UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2

IN THE MATTER OF THE GOWANUS CANAL SUPERFUND SITE Beam, Inc. Beazer East, Inc. Brink's Inc. Brooklyn Union Gas Co. d/b/a National Grid New York CBS Corp. Citigroup, Inc. Consolidated Edison Co. of New York, Inc. Dun and Bradstreet Corp. ExxonMobil Oil Corp. Hauck Manufacturing Co. Hess Corp. Honeywell International Inc. Kraft Foods Global, Inc. MCIZ Corp. and Fifteen Second Avenue LLC 36-2nd-J Corp. 107 Sixth Street LLC MRC Holdings, Inc. NL Industries, Inc. Northville Industries Corp. Patterson Fuel Oil Co., Inc. Phillips 66 Co. Puget Sound Commerce Center, Inc. Rexam Beverage Can Co. SPX Corp. Stauffer Management Company, LLC TDA Industries, Inc. The Brooklyn Improvement Co. The Union Oil Company of California Verizon New York Inc. Respondents. Proceeding under Section 106(a) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9606(a).	INDEX NO. CERCLA - 02-2014-2001 ADMINISTRATIVE ORDER FOR REMEDIAL DESIGN

283917

I. JURISDICTION AND GENERAL PROVISIONS

1. This Administrative Order ("Order") is issued to the above-captioned Respondents by the United States Environmental Protection Agency, Region 2 ("EPA") and requires Respondents to undertake a Remedial Design ("RD"), including various pre-RD investigations and analyses, to produce a set of biddable plans and specifications for the implementation of the remedy selected in EPA's September 27, 2013 Record of Decision ("ROD") for the Gowanus Canal Superfund Site ("Site"), other than the CSO controls and the cleanup and restoration of the former 1st Street turning basin, which EPA expects to be conducted by New York City.

2. This Order is issued to Respondents by EPA pursuant to the authority vested in the President of the United States under Section 106(a) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended ("CERCLA"), 42 U.S.C. § 9606(a), and delegated to the Administrator of EPA on January 23, 1987, by Executive Order No. 12580 (52 Federal Register 2926, January 29, 1987). This authority was further delegated to the EPA Regional Administrators by EPA Delegation Nos. 14-14-A and 14-14-B and to the Director of the Emergency and Remedial Response Division in Region 2 by Regional Delegation R-1200, dated November 23, 2004.

3. EPA has notified the New York State Department of Environmental Conservation ("NYSDEC") of this Order pursuant to Section 106(a) of CERCLA, 42 U.S.C. § 9606(a).

II. PARTIES BOUND

4. This Order shall apply to and be binding upon Respondents and their directors, officials, employees, agents, successors and assigns. No change in the status or control of Respondents shall alter Respondents' responsibilities under this Order. Respondents are jointly and severally responsible for carrying out all Work required by this Order.

5. Until EPA notifies Respondents under Paragraph 94 that the Work has been completed, Respondents shall provide a copy of this Order to any prospective purchaser or successor before a controlling interest in Respondents' assets or property rights are transferred to any successor.

III. DEFINITIONS

6. Unless otherwise expressly provided herein, terms used in this Order which are defined in CERCLA or in regulations promulgated under CERCLA shall have the meaning assigned to them in CERCLA or its implementing regulations. Whenever terms listed below are used in this Order or in an attachment to this Order, the following definitions shall apply:

a. "CERCLA" shall mean the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. §§ 9601-9675.

b. “Day” shall mean a calendar day. In computing any period of time under this Order, where the last day would fall on a Saturday, Sunday or federal holiday, the period shall run until the close of business of the next working day.

c. “Effective Date” shall be the date this Order goes into effect as provided in Subsection T (Opportunity to Confer, Effective Date).

d. “EPA” shall mean the United States Environmental Protection Agency and any successor departments or agencies of the United States.

e. “National Contingency Plan” or “NCP” shall mean the National Oil and Hazardous Substances Pollution Contingency Plan promulgated pursuant to Section 105 of CERCLA, 42 U.S.C. § 9605, and codified at 40 C.F.R. Part 300, including any amendments thereto.

f. “NYSDEC” shall mean the New York State Department of Environmental Conservation and any successor departments or agencies of the State.

g. “Order” shall mean this Administrative Order and all appendices attached hereto. In the event of conflict between this Order and any appendix, this Order shall control.

h. “Paragraph” shall mean a portion of this Order identified by an Arabic numeral.

i. “Performance Standards” shall mean the cleanup standards and Remedial Action Objectives and other measures of achievement of the goals of the remedy set forth in the ROD and Section II of the Remedial Design Statement of Work (“RD SOW”) attached hereto as Appendix A.

j. “Pre-Remedial Design Work Plan” or “Pre-RD Work Plan” shall mean the document describing the preliminary fieldwork activities to be undertaken by Respondents to gather the information necessary to fully develop the Remedial Design. A draft Pre-RD Work Plan was prepared by Respondent Brooklyn Union Gas Co. d/b/a National Grid New York (“National Grid”) pursuant to a January 24, 2014 Amendment to Administrative Order and Settlement Agreement, Index Number CERCLA-02-2010-2009 (“National Grid Amended Settlement Agreement”), attached hereto as Appendix B, and which, following approval by EPA, shall be incorporated into and made an enforceable part of this Order, as well as any amendments thereto.

k. “Record of Decision” or “ROD” shall mean the EPA Record of Decision relating to the Site signed on September 27, 2013 by the Director of the Emergency Remedial Response Division, EPA Region 2, including all attachments thereto, attached hereto as Appendix C.

l. “Remedial Design” or “RD” shall mean those activities to be undertaken by Respondents to develop the final plans and specifications for the Remedial Action pursuant to the Remedial Design Work Plan.

m. “Remedial Design Statement of Work” or “RD SOW” shall mean the Statement of Work attached hereto as Appendix A.

n. “Remedial Design Work Plan” or “RD Work Plan” shall mean the document developed by Respondent National Grid pursuant to the National Grid Amended Settlement Agreement, a draft of which is attached hereto as Appendix D and which, following approval by EPA, shall be incorporated into and made an enforceable part of this Order, as well as any amendments thereto.

o. “Respondents” shall mean:

1. Beam, Inc.
2. Beazer East, Inc.
3. Brink’s Inc.
4. National Grid
5. CBS Corp.
6. Citigroup, Inc.
7. Consolidated Edison Co. of New York, Inc.
8. Dun and Bradstreet Corp.
9. ExxonMobil Oil Corp.
10. Hauck Manufacturing Co.
11. Hess Corp.
12. Honeywell International Inc.
13. Kraft Foods Global, Inc.
14. MCIZ Corp. and affiliated entities:
    a. Fifteen Second Avenue LLC
    b. 36-2nd-J Corp.
    c. 107 Sixth Street LLC
15. MRC Holdings, Inc.
16. National Grid
17. NL Industries, Inc.
18. Northville Industries Corp.
19. Patterson Fuel Oil Co., Inc.
20. Phillips 66 Co.
21. Puget Sound Commerce Center, Inc.
22. Rexam Beverage Can Co.
23. SPX Corp.
24. Stauffer Management Company, LLC
25. TDA Industries, Inc.
26. The Brooklyn Improvement Co.
27. The Union Oil Company of California

28. Verizon New York Inc.

p. “Section” shall mean a portion of this Order identified by an upper-case Roman numeral and includes one or more Paragraphs.

q. “Site” shall mean the Gowanus Canal Superfund Site, an approximately 100-foot wide, 1.8-mile-long canal located in the New York City borough of Brooklyn, Kings County, New York, and also includes any areas which are sources of contamination to the Canal, areas where contamination has migrated from the Canal, and/or suitable areas in very close proximity to the contamination which are necessary for implementation of the Work. The Site is depicted generally on the map attached as Appendix E.

r. “State” shall mean the State of New York.

s. “United States” shall mean the United States of America.

t. “Waste Material” shall mean (i) any “hazardous substance” under Section 101(14) of CERCLA, 42 U.S.C. § 9601(14); (ii) any “pollutant or contaminant” under Section 101(33) of CERCLA, 42 U.S.C. § 9601(33); and (iii) any “solid waste” under Section 1004(27) of the Solid Waste Disposal Act, as amended, 42 U.S.C. § 6903(27).

u. "Work" means all activities Respondents are required to perform pursuant to this Order, except those required by Paragraph 69, below.

IV. FINDINGS OF FACT AND CONCLUSIONS OF LAW

7. Gowanus Canal (“Canal”) is a brackish, tidal arm of the New York–New Jersey Harbor Estuary, extending for approximately 1.8 miles through Brooklyn, New York. The approximately 100–foot–wide Canal runs southwest from Butler Street to Gowanus Bay and Upper New York Bay. The adjacent waterfront is primarily commercial and industrial, currently including concrete plants, warehouses and parking lots, and the Site is near several residential neighborhoods.

8. In 1849, the State authorized construction of the Canal to open the area to barge traffic, flush away sewage, receive storm water and fill the adjacent lowlands for development.

9. The Canal was constructed by bulkheading and dredging a tidal creek and wetland. Additional fill was utilized to raise the grade of the surrounding land. The authorizing legislation and the initial canal designs had recognized the likelihood that the Canal would be stagnant, creating pollution problems. As a result, various flushing solutions were contemplated. However, these were not implemented as part of its initial construction.

10. Following the construction of the Canal, infrastructure was added at various times, including combined sanitary and storm sewers and direct discharge pipes, all of which deposited into the Canal from the surrounding watershed, which is approximately 1,758 acres in size.

11. After completion of construction in the 1860s, the Canal quickly became one of the nation's busiest industrial waterways, home to heavy industry including gas works (*i.e.*, manufactured gas plants), coal yards, cement makers, soap makers, tanneries, paint and ink factories, machine shops, chemical plants and oil refineries.

12. As a result of decades of direct and indirect discharges of hazardous substances generated by industrial and other activity, the Canal is a repository for untreated industrial wastes, raw sewage, and runoff causing it to be one of New York's most polluted waterways.

13. The Canal was first declared a public nuisance in 1877 due to discharge of sanitary and industrial waste, in combination with stagnant water conditions. Subsequent studies and commissions have repeatedly examined methods of addressing the contamination. A series of unsuccessful solutions were implemented between 1891 and 1904, including directing additional sewage discharges to the Canal in order to improve flow.

14. A "Flushing Tunnel" began operating in 1911 as the next attempt to address the Canal's pollution problems. Designed to improve circulation and flush pollutants from the Canal, the Flushing Tunnel consists of a one mile long, 12-foot diameter tunnel stretching from New York Bay near Governors Island to the head of the Canal. Originally using a large ship propeller-type pump system, it could pump water in either direction. It operated with mixed results until the mid-1960s when it fell into disrepair.

15. Periodic infrastructure improvements have gradually reduced direct and indirect discharges to the Canal. The Owl's Head Waste Water Treatment Works ("WWTW") was completed in 1952, serving portions of the Park Slope area. The Red Hook WWTW was completed in 1987. The Second Avenue pump station was completed in 1990, eliminating the last area of dry weather discharges along the Canal. However, Combined Sewer Overflow ("CSO") discharges continue to the present date at an estimated volume of 377 million gallons per year. CSO discharges contain CERCLA hazardous substances from a range of sources, including but not limited to household and industrial discharges to the sanitary sewers and contaminated stormwater captured by storm drains.

16. Throughout the period described in Paragraph 15, above, depending on location relative to infrastructure improvements, facilities located directly adjacent to the Canal discharged untreated industrial and sanitary waste directly into the Canal in both dry weather and wet weather conditions due to the lack of infrastructure necessary to divert discharges from the Canal to upgradient sewer lines that discharged into New York Harbor. During this era, facilities not directly adjacent to the Canal but downgradient of main sewer lines also discharged untreated industrial and sanitary waste indirectly into the Canal in both dry weather and wet weather conditions. Facilities upgradient of the main sewer lines also discharged untreated industrial and sanitary waste indirectly into the Canal in wet weather conditions.

17. Hazardous substances, pollutants and contaminants have entered and continue to enter the Canal via several transport pathways or mechanisms, including spillage during product shipping and handling, direct disposal or discharge, contaminated groundwater discharge, surface water runoff, storm water discharge (including CSO events) and contaminated soil erosion.

18. Much of the heavy industrial activity along the Canal has ceased, although many upland areas adjacent to the Canal remain zoned as manufacturing districts. Land uses along and near certain portions of the Canal are in the process of transitioning from heavy industrial to light industrial, commercial, and residential uses. The Canal is currently used by some for recreational purposes such as boating, diving, and catching fish for consumption. The Canal and New York City harbor are subject to New York State fishing advisories for various ingestion risks, including polychlorinated biphenyls ("PCBs").

19. The Site was placed on the National Priorities List pursuant to Section 105 of CERCLA, 42 U.S.C. § 9605, on March 2, 2010.

20. A Remedial Investigation ("RI") report was completed by EPA in January 2011 and a Feasibility Study ("FS") report was completed by EPA in December 2011. An FS addendum report was issued by EPA in December 2012, together with a Proposed Plan. The Proposed Plan described the remedial alternatives considered to address the contamination in the Canal and identified the preferred remedy with the rationale for this preference.

21. Sampling results from the RI/FS document the presence of a wide range of hazardous substances in the groundwater, soil, and Canal sediments at the Site. These include polycyclic aromatic hydrocarbons ("PAHs"), PCBs, pesticides (such as methoxychlor and DDT), metals (such as barium, cadmium, copper, lead, mercury, nickel and silver), as well as volatile organic compounds ("VOCs") (such as benzene, toluene, ethylbenzene and xylene). The contamination in the sediments extends the entire length of the Canal. The contamination is present in both the sediment which has accumulated above the native sediments (referred to as "soft sediments"), and in the native sediment below the original bed of the Canal. Some of the hazardous substances are present at high levels. The soft sediment layer ranges in thickness from approximately 1 foot to greater than 20 feet, with an average thickness of about 10 feet. For example, total PAH concentrations in surface sediment (defined as the top 6 inches of the soft sediments, where potential exposure is more likely to occur) range up to 8,001,000 ug/kg . PCBs in surface sediment were detected up to 3,400 ug/kg. In the subsurface (i.e., deeper than 6 inches), total PAH concentrations in the soft sediment ranged up to 45,000,000 ug/kg. Total PAH concentrations in the native sediment were detected up to 47,500,000 ug/kg. In the subsurface, total PCB concentrations in the soft sediment were detected up to 50,700 ug/kg. In the native sediments, total PCBs were detected up to 2,610 ug/kg.

22. Based on the results of the RI/FS, chemical contamination in the Canal sediments presents an unacceptable ecological and human health risk, primarily due to exposure to PAHs, PCBs, and metals (barium, cadmium, copper, lead, mercury, nickel and silver) in surface water and sediment, and from ingesting fish and crabs from the Canal.

23. PCBs and PAHs have been demonstrated to cause a variety of adverse health effects. PCBs have been shown to cause cancer in test animals. PCBs have also been shown to cause a number of serious non-cancer health effects in animals, including effects on the immune system, reproductive system, nervous system, endocrine system and other health effects. Studies in humans provide supportive evidence for potential carcinogenic and non-carcinogenic effects of PCBs. The toxicity of PAHs can vary from being nontoxic to extremely toxic. EPA has classified seven PAH compounds as probable human carcinogens: benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. PAHs known for their carcinogenic, mutagenic, and teratogenic properties are benz[a]anthracene and chrysene, benzo[b]fluoranthene, benzo[j]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, benzo[ghi]perylene, coronene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and ovalene. High prenatal exposure to PAHs is associated with lower IQ and childhood asthma. The Center for Children's Environmental Health reports studies that demonstrate that exposure to PAH pollution during pregnancy is related to adverse birth outcomes including low birth weight, premature delivery, and heart malformations. Cord blood in cases of prenatal exposure shows DNA damage that has been linked to cancer. Follow-up studies show increased developmental delays at age three, and lower scores on IQ tests and increased behavioral problems at ages six and eight.

24. EPA's ecological risk assessment of the Site determined that PAHs, PCBs and metals in the sediment are toxic to benthic organisms. PAHs were detected in sediment at the highest concentrations relative to their ecological screening benchmarks and represent the greatest site-related risk to the benthic community. PCBs and seven metals (barium, cadmium, copper, lead, mercury, nickel and silver) were also detected at concentrations above their ecological screening benchmarks and at concentrations significantly higher than those detected in reference area sediments and also represent a potential site-related risk to the benthic community. PAHs were found to be a potential risk to aquatic herbivores (represented by the black duck) and mercury was found to be a potential risk to avian omnivores (represented by the heron).

25. On September 27, 2013, EPA issued a ROD for the Site which includes the following response actions: 1) Dredging of the entire column of hazardous substance-contaminated soft sediments in the upper and mid-reaches of the canal; 2) in-situ stabilization of those native sediments in select areas in the upper and mid-reaches of the canal contaminated with high levels of nonaqueous phase liquid ("NAPL"); 3) construction of a multilayered cap in the upper and mid-reaches of the canal to isolate and prevent the migration of PAHs and residual NAPL from native sediments; 4) dredging of the entire soft sediment column in the lower reach of the canal; 5) construction of a multilayer cap to isolate and prevent the migration of PAHs from native sediments in the lower reach of the canal; 6) off-Site treatment with thermal desorption of the NAPL-impacted sediments dredged from the upper and mid-reaches of the canal, followed by beneficial reuse off-Site (*e.g.*, landfill daily cover) if possible; 7) off-Site stabilization of the less contaminated sediments dredged from the lower reach of the canal and the sediments in the other reaches not impacted by NAPL, followed by beneficial reuse off-Site; 8) excavation and restoration of approximately 475 feet of the filled-in former 1st Street turning basin; 9) excavation and restoration of the portion of the 5th Street turning basin beginning underneath the

3rd Avenue bridge and extending approximately 25 feet to the east and the installation of a barrier or interception system at the eastern boundary of the excavation; 10) implementation of institutional controls incorporating the existing fish consumption advisories (modified as needed), as well as other controls to protect the integrity of the cap; 11) periodic maintenance of the cap and long-term monitoring to insure that the remedy continues to function effectively; and 12) CSO controls to significantly reduce overall contaminated solid discharges to the canal, which shall include a) construction of in-line sewage/stormwater retention tanks to retain stormwater which currently discharges through outfalls RH-034 and OH-007; and b) implementation of appropriate engineering controls to ensure that hazardous substances and solids from separated stormwater, including from future upland development projects, are not discharged to the canal.

26. In 2009, EPA began the investigation of potentially responsible parties ("PRPs") for the Site. EPA began issuing letters notifying parties of their potential liability, and thus their status as PRPs, in August 2009.

27. In March 2012, EPA convened a meeting of all of the PRPs that had received a notice letter as of that date for the purpose of providing a technical and enforcement briefing regarding the Site, and to encourage the PRPs to begin preparations for future settlement negotiations.

28. On September 30, 2013, EPA issued a Notice for the Commencement of Remedial Design Negotiations and Demand for Past Costs ("Notice and Demand") to each of the Respondents named herein. The Notice and Demand sought $5 million in partial reimbursement of EPA's outstanding past costs for the Site, and execution of an RD consent order, a draft of which was included therein, by December 13, 2013, which deadline was determined by EPA to be necessary in order to ensure RD fieldwork could begin in spring 2014.

29. To facilitate settlement discussions between and among the Agency and the PRPs, EPA convened a meeting of the PRPs on November 7, 2013. To provide further time for negotiations, EPA extended the time for Respondents to enter into the RD consent order from December 13, 2013 to January 31, 2014 and then later to February 14, 2014.

30. To prevent a delay in implementing the RD during the negotiation extension period, on January 24, 2014, National Grid and EPA entered into the National Grid Amended Settlement Agreement. Pursuant to the National Grid Amended Settlement Agreement, National Grid developed and submitted for EPA approval the Pre-RD and RD Work Plans, on January 29, 2014 and February 27, 2014, respectively, attached hereto as Appendices B and D. On February 3, 2014, National Grid also paid EPA $1 million in partial reimbursement of EPA's outstanding past response costs.

31. EPA is currently conducting separate consent order negotiations with New York City for that portion of the RD that involves the siting and design of the CSO retention tanks and the design for the cleanup and restoration of the former 1st Street turning basin. EPA is also negotiating an administrative order for a removal action with Bayside Fuel Oil Corp. and its affiliates, Bayside Fuel Oil Depot Corp., Sackett Street Properties, LLC, Smith Street Properties

LLC, OAA Realty LLC, LAA Realty LLC and Victor Allegretti Credit Shelter Trust, which requires, under EPA supervision, implementation of bulkhead upgrades on Bayside's property to EPA's remedial standards, as well as the coordination and cooperation with Respondents regarding the RD.

32. The Site constitutes a "facility" within the meaning of Section 101(9) of CERCLA, 42 U.S.C. § 9601(9).

33. The contamination found at the Site, as identified in the Findings of Fact above, includes hazardous substances as defined in Section 101(14) of CERCLA, 42 U.S.C. § 9601(14).

34. Each Respondent is a responsible party with respect to the Site pursuant to Section 107(a) of CERCLA, 42 U.S.C. §9607(a), for reasons including but not limited to, each Respondent's status as the current owner/operator of a Facility at the Site and/or the owner/operator of a Facility at the Site at a time of disposal of one or more hazardous substances, and/or a successor in interest thereto.

35. Each Respondent is a corporation and/or a limited liability company, and therefore is a "person" within the meaning of Section 101(21) of CERCLA, 42 U.S.C. § 9601(21).

36. The conditions described in these Findings of Fact constitute an actual or threatened "release" of one or more a hazardous substances from a facility as defined by Section 101(22) of CERCLA, 42 U.S.C. § 9601(22). Such actual or threatened releases include, but are not limited to, the discharge of high levels of PAHs, PCBs, pesticides, metals, and VOCs into the Canal, and/or the indirect discharge of such hazardous substances into the Canal through sewer or other pipes and/or the soil and/or groundwater at the Site, as well as the potential for future migration of hazardous substances at and from the Site.

