGs and removing contaminant mass from the aquifer. Groundwater extraction systems would induce a hydraulic gradient capturing COCs within days or weeks of system startup. Alternatives 3A, 3B, and 4 would only provide control of the plume containing site contaminants at concentrations greater than 50 ppb, 50, ppb, and 100 ppb, respectively, while Alternatives 2A, 2B, 5A, and 5B would provide control of groundwater with contaminant concentrations exceeding the SCGs

With the drilling of extraction wells, installation of underground conveyance piping, construction of treatment plants, and development of discharge locations (e.g., construction of a central recharge basin, rehabilitation of existing recharge basins, construction of surface water outfall, and/or construction of a storage tank for irrigation purposes), each of the alternatives would have short-term impacts on the community. While each of the alternatives would have short-term impacts on the Town of Oyster Bay communities, these disruptions would be minimized through noise and traffic control plans as well, as community air monitoring programs during construction, to minimize and address potential impacts to the community, remediation workers, and the environment.

Alternatives 2A, 3A, and 5A would have significant short-term impacts to workers, the public, and the environment during construction of the 12-17 decentralized treatment plants and 82,000-131,000 feet (15.5-24.8 miles) of underground piping and the rehabilitation of 12-16 existing recharge basins. Alternatives involving the use of centralized treatment plants and a centralized recharge basin (Alternatives 2B, 3B, and 5B), are expected to have significantly less short-term impacts on the community. Alternative 5A, with the construction of 24 extraction wells and 17 treatment plants, the reworking of 16 existing recharge basins, and the installation of approximately 131,000 feet (24.8 miles) of underground piping, would have the most significant short-term impacts to the Town of Oyster Bay communities relative to Alternatives 2A, 2B, 3A, 3B, 5A, and 5B.

Alternative 4 (Aquifer Flushing) includes the largest amount of subsurface drilling (26 extraction wells and 43 injection wells) relative to the other remedial alternatives. While the use of injection wells under Alternative 4 eliminates the need for recharge basins to manage treated water, the drilling of injection wells and the associated underground piping (more than 93,000 linear feet (17.6 miles)) to convey contaminated water from point of extraction to treatment and then to the injection wells would result in significant short-term impacts to the community.

6. Implementability. The technical and administrative feasibility of implementing each alternative are evaluated. Technical feasibility includes the difficulties associated with the construction of the remedy and the ability to monitor its effectiveness. For administrative feasibility, the availability of the necessary personnel and materials is evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, institutional controls, and so forth.

While each alternative involves technologies that have been applied by the Department and are implementable, the size of the groundwater plume and location within a heavily developed area in the Town of Oyster Bay makes each alternative difficult to implement. The construction of decentralized treatment plants combined with decentralized recharge makes Alternatives 2A, 3A, and 5A more difficult to implement than Alternatives 2B, 3B, and 5B that involve centralized treatment and recharge. Similarly, Alternative 4 (Aquifer Flushing) would be more difficult to implement than the centralized treatment and recharge alternatives (Alternatives 2B, 3B, and 5B) due to the need for installing 26 extraction wells and 43 injection wells, construction of 23 decentralized treatment plants, and 93,000 linear feet (17.6 miles) of underground piping needed to convey water.

Alternatives 2A, 3A, and 5A would require acquisition of land and permits to build decentralized treatment plants in heavily developed areas. These three alternatives would also result in greater disruptions (than Alternatives, 2B, 3B, and 5B) to traffic within numerous areas to build each of the decentralized treatment plants and to install conveyance piping between the extraction wells and the decentralized treatment plants, and from the treatment plants to the individual recharge basins or surface water discharge locations.

Alternatives 2B, 3B, and 5B require the potential acquisition of land in the vicinity of the former Northrop Grumman and U.S. Navy property and near the headwaters of Massapequa Creek for the construction of centralized, large capacity treatment plants. The construction of a single treatment plant in an area that is already zoned for commercial and industrial uses makes these alternatives (Alternatives 2B, 3B, and 5B) more implementable than the alternatives (Alternatives 2A, 3A, and 5A) involving treatment plant construction in mixed commercial and residential areas. These alternatives also require potential land acquisition for the installation of extraction wells, and significant disruption to traffic along a number of major roadways to install conveyance piping. The construction of a centralized recharge basin within the vicinity of Bethpage State Park is anticipated to be less disruptive to developed areas than the alternatives that rehabilitate existing recharge basins. The acquisition of land and permits is not expected to be necessary for construction of the centralized recharge basin under Alternatives 2B, 3B, and 5B.

7. <u>Cost-Effectiveness.</u> Capital costs and annual operation, maintenance, and monitoring costs are estimated for each alternative and compared on a present worth basis. Although cost-effectiveness is the last balancing criterion evaluated, where two or more alternatives have met the requirements of the other criteria, it can be used as the basis for the final decision.

The costs of the alternatives vary significantly. Alternative 3B has the lowest present worth cost ($332 million (M)), but the contaminated groundwater within the SCG plume but outside of the 50 ppb plume would not be addressed under this alternative. Similarly, Alternative 2B has a lower cost, but this alternative does not address groundwater in the central portion of the plume where contaminant concentrations are the highest. Due to the large number of individual treatment plants and treated water discharge locations, Alternatives 4 and 5A have the highest overall costs ($608 M and $748 M respectively). While Alternatives 2A, 3A, and 5B each have comparable costs (ranging from $522 M to $585 M), Alternative 5B is the most cost-effective because it includes extraction of groundwater from the central portion of the plume combined with hydraulic containment of the entire Navy Grumman groundwater plume.

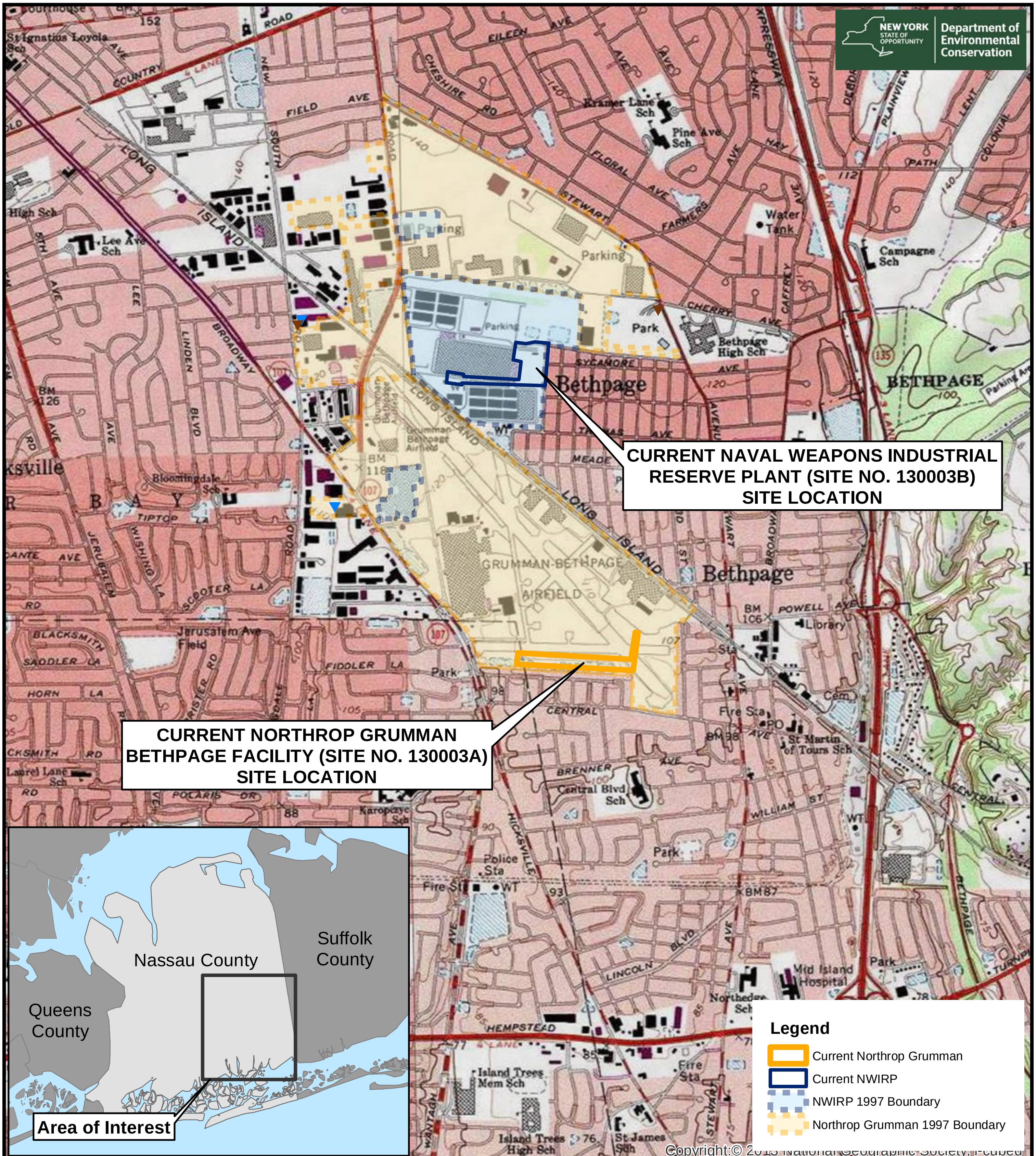
8. <u>Land Use.</u> When cleanup to pre-disposal conditions is determined to be infeasible, the Department may consider the current, intended, and reasonable anticipated future land use of the site and its surroundings in the selection of the soil remedy.

