FEASIBILITY STUDY

THE BROOKLYN NAVY YARD PARCEL
BROOKLYN, NEW YORK
NYSDEC SITE ID NO. 224019A

Prepared by:

HydroQual Environmental Engineers & Scientists, P.C.
1200 MacArthur Boulevard
Mahwah, New Jersey 07430

Under the Direction of:

New York City Department of Sanitation
Waste Management Engineering
44 Beaver Street, 9th Floor
New York, New York 10004

September 2007
Revised February 2008
Revised June 2008
Project No: NYCS.020.016.002

Environmental
Engineers & Scientists

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STATE OF NEW YORK
GARY J. DI PIPPO
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6/11/2008

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EXECUTIVE SUMMARY

This Feasibility Study report describes the development and evaluation of remediation alternatives for a 9.5-acre parcel within the Brooklyn Navy Yard and is the subject of an Order on Consent (Consent Order) [File Number D2-0001-9403] with the New York State Department of Environmental Conservation (NYSDEC). The site has been the subject of several environmental investigations. Information from these previous investigations was compiled into a site-wide data set that was used in the preparation of the Remedial Investigation Report (RI). The RI Report was submitted to the NYSDEC in September 2006, and the NYSDEC approved the RI in a letter dated December 4, 2006, and indicated that the RI report was sufficient "… for moving forward with the feasibility study".

The relevant characteristics of the site related to the development of remedial alternatives are summarized as follows:

- Metals and SVOCs above cleanup criteria are widely distributed around the site with no horizontally or vertically discernable pattern. The lack of a link to specific sources, the prevalence of SVOCs and metals above criteria, the generally low concentrations and random nature of contaminant distribution is characteristic of the presence of historic, urban fill.

- PCBs are present at concentrations above cleanup criteria within the area adjacent to Former Building 419 and Former Drum Storage Area B, and in a limited portion of the former Railroad Siding Area. PCBs found around Building 419 are related to a former transformer fire, those found around Drum Storage Area B could be related to storage of drums with oil containing PCBs. The PCBs detected in the Railroad Siding Area are not readily identified with past operations.

- While lead is prevalent in historic, urban fill, and at concentrations typical of that found at the Site, sampling in Former Drum Storage Area A displayed two locations where the TCLP criterion for lead was exceeded.

- Concentrations of volatile compounds were observed in soil vapor samples at concentrations sometimes exceeding guidance levels. While currently constituents detected in soil vapor, above NYSDOH guidance values, do not present a complete exposure pathway because of the absence of buildings, a potential exposure pathway exists in the future, if buildings are constructed on-site.

- The exposure pathway for groundwater is currently incomplete, as groundwater beneath the Site is not used as a potable supply and there are no surface manifestations of groundwater that would allow for direct contact. The urban fill at the site has had a generalized, limited affect on groundwater quality. Furthermore, groundwater will be addressed on the Keyspan parcel as a separate operable unit.

In addition, an Interim Remedial Measure (IRM) Work Plan (Quay Consulting LLC, March 2007) has been developed and submitted to the NYSDEC for Former Drum Storage Area

B. The IRM is designed to accommodate redevelopment including the construction of a multi-story industrial building.

The IRM Work Plan includes excavation within the footprint of Former Drum Storage Area B to address PCBs and lead. Because redevelopment will include a building and parking areas, the intent of the IRM Work Plan is to effect a final remedy for this portion of the site so that additional remedial efforts would not have to be undertaken following implementation of the redevelopment plan. Since the soil removal proposed in the IRM Work Plan meets the remedial action objectives, as defined below, and because the intent is that the IRM become the final remedy, the IRM is, therefore, incorporated by reference into this FS. Each remedial alternative presented below includes the Former Drum Storage Area B IRM work as a remedial component.

The remedial action objectives established for the FS are as follows:

- Direct contact control for soils to eliminate the complete pathway for metals, PCBs, and SVOCs found above criteria.

- Control of the potential for future exposure to soil vapor, because of the potential for a complete exposure pathway in the future.

- Use of institutional controls for groundwater to maintain an incomplete exposure pathway for groundwater, pending completion of the groundwater work that will be performed for the Keyspan parcel.

The FS was conducted by the following process for the sequential development of remedial alternatives:

- Identification of applicable general response actions (i.e., broad categories of remedial action);
- Identification and screening of technologies within retained general response actions;
- Development of alternatives from the technologies retained following screening;
- Screening of alternatives to narrow the field to the most appropriate options; and
- Detailed and comparative analyses of the alternative(s) retained following screening.

GENERAL RESPONSE ACTIONS

Based upon the site characteristics, the general response actions that were considered include:

- No action
- Limited action/institutional controls
- Containment
- Removal
- In-situ or ex-situ treatment
- Disposal
- Discharge

The general response action of discharge was removed from consideration because groundwater will be addressed as part of the Keyspan parcel. To the extent that discharge may be a component of an ex-situ or in-situ treatment technology potentially applicable to the site soils (e.g., flushing), such discharges would be addressed under the applicable treatment technology.

TECHNOLOGY IDENTIFICATION AND SCREENING

The following technologies were screened against the criteria of effectiveness, implementability, and cost:

- No action
- Institutional controls
- Capping
- Sub-slab depressurization (vapor intrusion control)
- Excavation
- In-situ treatment by solidification/stabilization (limited to TCLP lead)
- Off-site disposal
- In-situ treatment by soil vapor extraction
- In-situ treatment by chemical oxidation
- In-situ treatment by phytoremediation
- In-situ treatment by soil flushing
- Ex-situ treatment by solid-phase separation/soil washing
- Ex-situ treatment by incineration
- Ex-situ treatment by high temperature thermal desorption

The screening process eliminated inapplicable or inappropriate technologies and resulted in the following technologies being retained for the development of alternatives:

- No action
- Institutional Controls
- Capping
- Sub-slab depressurization (vapor intrusion control)
- Excavation
- In-situ treatment by solidification/stabilization (limited to TCLP lead)
- Off-site disposal

ALTERNATIVE DEVELOPMENT AND SCREENING

From the screened list of technologies, seven alternatives were developed as follows:

- Alternative No. 1: No action
- Alternative No. 2: Institutional Controls
- Alternative No. 3: Site-wide excavation
- Alternative No. 4: Site-wide cap
- Alternative No. 5: Localized soil excavation
- Alternative No. 6: Localized soil excavation and site-wide cap

- Alternative No. 7: Localized soil excavation including PCBs to Part 375 commercial criteria, and site-wide cap.

These alternatives were screened against the criteria of effectiveness, implementability and cost. The alternatives retained for detailed evaluation consist of the following:

- Alternative No. 1: No action was retained as a baseline for comparison with other alternatives.
- Alternative No. 3: Complete site excavation was retained because it meets the remedial action objectives and is implementable. This remedy would also restore the Site to pre-development conditions, above the water table.
- Alternative No. 4: Site-wide cap was retained as it also meets the remedial action objectives and is implementable, particularly when combined with site redevelopment.
- Alternative No. 6: Localized soil excavation and site-wide cap is a combination of Alternative Nos. 4 and 5. This alternative would meet the remedial action objectives and is implementable.
- Alternative No. 7: Localized soil excavation including PCBs to the Part 375 commercial criteria, and site-wide cap. This alternative is similar to Alternative No. 6 and would meet the remedial action objectives and is implementable.

Alternative Nos. 2 and 5 were eliminated during the screening process. While these alternatives are lower in cost, they do not meet the remedial action objectives.

DETAILED EVALUATION AND COMPARATIVE ANALYSIS OF ALTERNATIVES

The five alternatives remaining from the screening process were analyzed by comparison to the eight evaluation criteria established by the NYSDEC draft DER-10 Technical Guidance for Site Investigation and Remediation, which include:

- Overall protection of human health
- Compliance with Standards, Criteria, and Guidance (SCGs)
- Long-term effectiveness and permanence
- Reduction or toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Cost
- Community acceptance (addressed through public participation process)

Table ES-1 provides a summary of the evaluation and comparisons of the five alternatives. On balance, Alternative No. 6 meets the remedial action objectives, reduces the volume of contaminants on site, is readily implementable, will be effective over the long-term with proper maintenance, has limited short-term impacts, and is cost effective, being approximately an order of magnitude below Alternative No 3 – Site-Wide Excavation for a 30 year operational period, and only slightly more costly than Alternative No. 4, which is a very similar alternative. By comparison, Alternative No. 3 would have substantial short-term impacts and while a larger volume reduction would occur, residuals (historic fill) would remain on site and in the general environs. Therefore, overall, the benefits of Alternative No. 3 do not outweigh the implementation difficulties nor the nearly order of magnitude cost differential, particularly since other alternatives perform equally well in protecting human health and the environment. Alternative No. 7 is very similar to Alternative No. 6 with additional excavation to achieve the commercial criteria for PCBs at depth. Alternative No. 7 does not result in incremental risk reduction, has the potential to complicate the excavation process at the 1 ppm PCB cleanup level, and has an increment of cost without additional benefit. Therefore, Alternative No. 6 is recommended for implementation.

Table ES-1. Detailed Analysis Summary and Comparative Analysis of Alternatives
Brooklyn Navy Yard Parcel Feasibility Study

Evaluation Criteria	Alt. No. 1: No Action	Alt. No. 3: Site-Wide Soil Excavation	Alt. No. 4: Site-Wide Cap	Alt. No. 6: Localized Soil Excavation and Site-Wide Cap	Alt. No. 7: Localized Soil Excavation (PCBs >1 ppm) and Site-Wide Cap
Protection of Human Health and the Environment	Not protective of human health Relative Scale = 1	Protective of human health and the environment Relative Scale = 5	Protective of human health and the environment Relative Scale = 4	Protective of human health and the environment Relative Scale = 4	Protective of human health and the environment Relative Scale = 4
Compliance with SCGs	Does not comply with SCGs Relative Scale = 1	Complies with SCGs Relative Scale = 5	Complies with SCGs Relative Scale = 5	Complies with SCGs Relative Scale = 5	Complies with SCGs Relative Scale = 5
Long-Term Effectiveness and Permanence	No long-term effectiveness. Relative Scale = 1	Effective in the long-term but still requires use restrictions below water table Relative Scale = 4	Effective in the long-term with proper cap maintenance. Relative Scale = 4	Effective in the long-term with proper cap maintenance Relative Scale = 4	Effective in the long-term with proper cap maintenance Relative Scale = 4
Reduction of Toxicity, Mobility or Volume	Does not reduce toxicity, mobility or volume. Relative Scale = 1	Reduces volume through removal of site soils. Relative Scale = 5	Reduces mobility of contaminated soil with respect to direct contact exposure. Relative Scale = 3	Reduces mobility of contaminated soil with respect to direct contact exposure. Reduces volume by removal of impacted soil related to past operations. Relative Scale = 4	Reduces mobility of contaminated soil with respect to direct contact exposure. Reduces volume by removal of impacted soil related to past operations. Relative Scale = 4
Short-Term Effectiveness	No short-term impacts. No implementation items. Relative Scale = 5	Typical construction short-term impacts; significant traffic impacts and potential dust generation. Relative Scale = 3	Typical construction short-term impacts. Short term implementation. Relative Scale = 4	Typical construction short-term impacts. Short term implementation. Relative Scale = 4	Typical construction short-term impacts. Short term implementation. Relative Scale = 4
Implementability	Readily implemented Relative Scale = 5	Would require temporary closure of entrance to Brooklyn Navy Yard Industrial Park. Large scale excavation implementation. Relative Scale = 3	Generally implementable with conventional equipment and materials. Relative Scale = 4	Generally implementable with conventional equipment and materials. Relative Scale = 4	Generally implementable with conventional equipment and materials. Relative Scale = 4
Cost	None Relative Scale = 5	$11,242,000 Relative Scale = 1	$2,305,000 Relative Scale = 4	$2,510,000 Relative Scale = 4	$2,668,000 Relative Scale = 4

Relative Scale: 1 ◄──────► 5

Worse Than Other Alternatives Better

1.0 INTRODUCTION

This Feasibility Study (FS) report describes development and evaluation of remediation alternatives for a 9.5-acre parcel within the Brooklyn Navy Yard in Brooklyn, New York (Site). The site location is shown in Figure 1-1.

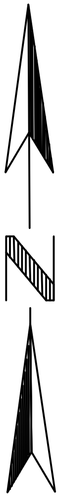
In September 2006, a site wide Remedial Investigation (RI) report was submitted to the New York State Department of Environmental Conservation (NYSDEC). The RI Report compiled the results of the various investigations that have been performed for Site characterization, including the most recent Supplementary Site Investigation (SSI) conducted from December 4, 2005 through February 2, 2006. The RI Report was approved by the NYSDEC in a letter dated December 4, 2006.

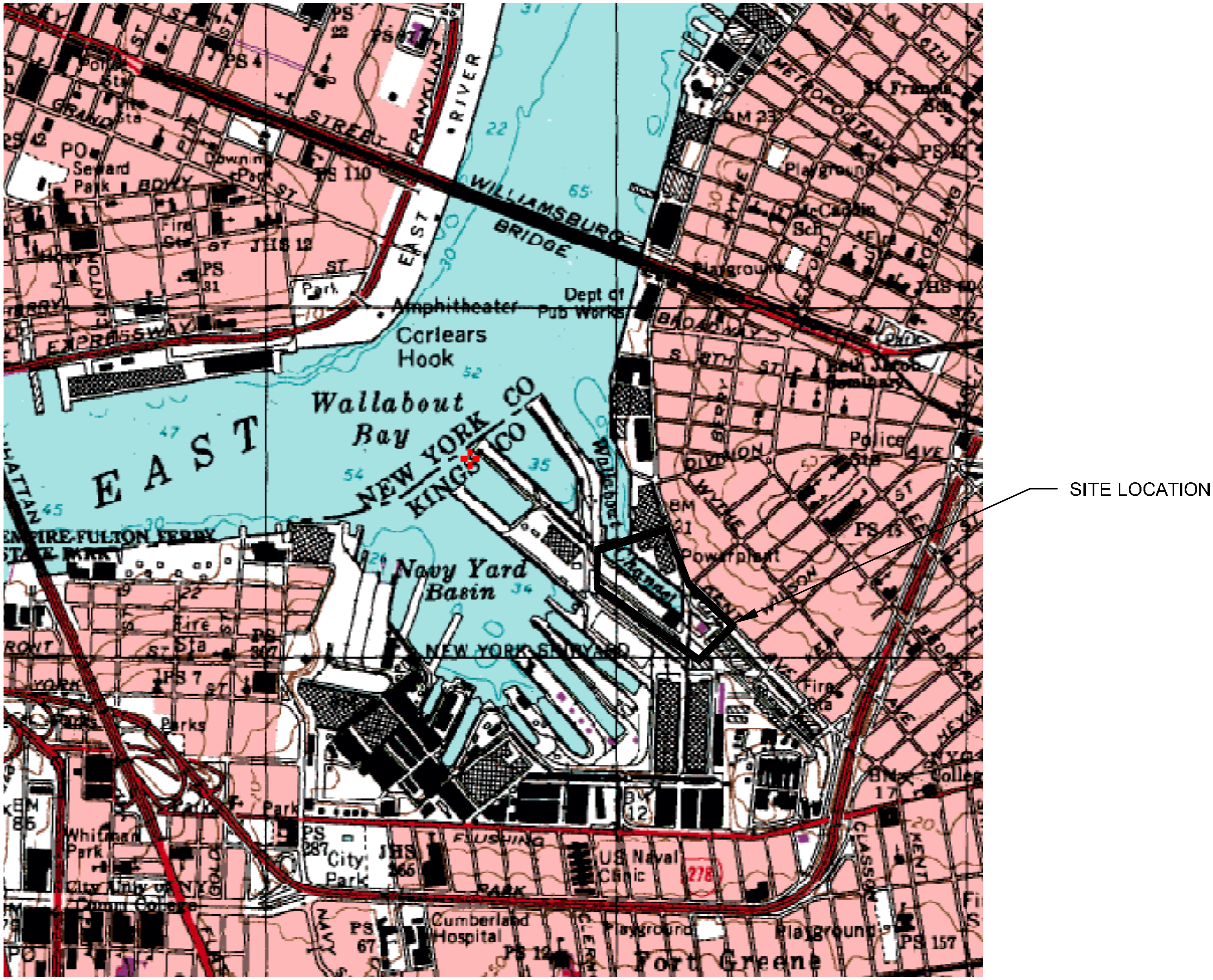
The NYSDEC approval letter indicated that the RI Report was sufficient "…for moving forward with the feasibility study." The NYSDEC's letter also stated that "Since the RI indicates the nature and extent of contamination at the site is such that excavation and/or capping are likely to be the only practical remedy, the feasibility study may be limited to the following options: (1) no action, (2) complete removal to unrestricted-use levels, (3) hot spot/source area removal, and (4) hot spot/source area removal and capping. This FS has been developed considering this NYSDEC guidance regarding the alternatives.

In addition, in an electronic mail dated June 19, 2007, the NYSDEC gave the option to the City of New York, Department of Sanitation (DSNY) to proceed directly to preparation of an FS without the need for an FS Work Plan. DSNY opted to proceed directly to the FS, because, as also indicated by the NYSDEC, the number of options applicable to the site is limited, and the FS process is well established.

This FS report has been prepared in general accord with the NYSDEC's Draft DER-10, Technical Guidance for Site Investigation and Remediation, December 2002, and has been organized as follows:

- Section 1 – Introduction
- Section 2 – Site Description and History provides background on the 9.5-acre parcel covered by the FS.
- Section 3 – Summary of Remedial Investigation and Exposure Assessment provides the site characterization data from the RI Report in a form for use directly in the FS.
- Section 4 – Remedial Action Objectives sets forth the objectives that guide the FS and development of alternatives.
- Section 5 – Standards, Criteria, and Guidance provides the various laws, regulations, and guidance that would be potentially applicable to the various remedial alternatives under consideration.
- Section 6 – General Response Actions describes the general categories of remedial response applicable at the Site.





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BROOKLYN NAVY YARD PARCEL
FEASIBILITY STUDY

SITE LOCATION MAP

SEPTEMBER 2007	Project No. NYCS.020.016.002	Figure No. 1–1	Issue 0
	File Name:		

C:\DOCUMENTS AND SETTINGS\AWARD\LOCAL SETTINGS\TEMP\BGPLOT_2540\FIG_1-1_SITE LOCATION MAP_NEW_FIGURE.DWG 02/15/2008 LAYOUT: 8.5X11

- Section 7 – Identification and Screening of Technologies identifies potentially applicable technologies and then screens these technologies to develop a list that is used to create alternatives.
- Section 8 – Development and Screening of Alternatives assembles technologies into alternatives and then screens the alternatives to develop a list for detailed analysis.
- Section 9 – Detailed Analysis of Alternatives provides an evaluation of the alternatives against established criteria.

2.0 SITE DESCRIPTION AND HISTORY

2.1 BACKGROUND

The Brooklyn Navy Yard is owned by the City of New York (City) and managed by the Brooklyn Navy Yard Development Corporation (BNYDC). The Site is a 13-acre parcel located within the larger 260-acre Brooklyn Navy Yard in the City of New York (City). The Site is the subject of an Order on Consent (Consent Order) [File Number D2-0001-9403] with the NYSDEC governing remedial activities. In addition, the Site was listed by the NYSDEC as an inactive hazardous waste site (Classification 2) in January 2002.

A coal gasification plant formerly occupied a portion of the Site (approximately 3.5 acres) and was operated by Brooklyn Union Gas, now owned by Keyspan. Negotiations among DSNY, Keyspan, the New York City Law Department and NYSDEC resulted in an agreement that Keyspan will be responsible for remediation of the 3.5-acre former coal gasification plant site and the associated plume of contaminants (i.e., groundwater) originating from the 3.5 acres. Figure 2-1 illustrates the delineation of the 3.5-acre Keyspan parcel and the remaining 9.5-acre DSNY parcel. The Site, as referred to in this report, is the 9.5-acre DSNY parcel.

The Site has been the subject of several investigations the work plans for which and results of which were reported in the following documents:

- “Environmental Assessment Report,” November 1988, prepared by Wehran Engineering for Wheelabrator Environmental Services Incorporated;
- “Work Plans for a Thirteen-Acre Parcel of The Brooklyn Navy Yard, Part I – Interim Remedial Measures [IRM] Work Plan,” July 1996, prepared by HDR for DSNY;
- “Work Plans for a Thirteen-Acre Parcel of The Brooklyn Navy Yard, Part II – Supplementary Site Assessment [SSA] Work Plan,” March 1997, prepared by HDR for DSNY;
- “Final Interim Remedial Measures Report, The Brooklyn Navy Yard,” September 1997, prepared by HDR for DSNY;
- “Final Supplementary Site Assessment Report for a 13-Acre Parcel of The Brooklyn Navy Yard,” June 1998, prepared by HDR for DSNY;
- January 26 1999 HDR letter to the NYSDEC providing supplemental information related to the SSA;
- “Meeting with Federal Agencies; Summary of Water Quality, Aquatic Ecology, and Sediment Sampling Results; Brooklyn Navy Yard Nearshore Confined Disposal Facility,” January 2001, prepared by PB in Association with Anchor and EEA, for BNYDC;

- April 13, 2004 Quay letter to the NYSDEC providing soil sample data results for areas that will be occupied by proposed new roadways for future use of the property;

- October 2004 Data Usability Summary Report the Brooklyn Navy Yard Parcel, prepared by HDR and December 1 2004 addendum;

- Supplementary Site Investigation [SSI] Work Plan, The Brooklyn Navy Yard Parcel, Brooklyn, New York, Site ID No. 224019A, HDR and HydroQual Environmental Engineers and Scientists, P.C., August 2005.

The information contained in the above noted documents was compiled for the site as a whole and constitutes the complete data set that was used in the preparation of the "Remedial Investigation Report [RI Report], The Brooklyn Navy Yard Parcel, Brooklyn, New York, Site ID No. 224019A", HydroQual Environmental Engineers and Scientists, P.C., September 2006.

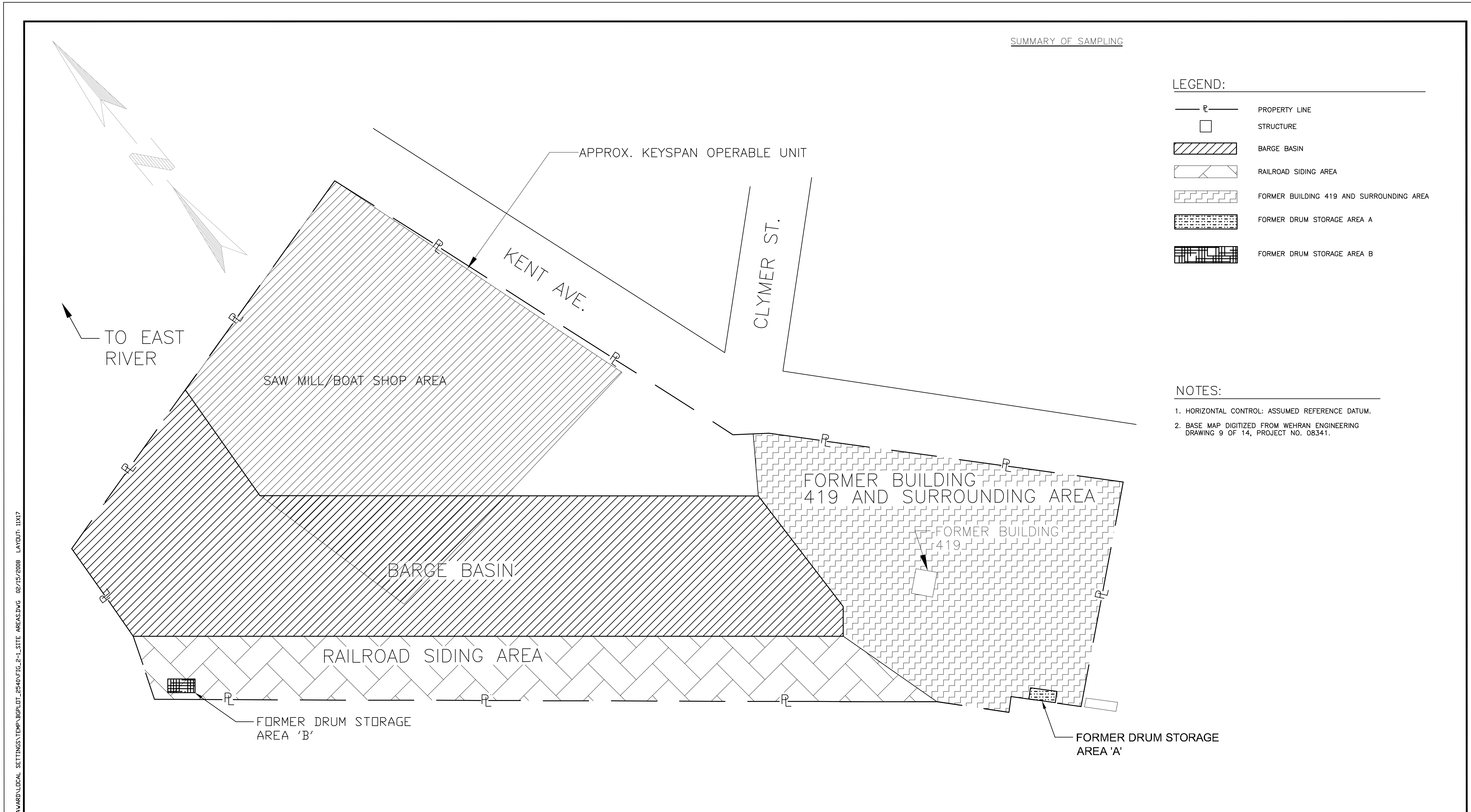
Additional details of the prior site investigations and interim remedial measures performed at Building 419 in response to the transformer fire are presented in the RI Report.

2.2 SITE DESCRIPTION

The Site is located in the northeast corner of the former Brooklyn Navy Yard near the intersection of Clymer Street and Kent Avenue (as shown in Figure 2-1) and includes approximately four acres of the Wallabout Channel (Barge Basin) along the East River. Based upon historical information, the northern corner of the Site, within the Keyspan parcel, is an area that formerly housed a saw mill and boat shop (Saw Mill/Boat Shop Area) (see Figure 2-1), and contains remnants of old concrete foundations and floor slabs from these and older structures. Across the Barge Basin from the Saw Mill/Boat Shop Area, railroad tracks from a former railroad siding area (Railroad Siding Area) run in a northwest-to-southeast direction along the southwestern portion of the Site, and a building (Former Building 419) was previously located on the southern portion of the Site (see Figure 2-1).

Two locations on the Site were identified as Former Drum Storage Areas (see Figure 2-1). One of the former drum storage areas is located near Former Building 419 and was used to store a roll-off container reportedly filled with five-gallon drums that were labeled as containing various solvents and lubricating and cutting oils (Former Drum Storage Area A). Because Former Drum Storage Area A was used to store a roll-off container with drums, evidence of prior drum storage activities does not exist, and neither regulatory nor site personnel could specifically identify the location. The location of Former Drum Storage Area A is, therefore, based upon estimated locations provided in a 1988 Environmental Assessment. Former Drum Storage Area A was paved with asphalt and concrete.

The second drum storage location is at the northwestern end of the former Railroad Siding Area and was reportedly used to store approximately 12, 55-gallon drums that appeared to contain waste oils (Former Drum Storage Area B). As with the Former Drum Storage Area A, the location of Former Drum Storage Area B is based upon estimated locations provided in a 1988 Environmental Assessment. The storage area was covered with compacted gravel.



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BROOKLYN NAVY YARD PARCEL FEASIBILITY STUDY REPORT

SITE AREAS

SEPTEMBER 2007	Project No. NYCS.020.016.002	Figure No. 2-1	Issue: 0
NTS	File Name:		

Building 419 is an enclosure for transformers, the "building" has no roof and the "floor" consists of individual concrete slabs, on which the transformers were formerly located, separated by exposed earth. In June 1986, there was an explosion and subsequent fire in the PCB transformer located in Building 419. Building 419 was decontaminated, and the contaminated soils were removed from the immediate vicinity of the transformer.

The Former Railroad Siding Area was located along the southwestern portion of the site and ran in the northwest to southeast direction. Sampling in this area initially occurred during a 1988 Environmental Assessment and indicated the presence of PCBs at low concentrations in a single composite sample collected. This resulted in further exploratory borings and test pits in the Former Railroad Siding Area to investigate the potential presence of PCBs.

2.3 SITE HYDROGEOLOGY

The uppermost shallow aquifer underlying the Site includes the surficial fill unit and, in places, portions of silt and silty sand horizons. The uppermost "shallow" aquifer contains water under unconfined conditions. The "deep" aquifer exists within the sandy outwash deposits that underlie the Gardiners Clay. The Gardiners Clay is a continuous confining unit, which presents an effective barrier between the "shallow" and "deep" aquifers on Site, which are the regional glacial aquifer, and underlying regional water supply aquifers, such as the Jameco and Magothy Aquifers of pre-Wisconsin and Upper Cretaceous ages, respectively.

The general pattern of groundwater flow is from the northeast to the southwest, from Kent Avenue toward the Barge Basin. The estimated horizontal flow for the shallow aquifer is 6.25×10^{-6} centimeters per second (cm/sec) or 0.018 feet/day (6.5 feet/year). The estimated horizontal groundwater flow for the deep sand aquifer is 2.60×10^{-6} cm/sec or 7.4×10^{-3} feet/day (2.69 feet/year).

Historic water table elevations ranged from 5.95 feet above mean sea level (MSL) to 1.23 feet above MSL. The groundwater elevations for the deep aquifer ranged from 3.02 feet above MSL to 2.55 feet above MSL. The maximum measured hydraulic gradient for the deep aquifer is 0.001. The water in both the shallow and deep aquifer discharges into the Barge Basin.

2.4 SITE HISTORY

In 1637, a Dutchman from the adjoining settlement of Breuckelen (Brooklyn) purchased the land on which the Brooklyn Navy Yard is located. At the time of the purchase, the land consisted mostly of mud flats, swamps and creeks. In 1678, John Jackson purchased the property and established a shipyard on the property called the Broldest Industry. In 1801, the United States Navy purchased the land, which officially became the nation's largest government-owned shipyard. The shipyard, commonly referred to as the Brooklyn Navy Yard, contained 270 buildings, in which approximately 71,000 men and women worked during World War II. The Brooklyn Navy Yard was virtually abandoned by the federal government in the 1960s and was officially closed in 1965. The federal government then sold the Brooklyn Navy Yard to the City in 1968. The property has since been leased from the City by the BNYDC.

A comparison of historical maps for the Brooklyn Navy Yard shows that the Wallabout Channel shoreline, located within the Site, changed between 1801 and the 1950s as a result of various site improvement activities; much of the Brooklyn Navy Yard is underlain by fill material which was used to build up the swamp land to create the present day configuration.

3.0 SUMMARY OF REMEDIAL INVESTIGATION AND EXPOSURE ASSESSMENT

As noted previously, an RI Report was completed in September 2006 and was approved by the NYSDEC in December 2006. The results of the RI are summarized below, particularly as they relate to the completion of this FS (e.g., defining the quantity of impacted soil that would be the subject of a remedy). The RI had noted that the site contains fill, and that historic, urban fill often contains various constituents at concentrations above cleanup criteria. The NYSDEC does not have guidance or criteria for addressing urban fill. For the purpose of this FS, however, understanding the site with respect to both Standards, Criteria, and Guidance (SCGs) and within the context of urban fill is important to the development of remedial alternatives. As a starting point in the summary of the RI, therefore, the screening criteria and potential relevance to the Site are discussed, followed by the results of the investigation of various areas of the Site.

3.1 REMEDIAL INVESTIGATION CONTAMINANT SCREENING CRITERIA

The following screening criteria were used in the evaluation of the data presented in the RI Report:

Soils:

- NYSDEC Recommended Soil Cleanup Objectives (RSCO) identified in NYSDEC's Technical and Administrative Guidance Memorandum (TAGM) HWR-94-4046 (TAGM 4046)
- NYSDEC 6NYCRR Part 375, Environmental Remediation Program, 375-6, Remedial Program Soil Cleanup Objectives

Groundwater:

- NYSDEC 6NYCRR Part 703, Surface and Groundwater Quality Standards
- NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations

Sediments:

- NYSDEC Division of Fish, Wildlife and Marine Resources Sediment Criteria in the 1999 Technical Guidance for Screening of Contaminated Sediments

In addition to the above, during the course of previous investigation and remediation work performed at the Site, the NYSDEC had developed two site-specific soil cleanup criteria, as follows:

- Lead: 400 mg/kg

- PCBs: 1 mg/kg in first 2', 10 mg/kg >2'

These site-specific criteria are also generally consistent with the TAGM 4046 and Part 375 residential/commercial criteria, but are higher than the Part 375 unrestricted use criteria, and for PCBs higher than the commercial criteria at depth.

The TAGM 4046 soil criteria have been used historically by NYSDEC for evaluation of soil contamination, and are intended for unrestricted use. More recently, the NYSDEC 6NYCRR Part 375 soil criteria were promulgated, and are human health and risk based criteria developed for unrestricted, residential, restricted-residential, commercial, and industrial uses. The criteria intended for commercial use were considered applicable to the intended development at this site and were applied as another level for soils data comparison. In addition, a comparison is provided in this feasibility study to the Part 375 unrestricted use criteria, for completeness. Finally, as noted above, in the RI, the soils characterization data were also evaluated in the context of the urban fill found at the site, the urban nature of the surrounding environment and waterways, and background constituent concentrations and conditions, to the extent practicable. That is, the NYSDEC does not have regulations or guidance relative to urban fill and a formal background study was not attempted in the area, especially given the urban nature of the area and the ubiquitous presence of fill in the originally low-lying areas. While the NYSDEC has not developed specific provisions for dealing with urban fill, research has been conducted on this subject in New Jersey and a historic fill database and summary table has been produced which is presented in the Technical Requirements for Site Remediation, N.J.A.C. 7:26E, Appendix D. Constituent values listed in the New Jersey historic fill database were used to help further differentiate between historic fill and contamination due to site operations.

The groundwater data were compared to the groundwater quality criteria published as noted above. Other criteria often used in such comparisons are the Maximum Contaminant Levels developed under the Safe Drinking Water Act. However, as discussed further below, there was no reason for further evaluation of the groundwater data beyond comparison to the groundwater quality criteria.

Lastly, for the sediments data, the specific objective of the RI was to assess whether there were differences in sediment quality adjacent to the site versus farther from the site. The purpose of this assessment was to evaluate whether the site may have had an impact on sediments (e.g., due to runoff) and to do so in an urban setting where concentrations of various constituents are typically above the screening criteria.

With the above as background, the following sections discuss the results of the RI for each of the various areas of investigation.

3.2 SOIL SAMPLING

3.2.1 Building 419 and Surrounding Area

Historic characterization work in and around Former Building 419 had focused principally on PCBs and the characterization data indicates the presence of PCBs above the site-specific, TAGM 4046, and Part 375 cleanup criteria. Horizontal and vertical delineation of PCB concentrations above criteria was completed and 23 samples contained PCBs above cleanup criteria. Analytical results indicate that PCB levels above criteria are localized within and around Former Building 419 and are generally within shallow (less than 2 feet) soil. Figure 3-1 illustrates the distribution of PCBs above site-specific cleanup criteria, as well as other constituents above TAGM 4046 criteria. Table 3-1 summarizes the range of concentrations found on site for the various constituents detected and provides a comparison to cleanup criteria.