37. Each Respondent was given an opportunity to enter into a settlement agreement, either individually or collectively, for the Work required by this Order. No party consented to perform the Work.

V. DETERMINATIONS

38. Based on the Findings of Fact and Conclusions of Law set forth above and the entirety of the administrative record, EPA has determined that the release or threatened release of hazardous substances from the Site may present an imminent and substantial endangerment to the public health or welfare or the environment within the meaning of Section 106(a) of CERCLA, 42 U.S.C. § 9606(a).

39. The actions required by this Order are necessary to protect the public health or welfare or the environment, are in the public interest, and are consistent with CERCLA and the NCP.

VI. ORDER

40. Based upon the foregoing Findings of Fact, Conclusions of Law and Determinations, and the administrative record supporting the Record of Decision for this Site, it is hereby ordered that Respondents comply with all requirements of this Order including, but not limited to, performance of the Remedial Design at the Site in accordance with Subsection A herein (Description of Work), the RD SOW, and following approval by EPA, the Pre-RD and RD Work Plans.

41. Respondents are jointly and severally responsible for carrying out all activities required by this Order, the RD SOW, and following approval by EPA, the Pre-RD and RD Work Plans. Any failure to perform, in whole or in part, any requirement of this Order by any Respondent hereto shall not relieve Respondents of their obligation to perform each and every requirement of this Order. No Respondent shall interfere in any way with the performance of Work in accordance with this Order by any other Respondent.

A. Description of Work

42. Respondents shall perform the following:

a. Obligation to Cooperate and Coordinate: Respondents shall make best efforts to coordinate in the performance of the Work required by this Order with any person not a party to this Order who is directed by EPA and who makes good-faith offers to perform or, in lieu of performance to pay for, in whole or in part, the Work required by this Order. Best efforts to coordinate shall include, at a minimum:

i. replying in writing within a reasonable period of time to good-faith offers to perform or pay for the Work required by this Order;

ii. engaging in good-faith negotiations with any person not a party to this Order who makes good-faith offers to perform or pay for the Work required by this Order; and

iii. good-faith consideration of good-faith offers to perform or pay for the Work required by this Order.

Upon request of EPA and subject to any claims of applicable privileges(s), Respondents shall submit to EPA (1) any offer to perform or pay for, or (2) all documentation relating to the performance of or payment for, the Work required by this Order by any non--respondent to this Order.

Nothing in this Paragraph shall be construed to require or permit Respondents to delay implementing the Pre-RD and/or RD Work Plan, following EPA approval, or for otherwise complying with the terms of this Order.

b. Work: Respondents shall conduct the Work required hereunder in accordance with CERCLA, the NCP, the ROD, the Performance Standards, the RD SOW, and, following EPA approval, the Pre-RD Work Plan, and RD Work Plan, as well as applicable provisions of the following guidance documents, (and of other guidance documents referenced therein) as they may be amended or modified by EPA: *Uniform Federal Policy for Implementing Quality Systems* (UFP-QS), EPA-505-F-03-001, March 2005, *Uniform Federal Policy for Quality Assurance Project Plans* (UFP-QAPP), Parts 1, 2 and 3, EPA-505-B-04-900A, B and C, March 2005, *EPA Region 2's "Clean and Green Policy"* which may be found at http://epa.gov/region2/superfund/greenremediation/policy.html, *Guidance for Scoping the Remedial Design* (EPA 540/R-95/025, March 1995), and *Guide to Management of Investigation-Derived Wastes* (OSWER Publication 9345.3-03FS, January 1992). The tasks that Respondents must perform (including future deliverables) and the scope of such Work are identified in this Order and the RD SOW which is incorporated into and is an enforceable part of this Order. Each deliverable submitted pursuant to this Settlement Agreement shall be deemed incorporated into and an enforceable part of this Settlement Agreement upon its approval by EPA.

43. Respondents shall assure that all field personnel used by Respondents are properly trained in the use of field equipment and in chain-of-custody procedures.

B. Designation Of Contractor and Designated Project Coordinator

44. Within twenty-one (21) days after the Effective Date, Respondents shall select a coordinator to be known as the Project Coordinator and shall submit the name, address, qualifications, and telephone number of the Project Coordinator to EPA. The Project Coordinator shall be responsible on behalf of Respondents for oversight of the implementation of the Work to be carried out under this Order. The Project Coordinator shall not be an attorney engaged in the practice of law. He or she shall have the technical expertise sufficient to adequately oversee all aspects of the Work contemplated by this Order. The Project Coordinator shall be knowledgeable at all times about all matters relating to the Work being performed under this Order.

45. Selection of the Project Coordinator shall be subject to approval by EPA in writing. If EPA disapproves a proposed Project Coordinator, Respondents shall propose a different person and notify EPA of that person's name, address, telephone number and qualifications within seven (7) days following EPA's disapproval. Respondents may change their Project Coordinator provided that EPA has received written notice at least seven (7) days prior to the desired change. All changes of the Project Coordinator shall be subject to EPA approval.

46. EPA correspondence related to this Order will be sent to the Project Coordinator. Notice by EPA in writing to the Project Coordinator shall be deemed notice to Respondents for all matters relating to the Work under this Order and shall be effective upon receipt. To the extent possible, the Project Coordinator shall be present on-Site or readily available for EPA to contact

during all working days and be retained by Respondents at all times until EPA issues a notice of termination of this Order upon the completion of the Work in accordance with Paragraph 94.

47. Within twenty-one (21) days after the Effective Date, Respondents shall select a Supervising Contractor and shall submit the name, address, qualifications, and telephone number of the Supervising Contractor to EPA. The Supervising Contractor may be the same person as the Project Coordinator. Respondents shall also notify EPA of the name and qualifications of any other contractor or subcontractor proposed to perform Work under this Order at least ten (10) days prior to commencement of such Work.

48. All activities required of Respondents under the terms of this Order shall be performed only by well-qualified persons possessing all necessary permits, licenses, and other authorizations required by Federal, State and/or local governments consistent with Section 121 of CERCLA, 42 U.S.C. § 9621, and all Work conducted pursuant to this Order shall be performed in accordance with prevailing professional standards. All plans and specifications shall be prepared under the supervision of, and signed/certified by, a licensed New York professional engineer.

49. EPA retains the right to disapprove any or all of the contractors and/or subcontractors proposed by Respondents to conduct the Work. If EPA disapproves in writing of any of Respondents' proposed contractors to conduct the Work, Respondents shall propose a different contractor within seven (7) days of receipt of EPA's disapproval.

50. Respondents shall provide a copy of this Order to each contractor and subcontractor approved and retained to perform the Work required by this Order. Respondents shall include in all contracts or subcontracts entered into for Work required under this Order provisions stating that such contractors or subcontractors, including their agents and employees, shall perform activities required by such contracts or subcontracts in compliance with this Order and all applicable laws and regulations. Respondents shall be responsible for ensuring that their contractors and subcontractors perform the Work contemplated herein in accordance with this Order.

C. EPA Remedial Project Manager, Other Personnel and Modification to EPA-Approved Pre-RD and RD Work Plans

51. EPA has designated Christos Tsiamis of the New York Remediation Branch, Emergency and Remedial Response Division, EPA Region 2, as its Remedial Project Manager ("RPM") for the Site. Except as otherwise provided in this Settlement Agreement, Respondents shall direct all submissions required by this Settlement Agreement to the RPM via e-mail at tsiamis.christos@epa.gov and by regular mail, at U.S. EPA, Region 2, 290 Broadway, 20th Floor, New York, NY 10007.

52. EPA, including the RPM, or his authorized representative, will conduct oversight of the implementation of this Order. The RPM shall have the authority vested in an RPM by the NCP, including the authority to halt, conduct or direct any Work required by this Order, or to direct

any other response action undertaken by EPA or Respondents at the Site consistent with this Order. Absence of the RPM from the Site shall not be cause for stoppage of Work unless specifically directed by the RPM.

53. As appropriate during the course of implementation of the actions required of Respondents pursuant to this Order, Respondents or their consultants or contractors, acting through the Designated Project Coordinator, may confer with EPA concerning the required actions. Based upon new circumstances or new information not in the possession of EPA on the Effective Date of this Order, the Project Coordinator may request in writing EPA approval of modification(s) to the EPA-approved Pre-RD Work Plan and RD Work Plan. In addition, Respondents may propose other additional investigations, studies, and response actions and, upon EPA approval of the same, Respondents shall conduct such actions pursuant to this Order. Only modifications approved by EPA in writing shall be deemed effective.

D. EPA Review of Submissions

54. After review of any deliverable, plan, report or other item which is required to be submitted for review and approval pursuant to this Order, EPA may: (a) approve the submission; (b) approve the submission with modifications; (c) disapprove the submission and direct Respondents to re-submit the document after incorporating EPA's comments; or (d) disapprove the submission and assume responsibility for performing all or any part of the response action. As used in this Order, the terms "approval by EPA," " EPA approval," or a similar term means the action described in subparagraphs (a) or (b) of this Paragraph.

55. In the event of approval or approval with modifications by EPA, Respondents shall proceed to take any action required by the plan, report or other item, as approved or modified by EPA.

56. Upon receipt of a notice of disapproval or a direction for a modification, Respondents shall correct the deficiencies and resubmit the plan, report or other item for approval within thirty (30) days or such other time as may be specified by EPA in its notice of disapproval or request for modification. Notwithstanding the notice of disapproval or approval with modifications, Respondents shall proceed, at the direction of EPA, to take any action required by any non-deficient portion of the submission.

57. If any plan, report or other item required to be submitted to EPA for approval pursuant to this Order is disapproved by EPA, even after being resubmitted following Respondents' receipt of EPA's comments on the initial submittal, Respondents shall be deemed to be out of compliance with this Order. If any resubmitted plan, report or other item, or portion thereof, is disapproved by EPA, EPA may again direct Respondents to make the necessary modifications thereto, and/or EPA may amend or develop the item(s) and recover the costs of doing so from Respondents. Respondents shall implement any such item(s) as amended or developed by EPA.

58. EPA shall be the final arbiter regarding the sufficiency or acceptability of all documents submitted and all activities performed pursuant to this Order. EPA may modify those documents and/or perform or require the performance of additional work unilaterally.

59. All plans, reports and other submittals required to be submitted to EPA under this Order shall, upon approval by EPA, be deemed to be incorporated in and an enforceable part of this Order. In the event EPA approves a portion of a plan, report or other item required to be submitted to EPA under this Order, the approved portion shall be deemed to be incorporated in and an enforceable part of this Order.

E. Reporting Requirements

60. Reporting

a. Respondents shall submit written progress reports to EPA concerning actions undertaken pursuant to this Order every thirtieth (30^{th}) day after the date of receipt of EPA's approval of the RD Work Plan until termination of this Order, unless otherwise directed in writing by EPA. These reports shall describe all significant developments during the preceding period, including the actions performed and any problems encountered, analytical data received during the reporting period, and the developments anticipated during the next reporting period, including a schedule of actions to be performed, anticipated problems and planned resolutions of past or anticipated problems.

b. Respondents shall submit copies of all plans, reports or other submissions required by this Order, the RD SOW or any approved work plan as set forth below. Any electronic submissions must be in a format that is compatible with EPA software and in database files and sizes to be specified by EPA. Reports should be submitted to the following:

4 copies: (2 bound, 1 unbound, 1 electronic)	Remedial Project Manager – Gowanus Canal Site Emergency and Remedial Response Division United States Environmental Protection Agency, Region 2 290 Broadway, 20^{th} Floor New York, New York 10007-1866
1 copy:	Chief, New York/Caribbean Superfund Branch Office of Regional Counsel United States Environmental Protection Agency, Region 2 290 Broadway, 17^{th} Floor New York, New York 10007-1866 Attn: Gowanus Canal Superfund Site Attorney
3 copies: (2 unbound, 1 electronic)	Director, Division of Environmental Remediation New York State Department of Environmental Conservation 625 Broadway, 12^{th} Floor Albany, New York 12233-7011

Attn: Gowanus Canal Superfund Site

F. Oversight

61. During the implementation of the requirements of this Order, Respondents and their contractor(s) and subcontractors shall be available for such conferences with EPA and inspections by EPA or its authorized representatives as EPA may determine are necessary to adequately oversee the Work being carried out or to be carried out by Respondents, including inspections at the Site and at laboratories where analytical work is being done hereunder.

62. Respondents and their employees, agents, contractor(s) and consultant(s) shall cooperate with EPA in its efforts to oversee Respondents' implementation of this Order.

G. Community Relations

63. Respondents shall cooperate with EPA in providing information relating to the Work required hereunder to the public. As requested by EPA, Respondents shall participate in the preparation of all appropriate information disseminated to the public; participate in public meetings which may be held or sponsored by EPA to explain activities at or concerning the Site; and provide a suitable location for public meetings, as needed.

H. Access to Property and Information

64. EPA, NYSDEC and their designated representatives, including, but not limited to, employees, agents, contractor(s) and consultant(s) thereof, shall be permitted to observe the Work carried out pursuant to this Order. Respondents shall at all times permit EPA, NYSDEC, and their designated representatives full access to and freedom of movement at the Site and any other premises where Work under this Order is to be performed for purposes of inspecting or observing Respondents' progress in implementing the requirements of this Order, verifying the information submitted to EPA by Respondents, conducting investigations relating to contamination at the Site or for any other purpose EPA determines to be reasonably related to EPA oversight of the implementation of this Order.

65. In the event that action under this Order is to be performed in areas owned by or in possession of a person other than Respondents, Respondents shall use their best efforts to obtain access agreements from such persons within forty-five (45) working days of the Effective Date of this Order for purposes of implementing the requirements of this Order. Such agreements shall provide access not only for Respondents, but also for EPA and its designated representatives or agents, as well as NYSDEC and its designated representatives or agents. Such agreements shall specify that Respondents are not EPA's representative with respect to liability associated with Site activities. If such access agreements are not obtained by Respondents within the time period specified herein, Respondents shall immediately notify EPA of their failure to obtain access and shall include in that notification a summary of the steps Respondents have taken to attempt to obtain access. Subject to the United States' non-reviewable discretion, EPA may use its legal authorities to obtain access for Respondents, may

perform those response actions with EPA contractors at the property in question, or may terminate the Order if Respondents cannot obtain access agreements. If EPA performs those tasks or activities with EPA contractors and does not terminate the Order, Respondents shall perform all other activities not requiring access to that property. Respondents shall integrate the results of any such tasks undertaken by EPA into its reports and deliverables.

66. Upon request, Respondents shall provide EPA with access to all records and documentation related to the conditions at the Site, hazardous substances found at or released from the Site and the actions conducted pursuant to this Order except for those items, if any, subject to the attorney-client or work product privilege. Nothing herein shall preclude Respondents from asserting a business confidentiality claim pursuant to 40 CFR Part 2, Subpart B. All data, information and records created, maintained or received by Respondents or their contractor(s) or consultant(s) in connection with implementation of the Work under this Order, including, but not limited to, contractual documents, invoices, receipts, work orders and disposal records shall, without delay, be made available to EPA upon request, subject to the same privileges specified above in this paragraph. EPA shall be permitted to copy all such documents. Respondents shall submit to EPA upon receipt the results of all sampling or tests and all other technical data generated by Respondents or their contractor(s), or on the Respondents' behalf, in connection with the implementation of this Order.

67. Upon request by EPA, Respondents shall provide EPA or its designated representatives with duplicate and/or split samples of any material sampled in connection with the implementation of this Order.

68. Notwithstanding any other provision of this Order, EPA hereby retains all of its information gathering, access, and inspection authority under CERCLA, the Resource Conservation and Recovery Act ("RCRA"), 42 U.S.C §6901, *et seq.* and any other applicable statutes or regulations.

I. Record Retention, Documentation, Availability of Information

69. Respondents shall preserve all documents and information relating to Work performed under this Order, or relating to Waste Materials found on or released from the Site, for ten (10) years after completion of the Work required by this Order. At the end of the ten (10) year period, Respondents shall notify EPA at least thirty (30) days before any such document or information is destroyed that such documents and information are available for inspection. Upon request, Respondents shall provide EPA with the originals or copies of such documents and information.

70. All documents submitted by Respondents to EPA in the course of implementing this Order shall be available to the public unless identified as confidential by Respondents pursuant to 40 CFR Part 2, Subpart B, and determined by EPA to merit treatment as confidential business information in accordance with applicable law. In addition, EPA may release all non-confidential documents to NYSDEC, and NYSDEC may make those documents available to

the public unless Respondents conform with applicable New York State law and regulations regarding confidentiality. Respondents shall not assert a claim of confidentiality regarding any monitoring or hydrogeological data, any information specified under Section 104(e)(7)(F) of CERCLA, or any other chemical, scientific or engineering data relating to the Work performed hereunder.

J. Off-Site Shipments

71. All hazardous substances, pollutants, or contaminants removed from the Site pursuant to this Order for off-Site treatment, storage or disposal shall be treated, stored or disposed of in compliance with (a) Section 121(d)(3) of CERCLA, 42 U.S.C. § 9621(d)(3), (b) Section 300.440 of the NCP,(c) RCRA, (d) the Toxic Substances Control Act, 15 U.S.C. § 2601, et seq. and (e) all other applicable federal and New York State requirements.

72. If hazardous substances from the Site are to be shipped outside of the State of New York, Respondents shall provide prior notification of such Waste Material shipments to the RPM at the address set forth in Paragraph 60 and in accordance with the EPA Memorandum entitled "Notification of Out-of-State Shipments of Superfund Site Wastes" (OSWER Directive 9330.2-07, September 14, 1989). At least five (5) working days prior to such Waste Material shipments, Respondents shall notify the environmental agency of the accepting state of the following: (a) the name and location of the facility to which the Waste Materials are to be shipped; (b) the type and quantity of Waste Material to be shipped; (c) the expected schedule for the Waste Material shipments; (d) the method of transportation and name of transporter; and (e) the treatment and/or disposal method of the Waste Material streams.

73. Certificates of destruction must be provided to EPA upon Respondents' receipt of such. These certificates must be included in the monthly progress reports and in the Final Report.

K. Compliance With Other Laws

74. Respondents shall undertake all action that this Order requires in accordance with the requirements of all applicable local, state and federal laws and regulations, unless an exemption from such requirements is specifically provided by law or in this Order.

75. Except as provided in Section 121(e)(1) of CERCLA, 42 U.S.C. § 9621(e)(1), and the NCP, no permit shall be required for any portion of the Work required hereunder that is conducted entirely on-Site. Where any portion of the Work requires a federal or New York State permit or approval, Respondent shall submit timely applications and shall take all other actions necessary to obtain and to comply with all such permits or approvals. This Order is not, nor shall it be construed to be, a permit issued pursuant to any federal or New York State statute or regulation.

L. Emergency Response and Notification of Releases

76. Upon the occurrence of any event during performance of the Work required hereunder which, pursuant to Section 103 of CERCLA, 42 U.S.C. § 9603, requires reporting to the National Response Center (800) 424-8802, Respondents shall then immediately orally notify the Chief of the Removal Action Branch of the Emergency and Remedial Response Division of EPA, Region 2, at (732) 321-6658, of the incident or Site conditions. Respondent shall also submit a written report to EPA within seven (7) days after the onset of such an event, setting forth the events that occurred and the measures taken or to be taken, if any, to mitigate any release or endangerment caused or threatened by the release and to prevent the reoccurrence of such a release. The reporting requirements of this paragraph are in addition to, not in lieu of, reporting under CERCLA Section 103, 42 U.S.C. § 9603, and Section 304 of the Emergency Planning and Community Right-To-Know Act of 1986, 42 U.S.C. § 11004.

77. In the event of any action or occurrence during Respondents' performance of the requirements of this Order which causes or threatens to cause a release of a hazardous substance or which may present an immediate threat to public health or welfare or the environment, Respondents shall immediately take all appropriate action to prevent, abate or minimize the threat and shall immediately notify EPA as provided in the preceding paragraph. Respondents shall take such action in accordance with applicable provisions of this Order including, but not limited to, the Health and Safety Plan required to be submitted pursuant to Section IV.E. of the RD SOW. In the event that EPA determines that (a) the activities performed pursuant to this Order, (b) significant changes in conditions at the Site or (c) emergency circumstances occurring at the Site pose a threat to human health or the environment, EPA may direct Respondents to stop further implementation of any actions pursuant to this Order or to take other and further actions reasonably necessary to abate the threat.

78. Nothing in the preceding paragraph shall be deemed to limit any authority of the United States to take, direct, or order all appropriate action to protect human health and the environment or to prevent, abate, or minimize an actual or threatened release of hazardous substances on, at, or from the Site.

M. Modifications

79. No informal advice, guidance, suggestion, or comment by EPA regarding reports, plans, specifications, schedules or any other writing submitted by Respondents shall relieve Respondents of their obligation to obtain such formal approval as may be required by this Order and to comply with all requirements of this Order.

N. Delay in Performance

80. Any delay in performance of the Work under this Order that, in EPA's judgment, is not properly justified by Respondents under the terms of Paragraph 81 below, shall be considered a

violation of this Order. Any delay in performance of this Order shall not affect Respondents' obligations to perform all obligations fully under the terms and conditions of this Order.

81. Respondents shall notify EPA of any delay or anticipated delay in performing any requirement of this Order. Such notification shall be made by telephone to EPA's RPM as soon as Respondents know that a delay might occur. Respondents shall adopt all reasonable measures to avoid or minimize any such delay. Within two (2) days after notifying EPA by telephone, Respondents shall provide written notification fully describing the nature of the delay, any justification for the delay, any reason why Respondents should not be held strictly accountable for failing to comply with any relevant requirements of this Order, the measures planned and taken to minimize the delay and a schedule for implementing the measures that have been or will be taken to mitigate the effect of the delay. Increased cost or expense associated with the implementation of the activities called for in this Order is not a justification for any delay in performance.