Each of the alternatives address off-site portions of the groundwater plume. The selected remedies outlined in the existing RODs address on-site soil, soil vapor, and groundwater contamination. These existing on-site remedies, along with institutional and engineering controls, for the site would remain in place as part of each alternative to address the off-site groundwater plume.

The final criterion, Community Acceptance, is considered a "modifying criterion" and is taken into account after evaluating those above. It is evaluated after public comments on the proposed AROD have been received.

9. Community Acceptance. Concerns of the community regarding the investigation, the evaluation of alternatives, and the proposed AROD are evaluated. A responsiveness summary will be prepared that describes public comments received and the manner in which the Department will address the concerns raised. If the selected remedy differs significantly from the proposed remedy, notices to the public will be issued describing the differences and reasons for the changes

Alternative 5B (Hydraulic Containment of Site Contaminants Above SCGs Combined with Mass Flux Remediation - Centralized Treatment Plants with a Centralized Recharge Basin) is being proposed because, as described above, it satisfies the threshold criteria and provides the best balance of the balancing criterion.



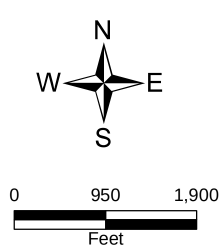
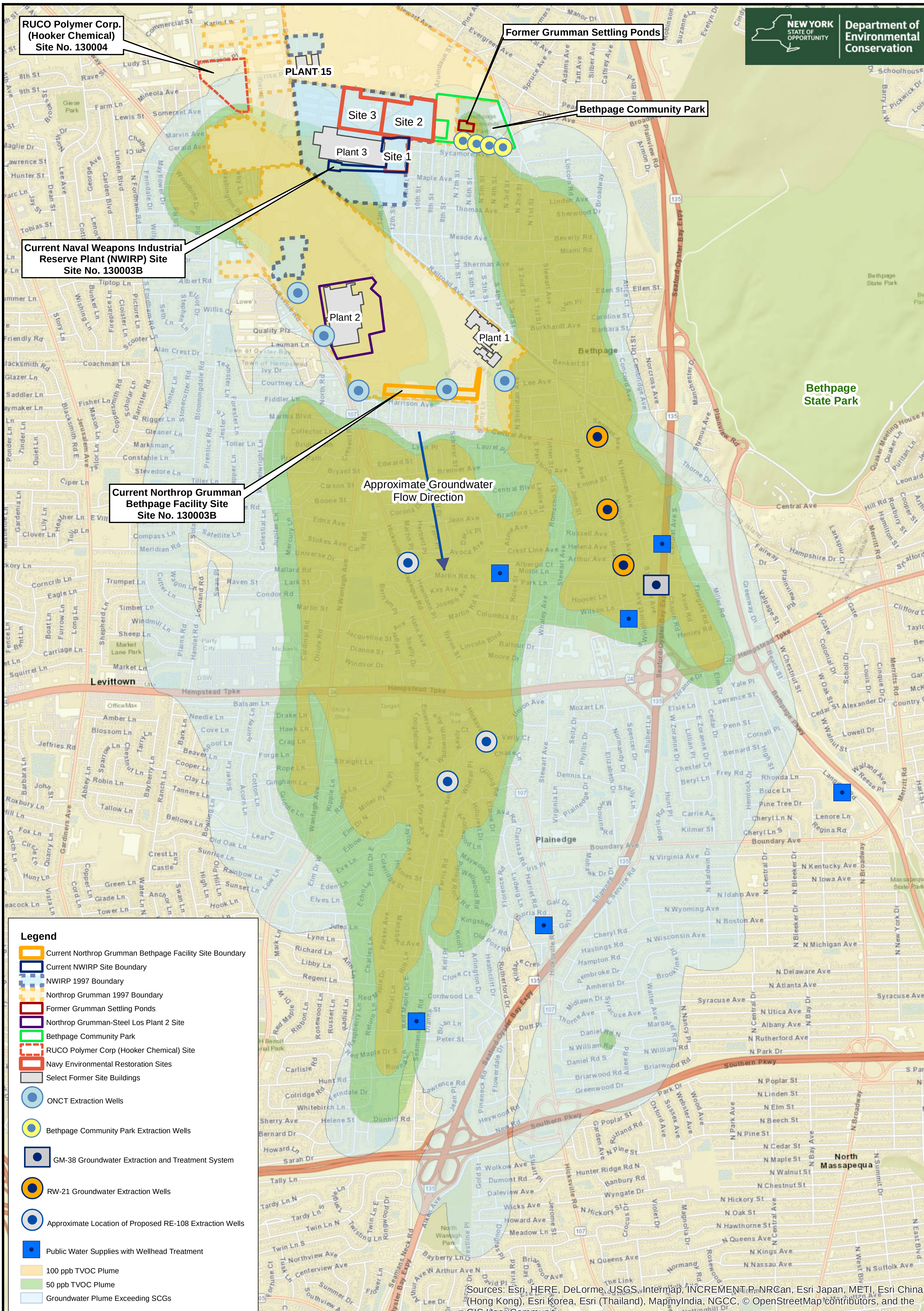
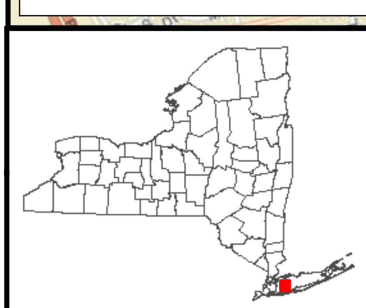


Figure 1

Site Location Map

Northrop Grumman and NWIRP Sites
Town of Oyster Bay, Nassau County
Site Nos. 130003A and 130003B