Samples collected from the Building 419 area were also analyzed for the full Target Compound List (TCL), which includes VOCs, SVOCs, pesticides, and inorganics including cyanide, for further general characterization. These sample locations were co-located with several of the PCB delineation samples around the building perimeter. A number of SVOCs, (primarily PAHs), lead and other metals (lead, arsenic, and copper) were reported above TAGM 4046 and Part 375-6 unrestricted use criteria (Figures 3-1 and 3-2) and the Part 375-6 commercial cleanup criteria (Figure 3-3). VOCs were not observed at levels above either TAGM 4046 or Part 375-6 criteria in the area in or around Former Building 419. Two samples had concentrations of pesticides only slightly above TAGM 4046 and Part 375-6 unrestricted use criteria and well below Part 375-6 commercial criteria.

The NYSDEC has a policy of evaluating restoration of sites to pre-release conditions for released constituents (e.g., not for historic fill constituents). The only constituents detected at the site that are reasonably linked to a release from former site operations are PCBs. Therefore, to aid in the evaluation of pre-release conditions for PCBs, the extent of PCBs delineation has been further illustrated on Figures 3-2a and 3-3a. These figures are limited to illustrating data for PCBs. Figure 3-2a illustrates sample locations where testing for PCBs has been performed and where PCBs have been detected above the Part 375-6 unrestricted-use criteria. Figure 3-3a is similar but for a comparison to the Part 375-6.

As noted above, apart from a comparison of site characterization data to NYSDEC cleanup levels, the nature of the fill on site was evaluated as well. That is, the Site has urban fill; used to create the grades upon which prior development took place. As previously indicated, the NYSDEC does not have an urban fill database to use for comparison of analytical data. Therefore, the State of New Jersey historic fill database was used as another point of comparison. Comparison of detected concentrations of SVOCs and metals with the historic fill data indicated that the concentrations found in the Building 419 area were within the range of typical values observed in the NJDEP historic fill database (Table 3-1), except for copper which is not listed in the NJDEP historic fill database. Levels above cleanup criteria for multiple metals, including lead, were often observed in the same sample. Metals and SVOC concentrations did not display an obvious spatial pattern horizontally or vertically. The lack of a clear pattern in distribution is consistent with the assessment that elevated SVOC and metals levels are associated with historic, urban fill and not with a specific on-site use or operation.

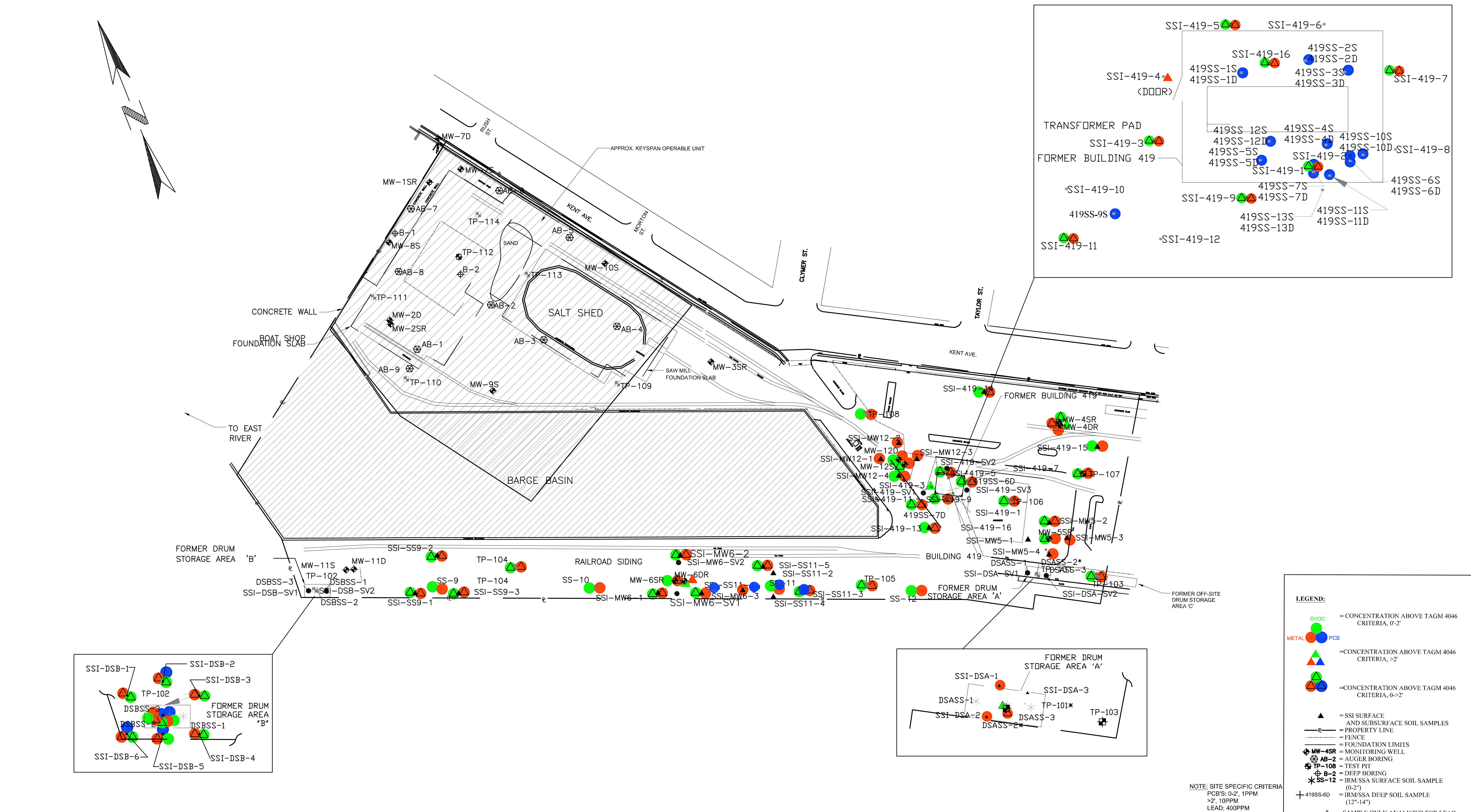
3.2.2 Former Drum Storage Area A

The historical focus of analytical characterization of Drum Storage Area A had been for lead. During IRM and SSA investigations, no results were observed during soil analysis above either Part 375-6 commercial or the TAGM 4046 criteria for lead in surface soils. Surficial lead levels are above the Part 375-6 unrestricted use criteria for impact to groundwater, but not for

Table 3-1. Summary of RI Soils Data and Screening Criteria
Feasibility Study – Brooklyn Navy Yard Parcel

Category	Parameter	Range on Site (Min, Max)		TAGM 4046 / Site Specific Criteria	NYSDEC Part 375 Criteria (Commercial)	NYSDEC Part 375 Criteria (Unrestricted)	NJDEP Historic Fill Concentration (min, mean, max)
Metals (ppm)	Arsenic	0.38	170	7.5 or SB (3-12)	16	13	0.05, 13.2, 1098
	Barium	7	590	300 or SB (15-600)	400	350	
	Beryllium	0.1	20	0.16 (HEAST) or SB (0-1.75)	590	7.2	0.01, 1.23, 79.7
	Cadmium	0.1	14	1 or SB (0.1-1)	9.3	2.5	0.02, 11.1, 510
	Calcium	520	210000	SB (130 - 35,000)			
	Chromium	4	150	10 or SB (1.3 - 40)	400-800	1-30	
	Cobalt	2	140	30 or SB (2.5 - 60)			
	Copper	9	1500	25 or SB (1-50)	270	50	
	Iron	3400	68000	2,000 or SB (2,000 -550,000)			
	Lead	4	5300	400* / 5 (TCLP)	1000	63/400	0.28, 574, 10700
	Magnesium	56	66000	SB (100-5000)			
	Mercury	0.10	5.4	0.1	2.8	0.18	
	Nickel	4	330	13 or SB (0.5-25)	310	30	
	Selenium	0.3	14	2 or SB (0.1-3.9)	1500	3.9	
	Sodium	18	11901	SB (6,000-8,000)			
	Zinc	19	7400	20 or SB (9-50)	89,000	109	2.45, 575, 10900
Semi-Volatile Organics (ppb)	Phenol	42	9260	30 or MDL (330)	500000	330	
	Naphthalene	35.8	28300	13000	500000	12000	
	Dibenzofuran	40.5	15100	6200			
	Anthracene	43.4	2E+05	50000	500000	100000	
	Fluoroanthene	42.1	2E+05	50000	500000	100000	
	Butylbenzylphthalate	42.5	79400	50000			
	Benzo(a)anthracene	39.1	20600	224 or MDL (330)	5600	1000	30, 1370, 160000
	Chrysene	37	17200	400	56000	1000	
	Benzo(b)fluoranthene	47.2	25300	1100	6000	1000	20, 1910, 110000
	Benzo(k)fluoranthene	57.3	7400	1100	56000	800	20, 1790, 93000
	Benzo(a)pyrene	38	15600	61 or MDL (330)	1000	1000	20, 1890, 120000
	Indeno(1,2,3-cd)pyrene	41.9	7880	3200	5600	500	20, 1410, 67000
	Dibenzo(a,h)anthracene	47.9	2510	14 or MDL (330)	560	330	10, 1240, 25000
Volatile Organics (ppb)	Benzene	11	69	60	45000	60	
Pesticide/PCB (ppb)	Heptachlor epoxide	1.8	29.2	20			
	gamma-BHC (Lindane)	1.8	17	6	9200	100	
	Dieldrin	1.8	60.9	44	1900	5	
	PCBs	33	2E+05	1000(0-2')/10,000 (>2') *	1000	100	

*Site Specific Criteria



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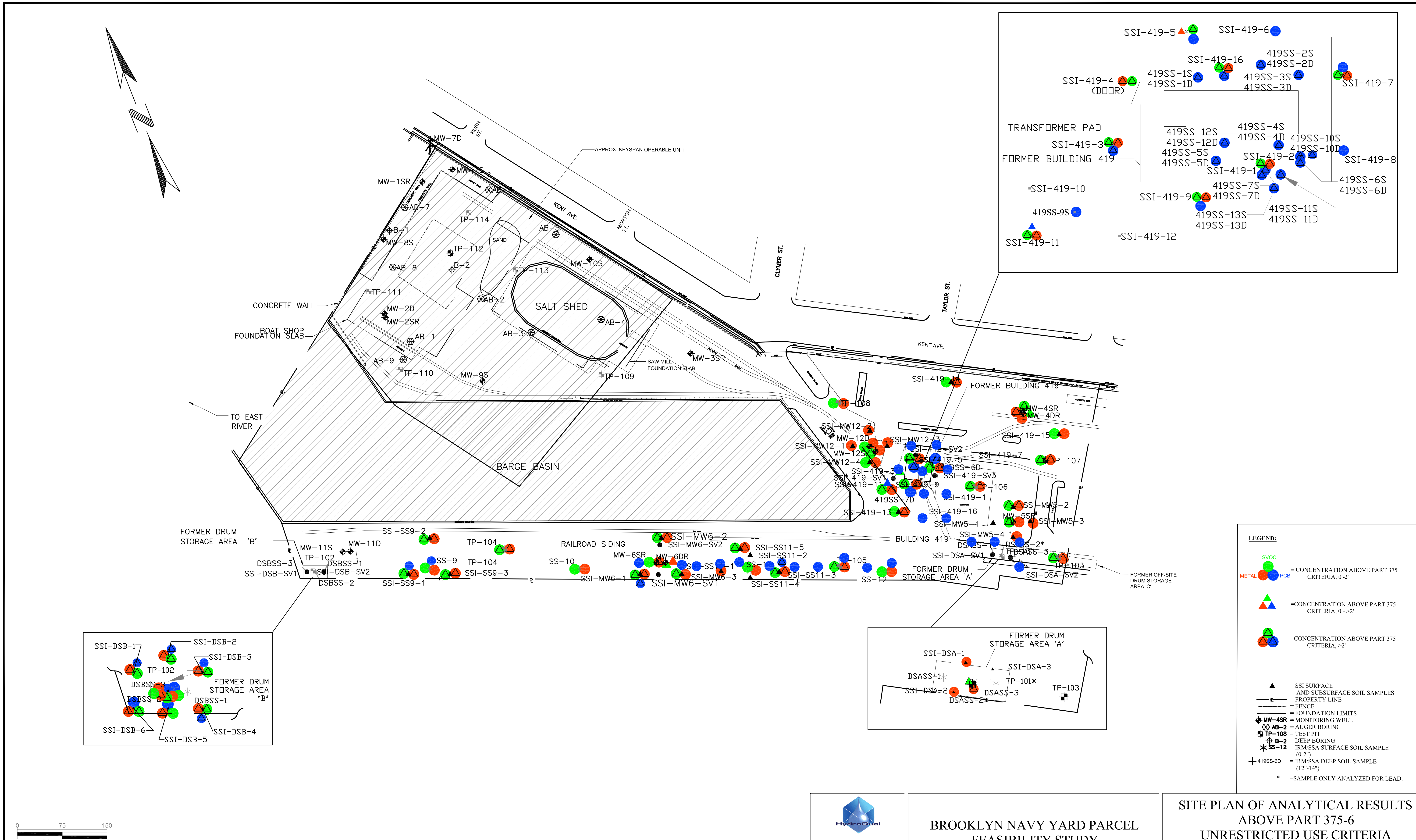
BROOKLYN NAVY YARD PARCEL
FEASIBILITY STUDY

SITE PLAN OF
ANALYTICAL RESULTS ABOVE TAGM
4046 OR SITE-SPECIFIC CRITERIA

9/27/2007	Project No. NYCS.020.016.002	Figure No. 3-1	Issue:
	File Name:		



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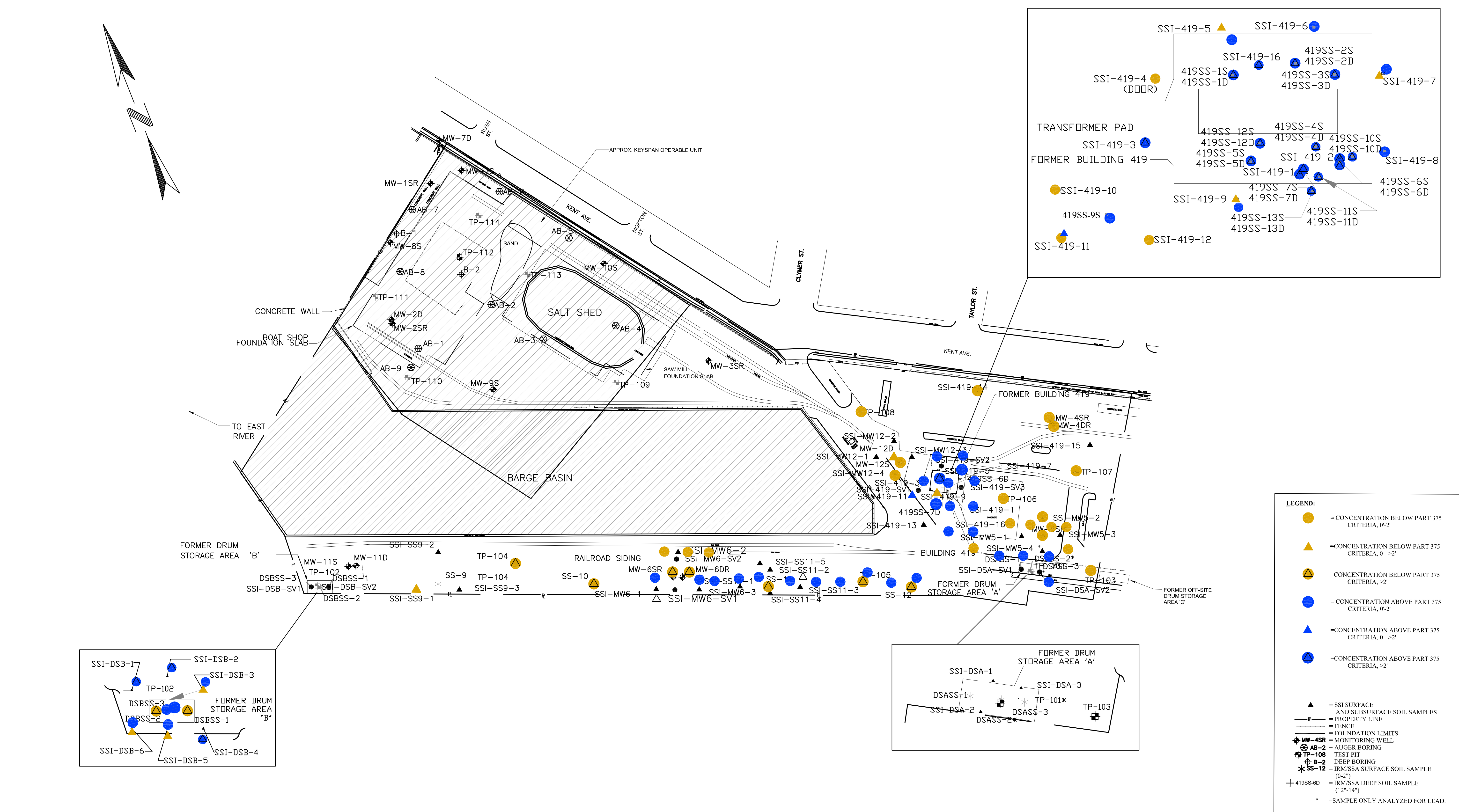
BROOKLYN NAVY YARD PARCEL
FEASIBILITY STUDY

SITE PLAN OF ANALYTICAL RESULTS ABOVE PART 375-6 UNRESTRICTED USE CRITERIA

Date	Project No.	Figure No.	Issue:
3/27/2008	NYCS.020.016.002	3-2	
	File Name:		



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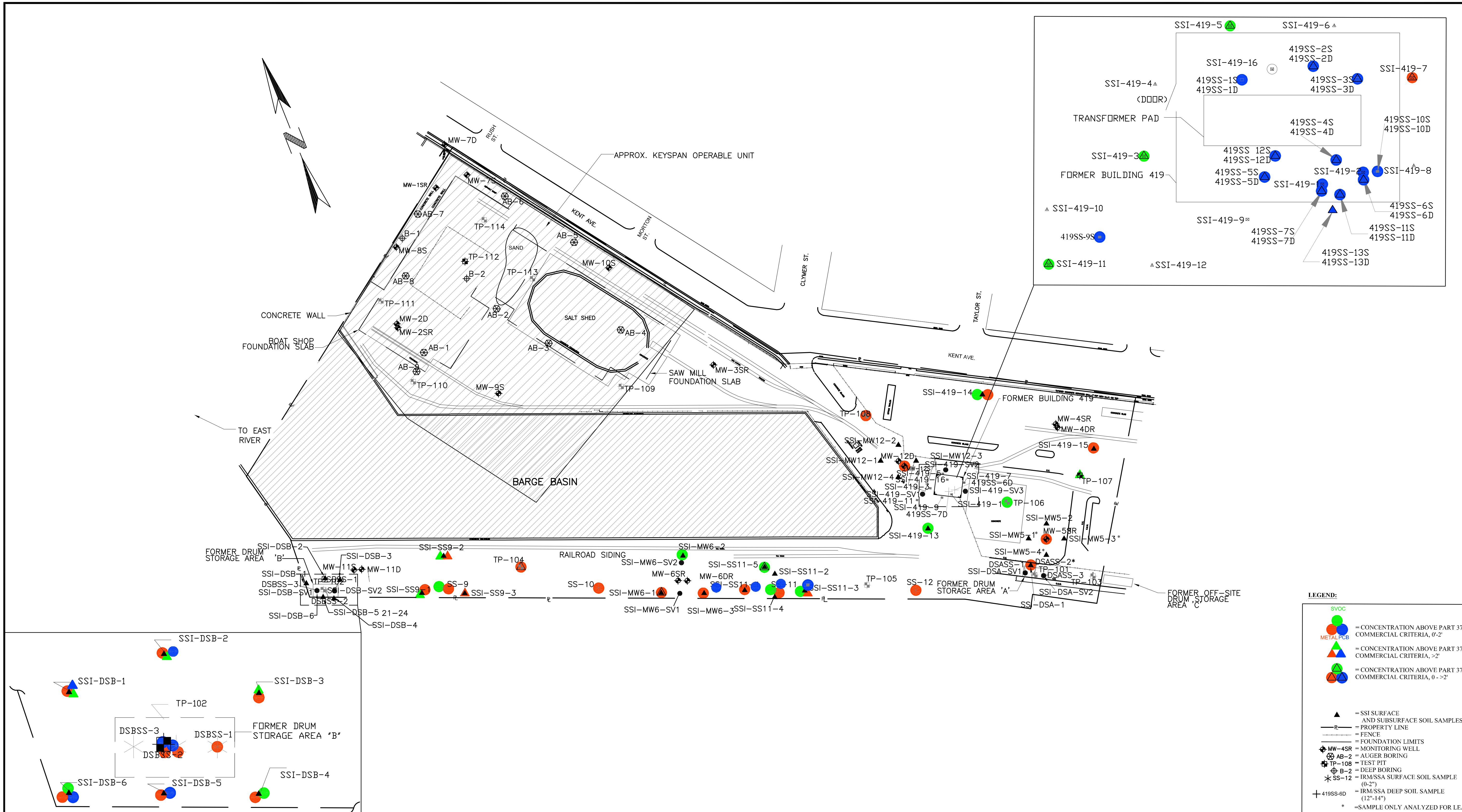
SITE PLAN OF PCB ANALYSES BY COMPARISON TO PART 375-6 UNRESTRICTED USE CRITERIA

3/27/2008	Project No. NYCS.020.016.002	Figure No. 3-2a
	File Name:	Issue:



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SITE PLAN OF ANALYTICAL RESULTS ABOVE PART 375-6 COMMERCIAL CRITERIA

JUNE 2008

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Figure No. 3-3

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FEASIBILITY STUDY

SITE PLAN OF PCB ANALYSES BY COMPARISON TO PART 375-6 COMMERCIAL CRITERIA

JUNE 2008	Project No. NYCS.020.016.002	Figure No. 3-3a	Issue:

residential direct contact. However, lead levels were observed in TCLP testing above the hazardous waste classification criterion in two samples. Additional sampling for lead during the SSI resulted in three samples with lead above screening criteria (Figure 3-1) at depth, but not in surficial soils. The absence of elevated lead levels in near surface soils and the variability in concentration with location, suggests that the detected lead concentrations above 400 ppm are again related to the urban fill material as opposed to a source associated with Drum Storage Area A.

3.2.3 Former Drum Storage Area B

During the IRM, SSA and SSI, surface soil lead levels and concentrations of other metals were observed above cleanup criteria. Lead levels above 400 ppm and the presence of other metals at concentrations above TAGM 4046, Part 375-6 unrestricted use, and Part 375-6 commercial cleanup levels, are randomly spread at this location (see Figures 3-1, 3-2, and 3-3, respectively). These data continue to suggest that the elevated concentrations of metals are associated with historic, urban fill, as discussed previously. Similarly, while SVOCs were not detected above cleanup criteria in earlier sampling performed as a part of the IRM and SSA work, during the SSI PAHs were detected above cleanup criteria at several locations, again without a specific pattern and likely associated with the historic fill.

Levels of PCBs above criteria (1000 ppb) were also observed in surface soils (Figures 3-1, 3-2, and 3-3) and may be associated with the storage of drums of PCB contaminated oil at this location. PCBs were also detected in deep soils, but in all cases below the 10000 ppb site-specific cleanup criterion. However, applying the 1000 ppb commercial criterion from Part 375-6 at all depths, concentrations above this level were found at several locations up to depths of four feet, as shown on Figure 3-3a. These observations generally delineate the horizontal and vertical extent of PCB concentrations above cleanup criteria, with the limit to the south consistent with the location of Railroad Avenue. This road was paved in the early 1960's and thus predates the use of this location as a drum storage area in the early 1980's. The presence of a road in this area, and the fact that it is, and was a paved surface, indicates that the road represents the southerly limit of PCB impacted soils. To the extent that remedies address the PCBs in this area, either pre-design delineation or post-excavation sampling would be used to confirm the southerly boundary of impacts.

3.2.4 Railroad Siding Area

Sampling and analysis in the railroad siding area occurred during the 1988 Environmental Assessment, the IRM, the SSA, and the SSI. The 1988 Environmental Assessment and the IRM sampling focused on PCBs. In general only low PCB concentrations were observed in the area. The SSA and SSI included additional subsurface soil samples to characterize the extent of PCBs, as well as a more generalized (i.e., TCL sampling) characterization of the area. Of the sampling completed for the various investigations, a total of four samples exhibited PCB concentrations above the TAGM surface criteria (Figure 3-1) and above Part 375-6 unrestricted and commercial use criteria (Figures 3-2 and 3-3). These samples included three grid locations (G2SS-7, 8 and 9) and one supplementary site investigation sample (SSI-SS11-3) with concentrations ranging from 1.4 to 2.5 ppm.

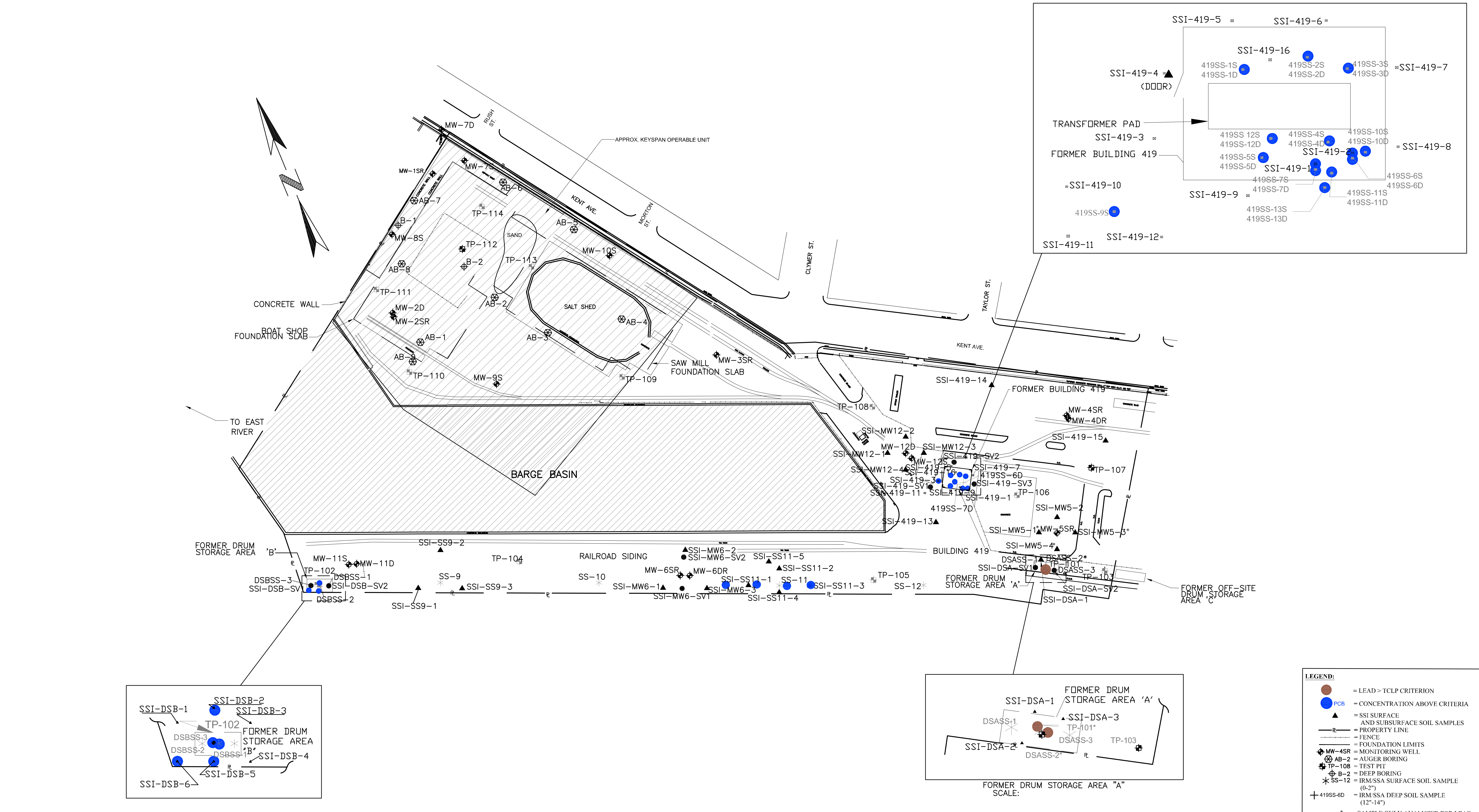
Lead levels above 400 ppm were observed in the vicinity of SSA sample locations SS-11, MW-5, and MW-12, possibly related to the presence of urban fill. Additional samples collected during the SSI indicated lead concentrations above 400 ppm in both shallow and deeper samples intermittently throughout the area, generally limited in size and without a clear spatial pattern horizontally or vertically (Figures 3-1 and 3-2). These observations are again consistent with the interpretation that these lead levels are associated with urban fill.

To better characterize a number of areas where SVOCs were previously detected or data were limited, samples were collected in the railroad siding area, proximate to MW-6, SS-9 and SS-11, in the area north and south of Former Building 419, and to the northeast of TP-107. PAHs were detected above TAGM 4046, Part 375-6 unrestricted use, and Part 375-6 commercial criteria, as shown on Figures 3-1, 3-2, and 3-3. Lead was observed to be above criteria (400 ppm) at a number of locations, and in addition, other metals, most frequently arsenic and copper, were observed at concentrations above criteria. With limited exceptions (mostly J qualified data, (one PCB sample noted above at 12”-14”) VOCs, pesticides or PCBs were not detected above TAGM 4046, Part 375 unrestricted use, or Part 375-6 commercial criteria in these samples. As with other data, the distribution of the SVOCs did not show any particular patterns and are consistent with the presence of urban fill.

3.2.5 Site Wide Data Analysis

While the previous soil investigations culminating in the findings reported in the RI had focused on specific areas of the Site (i.e., the drum storage areas, former Building 419) because of the presumption that these are potential source areas, the site characterization data, when viewed in the context of historic, urban fill, depict a generally non-area-specific pattern of contaminant distribution, with limited exception. Specifically, when viewed on a site-wide basis, locations where concentrations of metals and SVOCs are found above TAGM 4046 or Part 375-6 unrestricted use criteria are widely distributed around the Site without a readily discernable pattern, either horizontally or vertically (Figures 3-1 and 3-2). A similar interpretation exists when comparing the data to Part 375-6 commercial criteria (Figure 3-2), that is, widely distributed and no discernable pattern. This lack of a link to specific sources, the prevalence of SVOC and metals above criteria, the generally low concentrations, and the random nature of contaminant distribution is characteristic of the presence of historic, urban fill. This contrasts with the distribution of PCBs that are localized in the areas immediately adjacent to Former Building 419 (with a known source) and a small portion of Former Drum Storage Area B (with a possible source) and a small portion of the former Railroad Siding Area (with an unknown source). In the Building 419 and Former Drum Storage Area B areas, these PCB concentrations show a pattern consistent with past site activities, while lead, other metal, and SVOC concentrations above guidance values appear randomly distributed and are believed to be associated with historic, urban fill.

To further illustrate this point, if one screens the analytical data against the New Jersey historic fill database a very different pattern emerges. This screening is presented on Figure 3-4, and the results clearly distinguish the PCBs around Former Building 419 and Former Drum Storage Area B as unassociated with historic fill. In addition, the lead levels found above the TCLP criterion at Former Drum Storage Area A, while not necessarily linked with former operations, are notably different than other areas of the site (i.e., the soils would be classified as a hazardous waste in this location). Also remaining after this screening process is copper.



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BROOKLYN NAVY YARD PARCEL
FEASIBILITY STUDY

SITE PLAN OF PCB's ABOVE SITE-SPECIFIC CRITERIA AND LEAD ABOVE TCLP CRITERION

SEPTEMBER 2007	Project No. NYCS.020.016.002	Figure No. 3-4	Issue:

However, the New Jersey historic fill database does not contain data on copper. Copper is found at the Site similar to the other metals, exceeding TAGM 4046, Part 375-6 unrestricted use, and Part 375-6 commercial criteria over a wide-spread area with no discernable pattern, which suggests that copper is also potentially attributable to historic, urban fill.

A remaining question relative to the FS is, then, whether copper as a contaminant would deserve attention separate from other historic fill parameters, in assessing potential remedial alternatives. The answer to this question lies in part in the basis for the NYSDEC Part 375 commercial soil cleanup criterion for copper (i.e., TAGM 4046 and Part 375-6 unrestricted use criteria for metals are background). The Part 375 criterion is a human-health, risk-based value generated by using an acute exposure to ingestion of copper contaminated soil by a child, which results in a criterion concentration value of 270 mg/kg. The Part 375 acute soil ingestion soil cleanup criterion calculation assumes that a child will ingest a large amount, 10 grams, of soil. At the concentration of 270 mg/kg, the child would consume 2.7 mg of copper. The acute copper soil ingestion criterion is based, in part, on the World Health Organization's (WHO) drinking water guidance of 2 mg/L, which is a copper water concentration versus a copper soil mass concentration. Some uncertainty exists between the direct comparison of ingestion of copper contaminated water versus copper contaminated soil (i.e., copper can be bound to organic material in the soil and not readily bioavailable). In calculation of the Part 375 acute reference dose for copper, it was assumed that a child drinks one liter of water a day, for a total intake of 2 mg of copper. As stated in the WHO background document for the development of copper drinking water guidance, adverse effects of copper consumption are influenced by temporal aspects of exposure and the concentration ingested to a greater extent than the total mass ingested. In addition, the study on which the Part 375 chronic copper soil ingestion criterion, used for the industrial soil cleanup level, is based (Institute of Medicine, 2001) lists tolerable upper intake levels (i.e., highest level of daily nutrient intake that is likely to pose no risk of adverse health effects for almost all individuals) between 8 – 10 mg/day for adolescents and adults and between 1 – 5 mg/day for children.

In addition to the health studies on copper intake presented above, the Part 375 commercial copper criterion was compared to the EPA Region 9 Preliminary Remediation Goals (PRGs) industrial criterion which is a chronic human-health, risk-based exposure concentration. The industrial PRG for copper is listed as 41,000 mg/kg. The main differences between the PRG and Part 375 criteria are the assumptions on land use and the application of acute verse chronic exposure scenarios.

The above discussion indicates that copper present at concentrations above 275 mg/kg does not necessarily represent an incremental risk, and that other criteria, particularly chronic-based, are set at much higher levels. Given that the copper distribution around the site is similar to other metals which are components of historic fill, and health effects of these relatively low levels of copper are questionable, copper contamination at the site would be more appropriately addressed as a part of the historic fill rather than as a site-specific constituent.

3.3 SOIL VAPOR SURVEY

To assess the vapor intrusion pathway, a screening-level soil vapor assessment was performed at the Site. Two soil vapor samples were collected in each of the Former Drum Storage Areas (SSI-DSA-SV1, SSI-SDA-SV2, SSI-DSB-SV1, and SSI-DSB-SV2), in the vicinity of monitoring well MW-6 within the railroad siding (SSI-MW6-SV1 and SSI-MW6-SV2) and three soil vapor samples were collected in the vicinity of Former Building 419 SSI-419-SV1 through SSI-419-SV3). The results of the soil vapor testing are summarized in Table 3-2.

Three constituents detected in soil gas, methylene chloride, tetrachloroethene, and trichloroethene, were detected in soil vapor at levels above the New York State Department of Health (NYSDOH) air guideline values for these constituents. Also, collectively, the soil gas results report concentrations of acetone, benzene, ethylbenzene, toluene, xylene, MTBE and several other compounds at concentrations that are, with few exceptions, generally below USEPA shallow soil vapor screening criteria. These constituents were also reported at low levels (typically "J" qualified results) in some, but not all of the soil samples. Finally, trace levels (below groundwater standards) of benzene, ethylbenzene and toluene were also detected in some of the monitoring well samples.