O. Enforcement and Reservation of Rights

82. Notwithstanding any other provision of this Order, failure of any Respondent to comply with any provision of this Order may subject such Respondent to civil penalties of up to thirty-seven thousand five hundred dollars ($37,500) per violation per day, as provided in Section 106(b)(1) of CERCLA, 42 U.S.C. § 9606(b)(1), the Debt Collection and Improvement Act of 1996 (see Civil Monetary Penalty Inflation Adjustment Rule, 73 Fed. Reg. 75340 (December 11, 2008) and 40 CFR Part 19. Respondents also may be subject to punitive damages in an amount at least equal to but not more than three times the amount of any costs incurred by the United States as a result of such failure to comply with this Order, as provided in Section 107(c)(3) of CERCLA, 42 U.S.C. § 9607(c)(3). Should Respondents violate this Order or any portion thereof, EPA may carry out the required actions unilaterally, pursuant to Section 104 of CERCLA, 42 U.S.C. § 9604, and/or may seek judicial enforcement of this Order pursuant to Section 106 of CERCLA, 42 U.S.C. § 9606.

83. Nothing herein shall limit the power and authority of EPA or the United States to take, direct or order all actions necessary to protect public health, welfare, or the environment or to prevent, abate or minimize an actual or threatened release of hazardous substances, pollutants or contaminants or hazardous or solid waste on, at or from the Site. Further, nothing herein shall prevent EPA from seeking legal or equitable relief to enforce the terms of this Order, from taking other legal or equitable action as it deems appropriate, or from requiring Respondents in the future to perform additional activities pursuant to CERCLA or any other applicable law. EPA reserves the right to bring an action against Respondent under Section 107 of CERCLA, 42 U.S.C. § 9607, for recovery of any response costs incurred by the United States related to this Order or the Site.

P. Other Claims

84. By issuance of this Order, the United States and EPA assume no liability for injuries or damages to persons or property resulting from any acts or omissions of Respondent or

Respondent's employees, agents, contractors, or consultants in carrying out any action or activity pursuant to this Order. The United States or EPA shall not be held out as or deemed a party to any contract entered into by Respondents or their directors, officers, employees, agents, successors, representatives, assigns, contractors or consultants in carrying out actions pursuant to this Order.

85. Nothing in this Order constitutes or shall be construed as a satisfaction of or release from any claim or cause of action against Respondents or any person not a party to this Order for any liability that Respondents or other persons may have under CERCLA, other statutes, or the common law, including but not limited to any claims of the United States for injunctive relief, costs, damages and interest under Sections 106(a) and 107 of CERCLA, 42 U.S.C. §§ 9606(a) and 9607. Nothing herein shall constitute a finding that Respondents are the only responsible parties with respect to the release and threatened release of hazardous substances at and from the Site.

86. Nothing in this Order shall affect any right, claim, interest, defense, or cause of action of any party hereto with respect to third parties.

87. Nothing in this Order shall be construed to constitute preauthorization under Section 111(a)(2) of CERCLA, 42 U.S.C. § 9611(a)(2), and 40 CFR § 300.700(d).

Q. Insurance

88. At least five (5) days prior to commencing any on-Site Work under this Order, Respondents shall secure and shall maintain for the duration of this Order comprehensive general liability insurance and automobile insurance with limits of $5 million dollars, combined single limit, naming the EPA as an additional insured. Within the same period, Respondents shall provide EPA with certificates of such insurance and a copy of each insurance policy. Respondents shall submit such certificates and copies of policies each year on the anniversary of the Effective Date. In addition, for the duration of the Order, Respondents shall satisfy, or shall ensure that their contractors or subcontractors satisfy, all applicable laws and regulations regarding the provision of worker's compensation insurance for all persons performing the Work on behalf of Respondents in furtherance of this Order. If Respondents demonstrate by evidence satisfactory to EPA that any contractor or subcontractor maintains insurance equivalent to that described above, or insurance covering some or all of the same risks but in an equal or lesser amount, then Respondents need provide only that portion of the insurance described above that is not maintained by such contractor or subcontractor.

R. Financial Assurance

89. Within thirty (30) days of the Effective Date of this Order, Respondents shall demonstrate their financial ability to complete the Work by submitting to EPA copies of one or more of Respondents' most recent Annual Reports. Such Annual Reports shall demonstrate that Respondents have sufficient assets to perform the Work, which is valued by EPA at $35,000,000. Each year thereafter, until the completion of the work, Respondents shall submit one or more

Respondents' most recent Annual Reports to EPA within thirty (30) days of publication of such reports. In the event that EPA determines at any time that the financial assurances provided by the Annual Reports do not demonstrate Respondents' ability to complete the Work, then Respondents shall establish and maintain financial security in the amount needed to complete the Work, in one or more of the following forms:

a. A surety bond unconditionally guaranteeing payment and/or performance of the Work that is issued by a surety company among those listed as acceptable sureties on Federal bonds as set forth in Circular 570 of the U.S. Department of the Treasury;

b. One or more irrevocable letters of credit, payable to or at the direction of EPA, that is issued by one or more financial institution(s) (i) that has the authority to issue letters of credit and (ii) whose letter-of-credit operations are regulated and examined by a U.S. Federal or State agency;

c. A trust fund established for the benefit of EPA that is administered by a trustee (i) that has the authority to act as a trustee and (ii) whose trust operations are regulated and examined by a U.S. Federal or State agency;

d. A policy of insurance that (i) provides EPA with acceptable rights as a beneficiary thereof; and (ii) is issued by an insurance carrier (a) that has the authority to issue insurance policies in the applicable jurisdiction(s) and (b) whose insurance operations are regulated and examined by a State agency;

e. A demonstration by one or more Respondents that such Respondent(s) meets the financial test criteria of 40 C.F.R. § 264.143(f) with respect to the Estimated Cost of the Work, provided that all other requirements of 40 C.F.R. § 264.143(f) are satisfied; and

f. A written guarantee to fund or perform the Work executed in favor of EPA by one or both of the following: (i) a direct or indirect parent company of a Respondent or (ii) a company that has a "substantial business relationship" (as defined in 40 C.F.R. § 264.141(h)) with at least one Respondent; provided, however, that any company providing such a guarantee must demonstrate to the satisfaction of EPA that it satisfies the financial test requirements of 40 C.F.R. § 264.143(f) with respect to the Estimated Cost of the Work that it proposes to guarantee hereunder.

90. Any and all financial assurance instruments provided pursuant to this Section shall be in form and substance satisfactory to EPA, determined in EPA's sole discretion. In the event that EPA determines at any time that the financial assurances provided pursuant to this Section (including, without limitation, the instrument(s) evidencing such assurances) are inadequate, Respondents shall, within thirty (30) days of receipt of notice of EPA's determination, obtain and present to EPA for approval one of the other forms of financial assurance listed in Paragraph 89, above. In addition, if at any time EPA notifies Respondents that the anticipated cost of completing the Work has increased, then, within thirty (30) days of such notification, Respondents shall obtain and present to EPA for approval a revised form of financial assurance

(otherwise acceptable under this Section) that reflects such cost increase. Respondents' inability to demonstrate financial ability to complete the Work shall in no way excuse performance of any activities required under this Order.

91. If Respondents seek to ensure completion of the Work through a guarantee pursuant to Subparagraph 89(e) or 89(f) of this Order, Respondents shall: (i) demonstrate to EPA's satisfaction that the guarantor satisfies the requirements of 40 C.F.R. Part 264.143(f); and (ii) resubmit sworn statements conveying the information required by 40 C.F.R. Part 264.143(f) annually, on the anniversary of the Effective Date, to EPA. For the purposes of this Order, wherever 40 C.F.R. Part 264.143(f) references "sum of current closure and post-closure costs estimates and the current plugging and abandonment costs estimates," the current EPA cost estimate of $35,000,000 for the Work at the Site shall be used in relevant financial test calculations.

92. If, after the Effective Date, Respondents can show that the estimated cost to complete the remaining Work has diminished below the amount set forth in Paragraph 89 of this Section, Respondents may, on any anniversary date of the Effective Date, or at any other time agreed to by EPA and Respondents, reduce the amount of the financial security provided under this Section to the estimated cost of the remaining Work to be performed. Respondents shall submit a proposal for such reduction to EPA, in accordance with the requirements of this Section, and may reduce the amount of the security after receiving written approval from EPA.

93. Respondents may change the form of financial assurance provided under this Section at any time, upon notice to and prior written approval by EPA, provided that EPA determines that the new form of assurance meets the requirements of this Section.

S. Termination and Satisfaction

94. Upon a determination by EPA that the Work required pursuant to this Order has been fully carried out in accordance with this Order, EPA will so notify Respondents in writing.

T. Opportunity to Confer, Effective Date

95. This Order shall be effective ten (10) days after receipt by Respondents, unless a conference is timely requested pursuant to Paragraph 96 below. If such a conference is timely requested, this Order shall become effective three (3) days following the date the conference is held, unless the effective date is modified by EPA. All times for performance of ordered activities shall be calculated from this Effective Date.

96. Respondents may, within ten (10) days after receipt of this Order, request a conference with EPA to discuss this Order. If requested, the conference shall occur within seven (7) days of Respondents' request for a conference. The conference may occur in person or telephonically.

97. The purpose and scope of the conference is to discuss issues involving the implementation of the Work required by this Order and the extent to which Respondents intend

to comply with this Order. The conference is not intended to be a forum for discussing liability issues or whether the Order should have been issued. This conference is not an evidentiary hearing and does not constitute a proceeding to challenge this Order. It does not give Respondents a right to seek review of this Order or to seek resolution of potential liability, and no official stenographic record of the conference will be made. At any conference held pursuant to Respondents' request, Respondents may appear in person or by an attorney or other representative.

98. A request for a conference must be made by telephone to Brian E. Carr, Assistant Regional Counsel, Office of Regional Counsel, EPA Region II, telephone (212) 637-3170, followed by written confirmation emailed that day to Mr. Carr at carr.brian@epa.gov.

U. Notice of Intent to Comply

99. Each Respondent shall provide, not later than five (5) days after the Effective Date, written notice to EPA stating whether it will comply with the terms of this Order. The notice should state the manner in which the Respondent intends to comply. If a Respondent does not unequivocally commit to perform the work required by this Order, it shall be deemed to have violated this Order and to have failed or refused to comply with this Order. Each Respondent's written notice shall describe, using facts that exist on or prior to the effective date of this Order, any "sufficient cause" defenses asserted by Respondent under Sections 106(b) and 107(c)(3) of CERCLA. Each Respondent's written notice shall be sent to the EPA addressees listed in Paragraph 60 above. The absence of a response by EPA to the notice required by this paragraph shall not be deemed to be an acceptance of a Respondent's assertions.

U.S. ENVIRONMENTAL PROTECTION AGENCY

March 20, 2014

Walter E. Mugdan
Director
Emergency and Remedial Response Division
U.S. Environmental Protection Agency
Region 2

Date of Issuance

APPENDICES

Available Electronically on EPA's Gowanus Webpage:
http://www.epa.gov/region02/superfund/npl/gowanus/additionaldocs.html

Appendix A – Statement of Work

Appendix B – Draft Pre-Design Work Plan

Appendix C – Record of Decision

Appendix D - Draft Remedial Design Work Plan

Appendix E – Site Map

STATEMENT OF WORK
PRE-REMEDIAL DESIGN AND REMEDIAL DESIGN
GOWANUS CANAL SUPERFUND SITE
BROOKLYN, KINGS COUNTY, NEW YORK

I. INTRODUCTION AND RECORD OF DECISION REQUIREMENTS

The purpose of this Statement of Work (SOW) is to specify the tasks Respondents shall undertake to design the remedy selected in the Record of Decision (ROD) issued by the U.S. Environmental Protection Agency (EPA) on September 27, 2013, for the Gowanus Canal Superfund Site (Site). This SOW is an attachment to the Administrative Order, Index Number CERCLA-02-2014-2001 (Order).

The ROD includes, but is not limited to, the following components:

- Dredging of the entire column of hazardous substance-contaminated sediments which have accumulated above the native sediments in the upper and mid-reaches of the Canal (referred to as “soft sediments”).

- In-situ stabilization (ISS)[1] of those native sediments in select areas in the upper and mid-reaches of the Canal contaminated with high levels of nonaqueous phase liquid (NAPL).[2]

- Construction of a multilayered cap in the upper and mid-reaches of the Canal to isolate and prevent the migration of polycyclic aromatic hydrocarbons (PAHs) and residual NAPL from native sediments.

- Dredging of the entire soft sediment column in the lower reach of the Canal.

- Construction of a multilayer cap to isolate and prevent the migration of PAHs from native sediments in the lower reach of the Canal.

- Off-Site treatment of the NAPL-impacted sediments dredged from the upper and mid-reaches of the Canal with thermal desorption,[3] followed by beneficial reuse off-Site (*e.g.,* landfill daily cover) if possible.

- Off-Site stabilization of the less contaminated sediments dredged from the lower reach of the Canal and the sediments in the other reaches not

[1] ISS involves mixing of materials, such as Portland cement, into sediments to bind the contaminants physically/chemically.

[2] NAPL is concentrated liquid contamination, typically oil-like, that forms a separate phase and is not miscible with water.

[3] Desorption utilizes heat to increase the volatility of organic contaminants so that they can be removed and destroyed.

impacted by NAPL, followed by beneficial reuse off-Site.

- Excavation and restoration of approximately 475 feet of the filled-in former 1st Street turning basin.

- Excavation and restoration of the portion of the 5th Street turning basin beginning underneath the 3rd Avenue bridge and extending approximately 25 feet to the east and the installation of a barrier or interception system at the eastern boundary of the excavation.

- Implementation of institutional controls incorporating the existing fish consumption advisories (modified, as needed), as well as other controls to protect the integrity of the cap.

- Periodic maintenance of the cap and long-term monitoring to insure that the remedy continues to function effectively.

- Combined sewer overflow (CSO) control measures for the upper reach of the Canal to significantly reduce overall contaminated solid discharges to the Canal as follows:

    - Construction of in-line sewage/stormwater retention tanks to retain stormwater which currently discharges through outfalls RH-034 and OH-007. It is estimated that an 8-million gallon tank and a 4-million gallon tank shall be required to address CSOs from outfalls RH-034 and OH-007, respectively. In addition, outfalls located in the vicinity of outfalls RH-034 and OH-007 that contribute smaller CSOs shall be connected to the retention tanks. The location of the retention tanks shall be determined during the remedial design. While the sizes of the tanks shall be determined during the remedial design, they are expected to conform with the requirements of the Clean Water Act and to accommodate projected additional loads to the combined sewer system that result from current and future residential development, as well as periods of high rainfall, including future rainfall increases that may result from climate change.

    - In the event that the permanent measures described above are not implemented in a timely manner, interim controls, such as temporary solids capture and removal, shall be implemented to mitigate sediment from the CSO discharges until the permanent measures have been implemented.[4]

[4] It is unlikely that permanent measures to control the CSO discharges will be in place before the commencement of the remediation of the canal sediments.

- Implementation of appropriate engineering controls to ensure that hazardous substances and solids from separated stormwater, including from future upland development projects, are not discharged to the Canal.

- To prevent recontamination of the Canal following the implementation of the above-described remedial actions, the upland sources of hazardous substances, including discharges from three former manufactured gas plants (MGPs), CSOs, other contaminated upland areas and unpermitted pipes along the Canal, must be addressed prior to the commencement of, or in phased coordination with, the implementation of the selected remedy.

- The former MGP facilities are being addressed by National Grid, a potentially responsible party (PRP) for these facilities and the Site, under New York State Department of Environmental Conservation (NYSDEC) oversight. Based upon the first NYSDEC-selected remedy at one of these former MGP facilities and NYSDEC guidance for presumptive remedies at former MGP facilities, it is assumed that a range of actions shall be implemented at the facilities (that may include removal of mobile sources, construction of cut-off walls along the Canal, and active recovery of NAPL near the cut-off walls for each of the former MGP facilities) which shall prevent the migration of contamination from the former MGP facilities into the Canal. The cleanup of the former MGP facilities shall be completed in accordance with schedules agreed upon between the EPA and NYSDEC.

- In the unlikely event that timely and effective state-selected remedial actions are not implemented at a given former MGP facility, the EPA may implement actions pursuant to CERCLA to ensure the protectiveness of the selected remedy.

- Current and future high density residential redevelopment along the banks of the Canal and within the sewershed shall adhere to NYC rules for sewer connections (Chapter 31 of Title 15 of the Rules of the City of New York) and shall be consistent with current NYC Department of Environmental Protection (NYCDEP) criteria (NYCDEP, 2012) and guidelines to ensure that hazardous substances and solids from additional sewage loads do not compromise the effectiveness of the permanent CSO control measures by exceeding their design capacity.

- The remedy also includes the control or elimination of unpermitted pipe outfalls.

II. **PERFORMANCE STANDARDS**

Performance standards are the cleanup standards, Remedial Action Objectives, and other measures of achievement of the goals of the remedy selected in the ROD. The pre-Remedial Design (RD) and RD performed pursuant to this SOW shall be developed to achieve compliance with the Performance Standards. See ROD, "Remedial Action Objectives" and "Compliance with ARARs" sections and Order, Paragraph 10.k.

The following RAOs were established for the Site:

- Reduce the cancer risk to human health from the incidental ingestion of and dermal contact with PAHs in sediment during recreational use of the Canal or from exposure to Canal overflow to levels that are within or below the EPA's excess lifetime cancer risk range of 10^{-6} to 10^{-4}.

- Reduce the contribution of PCBs from the Gowanus Canal to fish and shellfish by reducing the concentrations of PCBs in Gowanus Canal sediment to levels that are within the range of Gowanus Bay and Upper New York Bay reference concentrations.

- Reduce the risks to benthic organisms in the Canal from direct contact with PAHs. PCBs and metals in the sediments by reducing sediment toxicity to levels that are comparable to reference conditions in Gowanus Bay and Upper New York Bay.

- Reduce the risk to herbivorous birds from dietary exposure to PAHs.

- Eliminate the migration of NAPL into the Canal so as to minimize NAPL serving as a source of contaminants, primarily PAHs, to the Canal.

III. **COMMUNITY RELATIONS**

To the extent requested by the EPA, Respondents shall provide information relating to the Work required hereunder for the EPA's use in developing and implementing a Community Relations Plan. As requested by the EPA, Respondents shall participate in the preparation of appropriate information disseminated to the public and participate in public meetings, which may be held or sponsored by the EPA, to explain activities at or concerning the Site.

IV. PRE-REMEDIAL DESIGN ACTIVITIES

A. Pre-RD activities shall be conducted by Respondents to gather sufficient information to fully develop the RD. Respondents shall perform pre-RD activities and investigations including, but not limited to, the following:

1. A detailed survey of the Canal bottom for performing pre-construction large debris removal;

2. A plan for debris removal, decontamination and disposal;

3. A survey and assessment, as it relates to the implementation of the remedy, of the integrity of existing bulkhead along the Canal and a determination of the extent of temporary bulkhead installation required for remedy implementation;

4. A plan for staging site selection and implementation of staging operations;

5. Data collection for the evaluation of groundwater upwelling at the Canal bottom for identification of groundwater discharge areas and measurements of discharge rate;

6. Evaluation of upland locations requiring cut-off walls or other remedial measures as a result of NAPL that has migrated to upland locations and determination of the extent (depth, length) of cut-off walls at each location;

7. Evaluation of Canal native sediment to identify areas of potentially mobile NAPL for the ISS treatment boundaries; and

8. A plan for compliance with Federal and State archeological requirements.

B. All work required under Section IV.A., above, shall be completed and all deliverables submitted to the EPA for approval no later than October 1, 2014.

C. National Grid entered into an Amendment to Administrative Order and Settlement Agreement (Settlement Agreement), Index Number CERCLA-02-2010-2009), which included a SOW ("Settlement Agreement SOW"). Consistent with Section IV of the Settlement Agreement SOW, National Grid developed and submitted for EPA approval a Pre-RD Work Plan on January 29, 2014. The EPA will either approve the Pre-RD Work Plan or otherwise respond pursuant to Section IX (the EPA Approval of Plans and Other Submissions) of the Order.

V. REMEDIAL DESIGN ACTIVITIES

A. Respondents shall perform the RD of the remedy selected in the ROD. The RD activities to be performed pursuant to and in accordance with this SOW, the Order and the ROD include, but are not limited to, the following:

1. Development of planning documents including but not limited to work plans and schedules for remedy implementation. Tasks shall include pre-RD activities and investigations, preliminary design report (35% completion) which will include the findings and results of the pre-RD activities and investigations, an intermediate design (65%) and a final design report (100% completion). Schedules shall be consistent with the schedule for completion of the remedy specified in the ROD;

2. Detailed design of all the components of the remedy, described in Section I, including, but not limited to: the dredging of the "soft" sediment, capping with a multilayer cap, ISS, excavation and restoration of the portion of the 5th Street basin specified in the remedy, and treatment and disposal of dredged sediment, (except for the design of the CSO retention tanks and the restoration of the 1st Street basin, to be performed by New York City);

3. Tasks required for implementing institutional controls;

4. Tasks for construction, operation, and maintenance of all remedy components;

5. Tasks to monitor the effectiveness of ISS, the active cap, the cut-off walls and retention tanks;

6. To the extent that the EPA conducts data collection and any ISS pilot study work, Respondents shall incorporate such work into the RD; and

7. Tasks to identify how the RD and the RA will be implemented using the principles specified in the EPA Region 2's Clean and Green Policy and NYSDEC's Green Remediation Policy.[5]

---

[5] See http://epa.gov/region2/superfund/green_remediation and http://www.dec.ny.gov/docs/ remediation_hudson_pdf/der31.pdf.

VI. REMEDIAL DESIGN WORK PLAN

Consistent with Section V of the Settlement Agreement SOW, National Grid developed and submitted for EPA approval an RD Work Plan on February 27, 2014. The EPA will either approve the RD Work Plan or otherwise respond pursuant to Section IX (the EPA Approval of Plans and Other Submissions) of the Order.

VII. REMEDIAL DESIGN

A. Respondents shall perform the RD activities in conformance with the RD Work Plan approved by the EPA and within the time frames specified in the RD schedule contained in the EPA-approved RD Work Plan.