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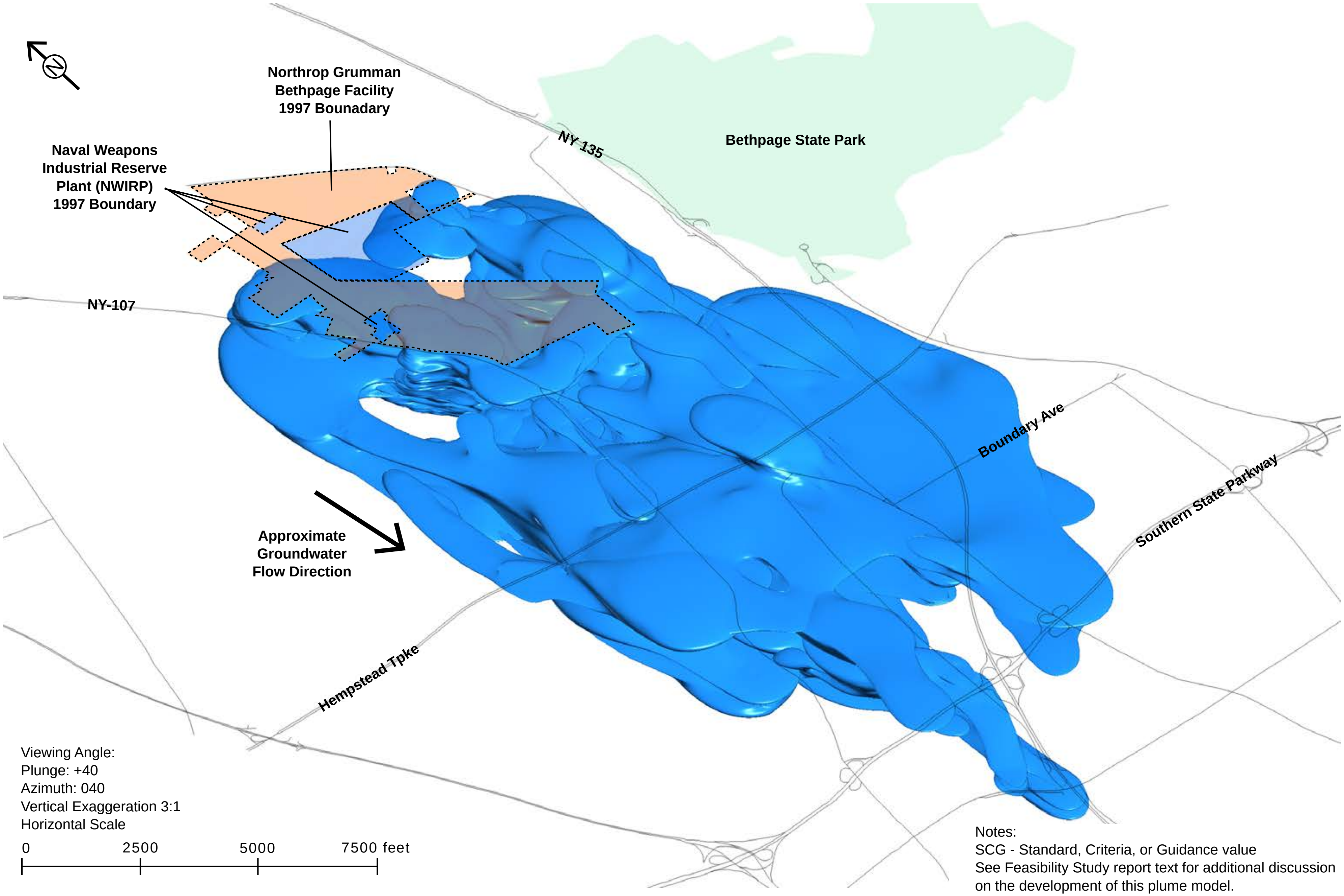
W E
S

0 800 1,600
Feet

Figure 2

Site Detail Map

Northrop Grumman and NWIRP Sites
Town of Oyster Bay, Nassau County
Site Nos. 130003A and 130003B



Viewing Angle:
Plunge: +40
Azimuth: 040
Vertical Exaggeration 3:1
Horizontal Scale

0 2500 5000 7500 feet

Notes:
SCG - Standard, Criteria, or Guidance value
See Feasibility Study report text for additional discussion on the development of this plume model.

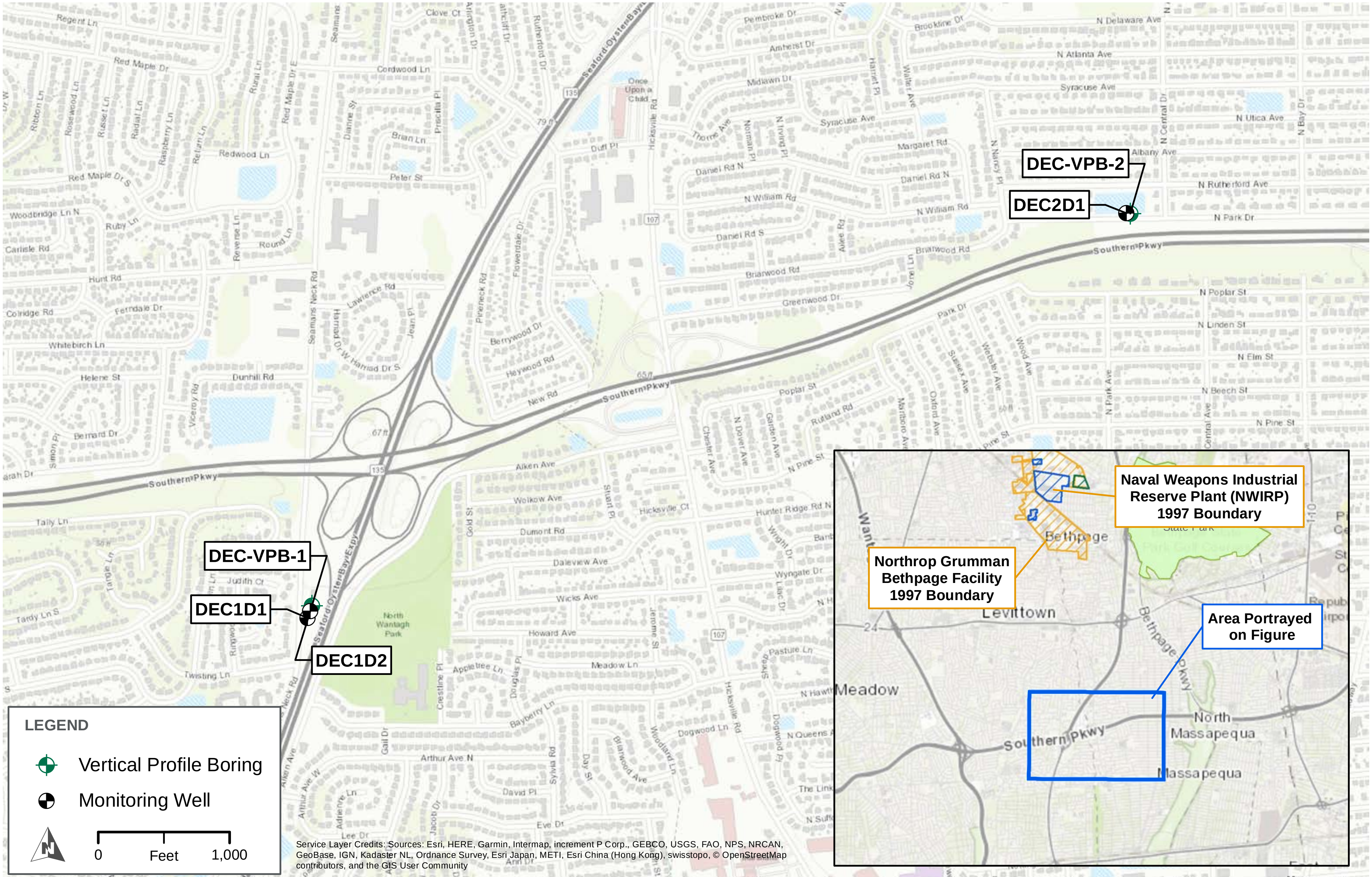
HDR | NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