The collective data suggest that the soil gas results are generally consistent across the site and do not provide evidence of the presence of a "plume" or defined area of elevated VOCs. The consistent nature of the BTEX compounds (benzene, ethylbenzene, toluene, and xylene) and their presence at trace levels within the soil appears to be consistent with the observed use of the majority of the area for construction equipment and vehicle storage. There are no buildings on the Site so that the evaluation of sub-slab and/or indoor air samples is not possible.

3.4 GROUNDWATER SAMPLING

Analytical results for groundwater represent groundwater contained within the urban fill material and are consistent with the analytical results obtained from these fill deposits as described in the previous sections. That is, various constituents are present above groundwater quality criteria, at generally low levels throughout the site and consistent with the fact that the groundwater exists within the urban fill. Water level elevations measured in the monitoring wells have indicated flow towards the adjacent barge basin.

Both the groundwater (see Table 3-3) and urban fill contain metals and a limited number of SVOCs. No pesticides, or PCBs were observed above screening criteria in groundwater. With respect to VOCs, only Xylene was above NYSDEC Part 703 criteria (21-41 ppb) in one well (MW-6SR). Metals observed above their respective criteria included antimony, lead, iron, manganese, selenium and sodium. A small number of SVOCs were also observed to have concentrations moderately above screening criteria. Groundwater quality data associated with the site are illustrated on Figure 3-5, which also illustrates the direction of groundwater flow.

In general observed concentrations in groundwater are consistent with the conclusions that the urban fill has a generalized, low level effect on groundwater quality, and direct groundwater impacts (i.e., from past activities) are restricted to the Keyspan operable unit.

Table 3-2. Soil Vapor Analytical Results
Feasibility Study - Brooklyn Navy Yard Parcel

Compound	NYDOH indoor/ outdoor air guidelines ug/m^3	EPA Shallow Soil Vapor Target Value, 0.1 Attenuation Factor, 1x10^{-5} Risk ug/m^3	Lab Reporting Limit ug/m^3	SSI-MW6-SVI ug/m^3	SSI-MW6-SV2 ug/m^3	SSI-DSA-SVI ug/m^3	SSI-DSA-SV2 ug/m^3	SSI-419-SVI ug/m^3	SSI-419-SV2 ug/m^3	SSI-419-SV3 ug/m^3	SSI-419-SV3 dup ug/m^3	SSI-DSB-SV1 ug/m^3	SSI-DSB-SV2 ug/m^3
Acetone		3500	1	78	76	129	242	87	69	44	40	34	17
Benzene		31	2	18	16	23	22	14	15	8.5	9.2	7.6	5.5
Bromodichloromethane		14	3	<RL	<RL	**137**	10	<RL	<RL	<RL	<RL	<RL	<RL
Bromoethene			2	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
Bromoform		220	5	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
Bromomethane			2	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
1,3-Butadiene		0.9	1	<RL	**1.4**	**6.2**	**2.3**	<RL	**1.4**	**1.4**	**1.6**	<RL	<RL
tert-Butyl alcohol			2	<RL	2.8	<RL	12	4.9	20	5.8	6.5	<RL	<RL
Carbon disulfide		7000	2	<RL	<RL	46	1.7	3.8	<RL	<RL	<RL	2	<RL
Carbon tetrachloride		16	3	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
Chlorobenzene		600	2	<RL	<RL	40	5.4	<RL	<RL	<RL	<RL	<RL	<RL
Chloroethane		100000	1	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
Chloroform		11	2	<RL	<RL	<RL	2.6	<RL	**27**	<RL	<RL	<RL	<RL
Chloromethane			1	1.2	1.6	<RL	<RL	<RL	<RL	1.3	1.4	1.3	<RL
3-Chloropropene			2	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
2-Chlorotoluene			3	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
Cyclohexane			2	13	8.1	109	395	4.5	14	7.7	4.3	10	2.3
Dibromochloromethane			4	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
1,2-Dibromoethane			4	<RL	<RL	5.3	<RL	<RL	<RL	<RL	<RL	<RL	<RL
1,2-Dichlorobenzene		2000	3	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
1,3-Dichlorobenzene		1100	3	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
1,4- Dichlorobenzene		8000	3	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
Dichlorodifluoromethane		2000	2	4.9	5.1	5	4.7	4.7	8.2	5.1	4.9	6.3	6
1, 1- Dichloroethane		5000	2	<RL	<RL	2.4	<RL	<RL	<RL	<RL	<RL	<RL	<RL
1,2- Dichloroethane		9.4	2	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
1,I-Dichloroethylene		2000	2	<RL	<RL	2.5	<RL	2.8	<RL	<RL	<RL	<RL	<RL
cis-l,2-Dichloroethylene		350	2	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
trans-l ,2- Dichloroethylene		700	2	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
1,2- Dichloropropane		40	2	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
cis-l ,3 - Dichloropropene			2	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
trans-l,3-Dichloropropene			2	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
Dichlorotetrafluoroethane			3	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL

Table 3-2. Soil Vapor Analytical Results
Feasibility Study - Brooklyn Navy Yard Parcel

Compound	NYDOH indoor/ outdoor air guidelines ug/m^3	EPA Shallow Soil Vapor Target Value, 0.1 Attenuation Factor, 1x10^{-5} Risk ug/m^3	Lab Reporting Limit ug/m^3	SSI-MW6-SVI ug/m^3	SSI-MW6-SV2 ug/m^3	SSI-DSA-SVI ug/m^3	SSI-DSA-SV2 ug/m^3	SSI-419-SVI ug/m^3	SSI-419-SV2 ug/m^3	SSI-419-SV3 ug/m^3	SSI-419-SV3 dup ug/m^3	SSI-DSB-SV1 ug/m^3	SSI-DSB-SV2 ug/m^3
Ethylbenzene		220	2	5.1	31	<RL	28	17	9.4	18	20	6.2	9.5
4-Ethyltoluene			2	4.2	19	8.4	37	13	11	14	16	3.3	4.5
Heptane			2	<RL	17	16	28	6.4	12	5.8	6.6	7.2	5
Hexachlorobutadiene		0.53	5	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
Hexane		2000	2	5.6	20	90	64	8.1	24	8.9	9.7	13	7.6
Methyl ethyl ketone		10000	1	2.6	9.5	21	6.4	20	10	8.4	7.5	4.5	3
Methyl isobutyl ketone		800	2	<RL	<RL	<RL	3	2.7	2.5	<RL	<RL	<RL	<RL
Methylene chloride	60	520	2	4.3	2.7	2.9	**115**	2.5	28	3.1	3.7	5.5	2
Methyl-t-butyl ether		30000	2	<RL	19	24	32	21	10	8	8.6	3.9	2.9
Styrene		10000	2	2.2	3	4.1	4.4	2.6	3.2	<RL	<RL	<RL	<RL
1,1,2,2- Tetrachloroethane		4.2	3	**6.1**	<RL	<RL	<RL	**12**	<RL	<RL	<RL	<RL	<RL
Tetrachloroethylene	100	81	3	<RL	23	33	**144**	**105**	27	16	16	<RL	<RL
Toluene		4000	2	11	131	28	143	89	606	87	93	47	88
1,1,2- Trichloro-1,2,2-trifluoroethane		300000	4	5.4	<RL	<RL	5.7	<RL	<RL	<RL	<RL	<RL	<RL
1,2,4- Trichlorobenzene		2000	4	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
1,1,1- Trichloroethane		22000	3	<RL	<RL	<RL	<RL	3.8	<RL	<RL	<RL	<RL	<RL
1,1,2- Trichloroethane		15	3	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
Trichloroethylene	5	2.2	3	<RL	<RL	<RL	**3.3**	<RL	**18**	<RL	<RL	<RL	<RL
Trichlorofluoromethane		7000	3	<RL	<RL	<RL	4	11	<RL	<RL	<RL	<RL	<RL
1,2,4- Trimethylbenzene		60	2	5.6	13	7.3	43	15	13	20	22	3.7	4.8
1,3,5- Trimethylbenzene		60	2	<RL	6	3.1	15	5.1	4.1	4.7	6.1	<RL	<RL
2,2,4- Trimethylpentane			2	<RL	4.4	75	25	3.3	5.1	3.4	3.7	3.2	<RL
Vinyl chloride		28	1	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL	<RL
m or p-Xylene		70000	2	8.2	54	<RL	46	26	14	29	33	8	14
o-Xylene		70000	2	3.5	32	29	30	16	8.6	17	19	4.7	6.9
Notes: <RL less than lab reporting limit													
Bold values are above NYDOH or EPA criteria													

Table 3-3. Groundwater Results Above Screening Criteria
Feasibility Study - Brooklyn Navy Yard Parcel

Well Details/ Parameters	Groundwater Screening Criteria[1]	MW4SR	MW4DR	MW5SR	MW6SR	MW6DR	MW12S	MW12D	MW-12-SR	MW-3-SR	MW-5-SR	MW-6-SR	SSI-MW-4DR	SSI-MW-4DR DUP	SSI-MW-4SR
Well Installation Date		4/21/1997	5/8/1997	4/21/1997	4/21/1997	5/15/1997	4/25/1997	5/9/1997	1/18/2006	1/18/2006	1/17/2006	1/17/2006	5/8/1997	5/8/1997	4/21/1997
Screen Length		20'	20'	20'	15'	20'	10'	20'	10'	10'	20'	15'	20'	20'	20'
Total Depth		25'	101.5'	25'	18.5'	102'	15'	100'	15'	15'	25'	18.5'	101.5'	101.5'	25'
Sample Date		5/29/1997	5/29/1997	5/29/1997	5/28/1997	5/28/1997	5/28/1997	5/28/1997	2/2/2006	2/2/2006	2/2/2006	2/2/2006	12/19/2005	12/19/2005	12/19/2005
Sample Time		10:45 a.m.	10:20 a.m.	12:30 p.m.	3:40 p.m.	2:40 p.m.	12:15 p.m.	1:00 p.m.							
Sample Analyzed Date		6/6/1997	6/6/1997	6/6/1997	6/4/1997	6/4/1997	6/4/1997	6/4/1997	2/9/2006-2/22/06	2/9/2006-2/22/06	2/9/2006-2/22/06	2/9/2006-2/22/06	12/22/2005-12/29/2005	12/22/05-1/4/2006	12/22/2005-1/4/2006
Antimony	0.003 (S)			0.0149 J					0.0067 J	0.012 J		0.01 J		0.012 J	
Arsenic	0.025 (S)			0.165											
Cadmium	0.005 (S)			0.0076 N											
Chromium	0.05 (S)			0.109 J											
Copper	0.2 (S)			0.467											
Iron	0.3 (S)	16.4 J	1.89 J	48.2 J	4.66 J	9.43 J	5.52 J	5.38 J	16	33	15	2.4	19	20	3.1
Lead	0.025 (S)			0.689 J			0.136			0.07	0.038				
Magnesium	35 (S)	49.3 J	421 J	72.1 J	46.6 J	481 J		409 J					550	570	51
Manganese	0.3 (S)	1.08 J	3.36 J	0.749 J	1.4 J	2.51 J	1.27 J	2.61 J	3.4	0.76	0.58		4.9	5.2	1
Mercury	0.0007 (S)			0.0024											
Selenium	0.01 (S)												0.026 J	0.023 J	0.012 J
Sodium	20 (S)	98.2	5370	875	638	4870	822	4450	470	4300	230	570	4700	4600	99
Naphthalene	10 (G)	23									28.9				
Acenaphthene	20 (S)										28.2				
Diethylphthalate	50 (G)											71.1			
4-Chloroaniline	5	NM	NM	NM	NM	NM	NM	NM		12.6					
bis(2-Ethylhexyl)phthalate	5	NM	NM	NM	NM	NM	NM	NM	5.24 JB	6.45 JB		6.25 JB	5.7 JB	49.9 JB	
Phenol	1	NM	NM	NM	NM	NM	NM	NM			1.95 J	20.5			
Xylenes(total)	5 (S)				21							41.36 J			

Notes:

[1] Groundwater Screening Criteria are based on NYSDEC Part 703 groundwater standards or TOGS No. 1.1.1 groundwater guidance values.

ppb parts per billion, equivalent to micrograms per liter

ppm parts per million, equivalent to milligrams per liter

NM Not measured

B The analyte was found in the blank

J Analyte detected below method detection limit and/or estimated concentration

NM Spiked sample recovery not within control limits

3.5 SEDIMENT SAMPLING

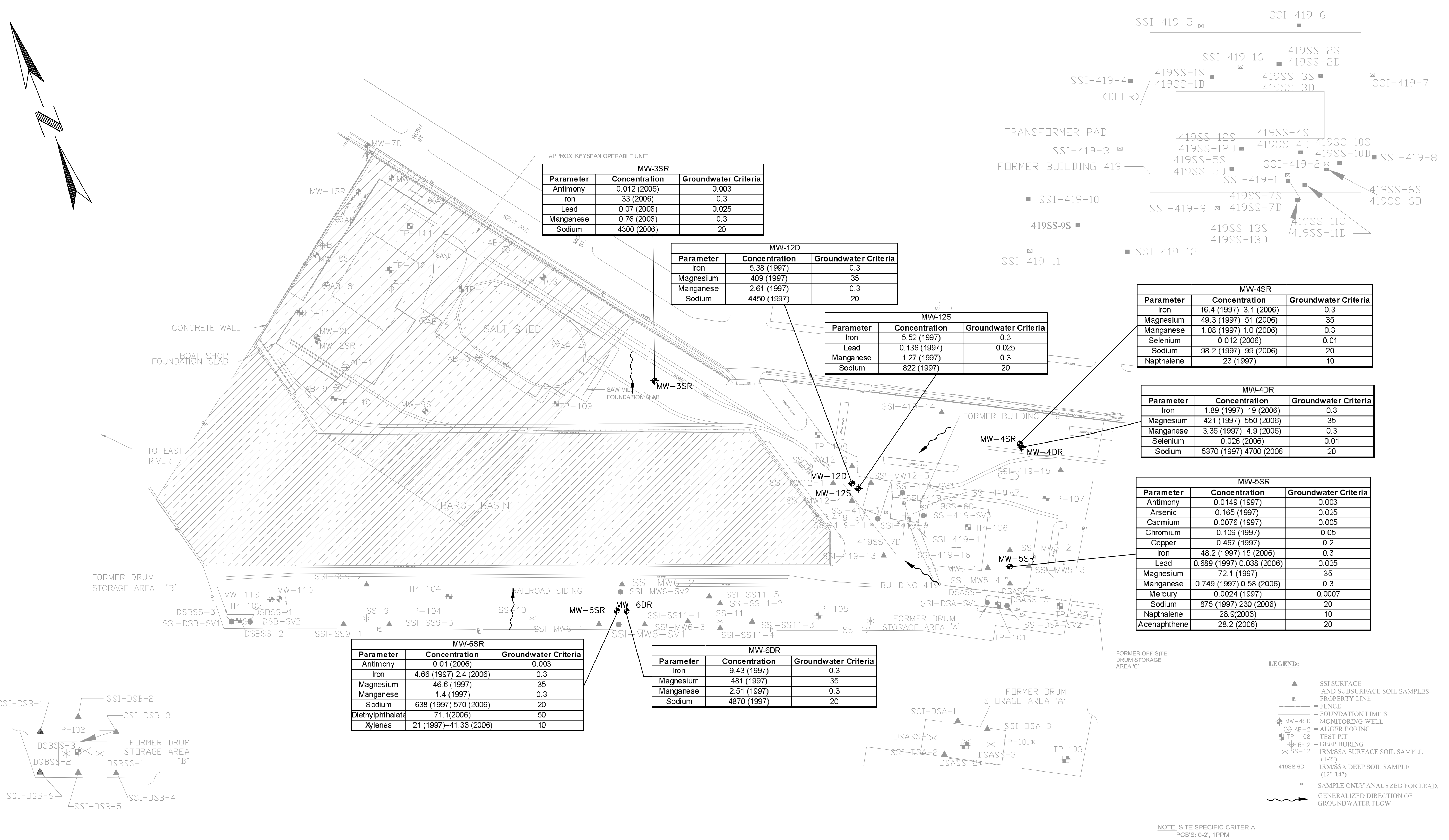
In January of 2001, Parsons, Brinkerhoff, Quade & Douglas, Inc. submitted a report to the Brooklyn Navy Yard Development Corporation for the *Brooklyn Navy Yard Nearshore Confined Disposal Facility*. This report included sampling and analytical data for five discrete sediment samples collected from the Barge Basin. To supplement these existing data and focus on the potential for runoff from the Brooklyn Navy Yard parcel to affect sediments, three additional surface sediment samples were collected on the perimeter of the barge basin as part of the SSI. The sediment characterization data are presented in Table 3-4. Concentrations of metals, including arsenic, copper, lead and mercury in new samples collected near the edges of the barge basin were similar to or lower than those observed previously in samples collected near the center of the basin. These samples from the edges of the barge basin contained few detectable levels of pesticides, consistent with the absence of pesticides in the Site soils, and low levels observed in prior sediment samples from the center of the barge basin. Concentrations of SVOCs were also generally similar to, or lower than, those previously observed in the center of the basin. These consistent observations of similar or lower concentrations for parameters within the sediments found at the edges of the barge basin demonstrate that elevated levels of metals and SVOCs in the sediment, reflect the urban nature of these waterways as opposed to the transport of contaminated soils from the site via surface runoff.

Concentrations observed within the barge basin are not significantly different from those prevalent throughout the region. Both metal and SVOC concentrations in the barge basin sediments were generally comparable to a background sample previously collected near the mouth of the East River. In addition, samples collected from nearby Wallabout basin also displayed similar concentrations of metals and many SVOCs as observed in the boat basin. Therefore, comparison, both between samples within the barge basin and between the barge basin and independent locations, indicate that observed concentrations reflect the urban nature of local waterways rather than impacts from the site. Consequently no remedial alternatives will be considered for sediments within the boat basin.

3.6 EXPOSURE ASSESSMENT

The above data summary from the RI indicates that constituents are present above human health criteria in soil, groundwater, and soil vapor. Constituents found in soils above applicable criteria include metals, PCBs, and SVOCs – principally PAHs. These constituents are present in both shallow and deeper soils. The soils represent an exposure point where direct human contact would be possible through dermal absorption, ingestion, or inhalation. The exposure pathway for soils is considered complete.

Constituents in groundwater above the Part 703 groundwater quality criteria include primarily several metals and a limited number of SVOCs. However, the groundwater is found within the historic, urban fill, is brackish, and could not be used as a potable supply. The Site and surrounding areas are served by public water supply. There are no surface manifestations of groundwater where direct contact would be possible. Therefore, the exposure pathway for groundwater is currently considered incomplete. Institutional controls (use restrictions) could be employed to address the fact that, in general, groundwater in New York state is classified as GA, suitable for potable use, and such restrictions would eliminate the potential for future use and



MW-3SR		
Parameter	**Concentration**	**Groundwater Criteria**
Antimony	0.012 (2006)	0.003
Iron	33 (2006)	0.3
Lead	0.07 (2006)	0.025
Manganese	0.76 (2006)	0.3
Sodium	4300 (2006)	20

MW-12D		
Parameter	**Concentration**	**Groundwater Criteria**
Iron	5.38 (1997)	0.3
Magnesium	409 (1997)	35
Manganese	2.61 (1997)	0.3
Sodium	4450 (1997)	20

MW-12S		
Parameter	**Concentration**	**Groundwater Criteria**
Iron	5.52 (1997)	0.3
Lead	0.136 (1997)	0.025
Manganese	1.27 (1997)	0.3
Sodium	822 (1997)	20

MW-4SR		
Parameter	**Concentration**	**Groundwater Criteria**
Iron	16.4 (1997) 3.1 (2006)	0.3
Magnesium	49.3 (1997) 51 (2006)	35
Manganese	1.08 (1997) 1.0 (2006)	0.3
Selenium	0.012 (2006)	0.01
Sodium	98.2 (1997) 99 (2006)	20
Napthalene	23 (1997)	10

MW-4DR		
Parameter	**Concentration**	**Groundwater Criteria**
Iron	1.89 (1997) 19 (2006)	0.3
Magnesium	421 (1997) 550 (2006)	35
Manganese	3.36 (1997) 4.9 (2006)	0.3
Selenium	0.026 (2006)	0.01
Sodium	5370 (1997) 4700 (2006	20

MW-5SR		
Parameter	**Concentration**	**Groundwater Criteria**
Antimony	0.0149 (1997)	0.003
Arsenic	0.165 (1997)	0.025
Cadmium	0.0076 (1997)	0.005
Chromium	0.109 (1997)	0.05
Copper	0.467 (1997)	0.2
Iron	48.2 (1997) 15 (2006)	0.3
Lead	0.689 (1997) 0.038 (2006)	0.025
Magnesium	72.1 (1997)	35
Manganese	0.749 (1997) 0.58 (2006)	0.3
Mercury	0.0024 (1997)	0.0007
Sodium	875 (1997) 230 (2006)	20
Napthalene	28.9(2006)	10
Acenaphthene	28.2 (2006)	20

MW-6SR		
Parameter	**Concentration**	**Groundwater Criteria**
Antimony	0.01 (2006)	0.003
Iron	4.66 (1997) 2.4 (2006)	0.3
Magnesium	46.6 (1997)	35
Manganese	1.4 (1997)	0.3
Sodium	638 (1997) 570 (2006)	20
Diethylphthalate	71.1(2006)	50
Xylenes	21 (1997)–41.36 (2006)	10

MW-6DR		
Parameter	**Concentration**	**Groundwater Criteria**
Iron	9.43 (1997)	0.3
Magnesium	481 (1997)	35
Manganese	2.51 (1997)	0.3
Sodium	4870 (1997)	20

NOTE: SITE SPECIFIC CRITERIA
PCB'S: 0-2', 1PPM
>2', 10PPM
LEAD: 400PPM

0 75 150
SCALE IN FEET

HYDROQUAL ENVIRONMENTAL ENGINEERS AND SCIENTISTS, P.C.
1200 MACARTHUR BOULEVARD
MAHWAH, NEW JERSEY 07430

BROOKLYN NAVY YARD PARCEL
FEASIBILITY STUDY

GROUNDWATER PARAMETERS ABOVE PART 703 OR TOGS No. 1.1.1 WATER QUALITY CRITERIA

1/28/2008
Project No. NYCS.020.016.002
File Name:
Figure No. 3–5
Issue:

Table 3-4. Sediment Analytical Results
Feasibility Study - Brooklyn Navy Yard Parcel

Parameter	SSI-SEDMW-12-1		SSI-SEDMW-3-1		SSI-SEDMW-6-1		PB COMP F		PBDIS SURF-01		PB DIS SURF-02		PBDIS SURF-03		PBDIS SURF-04		PBDIS SURF-05		PB REF SURF COMP		PB COMP A		PB COMP B		PB COMP C		PB COMP D		PB DREDGE SURF COMP	
Sample Date	12/20/2005		12/20/2005		12/20/2005		10/2/2000		10/3/2000		10/3/2000		10/3/2000		10/3/2000		10/3/2000		10/3/2000		10/2/2000		10/2/2000		10/2/2000		10/2/2000		10/3/2000	
Metals (ppm)																														
Aluminum	6300	J	6100	J	6600	J	NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Antimony	1.6	J	1.5	J	1.3	J	NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Arsenic	2.9	J	2.3	J	4.1	J	10.3		6.33		4.54		6.15		6.06		6.31		8.73		10		10.7		10.4		12.4		8.93	
Barium	42	J	44	J	50	J	NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Beryllium	0.087	J	0.1	J	0.51	J	NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Cadmium	0.71		0.9		0.81		3.67		3.4		2.64		3.84		3.5		3.36		2.52		3		3.18		3.08		4.7		2.66	
Calcium	7600		24000		9800		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Chromium	32	J	39	J	34	J	83.8		42		30.7		47.2		45.9		45.2		47		74		68.8		66.5		125		51.4	
Cobalt	6.9		6.7		7.1		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Copper	84		94		85		128		193		94.3		171		142		116		79.2		109		104		116		178		86.5	
Iron	19000		17000		19000		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Lead	90		100		94		113		301		129		243		178		136		88.3		101		93.2		90.5		150		78.4	
Magnesium	7200		6400		6300		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Manganese	180		190		200		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Mercury	0.43	J	0.57	J	0.55		2.33		2.12		1.52		2.75		2.03		1.77		1.34		1		1.51		1.38		2.64		1.28	
Nickel	17	J	19	J	18	J	24.1		23.8		16.8		27.1		23.8		22.3		20.9		23		23.3		23.1		27.7		21.8	
Potassium	1800	J	2000	J	1800	J	NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Selenium	3	J	2.8	J	3.2	J	NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Silver	1.3		2.5		1.5		0.19	U	1.09		0.73		1		0.29		0.1		0.82		1		0.17	J	0.23		1.73		0.19	
Sodium	12000		14000		10000		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Thallium	12	J	13	J	11		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Vanadium	21		26		23		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Zinc	170		250		180		179		464		233		430		324		259		150		161		162		175		214		146	
Cyanide	1.2	U	1.5		1.1	U	NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Pesticides/PCBs (ppb)																														
alpha -BHC	4.06	U	4.49	U	3.61	U	NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
beta-BHC	4.06	U	4.49	U	3.61	U	NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
delta-BHC	4.06	U	4.49	U	3.61	U	NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
gamma-BHC (Lindane)	4.06	U	4.49	U	3.61	U	NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Heptachlor	4.06	U	4.49	U	3.61	U	0.65	U	0.89	U	0.9	U	0.92	U	0.96	U	0.8	U	0.45	U	0.62	U	0.65	U	0.67	U	0.60	U	0.73	U
Aldrin	4.06	U	4.49	U	3.61	U	0.94		3.17		1.19	U	1.21	U	1.26	U	1.05	U	0.6	U	0.81	U	0.72	J	0.80	J	1.14		1.80	
Heptachlor epoxide	4.06	U	4.49	U	3.61	U	0.66	U	0.9	U	0.91	U	0.93	U	0.97	U	0.81	U	0.46	U	0.63	U	0.66	U	0.68	U	0.60	U	0.74	
Endosulfan I	4.06	U	4.49	U	3.61	U	0.61	U	0.83	U	0.84	U	0.86	U	0.89	U	0.75	U	0.42	U	0.58	U	0.61	U	0.63	U	0.56	U	0.68	
Dieldrin	8.13	U	8.99	U	7.23	U	0.59	U	0.81	U	0.82	U	0.84	U	0.87	U	0.73	U	0.41	U	0.57	U	0.59	U	0.61	U	0.54	U	0.67	
4,4’ - DDE	8.13	U	8.99	U	7.23	U	9.3		8.74		0.68	U	0.70	U	0.72	U	0.61	U	0.34		18.40		10.50		10.30		18.30		10.00	
Endrin	8.13	U	8.99	U	7.23	U	NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Endosulfan II	8.13	U	8.99	U	7.23	U	0.4	U	0.54	U	0.55	U	0.56	U	0.59	U	0.49	U	0.28	U	0.38	U	0.40	U	0.41	U	0.36	U	0.45	
4,4’ - DDD	8.13	U	8.99	U	7.23	U	3.47		28.5		0.93	U	0.95	U	0.99	U	0.83	U	0.47	U	6.65		3.16		3.05		5.75		4.25	
Endosulfan sulfate	8.13	U	8.99	U	7.23	U	0.3	U	0.4	U	0.41	U	0.42	U	0.44	U	0.37	U	0.21	U	0.28	U	0.30	U	0.31	U	0.27	U	0.33	
4,4’ - DDT	8.13	U	8.99	U	7.23	U	0.26	U	O.35	U	0.36	U	0.37	U	0.38	U	0.32	U	0.18	U	0.25	U	4.09		5.15		0.24	U	0.29	
Methoxychlor	40.6	U	44.9	U	36.1	U	NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Endrin ketone	8.13	U	8.99	U	7.23	U	NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
Endrin aldehyde	8.13	U	8.99	U	7.23	U	NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM		NM	
alpha - Chlordane	4.06	U	4.49	U	3.61	U	0.6	U	0.82	U	0.83	U	0.85	U	0.88	U	0.74	U	0.42		1	U	0.6	U	0.62	U	NM		0.67	
gamma - Chlordane	5.2		4.49	U	3.61	U	0.45	U	0.61	U	0.62	U	0.64	U	0.66	U	0.55	U	0.31	U	0	U	0.45	U	0.46	U	NM		0.5	
Toxaphene	406	U	449	U	361	U																								
Aroclor -1016	81.3	U	89.9	U	72.3	U																								
Aroclor -1221	163	U	180	U	145	U																								
Aroclor -1232	81.3	U	89.9	U	72.3	U																								
Aroclor -1242	81.3	U	89.9	U	72.3	U																								
Aroclor -1248	81.3	U	89.9	U	72.3	U																								
Aroclor -1254	81.3	U	89.9	U	72.3	U																								
Aroclor - 1260	375	E	112		72.3	U																								
Total PCB Congeners	376	E	113		145	U	166		197		130		151		218		138		38.5		150		165		158		242		125	

Table 3-4. Sediment Analytical Results
Feasibility Study - Brooklyn Navy Yard Parcel

Parameter	SSI-SEDMW-12-1	SSI-SEDMW-3-1	SSI-SEDMW-6-1	PB COMP F	PBDIS SURF-01	PB DIS SURF-02	PBDIS SURF-03	PBDIS SURF-04	PBDIS SURF-05	PB REF SURF COMP	PB COMP A	PB COMP B	PB COMP C	PB COMP D	PB DREDGE SURF COMP
Sample Date	12/20/2005	12/20/2005	12/20/2005	10/2/2000	10/3/2000	10/3/2000	10/3/2000	10/3/2000	10/3/2000	10/3/2000	10/2/2000	10/2/2000	10/2/2000	10/2/2000	10/3/2000
SVOCs (ppb)															
bis(2-Chloroethyl)ether	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
2-Chlorophenol	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
1,2-Dichlorobenzene	24.4 U	27 U	21.7 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
1,3-Dichlorobenzene	24.4 U	27 U	21.7 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
1,4-Dichlorobenzene	24.4 U	27 U	21.7 U	34 J	510	130	170	66 J	42 J	14.1 J	29 J	29 J	30 J	40	22
2-Methylphenol	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
2,2'-oxybis(1-Chloropropane)	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
4-Methylphenol	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
N-Nitroso-di-n-propylamine	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Hexachloroethane	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Nitrobenzene	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Isophorone	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
2-Nitrophenol	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
2,4-Dimethylphenol	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
bis(2-Chloroethoxy)methane	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
2,4-Dichlorophenol	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
1,2,4-Trichlorobenzene	24.4 U	27 U	21.7 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Naphthalene	811 U	99.9 J	2170 U	120	280	160	170	80	67	76	130	110	110	130	89
4-Chloroaniline	1300	1010	2290	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Hexachlorobutadiene	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
4-Chloro-3-methylphenol	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
2-Methylnaphthalene	811 U	900 U	2170 U	140	250	220	270	110	72	69	140	120	120	150	89
Hexachlorocyclopentadiene	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
2,4,6-Trichlorophenol	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
2,4,5-Trichlorophenol	2030 U	2250 U	5440 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
2-Chloronaphthalene	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
2-Nitroaniline	2030 U	2250 U	5440 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Dimethylphthalate	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Acenaphthylene	147 J	264 J	252 J	280 J	69	130	120	170	79	680	410	290 J	240	510	190
2,6-Dinitrotoluene	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
3-Nitroaniline	2030 U	2250 U	5440 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Acenaphthene	811 U	900 U	2170 U	92	100	81	87	120	37 J	67	280 J	95	75	130	65
2,4-Dinitrophenol	2030 U	2250 U	5440 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
4-Nitrophenol	2030 U	2250 U	5440 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Dibenzofuran	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
2,4-Dinitrotoluene	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Diethylphthalate	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
4-Chlorophenyl-phenylether	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Fluorene	106 J	900 U	2170 U	91	150	130	150	190	34 J	73	150	92	82	110	66
4-Nitroaniline	2030 U	2250 U	5440 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
4,6-Dinitro-2-methylphenol	2030 U	2250 U	5440 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
N-Nitrosodiphenylamine	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
4-Bromophenyl-phenylether	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Hexachlorobenzene	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Pentachlorophenol	2030 U	2250 U	5440 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Phenanthrene	295 J	368 J	598 J	650	2990	2030	2970	1310	220	1660	990	630	590	1070	590
Anthracene	158 J	266 J	235 J	190	230	160	140	190	75	680	390	200	190	210	180
Carbazole	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Di-n-butylphthalate	434 JB	603 JB	592 JB	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Fluoranthene	1090	1590	1720 J	960	3000	2450	3330	2370	320	2480	1400	1020	1000	1420	1060
Pyrene	533 J	1190	1100 J	1100	2310	410	340	2230	300	2720	1620	1160	1130	1750	1180
Butylbenzylphthalate	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
3,3'-Dichlorobenzidine	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Benzo(a)anthracene	382 J	633 J	705 J	700	290	1220	1280	1040	560	1870	1030	720	720	980	710
Chrysene	426 J	621 J	798 J	480	210	980	1060	770	380	1120	670	470	490	630	260
bis(2-Ethylhexyl)phthalate	6160 B	7250 B	9250 B	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Di-n-octylphthalate	811 U	900 U	2170 U	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Benzo(b)fluoranthene	637 J	848 J	1130 J	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Benzo(k)fluoranthene	212 J	275 J	426 J	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Benzo(a)pyrene	389 J	587 J	752 J	520	91	820	830	690	380 J	170	820	220	210	710	190
Indeno(1,2,3-cd)pyrene	233 J	264 J	444 J	280 J	63	570	590	460 J	240 J	58	170	96	93	420	68
Dibenzo(a,h)anthracene	92.4 J	900 U	2170 U	130 J	37 J	250 J	280 J	180 J	100 J	32	98	53	49	180 J	37
Benzo(g,h,i)perylene	271 J	261 J	489 J	340	69	620	640	500	260 J	57	200	100	100	520	69

exposure. Groundwater will also be considered further separately as a part of the Keyspan parcel, and any further remedial action would supplement the institutional controls for the site.

Several VOCs were found in soil vapor, and three were present in concentrations above NYSDOH air guideline values. While there are currently no buildings on the Site, there is the potential that if buildings were constructed in the future, soil gas migration could occur into such buildings. Therefore, while a current exposure pathway does not exist, there is a potential exposure pathway in the future.

3.7 REMEDIAL INVESTIGATION AND EXPOSURE ASSESSMENT CONCLUSIONS

Data obtained from previous site environmental investigations and remedial actions, as summarized in the preceding Sections and presented in detail in the RI Report, have resulted in a well developed understanding of contaminant distribution within the Brooklyn Navy Yard parcel. The key observations and conclusions from these investigations, relating to the evaluation of remedial alternatives, are as follows:

PCBs are present at concentrations above cleanup criteria within and immediately adjacent to former Building 419, Former Drum Storage Area B and a small portion of the Railroad Siding Area. The horizontal and vertical extent of PCBs above criteria has been fully defined at Former Building 419. At the Former Drum Storage Area B, the extent of PCB concentrations above cleanup criteria is delineated within the site to the north and extends to the property line where a paved roadway, which predates the use of the location for drum storage, provides a logical boundary, that would be delineated as a part of remedy implementation activities. PCB concentrations above cleanup criteria within the Railroad Siding Area are delineated similarly to the Former Drum Storage Area B and would be further delineated as part of remedy implementation activities.