B. In accordance with the schedule set forth in the EPA-approved RD Work Plan, Respondents shall submit the findings of the pre-remedial design investigations in the preliminary design report (35% completion). The findings should include the results and analysis of all data collected during the pre-remedial design field studies.

C. The RD Reports (35%, 65% and 100% completion) shall be submitted to the EPA in accordance with the schedule set forth in the EPA approved RD Work Plan. The RD Reports shall include a discussion of the design criteria and objectives, with emphasis on the capacity and ability to meet design objectives successfully. The RD Reports shall also include the plans and specifications that have been developed at that point in time, along with a design analysis. The design analysis shall provide the rationale for the plans and specifications, including results of relevant sampling and testing performed, supporting calculations and documentation of how these plans and specifications will meet the requirements of the ROD and shall provide a discussion of any impacts these findings may have on the RD. In addition to the above, the RD Reports shall include the following items:

1. Specifications for photographic documentation of the remedial construction;

2. A discussion of the manner in which the Remedial Action (RA) will achieve the Performance Standards;

3. A discussion of the manner in which the RA will comply with the EPA Region 2's Clean and Green Policy;

4. A draft schedule for RA activities;

5. The draft schedule for the RA shall provide for the completion of the installation of the remedy within 6 months of the EPA’s approval of the RA Work Plan. The draft schedule for RA and monitoring activities may be revised during the remedial process, subject to the EPA's approval;

6. A preliminary Construction Quality Assurance Project Plan which shall detail the approach to quality assurance during construction activities at the Site;

7. A report describing those efforts made to secure access and obtain other approvals and the results of those efforts; and

8. A plan for implementation of construction and construction oversight.

D. The EPA’s comments on the preliminary design report (35%) shall be incorporated by Respondents into the intermediate design report. EPA’s comments on the intermediate design report (65% completion) shall be incorporated by Respondents into the final design report (100% completion).

Prepared for

National Grid
One MetroTech Center
Brooklyn, NY 11201

PRE-DESIGN WORK PLAN

GOWANUS CANAL SUPERFUND SITE
BROOKLYN, NEW YORK

Prepared by

Geosyntec consultants

engineers | scientists | innovators

Project Number HPH104

January 2014

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

LIST OF ACRONYMS

AOC	Administrative Order on Consent
BOD	basis of design
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	chemical of potential concern
CSM	conceptual site model
CSO	combined sewer overflow
DQO	data quality objective
EPA	United States Environmental Protection Agency
FS	feasibility study
HASP	Health and Safety Plan
ISS	in situ stabilization
mgd	million gallons per day
MGP	manufactured gas plant
MLLW	mean lower low water
MTA	Metropolitan Transit Authority
NAPL	non-aqueous phase liquid
NPL	National Priorities List
NYC	New York City
NYCDEP	New York City Department of Environmental Protection
NYSDEC	New York State Department of Environmental Conservation
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PD	pre-design
PDWP	pre-design Work Plan
PRP	potentially responsible party
QAPP	Quality Assurance Project Plan
RI	remedial investigation
ROD	Record of Decision
RTA	remediation target area
SOW	scope of work
USACE	United States Army Corps of Engineers
WPCP	water pollution control plant

1. INTRODUCTION

This Pre-design Work Plan (PDWP) is being developed for the Gowanus Canal Superfund Site (the Site) under the Administrative Order and Settlement Agreement for Investigation, Sampling and Evaluation dated April 29, 2010, as amended on January 24, 2014 (the AOC). The AOC covers only the development of those portions of the PDWP detailed in the scope of work (SOW) attached to the AOC Amendment (AOC Attachment A). The PDWP is a necessary step in developing the technical activities required by the Record of Decision (ROD) dated September 27, 2013, and provides the data needed to implement the remedial design.

Implementation and completion of the PDWP activities will be performed under a separately negotiated Administrative Order by a group of potentially responsible parties (PRPs) identified by the United States Environmental Protection Agency (EPA). The PDWP work elements will be further developed under the separate Administrative Order, and this PDWP does not commit any party to performing the work described herein.

1.1 Purpose

This PDWP provides a roadmap of the pre-design work elements required to be conducted prior to the final remedial design activities (RD) being developed. The PDWP identifies 26 individual pre-design work elements (PD-1 through PD-26), summarized on Tables 1-1 and 1-2.

PD-1: Quality Assurance Project Plan (QAPP) and PD-2: Health and Safety Plan (HASP), outlined in Sections 5 and 6, are currently under development and will be submitted under separate cover in late February 2014. This PDWP addresses work elements PD-3 through PD-8 in detail in Section 3 and Attachment A. Work elements PD-9 through PD-26 are addressed in Section 4; an overview of likely major scope items is provided for each of these work elements, which will be further developed in subsequent phases of the PDWP.

1.2 Organization

This PDWP is organized as follows:

- Section 2 presents the project background;
- Section 3 details pre-design work elements included in the first phase of the PDWP;

- Section 4 describes pre-design work elements that are anticipated to be included with subsequent phases of the PDWP;
- Section 5 outlines the QAPP;
- Section 6 outlines the HASP;
- Section 7 provides References cited herein; and
- Attachment A provides Work Plans and additional details for pre-design work elements PD-3 through PD-8.

2. PROJECT BACKGROUND

2.1 Brief History of Gowanus Canal

The Gowanus Canal (the Canal) is a 1.8-mile-long, man-made canal constructed within the former Gowanus Creek in the Borough of Brooklyn in New York City (NYC), Kings County, New York (Figure 2-1). Gowanus Creek and the associated wetlands complex previously covered the area in South Brooklyn between the current Carroll Gardens and Park Slope neighborhoods. While development of the Canal began as early as 1767 (Hunter Research, Inc., et al., 2004), the Canal was officially authorized in 1848 by the State of New York for the dual purposes of draining the wetlands of South Brooklyn and opening the area to development. The Canal was constructed between 1853 and 1869 and was designed as a conveyance channel for barges (NYC Department of City Planning, 1985). The original creek was widened and deepened for 1½ miles from the bay to Butler Street (Brooklyn Historical Society, 2000). The banks of the Canal were created by driving pilings adjacent to each other, securing them with ribs and caps, and connecting them into the existing bank (Richards, 1848). Excavated materials from the creek were reportedly used as fill behind the walls of the Canal (Richards, 1848). By 1869, the Gowanus Canal was reported complete with the current street configuration surrounding the Canal. The Canal enabled easy transportation and storage of bulk materials such as coal, petroleum, asphalt, and lumber to support the rapid growth of industry in Brooklyn and surrounding areas.

The Canal continued to be a primary route of transportation for goods and materials into the area until the completion of the Gowanus Expressway in 1951 (NYC Department of City Planning, 1985). The construction of the expressway essentially eliminated the need for the Canal to be used for transportation purposes; however, it was still used for manufacturing and storage. The decline of inner-city industry began in the early 1960s and by the mid-1970s more than half of the properties along the Gowanus Canal were reported as unused and in disrepair (Gowanus Canal Community Development Corporation, 2003). As the use of the Canal declined, portions of the 1st Street, 5th Street, and 7th Street basins were filled. The 1st Street basin and 5th Street basin to the southwest of 3rd Avenue were filled between 1950 and 1969. The eastern end of the 7th Street basin was also filled during this period (Sanborn, 1950 and 1969) and a building was constructed in this area.

2.1.1 Industrial Uses of the Canal

The Gowanus Canal has served as the conveyance of sewage and industrial wastes as part of the development and industrialization of the area. During the canal construction, the City of Brooklyn constructed sewers emptying into the Gowanus Canal as early as

1858. The confined nature of the Canal and limited tidal exchange resulted in sedimentation and water quality degradation shortly after construction. Accumulation of sludge and sediments in the Canal became problematic as early as the late 1800s because of discharges of sewage to the Canal. By 1889, the waters in the Gowanus Canal were heavily impacted by sewage and industrial discharges and they were considered a public health hazard and a hazard to travel in the Canal.

In 1889, the State Commission suggested that filling the Canal was the best solution to improve water quality conditions, but because of the expense of filling in the Canal, the Commission provided alternative recommendations including "absolute cutting off of all discharges to the Canal," bulkhead repair, dredging, replacement of bridges with fixed spans, and the installation of a flushing system (Hunter Research, Inc., et al., 2004). That same year, the City of Brooklyn constructed storm sewer outfalls that drained the Fort Greene section of Brooklyn to the head of the Canal in an effort to improve flow/tidal exchange within the Canal; however, the effort was unsuccessful and only contributed to water quality degradation in the Canal.

A review of Sanborn, Hyde, and Bromley maps, as well as other historical sources, identified numerous historic business operations that potentially had operations of environmental concern near the Canal. The numbers and types of operations that occurred along Canal are estimated to include, but are not limited to, the following:

- 47 historic coal yards operated along the Canal from the time that it was completed in the late 1860s through the late 1960s.

- Numerous asphalt and coal tar products companies were located along the central and lower portions of the Canal; 17 of these sites operated as early as 1886 through the present.

- 11 bulk oil storage facilities or oil works operated along the entire length of the Canal from as early as 1880 through recent times.

- 37 chemical, paint, fertilizer, and plastic manufacturing facilities were located along the entire length of the Canal from as early as the 1860s to the present.

- 2 incinerators and city dumping platforms located along the Canal were operated by the City of New York.

- Power plants, substations, and railroad repair yards have operated along the Canal from as early as 1886 through recent years.

- 3 manufactured gas plants (MGPs) operated along the Canal and are discussed further in Section 2.5.3.

2.1.2 Combined sewer overflows (CSOs)

The Gowanus Canal and surrounding area are currently serviced by combined sewer systems which convey sewage and stormwater to the Red Hook Water Pollution Control Plant (WPCP) and Owls Head WPCP. During wet weather, the combined sewer system becomes overwhelmed, and a mixture of sewage and stormwater is discharged into the canal via 11 CSO outfalls (NYCDEP, 2008). Ten of these CSO outfalls are within the study area defined by the EPA (CSO outfall OH-024 is located south of the study area) (CH2M Hill and HDR, 2011). The 11 CSO outfalls are shown in Figure 2-1. Six percent of the watershed does not contain sanitary sewers such that stormwater drains directly to the Canal (NYCDEP, 2008).

The Red Hook WPCP services areas to the north and west of the Canal. Outfalls discharging to the Canal associated with the Red Hook WPCP are CSOs RH-031, RH-033, RH-034, RH-035, RH-036, RH-037, RH-038, and one active stormwater outfall (RH-601 formerly RH-032). These outfalls drain approximately 935 acres (slightly less than half) of the Gowanus Canal watershed (NYCDEP, 2008). The Owls Head WPCP services areas to the south and east of the Canal. Outfalls discharging to the Canal associated with the Owls Head WPCP are CSOs OH-005, OH-006, OH-007, and OH-024 and three stormwater outfalls (OH-601, OH-602, OH-607 (formerly OH-008)). The Owls Head WPCP services 719 acres (slightly less than half) of the Gowanus Canal watershed (NYCDEP, 2008).

The greatest annual discharges occur from outfalls RH-034, RH-035, and OH-007 (NYCDEP, 2008).

2.1.3 Flushing Tunnel

In 1911, the Gowanus Canal Flushing Tunnel was constructed to pull the less polluted waters of Gowanus Bay into the Gowanus Canal while discharging polluted water at the head of the Canal to the Buttermilk Channel via a propeller and underground tunnel. The flushing tunnel system includes an electric-powered propeller and a 12-foot internal diameter 6,280-foot-long tunnel that runs primarily under Degraw Street to the Buttermilk Channel. The flushing tunnel inported approximately 300 million gallons per day (mgd) of water from the Gowanus Bay into the Canal, and operated from 1911 until 1960 when mechanical failure, reportedly from a manhole cover that was dropped into the flushing tunnel propeller shaft, rendered the pump inoperable (Hunter Research, Inc., et al., 2004). With the flushing tunnel inoperable, siltation of the Canal occurred and Canal water quality returned to its degraded state. Through the Gowanus Facilities Upgrade project, the NYCDEP is in the process of upgrading the single pump system to a three pump system, which is intended to provide additional capacity and needed redundancy to maintain operation with one or two pumps out of service for maintenance or repairs, and allow for continuous operation throughout the tidal cycle. The projected flow range for the upgraded system is 175 mgd at low tide to 250 mgd at high tide, with an average flow of approximately 215 mgd. The upgraded system will incorporate variable frequency drives to allow the pump speed and flow rate to be adjusted according to the tides.

2.2 Current Configuration of Gowanus Canal

The EPA Feasibility Study (FS, CH2M Hill, 2011) divided the Canal into three remediation target areas (RTAs) that correspond to the upper reach (RTA 1), middle reach (RTA 2), and lower reach (RTA 3) of the Canal in order to facilitate the assessment and management of the Canal (Figure 2-2).

There are five east–west surface streets with bridges that cross over the Canal, as shown in Figure (2-2): Union Street, Carroll Street, 3rd Street, 9th Street, and Hamilton Avenue. Hamilton Avenue is a divided roadway with two bridges spanning the Canal. The Gowanus Expressway and a viaduct for Metropolitan Transit Authority (MTA) subway trains also pass overhead. The Gowanus Expressway is co-located with Hamilton Avenue bridges and the MTA viaduct is co-located with the 9th Street bridge.

North of Hamilton Avenue, the Canal is approximately 5,600 feet long with a maximum water depth of approximately -15 feet mean lower low water (MLLW) in the main channel. The Canal is approximately 100 feet wide though there are narrower sections. There are four short turning basins that branch to the east of the main channel at 5th Street, 6th Street, 7th Street, and 11th Street. A former turning basin at 1st Street and an extension of the 5th Street turning basin were filled in between 1953 and 1965, and an extension of the 7th Street turning basin has also been filled. South of Hamilton Avenue, the Canal widens to a maximum of approximately 2,200 feet and ranges in depth from -15 to -35 feet MLLW. The Gowanus Canal has no remaining natural shoreline or natural wetlands, though various small, unconnected areas of vegetation and intertidal habitat exist. The vast majority of the shoreline of the Canal is lined with retaining structures or bulkheads.

The Canal is located in a mixed residential-commercial-industrial area. It borders several residential neighborhoods, including Gowanus, Park Slope, Cobble Hill, Carroll Gardens, and Red Hook, with housing located within one block of the Canal. The waterfront properties abutting the Canal are primarily commercial and industrial. Re-zoning of Canal-front parcels to high density residential began in 2009 and further such re-zoning is anticipated.

2.3 Recent CERCLA Regulatory History

Since 1983, the NYC Department of Environmental Protection (NYCDEP) has compiled four separate reports on water quality and CSO controls for the Canal, each of which was approved by the New York State Department of Environmental Conservation (NYSDEC) for proposed further actions. Since 2003, the United States Army Corps of Engineers (USACE) has issued about a dozen reports regarding the Canal. National Grid has completed numerous reports regarding its former MGP sites, and studies and/or cleanups have been conducted at another dozen or more upland areas.

In April 2009, the Gowanus Canal was proposed for inclusion on the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at the request of NYSDEC. EPA commenced a remedial investigation (RI) following the proposal for inclusion on the NPL, and on March 2, 2010, EPA placed the Canal on the NPL.

In April 2010, EPA entered into Administrative Orders of Consent with NYC and National Grid to perform work in support of EPA's remedial investigation/feasibility study (RI/FS). The RI Report was completed in January 2011 and the draft FS Report was completed in December 2011. An FS addendum report was completed in December 2012.

2.4 Select Potentially Responsible Parties

As of September 2013, EPA has sent notices of potential liability to thirty-three companies, NYC, the US Navy, the US Postal Service, the US General Services Administration, the US Maritime Administration and the former owner of a company, since deceased. These parties were also sent information request letters. The recipients of notice of potential liabilities are listed in Table 2-1, and the location of the properties relative to the Gowanus Canal are shown in Figures 2-3 to 2-6. Seventy-one other companies have been sent information request letters as well.

2.5 Overview of Proposed Remedy

2.5.1 In-Canal Remedial Activities

The ROD includes, but is not limited to, the following components to complete the remedy in the Canal.

- Dredging of the entire column of hazardous substance-contaminated sediments which have accumulated above the native sediments in the upper and mid-reaches of the Canal (referred to as "soft sediments").

- In situ stabilization (ISS) of those native sediments in select areas in the upper and mid-reaches of the Canal contaminated with high levels of non-aqueous phase liquid (NAPL).

- Construction of a multilayer cap in the upper and mid-reaches of the Canal to isolate and prevent the migration of polycyclic aromatic hydrocarbons (PAHs) and residual NAPL from native sediments.

- Dredging of the entire soft sediment column in the lower reach of the Canal.

- Construction of a multilayer cap in the lower reach of the Canal to isolate and prevent the migration of PAHs from native sediments.

- Off-site treatment of the NAPL-impacted sediments dredged from the upper and mid-reaches of the Canal with thermal desorption followed by beneficial reuse off-site (e.g., landfill daily cover) if possible.

- Off-site stabilization of the less contaminated sediments dredged from the lower reach of the Canal and the sediments in the other reaches not impacted by NAPL, followed by beneficial reuse off-site.

- Excavation and restoration of approximately 475 feet of the filled-in former 1st Street turning basin.

- Excavation and restoration of the portion of the 5th Street turning basin beginning underneath the 3rd Avenue bridge and extending approximately 25 feet to the east, and installation of a barrier or interception system at the eastern boundary of the excavation.

- Implementation of institutional controls incorporating the existing fish consumption advisories (modified as needed) as well as other controls to protect the integrity of the cap.

- Periodic maintenance of the cap and long-term monitoring to ensure that the remedy continues to function effectively.

2.5.2 Control of Point Source Discharges

The ROD also requires the following components:

- CSO control measures are required for the upper reach of the Canal to significantly reduce overall contaminated solid discharges to the Canal.

- Other potential point sources discharges that need to be addressed as part of the remedial actions include; storm drains, and unpermitted discharges.

2.5.3 Remediation of Upland Sites

In order for the selected remedy in the Canal to be effective, upland sources which have the potential to recontaminate the Canal must be addressed. The impacted upland areas along the Canal (which could cause Canal recontamination post-remedy by erosion from the surface and through bulkheads in disrepair) are required by the ROD to be addressed prior to the commencement of, or in phased coordination with, implementation of the selected remedy. Potential upland sources are the properties referenced in Section 2.4 and shown in Figures 2-3 to 2-6. The former MGP facilities are being addressed by National Grid, a PRP for the three former MGP facilities at the Site, under NYSDEC oversight. In addition, the ROD recognizes there are additional impacted upland sites which have been referred to NYSDEC.

2.6 Summary of Existing Data

A number of field investigations have been completed as part of the RI leading up to the ROD for the Gowanus Canal and as part of the development of corrective measures for the upland sites. This information was used to develop a conceptual site model (CSM). The available data includes:

- EPA investigations in the Gowanus Canal including “Gowanus Canal Remedial Investigation Report” (CH2M Hill and HDR, 2011) and “Draft Feasibility Study, Gowanus Canal” (CH2M Hill, 2011).

- Bench-scale testing data conducted in 2013 by CH2M Hill included in "Bench-Scale Testing Report Pre-Design Investigations Gowanus Canal Brooklyn, New York" (CH2M Hill, 2013).

- Canal samples collected by GEI included in the following reports from 2007 and 2009: "Draft Remedial Investigation Technical Report: Gowanus Canal Superfund Site, Brooklyn, New York" (GEI Consultants, Inc., 2007) and "Remedial Investigation Technical Report, Gowanus Canal, Brooklyn, New York" (GEI Consultants, Inc., 2009).

- Reports associated with upland investigation and remediation, including RI/FS, interim remedial design, ROD, and design and construction documents as maintained at the community outreach internet sites below.

  Fulton Municipal former MGP
  http://www.fultonmgpsite.com/index.html

  Metropolitan former MGP
  http://www.metropolitanmgpsite.com/index.html

  Citizens former MGP
  http://www.citizensmgpsite.com/index.html

- CSO related information located in the following reports; "CSO/Gowanus Canal Sampling and Screening-Level Risk Assessment Report, Gowanus Canal Superfund Site, Brooklyn, New York" (GEI Consultants, Inc., 2011a), and "City-Wide Long Term CSO Control Planning Project, Gowanus Canal Waterbody/Watershed Facility Plan Report" (NYCDEP, 2007). –

- Debris surveys of the Canal located in appendix M of "Gowanus Canal Remedial Investigation Report" (CH2M Hill and HDR, 2011).

- Bulkhead and Bathymetric Surveys

  - Reports associated with bulkheads in the Gowanus Canal including "Gowanus Canal, Bulkhead Inventory Survey" (Brown, 2000), "Side Scan Sonar Report: Gowanus Canal Preliminary Bulkhead Study, Brooklyn, Kings County, NY" (Dolan Research, Inc., 2010), and "Draft Bulkhead Summary: Gowanus Canal Superfund Site, Brooklyn New York" (GEI Consultants, Inc., 2012).

- Bathymetric survey including "Multibeam Hydrographic Survey" (Ocean Surveys, Inc., 2013).

- Other reports used for the development of the Gowanus Canal CSM are as follows:

  - "Initial Geotechnical Investigation in Support of Cap Design, Gowanus Canal Superfund Site, Brooklyn New York" (GEI Consultants, Inc., 2013).

  - "Groundwater Model Report, Gowanus Canal Superfund Site, Brooklyn, New York" (GEI Consultants, Inc., 2011).

  - "Gowanus Canal Numerical Surface Water Modeling Phase 1 Report" (Baird, 2012).

3. PRE-DESIGN TASKS INCLUDED IN THE PDWP

3.1 Overview

The purpose of the PDWP is to provide data to support refinement of the comprehensive Site-wide CSM and development of the remedial design process. The PDWP will be developed through an incremental, phased approach with separate submittals for each phase of the PDWP. This first submittal of the PDWP addresses specific work elements identified as PD-1 through PD-8 of the SOW (in the AOC Amendment, Attachment A) and summarized in Table 1-1. Work elements PD-3 through PD-8 are described in Sections 3.3 through 3.8 and detailed in Attachment A.