GROUNDWATER EXCEEDING SCGs - OBLIQUE 3D VIEW

NYSDEC SITE # 130003

FIGURE 3

USER: CMILLS DATE: 07/30/2018



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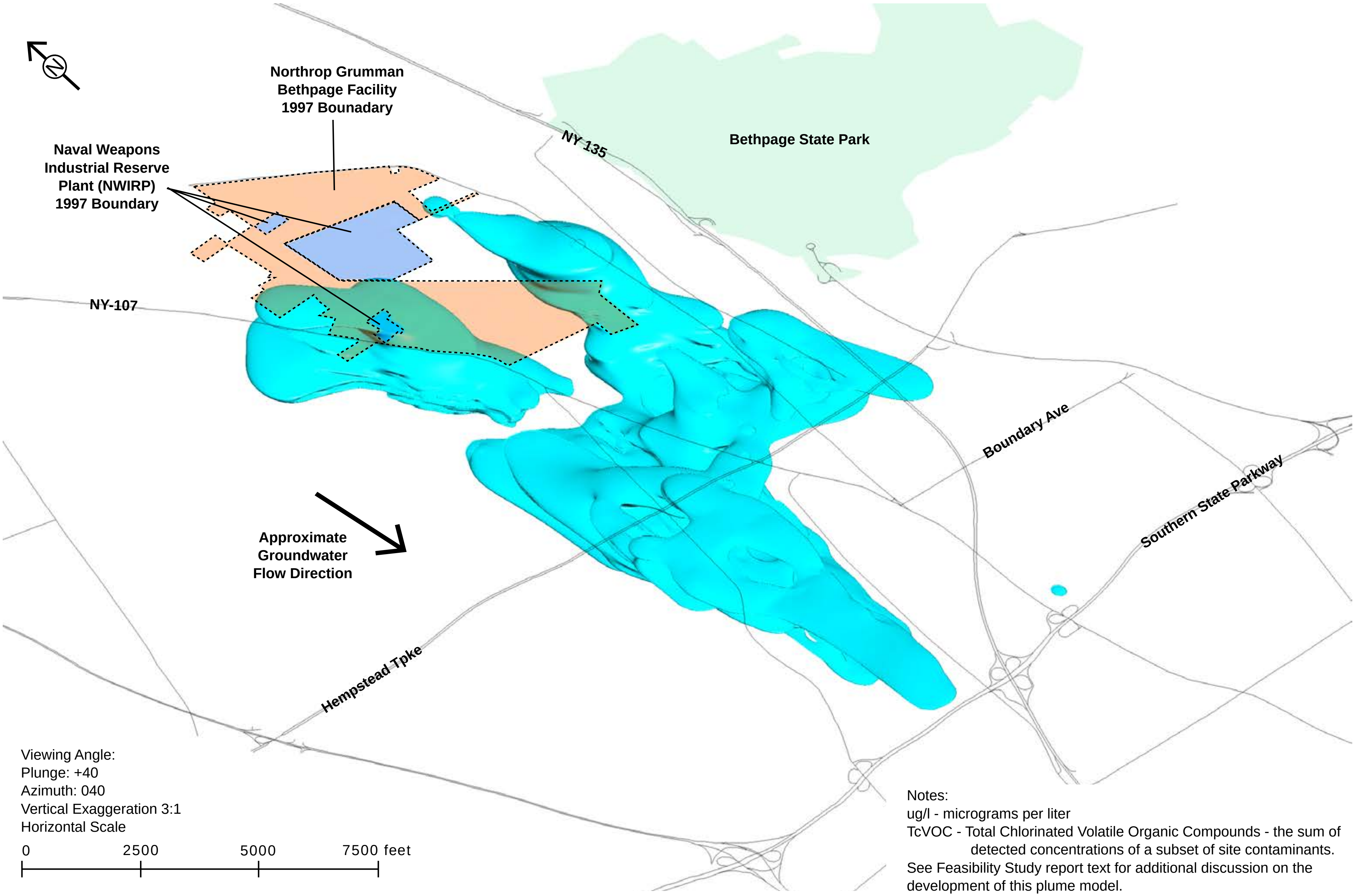
NYSDEC VPB AND MONITORING WELL LOCATIONS

NYSDEC SITE # 130003

FIGURE 4

PATH: \\MAHPI-FILE01\ACTIVEPROJECTS\4492\10054840\7.0_GIS_MODELS\7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\PRAP\PRAP_FIGURE 4 - DEC VPB AND MW LOCATIONS.MXD - USER: CMILLS - DATE: 4/29/2019



Notes:
ug/l - micrograms per liter
TcVOC - Total Chlorinated Volatile Organic Compounds - the sum of detected concentrations of a subset of site contaminants.
See Feasibility Study report text for additional discussion on the development of this plume model.

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50 ug/l TcVOC PLUME - OBLIQUE 3D VIEW

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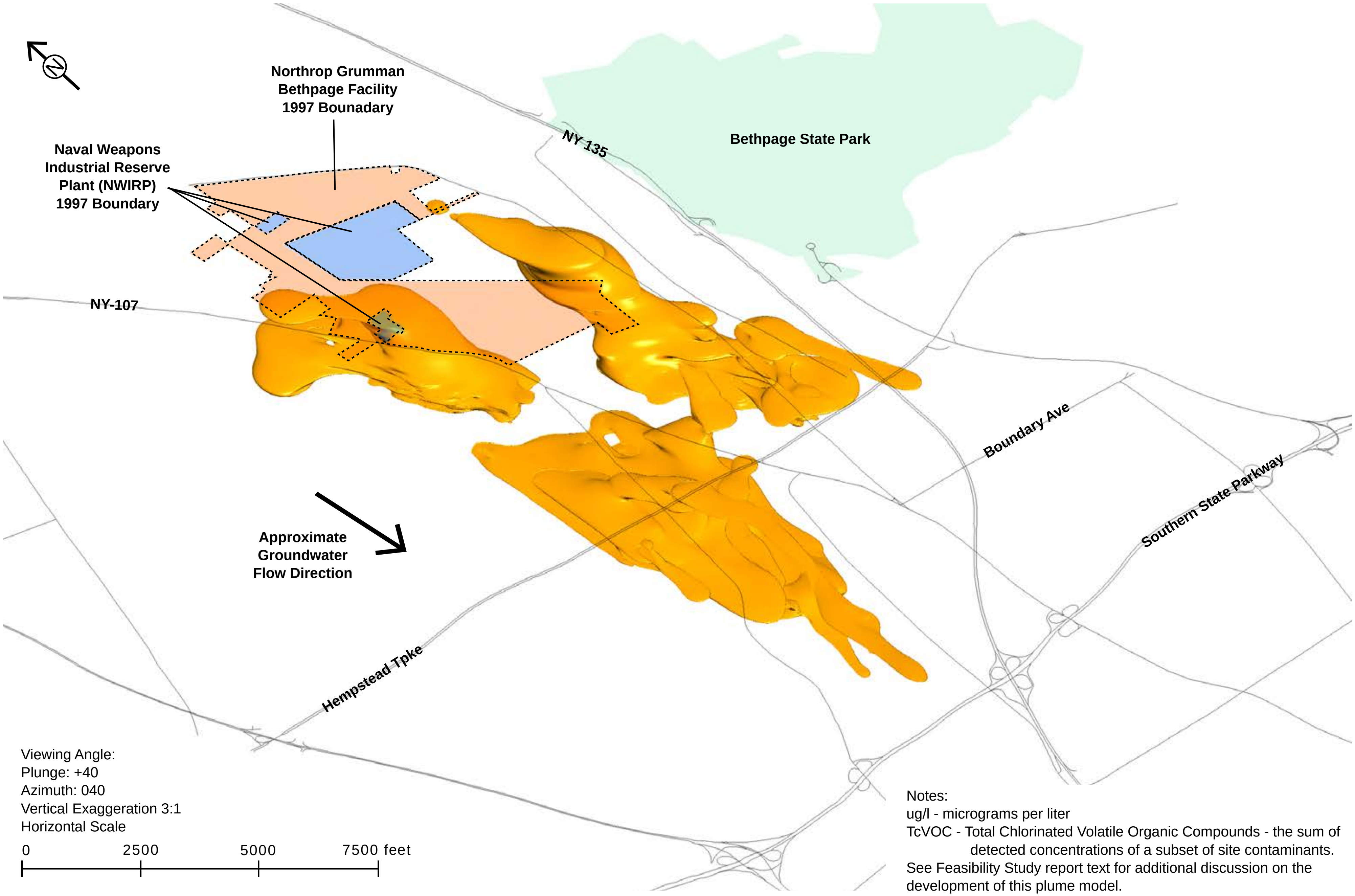
FIGURE 5



Viewing Angle:
Plunge: +40
Azimuth: 040
Vertical Exaggeration 3:1
Horizontal Scale

0 2500 5000 7500 feet

Notes:
ug/l - micrograms per liter
TcVOC - Total Chlorinated Volatile Organic Compounds - the sum of detected concentrations of a subset of site contaminants.
See Feasibility Study report text for additional discussion on the development of this plume model.