- Lead concentrations above TAGM and Part 375-6 unrestricted use cleanup criteria are observed at a number of locations across the site. Elevated lead concentrations do not appear to have any obvious spatial distribution and are within the range observed for historic fill. Similarly variable distributions are observed of concentrations of other metals such as arsenic and copper above cleanup criteria, yet within the typical range for historic, urban fill. Elevated levels of these metals are most likely related to the historic, urban fill used to raise the site above mean sea level as opposed to subsequent site activities. Two samples in Former Drum Storage Area A exceeded the TCLP criterion for lead.

- SVOCs, specifically several PAHs at concentrations above TAGM 4046, Part 375-6 unrestricted use, and Part 375-6 commercial criteria, were also observed throughout the site. These values do not display clear patterns in distribution horizontally or with depth. Concentrations were consistent with those observed in urban fill. The distribution and concentrations observed supports the interpretation that the source of these SVOCs is not historic site activity but the historic fill used to create the site.

- Detectable concentrations of BTEX compounds, as well as several other VOCs, were observed in soil gas vapor samples. The reported BTEX compounds are consistent with the generally low VOC concentrations observed in soil and groundwater at the site, and the observed use of a majority of the site for vehicle and construction material storage. Soil gas exposure controls will be incorporated into remedial actions, as necessary.

- Sediment sampling in the barge basin adjacent to the site yielded concentrations of SVOCs and metals consistent with or lower than those observed in samples previously collected from the center of the barge basin and typical of what would be expected in urban waterways. These data do not show a correlation with contamination from the Site, although based on the Site characterization data, the potential exists that constituents present on site could have contributed to the character of the urban waterways. While the data do not indicate that a specific remedial action objective is warranted for sediments and surface water, to the extent that remedies are evaluated that would control constituents that may remain on Site (e.g., urban fill), the potential for future releases to sediments or surface water would also be controlled.

- Groundwater at the site was observed to have levels of a small number of metals, SVOCs and one VOC moderately elevated above NYSDEC criteria, consistent with the urban fill material and the nature of the Site. Overall, groundwater quality was consistent with the conclusion that direct groundwater impacts (i.e., from past activities) are restricted to the Keyspan operable unit. Groundwater in New York State, in general, is classified as GA, suitable for potable use. And, therefore, while groundwater within the urban fill is not considered useable, use restrictions are considered in the FS to address groundwater at the site. Groundwater associated with the Keyspan parcel will be evaluated as a separate operable unit.

- Potential exposure to soils is a complete pathway and potential exposure to soil vapor is a potential future complete pathway. Potential exposure to groundwater is currently considered an incomplete pathway, has limited potential to be a complete pathway in the future, but could be addressed through institutional controls, and groundwater will be investigated further as a part of the Keyspan parcel.

3.8 AREAS AND VOLUMES OF CONTAMINATED SOIL

Estimates of areas and volumes of contamination have been developed for use in the evaluation of remedial alternatives. As stated above in Section 3.6, remedial alternatives will be developed for the contaminated soil found on the Site. As shown on Figures 3-1, 3-2, 3-3, and 3-4, the extent of contamination on the Site varies depending on the cleanup criteria selected. Areas and volumes of contaminated soil were calculated for the TAGM 4046/Part 375-6 unrestricted use criteria (Figures 3-1 and 3-2), for the historic fill screening, and the Part 375-6 commercial criterion for PCBs (Figure 3-3). Area and volume calculations for the Part 375-6 commercial criteria (all constituents as shown on Figure 3-3) are not materially different than the TAGM 4046 or Part 375 unrestricted use calculations, and therefore, the same numbers are used for both sets of cleanup criteria. A summary of the areas and volumes for these three cases is then as follows:

- TAGM 4046/Part 375-6 unrestricted use criteria: The area of impacted soil was calculated based on the limits of the property boundary and the mid-point between borings above and below the criteria for the various constituents. The volume was calculated using the deepest measured exceedances at a particular soil measurement location or to a maximum of the depth of the groundwater table (i.e., approximately 6 ft). In adjacent locations where the depths of exceedances were similar, or in areas containing adjacent borings to different total depths, the boring with the deepest recorded exceedances was used as the depth for the group. Table 3-5 presents the borings used to calculate the volume of impacted soil and includes the representative depths applied to each boring for volume calculation. The areas over which the depth is applied to generate the volume calculation are presented graphically in Appendix A, along with the details of the volume calculation. The total area and volume of impacted soil from the above calculation is then as follows:

Area: 5.6 Acres
Volume: 39,900 Cubic Yards (CY) in place

Historic fill screening: The historic fill screening areas are limited to the PCB contamination around Former Building 419, Former Drum Storage Area B, and a limited portion of the Former Railroad Siding Area. In addition, the area of lead above TCLP lead criteria is included at Former Drum Storage Area A, as this soil would be classified as a hazardous waste. The area was calculated from the mid-point between borings above and below the PCBs (>1 mg/kg 0-2', >10 mg/kg >2') and TCLP lead (>5 mg/l in extract) criteria. Table 3-6 presents the borings used to calculate the volume of PCB and TCLP-lead contamination and includes the representative depths applied to each boring for the volume calculation. Areas and the details of the volume calculations are again presented in Appendix A. The total area and volume of impacted soil from the above calculations are as follows:

Former Building 419:
Area: 1,550 Square Feet (SF)
Volume: 120 CY in place

Former Drum Storage Area A:
Area: 170 SF
Volume: 13 CY in place

Former Drum Storage Area B:
Area: 2,700 SF
Volume: 300 CY in place

Railroad Siding Area:
Area: 8,000 SF
Volume: 590 CY in place

Table 3-5. Sample Location/Depths Used in Volume Calculations
Feasibility Study - Brooklyn Navy Yard Parcel

Sample Location	> TAGM (ft)	>Part 375 Unrestricted (ft)	> Part 375 Commercial (ft)	Depth Used for Volume Calculation (ft)
DSASS-1	> 0.25	> 0.25		6
DSASS-2	> 0.25	> 0.25		6
DSASS-3	> 0.25	> 0.25		6
TP101-1	6.3 - 7	6.3 - 7	6.3 - 7	6
SSI-DSA-1	1.75 - 2	1.75 - 2	1.75 - 2	6
SSI-DSA-2	1 - 1.2	1.75 - 2	1 - 1.2	6
DSBSS-1	> 0.25	> 0.25	0 - 0.25	4.5
DSBSS-2	> 0.25	> 0.25	0 - 0.25	4.5
DSBSS-3	> 0.25	> 0.25		4.5
TP102	3.7 - 4.5	3.7 - 4.5	0 - 0.2	4.5
SSI-DSB-1	3.75 - 4	3.75 - 4	3.75 - 4	4.5
SSI-DSB-2	3.75 - 4	3.75 - 4	3.75 - 4	4.5
SSI-DSB-3	3.75 - 4	3.75 - 4	3.75 - 4	4.5
SSI-DSB-4	3.75 - 4	3.75 - 4	1.75 - 2	4.5
SSI-DSB-5	3.75 - 4	3.75 - 4	1.75 - 2	4.5
SSI-DSB-6	3.75 - 4	3.75 - 4	1 - 1.2	4.5
TP104	5 - 5.5	5 - 5.5	5 - 5.5	5.5
TP105	0 - 0.2	0 - 0.2		6
MW6SR	8 - 10	8 - 10		6
MW6D	11 - 14	11 - 14		6
SS9	1 - 1.2	1 - 1.2	1 - 1.2	6
SS10	1 - 1.2	1 - 1.2	0 - 0.25	6
SS11	1 - 1.2	1 - 1.2	1 - 1.2	2
SS12	1 - 1.2	1 - 1.2	1 - 1.2	1.2
SSI-MW6-1	6 - 6.25	6 - 6.25	3.75 - 4	6
SSI-MW6-2	6 - 6.25	3.75 - 4	1 - 1.2	6
SSI-MW6-3	6 - 6.25	6 - 6.25	1.75 - 2	6
SSI-SS11-1	1.75 - 2	1.75 - 2		2
SSI-SS11-2*		0 - 0.25		6
SSI-SS11-3	3.75 - 4	3.75 - 4	3.75 - 4	4
SSI-SS11-5	6 - 6.25	6 - 6.25	3.75 - 4	6
SSI-SS9-1	6 - 6.25	6 - 6.25	6 - 6.25	6
SSI-SS9-2	6 - 6.25	6 - 6.25	6 - 6.25	6
SSI-SS9-3	6 - 6.25	3.75 - 4	3.75 - 4	6
TP103	7.5	7.5		6
TP106	5.4 - 6.4	5.4 - 6.4	1.3 - 1.5	6
TP107	2.5 - 3	2.5 - 3	2.5 - 3	3
TP108	1.3 - 1.5	1.3 - 1.5	1.3 - 1.5	1.5
MW4SR	4 - 6	4 - 6		6
MW4DR	15 - 16	15 - 16		6
MW5SR	14 -16	14 -16	0 - 0.2	6
MW12S	2 - 10	2 - 10	0 - 0.2	6
MW12D	15.5 - 18	15.5 - 18		6
SSI-419-1	1.75 - 2	2.75 - 3	1.75 - 2	4
SSI-419-2	*1.75 - 2*	2.75 - 3	1.75 - 2	4
SSI-419-3	3.75 - 4	3.75 - 4	3.75 - 4	4
SSI-419-5	3.75 - 4	3.75 - 4	3.75 - 4	4

Table 3-5. Sample Location/Depths Used in Volume Calculations
Feasibility Study - Brooklyn Navy Yard Parcel

Sample Location	> TAGM (ft)	>Part 375 Unrestricted (ft)	> Part 375 Commercial (ft)	Depth Used for Volume Calculation (ft)
SSI-419-7	3.75 - 4	3.75 - 4	3.75 - 4	4
SSI-419-9	3.75 - 4	3.75 - 4		4
SSI-419-11	3.75 - 4	3.75 - 4	3.75 - 4	4
SSI-419-13	6 - 6.25	6 - 6.25	1.75 - 2	6
SSI-419-14-SB4	6 - 6.25	6 - 6.25	1.75 - 2	6
SSI-419-15	1.75 - 2	1.75 - 2	1 - 1.2	2
SSI-419-16	3.75 - 4	3.75 - 4	1 - 1.2	4
SSI-MW12-4	1 - 1.2	1 - 1.2	1 - 1.2	6
SSI-MW5-1*		1 - 1.2		6
SSI-MW5-2	3.75 - 4	3.75 - 4	3.75 - 4	4
SSI-MW5-3	1 - 1.2	1.75 - 2**	1 - 1.2	1.2
419SS-1	0 - 0.25	1 - 1.2	0 - 0.25	4
419SS-2	1 - 1.2	1 - 1.2	1 - 1.2	4
419SS-3	1 - 1.2	1 - 1.2	1 - 1.2	4
419SS-4	1 - 1.2	1 - 1.2	1 - 1.2	4
419SS-5	1 - 1.2	1 - 1.2	1 - 1.2	4
419SS-6	0 - 0.25	1 - 1.2	0 - 0.25	4
419SS-7	0 - 0.25	1 - 1.2	0 - 0.25	4
419SS-9	0 - 0.25	0 - 0.25	0 - 0.25	4
419SS-10	0 - 0.25	1 - 1.2	0 - 0.25	4
419SS-11	1 - 1.2	1 - 1.2	1 - 1.2	4
419SS-12	1 - 1.2	1 - 1.2	1 - 1.2	4
419SS-13	1 - 1.2	1 - 1.2	1 - 1.2	4

(1) Locations denoted with * were tested for lead only, but were adjacent to areas with SVOCs > criteria. Areas for these borings are assumed to be excavated to 6ft.
(2) Where concentration > criteria is below water table, excavation assumed to depth of water table, approximately 6 ft below grade.
(3) Sample SSI-MW5-3 - for lead impact to groundwater only.

Table 3-6. Sample Location/Depths Used in Volume Calculations
PCBs > Site-Specific Criteria and Lead > TCLP Criterion
Feasibility Study - Brooklyn Navy Yard Parcel

Sample Location	> Site Specific (ft)	Depth Used for Volume Calculation (ft)
SSI-SS11-3	1 – 1.2	2
G2SS-7D	1 – 1.2	2
G2SS-8D	1 – 1.2	2
GS22-9D	1 – 1.2	2
DSASS-2 *	> 0.25	2
TP101-1 *	1 - 1.2	2
DSBSS-2	0 - 0.2	3
TP102	0 - 0.2	3
SSI-DSB-2	1.75 - 2	3
SSI-DSB-5	0.5 - 0.75	3
SSI-DSB-6	0.5 - 0.75	3
SSI-419-1	1.75 - 2	3
SSI-419-25	1 - 2	3
419SS-1	0 - 0.25	1
419SS-2	1 - 1.2	2
419SS-3	1 - 1.2	2
419SS-4	1 - 1.2	3
419SS-5	1 - 1.2	2
419SS-6	0 - 0.25	3
419SS-7	0 - 0.25	3
419SS-9	0 - 0.25	1
419SS-10	0 - 0.25	3
419SS-11	1 - 1.2	3
419SS-12	1 - 1.2	2
419SS-13	1 - 1.2	3

(1) Locations denoted with * represent lead >TCLP criterion, all other locations are for PCBs > criteria.

- Restoration of PCBs to Part 375-6 Commercial Criteria: The restoration of PCBs to Part 375-6 commercial criteria would apply to areas around Former Building 419, Former Drum Storage Area B and a portion of the Former Railroad Siding Area. If one were to apply the unrestricted use criterion (100 ppb) to assess pre-release conditions, the calculation would simply revert to that shown above for TAGM 4046 and Part 375-6 unrestricted use criteria. Therefore, to provide an alternative means of assessment considering the commercial use of the property, the calculation is performed by comparison to the Part 375-6 commercial criterion for PCBs (1 ppm any depth). In addition, the area of lead above TCLP lead criteria is included in the calculation for Former Drum Storage Area A, based on the rationale discussed above. The area was calculated from the mid-point between borings above and below the 1 ppm PCB and/or 5 ppm TCLP-lead criteria. Table 3-7 presents the borings used to calculate the volume of PCB contamination and includes the representative depths applied to each boring for the volume calculation. Areas and the details of the volume calculations are again presented in Appendix B. The total area and volume of impacted soil from the above calculations are as follows:

Former Building 419:

Area:	1,550 Square Feet (SF)
Volume:	130 CY in place

Former Drum Storage Area A:

Area:	170 SF
Volume:	13 CY in place

Former Drum Storage Area B:

Area:	4,700 SF
Volume:	690 CY in place

Railroad Siding Area:

Area:	8,000 SF
Volume:	890 CY in place

Table 3-7. Sample Location/Depths Used in Volume Calculations
PCBs > Part 375-6 Commercial Criteria
Feasibility Study - Brooklyn Navy Yard Parcel

Sample Location	> Criteria (ft)	Depth Used for Volume Calculation (ft)
419SS-1	0 - 0.25	1
419SS-9	0 - 0.25	1
419SS-2	1 - 1.2	2
419SS-3	1 - 1.2	2
419SS-4	1 - 1.2	3
419SS-5	1 - 1.2	3
419SS-6	1 - 1.2	3
419SS-7	1 - 1.2	3
419SS-10	0 - 0.25	3
419SS-11	1 - 1.2	3
419SS-12	1 - 1.2	3
419SS-13	1 - 1.2	3
SSI-419-1	1.75 - 2	3
SSI-419-2	1.75 - 2	3
DSBSS-2	0 - 0.25	4
TP102	0 - 0.2	4
SSI-DSB-1	> 4	4
SSI-DSB-2	1.75 - 2	4
SSI-DSB-5	1 - 1.2	4
SSI-DSB-6	0.5 - 0.75	4
G2SS-7D	1 - 1.2	3
G2SS-8D	1 - 1.2	3
G2SS-9D	1 - 1.2	3
SSI-SS11-3	1 - 1.2	3
DSASS-2 *	> 0.25	2
TP101-1 *	1 - 1.2	2

(1) Locations denoted with * represent lead >TCLP criterion, all other locations are for PCBs > criteria.

4.0 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs), as stated in the NYSDEC Technical Guidance for Site Investigation and Remediation (DER-10), are medium-specific cleanup objectives for the protection of public health and the environment and are developed based on contaminant-specific criteria applicable to the site. The conclusions of the site investigation work are the primary basis for development of the RAOs, as presented in the RI Report and summarized in Section 3. Specifically, the conclusions relevant to development of the RAOs are as follows:

- Potential exposure to soils with constituents present above relevant criteria, via direct contact (i.e., dermal absorption, ingestion or inhalation) is considered a complete pathway. Constituents found in soils above applicable criteria include metals, PCBs, and SVOCs – principally PAHs.

- With the exception of PCBs and one area where lead concentrations were found above TCLP criteria, the constituents found above applicable criteria are typical of historic, urban fill.

- The exposure pathway for groundwater is currently considered incomplete, as groundwater beneath the Site is not useable as a potable supply and there are no surface manifestations of groundwater that would allow for direct contact. Groundwater in New York State, in general, however, is classified as GA, suitable for potable use. Furthermore, groundwater will be addressed as part of the Keyspan parcel operable unit.

- While currently constituents detected in soil vapor, above NYSDOH guidance values, do not present a complete exposure pathway because of the absence of buildings, a potential exposure pathway exists in the future, if buildings are constructed on-site.

Based on the above, the remedial action objectives that will be used to guide the development and evaluation of remedial alternatives, and selection of a remedy for the Brooklyn Navy Yard parcel are as follows:

- Direct contact control for soils to eliminate the complete pathway for metals, PCBs, and SVOCs found above criteria.

- Control of the potential for future exposure to soil vapor, because of the potential for a complete exposure pathway in the future.

- Use of institutional controls for groundwater to maintain an incomplete exposure pathway for groundwater, and pending completion of the groundwater work that will be performed for the Keyspan parcel.

As described in Section 3.2.5 and as noted above, site-wide exceedances of relevant criteria for various constituents are a result of the occurrence of historic, urban fill at the Site. The presence of historic urban fill should be considered when assessing the ability to address soil contamination in a practicable and meaningful manner.

5.0 STANDARDS, CRITERIA, GUIDANCE

Standards, Criteria, and Guidance (SCGs) are defined as promulgated requirements (standards and criteria) and non-promulgated guidance, which may apply to site characterization and remediation. SCGs as defined in the NYSDEC inactive hazardous waste site program also incorporate the Federal CERCLA concept of applicable, relevant, or appropriate requirements (ARARs) and to be considered (TBCs) non-enforceable criteria and guidance. Unless otherwise indicated for good cause, the expectation in the development of remedial alternatives is that they would comply with SCGs. SCGs may be applicable to the constituent(s) of interest (chemical specific), location of the remedial action (location specific), or the type of remedial action (action specific).

This section discusses the SCGs for the Brooklyn Navy Yard Site. Federal, State, and local environmental regulations, laws, and guidance are considered. The Federal, State and local SCGs presented in this section are used for screening and evaluating remedial alternatives.

Standards and criteria are cleanup standards and requirements promulgated under Federal, State, and/or local environmental laws that specifically address a constituent of concern, remedial action or location of the site. Guidance refers to cleanup standards and requirements that may not be specifically promulgated under Federal, State, and/or local environmental laws or that may not be directly applicable to constituents or actions, but may be useful as guidance for a particular constituent or action.

As noted above, SCGs fall into three general categories, which are determined on the basis of how they are applied to the site. These categories are as follows:

- Chemical-specific: These SCGs define cleanup goals for specific constituents in an environmental medium. An example of a chemical-specific SCG is the Part 375 soil cleanup criteria.

- Location-specific: These SCGs set restrictions on remedial activities at a site due to its proximity to specific natural or man-made features. An example of a location-specific SCG would be endangered and threatened species regulations, assuming the site contains habitat for endangered and threatened species.

- Action-specific: These SCGs set controls and restrictions on the remedial action to be used at the site. Each remedial action will be governed by appropriate action-specific SCGs that will specify performance standards for the remedial action. A SPDES permit to discharge to groundwater is an example of an action-specific SCG, which would apply to an action such as re-injection of groundwater following ex-situ treatment.

The chemical, location, and action-specific SCGs for the Brooklyn Navy Yard parcel are presented in Table 5-1.

Table 5-1. Site–Specific Standards, Criteria, and Guidance (SCGs)
Brooklyn Navy Yard Parcel Feasibility Study

Standard, Criteria, or Guidance	Citation or Reference	Type	Description	Status	Comments
FEDERAL					
Air: Clean Air Act	42 USC 7401, Section 112	Action specific	Establishes limits on emissions to atmosphere from industrial and commercial activities.	Standard/ Criteria	Applicable to remedial actions that may emit to the air.
National Ambient Air Quality Standards (NAAQS)	40 CFR Part 50	Action specific	Establishes primary and secondary NAAQS under Section 109 of the Clean Air Act	Standard/ Criteria	Applicable to remedial actions that may emit to the air.
National Emission Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR Part 61	Action specific	Establishes limits on hazardous emission to atmosphere	Standard/ Criteria	Sets requirements for public exposure to airborne emissions.
Groundwater: Underground Injection Control Program	40 CFR Part 146	Action specific	Establishes technical criteria and standards for underground injection wells.	Standard/ Criteria	Applicable for remedial activities that include discharge to groundwater.
Soil: Toxic Substances Control Act	40 CRF Part 761.61	Chemical specific	Establishes cleanup and disposal guidance for PCB remediation waste.	Standard/ Criteria	Applicable for selected remedial technologies.
EPA Region 9 Preliminary Remediation Goals (PRGs)	EPA Region 9 PRGs	Chemical specific	Establishes risk-based tolls for evaluation and cleanup of contaminated sites.	Guidance	Relevant and appropriate for screening of site contaminants for comparison against other risk-based criteria.
Surface Water: Clean Water Act (CWA)	33 USC 1251 et. Seq.	Action specific	Sets standards for the restoration and maintenance of chemical, physical and biological characteristics of surface water.	Standard/ Criteria	Applicable if remedial activities include discharge to surface water.
Coastal Zone: Floodplain Management	Executive Order No. 11988	Location specific	Requires Federal agencies to evaluate the potential effects of actions it may take in a floodplain to avoid adversely impacting floodplains whenever possible.	Standard/ Criteria	Applicable to remedial actions that affect floodplains.
Coastal Zone Management Act	16 USC 1451, Section 302	Location specific	Establishes state programs to preserve, protect, develop, and restore or enhance resources of the Nations' coastal zone.	Standard/ Criteria	Applicable for selected remedial technologies.

Table 5-1. Site–Specific Standards, Criteria, and Guidance (SCGs)
Brooklyn Navy Yard Parcel Feasibility Study

Standard, Criteria, or Guidance	Citation or Reference	Type	Description	Status	Comments
Fish and Wildlife: Fish and Wildlife Coordination Act	16 USC 661	Action specific	Provides procedures for consultation between agencies to consider wildlife conservation during water resource related projects.		Applicable to remedial actions that involve the off-site transportation of hazardous waste.
Hazardous Waste: RCRA – Part 260 General Hazardous Waste Management System Regulations	40 CFR Part 260	Action specific	Provides definitions of terms and general standards applicable to hazardous waste management system regulations.	Standard/ Criteria	Applicable if remedial activities include the management of hazardous waste.
RCRA – Part 268 Land Disposal Restrictions	40 CFR Part 268	Action specific	Defines the land disposal requirements for hazardous wastes	Standard/ Criteria	Applicable if remedial activities include the disposal of hazardous waste.
RCRA – Part 261 Identification and Listing of Hazardous Waste	40 CFR Part 261	Chemical specific and action specific	Defines those solid wastes, which are subject to regulation as hazardous wastes, and lists specific chemical and industry-source wastes.	Standard/ Criteria	Applicable to determining whether wastes are hazardous under RCRA.
Transportation of Hazardous Wastes	49 CFR Part 105 – 180 and 40 CFR Part 263	Action specific	Provides the requirements for the transportation of hazardous wastes.	Standard/ Criteria	Applicable if remedial activities include the off-site treatment or disposal of hazardous wastes.
Disposal and Treatment of Hazardous Waste	40 CFR 264 - 265	Action specific	Provides the requirements for owners and operators of hazardous waste treatment, disposal and storage facilities	Standard/ Criteria	Applicable if remedial activities include the treatment or disposal of hazardous wastes.
STATE OF NEW YORK					
Air: Air Quality Standards	6 NYCRR Part 257	Chemical specific and action specific	Establishes standards for air emissions.	Standard/ Criteria	Applicable to remedial activities that discharge to the atmosphere.
Control of Toxic Ambient Air Containments	DAR-1	Chemical specific	Provides guidance for the control of toxic ambient air containments.	Guidance	Applicable to remedial activities that discharge to the atmosphere.
Fugitive Dust	TAGM 4031	Action specific	Provides procedures for fugitive dust during remedial actions at hazardous waste sites	Guidance	Applicable for selected remedial technologies.

Table 5-1. Site–Specific Standards, Criteria, and Guidance (SCGs)
Brooklyn Navy Yard Parcel Feasibility Study

Standard, Criteria, or Guidance	Citation or Reference	Type	Description	Status	Comments
Groundwater and Surface Water: Surface water and groundwater standards	6 NYCRR Part 700-706	Chemical specific and action specific	Establishes water quality standards for surface water and groundwater	Standard/ Criteria	Applicable if remedial activities include discharge to surface water or groundwater.
State Pollutant Discharge Elimination System (SPDES)	6 NYCRR Part 750 - 758	Action specific	Establishes regulations to the control of stormwater discharges and establishment of soil and sediment erosion standards.	Standard/ Criteria	Applicable for selected remedial technologies, which may involve a discharge to surface water for a specific remedial alternative.
Ambient Water Quality Standards and Guidance Values	TOGS 1.1.1	Chemical specific	Establishes groundwater and surface water quality criteria	Guidance	Applicable if remedial activities include discharges to groundwater or surface water.
Groundwater Effluent Limitations Guidance	TOGS 1.1.2	Action specific	Provides guidance on groundwater effluent limitations for where there are no standards of regulatory effluent limitations	Guidance	Applicable if remedial activities include discharge to groundwater.
New Discharges to POTWs	TOGS 1.3.8	Action specific	Provides guidance for evaluating the potential effects of new non-domestic discharge to Publicly Owned Treatment Works (PTOW)	Guidance	Applicable if remedial activities include discharge to sewer system.
Underground Injection / Recirculation (UIR) at Groundwater Remediation Sites	TOGS 2.1.2	Action specific	Provides guidance to applicability of SPDES permits and groundwater effluent standards to UIR systems	Guidance	Applicable if remedial activities include re-injection or groundwater recirculation
Soil: Inactive Hazardous Waste Disposal Sites– Part 375	6 NYCRR Part 375	Action specific and chemical specific	Establishes remedial program soil cleanup criteria and other requirements of site remediation programs	Standard/ Criteria	Applicable for selected remedial technologies.
Selection of Remedial Actions At Inactive Hazardous Waste Sites	TAGM 4030	Action specific	Provides guidance on the inactive hazardous waste site remediation program remedy selection process	Guidance	Applicable to the Site for general guidance on remedy selection
Interim Remedial Measures	TAGM 4042	Action specific	Provides guidance on implementation of IRMs	Guidance	Applicable to IRM under consideration at specific site area.
Determination of Soil Cleanup Objectives and Cleanup Levels	TAGM 4046	Chemical specific	Establishes soil cleanup criteria for inactive hazardous waste sites	Guidance	Applicable for selected remedial technologies.

Table 5-1. Site–Specific Standards, Criteria, and Guidance (SCGs)
Brooklyn Navy Yard Parcel Feasibility Study

Standard, Criteria, or Guidance	Citation or Reference	Type	Description	Status	Comments
Coastal Zone: Waterfront Revitalization of Coastal Areas and Inland Waterways	19 NYCRR Part 600	Location	Establishes policy to evaluate local Waterfront Revitalization Programs	Standard/ Criteria	Applicable for selected remedial technologies.
Costal Erosion Management	6 NYCRR Part 505	Location specific	Establishes standards for issuance of coastal erosion management permits.	Standard/ Criteria	Applicable to selected remedies which may involve soil movement and/or construction in coastal areas.
Fish and Wildlife: Endangered and Threatened Species	6 NYCRR 182	Location specific	Identifies endangered and threatened spices and species or special concern	Standard/ Criteria	Applicable to remedial activities that may affect endangered or threatened spices.
Hazardous Waste: Listing of Hazardous Substances	6 NYCRR Part 371, 597	Chemical specific	Defines those solid wastes, which are subject to regulation as hazardous wastes, and lists specific chemical and industry-source wastes.	Standard/ Criteria	Applicable to selected remedies.
Hazardous waste manifest system	6 NYCRR Part 372	Chemical specific and action specific.	Establishes hazardous waste tracking and record keeping requirements	Standard/ Criteria	Applicable if remedial activities include the off-site treatment or disposal of hazardous wastes.
Hazardous Waste Handling	6 NYCRR Part 598	Chemical specific and action specific.	Establishes hazardous waste handling and storage regulations.	Standard/ Criteria	Applicable if remedial activities include the off-site treatment or disposal of hazardous wastes.
Land Disposal Restrictions	6 NYCRR Part 376	Chemical specific and action specific	Identifies hazardous waste restricted from land disposal.	Standard/ Criteria	Applicable if remedial activities include the off-site treatment or disposal of hazardous wastes within New York State.
Disposal and Treatment of Hazardous Waste	6 NYCRR Part 373	Chemical specific and action specific	Provides the requirements for owners and operators of hazardous waste treatment, disposal and storage facilities	Standard/ Criteria	Applicable if remedial activities include the treatment or disposal of hazardous wastes within New York State.
Other: Disposal of Drill Cuttings	TAGM 4032	Action specific and Chemical Specific	Provides for procedures for the handling of drill cuttings during installation of wells at a Class 2 inactive hazardous waste site.	Guidance	Applicable if remedial activities that include installation of wells.
Drilling Procedures	6 NYCRR Part 554	Action specific	Provides procedures for drilling to prevent pollution.	Standard/ Criteria	Applicable if remedial activities include installation of wells.

Table 5-1. Site–Specific Standards, Criteria, and Guidance (SCGs)
Brooklyn Navy Yard Parcel Feasibility Study

Standard, Criteria, or Guidance	Citation or Reference	Type	Description	Status	Comments
Noise	6 NYCRR Part 450	Action specific	Establishes noise standards for heavy motor vehicles.	Standard/ Criteria	Applicable to selected remedies.
Technical Guidance for Site Investigation and Remediation	DER – 10	Action specific	Specifies requirements for remedial actions within New York	Guidance	Provides guidance on the various aspects of New York State's environmental remediation program from site characterization through remedy implementation.
Final Guidance for Evaluation of Soil Vapor Intrusion in the State of New York	NYSDOH	Chemical and action specific	Provides guidance on the investigation and mitigation of soil vapor intrusion in New York State	Guidance	Applicable if buildings are constructed on site.
CITY OF NEW YORK					
Other: Construction Noise	RCNY, Title 15, Ch. 28	Action specific	Establishes construction noise limits and requires development of noise mitigation plan.	Standard/ Criteria	Applicable to selected remedies.
Waterfront Revitalization Program	Rules of City of New York, Title 62, Ch. 2	Location specific	Establishes evaluating actions in coastal zones to maximize environmental preservation.	Standard/ Criteria	Applicable to selected remedies.

6.0 GENERAL RESPONSE ACTIONS

General response actions are broad categories of remedial response that may meet the remedial action objectives and provide technologies applicable to site-specific characteristics. The general response actions that could be applicable to the Brooklyn Navy Yard parcel are as follows:

- No action
- Limited action/institutional controls)
- Containment
- Removal
- In-situ or ex-situ treatment
- Disposal
- Discharge

Each of these general response actions and their applicability to the Site are described below

6.1 NO ACTION

The no action general response action would not include any future activity or continuation of any existing activities (e.g., institutional controls). No action is typically retained as a baseline for comparison with other alternatives and is retained as such for this FS.

6.2 LIMITED ACTION/INSTITUTIONAL CONTROLS

The limited action general response action would include institutional controls (i.e., environmental easement) that would be a mechanism for implementation of various restrictions on the site (e.g., potential future use of groundwater). Such institutional controls would also provide the mechanism for future vapor intrusion control, if buildings were to be constructed. Institutional controls are retained in this FS because they can be a component of many alternatives as well as a stand alone alternative.

6.3 CONTAINMENT

The purpose of the containment general response action is to isolate site-related constituents in soil from the surrounding environment. A technology that could be considered under this general response action includes capping. The containment general response action is applicable to the site soil and, therefore, is retained for further analysis in this FS.

6.4 REMOVAL

The general response of removal typically involves active management of contaminated media, such as excavation of soils. The removal general response would meet remedial action objectives, for example, by excavating the contaminated site soils and transporting them off-site, which would control exposure, and therefore, is retained for further analysis in this FS.

6.5 IN-SITU OR EX-SITU TREATMENT

The general response action of treatment, whether in-situ or ex-situ, typically involves the application of any number or physical, chemical, or biological methods for treatment of site-related constituents in soil. Treatment technologies are potentially applicable to a variety of the constituents of interest at the Site. For instance, lead may be treated by solidification/ stabilization, and therefore, this general response action is retained for further analysis in this FS.

6.6 DISPOSAL

The general response action of disposal involves the means by which contaminated materials (soils or groundwater) are managed in accordance with relevant treatment standards. For example, disposal for soil may include landfilling at a permitted facility. Disposal is a necessary component of removal technologies, and to some extent ex-situ treatment technologies, and therefore, is retained for further analysis in this FS.

6.7 DISCHARGE

The general response action of discharge involves the means by which treated groundwater can be released to the environment in accordance with relevant treatment standards. Typical discharge options include reinjection to groundwater, discharge to surface waters, or discharge to a publicly owned treatment works. As previously stated, groundwater will be addressed as part of the Keyspan parcel, or through institutional controls as relates to the urban fill, and therefore discharge is eliminated as a general response action for the site. To the extent that discharge may be a component of an ex-situ or in-situ treatment technology potentially applicable to the site soils (e.g., flushing), such discharges would be addressed under the applicable treatment technology.

In summary, the retained and eliminated general response actions are as follows:

Retained GRAs	Eliminated GRAs
No Action	Discharge
Limited Action/Institutional Controls	
Containment	
Removal	
In-Situ or Ex-Situ Treatment	
Disposal	

Section 7 that follows, next identifies various technologies within the retained general response actions, and screens these technologies further for development of remedial action alternatives that will address the remedial action objectives for the Brooklyn Navy Yard parcel.

7.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

As described in Section 6, the following general response actions have been retained for the Brooklyn Navy Yard parcel:

- No action
- Limited Action/Institutional Controls
- Containment
- Removal
- In-situ/Ex-situ treatment
- Disposal

This section presents the process of identifying and screening technologies within each of the general response actions, which are potentially applicable to the remediation of the Site. Table 7-1 presents the technologies considered within each of these general response actions (except for no action, which does not have associated technologies). In addition, Table 7-1 presents a summary of the screening of these technologies against the criteria of effectiveness, implementability and cost, as a means to generate a list of practicable technologies to be used in the development of alternatives. The three screening criteria were applied as follows:

- Effectiveness – This criterion is used to assess the ability of a technology to meet the remedial objectives. Effectiveness is measured against meaningful goals such as the ability to control potential exposure pathways. Effectiveness also considers the nature of a technology (e.g., proven, reliable) and its applicability to site constituents and conditions. In addition, technologies which have been identified as presumptive\proven remedial technologies by the NYSDEC Division of Environmental Remediation (DER) are noted.

- Implementability – This criterion is used to assess the overall feasibility of implementing a technology (i.e., availability, difficulty of implementing, schedule, and administrative considerations).

- Cost – This criterion is used as a balancing factor among technologies of similar effectiveness and implementability. Cost is evaluated on a relative scale (i.e., low, moderate, or high by comparison to other similar technologies).