A preliminary list of additional pre-design work elements, PD-9 to PD-26, is provided in Table 1-2 and included here for completeness. The PDWP for the activities in Table 1-2 is anticipated to be submitted under a later Administrative Order performed jointly by the PRPs identified by EPA. In some cases, the information collected in PD-3 through PD-8 will be used to scope the later pre-design work elements identified in Table 1-2.

An initial list of remedial design components has been identified and is summarized in Table 3-1. Each PDWP work element (i.e., PD-3 to PD-8) supports specific design components, as highlighted in Table 3-1 and in the following work element descriptions.

3.2 Data Quality Objectives (DQOs) of PDWP

DQOs for each pre-design work element will be defined in the QAPP. An overview of the DQO development process is provided below. All steps may not be included in each work element, and finalization of the DQOs is contingent upon finalization of the approaches and methodologies associated with each individual work element.

- Step 1 – State the problem
- Step 2 – Identify the goals of the study
- Step 3 – Identify information inputs
- Step 4 – Identify boundaries of the study
- Step 5 – Develop the analytic approach
- Step 6 – Specify performance or acceptance criteria

3.3 PD-3: Additional Reconnaissance for Debris Removal

The overall objective of this work element is to identify and characterize debris present in the areas not included in the high-frequency side-scan sonar study completed in December 2010. If needed, areas of uncertainty in the previous survey will be revisited for confirmation. This additional debris reconnaissance builds upon information contained in the RI (CH2M Hill, 2011) for the Site. Information from this work element will assist in refining and improving the comprehensive Site-wide CSM and prepare for future remedial activities.

The results of PD-3, coupled with previous work, will be used to develop the plan for PD-4: A Plan for Debris Removal, Decontamination, and Disposal. The work element will also provide information to support design components related to equipment mobilization, staging and project infrastructure needs, and logistics.

3.4 PD-4: A Plan for Debris Removal, Decontamination, and Disposal

The overall objective of this work element is to develop a Debris Removal, Decontamination, and Disposal Plan to govern the removal and/or management of debris such that the underlying targeted sediment can be efficiently and effectively dredged and/or remediated.

Key components of the Debris Plan will include but not limited to:

- Debris removal;
- Debris decontamination;
- Debris handling and disposal; and
- Cultural resources management.

The results of PD-4 will be used specifically to develop the remedial design component associated with debris management. The work element will also provide information to support design components related to sediment dredging, dredge material management, transport off-site, dewatering and water treatment, and archeological methodologies to address cultural resources in debris removal and dredging.

3.5 PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation

The overall objectives of the bulkhead survey and assessment work element are to provide a plan for performing a preliminary assessment of the stability of existing bulkheads during and after remedy implementation, and to create a preliminary design of bulkhead support systems. The proposed field exploration program will collect data to be used as the basis for design of bulkhead support systems. It is anticipated that supplemental information will be required for the design of property-specific support systems.

The activities that are planned as part of PD-5 include:

- Subsurface investigation of existing bulkhead foundations;
- Geotechnical site investigation;
- Factual bulkhead investigation report;
- Evaluation of existing bulkhead stability during remedy implementation;
- Evaluation of final conditions for bulkheads; and
- Assessment and recommendation of existing bulkhead report.

The results of PD-5, coupled with previous work, will be used to develop the bulkhead stabilization design components. The work element will also provide information to support design components related to capping, amendment layer design, ISS, and archeological methodology.

3.6 PD-6: A Plan for Staging Site Selection and Implementation

This work element has been prepared to describe the approach and methods to be used to select sites for the staging activities necessary to assemble and transfer labor, equipment, supplies, and material during remedial activities. The objective of this work element is to develop a plan describing the means to:

- Identify project infrastructure needs;
- Determine necessary staging site requirements;
- Identify potential staging sites; and,

- Evaluate staging sites.

It is anticipated that candidate sites will be re-evaluated throughout the design process as project infrastructure needs are refined. The results of PD-6 will be used to develop several design components, including equipment mobilization, staging, sediment handling, transport off-site, dewatering and water treatment, and logistics. The work element will also provide information to support the design component related material procurement.

3.7 PD-7: Evaluation of Potential Groundwater Upwelling Areas and Measurement of Discharge Rates

Two primary objectives of this work element are to determine the approximate areas of significant groundwater upwelling in the Gowanus Canal and, for those areas where discharge is identified, to estimate the rate and velocity of this discharge.

The activities that are planned as part of PD-7 include:

- Evaluate and select applicable technologies for locating groundwater discharge areas and quantifying discharge rates;

- Evaluate and select areas of the Canal for groundwater upwelling measurements;

- Inspect Site to confirm feasibility of selected technologies at target locations;

- Implement selected technologies to assess groundwater upwelling areas and discharge rates;

- Characterize the hydraulic conductivity between the native and soft sediments;

- Refine the groundwater CSM and groundwater model; and

- Data management, analysis, and reporting.

The results of PD-7, coupled with previous work, will be used to develop the design elements related to capping, the capping amendment layer, ISS, and bulkheads. The work element will also provide information to support design components related to material procurement.

3.8 PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments

The primary objectives of this work element are to (i) quantify the coal tar NAPL distribution within the canal, (ii) define areas of potentially mobile NAPL, and (iii) identify and characterize the controlling factors of NAPL mobility.

The activities that are planned as part of PD-8 include:

- Desktop evaluation of NAPL mobility and selection of appropriate field-screening technology(ies) and assessment locations;
- Implementation of field-based approaches to assess in situ NAPL distribution;
- Laboratory mobility testing and NAPL characterization; and,
- Data management, analysis, and reporting.

The results of PD-8, coupled with previous work, will be used to develop the design component for ISS. The work element will also provide information to support design components related to bulkhead stabilization, capping, and material procurement.

4. PRE-DESIGN TASKS TO BE INCLUDED IN SUBSEQUENT PHASES OF THE PDWP

A preliminary list of additional pre-design work elements, PD-9 to PD-26, is provided in Table 1-2 and is included here for completeness. The PDWP for the activities in Table 1-2 is anticipated to be submitted under a later Administrative Order performed jointly by the PRPs identified by EPA. These future work elements will support specific design components, as highlighted in Table 4-1 and in the following work element descriptions.

4.1 PD-9: Additional Sampling for Polychlorinated Biphenyls (PCBs)

Mitigation of ongoing PCB sources will be a key component of a sustainable remedial design. Additional sampling is needed in areas with elevated PCB concentrations to determine if there are upland PCB sources that require controls. Hydrodynamic and sediment modeling will also be used to provide an additional line of evidence of upland PCB sources. The additional sampling data will also support the waste disposal component.

4.2 PD-10: Stabilized Material Use and Treatability Testing

The ROD referenced the potential beneficial reuse of dredged material as landfill cover. This option will be evaluated during treatability testing to determine the optimal amount of stabilization agents (e.g., pozzolonics) needed in order for the amended dredged material to reliably meet the acceptance criteria of a permitted end-use/disposal site such as a landfill or similar facility.

4.3 PD-11: Study of Canal Operations

A detailed evaluation of vessel operations in the Canal will be undertaken to refine sizing needs of the cap armoring layer in different RTAs. The conceptual layout of the armor layer provided in the FS did not include the influences of twin propellers and rudders which could result in larger bottom velocities and the need for larger armor layers. The refined understanding of vessel operations and armor layer needs will be incorporated into PD-24: Propeller Wash and Cap Armoring Study and will directly support cap design.

4.4 PD-12: Groundwater Model Update

Estimates of groundwater upwelling (discharge) in the Canal using the existing numerical groundwater model are based on a calibration to various inputs, including measured hydraulic conductivity of subsurface formations outside the Canal, measured groundwater elevations outside the Canal, and mean sea level in the Canal. The model's simulation of sediments within the Canal is approximated using fitted sediment hydraulic conductivity estimates. New data to be collected as part of PD-7: Evaluation of Potential Groundwater Upwelling Areas and PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments will include identification of groundwater discharge areas, quantification of discharge rates in selected areas, lithology descriptions, and possibly hydraulic conductivity values for the soft sediment and native sediments. Incorporation of these data into the groundwater model followed by a recalibration to match groundwater discharge rates (if necessary) will refine the model and enable it to be used for predictive assessment of NAPL mobility as well as potential groundwater gradients and elevations due to implementation of bulkhead stabilization, ISS, and capping.

4.5 PD-13: Upland Area Evaluation for Cut-off Walls

A land-side survey will be conducted along the Canal side-walls to identify upland locations requiring cut-off walls or other remedial measures due to NAPL that has migrated to upland locations. Follow-up investigations to evaluate the extent (depth, length) of the cut-off walls will be conducted. Mitigation of ongoing NAPL sources will be a key component of a sustainable remedial design.

4.6 PD-14: Compliance Plan for Federal and State Archeological Requirements

A plan will be developed to comply with applicable Federal and State archeological requirements. The plan will be referenced in the remedial design for sediment and debris removal.

4.7 PD-15: Laboratory Evaluation of NAPL Mobility

Additional laboratory evaluations will be conducted to assess the potential mobility of NAPL under in situ conditions. This work element will build upon and expand the bench-scale work completed by EPA and will complement PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments. An expanded number of tests to provide more representative data and confirmation of results are needed to support ISS boundary delineation. The work element addresses a CSM data gap and is directly related to ISS and capping design components.

4.8 PD-16: Revisions to Sediment and Hydrodynamic Models

Sediment and hydrodynamic models will be revised to incorporate recently collected sediment and water data. The model updates are of particular importance as they relate to of activation of the Flushing Tunnel. This work element will include updating the models based on recent data collection and refinement of the model grid or other features to ensure they are well suited for remedial design needs. The models will be used to evaluate the Flushing Tunnel impacts as well and can be used to inform the remedial design.

4.9 PD-17: Evaluation of Active Cap Treatment Technologies

Laboratory evaluation of active cap treatment technologies is needed to screen and validate potential amendments and amendment mixes to address contaminants that are present and mobile in the sediment matrix. Amendments will be evaluated under scenarios representative of in situ conditions in different RTAs to collect data on design parameters (e.g., sorption potential). Results will be incorporated directly into the remedial design for capping.

4.10 PD-18: Geotechnical Characterization for Cap Design

Additional field characterization of geotechnical parameters to support cap design will be conducted to improve data density in several areas and to further refine understanding of cap stability, consolidation, and strength gain over time. Additional testing will be conducted to assess the potential to accommodate potentially larger armor layer diameters as a result of a refined understanding of armor layer needs from PD-11: Study of Canal Operations. The results will directly support cap design over both soft and native sediments.

4.11 PD-19: Laboratory Evaluation of ISS Performance

Additional laboratory studies will be conducted to evaluate and optimize the performance of materials and mixture ratios for the ISS design. This work element will build upon the bench-scale work completed by EPA and will expand the number of tests to provide more representative data and confirmation of results. The work element directly supports ISS and capping remedial design components, including providing information to help optimize mix design and determining the appropriate remedy (capping or ISS) in various areas of the canal.

4.12 PD-20: Technical Workshops

Periodic technical workshops with EPA will be conducted to develop agreement on pre-design task scoping and share results in an expedited and direct manner. Periodic in-person meetings will be augmented with teleconference and videoconference meetings as the need arises. The technical workshops with EPA are intended to be mutually beneficial and maintain a productive remedial design schedule.

4.13 PD-21: Sediment Stabilization and Treatment Technologies Treatability Studies

Laboratory treatability studies of sediment stabilization and treatment technologies will be conducted to evaluate various approaches to optimize sediment dewatering and to identify material-specific pozzolonic mixing ratios to optimize the binding of the contaminants into a stable matrix. From these stabilization and treatability studies, the laboratory mixtures will be subjected to leachability studies to determine compliance with acceptability criteria at various disposal and/or permitted end-use facilities. Cost and performance data will be developed to screen approaches and support dredging design.

4.14 PD-22: Bathymetric Survey after Flushing Tunnel Operation

A bathymetric survey will be conducted after the Flushing Tunnel activation to assess sediment transport as a result of increased flow velocities and the potential need for sediment chemical of potential concern (COPC) re-characterization. Results from the bathymetric survey will be incorporated into sediment and hydrodynamic model updates planned as part of PD-16, to ensure the models are relevant and accurate for remedial design activities, including dredge and cap design.

4.15 PD-23: Dredge Volume Field Study

A refined dredge volume field study will be conducted to confirm the bathymetric survey and native sediment elevations. Results from the field study will be used to refine and confirm sediment and hydrodynamic model updates and finalize dredge and cap design, including dredge prism delineation.

4.16 PD-24: Propeller Wash and Cap Armoring Study

Evidence of vessel disturbance on the sediment bed is apparent in the high resolution multi-beam bathymetric surveys performed in 2010 and 2011, and needs to be accounted for in the design. A refined propeller wash and cap armoring study will be conducted after Flushing Tunnel operation. Hydrodynamic and sediment transport models will be used to evaluate impacts of propeller wash. Detailed assessment of flow velocities induced by propeller wash, as predicted by the modeling, will be quantified and incorporated into the cap armor layer design.

4.17 PD-25: CSM Refinement

The Site-wide comprehensive CSM must be refined so that the remedial design can account for all physical and chemical site processes that have bearing on remedial effectiveness. Results of the pre-design investigations and post-Flushing Tunnel activation studies will be integrated into the CSM to guide remedial design needs and enable predictive modeling of remedial actions.

4.18 PD-26: Basis of Design Report

The basis of design (BOD) is an integral step in the planning, scoping, and execution of the technical studies and engineering design required to develop a comprehensive remedial approach for contaminated sediments in the Gowanus Canal. The BOD will also be used to develop the project schedule and budget requirements. The BOD is a "living document" that is initiated at the beginning of the design effort and develops the design principals. The final BOD is completed later in the project, once the final design is completed, and synthesizes all project information, including defining and detailing the remedial approach and associated remedial design parameters that are developed, tested, and agreed to during the remedial design.

5. QUALITY ASSURANCE PROJECT PLAN

A QAPP will be developed to guide project quality assurance and control for the work to be performed under this PDWP. The QAPP will meet the objectives of the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP), Parts 1, 2 and 3, EPA-505-B-04-900A, B and C, March 2005 or newer, and other relevant policy and guidance. The QAPP will initially address work elements PD-3 through PD-8 of Table 1-1. The plan will be amended as details of the field and laboratory programs associated with these work elements are finalized. It may also be may be amended to support scope-specific work plans that follow. The QAPP will be submitted as a standalone document and is not appended to this PDWP.

6. HEALTH AND SAFETY PLAN

A HASP will be developed to address the protection of worker health and safety and the response to contingencies that could impact public health, safety, and the environment. The HASP will satisfy the requirements of the Occupational Safety and Health Guidance for Hazardous Waste Site Activities, (June 1990, DHHS NIOSH Publication No. 90-117), and the Occupational Safety and Health Administration, U.S. Department of Labor (OSHA) requirements. The HASP will initially address work elements PD-3 through PD-8 of Table 1-1. The plan will be amended as details of the field and laboratory programs associated with these work elements are finalized. It may also be may be amended to support scope-specific work plans that follow. The HASP will be submitted as a standalone document and is not appended to this PDWP.

7. REFERENCES

Baird and Associates, Ltd., October 22, 2012. *"Gowanus Canal Numerical Surface Water Modeling Phase 1 Report."*

Brooklyn Historical Society, 2000.

Brown, A., July 2000. *"Gowanus Canal, Bulkhead Inventory Survey."*

CH2M Hill and HDR, January 2011. *"Gowanus Canal Remedial Investigation Report."*

CH2M Hill, December 2011. "*Draft Feasibility Study, Gowanus Canal*."

CH2M Hill, July 2013. *"Bench-Scale Testing Report Pre-Design Investigations Gowanus Canal Brooklyn, New York."*

Dolan Research, Inc., December 2010. *"Side Scan Sonar Report: Gowanus Canal Preliminary Bulkhead Study. Brooklyn, Kings County, NY."*

GEI Consultants, Inc., April 2007. *"Draft Remedial Investigation Technical Report: Gowanus Canal Superfund Site, Brooklyn, New York."*

GEI Consultants, Inc., December 2009. *"Remedial Investigation Technical Report, Gowanus Canal, Brooklyn, New York."*

GEI Consultants, Inc., April 2011a. *"CSO/Gowanus Canal Sampling and Screening Level Risk Assessment Report Gowanus Canal Superfund Site, Brooklyn, New York."*

GEI Consultants, Inc., December 2011. "Groundwater Model Report, Gowanus Canal Superfund Site, Brooklyn, New York."

GEI Consultants, Inc., March 8, 2012. *"Draft Bulkhead Summary: Gowanus Canal Superfund Site, Brooklyn, New York."*

GEI Consultants, Inc., April 2013. *"Initial Geotechnical Investigation in Support of Cap Design, Gowanus Canal Superfund Site, Brooklyn, New York."*

Gowanus Canal Community Development Corporation, 2003.

Hunter Research Inc., Rabner Associates, Northern Ecological Associates, Inc. May 2004 [Revised December 2004]. *"Final Report National Register of Historic Places Eligibility Evaluation and Cultural Resource Assessment for The Gowanus Canal*

Borough of Brooklyn, King County, New York In Connection With The Proposed Ecosystem Restoration Study."

New York City Department of City Planning, October 1985. *"Gowanus: A Strategy for Industrial Retention."*

New York City Department of Environmental Protection (NYCDEP), September 2007. *"City-Wide Long Term CSO Control Planning Project, Gowanus Canal Waterbody/Watershed Facility Plan Report."*

New York City Department of Environmental Protection (NYCDEP), August 2008. *"Waterbody/Watershed Facility Plan Report."*

Ocean Surveys, Inc., 2013. *"Multibeam Hydrographic Survey."*

Richards, Daniel, 1848. *"Plan for drainage of that part of the city of Brooklyn, which empties its water into Gowanus Creek & Bay, Willard Day City Surveyor."*

Richards, Daniel, 1848. *"Report of the Street Committee of the Common Council on the drainage of the part of the city lying between Court Street, Fifth Avenue, Warren Street, and Gowanus Bay made Novemeber27, 1848."*

Sanborn Map Company, 1950. *"Insurance Maps, Borough of Brooklyn. Sanborn Map Company, New York, New York."*

Sanborn Map Company, 1969. *"Insurance Maps, Borough of Brooklyn. Sanborn Map Company, New York, New York."*

Table 1-1. Individual Pre-Design Work Elements (PD-1 through PD-8).

Item	Pre-Design Work Element
PD-1	Quality Assurance Project Plan, including Field Sampling Plan
PD-2	Health and Safety Plan
PD-3	Additional reconnaissance of the canal bottom for performing pre-construction debris removal
PD-4	A plan for debris removal, decontamination and disposal
PD-5	A survey and assessment, as it relates to the implementation of the remedy, of the integrity of existing bulkhead along the canal and a determination of the extent of temporary bulkhead installation required for remedy implementation
PD-6	A plan for staging site selection and implementation of staging operations
PD-7	Data collection for the evaluation of potential groundwater upwelling at the canal bottom for identification of groundwater discharge areas and measurements of discharge rate
PD-8	Evaluation of canal native sediment to identify areas of potentially mobile NAPL for the ISS treatment boundaries

Table 1-2. Additional Pre-Design Work Elements (PD-9 through PD-26).

Item	Potential Work Elements for Subsequent Phases
PD-9	Additional sampling of area with highest detected PCB concentration in the middle reach of the canal to determine if there is an upland PCB source which requires controls
PD-10	Refinement of options pertaining to beneficial use of stabilized material; treatability testing to evaluate of permitted disposal options
PD-11	Detailed study of tug-boats and operations in the canal
PD-12	Groundwater model update
PD-13	Evaluation of upland locations requiring cut-off walls or other remedial measures as a result of NAPL that has migrated to upland locations and determination of the extent (depth, length) of cut-off walls at each location
PD-14	Plan for compliance with Federal and State archeological requirements
PD-15	Laboratory evaluations of NAPL mobility
PD-16	Revision of sediment and hydrodynamic models to account for Flushing Tunnel operation
PD-17	Laboratory evaluation of active cap treatment technologies
PD-18	Field characterization of geotechnical parameters to support cap design
PD-19	Laboratory evaluation of ISS performance
PD-20	Periodic technical workshops with EPA
PD-21	Laboratory treatability studies of sediment stabilization and treatment technologies
PD-22	Bathymetric survey post Flushing Tunnel operation
PD-23	Refined dredge volume field study post Flushing Tunnel operation
PD-24	Refined propeller wash and cap armoring study post Flushing Tunnel operation
PD-25	Refinement of comprehensive CSM
PD-26	Basis of Design Report

Table 2-1. Recipients of Notice of Potential Liabilities.

Recipients	
Amerada Hess Corp.	National Grid USA
Bayside Fuel Oil Corp.	New York City
Beam Inc.	NL Industries, Inc.
Beazer East, Inc.	Northeastern Plastics, Inc.
Brink's Inc.	Northville Industries Corp. (NIC)
Brooklyn Improvement Co.	Patterson Fuel Oil Company, Inc.
CBS Corporation	Puget Sound Commerce Center, Inc.
Citigroup, Inc./MRC Holdings, Inc.	Rexam Beverage Can Co.
ConocoPhillips Co.	SPX Corporation
Consolidated Edison Company of New York, Inc.	Stauffer Management Co., LLC
Cooper Standard Automotive, Inc.	TDA Industries, Inc.
Dun & Bradstreet, Inc.	Chevron U.S.A. Inc.
Estate of Daniel Tinneny	U.S. General Services Administration
ExxonMobil Oil Corp.	U.S. Maritime Administration
Hauck Manufacturing, Inc.	U.S. Navy
Honeywell International Inc.	U.S. Postal Service
Kraft Foods Global, Inc.	Verizon New York, Inc.
MCIZ Corp.	

Table 3-1. Preliminary List of Remedial Design Components (PD-3 to PD-8).