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100 ug/l TcVOC PLUME - OBLIQUE 3D VIEW

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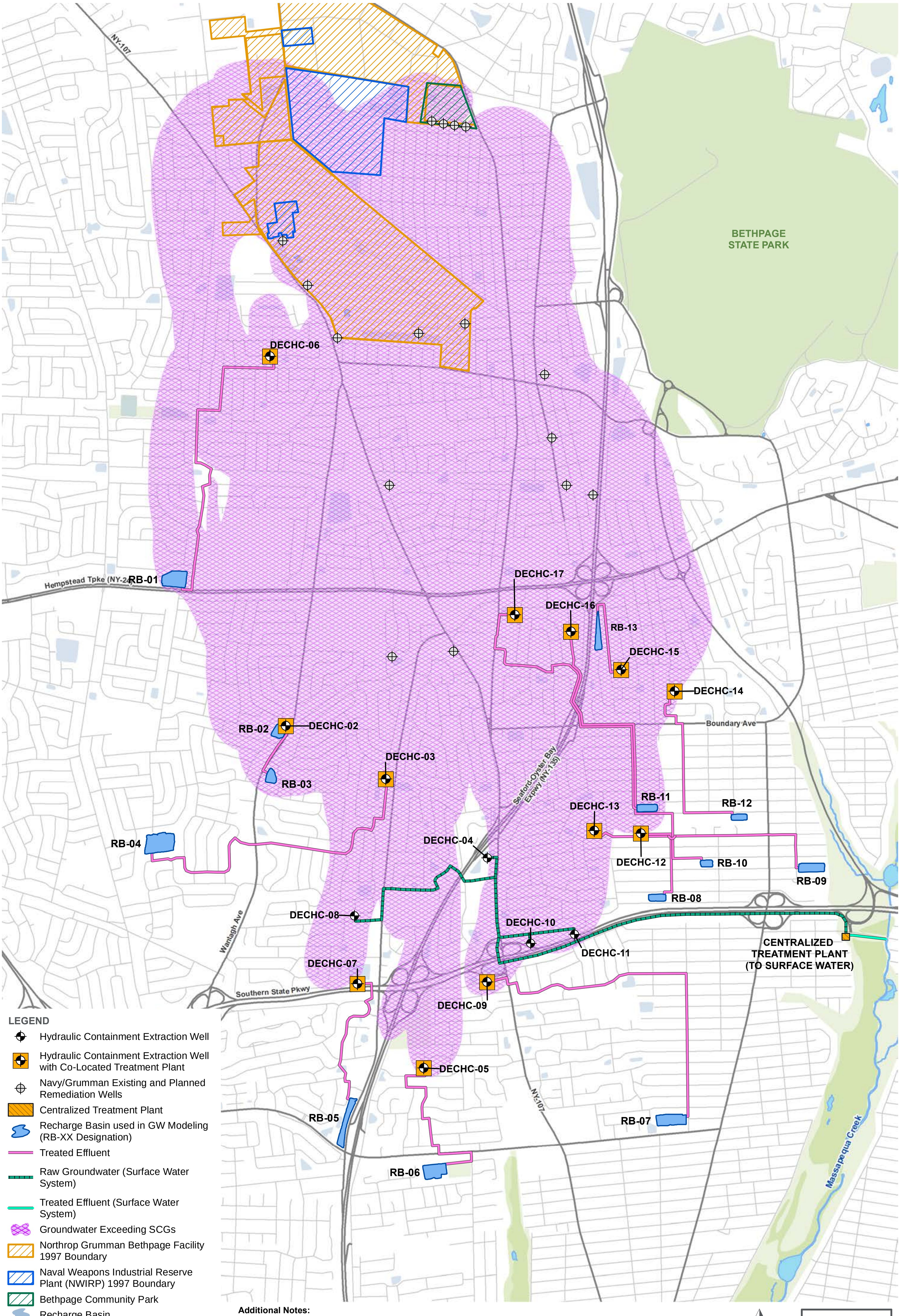
FIGURE 6



See Feasibility Study report text for additional information.
Base Layer (roads, parks, basins, surface water) Sources:
Nassau County GIS

Additional Notes:
SCG - Standards, Criteria, and Guidance Values
Basemap information provided by Nassau County GIS.

ALTERNATIVE 2A

HYDRAULIC CONTAINMENT OF SITE CONTAMINANTS ABOVE SCGs – DECENTRALIZED TREATMENT PLANTS WITH VARIOUS DISCHARGE METHODS

NYSDEC SITE # 130003

FIGURE 7

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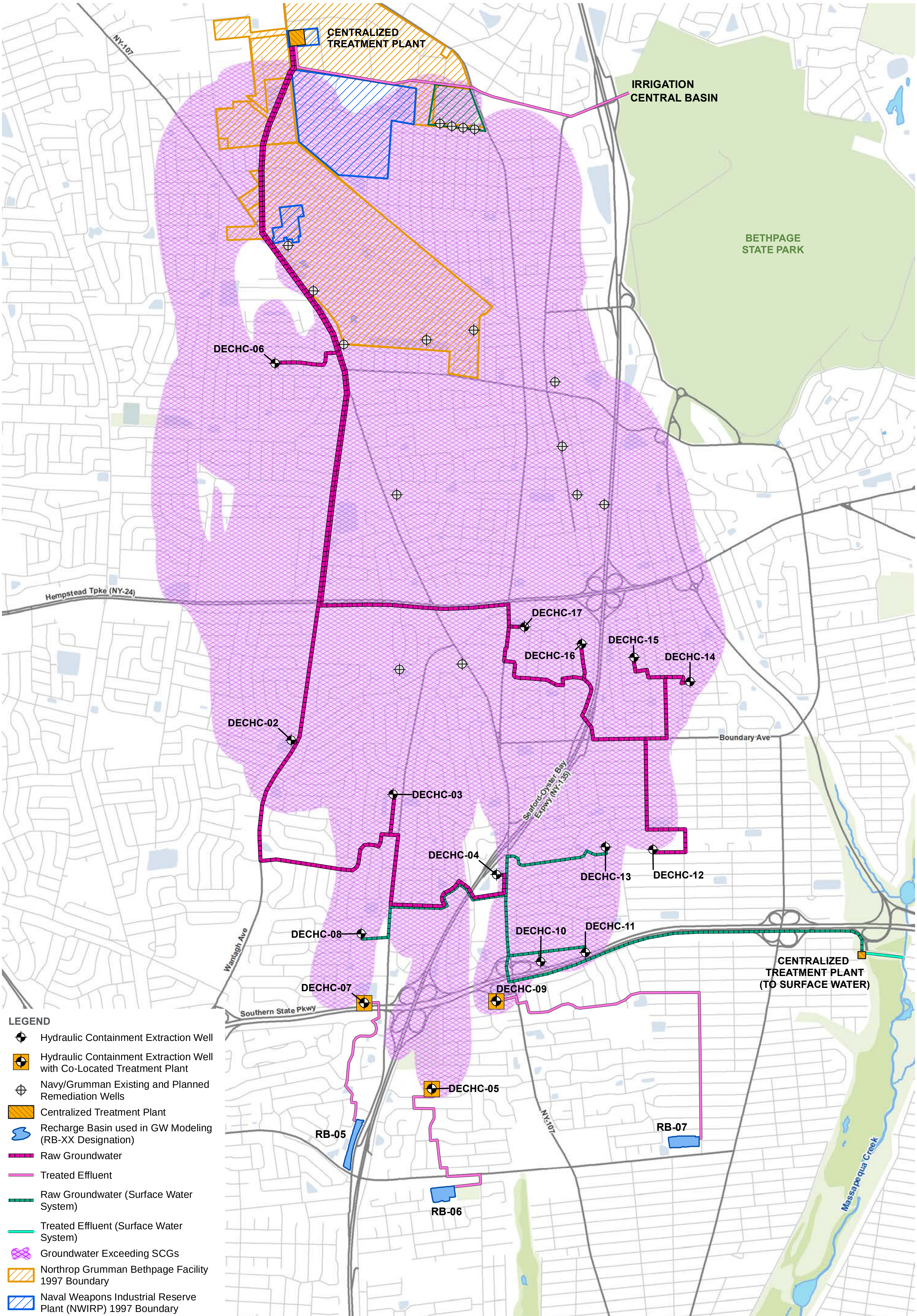