Table 7-1 presents the results of the technology screening. As shown in Table 7-1, after applying the above three screening criteria, the following technologies have been retained for consideration in developing alternatives:

- No action (as a baseline for comparison)
- Institutional controls
- Capping
- Sub-slab depressurization (vapor intrusion control)
- Excavation
- In-situ treatment by solidification/stabilization (limited to TCLP lead)
- Off-site disposal

Table 7-1. Technology Identification and Screening
Brooklyn Navy Yard Parcel
Feasibility Study

General Response Action	Technology	Process Option	Description	Effectiveness	Implementability	Cost	Conclusion
Limited Action/ Institutional Controls	Use Restrictions	Environmental Easement	Restricts use of property	Limits potential for exposure	Readily implemented.	Low	***Retained*** as a component that fits with various alternatives.
Limited Action/ Institutional Controls	Use Restrictions	Groundwater use restrictions	Restricts use of groundwater	Controls exposure	Readily implemented	Low	***Retained*** as a component that fits with various alternatives.
Containment	Capping	Capping	Physical barrier (e.g., asphalt) to eliminate direct contact exposure pathway for soil.	Controls direct contact exposure to soils.	Readily implemented.	Low - Moderate	***Retained,*** meets objectives.
Containment	Engineering Controls	Building sub-slab depressurization	Collects soil vapor below building foundation to prevent vapor intrusion. Includes vapor barrier, monitoring, and depressurization system.	Controls exposure due to potential vapor intrusion.	Readily implemented	Low	***Retained*** due to the potential for building construction related to site redevelopment. Sub-slab depressurization included for each remedial alternative to control potential for vapor intrusion.
Removal	Excavation	Soil Excavation	Physical removal of soil with concentrations of constituents above cleanup criteria	Eliminates direct contact exposure pathway via removal of contaminated soil. NYSDEC presumptive/ proven remedy for PCBs and metals in soil.	Readily implemented. Will require off-site disposal capacity.	Moderate to high depending on disposal costs.	***Retained,*** meets objectives.

Table 7-1. Technology Identification and Screening
Brooklyn Navy Yard Parcel
Feasibility Study

General Response Action	Technology	Process Option	Description	Effectiveness	Implementability	Cost	Conclusion
Treatment	In-Situ	Soil Vapor Extraction	Application of a vacuum to remove/ collect VOCs and some SVOCs from vadose zone.	VOCs generally not present. Primary SVOCs are PAHs. Not applicable to inorganics or PCBs	Readily implemented. May require off-gas treatment.	Low to moderate depending on need for off-gas treatment.	Eliminated. VOCs generally absent. Does not address variety of SVOCs, inorganics or PCBs.
Treatment	In-Situ	Chemical Oxidation	Application of oxidant to oxidize constituents.	Oxidants are generally effective on SVOCs, VOCs. Not effective on metals. Not demonstrated effective on PCBs. Effectiveness questionable in historic fill.	Available technology. Unproven for PCBs treatment.	Moderate to high depending on dose requirements	Eliminated due to practicality in historic (heterogeneous) fill, cost, ineffectiveness for metals, and unproven for PCBs.
Treatment	In-Situ	Phytoremediation	Use of plants to extract, degrade, contain, or immobilize contaminants from soil and groundwater	Limited to soil within the depth of plant root growth zone. Does not eliminate exposure pathway in short term. Requires management of leaf litter.	Limited by rate of root growth. Treatment limited during winter months while plants are dormant. Inconsistent with site re-development and industrial/commercial use	Low	Eliminated due to incompatibility with future site use when implemented on a site-wide basis. In addition, site treatment depths exceed typical depths of this technology.
Treatment	In-Situ	Soil Flushing	Application of water or solvents/ surfactants to mobilize and remove contaminants	Potentially effective on organics and typically effective on inorganics. Variability of fill would make control difficult and could limit effectiveness to higher permeability zones.	Available technology. Injection of flushing agents may have technical and/or regulatory limitations. Inconsistent with groundwater remedy implementation separately by Keyspan	Moderate to high	Eliminated. Effectiveness questionable, inconsistent with groundwater remedy implementation, no cost advantage, and could interfere with site redevelopment.

Table 7-1. Technology Identification and Screening
Brooklyn Navy Yard Parcel
Feasibility Study

General Response Action	Technology	Process Option	Description	Effectiveness	Implementability	Cost	Conclusion
Treatment	In-Situ	Solidification/ Stabilization	Solidify/stabilize contaminants into less soluble, mobile, or toxic forms.	Potentially effective for inorganics. Organics may interfere with curing of cementitious binder formulations, however other binders (i.e., proprietary binders) are possible. NYSDEC presumptive / proven remedy for metals in soil.	Available technology. Treatability study typically performed. Results in increased volume. Could interfere with site redevelopment. Variability of fill complicates implementation.	Moderate to high depending on binder.	***Retained*** for treatment of TCLP lead soils. Eliminated for side-wide implementation due to heterogeneity of fill, contaminant distribution, and questionable effectiveness without any cost advantage.
Treatment	Ex-Situ	Solid-Phase Separation/Soil Washing	Separation of fine-grained soil particles to which contaminants typically sorb to reduce mass for off-site disposal.	Presence of historic fill (i.e., cinders, ash, brick, etc.) may hinder separation process. Not applicable to materials such as ash.	Available technology. Wash water will require off-site treatment and disposal.	Moderate. Depends on quantity of fine-grained material for disposal.	Eliminated. Questionable effectiveness and implementability in historic fill.
Treatment	Ex-Situ	Incineration	High temperature is applied to volatilize and combust organics.	Potentially effective. Not effective on metals. NYSDEC presumptive / proven remedy for PCBs in soil.	Available technology. Metals content of soil needs to be characterized.	High	Eliminated. Not effective on metals. Not cost effective and does not offer additional benefit over off-site disposal of excavated soil.

Table 7-1. Technology Identification and Screening
Brooklyn Navy Yard Parcel
Feasibility Study

General Response Action	Technology	Process Option	Description	Effectiveness	Implementability	Cost	Conclusion
Treatment	Ex-Situ	High Temperature Thermal Desorption	Physical separation process were waste is heated to volatilize organic contaminants. The off-gas vapor is then treated.	Effective for VOCs, which are not generally present on site, and can be used to treat SVOCs typically at reduced effectiveness. Ineffective on inorganics. NYSDEC presumptive/ proven remedy for PCBs in soil.	Available technology. Metals may require treated soil residue to be stabilized.	Moderate	Eliminated. Will not treat inorganics and does not offer additional benefit over off-site disposal of excavated soil.
Disposal	Disposal of excavated soil	Off-site Disposal	Transportation of excavated soil to off-site permitted disposal facility.	Controls exposure through removal. Addresses various constituents present on site. NYSDEC presumptive/ proven remedy for PCBs and metals in soil.	Readily implemented.	Low to high depending on waste classification and quantity of excavated soil	***Retained.*** Necessary for excavation technologies.

A description of each of the retained technology's potential applicability to the Brooklyn Navy Yard parcel is provided below.

Institutional Controls – This technology is retained as a potential component of a variety of alternatives, as it would eliminate potential exposure pathways through use restrictions.

Capping – This technology is a commonly employed, readily implemented technology and is applicable to the contamination at the site. It meets the remedial action objective of controlling exposure to site soils via direct contact. In addition, a site wide cap, particularly in the form of asphaltic pavement, is consistent with the potential future site redevelopment plans. This technology was retained for further consideration.

Sub-Slab Depressurization (Vapor Intrusion Control) – This engineering control is retained and would be a common component of all alternatives, and reflected in institutional controls (i.e., a requirement for site redevelopment), to prevent the potential for vapor intrusion into occupied spaces of buildings that may be constructed on site as part of redevelopment.

Excavation – This is a commonly employed, readily implemented technology applicable to the media and contamination at the site. It meets the remedial action objectives of controlling exposure to site soils via direct contact. In addition, excavation is listed by the NYSDEC DER as a presumptive/proven remedial technology for the treatment of both PCBs and metals in soil. This technology was retained for further consideration in the development of alternatives.

In-situ Treatment by Solidification/Stabilization – Solidification/stabilization technology is not readily applicable to the mix of inorganic and organic contaminants (organics in particular may not bind permanently), is questionable in historic fill, and could potentially interfere with site redevelopment. This technology was, therefore, eliminated for use on a site-wide basis. However, this technology is potentially applicable for the site soils that exhibited the toxicity characteristic for lead. There are a number of available stabilization agents to address inorganic contaminants. Commonly applied inorganic stabilization agents include soluble silicates, carbon, phosphate, and sulfur-based binders, as well as Portland cement. Typically, these binders are applied in-situ by soil mixing. In addition, solidification/stabilization (i.e., immobilization) is listed by the NYSDEC DER as a presumptive/proven remedial technology for the treatment of metals in soil. As a result, this technology was retained for further consideration in the development of alternatives, as a treatment-based technology to address TCLP lead on a localized basis.

Off-Site Disposal – This technology is a commonly employed and readily implemented technology and has been retained for further consideration, as it is an integral component of the excavation technology. As with the excavation technology, off-site disposal is listed by the NYSDEC DER as a presumptive/proven remedial technology for both PCBs and metals in soil.

As shown in Table 7-1, after applying the previously described screening criteria, the following technologies were not retained for consideration in developing alternatives:

- In-situ treatment by soil vapor extraction
- In-situ treatment by chemical oxidation
- In-situ treatment by phytoremediation
- In-situ treatment by soil flushing
- Ex-situ treatment by solid-phase separation/soil washing
- Ex-situ treatment by incineration
- Ex-situ treatment by high temperature thermal desorption

The reasons for not retaining these technologies is summarized below.

Soil Vapor Extraction – This technology was eliminated because it is generally not applicable to the site constituents – metals, PAHs, and PCBs.

In-situ Treatment by Chemical Oxidation – Chemical oxidation technology is not applicable to inorganics (e.g., lead) and is not practical to implement as a site-wide remedy, particularly in a heterogeneous fill, and offers no cost advantage over other technologies. In addition, chemical oxidation is not a demonstrated technology for PCBs. Recent field studies of heat activated and high pH activated persulfate, for example, have indicated degradation of PCBs. However, the data are limited, the technology has had limited application and is not considered proven. Therefore, this technology was eliminated from consideration.

Phytoremediation – This technology was eliminated as it is typically limited to a treatment depth between 8 to 10 inches, although treatment depths upwards of 10 to 15 feet are possible depending on the plant species selected. In addition, phytoremediation generally is a long-term treatment process (i.e., would not address potential exposure pathways for soil for an extended period of time) and is not compatible with the future redevelopment of the site (i.e., majority of the redeveloped site surface would be paved and/or covered by structures). Such technology also typically requires management of leaf litter.

Soil Flushing – This technology was eliminated due to the possible inconsistency with separate implementation of the groundwater remedy (i.e., Keyspan parcel) and the difficulty for uniform distribution of flushing agents in the non-uniform historical fill. In addition, future site development would impede implementation.

Solid-Phase Separation/Soil Washing – This technology was eliminated on a site-wide basis due to the heterogeneity of the historic fill. Also, when compared to off-site disposal of excavated soil for the treatment of localized areas (i.e., areas identified in Section 3 in which PCB and lead contamination have been differentiated from the historic fill), separation/soil washing does not offer any additional benefits due to the relatively small volume of contaminated soil associated with theses localized areas, and is a more complex and likely more costly technology than removal.

Incineration – This technology was eliminated as it is not cost effective and does not offer any additional benefit over off-site disposal of excavated soil. In addition, incineration does not treat inorganics, which would potentially require stabilization of incinerator bottom ash before disposal.

High Temperature Thermal Desorption – This technology was eliminated as it does not address inorganics. Inorganics would require that treated soil residue be stabilized before reuse or disposal. In addition, thermal desorption does not offer any additional benefits over off-site disposal of excavated soil (i.e., not more cost-effective), particularly for the treatment of localized areas of PCBs contamination due to the relatively small volume of contaminated soil.

In summary, the retained and eliminated remedial technologies are as follows:

Retained Technologies	**Eliminated Technologies**
Institutional Controls	In-situ Treatment by Soil Vapor Extraction
Sub-Slab Depressurization	In-situ Treatment by Chemical Oxidation
Capping	In-situ Treatment by Phytoremediation
Excavation	In-situ Treatment by Soil Flushing
In-situ Treatment by Solidification/ Stabilization (localized TCLP lead areas)	Ex-situ Treatment by Solid-Phase Separation/Soil Washing
Off-Site Disposal	Ex-situ Treatment by Incineration
	Ex-situ Treatment by High Temperature Thermal Desorption
	In-situ Treatment by Solidification / Stabilization (site wide, PCBs)

These technologies are used to develop specific alternatives to meet the remedial action objectives presented in Section 4. Development and screening of alternatives is presented in Section 8. The alternatives are screened against effectiveness, implementability and cost to select those which are retained for detailed evaluation, as presented in Section 9.

8.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

The technologies retained after the screening process along with several site-specific elements provide the basis for the development of alternatives. The site-specific elements are discussed below, which are common to the alternatives development, followed by the combining of technologies into alternatives.

8.1 SITE-SPECIFIC ELEMENTS CONSIDERED FOR ALTERNATIVES DEVELOPMENT

8.1.1 Site Soils

The characteristics of the Site soils were previously described in Section 3. In summary, several of these characteristics relevant to the development of remedial alternatives are:

- Metals and SVOCs above cleanup criteria are widely distributed around the site with no horizontally or vertically discernable pattern. The lack of a link to specific sources, the prevalence of SVOCs and metals above criteria, the generally low concentrations and random nature of contaminant distribution is characteristic of the presence of historic, urban fill.

- PCBs are present at concentrations above cleanup criteria within the area adjacent to Former Building 419, Former Drum Storage Area B, and the Former Railroad Siding Area. PCBs found around Building 419 are related to a former transformer fire, those found around Drum Storage Area B could be related to storage of drums with oil containing PCBs, and those found around the former Railroad Siding Area are not linked to an identified potential source.

- While lead is prevalent in historic, urban fill, and at concentrations typical of that found at the Site, sampling in Former Drum Storage Area A displayed two locations where the TCLP criterion for lead was exceeded.

- Concentrations of volatile compounds were observed in soil vapor samples at concentrations sometimes exceeding guidance levels.

8.1.2 Former Drum Storage Area B IRM

An Interim Remedial Measure (IRM) Work Plan (Quay Consulting LLC, March 2007) has been developed and submitted to the NYSDEC for Former Drum Storage Area B. The IRM is designed to accommodate redevelopment including the construction of a multi-story industrial building.

The IRM Work Plan includes excavation within the footprint of Former Drum Storage Area B to address PCBs and lead. Because redevelopment will include a building and parking areas, the intent of the IRM Work Plan is to effect a final remedy for this portion of the site so that additional remedial efforts would not have to be undertaken following implementation of the redevelopment plan. Since the soil removal proposed in the IRM Work Plan meets the remedial action objectives, as defined in Section 4, and because the intent is that the IRM become the final remedy, the IRM is, therefore, incorporated by reference into this FS. Each remedial alternative presented below includes the Former Drum Storage Area B IRM work as a remedial component.

As of the preparation of this feasibility study, the IRM Work Plan has been reviewed by the NYSDEC, comments were provided to Quay Consulting LLC, and the work plan is in the process of revision and final review by the NYSDEC.

8.1.3 Natural Resource Damages

The NYSDEC's DER-10 guidance document indicates that remedy selection should consider natural resource damages (NRD) and the extent to which a remedy may mitigate NRD. The Brooklyn Navy Yard parcel is a fully developed site (unrelated to its classification as an inactive hazardous waste site), groundwater associated with the Keyspan parcel is being addressed separately, and none of the data collected indicate that the Site has had an impact on surface water or sediments that would require a discrete remedy component. Based on these conditions, none of the impacts addressed in this FS relate to NRD, nor would the remedies have an impact on NRD. Consequently, NRD is not considered further in this FS.

8.2 ALTERNATIVES DEVELOPMENT

The technologies retained after screening, as described in Section 7, provide the basis for development of alternatives. Alternatives are created by combining technologies to meet the remedial action objectives for the Site, as defined in Section 4. In addition, the No Action Alternative is maintained throughout the process as a baseline for comparison of other alternatives.

Using the above as framework, the following alternatives were developed:

- Alternative No. 1: No action
- Alternative No. 2: Institutional Controls
- Alternative No. 3: Site-wide excavation
- Alternative No. 4: Site-wide cap
- Alternative No. 5: Localized soil excavation
- Alternative No. 6: Localized soil excavation and site-wide cap
- Alternative No. 7: Localized soil excavation including PCBs to the Part 375-6 commercial criterion, and site-wide cap

Each of these alternatives is discussed below. The cost estimates presented for each alternative are developed for screening purposes, and are based on generally available cost factors, cost estimating guides (e.g., Means), and experience. More detailed cost estimates follow for alternatives retained through the detailed analysis. Where applicable, operation and maintenance components of the cost estimates are assumed over a 30-year planning horizon (i.e., long-term) and a discount rate of three percent is used for calculation of the net present worth of future costs.

8.2.1 Alternative No. 1: No Action

Alternative No. 1 is intended as a baseline for comparison of other alternatives. No actions would be taken nor would any existing actions (e.g., use restrictions) be continued. There would not be any costs associated with this alternative.

8.2.2 Alternative No. 2: Institutional Controls

This alternative would consist of institutional controls, in the form of an environmental easement per 6NYCRR Part 375-1.8(h)(2), which would cover the following:

- Limit activities that could be performed on site that would disturb soils or potentially create exposure to soils with concentrations of various constituents above the cleanup criteria. Activities permissible under the institutional controls would be performed in accordance with a site management plan, including a soils management plan (SMP) and a health and safety plan.

- Limit use of groundwater which may contain contaminants above groundwater or drinking water quality criteria, related to the urban fill and until such time as the groundwater work at the Keyspan parcel is completed.

- Require that building construction at the site, if any, would include vapor intrusion controls, would require notification to the appropriate agencies, and would be limited to commercial or industrial uses.

- Require that the use restrictions be properly maintained.

This alternative would limit the potential for exposure, through use restrictions, however, it would not meet the remedial action objective for soils.

The estimated costs for this alternative are based on estimates to establish use restrictions through an environmental easement. Based on experience, the estimated cost to complete this work, including survey to establish boundaries for the restricted area, is approximately $120,000. This cost includes annual costs associated with annual certification for institutional controls that would remain for the Site, as described in DER-10, Section 6.5.

8.2.3 Alternative No. 3: Site-Wide Soil Excavation

Alternative No. 3 would provide for removal of soils with concentrations of constituents above the TAGM 4046 and/or Part 375-6 unrestricted use cleanup criteria, which based on the presence of historic fill, is site-wide. The TAGM 4046 and Part 375-6 unrestricted use cleanup criteria are used as a means of evaluating an alternative intended to restore a site to pre-development conditions. Excavated soil would be transported off-site for treatment and/or disposal. This alternative would achieve the remedial action objective of direct contact control for soils to eliminate the complete pathway for metals, PCBs, and SVOCs found above criteria on a site-wide basis.

The components of this remedy would be as follows:

- Site clearing. Various surface structures (i.e., structure or structure remnants, curbs, utilities, etc.) will be removed to facilitate implementation of excavation.

- Excavation of soils above the soil cleanup criteria. Excavation depth would be limited to the groundwater table, or approximately 6 feet below grade. Excavated soils would be stockpiled on site to determine disposal requirements. Sheeting and shoring would be required around portions of the property boundary due to excavation depth (i.e., where greater excavation depths would border adjacent properties not otherwise supported (e.g., the barge basin area would not require sheeting as it already has a bulkhead). With an average depth of excavation of approximately six feet, sheeting depth was taken as approximately 15 feet. For the cost of this alternative, it is assumed that the site soils would be disposed of as non-hazardous waste, except for the area where lead was detected above the TCLP criterion in Former Drum Storage Area A and a small area of PCB impacted soil above 50 ppm in the vicinity of Former Building 419.

- Post remedial soil confirmatory sampling. Post-excavation confirmatory sampling would be conducted in a manner generally consistent with NYSDEC draft DER-10 Technical Guidance for Site Investigation and Remediation minimum requirements. Samples will be analyzed for metals, VOCs, SVOCs and PCBs. Recognizing that the Site is contained within a larger industrial property, characterized by urban fill as well, the potential exists for off-site contamination unrelated to the Site. Therefore, the approach to remediation activities along property boundaries would be as follows:

    - Pre-design delineation would be preferable to confirm the extent of off-site work, if any, prior to the start of remediation.
    - To the extent that delineation data (either pre-design or post-excavation) indicate circumstances are substantially different than known at the time of the Record of Decision, then the work would be interrupted and discussed with the NYSDEC to reconsider the approach to remediation.
    - To the extent that delineation data (either pre-design or post-excavation) indicate the presence of grossly contaminated media or source materials, as these media are defined in Part 375-1.2, related to the Site, then the limits of remediation would be adjusted accordingly.
    - To the extent that delineation data (either pre-design or post-excavation) indicate the presence of grossly contaminated media or source materials, as these media are defined in Part 375-1.2, unrelated to the Site, then the limits of remediation would not be adjusted.

- Backfill of excavation with certified clean fill and restoration of the site to pre-excavation conditions.

- An environmental easement for the area within the boundaries of the Site to limit site activities, future use, and groundwater use. The environmental easement would also require compliance with a Soils Management Plan, which would detail the methods by which contaminated soils would be handled, stored, and/or disposed during future ground-disturbing activities.

- A component of the environmental easement requiring the use of engineering controls (e.g., sub-slab depressurization system) to address the potential for vapor intrusion in new building construction.

Because this alternative includes excavation of the entire site, by default the IRM for former Drum Storage Area B is included.

The estimated costs for this alternative are based on capital costs for the site clearing, sheeting, excavation, stockpiling, backfill, site restoration and confirmatory sampling. Soil disposal costs are based on experience. As stated previously, each alternative includes provisions for vapor intrusion control, in the form of building sub-slab depressurization systems. Sub-slab depressurization systems would be designed to provide sufficient control of potential vapor intrusion based on the building footprint and layout. Without an actual building layout, the cost of a sub-slab depressurization system cannot be estimated. However, for the purposes of this feasibility study, since each alternative includes the same requirement, there would be no cost differential among the alternatives and such cost would not affect the decision-making process of the FS. No annual costs are assumed for this remedy. In addition, capital costs to establish an environmental easement are based on experience. Annual costs include annual certification for institutional/engineering controls that would remain for the Site. The estimated costs are summarized as follows:

Capital Costs	
Site Clearing	$150,000
Excavation and Backfill	$2,100,000
Disposal	$6,000,000
Post-Excavation Confirmatory Sampling	$10,000
Soil Erosion and Sediment Control/Site Restoration	$400,000
Establish Environmental Easement	$50,000
Miscellaneous (HASP, permits, survey)	$50,000
Engineering and Administration	$250,000
Total Capital Costs	**$9,010,000**
Continuing Certification for Institutional Controls, Net Present Worth ($2,500/yr)	$70,000
Net Present Worth, Capital and Maintenance	**$9,080,000**

8.2.4 Alternative No. 4: Site-Wide Cap

Alternative No. 4 is similar to Alternative No 3, in that it would control direct contact with soils on a site-wide basis (i.e., addressing TAGM 4046 and/or Part 375-6 unrestricted use soil cleanup criteria) using a capping system. A variety of caps could be considered for direct contact control (e.g., soil, asphalt, concrete, geosynthetics) and various redevelopment scenarios could become components of a cap. For example, a building slab would function as a cap, as would a paved parking lot associated with redevelopment of the Site. However, since the specifics of redevelopment are not currently known, for the purpose of evaluating this alternative, an asphalt cap has been assumed since it would be consistent with the current site conditions and future redevelopment as illustrated by the redevelopment contemplated by the IRM for former Drum Storage Area B. Redevelopment would also likely include some green/landscape areas and these would be capped with 24 inches or more of certified clean fill.

This alternative would achieve the remedial action objective of direct contact control for soils by eliminating the complete pathway for metals, PCBs, and SVOCs found above criteria on a site-wide basis.

The components of this remedy would be as follows:

- Site Clearing. Site clearing would consist of removal of surface structures (e.g., Former Building 419, fences, etc.) to facilitate installation of an asphalt cap.

- Asphalt cap. The asphalt cap would be installed site wide within the boundaries of Brooklyn Navy Yard parcel. Various areas of the parcel currently are paved and/or contain concrete slabs. Where cap currently exists, the assumption for this alternative is that the asphalt cap in these areas will be limited to a two-inch thick overlay. In areas that are unpaved, the asphalt cap would be installed with a four-inch base course and a two-inch wearing course, over a stone base course a minimum of four inches thick. These assumptions are made for the purpose of costing the alternative. The actual cap, as noted above, could be existing materials if they meet the minimums identified herein or redevelopment components including buildings and landscape areas with two feet of soil cover. The details of such capping would be developed during design and integrated with site redevelopment.

- Site restoration. Surface structures removed for installation of the cap would be restored as applicable (e.g., fences).

- An environmental easement for the area within the boundaries of the site to limit site activities, future use, and groundwater use. The environmental easement would also require compliance with a Soils Management Plan, which would detail the methods by which contaminated soils would be handled, stored, and/or disposed during future ground-disturbing activities.

- A component of the environmental easement requiring the use of engineering controls (e.g., sub-slab depressurization system) to address the potential for vapor intrusion in new building construction.

- Former Drum Storage Area B IRM.

The estimated costs for this alternative are based on capital costs for the site clearing, cap installation and site restoration. Soil disposal costs for the former Drum Storage Area B IRM are based on experience. In addition, capital costs to establish an environmental easement are based on experience. Annual maintenance costs are included for the cap, which would include patching cracks as necessary and pavement sealing on a bi-annual basis. In addition, annual costs include annual certification for institutional/engineering controls that would remain for the Site. Annual maintenance costs are converted to a net present worth using a discount rate of three percent over a period of 30 years. The estimated costs are summarized as follows:

Capital Costs	
Site Clearing	$20,000
Asphalt Cap	$600,000
Soil Erosion Controls/Site Restoration	$100,000
Drum Storage Area B IRM	$60,000
Establish Environmental Easement	$50,000
Miscellaneous (HASP, permits, survey)	$50,000
Engineering and Administration	$150,000
Total Capital Costs	**$1,030,000**
Cap Maintenance, Net Present Worth ($40,000/yr)	$790,000
Continuing Certification for Institutional Controls, Net Present Worth ($2,500/yr)	$70,000
Net Present Worth, Capital and Maintenance	**$1,890,000**

8.2.5 Alternative No. 5: Localized Soil Excavation

Alternative No. 4 differentiates the historic urban fill from what appear to be potential site-related operations impacts. As discussed in Section 3, two areas have been identified as being impacted by PCBs from historic operations (i.e., Former Drum Storage Area B and Former Building 419). In addition, because of lead concentrations above the TCLP criterion, one area would be characterized as containing a characteristic hazardous waste. The PCB and TCLP lead areas are not necessarily typical of the historic urban fill found on the site. Under this alternative, the localized PCB and TCLP lead areas would be addressed. While this would control the direct contact pathway for these areas, direct contact control would not be achieved for the historic urban fill because this alternative acknowledges the likely presence of historic, urban fill over a much broader area than the Brooklyn Navy Yard parcel.

Under this alternative, the localized PCB and TCLP lead areas would be addressed via excavation. The TCLP lead impacted soil could also be treated in-situ via solidification/ stabilization, but with the relatively small volume of contaminated soil, there would not be a material cost difference between solidification/stabilization and excavation. Therefore, the process option best suited to the TCLP lead soil does not materially affect remedy selection and can be made at the time of remedy design, if this alternative were selected.

The components of this remedy would then be as follows:

- Site clearing. Any surface structures would be removed to facilitate to excavation activities in the two localized areas.

- Excavation of soils impacted by PCBs (>1 mg/kg 0-2’, >10 mg/kg >2’) and TCLP lead (>5 mg/l in extract) exceedances. Area and depth of excavation would be as indicated above in Section 3.8. Excavated soils would be stockpiled on site to confirm disposal requirements. For the cost of this alternative, it is assumed that the site soils will be disposed of as non-hazardous waste, except for the area of lead TCLP exceedance in Former Drum Storage Area A and a small area of PCB impacted soil above 50 ppm in the Former Building 419 area.

- Post remedial soil confirmatory sampling. Post remedial soil confirmatory sampling would be would be conducted in a manner generally consistent with NYSDEC draft DER-10 Technical Guidance for Site Investigation and Remediation minimum requirements. Samples would be taken and analyzed for TCLP lead and PCBs. Portions of former Drum Storage Areas A and B are adjacent to the southern boundary of the Site. Recognizing that the Site is contained within a larger industrial property, characterized by urban fill as well, the potential exists for off-site contamination unrelated to the Site. Therefore, the approach to remediation activities along property boundaries would be as follows:

    - Pre-design delineation for PCBs and TCLP lead would be preferable to confirm the extent of off-site work, if any, prior to the start of remediation.
    - To the extent that delineation data (either pre-design or post-excavation) indicate circumstances are substantially different than known at the time of the Record of Decision, then the work would be interrupted and discussed with the NYSDEC to reconsider the approach to remediation.
    - To the extent that delineation data (either pre-design or post-excavation) indicate the presence of grossly contaminated media or source materials, as these media are defined in Part 375-1.2, related to the Site, then the limits of remediation would be adjusted accordingly.
    - To the extent that delineation data (either pre-design or post-excavation) indicate the presence of grossly contaminated media or source materials, as these media are defined in Part 375-1.2, unrelated to the Site, then the limits of remediation would not be adjusted.

- Backfill of excavation with certified clean fill and restoration of the site to pre-excavation conditions.

- An environmental easement for the area within the boundaries of the site to limit site activities, future use, and groundwater use. The environmental easement would also require compliance with a Soils Management Plan, which would detail the methods by which contaminated soils would be handled, stored, and/or disposed during future ground-disturbing activities.

- A component of the environmental easement requiring the use of engineering controls (e.g., sub-slab depressurization system) to address the potential for vapor intrusion in new building construction.

- Former Drum Storage Area B IRM.

The estimated costs for this alternative are based on capital costs for the site clearing, excavation, backfill, site restoration and confirmatory sampling. Soil disposal costs are based on experience. Annual costs include annual certification for institutional/engineering controls that would remain for the Site. In addition, capital costs to establish an environmental easement are based on experience. The estimated costs are summarized as follows:

Capital Costs	
Site Clearing	$5,000
Excavation and Backfill	$15,000
Disposal	$70,000
Post Remedial Confirmatory Sampling	$10,000
Erosion Control / Site Restoration	$15,000
Establish Environmental Easement	$50,000
Miscellaneous (HASP, permit, survey)	$30,000
Engineering and Administration	$75,000
Total Capital Costs	**$270,000**
Continuing Certification for Institutional Controls, Net Present Worth ($2,500/yr)	$70,000
Net Present Worth, Capital and Maintenance	**$340,000**

8.2.6 Alternative No. 6: Localized Soil Excavation and Site-Wide Cap

Alternative No. 6 combines Alternative Nos. 4 and 5. This alternative would achieve the remedial action objective of direct contact control for soils to eliminate the complete pathway for metals, PCBs, and SVOCs found above criteria on a site-wide basis. The PCBs and TCLP localized soil areas would be excavated and disposed of, thereby removing what appear to be the only site operations related impacts. The direct contact pathway for the historic urban fill would be controlled by the site-wide cap.

The components of this remedy would be as follows:

- Site clearing. Various surface structures (i.e., building, curbs, etc.) would be removed to facilitate excavation and capping activities.

- Excavation of soils impacted by PCBs (>1 mg/kg 0-2’, >10 mg/kg >2’) and TCLP lead (>5 mg/l in extract). Area and depth of excavation would be as indicated above in Section 3.8 for historic fill screening. Excavated soils would be stockpiled on site to confirm disposal requirements. For the cost of this alternative, it is assumed that the site soils will be disposed of as non-hazardous waste, except for the area of lead TCLP exceedance in Former Drum Storage Area A and a small area of PCB impacted soil above 50 ppm in the Former Building 419 area.

- Post remedial soil confirmatory sampling. Post remedial soil confirmatory sampling would be conducted in a manner generally consistent with the NYSDEC draft DER-10 minimum requirements. Samples will be taken and analyzed for TCLP lead and PCBs. Portions of former Drum Storage Areas A and B and the former Railroad Siding Area are adjacent to the southern boundary of the Site. Recognizing that the Site is contained within a larger industrial property, characterized by urban fill as well, the potential exists for off-site contamination unrelated to the Site. Therefore, the approach to remediation activities along property boundaries would be as follows:

    - Pre-design delineation would be preferable to confirm the extent of off-site work, if any, prior to the start of remediation.

- To the extent that delineation data (either pre-design or post-excavation) indicate circumstances are substantially different than known at the time of the Record of Decision, then the work would be interrupted and discussed with the NYSDEC to reconsider the approach to remediation.
- To the extent that delineation data (either pre-design or post-excavation) indicate the presence of grossly contaminated media or source materials, as these media are defined in Part 375-1.2, related to the Site, then the limits of remediation would be adjusted accordingly.
- To the extent that delineation data (either pre-design or post-excavation) indicate the presence of grossly contaminated media or source materials, as these media are defined in Part 375-1.2, unrelated to the Site, then the limits of remediation would not be adjusted.

- Backfill of excavation with certified clean fill and restoration of the site to pre-excavation conditions.

- The asphalt cap would be installed site wide within the boundaries of Brooklyn Navy Yard parcel. Various areas of the parcel currently are paved and/or contain concrete slabs. Where cap currently exists, the assumption for this alternative is that the asphalt cap in these areas will be limited to a two-inch thick overlay. In areas that are unpaved, the asphalt cap would be installed with a four-inch base course and a two-inch wearing course, over a stone base course a minimum of four inches thick.

- An environmental easement for the area within the boundaries of the site to limit site activities, future use, and groundwater use. The environmental easement would also require compliance with a Soils Management Plan, which would detail the methods by which contaminated soils would be handled, stored, and/or disposed during future ground-disturbing activities.

- A component of the environmental easement requiring the use of engineering controls (e.g., sub-slab depressurization system) to address the potential for vapor intrusion in new building construction.

- Former Drum Storage Area B IRM.

The estimated costs for this alternative are based on capital costs for the site clearing, soil excavation and disposal, cap installation and site restoration. Soil disposal costs are based on experience. In addition, capital costs to establish an environmental easement are based on experience. Annual maintenance costs are included for the cap, which would include patching cracks as necessary and pavement sealing on a bi-annual basis. In addition, costs include annual certification for institutional/engineering controls that would remain for the Site. Annual maintenance costs are converted to a net present worth using a discount rate of three percent over a period of 30 years. The estimated costs are summarized as follows:

Capital Costs	
Site Clearing	$20,000
Excavation and Backfill	$20,000
Disposal	$150,000
Post Remedial Confirmatory Sampling	$35,000
Asphalt Cap	$600,000
Soil Erosion Controls / Site Restoration	$100,000
Establish Environmental Easement	$50,000
Miscellaneous (HASP, permit, survey)	$50,000
Engineering and Administration	$150,000
Total Capital Costs	**$1,175,000**
Cap Maintenance, Net Present Worth ($40,000/yr)	$790,000
Continuing Certification for Institutional Controls, Net Present Worth ($2,500/yr)	$70,000
Net Present Worth, Capital and Maintenance	**$2,035,000**

8.2.7 Alternative No. 7: Localized Soil Excavation Including PCBs to the Part 375-6 Commercial Critera, and Site-Wide Cap

Alternative No. 7 is similar to Alternative No 6. except that the criterion for PCB soil cleanup is 1 ppm, regardless of depth, consistent with the Part 375-6 commercial criterion. Area and depth of excavation would be as indicated above in Section 3.8 for restoration of contamination by PCBs to pre-release conditions, based on the commercial criterion. This alternative would achieve the remedial action objective of direct contact control for soils to eliminate the complete pathway for metals, PCBs, and SVOCs found above criteria on a site-wide basis, and would address and NYSDEC preference for remediation of constituents that may have been released (for this site PCBs) as a part of site operations to pre-release conditions or in this case to a specified cleanup criterion. The direct contact pathway for the historic urban fill would be controlled by the site-wide cap.