Select Design Components	Additional Debris Reconnaissance	Debris Management Plan	Bulkhead Survey and Assessment	Staging Site Selection Plan	Groundwater Upwelling Investigation	NAPL Characterization in Native Sediments
	PD-3	PD-4	PD-5	PD-6	PD-7	PD-8
Bulkhead Stabilization			P		S	S
Mobilization of Multiple Water and Land Based Construction Equipment	S			P		
Staging and Project Infrastructure Needs	S			P		
Debris Management	P	P				
Sediment Dredging		S				
Dredged Material Management		S				
Sediment Treatment and Proper Disposal						
Sediment Handling Area				P		
Transport Off-site		S		P		
Dewatering and Water Treatment		S		P		
Capping			S		P	S
Material Procurement				S	S	S
Amendment (Treatment) Layer Design			S		P	S
In Situ Stabilization			S			P
Geotechnical and Hydrodynamic Stability						
Archeological methodology during debris removal and dredging		S	S			
Logistics plan for Canal transport	S			P		

P - Primary use of information

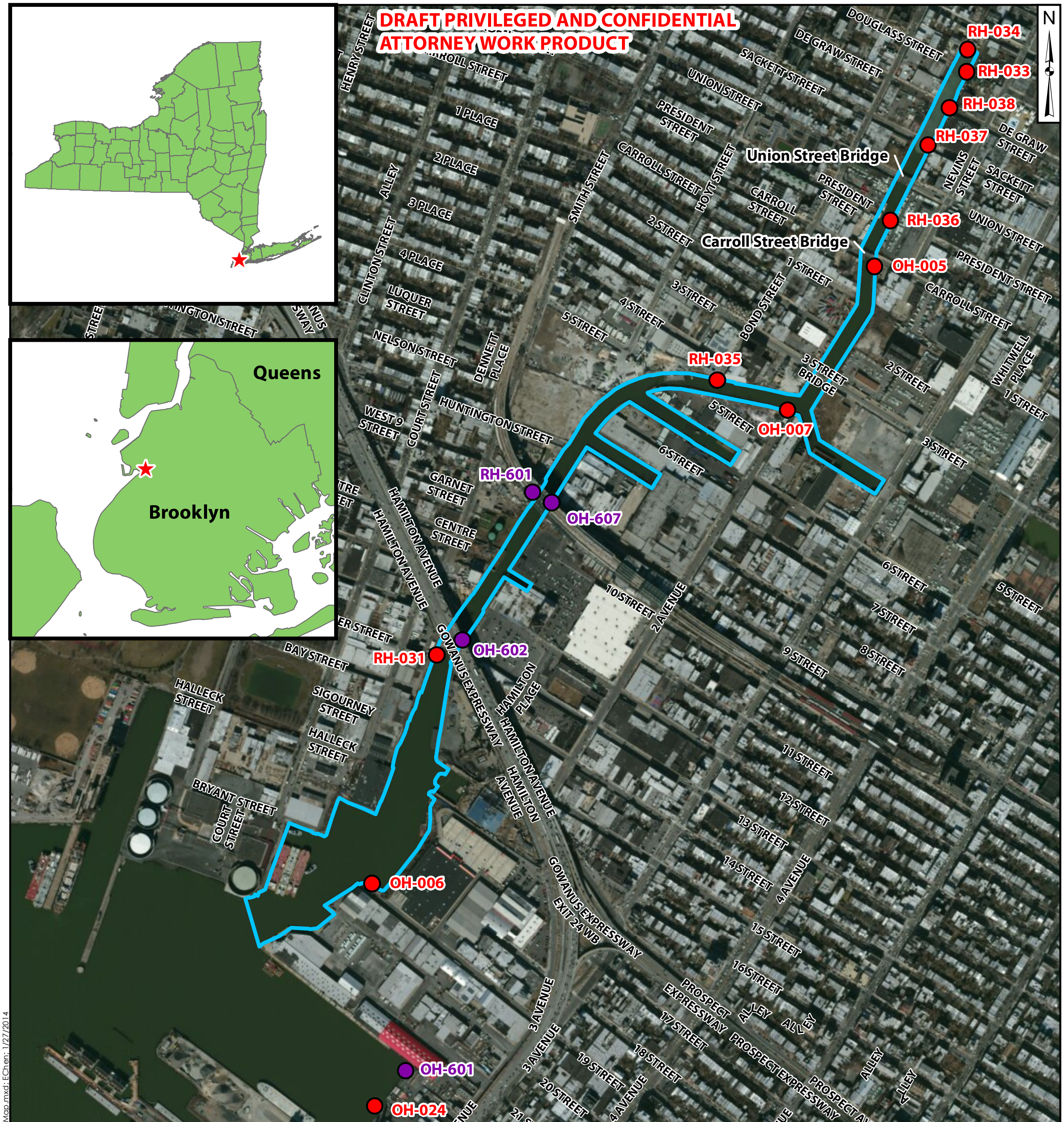
S - Supplements information collected under other work elements

Table 4-1. Preliminary List of Remedial Design Components (PD-9 to PD-26).

Select Design Components	Additional Sampling for PCBs	Stabilized Material Use and Treatability Testing	Study of Canal Operations	Groundwater Model Update	Upland Area Evaluation for Cut-off Walls	Compliance Plan for Federal and State Archeological Requirements	Laboratory Evaluations of NAPL Mobility	Revisions to Sediment and Hydrodynamic Models	Evaluation of Active Cap Treatment Technologies	Geotechnical Characterization for Cap Design	Laboratory Evaluation of ISS Performance	Technical Workshops	Sediment Stabilization and Treatment Technologies Treatability Studies	Bathymetric Survey Post Flushing Tunnel Operation	Dredge Volume Field Study	Propeller Wash and Cap Armoring Study	CSM Refinement	Basis of Design Report
	PD-9	PD-10	PD-11	PD-12	PD-13	PD-14	PD-15	PD-16	PD-17	PD-18	PD-19	PD-20	PD-21	PD-22	PD-23	PD-24	PD-25	PD-26
Bulkhead Stabilization				S	P	S	S			S		P		S		S	P	P
Mobilization of Multiple Water and Land Based Construction Equipment			S									P		S				P
Staging and Project Infrastructure Needs			S									P	S					P
Debris Management			S			S						P	S				P	P
Sediment Dredging						S		S				P	S	S	P		P	P
Dredged Material Management	P	P										P	P					P
Sediment Treatment and Proper Disposal	P	P										P	P				P	P
Sediment Handling Area	S											P	S	`				P
Transport Off-site	S	P	S									P	S					P
Dewatering and Water Treatment	S											P						P
Capping				P	P		P	P	P	P	S	P		P	P	P	P	P
Material Procurement			S				S	S	S			P						P
Amendment (Treatment) Layer Design				P	P		P		P	S	S	P					P	P
In Situ Stabilization				P			P			S	P	P					P	P
Geotechnical and Hydrodynamic Stability			P					P		P	S	P		P	P	P		P
Archeological methodology during debris removal and dredging						P						P						P
Logistics plan for Canal transport			P									P	S					P

P - Primary use of information

S - Supplements information collected under other work elements



Site	
CSO Outfalls	
Storm Outfalls	

900 450 0 900 Feet

Site Map and Combined Sewer Outfall (CSO) Locations

Gowanus Canal Superfund Site
Brooklyn, New York

nationalgrid
HERE WITH YOU. HERE FOR YOU.

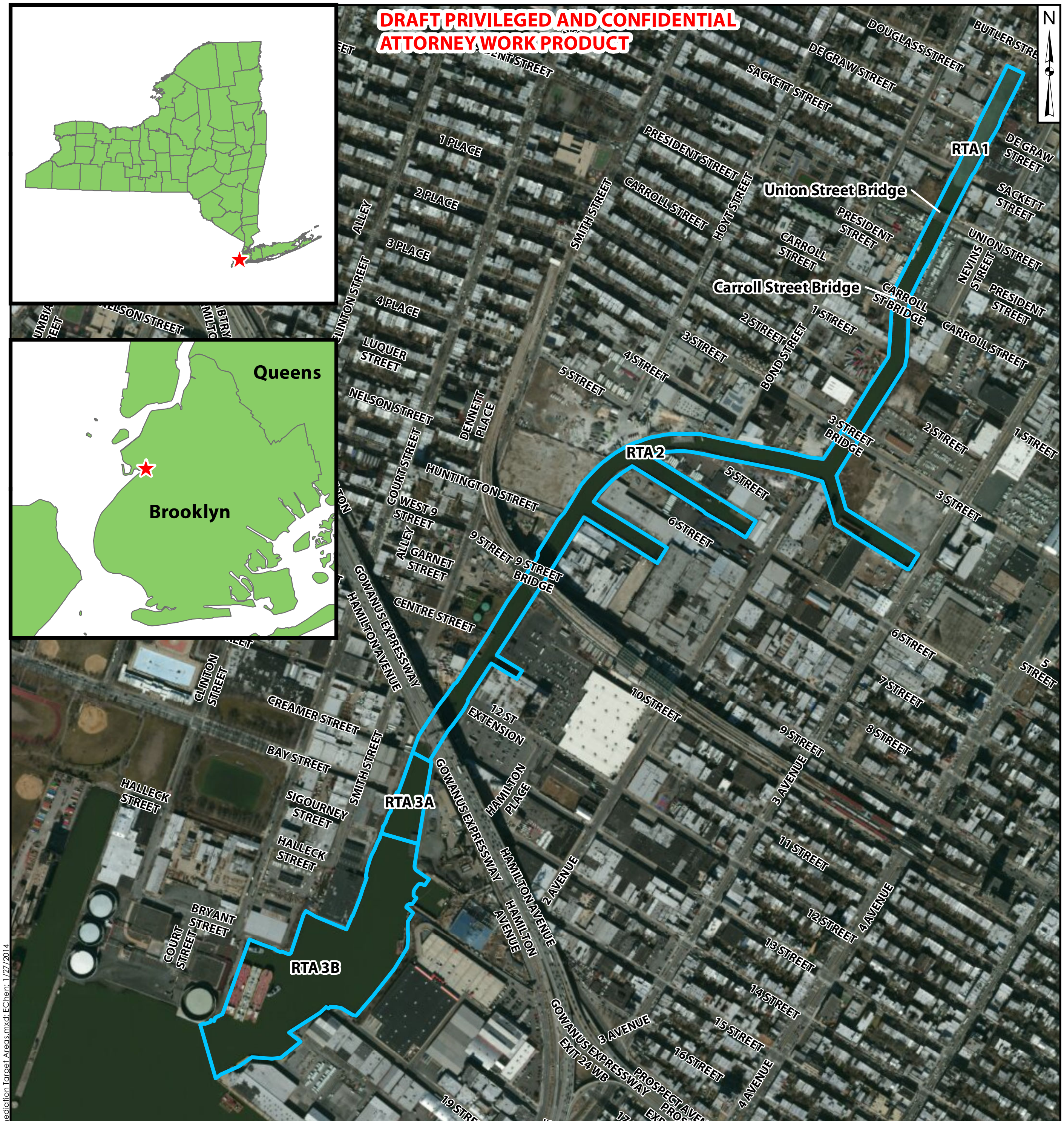
Geosyntec consultants

Figure **2-1**

Kennesaw, GA

January 2014

N:\N\National Grid\Gowanus\Tasks and Deliverables\PDWP Figures\Figure 2-1 Site Map.mxd; EChen; 1/27/2014



800	400	0	800	Feet

RTA

Remediation Target Areas (RTAs)

Gowanus Canal Superfund Site
Brooklyn, New York

nationalgrid
HERE WITH YOU. HERE FOR YOU.

Geosyntec consultants

Kennesaw, GA

January 2014

Figure **2-2**

N:\N\National Grid\Gowanus\Tasks and Deliverables\PDWP Figures\Figure 2-2 Remediation Target Areas.mxd; EChen; 1/27/2014

RTA

Recipients of Notice of Potential Liabilities

500 250 0 500 Feet

Property Locations of Recipients of Notice of Potential Liabilities (RTA1)

Gowanus Canal Superfund Site
Brooklyn, New York

nationalgrid
HERE WITH YOU. HERE FOR YOU.

Geosyntec consultants

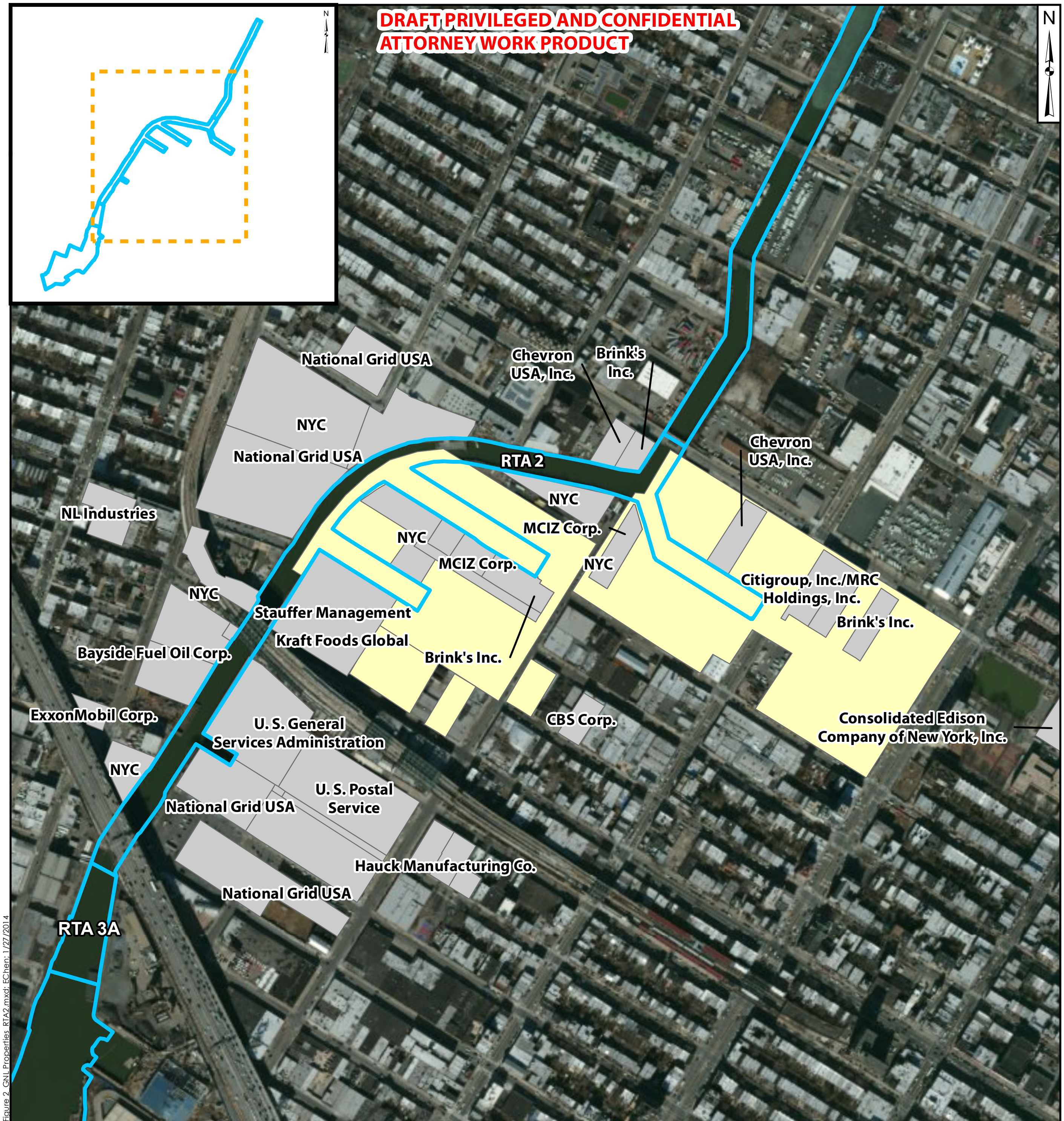
Figure

2-3

Kennesaw, GA

January 2014

N:\N\National Grid\Gowanus\Tasks and Deliverables\Maps of GNL Properties\GIS\Figure 1_GNL Properties_RTA1.mxd; EChen; 1/27/2014



N:\N\National Grid\Gowanus\Tasks and Deliverables\Maps of GNL Properties\GIS\Figure 2_GNL Properties_RTA2.mxd; EChen; 1/27/2014

RTA

Recipients of Notice of Potential Liabilities

Brooklyn Improvement Company

600 300 0 600 Feet

Property Locations of Recipients of Notice of Potential Liabilities (RTA2)

Gowanus Canal Superfund Site
Brooklyn, New York

nationalgrid
HERE WITH YOU. HERE FOR YOU.

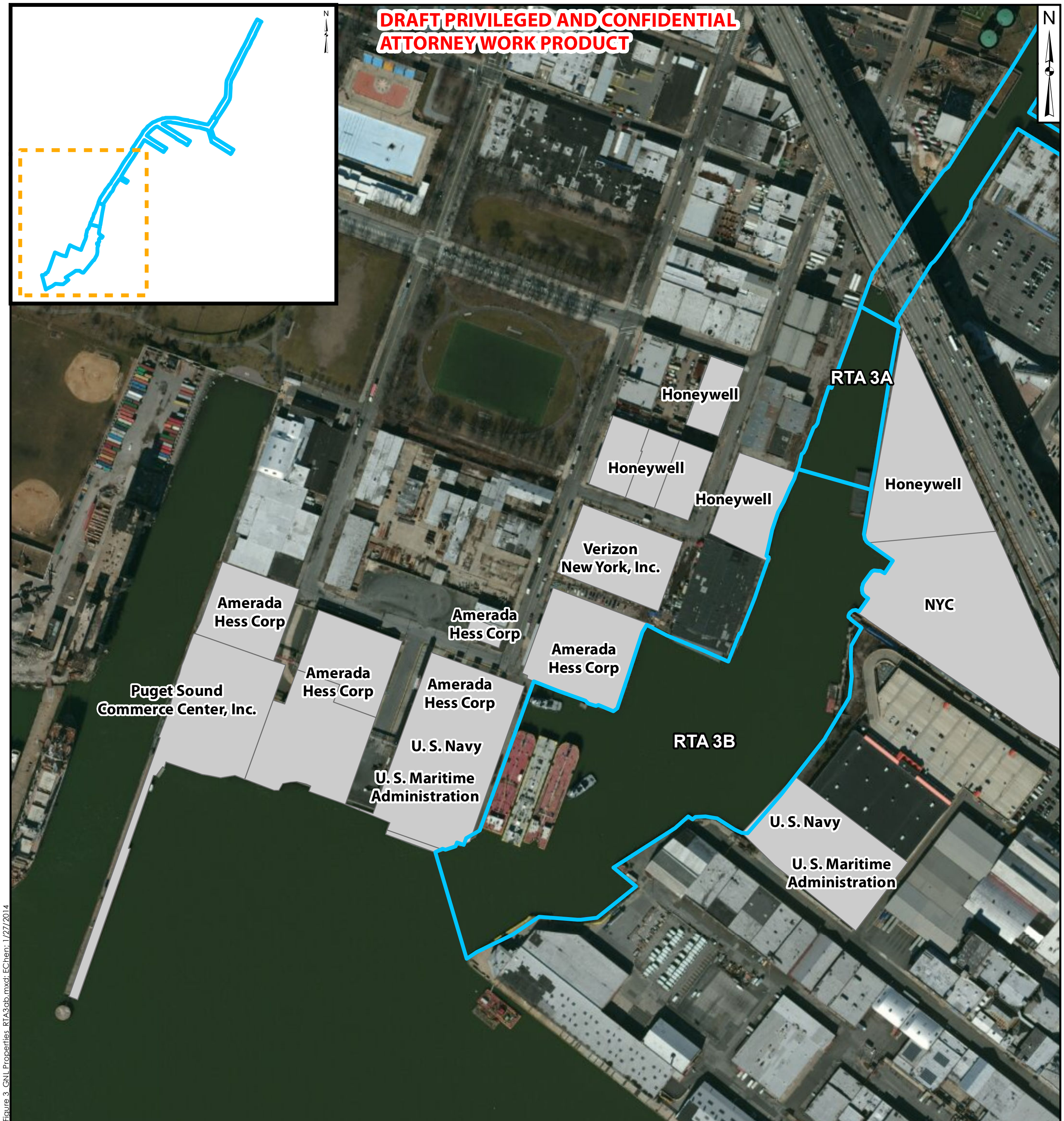
Geosyntec consultants

Kennesaw, GA

January 2014

Figure

2-4



RTA

Recipients of Notice of Potential Liabilities

400 200 0 400 Feet

Property Locations of Recipients of Notice of Potential Liabilities (RTA3)

Gowanus Canal Superfund Site
Brooklyn, New York

nationalgrid
HERE WITH YOU. HERE FOR YOU.

Geosyntec consultants

Figure

2-5

Kennesaw, GA

January 2014

N:\N\National Grid\Gowanus\Tasks and Deliverables\Maps of GNL Properties\GIS\Figure 3_GNL Properties_RTA3ab.mxd; EChen; 1/27/2014

RTA

Recipients of Notice of Potential Liabilities

1,000 500 0 1,000 Feet

Property Locations of Recipients of Notice of Potential Liabilities (Bay)

Gowanus Canal Superfund Site
Brooklyn, New York

nationalgrid
HERE WITH YOU. HERE FOR YOU.