See Feasibility Study report text for additional information.
Base Layer (roads, parks, basins, surface water) Sources: Nassau County GIS

Additional Notes:
SCG - Standards, Criteria, and Guidance Values.
Basemap information provided by Nassau County GIS.

ALTERNATIVE 2B

HYDRAULIC CONTAINMENT OF SITE CONTAMINANTS ABOVE SCGs – CENTRALIZED TREATMENT PLANTS WITH A CENTRALIZED RECHARGE BASIN

NYSDEC SITE # 130003

FIGURE 8

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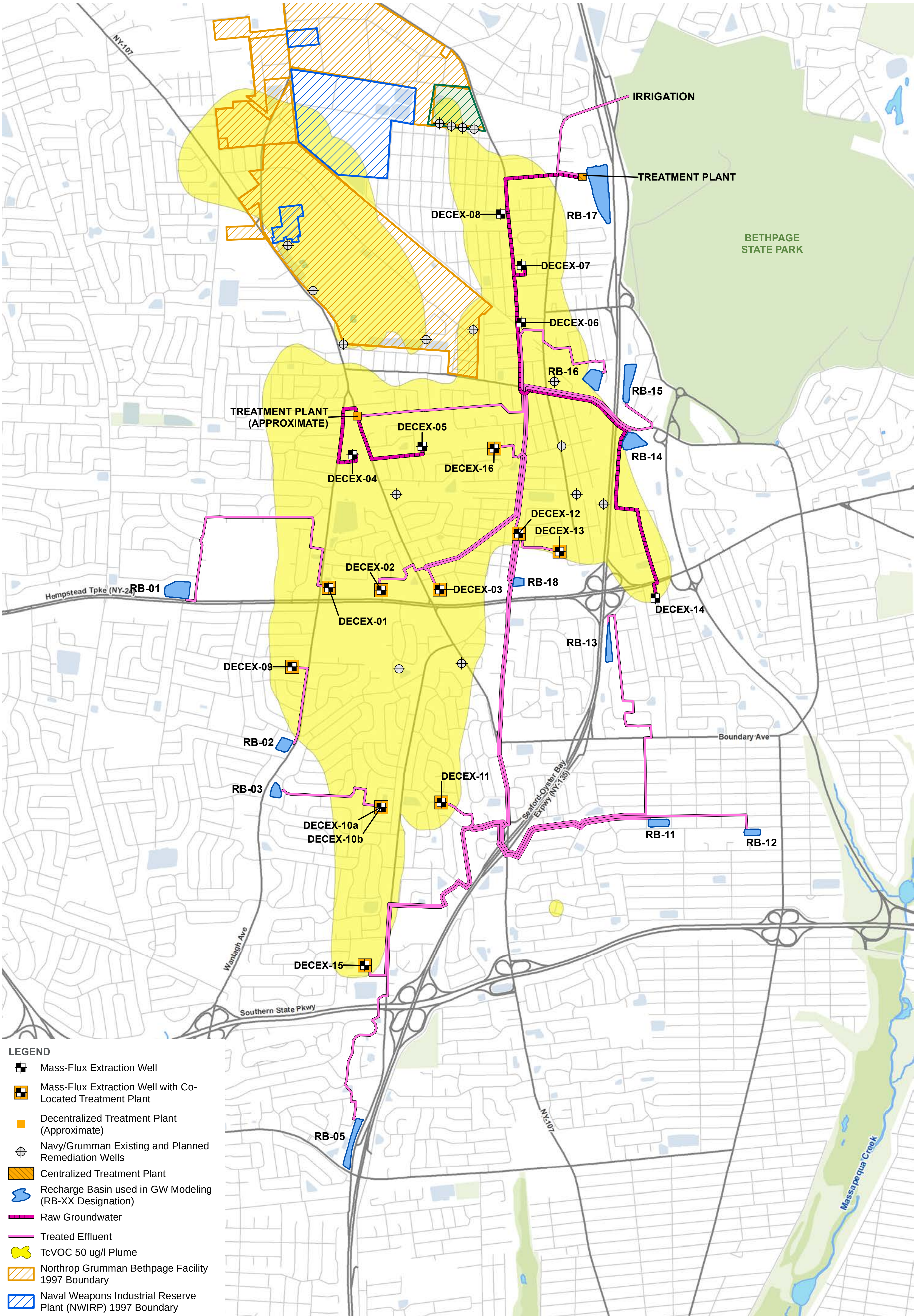

See Feasibility Study report text for additional information.
Base Layer (roads, parks, basins, surface water) Sources: Nassau County GIS

Additional Notes:
ug/l - micrograms per liter
TCVOC - Total Chlorinated Volatile Organic Compounds (subset list of site contaminants of concern)
Basemap information provided by Nassau County GIS.

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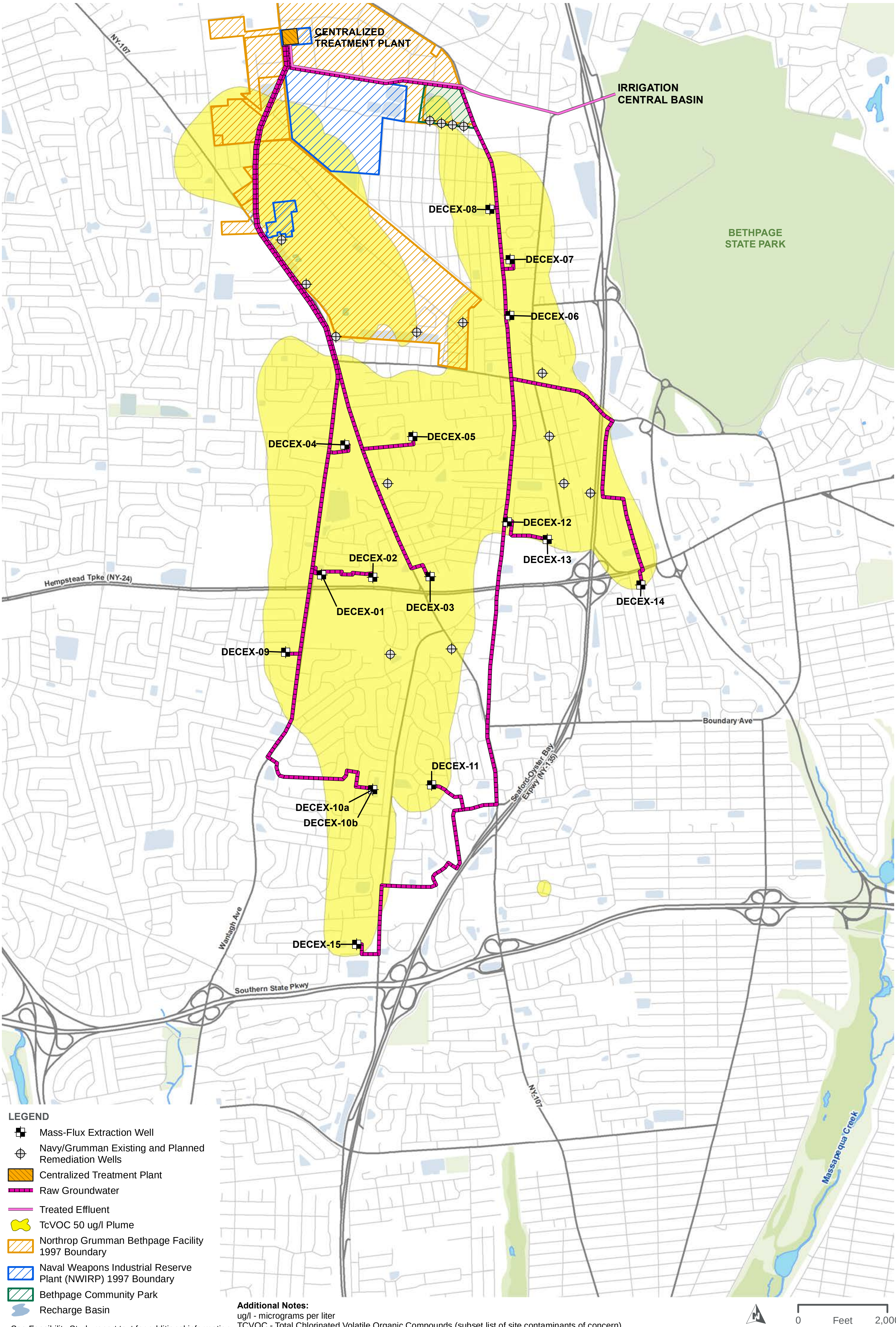
ALTERNATIVE 3A