The components of this remedy are the same as those described above for Alternative No. 6, with the only difference being the quantity of excavated material related to the PCB cleanup criterion.

The estimated costs for this alternative are based on capital costs for the site clearing, soil excavation and disposal, cap installation and site restoration. Soil disposal costs are based on experience. In addition, capital costs to establish an environmental easement are based on experience. Annual maintenance costs are included for the cap, which would include patching cracks as necessary and pavement sealing on a bi-annual basis. In addition, costs include annual certification for institutional/engineering controls that would remain for the Site. Annual maintenance costs are converted to a net present worth using a discount rate of three percent over a period of 30 years. The estimated costs are summarized as follows:

Capital Costs	
Site Clearing	$20,000
Excavation and Backfill	$40,000
Disposal	$250,000
Post Remedial Confirmatory Sampling	$40,000
Asphalt Cap	$600,000
Soil Erosion Controls / Site Restoration	$100,000
Establish Environmental Easement	$50,000
Miscellaneous (HASP, permit, survey)	$50,000
Engineering and Administration	$150,000
Total Capital Costs	**$1,300,000**
Cap Maintenance, Net Present Worth ($40,000/yr)	$790,000
Continuing Certification for Institutional Controls, Net Present Worth ($2,500/yr)	$70,000
Net Present Worth, Capital and Maintenance	**$2,160,000**

8.3 ALTERNATIVES SCREENING

The seven alternatives described above were screened against the criteria of effectiveness, implementability, and cost. For the purpose of the alternatives screening, these criteria were applied as follows:

- Effectiveness – Similar to the technology screening, this criterion is used to assess the ability of a technology to meet the remedial action objectives. Effectiveness is measured against meaningful goals including the alternative's ability to control potential exposure pathways. Effectiveness also considers items such as an alternative's ability to meet SCGs and short-term and long-term effects of implementation.

- Implementability – This criterion is used to assess the technical and administrative feasibility of implementing an alternative. Consideration is given to the practicability of implementing the technology used in the alternative, the ability to meet the substantive requirements of permitting regulations, the availability of the remedy components, and the timing for implementation.

- Cost – Cost is used to compare alternatives of otherwise similar effectiveness and implementability. If an alternative does not offer measurable and meaningful benefits while costing more than another alternative, it can be eliminated from further consideration.

The screening of the seven identified alternatives is presented in Table 8-1. Based on the results of the screening, the alternatives retained for detailed evaluation include:

- Alternative No. 1: No action was retained as a baseline for comparison with other alternatives.

- Alternative No. 3: Complete site excavation was retained because it meets the remedial action objectives and is implementable. This remedy would also restore the Site to pre-development conditions, at least above the water table.

- Alternative No. 4: Site-wide cap was retained as it also meets the remedial action objectives and is implementable, particularly when combined with site redevelopment.

- Alternative No. 6: Localized soil excavation and site-wide cap is a combination of Alternative Nos. 3 and 4. This alternative would meet the remedial action objectives and is implementable.

- Alternative No. 7: Localized soil excavation including PCBs to the Part 375-6 commercial criterion, and site-wide cap is a modification of Alternative No. 6 using a different cleanup criterion for PCBs. This alternative would meet the remedial action objectives and is implementable.

Alternative Nos. 2 and 5 were eliminated during the screening process. Alternative No. 2 while low cost, would not meet the remedial action objectives. Similarly, while Alternative No. 5 is lower in cost than other alternatives involving active remediation, it does not meet the remedial action objectives.

Table 8-1. Alternative Development and Screening
Brooklyn Navy Yard Parcel
Feasibility Study

Alternative	Effectiveness	Implementability	Screening Level Cost	Conclusion
No. 1 No Action	Would not be effective in controlling potential for exposure	Readily implementable because no work is necessary	None	Retained as a baseline for comparison of other alternatives
No. 2 – Institutional Controls	Would control potential for exposure.	Readily implementable	$120,000	Eliminated. Does not meet remedial action objectives.
No. 3 – Site-Wide Excavation	Meets the remedial action objectives on a site-wide basis through excavation to the water table. Also represents an alternative targeted to restoration to pre-development conditions, to the extent practicable.	Generally implementable. Would require coordination of logistics with neighboring properties and/or phasing of work due to aerial extent of the work. Would require restoration of site facilities including underground utilities.	$9,080,000	Retained. Alternative is effective and implementable.
No. 4 – Site-Wide Cap	Meets the remedial action objective on a site-wide basis through the use of a cap and/or site redevelopment features.	Generally implementable. Would require coordination of logistics with neighboring properties and/or phasing of work due to aerial extent of the work.	$1,890,000	Retained. Alternative is effective, implementable and cost effective.
No. 5 – Localized Soil Excavation	Does not meet the remedial action objectives.	Readily implementable.	$340,000	Eliminated. Does not meet remedial action objective.
No. 6 – Localized Soil Excavation and Site-Wide Cap	Meets the remedial action objectives on a site-wide basis through excavation and capping.	Generally implementable. Would require coordination of logistics with neighboring properties and/or phasing of work due to aerial extent of the work	$2,035,000	Retained. Alternative is effective, implementable and cost effective.
No. 7 – Localized Soil Excavation Including PCBs to Part 375-6 Commercial Criterion, and Site-Wide Cap	Meets the remedial action objectives on a site-wide basis through excavation and capping.	Generally implementable. Would require coordination of logistics with neighboring properties and/or phasing of work due to aerial extent of the work	$2,160,000	Retained. Alternative is effective, implementable and not significantly more costly than Alternative No. 6.

9.0 DETAILED ANALYSIS OF ALTERNATIVES

Following the alternative screening presented in Section 8, five alternatives remain for detailed evaluation, as follows:

- Alternative No. 1: No action. Alternative No. 1 was retained as a baseline for comparison with other alternatives.

- Alternative No. 3: Site-wide excavation. Site-wide soil excavation was retained because it meets the remedial action objectives and is generally implementable.

- Alternative No. 4: Site-wide cap. The site-wide cap was retained, because it is generally implementable and provides a containment-based alternative that addresses the entire site and meets the remedial action objectives.

- Alternative No. 6: Localized soil excavation and site-wide cap. Alternative No. 6 makes a distinction between historic urban fill and soil impacted by past site operations. This alternative was retained because it is generally implementable and meets remedial action objectives.

- Alternative No. 7: Localized soil excavation including PCBs to the Part 375-6 commercial criterion, and site-wide cap. Similar to Alternative No. 6, Alternative No. 7 makes a distinction between historic, urban fill and soil impacted by past site operations, and also targets achieving pre-release conditions for PCBs, based on the commercial criteria, addressing a policy preference of the NYSDEC. This alternative was retained because it is generally implementable, meets the remedial action objectives, and is not significantly more costly than Alternative No. 6.

The detailed evaluation of these alternatives is described in the sections that follow.

9.1 EVALUATION CRITERIA

The five alternatives remaining from the screening process were analyzed by comparison to the eight evaluation criteria established in NYSDEC draft DER-10 Technical Guidance for Site Investigation and Remediation, which include:

- Overall protection of human health and the environment: This criterion assesses the overall performance of an alternative in protecting human health and the environment by evaluation of the alternative's ability to meet the remedial action objectives, the efficacy of the alternative, and its ability to control or eliminate the potential risk pathways (e.g., direct contact with soils).

- Compliance with Standards, Criteria, and Guidance (SCGs): This criterion is used to establish whether an alternative complies with applicable or relevant and appropriate environmental laws, regulations, standards, and guidance. The criterion also reviews the relative permitting requirements applicable to the alternative.

- Long-term effectiveness and permanence: This criterion is used to assess how the alternative is expected to perform over the long-term and whether the remedy is permanent. In addition, this criterion deals with the magnitude of the remaining risk and ability of the remedy to meet remedial action objectives in the future if contaminants remain on-site after implementation of the remedy.

- Reduction of toxicity, mobility or volume: This criterion is used to assess how the alternative reduces the toxicity, mobility, or volume of site-related constituents (i.e., metals, PCBs, and SVOCs contaminated soil) through removal and or treatment.

- Short-term effectiveness: This criterion is used to evaluate the implementation related impacts of an alternative, safety, and the alternative's protectiveness related to the community, the workers, and the environment during the short-term implementation period.

- Implementability: This criterion is used to evaluate the availability of equipment, materials, and methods associated with an alternative and the practicability of implementing an alternative.

- Cost: This criterion provides an overall estimate of the capital, operation, maintenance, and monitoring costs associated with an alternative, for comparison to the alternative's expected performance and to other alternatives. Present worth costs are calculated for each alternative using a discount rate of three percent (estimated as a reasonable difference between interest and inflation) and a planning horizon of 30 years. Cost estimates are typically evaluated on an accuracy of +50%/-30%.

- Community Acceptance: This criterion is addressed through the public participation requirements for the inactive hazardous waste site program, in accordance with 375-2.10. Part 375-2.10 provides for public participation through the Department's issuance of a proposed remedial plan, a public comment period and establishing a public repository for site-related documents. Public repositories for the Brooklyn Navy Yard parcel have been established at Brooklyn Community Board Nos. 1 and 2 and at the Brooklyn Public Library. Following completion of the FS, the NYSDEC will issue a proposed remedial plan for public comment that will provide the mechanism for evaluating community acceptance through evaluation of comments received and development of a responsiveness summary. As such, community acceptance is not considered further at this time in the FS.

A description of each alternative and evaluation against the above criteria are provided in the sections that follow.

9.2 DESCRIPTION OF ALTERNATIVES

The alternative descriptions that follow are developed in sufficient detail to permit evaluation against the previously described criteria and preparation of cost estimates.

9.2.1 Alternative No. 1: No Action

Alternative No. 1 is intended as a baseline for comparison of other alternatives, and would not control the potential for exposure, or meet the remedial action objectives. This alternative would not include any future actions nor would it continue any existing activities (e.g., site restrictions). This alternative would also not have any costs associated with it, as it does not require any action.

9.2.2 Alternative No. 3: Site-Wide Excavation

This alternative constitutes a soil removal remedy to the depth at which concentrations are not above the TAGM 4046 guidance and/or Part 375-6 unrestricted use soil cleanup criteria or to the water table, whichever is encountered first. This alternative would meet the remedial action objective of control of the direct contact exposure pathway. In addition, this remedy represents an alternative that restores the Site to pre-development conditions to the extent practicable (i.e., historic fill would still remain below the water table).

The components of this remedy are illustrated on Figure 9-1, and include the following:

- Site clearing. Various surface structures (i.e., building 419 foundation, curbs, utilities, etc.) would be removed to facilitate implementation of excavation activities.

- Excavation of soils above the TAGM soil cleanup criteria. Excavation depth would be limited to the groundwater table, or approximately 6 feet below grade. The limit of excavation is shown on Figure 9-1, and represents a total volume of 39,900 cy. It is expected that soils above the TAGM soil cleanup criteria extend to the Brooklyn Navy Yard Parcel property line based on the presence of historic fill site wide, and the relationship between various constituents present (e.g., PAHs) and historic fill. To implement site-wide excavation, sheeting/shoring would be temporarily installed along the property lines, as shown on Figure 9-1. In other areas, the excavation would be sloped or benched in accordance with OSHA regulations. Excavation activities would be implemented in accordance with applicable OSHA regulations.

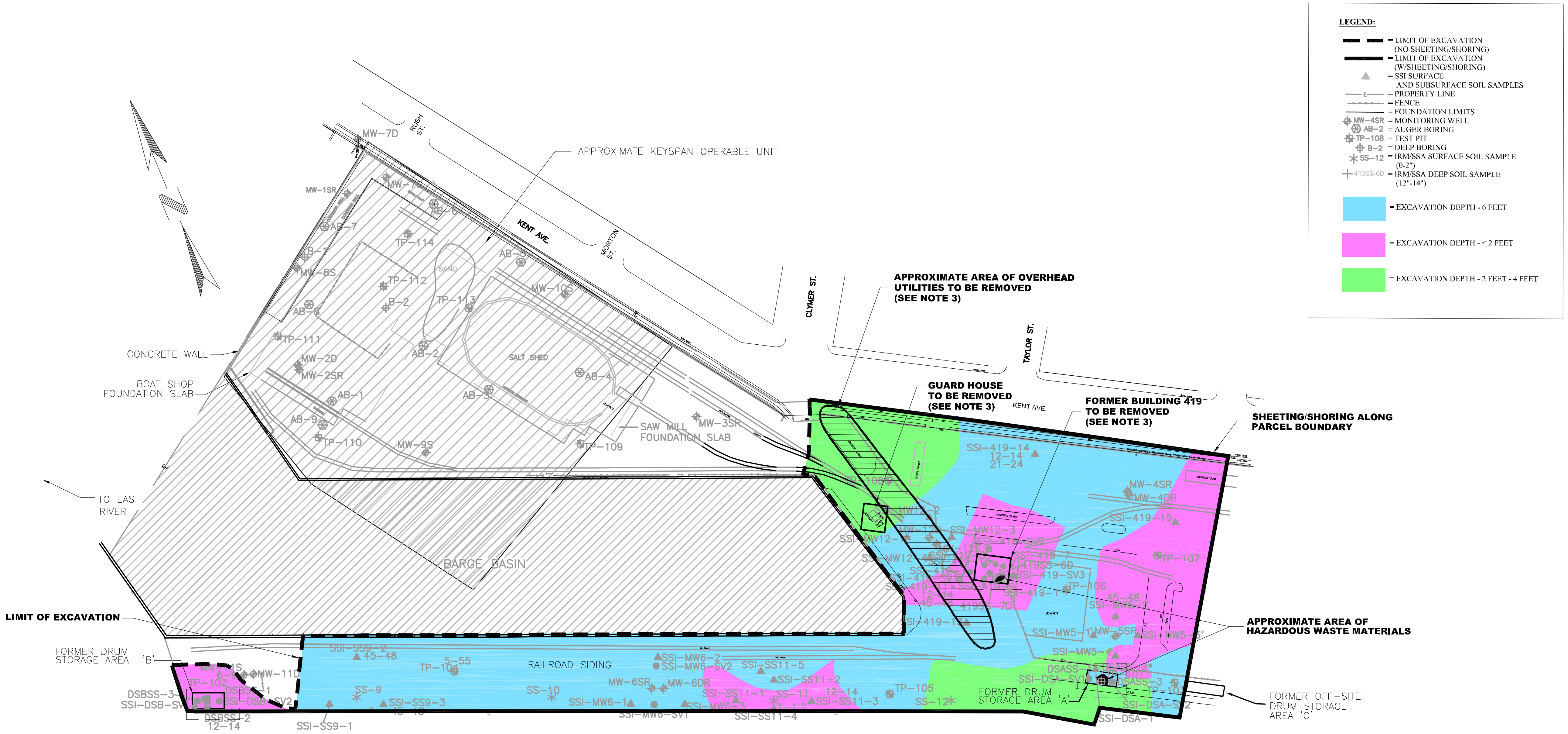
  Excavated soils would be stockpiled on site to confirm disposal requirements (i.e., sampling and analysis in accordance with the receiving facility requirements). For costing purposes, the assumption has been made that the site soils will be disposed of as non-hazardous waste, except for the area of lead concentrations above the TCLP criterion in Former Drum Storage Area A and a small area of PCB impacted soil above 50 ppm in the vicinity of Former Building 419.

- Post remedial soil confirmatory sampling. Post-excavation confirmatory soil sampling would be conducted in a manner generally consistent with the NYSDEC draft DER-10 Technical Guidance for Site Investigation and Remediation minimum requirements. As the excavation would not extend below the water table and results of testing performed during the RI indicate that there are areas where soil cleanup criteria are exceeded below the water table, only excavation sidewall samples would be collected to confirm the boundaries of the excavation. Bottom samples would be collected as a record of constituents that remain on site. Ten sidewall samples are assumed based on the excavation configuration shown in Figure 9-1. The samples would be analyzed for metals, SVOCs and PCBs. If a sample result is above the TAGM 4046 or Part 375-6 criteria, the excavation limits in this area would be expanded and the area re-sampled until excavation sidewall sample results are below the soil cleanup criteria. A total of approximately 25 samples are assumed in the bottom, spaced approximately 100 feet on center. Given the size of the excavation, this frequency, while less than the guidance in DER-10, is considered reasonable for this larger excavation and for the purpose of characterization for an environmental easement, as provided for in Section 5.4 of DER-10. As previously noted in Section 8, recognizing that the Site is contained within a larger industrial property, characterized by urban fill as well, the potential exists for off-site contamination unrelated to the Site. Therefore, the approach to remediation activities along property boundaries would be as follows:

- Pre-design delineation would be preferable to confirm the extent of off-site work, if any, prior to the start of remediation.
- To the extent that delineation data (either pre-design or post-excavation) indicate circumstances are substantially different than known at the time of the Record of Decision, then the work would be interrupted and discussed with the NYSDEC to reconsider the approach to remediation.
- To the extent that delineation data (either pre-design or post-excavation) indicate the presence of grossly contaminated media or source materials, as these media are defined in Part 375-1.2, related to the Site, then the limits of remediation would be adjusted accordingly.
- To the extent that delineation data (either pre-design or post-excavation) indicate the presence of grossly contaminated media or source materials, as these media are defined in Part 375-1.2, unrelated to the Site, then the limits of remediation would not be adjusted.

- Backfill of excavation with certified clean fill. The site will be graded and restored to pre-excavation grades. However, to the extent that redevelopment plans would require alternative grades (e.g., higher or lower final elevations, a building occupying a portion of the excavation area), backfill requirements would be adjusted accordingly, provided redevelopment plans are being implemented at the time the remediation occurs. Otherwise, backfill will be to pre-excavation grades.

- An environmental easement requiring the use of engineering controls (e.g., sub-slab depressurization system) to address the potential for vapor intrusion in new building construction, and limiting the future use and permissible activities on the site, as previously described. The environmental easement would also require compliance with a Soils Management Plan, which would detail the methods by which contaminated soils would be handled, stored, and/or disposed during future ground-disturbing activities. Sub-slab depressurization systems would be designed to provide control of soil vapor based on the building footprints and layouts. Since redevelopment plans for the Site are still in the development phase, the design of soil vapor controls cannot be determined at this time. For the purposes of this feasibility study, it is assumed that each alternative would include the same depressurization system, and therefore, the cost associated with



NOTES:

1. Total Excavation Area = 5.6 Acres
2. Total Excavation Volume = 39900 CY
3. Structures and Utilities Shown to be Removed for Remedy Implementation are Typical.

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BROOKLYN NAVY YARD PARCEL
FEASIBILITY STUDY

ALTERNATIVE No. 3
SITE -WIDE EXCAVATION

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such a system would be the same under each alternative. As such, costs for the sub-slab depressurization system would not affect remedy comparisons or selection.

- An IRM work plan has been submitted to the NYSDEC as a final remedy for the Former Drum Storage Area B to facilitate redevelopment. The IRM includes excavation within the former footprint of Drum Storage Area B. By default, for this site-wide excavation alternative, the IRM for former Drum Storage Area B is included in the remedy.

A cost estimate for this alternative is presented in Table 9-1. The estimated costs for this alternative are based on the capital costs for site clearing, sheeting/shoring, excavation, backfill, site restoration and soil disposal and laboratory analyses. Operation and maintenance is limited to annual certification for institutional controls (e.g., groundwater use restrictions) that would remain for the Site.

Table 9-1. Alternative No. 3 - Site-Wide Excavation Cost Estimate
Brooklyn Navy Yard Parcel
Feasibility Study

Capital Costs				
Item	**Unit**	**Unit Price**	**Quantity**	**Amount**
Mobilization/Demobilization	LS	$50,000		$50,000
Site Clearing	LS	$150,000		$150,000
Sheeting and Shoring	SF	$30	33000	$990,000
Excavation	CY	$7	39900	$279,000
Stockpiling and Testing	CY	$4	39900	$160,000
Soil Transport and Disposal, Hazardous	Ton	$200	40	$8,000
Soil Transport and Disposal, Non-Hazardous	Ton	$88	65000	$5,720,000
Backfill and Compaction	CY	$20	39900	$798,000
Post Excavation Confirmatory Sampling	LS	$40,000		$40,000
Soil Erosion and Sediment Control	LS	$50,000		$50,000
Site Restoration	LS	$400,000		$400,000
Miscellaneous (HASP, survey, permits)	LS	$50,000		$50,000
Environmental Easement	LS	$50,000		$50,000
Subtotal				$8,745,000
Engineering and Administration	LS	$250,000		$250,000
Contingency	%	25		$2,186,000
Total Capital Costs				$11,181,000
Annual Operation and Maintenance Costs				
Annual Certification of Institutional Controls	LS	$2,500		$2,500
Subtotal				$2,500
Contingency	%	25		$600
Total Annual Operation and Maintenance Costs				$3,100
Net Present Worth (3%, 30yrs)				$61,000
Total Net Present Worth				$11,242,000

9.2.3 Alternative No. 4: Site-Wide Cap

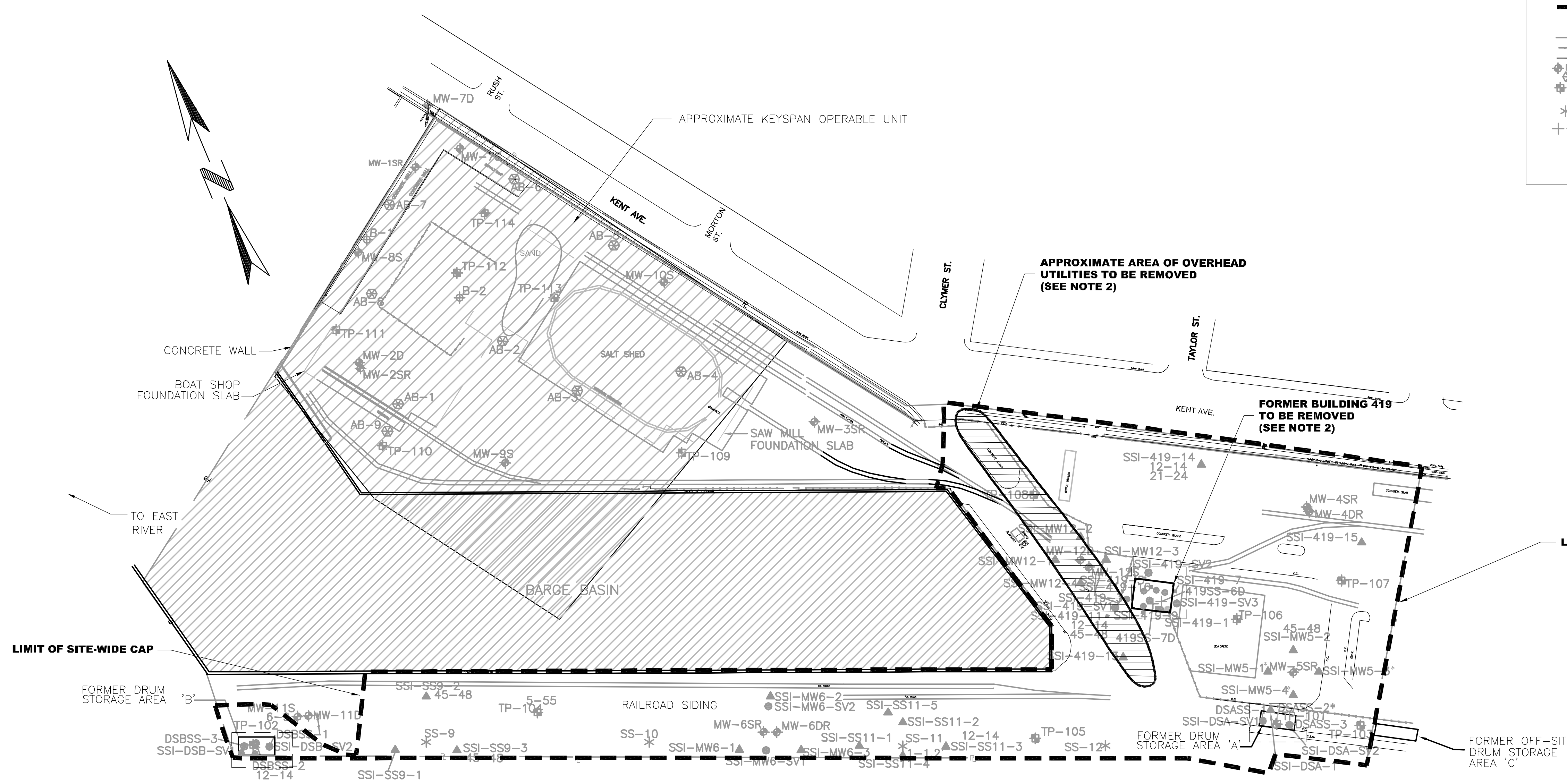
This alternative constitutes a containment remedy to the boundaries at which concentrations are above the TAGM 4046 guidance and/or Part 375-6 unrestricted use soil cleanup criteria or the property boundary, whichever is encountered first. This alternative would meet the remedial action objective of control of the direct contact exposure pathway. The components of this remedy are illustrated on Figure 9-2, and include the following:

- Site Clearing. Site clearing would consist of removal of surface structures (e.g., Former Building 419 foundation, fences, overhead utilities that may interfere with cap placement, etc.) to facilitate installation of a cap.

- Installation of an asphalt cap. A variety of caps could be considered for direct contact control (e.g., soil, asphalt, concrete, geosynthetics). And various redevelopment scenarios could become components of a cap. For example, a building slab would function as a cap, as would a paved parking lot associated with redevelopment of the Site. However, since the specifics of redevelopment are not currently known, for the purpose of evaluating this alternative, an asphalt cap has been assumed since it would be consistent with the current site conditions and future redevelopment as illustrated by the redevelopment contemplated by the IRM for former Drum Storage Area B. Redevelopment would also likely include some green/landscape areas and these would be capped with 24 inches or more of certified clean fill. The asphalt cap would be installed site wide to provide containment of exposed soils with concentrations above the TAGM 4046 guidance or Part 375-6 unrestricted use soil cleanup criteria, as shown on Figure 9-2. The total area to be caped is 5.6 acres. Various areas of the parcel currently are paved and/or contain concrete slabs. The asphalt cap in these areas would be installed as a two-inch thick overlay (approximately 49% of the site), under the assumption that an additional layer of material would be necessary for uniform coverage (e.g., control of cracks in existing features). In areas that are currently unpaved, a new asphalt cap would be installed, consisting of, in ascending order, a minimum of four inches of aggregate sub-base, a two and one-half-inch base course, and a two-inch wearing course (approximately 51% of the site).

  The extent and nature of the cap would be confirmed during design and in concert with site redevelopment plans. Asphalt cap is to be installed over exposed soils to limit potential for direct contact with site soils. For example, building foundations/slabs would serve the same purpose. If applicable (i.e., redevelopment building designs are confirmed), building foundations can be installed in an area in lieu of an asphalt cap and be integrated into the site-wide cap. Similarly, the nature and extent of existing "cap" materials (e.g., existing pavement) would be confirmed. Based on field data, the existing features may be functionally equivalent to the proposed cap without any overlay. Only if the existing features were inadequate to control the potential direct contact pathway, would an additional overlay be necessary.

  Site restoration. Surface structures removed for installation of the cap would be restored as applicable (e.g., fences).



LEGEND:

- = LIMIT OF SITE-WIDE CAP
- = SSI SURFACE AND SUBSURFACE SOIL SAMPLES
- = PROPERTY LINE
- = FENCE
- = FOUNDATION LIMITS
- MW-4SR = MONITORING WELL
- AB-2 = AUGER BORING
- TP-108 = TEST PIT
- B-2 = DEEP BORING
- SS-12 = IRM/SSA SURFACE SOIL SAMPLE (0-2")
- 419SS-6D = IRM/SSA DEEP SOIL SAMPLE (12"-14")

NOTES:

1. Total Cap Area = 5.6 Acres
2. Structures Shown to be Removed for Remedy Implementation are Typical.

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BROOKLYN NAVY YARD PARCEL
FEASIBILITY STUDY

ALTERNATIVE No. 4
SITE -WIDE CAP

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- An environmental easement, as described for Alternative No. 3.
- Building sub-slab depressurization system, as described for Alternative No. 3.
- Former Drum Storage Area B IRM, as described for Alternative No. 3.

A cost estimate for this alternative is presented in Table 9-2. The estimated costs for this alternative are based on the capital costs for site clearing, asphalt cap installation and site restoration along with excavation and disposal of soil for the former Drum Storage Area B IRM. Operation and maintenance costs include site inspections, cap maintenance, and annual certification for institutional/engineering controls that would remain for the Site.

9.2.4 Alternative No. 6: Localized Soil Excavation and Site-Wide Cap

This alternative represents a combination of a site-wide cap and localized excavation in areas at which data indicate impacts from prior site activities as compared to the TAGM and Site-Specific criteria for PCBs. Installation of a site-wide cap provides for the control of the soil direct contact exposure, thereby meeting the overall remedial action objective, including potential direct contact with the constituents present in the historic, urban fill. As discussed in Section 3, three areas have been identified as being impacted by PCBs from historic operations above the TAGM and Site-Specific criteria (i.e., Former Drum Storage Area B, Former Building 419, and a small portion of the Former Railroad Siding Area). In addition, because of lead concentrations above the TCLP criterion, one area would be characterized as containing a characteristic hazardous waste. The PCB and TCLP lead areas are not necessarily typical of the historic urban fill found on the site. Under this alternative, the localized PCB and TCLP lead areas would be addressed through excavation while the remainder of the site would be addressed through the site-wide cap.

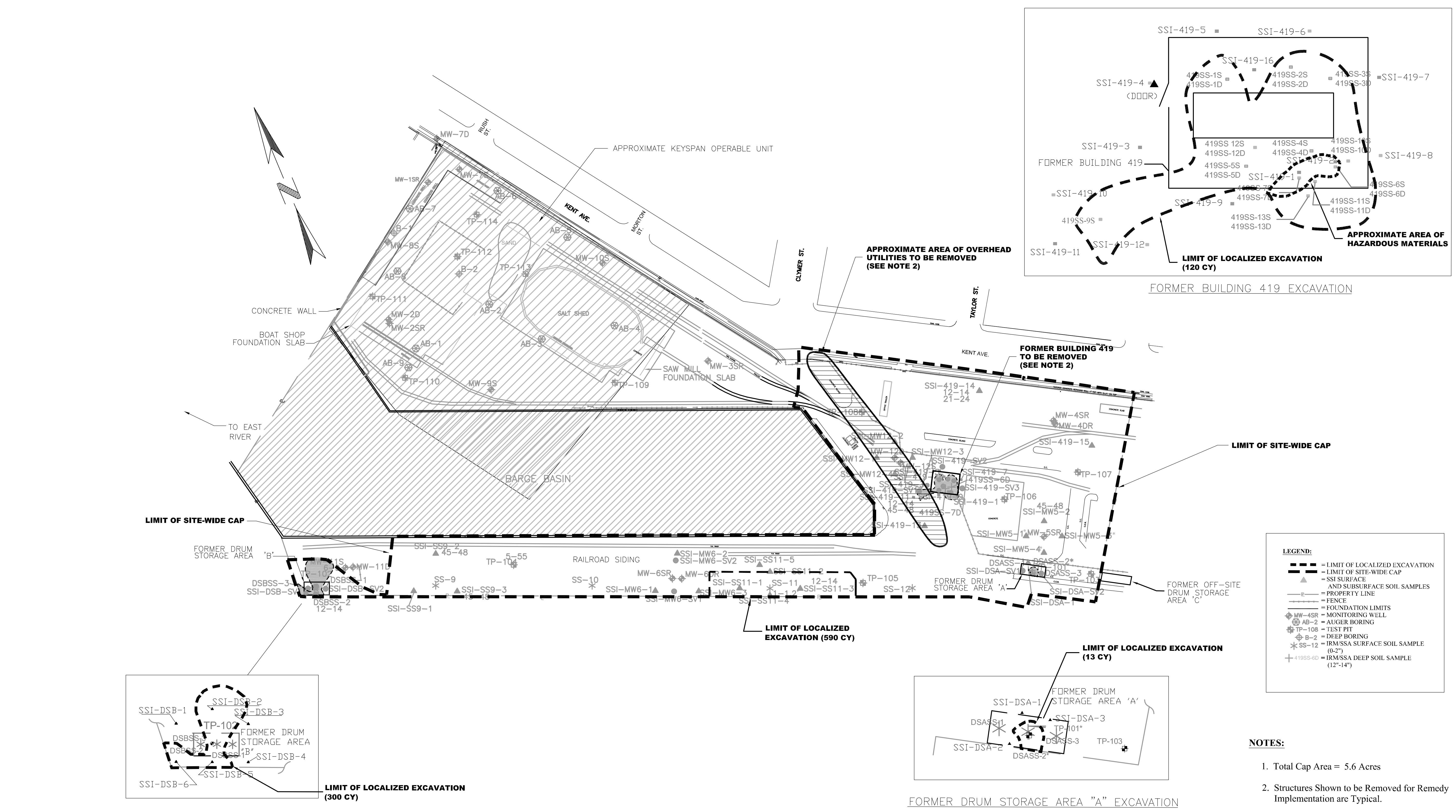
The components of this remedy are illustrated on Figure 9-3, and include the following:

- Site Clearing. Site clearing will consist of removal of surface structures (e.g., Former Building 419, fences, utilities, etc.) to facilitate installation of asphalt cap. No major site clearing is anticipated for the three localized areas of excavation.
- Excavation of soils above the TCLP lead criterion (>5 mg/l in extract) and the PCB soil cleanup criteria (>1 mg/kg 0-2', >10 mg/kg >2'), as described in Section 3. The maximum depth of excavation as indicated by the RI data is approximately three feet, and the extent of contamination has been defined from site investigations. The limits of excavation are shown on Figure 9-3, and the total volume of material to be excavated would be approximately 723 cy (excluding former Drum Storage Area B IRM). Excavation activities would be implemented in accordance with applicable OSHA regulations.

  Excavated soils would be stockpiled on site to confirm disposal requirements (i.e., sampling and analysis in accordance with the receiving facility requirements). Based on the site characterization data, for costing, the area where lead concentrations are found above the TCLP criterion in Former Drum Storage Area A and a small area of PCB impacted soil above 50 ppm in the vicinity of Former Building 419 are assumed to be disposed of as hazardous material.