Geosyntec consultants

Kennesaw, GA

January 2014

Figure **2-6**

N:\N\National Grid\Gowanus\Tasks and Deliverables\Maps of GNL Properties\GIS\Figure 4 GNL Properties RTA Gowanus Bay.mxd; EChen; 1/27/2014

ATTACHMENT A:
PRE-DESIGN WORK ELEMENTS
PD-3 THROUGH PD-8

GOWANUS CANAL SUPERFUND SITE
BROOKLYN, NEW YORK

January 2014

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

3-D	three dimensional
ADCP	acoustic doppler current profiler
AOC	Administrative Order and Settlement Agreement for Investigation, Sampling and Evaluation
BOA	brownfield opportunity area
cm	centimeter
CSM	conceptual site model
CPTs	cone penetrometer tests
CSO	combined sewer overflow
CU	consolidated undrained
DGPS	differential Global Positioning System
DNAPL	dense Non-Aqueous Phase Liquid
DTS	distributed temperature sensing
EPA	Environmental Protection Agency
FBIR	Factual Bulkhead Investigation Report
FS	Feasibility Study
ft	feet
FSP	Field Sampling Plan
GIS	Geographical Information System
HASP	Health and Safety Plan
HPT	Hydraulic Profiling Tool
ISPFS	In Situ Permeable Flow Sensor
ISS	in situ stabilization
LNAPL	light Non-Aqueous Phase Liquid
m	meter
m/s	meters per second
MGPs	manufactured gas plants
NAPL	Non-Aqueous Phase Liquid
NHPA	National Historic Preservation Act
NPL	National Priorities List
NRHP	National Register of Historic Places
NYC	New York City
NYSDEC	New York State Department of Environmental Conservation
NYSDOS	New York State Department of State
OTS	oxygen transfer system
PD	pre-design
PDWP	pre-design Work Plan
PRPs	Potentially Responsible Parties

PVP	point velocity probe
QAPP	Quality Assurance Project Plan
RI	Remedial Investigation
ROD	Record of Decision
RTA	Remediation Target Areas
SPT	standard penetrometer test
SCA	sediment consolidation area
SOW	Scope of Work
TarGOST	Tar-specific Green Optical Screening Tool
UU	undrained unconsolidated
UV	ultraviolet light

1. INTRODUCTION

1.1 Terms of Reference

This Pre-design Work Plan (PDWP) is being developed for the Gowanus Canal Superfund Site (the Site) under the Administrative Order and Settlement Agreement for Investigation, Sampling and Evaluation dated April 29, 2010, as amended on January 24, 2014 (the AOC). The AOC covers only the development of the PDWP as detailed in the scope of work (SOW) attached to the AOC Amendment (AOC Attachment A). The PDWP is a necessary step in developing the technical activities required by the Record of Decision (ROD) dated September 27, 2013, and provide the data needed to implement the remedial design.

Implementation of the PDWP activities will be performed under a separately negotiated Administrative Order by a group of potentially responsible parties (PRPs) identified by the United States Environmental Protection Agency (EPA). The PDWP work elements will be further developed under the separate Administrative Order, and this PDWP does not commit any party to performing the work described herein.

The pre-design (PD) work elements included in this Attachment are as follows:

- Additional reconnaissance of the Gowanus Canal (the Canal) bottom for pre-construction debris removal (PD-3, SOW Table 1);
- A plan for debris removal, decontamination, and disposal (PD-4, SOW Table 1);
- A survey and assessment, as it relates to the implementation of the remedy, of the integrity of existing bulkhead along the canal and a determination of the extent of temporary bulkhead installation required for remedy implementation (PD-5, SOW Table 1);
- A plan for staging site selection and implementation of staging operations (PD-6, SOW Table 1);
- Data collection for the evaluation of potential groundwater upwelling at the Canal bottom, including identification of groundwater discharge areas and measurement of discharge rates (PD-7, SOW Table 1); and,
- Evaluation of native sediments in the Canal to identify areas of potentially mobile non-aqueous phase liquid (NAPL) to define the in situ stabilization (ISS) treatment boundaries (PD-8, SOW Table 1).

Sample collection, analysis, and data management methods and procedures will be in accordance with the Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP) which will be provided under separate cover. A detailed Health and Safety Plan (HASP) for implementation of this Work Plan will also be provided under separate cover.

1.2 Document Organization

This Attachment to the PDWP is organized as follows:

- Section 2 presents PD-3: Additional Reconnaissance for Debris Removal;
- Section 3 presents PD-4: A Plan for Debris Removal, Decontamination, and Disposal;
- Section 4 presents PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation;
- Section 5 presents PD-6: A Plan for Staging Site Selection and Implementation;
- Section 6 presents PD-7: Evaluation of Potential Groundwater Upwelling Areas and Measurement of Discharge Rates;
- Section 7 presents PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments;
- Section 8 addresses the Implementation Schedule; and
- Section 9 provides References cited herein.

2. PD-3: ADDITIONAL RECONNAISSANCE FOR DEBRIS REMOVAL

This work element has been developed to perform additional debris reconnaissance for debris removal in the Canal in areas not previously surveyed or where survey results require confirmation. The debris reconnaissance work element builds upon information contained in the Remedial Investigation/Feasibility Study (RI/FS) reports for the Site and supports remedial design activities.

2.1 Site Debris Conditions

Previous reconnaissance activities for determining existing debris conditions in the Canal are summarized below.

In December 2010, a high-frequency side-scan sonar study was conducted in the Canal to identify site conditions, anomalies, obstructions, and potential submerged cultural resources (Dolan Research, 2010). Results from the study confirmed the presence of at least 29 separate features/obstructions in the Canal. Each of the sonar targets was identified as belonging to one of the following groups: potential submerged cultural resources (e.g., ship wrecks and/or barges), isolated debris (e.g., potential cars), linear or circular debris or debris fields, and rip-rap debris associated with apparent bulkhead failures. Debris material composition includes timber, metals, concrete and tires as well as other miscellaneous materials.

During the December 2010 side-scan sonar study, several areas of the Canal were not evaluated due to interferences, resulting in data gaps in the existing understanding of debris conditions existing at the Canal.

2.2 Objectives of Additional Reconnaissance for Debris Removal

This work element has been prepared to identify and characterize debris present in the areas not included in the high-frequency side-scan sonar study completed in December 2010. If needed, areas of uncertainty in the previous survey will be revisited for confirmation. This additional debris reconnaissance builds upon information contained in the RI (CH2M Hill, 2011) for the Site. Information from this work element will assist in refining and improving the comprehensive Site-wide Conceptual Site Model (CSM) and prepare for future remedial activities.

2.3 Additional Reconnaissance for Debris Removal Scope of Work

To meet the objective, a supplementary reconnaissance study will be performed to address the areas of the Canal not previously evaluated in the December 2010 study and identify and characterize site conditions, anomalies, obstructions, and potential submerged cultural resources in these areas.

Details of this task are provided in the sections below.

2.3.1 Supplemental Reconnaissance Study

The high-frequency side-scan sonar study of the Canal conducted in December 2010 improved the CSM by evaluating a majority of the Canal and confirming the presence of at least 29 separate features/obstructions in the Canal. The following areas of the Canal were unable to be evaluated at the time due to interferences (Figure A-1):

- Various locations between the 3rd Street Bridge and head of the Canal could not be investigated due to the presence and operation of the oxygen transfer system (OTS);

- Double-berthed construction and work barges prevented comprehensive acoustic coverage at several locations at the mouth of the Canal; and

- Differential Global Positioning System (DGPS) limitations while navigating under the five bridges created fragmented sonar coverage at these locations.

The supplemental reconnaissance study will complete reconnaissance coverage relative to features/obstructions present in the Canal. This information is important to completing the CSM and for the successful removal of debris that may interfere with future dredging, supplemental investigations, and capping remedial operations at the Site. Removal of debris interfering with remedial operations is a component of the remedy to be conducted prior to Canal remedy implementation and will increase the efficiency of remedial activities. If debris presents obstacles to PD and/or design investigations, then early implementation of debris removal activities will be considered.

A qualified subcontractor will conduct the additional reconnaissance activities.

The inferences that previously prevented the completion of the high-frequency side-scan sonar activities in these areas will be addressed by the following measures:

- The OTS system will be removed prior to the additional reconnaissance activities;

- The activities will be coordinated to occur when the mouth of the Canal is free of construction and work barges;

- Alternatives to side-scan sonar may be used, such as a tripod-mounted, high-resolution, 360-degree scanning sonar which can be deployed adjacent to hard-to-reach areas to generate plan-view sonar imagery; and,

- Physical verification of significant debris fields identified by during this survey and previous surveys.

As obstructions are identified during the supplemental reconnaissance/side-scan sonar study, they will be characterized as appropriate, i.e. timber, metal, concrete, or tires. The obstructions will then be added to the scope of the Plan for Debris Removal, Decontamination, and Disposal (PD-4) as well as the subject of future cultural resources assessments if warranted.

2.3.2 Reporting

A report of the findings will be developed and incorporated with other information previously gathered about debris in the Canal.

3. PD-4: A PLAN FOR DEBRIS REMOVAL, DECONTAMINATION, AND DISPOSAL

This work element has been developed to provide a plan to remove and/or otherwise manage debris in the Canal.

3.1 Site Debris Conditions

A current CSM for debris conditions existing in the Canal is presented in Section 2.1 of this document. As the additional reconnaissance work element (PD-3) is executed, the CSM will be updated to include new findings.

3.2 Objectives of the Plan for Debris Removal, Decontamination, and Disposal

This work element has been prepared to plan and manage the identification, removal, testing and disposal of all non-sediment materials present in the Canal. The overall objective of this work element is to develop a plan (Debris Plan) to govern the removal and/or management of debris such that the underlying targeted sediment can be efficiently and effectively dredged and/or remediated.

3.3 Debris Removal and Management Plan Scope of Work

To meet the primary objectives of this work element, a Debris Plan will be developed that governs the handling of debris at the Site. Key components of the Debris Plan will include but not be limited to:

- Debris removal;
- Debris decontamination;
- Debris handling and disposal; and
- Cultural resources management.

Details of each Debris Plan component are provided in the sections below.

3.3.1 Debris Removal and Management

Currently, much of the debris present in the Canal provides an obstruction to future dredging or capping remedial operations at the Site. Based on precedent and experience, proper debris management and removal is critical to ensuring the efficiency of these future remedial activities. Debris that could damage equipment and/or interfere with the operation of the dredging, sediment transport or sediment processing equipment must be removed prior to commencing dredging and/or capping activities.

The PD-4 will outline the processes and criteria for debris removal. It is anticipated that the debris removal portion of the Debris Plan will address, but not be limited to, the issues below.

- Not all debris present in the Canal requires removal. Certain debris may be left in place, including smaller debris that can be effectively removed by future dredge operations and/or debris which may be classified as a cultural resource (described in Section 3.3.3). As information from the additional reconnaissance for debris removal work element (PD-3) becomes available, additional debris targets may be added to the removal scope.

- While debris management is most efficiently undertaken in an adaptive management mode in the field, it is important to identify a range of materials to be removed and plan the equipment and removal methods in advance. In an adaptive management mode, the dredging contractor retains the flexibility to make real-time field decisions as additional data becomes available during sediment removal (dredging) operations. While overall management approaches are decided in advance, the specifics of what debris will be removed prior to remedial dredging and what debris will be removed by the dredge itself may be modified to address real-time field conditions encountered during dredging.

- Debris removal operations will be accomplished through the use of barge-mounted cranes and/or excavators using various types of attachments, such as environmental buckets, grapples, clam shells, and rakes.

- To the extent possible, and after any cultural resources have been addressed, all the sediment present at the targeted locations identified in the 2010 sonar study (Dolan Research, 2010) and supplemental debris investigations will be raked at a minimum.

- Media (sediment and water) separation will be required for much of the debris removed. Debris found to have sediment residue on it will be suspended over the water in the area from which it originated and washed off using an engine driven pump with a fire hose attached. The necessary amount of time will be allowed for the residual bulk sediment to wash off , or the debris will be placed on a rack (i.e., grizzly screen) where it can be raked to remove hardened sediment.

3.3.2 Debris Handling and Disposal

The Debris Plan will contain a section on debris handling and disposal, which is a vital aspect of the removal and management process. It is anticipated that the debris handling and disposal portion of the Debris Plan will address but not be limited to the issues below.

- Due to a general lack of available real estate on or close to the Canal, as well as intent to minimize impact of remedial operations on residential neighborhoods, it is anticipated that debris removal and management activities will be performed in or upon the water. Notwithstanding the completion of PD-6 to identify potential staging sites, it is not anticipated that a shoreline staging area will be available, so removed debris will be placed onto a transfer barge. The barge or series of barges will serve as a management staging area, where debris will be sorted based on material composition.

- To the extent practical and depending on a number of factors to be determined such as upland site selection, debris removed from the Canal will be subdivided into separate categories prior to offloading.

- The preference for schedule expediency is to perform sorting operations on the water prior to the marine transported transfer to the permitted processing facility or facilities. If the removed debris cannot be transported over water, then regular transfers of this debris to the shore may be made where debris will be loaded directly onto trucks for transportation to a permitted treatment and/or disposal facility.

- Debris removed from the Canal is anticipated to produce a significant source of volatile emissions and/or odors. Several emission mitigation steps will be identified and implemented as needed to minimize the generation of odors. These mitigation strategies may include:
    - Application of odor suppressants/foaming agents;
    - Covering the debris stockpiles on barges;
    - Minimizing debris storage/stockpiling on barges or near shorelines; and,
    - Covering debris trucks/containers during transport from the barge offloading area to the sediment consolidation area (SCA).

- Debris removed from the Canal will be subjected to the conditions of operating permits of the off-loading, processing, treatment and transfer facility or facilities that will be engaged and/or retained as part of this project. Regulated debris collected during operations will be handled by trained personnel and disposed of in accordance with all federal, state and local regulations and ordinances.

3.3.3 Cultural Resources Management

The Debris Plan will outline the protocols to be implemented regarding cultural resources that may be encountered during debris removal. It is anticipated that the cultural resources portion of the Debris Plan will address, but not be limited to, the issues below.

- The primary objective of cultural resource management, as it pertains to the remedy implementation, is to remove the cultural resource so the resource can be preserved, to the extent practical, and to ensure that targeted sediment can be efficiently and effectively remediated. If removal of the cultural resource is not feasible, the resource may need to be managed in place.

- The National Historic Preservation Act (NHPA) of 1966 encourages but does not mandate the preservation of cultural resources. To accommodate NHPA's preference for preservation, strategies may include avoidance, mitigation, or reclamation of the cultural resources or features. Where avoidance of identified cultural resources is not possible and/or feasible, the adverse impacts will be minimized to the extent possible and mitigation measures consistent with an approved Cultural Resources Management Plan will be implemented.

- For the purpose of the Debris Plan, cultural resources refer to archeological remains located on the bottom of the Canal that are potentially eligible for the National Register of Historic Places (NRHP). Of the 29 features identified during the 2010 sonar study (Dolan Research, 2010), 7 have been classified as potentially eligible: 4 are watercraft and 3 are associated with bulkheads. Details pertaining to handling these components will be discussed with EPA for concurrence and presented in the Debris Plan.

4. PD-5: DETAILED SURVEY AND ASSESSMENT OF EXISTING BULKHEADS FOR REMEDY IMPLEMENTATION

This work element has been developed to survey and assess bulkhead conditions along the Gowanus Canal and evaluate their anticipated integrity during remedial implementation. The bulkhead assessment work element builds upon information contained in the RI/FS reports for the Site and refines and improves the Site-wide comprehensive CSM to support remedial design activities.

4.1 <u>Site Bulkhead Conditions</u>

This section summarizes the bulkheads as developed during the RI/FS phases of the Site work.

The first step in this work element is a desktop study of existing data on the status of the bulkheads along the Canal, which will be conducted to qualitatively assess their existing conditions and anticipated conditions after dredging and overall remedial implementation. The desktop study of the existing bulkheads will be supported by the following documents:

- Brown, A., "Gowanus Canal, Bulkhead Inventory Survey," July 2000.
- GEI Consultants, Inc., "Draft Bulkhead Summary, Gowanus Canal Superfund Site, Brooklyn, New York," March 8, 2012.
- GEI Consultants, Inc., Gowanus Canal–Web GIS Interface, 2013.
- Ocean Surveys, Inc., Multibeam Hydrographic Survey, August 2013.
- United States Environmental Protection Agency, "Record of Decision, Gowanus Canal Superfund Site, Brooklyn, King County, New York," September 2013.

Three characteristics will be analyzed: (i) bulkhead type, (ii) current physical condition, and (iii) distance between bulkhead foundation and dredging depth. These characteristics will be used to assess the anticipated performance of existing bulkheads during remedy implementation based on visual, above waterline inspections of the existing bulkheads and assumed depth of existing foundations.

The study will also focus on the condition of dredging without any temporary support, considered a conservative critical condition. The study will not be a calculation-based assessment of bulkhead stability, but rather an experienced and qualitative based assessment. Therefore, a more detailed analysis will be needed for more accurate evaluation of bulkhead stability during remedy implementation.

Anticipated data gaps in the existing information that may introduce uncertainty into the initial desktop assessments include: (i) undefined foundations for all bulkheads along the Canal, (ii) lack of geotechnical data for foundation soils and retained materials, (iii) conditions of bulkheads below the waterline, and (iv) insufficient data for preliminary design of bulkhead support systems.

Addressing these data gaps will increase certainty regarding bulkhead condition. Further investigation will be required to better define the depth of the bulkhead foundations, the condition of the bulkheads below the waterline, the geotechnical design parameters of foundation soils and retained soils, and the overall condition of the bulkheads. The additional data will allow for: (i) a calculation-based analysis of the stability of existing bulkheads during remedy implementation with temporary support; (ii) a calculation-based analysis of the stability of existing bulkheads after the remedy implementation without any additional support; and (iii) the development of a typical, conceptual design of a bulkhead support system (anchored sheet pile wall or tieback sheet pile wall with deadman anchors) for post-remediation implementation conditions, if determined to be necessary.

4.2 Objectives of the Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation

The overall objectives of the bulkhead survey and assessment work element are to provide a plan for performing a preliminary assessment of the stability of existing bulkhead during and after remedy implementation, and to create a preliminary design of temporary and permanent bulkhead support systems.

Results from the bulkhead survey and assessment will be used to refine the comprehensive CSM (PD-25) and will directly support the remedial design and remedial activities.

4.3 Detailed Bulkhead Survey and Assessment Scope of Work

This work element details a field exploration program that will allow for the collection of data to be used for design of bulkhead support systems; and provides an evaluation and design procedure(s) that will be followed for each bulkhead.

The results of this work element will be used to identify bulkhead stabilization strategies, including temporary support, that are necessary for structural integrity purposes during remedial activities. It does not provide the complete design for upgrades or replacements.

To meet the stated objective(s), several sub-tasks have been identified that will be performed under this work element:

- Subsurface investigation of existing bulkhead foundations;
- Geotechnical site investigation;
- Factual Bulkhead Investigation Report;
- Evaluation of existing bulkhead stability during remedy implementation;
- Evaluation of final conditions for bulkheads; and
- Assessment and recommendation of existing bulkhead report.

Details of each sub-task are provided in the sections below.

4.3.1 Subsurface Investigation of Existing Bulkhead Foundations and Conditions

This sub-task has been developed to address the data gaps related to bulkhead foundation depth and bulkhead conditions below the water-line. The condition of existing bridge foundations and abutments will be also assessed as part of the investigation.

There are no available documents or construction as-builts that provide the bottom of the foundations of the existing bulkheads. All bulkheads have been assessed based on assumed foundation depths inferred from assumed construction practices. These assumptions include:

- Crib bulkheads are built on top of native soil (elevation determined from nearby cone penetrometer tests (CPTs) and borings);
- Steel and timber piles are driven approximately 5 feet (ft.) into medium dense to dense glacial till deposits with a maximum pile length of 50 ft. (elevation determined from nearby CPTs and borings); and
- Embankments are built directly on sediments.

Several subsurface exploration methods may be employed for investigating and evaluating the bulkhead foundations. The methods to be considered for implementation of this work element include, but are not limited to:

- Side-scan sonar;
- Double-beam sonar;
- Divers performing physical inspection and probing;
- Parallel seismic method (adaptation of ASTM D5882);
- Borehole geophysical methods (ASTM D4428, D5882, D7400); and
- Borehole induction method (adaptation of ASTM 5753).

To assess bulkhead conditions below the waterline, bulkheads along the Canal have been categorized as one of the following types: (1) timber cribs; (2) timber pile foundations; (3) steel sheet piles; and (4) embankments. For each bulkhead type except Type 4 (embankments), divers may be utilized to provide one line of evidence to gauge the integrity and condition of the bulkheads below the water level and to document physical damage or deterioration. Divers will be used only when other methods are inconclusive and physical inspection is required to determine bulkhead conditions. For each bulkhead category, multiple subsurface exploration methods are being considered:

- Timber cribs: Side-scan sonar, double-beam sonar, and borehole geophysical methods;
- Timber piles: borehole geophysical methods, and parallel seismic method;
- Steel sheet piles: Induction method, parallel seismic method, and borehole geophysical methods; and
- Embankments: No further inspection of foundation proposed due to the assumption that the surface of the embankment is available from existing bathymetric survey and sufficient information will be obtained from the geotechnical investigation described in Section 4.3.2.

As noted in Section 2.2, there are five surface streets with bridges that cross over the Canal (five streets accounts for the divided Hamilton Avenue crossing). The condition of the bridge foundations and abutments will be included in this study. The bridges are maintained by New York City (NYC). As a first step, the appropriate NYC representatives will be contacted for information on the bridge foundations and abutments. If sufficient information is available a field investigation may not be warranted; otherwise the methods described above will be used to investigate the bridges and abutments.

As part of the field investigation of the bulkhead condition the location of various pipe discharge outfalls identified by EPA in Appendix G of the RI (CH2M Hill and HDR, 2011) will be verified and there condition noted.

Final selection of methods and technologies for implementation will be communicated to EPA through a brief technical memorandum and presented in a technical workshop(s) as needed.

An investigation is planned to be performed for each bulkhead type for each property. In addition, if borings are performed in the proximity of the bulkheads, additional laboratory and visual soil classifications will be performed on recovered samples in a manner consistent with the geotechnical site investigation described in Section 4.3.2.

The determined elevations of the existing bulkhead foundations and any performed borings, CPTs, and laboratory data results will be incorporated in existing geographical information system (GIS) databases and the CSM. Results from field testing to determine the bottom of foundations and diver evaluations will also be included in the databases.

4.3.2 Geotechnical Site Investigation

Based on the review of existing data in the immediate proximity of the bulkheads at the Site, there are only a few geotechnical borings, no geotechnical parameter test results, and less than 20 CPTs readily available for geotechnical analyses. This is insufficient geotechnical data for the purpose of assessing stability of the existing bulkheads during and after remedy implementation.