PLUME MASS FLUX REMEDIATION – DECENTRALIZED TREATMENT PLANTS WITH VARIOUS DISCHARGE METHODS

NYSDEC SITE # 130003

FIGURE 9



See Feasibility Study report text for additional information.
Base Layer (roads, parks, basins, surface water) Sources: Nassau County GIS

Additional Notes:
ug/l - micrograms per liter
TCVOC - Total Chlorinated Volatile Organic Compounds (subset list of site contaminants of concern)
Basemap information provided by Nassau County GIS.

ALTERNATIVE 3B

PLUME MASS FLUX REMEDIATION – CENTRALIZED TREATMENT PLANTS WITH A CENTRALIZED RECHARGE BASIN

NYSDEC SITE # 130003

FIGURE 10

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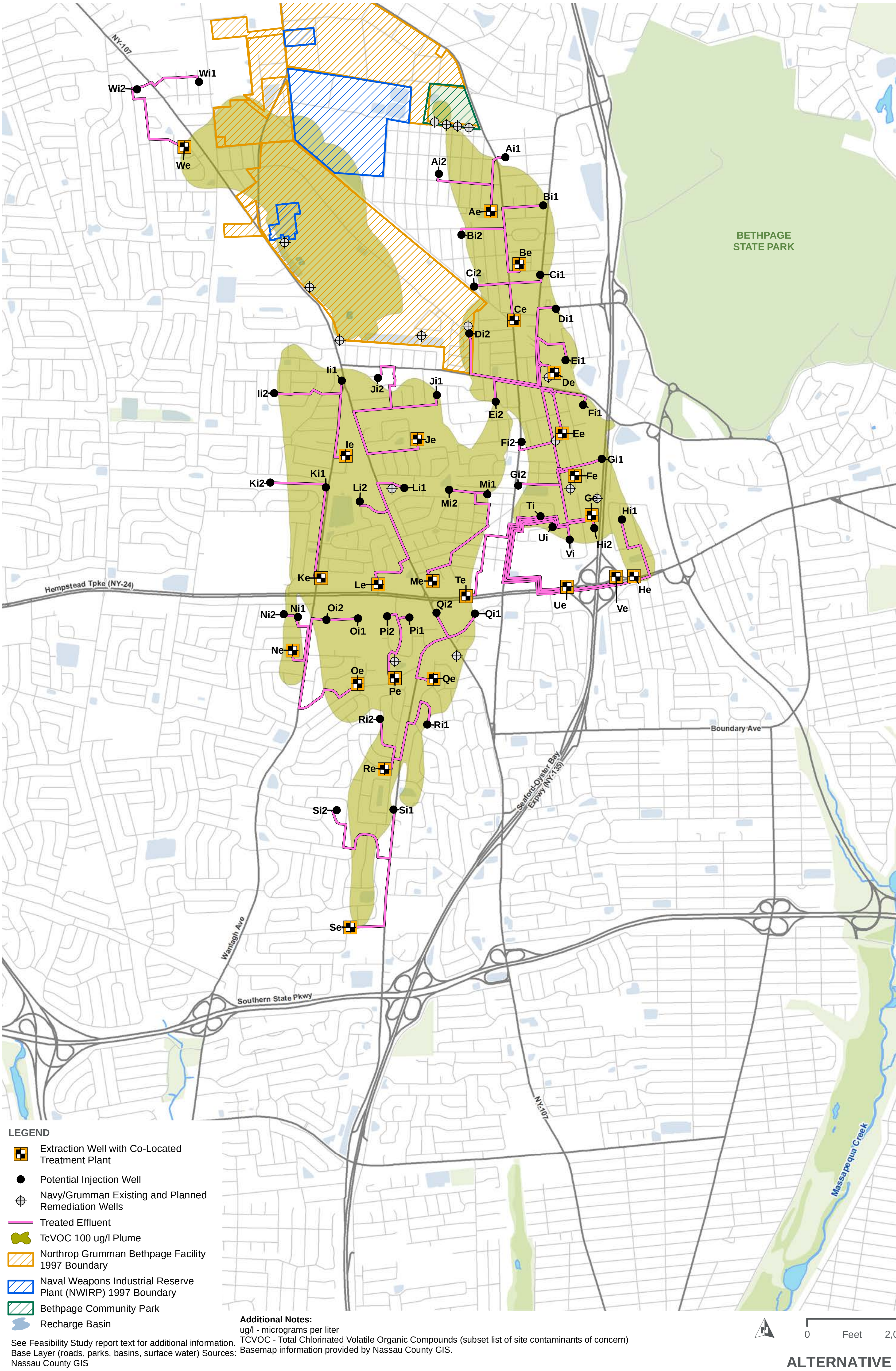

See Feasibility Study report text for additional information.
Base Layer (roads, parks, basins, surface water) Sources: Nassau County GIS

Additional Notes:
ug/l - micrograms per liter
TCVOC - Total Chlorinated Volatile Organic Compounds (subset list of site contaminants of concern)
Basemap information provided by Nassau County GIS.