Table 9-2. Alternative No. 4 - Site-Wide Cap Cost Estimate
Brooklyn Navy Yard Parcel
Feasibility Study

Capital Costs				
Item	**Unit**	**Unit Price**	**Quantity**	**Amount**
Mobilization/Demobilization	LS	$50,000		$50,000
Site Clearing	LS	$20,000		$20,000
Asphalt Cap, Overlay	Ac	$50,000	2.7	$137,000
Asphalt Cap, Full Depth	Ac	$150,000	2.9	$428,000
Drum Storage Area B IRM				
Excavation	CY	$7	300	$2,000
Stockpiling and Testing	CY	$10	300	$3,000
Soil Transport and Disposal, Non-Hazardous	Ton	$88	500	$44,000
Backfill and Compaction	CY	$20	300	$6,000
Post Excavation Confirmatory Sampling	LS	$2,500		$2,500
Soil Erosion and Sediment Control	LS	$50,000		$50,000
Site Restoration	LS	$50,000		$50,000
Miscellaneous (HASP, survey, permits)	LS	$50,000		$50,000
Environmental Easement	LS	$50,000		$50,000
Subtotal				$892,500
Engineering and Administration	LS	$150,000		$150,000
Contingency	%	25		$223,000
Total Capital Costs				$1,266,000
Annual Operation and Maintenance Costs				
Asphalt Cap Maintenance (sealcoating, crack repair)	Ac	$6,500	5.6	$36,000
Asphalt Cap Inspection	LS	$3,000		$3,000
Annual Certification of Institutional Controls	LS	$2,500		$2,500
Subtotal				$42,000
Contingency	%	25		$11,000
Total Annual Operation and Maintenance Costs				$53,000
Net Present Worth (3%, 30yrs)				$1,039,000
Total Net Present Worth				$2,305,000



NOTES:

1. Total Cap Area = 5.6 Acres
2. Structures Shown to be Removed for Remedy Implementation are Typical.

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BROOKLYN NAVY YARD PARCEL
FEASIBILITY STUDY

ALTERNATIVE No. 6
LOCALIZED SOIL EXCAVATION, AND SITE -WIDE CAP

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- Post-excavation soil confirmatory sampling. Post-excavation soil confirmatory sampling would be conducted in a manner generally consistent with NYSDEC draft DER-10 Technical Guidance for Site Investigation and Remediation minimum requirements. Samples would be collected from both the excavation bottom and from the excavation sidewalls. It is assumed that approximately 4 samples would be taken and analyzed for TCLP lead and approximately 31 samples would be taken and analyzed for PCBs, based on the configuration of the anticipated excavation limits. While this number of samples is less than the guidance in DER-10, it is considered reasonable for the multiple excavations and for the purpose of characterization for an environmental easement, as provided for in Section 5.4 of DER-10. If a sample result exceeds the TCLP lead criterion or the PCB cleanup criteria (5 ppm or 1 ppm shallow soils/10 ppm deep soils, respectively), the excavation limits would be expanded accordingly, followed by re-sampling until the sample results for the excavation sidewall and excavation bottom samples are below the relevant criteria. Portions of former Drum Storage Areas A and B are adjacent to the southern boundary of the Site. Recognizing that the Site is contained within a larger industrial property, characterized by urban fill as well, the potential exists for off-site contamination unrelated to the Site. Therefore, the approach to remediation activities along property boundaries would be as follows:

    - Pre-design delineation would be preferable to confirm the extent of off-site work, if any, prior to the start of remediation.
    - To the extent that delineation data (either pre-design or post-excavation) indicate circumstances are substantially different than known at the time of the Record of Decision, then the work would be interrupted and discussed with the NYSDEC to reconsider the approach to remediation.
    - To the extent that delineation data (either pre-design or post-excavation) indicate the presence of grossly contaminated media or source materials, as these media are defined in Part 375-1.2, related to the Site, then the limits of remediation would be adjusted accordingly.
    - To the extent that delineation data (either pre-design or post-excavation) indicate the presence of grossly contaminated media or source materials, as these media are defined in Part 375-1.2, unrelated to the Site, then the limits of remediation would not be adjusted.

- Backfill of excavation with certified clean fill. The excavation areas would be graded and restored to pre-excavation conditions. However, to the extent that redevelopment plans would require alternative grades (e.g., higher or lower final elevations, a building occupying a portion of the excavation area), backfill requirements would be adjusted accordingly, provided redevelopment plans are being implemented at the time the remediation occurs. Otherwise, backfill will be to pre-excavation grades.

- Installation of an asphalt cap, as described for Alternative 4.

- Site restoration as described for Alternative 4.

- An environmental easement, as described for Alternative No. 3

- Building sub-slab depressurization systems, as described for Alternative No. 3
- Former Drum Storage Area B IRM, as described for Alternative No. 3

A cost estimate for this alternative is presented in Table 9-3. The estimated costs for this alternative are based on the capital costs for site clearing, asphalt cap installation, excavation, backfill, site restoration and soil disposal and laboratory costs. Operation and maintenance costs include site inspections, cap maintenance, and annual certification for institutional/engineering controls that would remain for the Site.

Table 9-3. Alternative No. 6 - Localized Soil Excavation and Site-Wide Cap Cost Estimate Brooklyn Navy Yard Parcel Feasibility Study

Capital Costs				
Item	**Unit**	**Unit Price**	**Quantity**	**Amount**
Mobilization/Demobilization	LS	$50,000		$50,000
Site Clearing	LS	$20,000		$20,000
Excavation	CY	$7	1023	$7,000
Stockpiling and Testing	CY	$10	1023	$10,000
Soil Transport and Disposal, Hazardous	Ton	$200	40	$8,000
Soil Transport and Disposal, Non-Hazardous	Ton	$88	1650	$145,000
Backfilling and Compaction	CY	$17	1023	$17,000
Post Excavation Confirmatory Sampling	LS	$35,000		$35,000
Soil Erosion and Sediment Control	LS	$50,000		$50,000
Asphalt Cap, Overlay	Ac	$50,000	2.7	$137,000
Asphalt Cap, Full Depth	Ac	$150,000	2.9	$428,000
Site Restoration	LS	$50,000		$50,000
Miscellaneous (HASP, survey, permits)	LS	$50,000		$50,000
Environmental Easement	LS	$50,000		$50,000
Subtotal				$1,057,000
Engineering and Administration	LS	$150,000		$150,000
Contingency	%	25		$264,000
Total Capital Costs				$1,471,000
Annual Operation and Maintenance Costs				
Asphalt Cap Maintenance (sealcoating, crack repair)	Ac	$6,500	5.6	$36,000
Asphalt Cap Inspection	LS	$3,000		$3,000
Annual Certification of Institutional Controls	LS	$2,500		$2,500
Subtotal				$42,000
Contingency	%	25		$11,000
Total Annual Operation and Maintenance Costs				$53,000
Net Present Worth (3%, 30yrs)				$1,039,000
Total Net Present Worth				$2,510,000

9.2.5 Alternative No. 7: Localized Soil Excavation Including PCBs to the Part 375-6 Commercial Criteria, and Site-Wide Cap

This alternative represents a combination of a site-wide cap and localized excavation in areas at which data indicate impacts from prior site activities, similar to Alternative No. 6. This alternative increases the total volume of excavation of PCBs based on application of the Part 375-6 commercial criterion of 1 ppm regardless of depth, to address the NYSDEC preference for achieving pre-release conditions for constituents that may have been associated with past site operations. As noted previously, if pre-release conditions are assessed by the use of the Part 375-6 unrestricted use criteria, then this alternative would revert to Alternative No. 3. So, for the purpose of this alternative and given the future commercial use of the property, the Part 375-6 commercial criteria are applied to define excavation boundaries. Installation of a site-wide cap provides for the control of the soil direct contact exposure, thereby meeting the overall remedial action objective, including potential direct contact with the constituents present in the historic, urban fill. As discussed in Section 3, three areas have been identified as being impacted by PCBs from historic operations (i.e., Former Drum Storage Area B, Former Building 419, and a small portion of the Former Railroad Siding Area). In addition, because of lead concentrations above the TCLP criterion, one area would be characterized as containing a characteristic hazardous waste. The PCB and TCLP lead areas are not necessarily typical of the historic urban fill found on the site. Under this alternative, the localized PCB and TCLP lead areas would be addressed through excavation while the remainder of the site would be addressed through the site-wide cap.

The components of this remedy are illustrated on Figure 9-4, and include the following:

- Site Clearing Site, as described for Alternative No. 6

- Excavation of soils above the TCLP lead criterion (>5 mg/l in extract) and the PCB soil cleanup criteria (>1 mg/kg), as described in Section 3, for restoration of soils with PCBs to pre-release conditions. The maximum depth of excavation as indicated by the RI data is approximately four feet, and the extent of contamination has been defined from site investigations. The limits of excavation are shown on Figure 9-4, and the total volume of material to be excavated would be approximately 1,033 cy (excluding former Drum Storage Area B IRM which is estimated at 690 cy for this alternative). Excavation activities would be implemented in accordance with applicable OSHA regulations.

  Excavated soils would be stockpiled on site to confirm disposal requirements (i.e., sampling and analysis in accordance with the receiving facility requirements). Based on the site characterization data, for costing, the area where lead concentrations are found above the TCLP criterion in Former Drum Storage Area A and a small area of PCB impacted soil above 50 ppm in the vicinity of Former Building 419 are assumed to be disposed of as hazardous material.

- Post-excavation soil confirmatory sampling, as described for Alternative No, 6. It is assumed that approximately 4 samples would be taken and analyzed for TCLP lead and approximately 31 samples would be taken and analyzed for PCBs, based on the configuration of the anticipated excavation limits, as previously described for Alternative No. 6.

- Backfill of excavation with certified clean fill, as described for Alternative No. 6.
- Installation of an asphalt cap, as described for Alternative 4.
- Site restoration as described for Alternative 4.
- An environmental easement, as described for Alternative No. 3
- Building sub-slab depressurization systems, as described for Alternative No. 3
- Former Drum Storage Area B IRM, as described for Alternative No. 3, although the limits of excavation may vary somewhat based on the clean-up criteria.

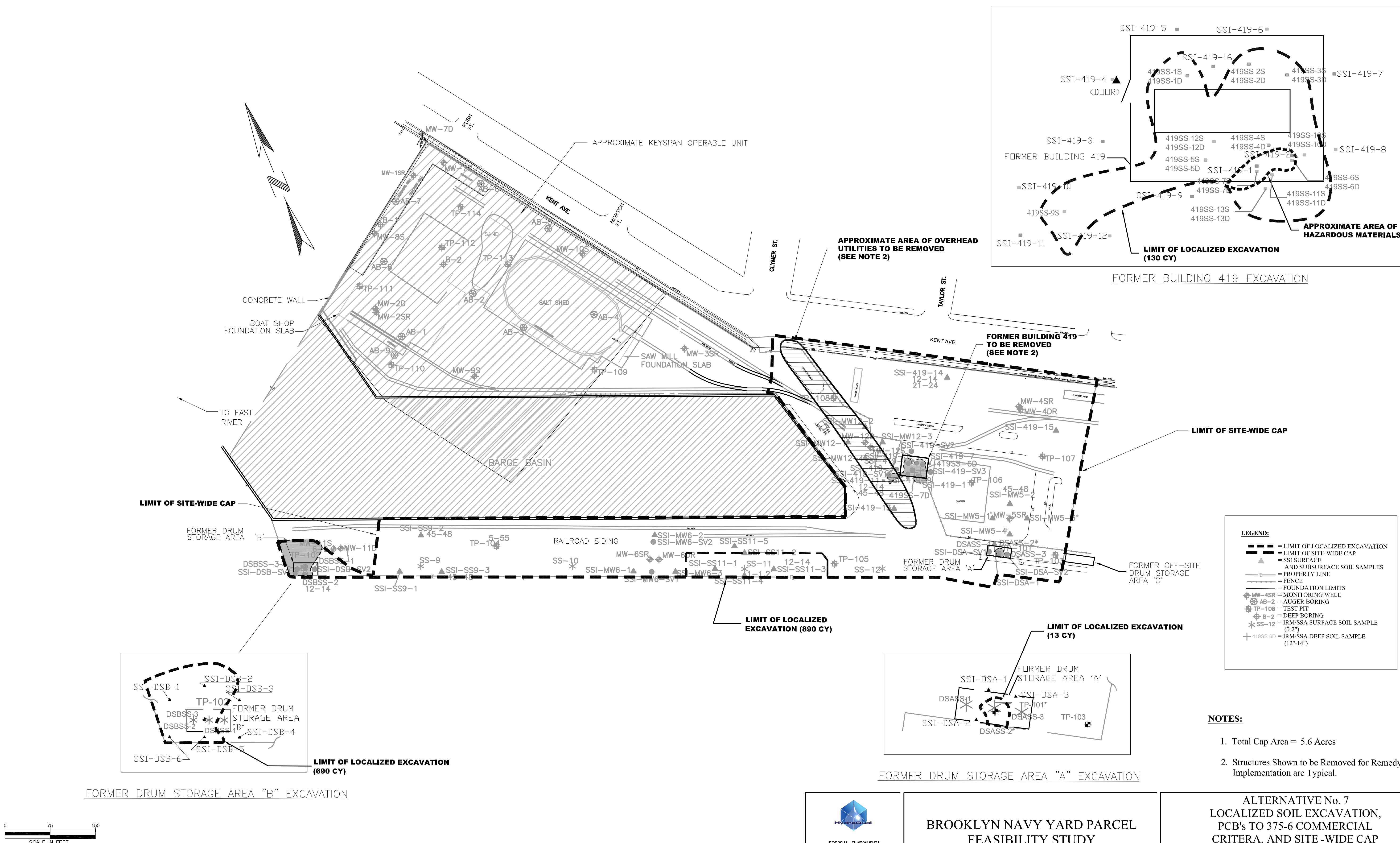
A cost estimate for this alternative is presented in Table 9-4. The estimated costs for this alternative are based on the capital costs for site clearing, asphalt cap installation, excavation, backfill, site restoration and soil disposal and laboratory costs. Operation and maintenance costs include site inspections, cap maintenance, and annual certification for institutional/engineering controls that would remain for the Site.

9.3 ALTERNATIVES ANALYSIS

Evaluation of the alternatives against the seven criteria described in Section 9.1 (i.e., community acceptance is addressed through the NYSDEC remedy selection process) is presented in Table 9-5. The results of this evaluation may be summarized as follows:

- Alternative No. 1 – No Action: This alternative was retained as a baseline for comparison with other alternatives. It would not be protective of human health. Alternative No. 1 would not reduce toxicity, mobility or volume of contamination nor would it meet SCGs. Because no remedial or construction actions are taken, there would not be short-term impacts from implementation. While it is readily implementable and has no associated costs, this alternative remains only as a benchmark for comparison of other alternatives.

  Alternative No. 3 – Site-Wide Excavation: This alternative would be protective of human health and the environment through the removal of site soils above the relevant cleanup criteria. It would also comply with SCGs (chemical, location, and action specific) and represents an alternative designed to restore the site to pre-development conditions, to the extent practicable. Permitting is expected to be conventional. The removal of impacted soils would reduce the volume of contamination found on site. The alternative is effective in the long term, as the removal of impacted soil from the site is permanent. Short term construction impacts would exist including traffic (over 5,000 truck trips – two-way), noise (albeit to a lesser extent given the industrial character of the area), and dust, and construction and health and safety controls would have to be in place during implementation to limit the potential for impacts to human health and environment on a short-term basis. The excavation alternative is generally implementable with conventional equipment and materials. However, some restrictions would apply such as temporarily closing one of the entrance gates to the Brooklyn Navy Yard Industrial Park.



NOTES:

1. Total Cap Area = 5.6 Acres
2. Structures Shown to be Removed for Remedy Implementation are Typical.

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BROOKLYN NAVY YARD PARCEL
FEASIBILITY STUDY

ALTERNATIVE No. 7
LOCALIZED SOIL EXCAVATION, PCB's TO 375-6 COMMERCIAL CRITERA, AND SITE -WIDE CAP

Date	Project No.	Figure No.	Issue
SEPTEMBER 2007	NYCS.020.016.002	9-4	
	File Name:		

Table 9-4. Alternative No. 7 - Localized Soil Excavation, Including PCBs to Part 375-6 Commercial Criteria, and Site-Wide Cap Cost Estimate Brooklyn Navy Yard Parcel Feasibility Study

Capital Costs				
Item	**Unit**	**Unit Price**	**Quantity**	**Amount**
Mobilization/Demobilization	LS	$50,000		$50,000
Site Clearing	LS	$20,000		$20,000
Excavation	CY	$7	1723	$12,000
Stockpiling and Testing	CY	$10	1723	$17,000
Soil Transport and Disposal, Hazardous	Ton	$200	40	$8,000
Soil Transport and Disposal, Non-Hazardous	Ton	$88	2750	$242,000
Backfilling and Compaction	CY	$17	1723	$29,000
Post Excavation Confirmatory Sampling	LS	$40,000		$40,000
Soil Erosion and Sediment Control	LS	$50,000		$50,000
Asphalt Cap, Overlay	Ac	$50,000	2.7	$137,000
Asphalt Cap, Full Depth	Ac	$150,000	2.9	$428,000
Site Restoration	LS	$50,000		$50,000
Miscellaneous (HASP, survey, permits)	LS	$50,000		$50,000
Environmental Easement	LS	$50,000		$50,000
Subtotal				$1,183,000
Engineering and Administration	LS	$150,000		$150,000
Contingency	%	25		$296,000
Total Capital Costs				$1,629,000
Annual Operation and Maintenance Costs				
Asphalt Cap Maintenance (seal coating, crack repair)	Ac	$6,500	5.6	$36,000
Asphalt Cap Inspection	LS	$3,000		$3,000
Annual Certification of Institutional Controls	LS	$2,500		$2,500
Subtotal				$42,000
Contingency	%	25		$11,000
Total Annual Operation and Maintenance Costs				$53,000
Net Present Worth (3%, 30yrs)				$1,039,000
Total Net Present Worth				$2,668,000

Table 9-5. Detailed Evaluation of Alternatives
Brooklyn Navy Yard Parcel
Feasibility Study

Alternative	Protection of Human Health and the Environment	Compliance w/ SCGs	Long-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Implementability	Cost (NPW, 30 years, 3% discount rate)
Alternative No. 1 -- No Action	Not protective of human health. Would not control potential for exposure.	Does not comply with SCGs.	No action, therefore, no long-term effectiveness.	Does not reduce toxicity, mobility, or volume.	No short-term impacts because no action taken.	Readily implementable.	None
Alternative No.3 – Site-Wide Soil Excavation	Protective of human health and the environment on a site-wide basis through excavation to the water table. Is an alternative for restoration to pre-development conditions, to the extent practicable.	Complies with SCGs, no special permitting requirements.	Removal is permanent; effective in the long-term for preventing direct contact with soil above the water table.	Reduces volume of contaminants through excavation and off-site disposal.	Construction related impacts including traffic, noise, and dust. Truck trips on the order of 5,000 because of large volume of excavation.	Generally implementable with conventional materials and equipment. Would require temporary closure of an entrance to the Brooklyn Navy Yard Industrial Park.	$11,242,000
Alternative No.4 – Site-Wide Cap	Protective of human health and the environment through containment of site soils. Would eliminate complete exposure pathway for soils.	Complies with SCGs, no special permitting requirements.	Effective in the long-term with proper maintenance of cap and/or redevelopment features serving as cap.	Reduces mobility of contaminants with respect to direct contact soil exposure (e.g., generation of dust)	Typical construction–related impacts (e.g., noise, dust, traffic) associated with installation of asphalt cap and site restoration.	Implementable with conventional materials and equipment.	$2,305,000

Table 9-5. Detailed Evaluation of Alternatives
Brooklyn Navy Yard Parcel
Feasibility Study

Alternative	Protection of Human Health and the Environment	Compliance w/ SCGs	Long-Term Effectiveness	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Implementability	Cost (NPW, 30 years, 3% discount rate)
Alternative No.6 – Localized Soil Excavation and Site-Wide Cap	Protective of human health and the environment through containment of site soils and localized excavation and disposal. Would eliminate complete exposure pathway for soils.	Complies with SCGs, no special permitting requirements.	Effective in the long-term with proper maintenance of cap and/or redevelopment features serving as cap. Soil removal component is permanent.	Reduces volume of contaminants through excavation and disposal. Reduces mobility of contaminants with respect to direct contact soil exposure (e.g., generation of dust)	Typical construction–related impacts (e.g., noise, dust, traffic) associated with excavation and disposal, installation of asphalt cap, and site restoration.	Implementable with conventional materials and equipment.	$2,510,000
Alternative No.7 – Localized Soil Excavation Including PCBs above Part 375-6 Commercial Criteria, and Site-Wide Cap	Protective of human health and the environment through containment of site soils and localized excavation and disposal. Would eliminate complete exposure pathway for soils.	Complies with SCGs, no special permitting requirements.	Effective in the long-term with proper maintenance of cap and/or redevelopment features serving as cap. Soil removal component is permanent.	Reduces volume of contaminants through excavation and disposal. Reduces mobility of contaminants with respect to direct contact soil exposure (e.g., generation of dust)	Typical construction–related impacts (e.g., noise, dust, traffic) associated with excavation and disposal, installation of asphalt cap, and site restoration.	Implementable with conventional materials and equipment.	$2,668,000

- Alternative No. 4 – Site-Wide Cap: This alternative would be protective of human health and the environment through the containment of site soils above the relevant cleanup criteria via an asphalt cap and/or future redevelopment features (e.g., building slabs, parking lots). It would also comply with SCGs and permitting is expected to be conventional. The alternative is generally effective in the short-term as construction-related impacts are not expected to be substantial (cap construction would likely require only several hundred truck trips), and dust and noise would be minimized by the limited construction duration, particularly if combined with site redevelopment. Nonetheless, construction and health and safety controls would be required during implementation. The remedy would be effective in the long-term with proper maintenance including regular inspection of the cap, seal coating to help preserve the asphalt, and crack repair. This alternative is readily implementable with conventional equipment and materials.

- Alternative No. 6 – Localized Excavation and Site-Wide Cap: This alternative would be protective of human health and the environment through the containment of site soils above the relevant cleanup criteria via an asphalt cap and/or future redevelopment features, and through the removal of contaminated soil within specific areas of the Site. It would also comply with SCGs and again, permitting is expected to be conventional. The alternative is generally effective in the short-term as construction-related impacts are not expected to be substantial (cap construction and localized excavation would likely require only several hundred truck trips), and dust and noise would be minimized by the limited excavation and construction duration, particularly if combined with site redevelopment. Nonetheless, construction and health and safety controls would be required during implementation. The remedy would be effective in the long-term with proper maintenance including regular inspection of the cap, sealcoating to help preserve the asphalt, and crack repair. This alternative is readily implementable with conventional equipment and materials. In addition, soils impacted by previous site operations will be removed from the site permanently; therefore, the volume of contamination on site will be reduced.

- Alternative No. 7 – Localized Excavation including PCBs above Part 375-6 commercial criteria (<1 ppm) and Site-Wide Cap: This alternative would be protective of human health and the environment through the containment of site soils above the relevant cleanup criteria via an asphalt cap and/or future redevelopment features, and through the removal of contaminated soil within specific areas of the Site. It would also comply with SCGs and again, permitting is expected to be conventional. The alternative is generally effective in the short-term as construction-related impacts are not expected to be substantial (cap construction and localized excavation would likely require only several hundred truck trips), and dust and noise would be minimized by the limited excavation and construction duration, particularly if combined with site redevelopment. Nonetheless, construction and health and safety controls would be required during implementation. The remedy would be effective in the long-term with proper maintenance including regular inspection of the cap, seal coating to help preserve the asphalt, and crack repair. This alternative is readily implementable with conventional equipment and materials. In addition, soils impacted by previous site operations will be removed from the site permanently; therefore, the volume of contamination on site will be reduced.

9.4 COMPARATIVE ANALYSIS OF ALTERNATIVES

To recommend a remedial alternative for the Brooklyn Navy Yard Parcel, a comparative analysis was performed for the alternatives presented above. This comparative analysis is presented in Table 9-6 using the seven evaluation criteria described in Section 9.1. A review of Table 9-6 indicates the following when comparing the alternatives:

- As expected, because Alternative No. 1 – No Action was retained as a baseline for comparison with other alternatives, it does not satisfy the evaluation criteria (e.g., does not meet SCGs).

- Each of the remaining alternatives (Alternative Nos. 3, 4, 6, and 7) would meet the remedial action objectives and would generally be equally protective of human health and the environment through the control of the direct contact pathway.

- Alternative Nos. 3, 6, and 7 would both provide a reduction in the volume of contaminants on site, with Alternative No. 3 providing the greatest reduction. Alternative Nos. 4, 6, and 7 would reduce the mobility of contaminants through the installation of an asphalt cap.

- Alternative Nos. 3, 4, 6, and 7 would each comply with SCGs and would not involve special permitting requirements.

- Alternative No. 3 is the more permanent of the remedies in that a large volume of soil would be removed permanently from the Site. However, residual contamination below the water table would remain and institutional controls would need to remain in effect as a consequence. Alternative Nos. 4, 6, and 7 are effective in the long-term with proper maintenance.

- All of the alternatives result in conventional, short-term, construction impacts. Alternative No. 3 would require a longer time frame for implementation than Alternative Nos. 4, 6, or 7 because of the large volume of excavation and the need to sheet and shore along the perimeter of the site. Alternative No. 3 would also have the greatest potential for short term impacts (traffic, dust) because of the large volume of excavation.

- All of the alternatives are generally implementable, as they consist of conventional construction methods. Alternative No. 3 would require the temporary closure of an entrance to the Brooklyn Navy Yard Industrial Park.

- The estimated total net present worth for a period of 30 years, using a discount rate of 3%, for Alternative Nos. 3, 4, 6, and 7 is $11,242,000, $2,305,000, $2,510,000, and $2,668,000, respectively.

Table 9-6. Detailed Analysis Summary and Comparative Analysis of Alternatives
Brooklyn Navy Yard Parcel
Feasibility Study

Evaluation Criteria	Alt. No. 1: No Action	Alt. No. 3: Site-Wide Soil Excavation	Alt. No. 4: Site-Wide Cap	Alt. No. 6: Localized Soil Excavation and Site-Wide Cap	Alt. No. 7: Localized Soil Excavation (PCBs >1 ppm) and Site-Wide Cap
Protection of Human Health and the Environment	Not protective of human health Relative Scale = 1	Protective of human health and the environment Relative Scale = 5	Protective of human health and the environment Relative Scale = 4	Protective of human health and the environment Relative Scale = 4	Protective of human health and the environment Relative Scale = 4
Compliance with SCGs	Does not comply with SCGs Relative Scale = 1	Complies with SCGs Relative Scale = 5	Complies with SCGs Relative Scale = 5	Complies with SCGs Relative Scale = 5	Complies with SCGs Relative Scale = 5
Long-Term Effectiveness and Permanence	No long-term effectiveness Relative Scale = 1	Effective in the long-term but still requires use restrictions below water table Relative Scale = 4	Effective in the long-term with proper cap maintenance. Relative Scale = 4	Effective in the long-term with proper cap maintenance Relative Scale = 4	Effective in the long-term with proper cap maintenance Relative Scale = 4
Reduction of Toxicity, Mobility or Volume	Does not reduce toxicity, mobility or volume. Relative Scale = 1	Reduces volume through removal of site soils. Relative Scale = 5	Reduces mobility of contaminated soil with respect to direct contact exposure. Relative Scale = 3	Reduces mobility of contaminated soil with respect to direct contact exposure. Reduces volume by removal of impacted soil related to past operations. Relative Scale = 4	Reduces mobility of contaminated soil with respect to direct contact exposure. Reduces volume by removal of impacted soil related to past operations. Relative Scale = 4
Short-Term Effectiveness	No short-term impacts. No implementation items. Relative Scale = 5	Typical construction short-term impacts; significant traffic impacts and potential dust generation. Relative Scale = 3	Typical construction short-term impacts. Short term implementation. Relative Scale = 4	Typical construction short-term impacts. Short term implementation. Relative Scale = 4	Typical construction short-term impacts. Short term implementation. Relative Scale = 4

Table 9-6. Detailed Analysis Summary and Comparative Analysis of Alternatives
Brooklyn Navy Yard Parcel
Feasibility Study

Evaluation Criteria	Alt. No. 1: No Action	Alt. No. 3: Site-Wide Soil Excavation	Alt. No. 4: Site-Wide Cap	Alt. No. 6: Localized Soil Excavation and Site-Wide Cap	Alt. No. 7: Localized Soil Excavation (PCBs >1 ppm) and Site-Wide Cap
Implementability	Readily implemented Relative Scale = 5	Would require temporary closure of entrance to Brooklyn Navy Yard Industrial Park. Large scale excavation implementation. Relative Scale = 3	Generally implementable with conventional equipment and materials. Relative Scale = 4	Generally implementable with conventional equipment and materials. Relative Scale = 4	Generally implementable with conventional equipment and materials. Relative Scale = 4
Cost	None Relative Scale = 5	$11,242,000 Relative Scale = 1	$2,305,000 Relative Scale = 4	$2,510,000 Relative Scale = 4	$2,668,000 Relative Scale = 4

Relative Scale: 1 ◄——► 5
Worse Than Other Alternatives Better

Based on the foregoing comparison, on balance, Alternative No. 6 meets the remedial objectives, reduces the volume of contaminants on site, can be implemented quickly, will be effective over the long-term with proper maintenance, has limited short-term impacts, and is cost effective, being approximately an order of magnitude below Alternative No 3 – Site-Wide Excavation for a 30 year operational period, only slightly more costly than Alternative No. 4, which is a similar alternative, and slightly less costly than Alternative No. 7. By comparison, Alternative No. 3 would have substantial short-term impacts and while a large volume reduction would occur, residuals (historic fill) would remain on site and in the general environs. Therefore, overall, the benefits of Alternative No. 3 do not outweigh the implementation difficulties nor the nearly order of magnitude cost differential, particularly since other alternatives perform equally well in protecting human health and the environment.

Alternative Nos. 6 and 7 are very similar with the only difference being that Alternative No. 6 uses the previously established site-specific criterion for PCB cleanup at depth (i.e., 10 ppm), which is also consistent with the TAGM 4046 criteria, while Alternative No. 7 uses the current Part 375-6 commercial criterion of 1 ppm regardless of depth. Alternative No. 7 was developed to address an NYSDEC preference for restoration to pre-release conditions for constituents associated with the site (i.e., released as opposed to components of historic fill). The presence of PCBs does have a link to prior site use (e.g., transformer fire at Building 419), and Alternative No. 7 would attempt to restore the site to pre-release conditions, as defined by the commercial criteria. If the unrestricted use criteria were applied, Alternative No. 7 would revert to Alternative No. 3, site-wide excavation. Excavation of PCBs to the 1 ppm level regardless of depth does not offer any incremental risk reduction, as the presence of historic fill results in contaminants remaining above cleanup criteria and risk-based levels for each of the alternatives. Therefore, Alternative No. 7 does not offer any meaningful advantage over Alternative No. 6, but does have an increment of cost. In addition, the PCB criterion of 1 ppm could result in excess excavation of historic fill since the PCB concentrations were variable on the site around this concentration, and may or may not be associated with past site use. For example, at sample location 419SS-13, the PCB concentration was 0.65 ppm in the 0-0.25' interval, whereas the concentration was 3 ppm at the 1'-1.2' interval. This reverse condition of what would be expected from a surface release occurred at several other locations (including G2SS-7, 8, and 9 and SSI-DSB-1). In addition, there were a variety of samples with PCBs detected at less than 1 ppm (e.g., in the range of 0.1 to 0.9 ppm), and on occasion one sample in a duplicate would be above the 1 ppm criterion while the other would be below (e.g., SSI-419-1-SB2 with 1.55 v. 0.394 ppm). These data suggest some inherent variability in the soil/fill around the 1 ppm level that could complicate the excavation process.

Therefore, on balance, given all of the above considerations, Alternative No. 6 is recommended for implementation.