ALTERNATIVE 4
AQUIFER FLUSHING

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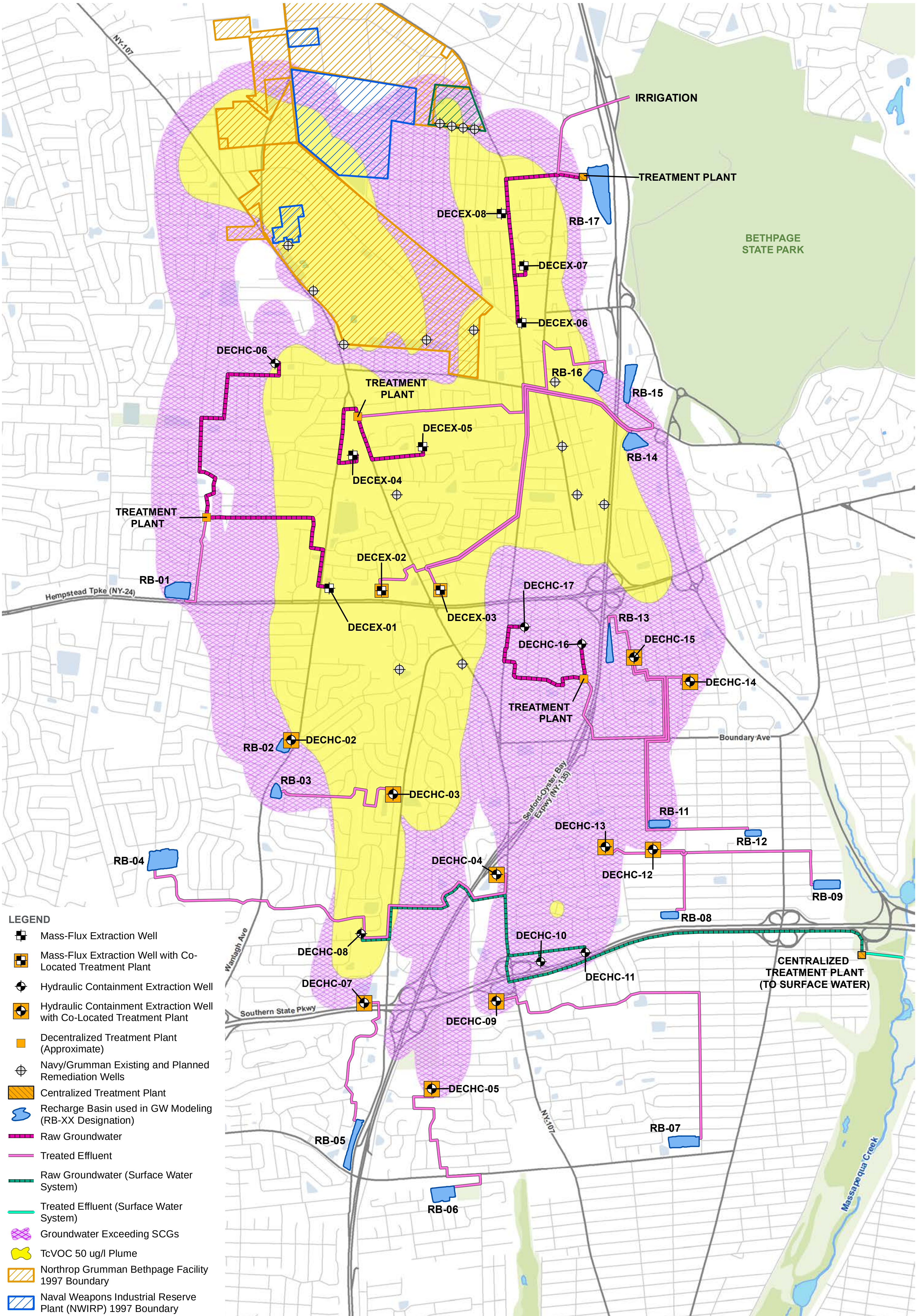
NYSDEC SITE # 130003

FIGURE 11



See Feasibility Study report text for additional information.
Base Layer (roads, parks, basins, surface water) Sources: Nassau County GIS

Additional Notes:
ug/l - micrograms per liter
TCVOC - Total Chlorinated Volatile Organic Compounds (subset list of site contaminants of concern)
SCG - Standards, Criteria, and Guidance Values
Basemap information provided by Nassau County GIS.

0 Feet 2,000

ALTERNATIVE 5A

HYDRAULIC CONTAINMENT OF SITE CONTAMINANTS ABOVE SCGs COMBINED WITH MASS FLUX REMEDIATION – DECENTRALIZED TREATMENT PLANTS WITH VARIOUS DISCHARGE METHODS

NYSDEC SITE # 130003

FIGURE 12

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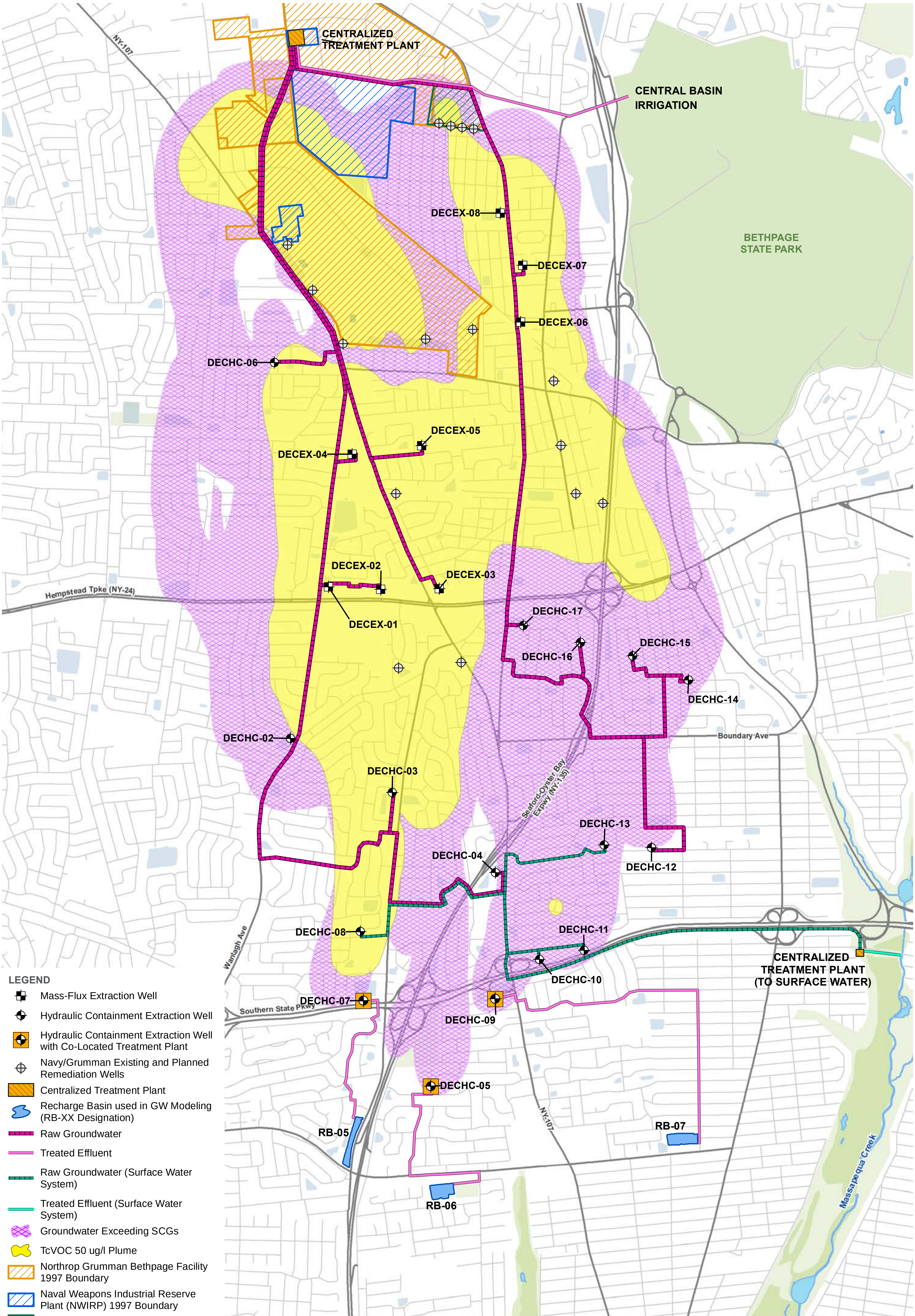

See Feasibility Study report text for additional information.
Base Layer (roads, parks, basins, surface water) Sources: Nassau County GIS

Additional Notes:
ug/l - micrograms per liter
TCVOC - Total Chlorinated Volatile Organic Compounds (subset list of site contaminants of concern)
SCG - Standards, Criteria, and Guidance Values
Basemap information provided by Nassau County GIS.

ALTERNATIVE 5B

HYDRAULIC CONTAINMENT OF SITE CONTAMINANTS ABOVE SCGs COMBINED WITH MASS FLUX REMEDIATION – CENTRALIZED TREATMENT PLANTS WITH A CENTRALIZED RECHARGE BASIN

NYSDEC SITE # 130003

FIGURE 13

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