APPENDIX A

AREAS AND VOLUMES OF CONTAMINATED SOIL CALCULATIONS

HydroQual

Environmental
Engineers & Scientists

AREA/VOLUME CALCULATION
REPRESENTATIVE OF CONCENTRATIONS GREATER THAN
TAGM-4046, PART 375-6 UNRESTRICTED, AND PART 375-6 COMMERCIAL

Depth to Conc. > Criteria (ft)	Area (sf)	Depth for Calculation if > GWT (ft)	Volume (cy)
4.5	6110	4.5	1018
6.25	13610	6	3024
5.5	10970	5.5	2235
1.2	11110	6	2469
14	13750	6	3056
6.25	5560	6	1236
6	3960	6	880
2	4370	2	324
4	4030	4	597
6	10620	6	2360
1.2	19900	1.2	884
7	420	7	109
7.5	4230	6	940
2	1950	2	144
1.2	6110	1.2	272
16	900	6	200
6	4860	6	1080
6.25	9600	6	2133
4	17360	4	2572
6.4	6800	6	1511
4	2990	4	443
2	6110	2	453
3	10400	3	1156
2	8330	2	617
16	12290	6	2731
6.25	15760	6	3502
18	11800	6	2622
1.5	22500	1.5	1250
Totals	**246400**		**39817**

AREA/VOLUME CALCULATION
BUILDING 419 PCB CONCENTRATIONS > SITE-SPECIFIC CRITERIA

Sample Location	Depth to Conc. > Site Specific Criteria (ft)	Depth for Volume Calculation (ft)	Area SF	Volume Calculation (ft)
419SS-1	0 - 0.25	1	419	16
419SS-9	0 - 0.25	1		
419SS-2	1 - 1.2	2	498	37
419SS-3	1 - 1.2	2		
419SS-5	1 - 1.2	2		
419SS-12	1 - 1.2	2		
SSI-419-1	1.75 - 2	3	611	68
SSI-419-25	1 - 2	3		
419SS-4	1 - 1.2	3		
419SS-6	0 - 0.25	3		
419SS-7	0 - 0.25	3		
419SS-10	0 - 0.25	3		
419SS-11	1 - 1.2	3		
419SS-13	1 - 1.2	3		
		Totals	**1528**	**121**

AREA/VOLUME CALCULATION
FORMER DRUM STORAGE AREA B PCB CONCENTRATIONS > SITE-SPECIFIC CRITERIA

Sample Location	Depth to Conc. > Site Specific Criteria (ft)	Depth for Volume Calculation (ft)	Area SF	Volume Calculation (ft)
DSBSS-2	0 - 0.2	3	2708	301
TP102	0 - 0.2	3		
SSI-DSB-2	1.75 - 2	3		
SSI-DSB-5	0.5 - 0.75	3		
SSI-DSB-6	0.5 - 0.75	3		

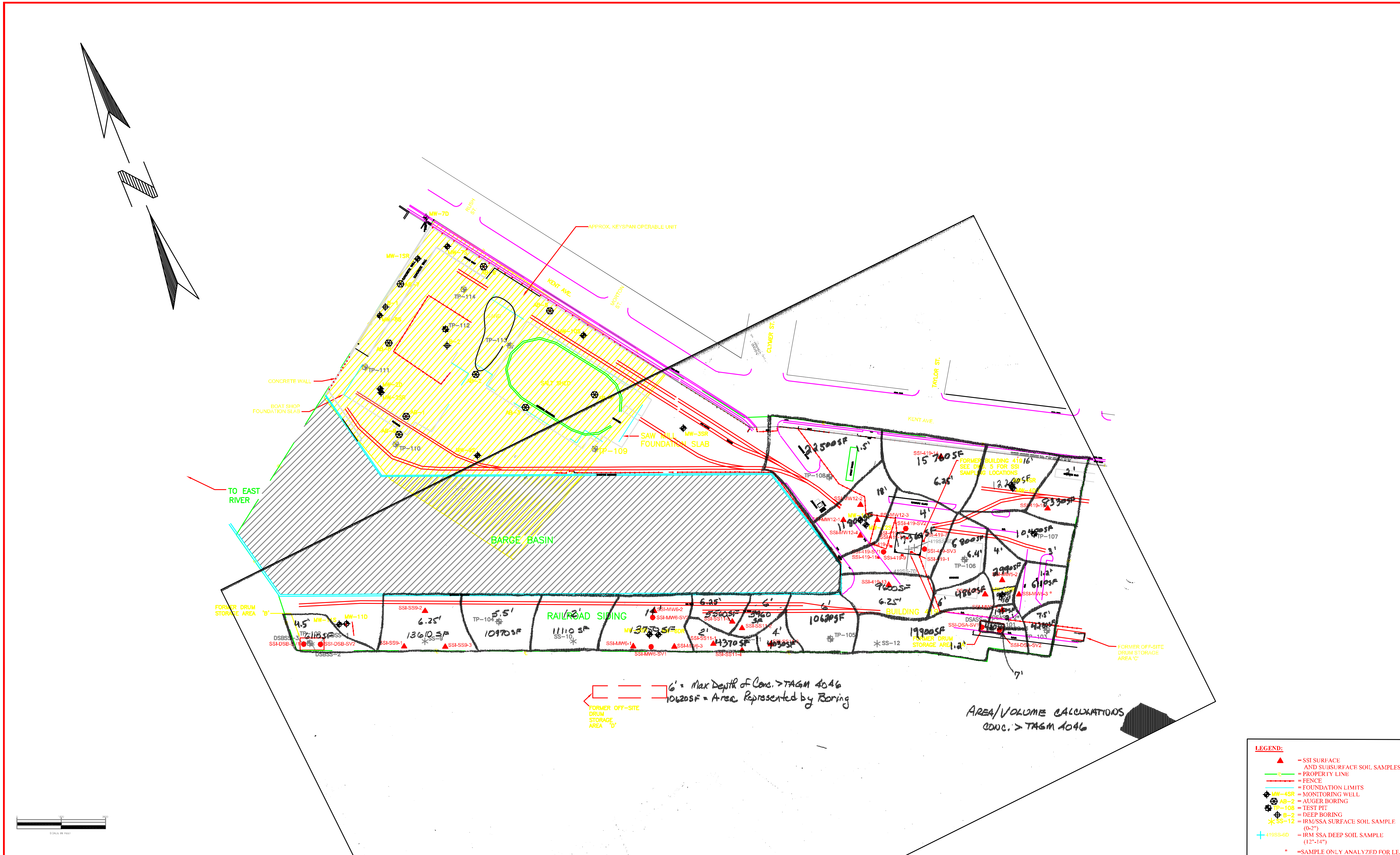
AREA/VOLUME CALCULATION
FORMER DRUM STORAGE AREA A LEAD CONCENTRATIONS > TCLP CRITERIA

Sample Location	Depth to Conc. > TCLP Criteria (ft)	Depth for Volume Calculation (ft)	Area (sf)	Volume Calculation (cy)
DSASS-2	> 0.25	2	170	13
TP101-1	1 - 1.2	2		

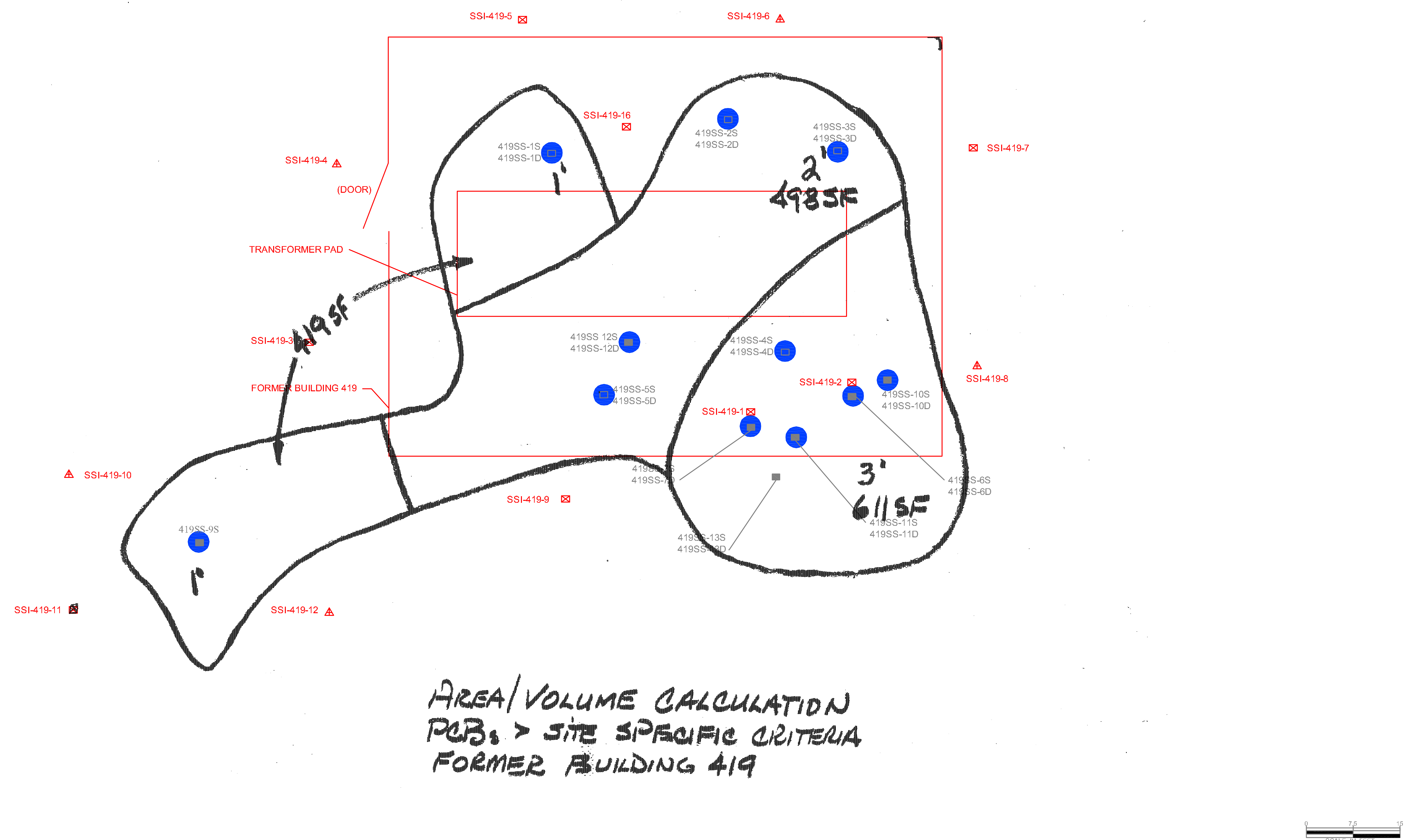
AREA/VOLUME CALCULATION
FORMER RAILROAD SIDING AREA PCB CONCENTRATIONS > TAGM 4046 / SITE-SPECIFIC CRITERIA

Sample Location	Depth to Conc. > Criteria (ft)	Next Lower Sample Inverval < Criteria (ft)	Projected Depth to 1 ppm	Depth for Volume Calculation (ft)	Area SF	Volume Calculation (CY)
G2SS-7D	1 - 1.2	NA	NA	2	7964	590
G2SS-8D	1 - 1.2	NA	NA			
G2SS-9D	1 - 1.2	NA	NA			
SSI-SS11-3*	1 - 1.2	3.75-4	2			

*Assume 1.5 mg/kg concentration is representative of upper two feet.



BARGE BASIN
RAILROAD SIDING
TO EAST RIVER
SAW MILL FOUNDATION SLAB
BUILDING 419
FORMER BUILDING 419 SEE FIG. 3 FOR SSI SAMPLING LOCATIONS
FORMER DRUM STORAGE AREA "B"
FORMER OFF-SITE DRUM STORAGE AREA "B"
KENT AVE.
TAYLOR ST.
6' = Max Depth of Conc. > TAGM 4046
10620SF = Area Represented by Boring
AREA/VOLUME CALCULATIONS
CONC. > TAGM 4046
LEGEND:
= SSI SURFACE AND SUBSURFACE SOIL SAMPLES
= PROPERTY LINE
= FENCE
= FOUNDATION LIMITS
= MONITORING WELL
= AUGER BORING
= TEST PIT
= DEEP BORING
= IRM/SSA SURFACE SOIL SAMPLE (0-2")
= IRM SSA DEEP SOIL SAMPLE (12"-14")
* = SAMPLE ONLY ANALYZED FOR LEAD.



AREA/VOLUME CALCULATION
PCBs > SITE SPECIFIC CRITERIA
FORMER BUILDING 419

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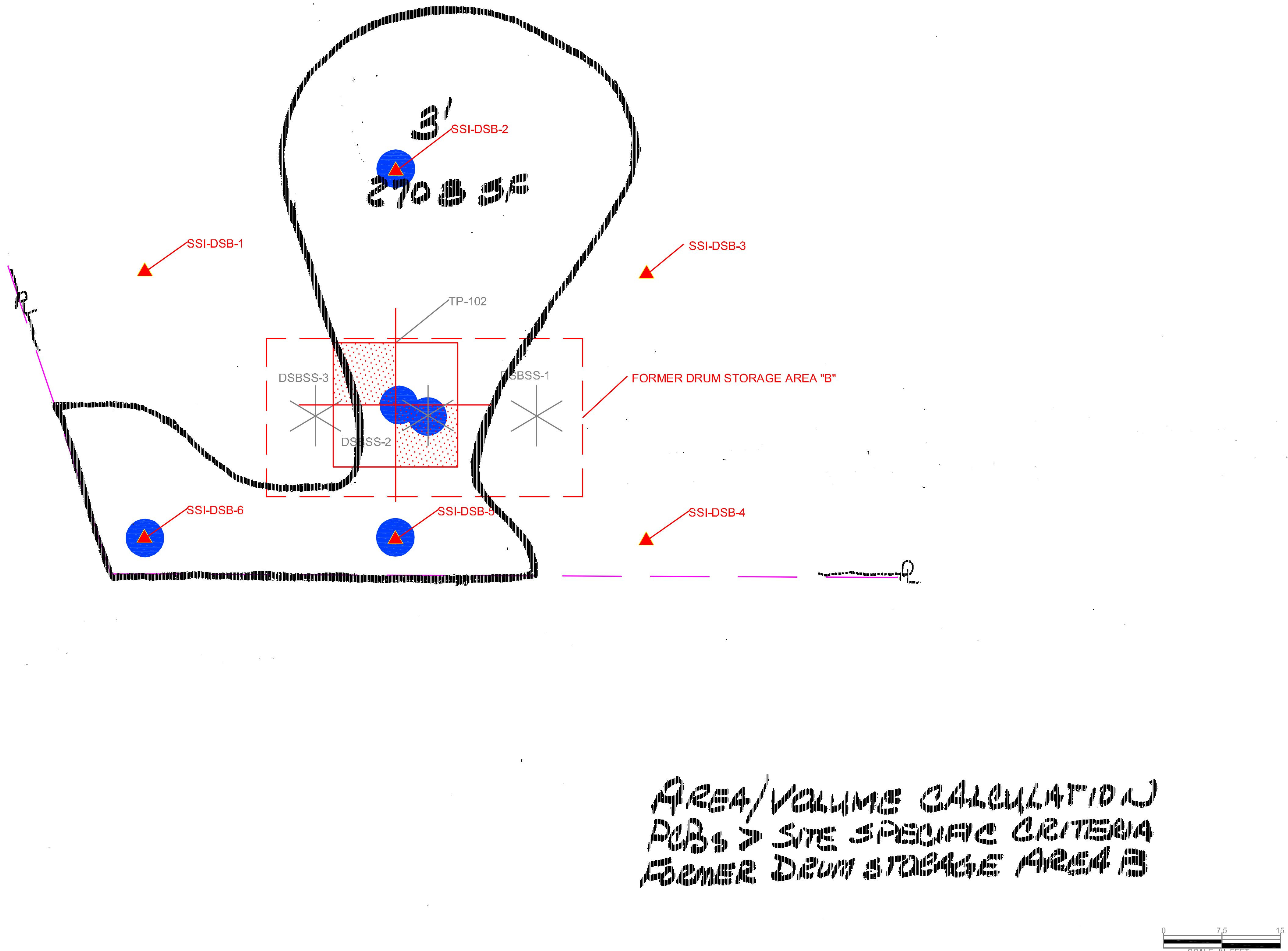

AREA/VOLUME CALCULATION
PCBs > SITE SPECIFIC CRITERIA
FORMER DRUM STORAGE AREA B

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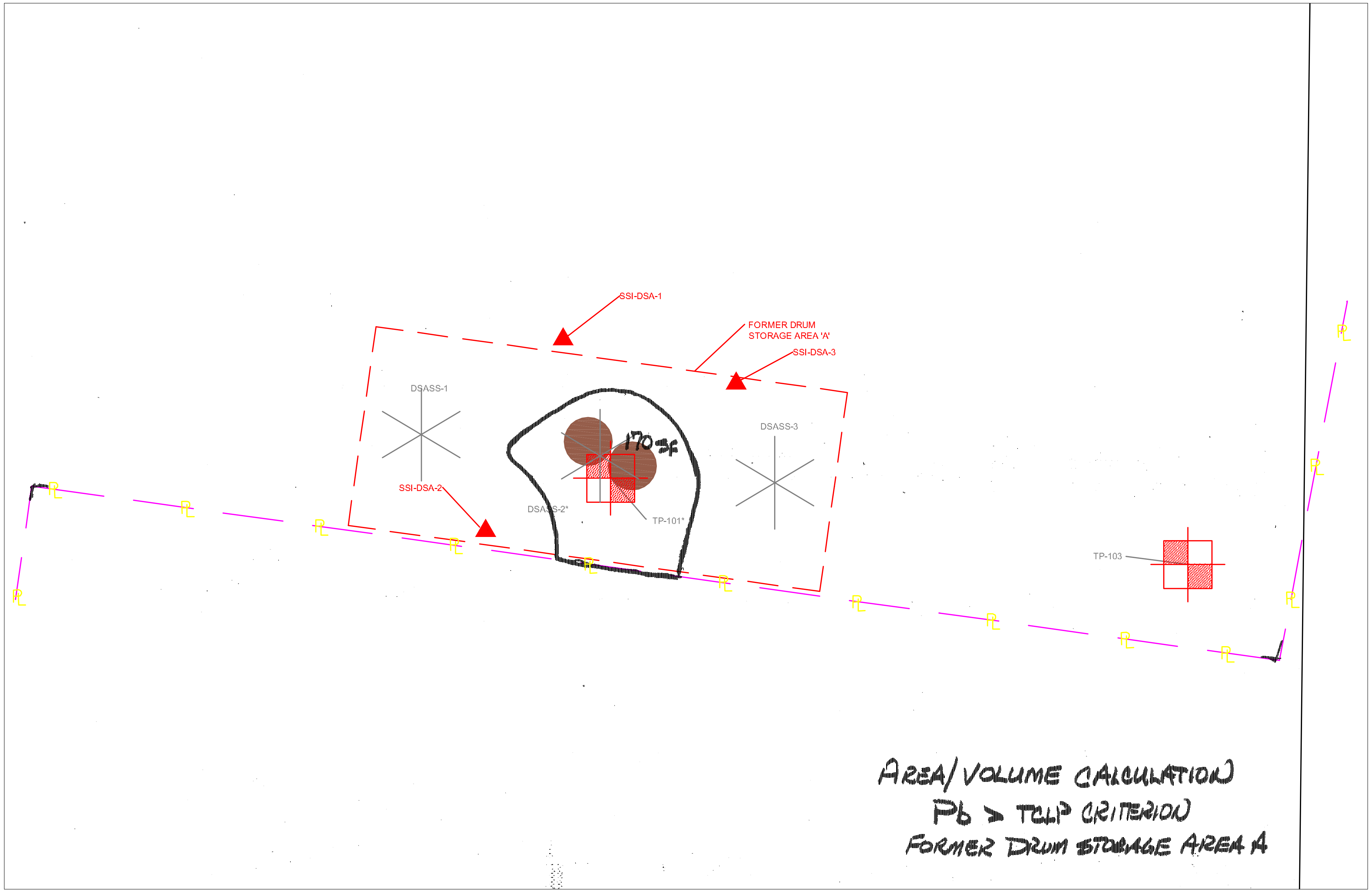

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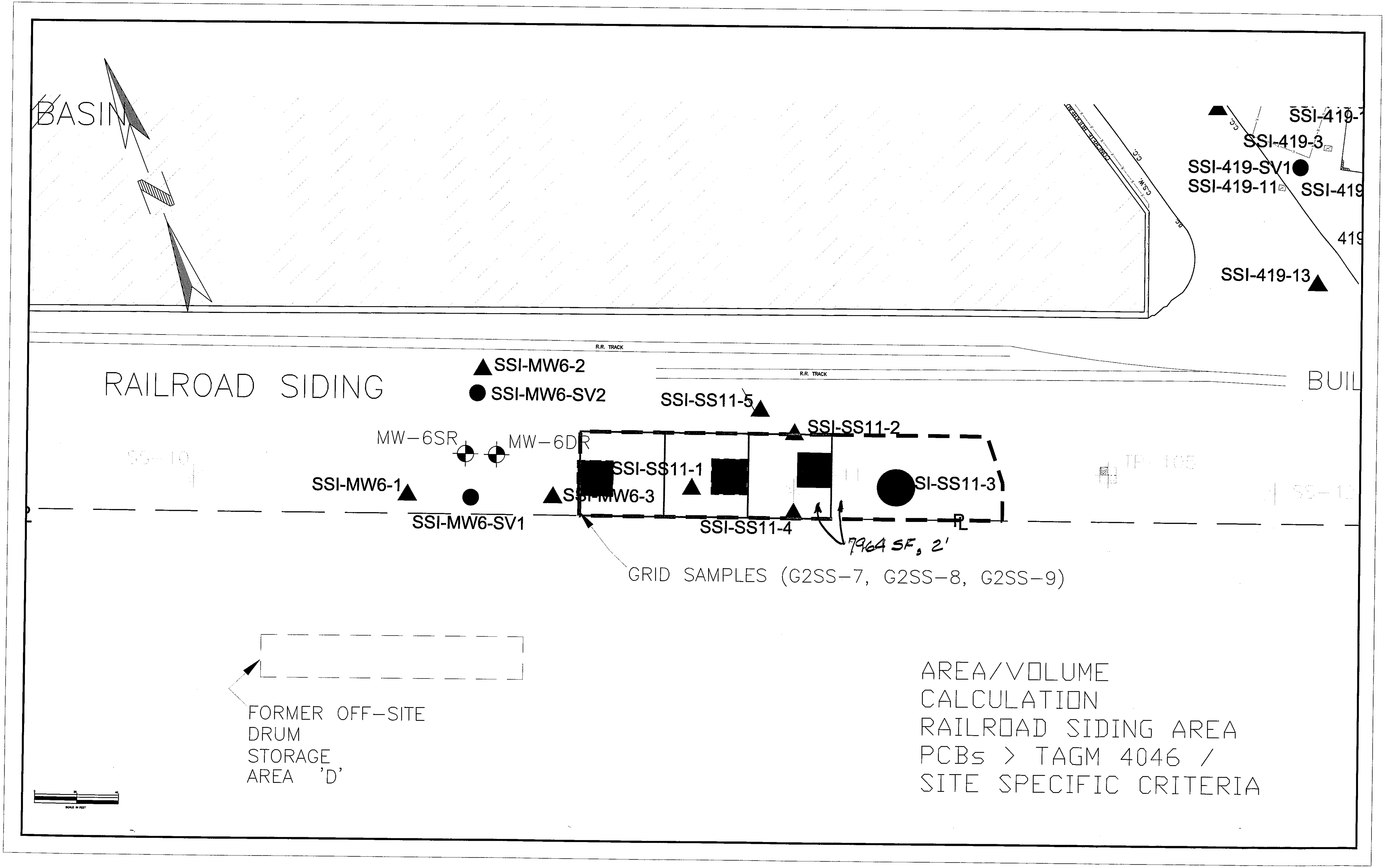

BASIN
RAILROAD SIDING
R.R. TRACK
R.R. TRACK
SSI-MW6-2
SSI-MW6-SV2
MW-6SR
MW-6DR
SSI-MW6-1
SSI-MW6-SV1
SSI-MW6-3
SSI-SS11-5
SSI-SS11-2
SSI-SS11-1
SSI-SS11-4
SI-SS11-3
7964 SF, 2'
GRID SAMPLES (G2SS-7, G2SS-8, G2SS-9)
SSI-419-3
SSI-419-SV1
SSI-419-11
SSI-419-13
FORMER OFF-SITE
DRUM
STORAGE
AREA 'D'
AREA/VOLUME
CALCULATION
RAILROAD SIDING AREA
PCBs > TAGM 4046 /
SITE SPECIFIC CRITERIA

AREA/VOLUME CALCULATION
BUILDING 419 PCB CONCENTRATIONS > PART 375-6 COMMERCIAL CRITERIA

Sample Location	Depth to Conc. > Criteria (ft)	Next Lower Sample Inverval < Criteria (ft)	Projected Depth (ft)	Depth for Volume Calculation (ft)	Area SF	Volume Calculation (CY)
419SS-1	0 - 0.25	1 - 1.2	NA	1	175	6
419SS-9	0 - 0.25	Surface Sample	NA	2	629	47
419SS-5	1 - 1.2	NA	1.4			
419SS-12	1 - 1.2	NA	1.9			
419SS-2	1 - 1.2	NA	1.5			
419SS-10	0 - 0.25	1 - 1.2	NA	3	724	80
419SS-11	1 - 1.2	NA	1.3			
419SS-13	1 - 1.2	NA	NA			
419SS-3	1 - 1.2	NA	2.6			
419SS-6*	1 - 1.2	NA	N/A			
419SS-7*	1 - 1.2	NA	N/A			
SSI-419-1	1.75 - 2	2.75 - 3	NA			
SSI-419-2	1.75 - 2	2.75 - 3	NA			
419SS-4	1 - 1.2	NA	3.9			
				Total	**1528**	**134**

* Not used in calculation because SSI-419-1 and SSI-419-2 used to delineate at these locations to depth.

Projected Depth Calculation (assume linear decrease in concentration with depth)

Sample Location	Depth Intervals sampled	Conc. (ppb)	Depth < 1000 ppb
419SS-2	0.25	2500	
	1.2	1400	1.5
419SS-3	0.25	3200	
	1.2	2300	2.6
419SS-4	0.25	4500	
	1.2	3600	3.9
419SS-5	0.25	3000	
	1.2	1300	1.4
419SS-11	0.25	4700	
	1.2	1400	1.3
419SS-12	0.25	4200	
	1.2	2300	1.9
419SS-13	0.25	650	
	1.2	3000	NA

AREA/VOLUME CALCULATION
FORMER RAILROAD SIDING AREA PCB CONCENTRATIONS > PART 375-6 COMMERCIAL CRITERIA

Sample Location	Depth to Conc. > Criteria (ft)	Next Lower Sample Inverval Depth (ft)	Projected Depth to 1 ppm	Depth for Volume Calculation (ft)	Area SF	Volume Calculation (CY)
G2SS-7D	1 - 1.2	NA	NA	3	7964	885
G2SS-8D	1 - 1.2	NA	NA			
G2SS-9D	1 - 1.2	NA	NA			
SSI-SS11-3	1 - 1.2	3.75-4	2.2			

Projected Depth Calculation (assume linear decrease in concentration with depth)

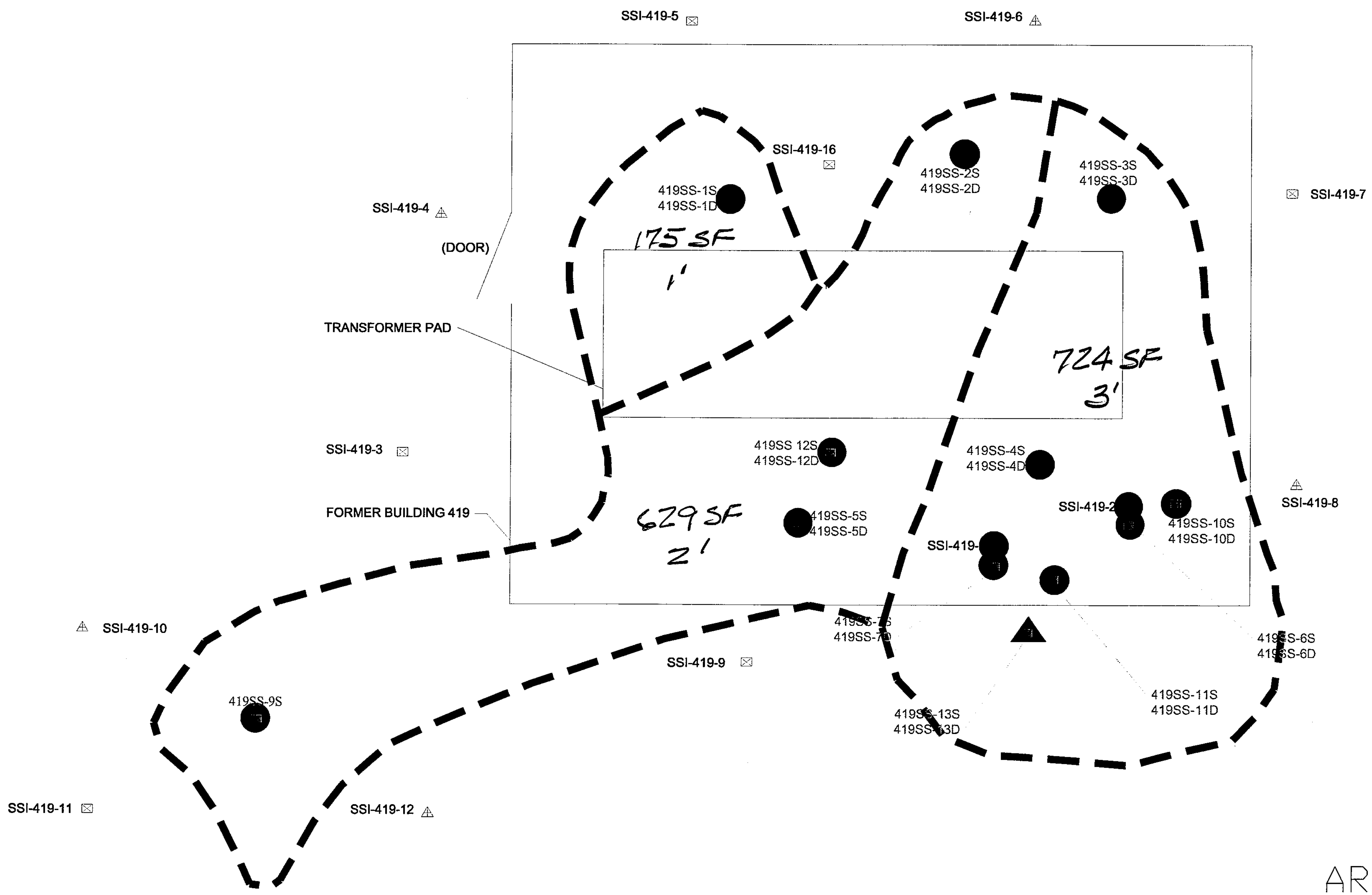
Sample Location	Intervals	Conc.	Depth <1
SSI-SS11-3	1.2	1500	
	4	144	2.2

AREA/VOLUME CALCULATION

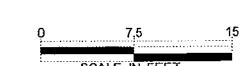
FORMER DRUM STORAGE AREA B PCB CONCENTRATIONS > PART 375-6 COMMERCIAL CRITERIA

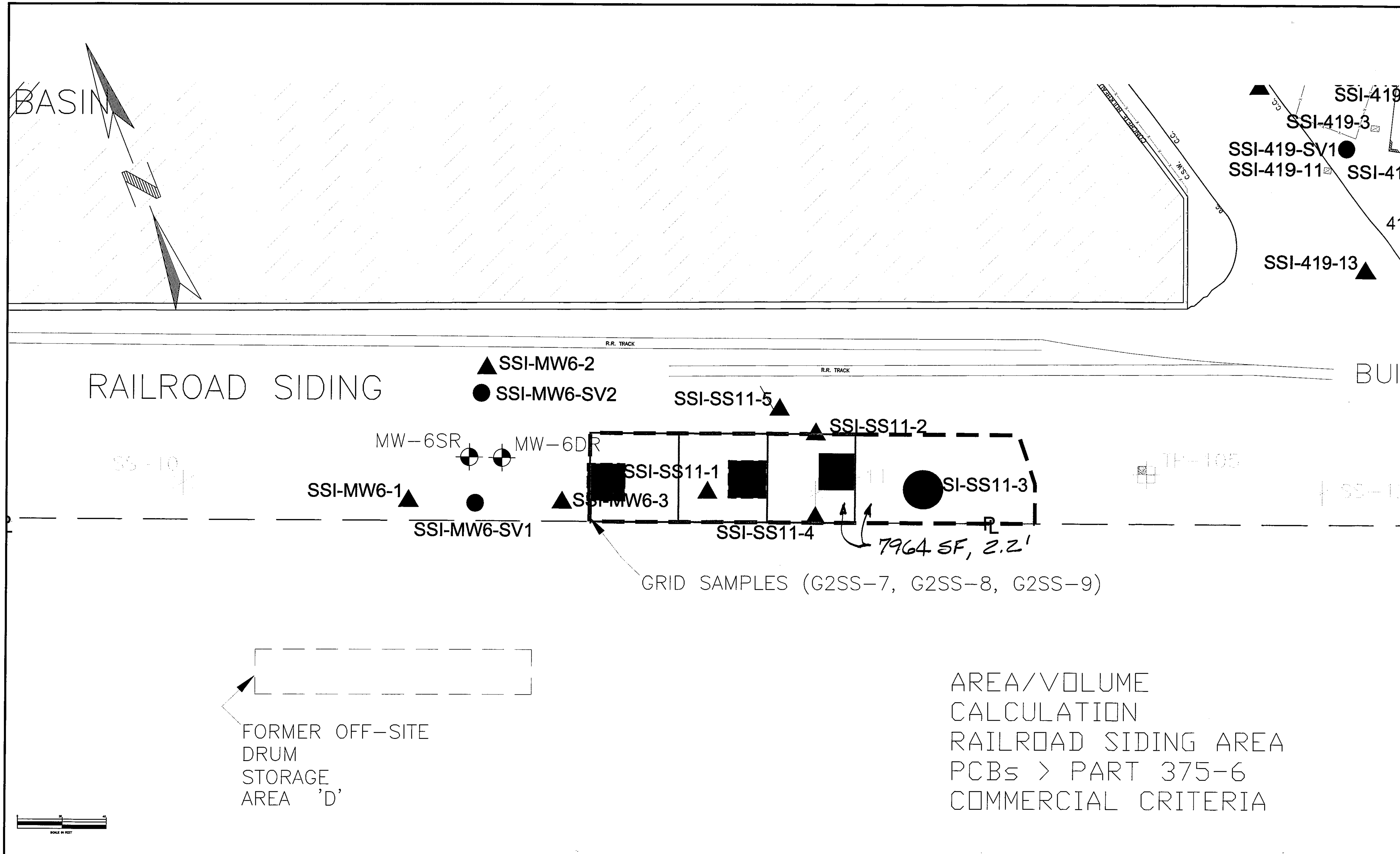
Sample Location	Depth to Conc. > Criteria (ft)	Next Lower Sample Inverval < Criteria (ft)	Depth for Volume Calculation (ft)	Area SF	Volume Calculation (CY)
DSBSS-2	0 - 0.25	1 - 1.2	4	4678	693
TP102	0 - 0.2	3.7-4.5			
SSI-DSB-1*	> 4	NA			
SSI-DSB-2	1.75 - 2	3.75 - 4			
SSI-DSB-5	1 - 1.2	1.75 - 2			
SSI-DSB-6	0.5 - 0.75	1 - 1.2			

*Samples above 3.75'-4.0' interval below criterion.

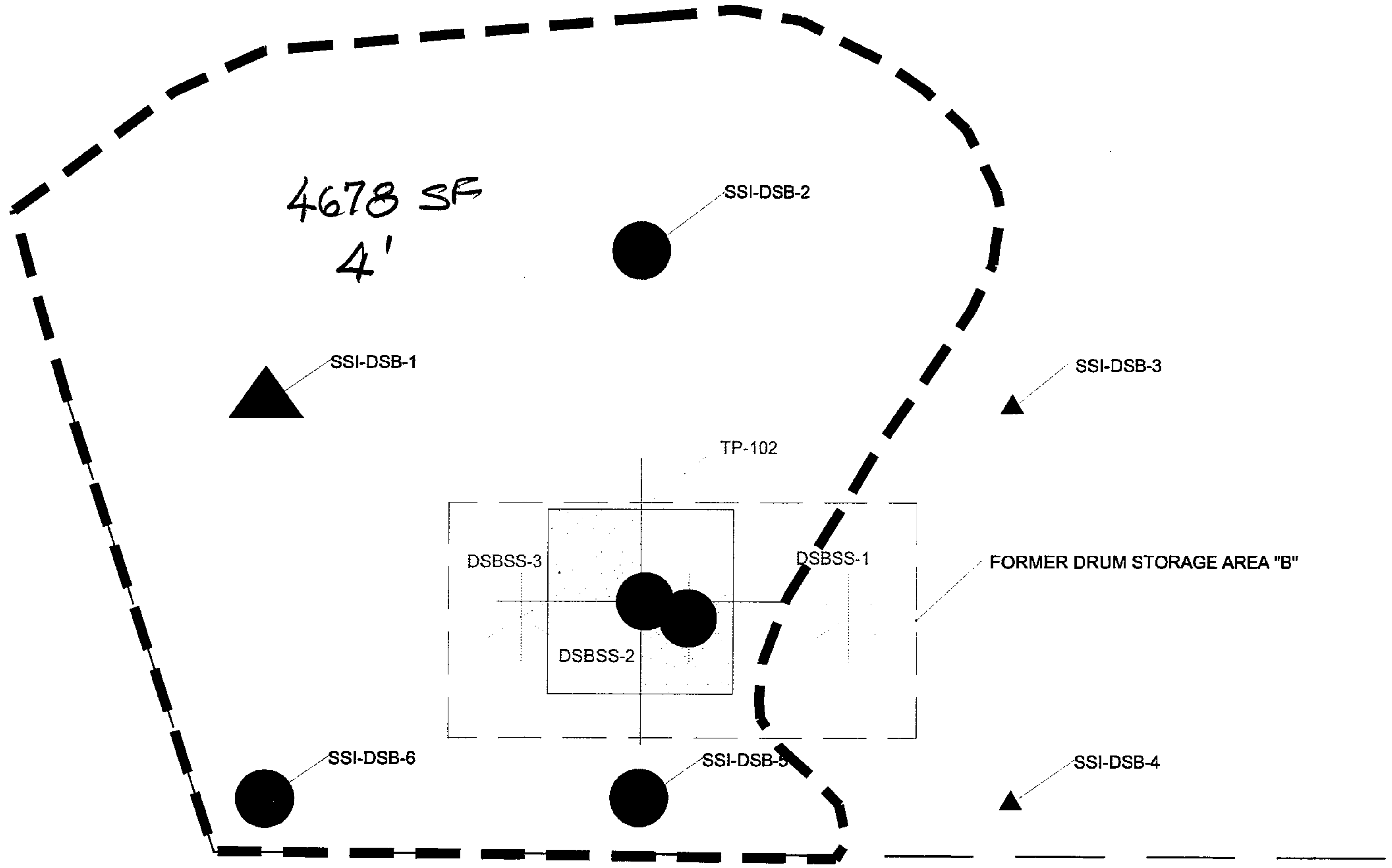


AREA/VOLUME
CALCULATION
FORMER BUILDING 419
PCBs > PART 375-6
COMMERCIAL CRITERIA

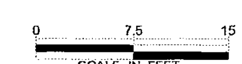




AREA/VOLUME
CALCULATION
RAILROAD SIDING AREA
PCBs > PART 375-6
COMMERCIAL CRITERIA



AREA/VOLUME CALCULATION DRUM STORAGE AREA B PCBs > PART 375-6 COMMERCIAL CRITERIA



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