A site investigation is required to provide additional geotechnical data to assess bulkhead stability and support remedial design. This investigation will be predominately performed on the land side of the Canal as the most critical soil parameters that need to be determined are for existing fills and native soils, both of which can be encountered from the land side. The site investigation will include, but not be limited to:

- Geotechnical borings with disturbed and undisturbed sample recovery, standard penetrometer test (SPT) blow count measurements (ASTM D1586), and geotechnical visual soil classifications (ASTM D2487/D2488);

- CPT soundings (ASTM D5778) with shear wave testing performed at select locations (ASTM D7400); and

- Geotechnical laboratory testing.

The geotechnical laboratory testing program will include, but not limited to:

- Moisture contents (ASTM D2216);

- Atterberg Limits (ASTM D4318);

- Unit weight (ASTM D7263);

- Grain size distribution (ASTM D422);

- Consolidated undrained (CU) triaxial shear testing (ASTM D4767); and

- Undrained unconsolidated (UU) shear testing (ASTM D2850).

Undisturbed samples for laboratory testing will be recovered following ASTM D1587. Soil samples will be handled and preserved in accordance with ASTM D4220.

The geotechnical investigation plan will include the following:

- At least one "shallow" geotechnical boring approximately every 100 ft. along the bulkhead. The depth of the boring will be selected based on estimates of the depth to the bulkhead foundations from the desktop study, plus an additional 10 ft. These borings are to be set near the rear face of the bulkhead so that they pass through fill. The purpose of these borings is to determine the variability of fill used behind the existing bulkheads, estimate geotechnical properties, and measure the depth to native soil. Approximately 150 borings are assumed necessary to complete this task.

- At least one "deep" geotechnical boring approximately every 400 ft. These borings are to be offset approximately 50 ft. from the face of the bulkhead wall. They may be done in place of a shallow boring. The purpose of these borings is to determine the variability of fill from the rear face of the bulkhead wall and to explore the deeper strata. Approximately 50 borings are assumed necessary to complete this task.

- CPTs may be recommended in place or alongside some shallow or deep borings so that the results can be correlated with the CPTs performed within the Canal. Approximately 50 soundings are assumed necessary to complete this task. However, CPTs may be challenging to push through existing fill material. Shear wave testing may be recommended at many of the CPT locations.

- A laboratory testing program will be performed on select samples and will include:

  - 50 to 75 UU and CU tests will be performed on undisturbed samples;

  - 1000+ moisture content tests;

  - 200+ Atterberg Limit tests;

  - 200+ unit weights; and

  - 200+ grain size distributions.

From the collected data soil, parameters for each identified soil layer for each zone along the Canal alignment will be established. The borings, CPTs, field results, laboratory data results, and selected soil parameters will be included in existing GIS databases and the CSM to support remedial design and decisions.

A summary of the finalized approach for implementation will be communicated to EPA through a brief technical memorandum and presented in a technical workshop(s) as needed.

4.3.3 Factual Bulkhead Investigation Report (FBIR)

A series of Factual Bulkhead Investigation Reports that summarize the geotechnical investigation procedures, results, selected soil parameters, and subsurface model for geotechnical design will be prepared. The selected soil parameters and subsurface stratigraphy will be based on all of the field and laboratory data collected from subsurface explorations described in Sections 4.3.1 and 4.3.2 as well as available existing data. The FBIRs will also include details on the physical conditions of each bulkhead, the type of bulkhead, and the observed/assumed bottom foundation of each bulkhead.

4.3.4 Evaluation of Existing Bulkhead Stability during Remedy Implementation

For this sub-task, the proposed evaluations will focus on bulkhead scenarios that will be created based on location along the Canal alignment and type of bulkhead; the number of scenarios for analysis is estimated to range from 25 to 60. The Canal regions will be defined by the Canal geometry and interpreted subsurface stratigraphy. These analyses will account for the effects of dredging, proposed construction methods, existing physical bulkhead conditions, bulkhead type, the proposed temporary support system and the geotechnical parameters selected as part of the FBIRs. For each bulkhead scenario, an assessment will be created that determines whether the proposed temporary support system is adequate or if additional support is required that could provide stability during and after the remedy implementation.

For each existing bulkhead, an applicable bulkhead scenario and associated stability analysis results and recommendations will be included in the GIS databases and CSM to support remedial design and decisions.

4.3.5 Evaluation of Final Conditions for Bulkheads

Given the anticipated poor conditions of some of the bulkheads leading to instability during and potentially after remedy implementation, more detailed analyses are needed for evaluations of bulkhead stability at final expected conditions. The same bulkhead scenarios, data set(s), and general assumptions considered for the preceding sub-task(s) will be considered for this sub-task as well.

For each existing bulkhead, the applicable bulkhead scenario and associated final conditions stability analysis results and recommendations will be included in the GIS databases and the CSM to directly support remedial design and decisions.

4.3.6 Assessment and Recommendation of Existing Bulkheads Report

An Assessment and Recommendation of Existing Bulkheads Report will be prepared and will include all calculations, description of the method of calculation, assumptions, discussion of acceptable stability, and final assessment/recommendation for each bulkhead. The evaluation results for both during remedy implementation and for final conditions will be included in the report.

5. PD-6: A PLAN FOR STAGING SITE SELECTION AND IMPLEMENTATION

This work element has been developed to provide a framework for the preparation of a Site Staging and Implementation Plan to govern infrastructure, construction, and site staging operations at the Site.

5.1 Staging Site Selection Conditions

The Gowanus Canal is a 1.8 mile long man-made canal originally constructed in the mid-1840s. Following its construction, the Canal quickly became one of the nation's busiest industrial waterways. By the late 1870s, sewers entering the Canal carried a combination of household waste, industrial effluent from the manufactured gas plants (MGPs) and other industries and stormwater runoff (Hunter Research et al., 2004). As a result of the poor waste disposal practices prior to the late 20th century, high levels of hazardous substances accumulated in Canal sediments. The remedial actions listed in the ROD will require the mobilization of manpower, machinery, and supplies to the area. Staging areas will be required to facilitate the movement of labor, equipment, and material between upland areas to and from the Canal.

The following excerpt from the ROD describes land use in the area.

> The canal is located in a mixed residential-commercial-industrial area. The waterfront properties abutting the canal are primarily commercial and industrial. Rezoning of several canal-front parcels in the upper canal to high density residential occurred in 2009. In March 2013, NYC approved the Lightstone Group's development plans for 700 rental units on these parcels. Construction is anticipated to begin in fall 2013. NYC has also entered into a public-private partnership called Gowanus Green to construct 774 units of high density mixed income housing on NYC-owned portion of the Public Place former MGP facility. NYC postponed an area-wide rezoning effort as a result of the NPL nomination. However, further rezoning and land use changes have continued during the Superfund process. For example, a hardship rezoning was approved in February 2013 for a Whole Foods market on two canal-side parcels. Construction is under way, with an anticipated completion in fall 2013. In response to the on-going development pressures, Community Board Six formally requested that NYC restart the area-wide re-zoning process.
>
> Through Community Board Six, the community has also received a grant from the New York State Department of State's (DOS's) Brownfield Opportunity Area (BOA) Program for a study to promote reuse and

> redevelopment of under-used properties in two large sections along the canal. Governmental participants in the ongoing BOA study include NYSDOS, NYSDEC, NYC Department of City Planning, the Mayor's Office of Environmental Remediation and the EPA.
>
> As a result of development speculation, numerous parcels have been acquired along and near the canal for potential residential and commercial uses in anticipation of the cleanup and further rezoning. Public use along and on the canal is expected to increase significantly over time due to NYC waterfront zoning requirements which mandate public esplanades at redevelopment sites along the canal. Such esplanades are under construction or planned at the Whole Foods, Lightstone Group and Gowanus Green projects. In addition, moderate–to--large-scale commercial activities, such as outdoor nightclubs and flea markets, have operated or sought permits to operate at canal-side parcels.
>
> The canal is regularly used by commercial barges at several facilities along the mid- and lower canal. Recreational boaters, primarily, canoers and kayakers, frequent the canal. A public boat launch where canoes are available is located at 2nd Street. This boat launch will be incorporated into the Lightstone Group project. The anticipated remediation and redevelopment will likely increase recreational boating use. A limited number of people reside in houseboats on the canal. (EPA, Record of Decision, 2013).

To facilitate the assessment and management of the canal, it was divided into three Remediation Target Areas (RTAs). Within the RTAs, there are five east–west bridges. There are four short turning basins that branch to the east of the main channel, and the majority of the Canal shoreline is lined with retaining structures or bulkheads. Most of the Canal is narrow, and the entire width is used for navigation in narrow reaches. Depths in the Canal vary widely depending upon presence of mounding of sediment from combined sewer overflow (CSO) discharges, scouring from tug movements, the presence of debris piles, and sediment redistribution from flushing and tidal movements. These factors affect the movement of barges and tugs and will affect the sequencing of marine construction activities. In addition to these constraints to remedial activities, it will be necessary to coordinate equipment movements with other navigational users of the Canal.

The physical conditions within the Canal, surrounding land uses, and proposed changes in zoning and future land uses make it necessary to carefully select staging sites to meet construction needs and avoid conflicts with local stakeholders.

5.2 Objectives of the Plan for Staging Site Selection and Implementation

This work element has been prepared to describe the approach and methods to be used to select sites for the staging activities necessary to assemble and transfer labor, equipment, supplies, and material during remedial activities. The objective of this work element is to develop a plan describing the means to:

- Identify project infrastructure needs;
- Determine necessary staging site requirements;
- Identify potential staging sites; and,
- Evaluate staging sites.

The Plan for staging and site selection and implementation will directly support future remedial implementation.

5.3 Staging Site Selection and Implementation Scope of Work

To meet the stated objective of this work element, a plan will be developed to include, but no be limited to:

- Evaluation of construction phasing and sequencing;
- Analysis of labor, equipment, and materials needs;
- Identification of staging site requirements;
- Staging site identification;
- Staging site evaluation; and
- Implementation of staging site activities.

Details of each plan component are provided in the sections below.

5.3.1 Evaluation of Construction Phasing and Sequencing

An evaluation of construction phasing and sequencing is important in determining site infrastructure needs for staging manpower, equipment, material, and supplies. An analysis of debris and contaminant distributions will be made to determine the appropriate remediation sequence. A determination will be made as to which areas of debris should be removed prior to the beginning of sediment removal versus those areas that should be addressed as part of sediment removal. The effect of tidal range, combined sewer overflow, and other flows will be considered in determining the appropriate construction sequence.

The evaluation will include an analysis of draft restrictions on the movement of barges, dredges, tugs, and work boats. The effect of the sequence of removal on the navigational needs of other users of the Canal will be considered. Accessibility and bridge opening restrictions will also be considered in determining the appropriate construction sequence. In addition, the types and distribution of contaminants will be considered when determining construction phasing to plan secondary sediment containment measures so that later phases of remediation can clean up any sediment that is resuspended and redistributed during remediation. Sediment requiring special handling or disposal will also affect the construction sequence.

Results from this sub-task will inform analysis of labor, equipment, and material needs.

5.3.2 Analysis of Labor, Equipment, and Material Needs

Information from analysis of the appropriate construction phasing and sequencing will feed analysis of mobilization requirements. Construction scheduling and resource loading analysis will determine peak manpower and equipment needs and the locations where those resources are needed. Requirements for temporary structures such as office trailers, repair shops, toilets, and materials storage will be determined. On shore equipment staging needs will be evaluated, as well as the need for facilities for docking work boats for surveys, monitoring, and transferring labor and supplies.

While most processing and treatment operations are expected to take place at off-site locations or on barges, it is possible that some debris or waste could require segregation and special handling. The need for on-shore facilities to handle these materials will be evaluated.

The effect of construction phasing and sequencing on storage needs for materials and equipment for dredging, installation of caps and barrier layers, and ISS will also be evaluated. Storage of supplies for operations and maintenance will be needed along with facilities for fuel storage and transfer.

Planning will include an evaluation of utility and parking needs. Parking requirements will be evaluated based on construction sequencing. Sanitary and solid waste disposal needs will also be considered.

Results from this sub-task will be input to a determination of staging site requirements.

5.3.3 Identification of Staging Site Requirements

Requirements for staging sites will be determined based on construction sequence planning and the subsequent analysis of labor, equipment, and material needs. Requirements for the following facilities will be determined.

- Office
- Shift change, lunch, and break facilities
- Parking and vehicular access
- Emergency response access
- Supply and materials storage
- Equipment staging
- Crew staging and transfer
- Dock and wharf facilities
- Environmental monitoring
- Utilities
- Sanitary and solid waste
- Fueling
- Material processing
- Spill prevention and containment
- Operating area proximity

- Operating hours

5.3.4 Staging Site Identification

After the physical requirements for the staging sites are determined, an initial screening of potential sites will be made using information from satellite imagery, mapping, and GIS. In the initial screening, zoning and land use restrictions will be considered. Buffer and setback requirements for prospective properties will also be evaluated. The potential for user conflicts will be identified, such as schedules for material deliveries conflicting with peak traffic patterns for local businesses and schools.

After a list of potential staging sites is identified, site visits will be made to ground truth the information from earlier steps and determine if additional sites should be considered or potential sites be removed from further consideration.

5.3.5 Staging Site Evaluation

After a list of candidate sites is developed, each site will be evaluated and ranked relative to the following criteria.

- Upland traffic routing and impacts
- Marine traffic routing and impacts
- Truck and barge access
- Geotechnical stability and structural offsets
- Shoreline protection
- Runoff and erosion control
- Sedimentation, shoaling, and scouring
- Tidal range, wave, current, and wake
- Visual impacts and light pollution
- Noise and vibration
- Fencing and security

- Air quality and fugitive emissions
- Bridge and utility clearance
- Historic and cultural resources
- Socioeconomic impacts
- Brownfield issues
- Rodent control
- Open space

Sites with unacceptable characteristics or with adverse impacts that cannot be acceptably mitigated will be removed from further consideration.

5.3.6 Implementation of Staging Site Activities

Discussions will be held with EPA concerning the potential sites remaining after the preceding evaluation steps. At the appropriate time as directed by EPA, discussions will be entered with local regulatory agencies and other stakeholders regarding staging sites. From these discussions, a plan will be developed for implementing staging site activities including site acquisition, zoning and public notice activities, permitting, and staging site construction.

6. PD-7: EVALUATION OF POTENTIAL GROUNDWATER UPWELLING AREAS AND MEASUREMENT OF DISCHARGE RATES

This work element has been developed to investigate the occurrence of groundwater upwelling within the Gowanus Canal and measure representative groundwater discharge rates associated with these upwelling areas. The groundwater upwelling work element builds upon information contained in the RI/FS reports for the Site and refines and improves the Site-wide comprehensive CSM to support remedial design activities.

6.1 Existing Groundwater Upwelling CSM

This section summarizes the existing CSM for groundwater discharge into Gowanus Canal as developed during the RI/FS phases of the Site work and from the numerical flow simulations prepared for National Grid.

During the RI Site work, synoptic groundwater level measuring events were conducted in monitoring wells along the Canal to develop potentiometric surfaces for native sediments and underlying glacial deposits. Potentiometric data from wells screened within the native sediments indicate that shallow groundwater is flowing toward the Canal. Potentiometric elevation data acquired from wells screened in the deeper glacial deposits suggest that deeper groundwater is also generally flowing upward toward the Canal. However, during high tides, short periods of groundwater recharge are possible when the potentiometric elevation of the groundwater within the native sediments is at a lower elevation than the water within the Canal.

In order to evaluate the overall groundwater discharge into the Canal, a three-dimensional (3-D) groundwater flow model for the Site was developed in 2011 and calibrated to measured groundwater elevations in the vicinity of the Canal (GEI and Mutch Associates, 2011). The total discharge rate under ambient conditions into the Canal was estimated to be approximately 675 gallons per minute. These data were presented as bulk discharge values in six separate segments comprising the entire length of Gowanus Canal, although more discrete location discharge data can be calculated with the existing model. The model was also used to estimate groundwater seepage velocity.

The modeled upwelling conditions to the Canal, coupled with the lack of empirical data confirming upwelling conditions and rates, presents a significant data gap that warrants pre-design investigation. The 3-D numerical flow model used to evaluate groundwater discharge and seepage rates through Canal sediments only provides a qualitative estimate; it does not account for preferential flow paths and variable flow velocities and the discharges predicted by the model have not been calibrated to direct measurements of groundwater seepage rates within the Canal. In order to better characterize groundwater discharge rates into the Canal, and the impact on remedial design for ISS, capping, and bulkheads, field data is needed to identify groundwater upwelling areas and discharge rates.

6.2 Objectives of the Groundwater Upwelling Evaluation

Two primary objectives of this work element are to determine the approximate areas of significant groundwater upwelling in the Gowanus Canal and, for those areas where discharge is identified, to estimate the rate and velocity of this discharge.

Results from the upwelling study will be used to refine the overall groundwater model (PD-12) and will be incorporated into the evaluation of NAPL mobility (PD-8). The data collected will be integrated into the cap designs for NAPL impacted and non-NAPL impacted areas, and will be used to refine the comprehensive CSM (PD-25). Other remedial design components that will benefit from a refined understanding of groundwater upwelling include bulkhead evaluation, ISS, and capping.

6.3 Groundwater Upwelling Scope of Work

To meet the primary objectives of this work element, the following sub-tasks will be performed:

- Evaluate and select applicable technologies for locating groundwater discharge areas and quantifying discharge rates;
- Evaluate and select areas of the Canal for groundwater upwelling measurements;
- Inspect Site to confirm feasibility of selected technologies at target locations;
- Implement selected technologies to assess groundwater upwelling areas and discharge rates;
- Characterize the hydraulic conductivity between the native and soft sediments;
- Refine the groundwater CSM and groundwater model; and
- Data management, analysis, and reporting.

It is anticipated that activities described for this work element will be conducted in a dynamic manner with several decision steps required, potentially leading to modifications of the scope of work as it is implemented. If the scope should require modification during implementation, the scope changes will be appropriately documented and communicated to EPA.

Details of the sub-tasks are provided in the sections below.

6.3.1 Evaluate and Select Applicable Technologies

Various technologies for assessing groundwater upwelling and discharge rates will be screened for applicability in the Canal. A list of potential technologies to be included in the detailed screening is provided in Table A1. These approaches will be evaluated for their anticipated ability to identify potential areas for groundwater discharge, quantify groundwater discharge rate, and quantify seepage velocity. Additionally, the detailed screening will evaluate the feasibility of implementation in the Gowanus Canal and costs of implementation.

Final selection of technologies for implementation will be communicated to EPA through a brief technical memorandum and presented in a technical workshop(s) as needed. It is anticipated that multiple technologies will be selected to provide independent and complementary lines of evidence that characterize the nature and extent of groundwater discharge into the Canal.

6.3.1.1. Technologies to Locate Groundwater Discharge Areas

The following provides a brief description of each of the identified technologies to be considered in the screening assessment.

Airborne Thermal Infrared Imaging

A thermal infrared camera mounted on a fixed wing or rotary aircraft would be used to survey the Canal and identify zones where surface water temperatures within the Canal are different than the ambient marine water temperature. The flyover and infrared imaging would be conducted in mid-winter when the groundwater temperature has the highest contrast from surface water in the Canal. A winter deployment would reveal relatively warmer surface water temperatures indicative of groundwater discharging into the colder Canal water. Thermal signatures in summer deployments, with relatively cooler groundwater discharging into warmer surface waters, are not ideal; density differences of the water lead the cooler water to remain deeper in the water column, causing airborne-based detections to be less precise. A thermal imaging survey would be intended to provide a general initial evaluation of possible groundwater discharge areas (Majcher et al., 2007).

Satellite Infrared Imaging

Similar to the airborne thermal infrared imagery, satellite remote sensing of infrared thermal bands can be utilized to identify locations of contrasting temperatures where groundwater is discharging into the Canal. Image data can be acquired from a number of providers and should be collected during a timeframe that i) maximizes the temperature contrast between the groundwater and surface water; ii) minimizes cloud cover; and iii) captures low tide and high water table conditions to maximize potential groundwater discharge rate and minimize the overlying surface water volume. Spatial resolution of the imagery will likely be less than for thermal infrared imagery acquired using aircraft surveys (Wang et al., 2008).

Distributed Temperature Sensing (DTS) Cable

This technology utilizes a DTS fiber optic cable paired with specialized electronics and software to precisely and continuously measure temperature at thousands of locations over large areas. It is possible to locate where groundwater is discharging into surface waters by precisely monitoring temperature variability in sediment. Implementation requires a network of fiber optic cables to be deployed across the Canal. Divers would likely be needed to bury the cables within the Canal sediments at a constant depth and to ensure that debris does not interfere with cable placement. It is possible that deployment would need to follow debris removal actions in the Canal. Once installed, the cables can be left in place for long periods with continuous monitoring over tide cycles or seasons, assuming the cables are secure (Selker Metrics, 2013).

Resistivity Array

Electrical resistivity arrays are used to identify potential groundwater discharge locations using electrical current. A current is circulated through a system with built-in sensors as the array is either towed behind a boat or directly laid on the Canal sediments. A difference in conductivity would be observed near groundwater discharge locations because groundwater discharging into the Canal would have a higher resistivity than the more saline surface water in the Canal. Tow-behind resistivity surveys can provide broad areal coverage in a relatively rapid manner whereas cable-to-ground resistivity surveys provide higher resolution (Advanced Geosciences Inc., 2013).

Trident Probe

The Trident probe utilizes a sub-bottom coring device to collect sediment and pore water samples. The Trident Probe allows for the precise identification of groundwater discharge zones by logging changes in temperature and conductivity in the sediment pore water relative to the more saline water in the Canal above (EAS, 2013). The probe can be deployed from a boat without the use of divers.

Monitoring of Natural Tracers

The monitoring of natural tracers allows for identification of groundwater discharge locations and quantification of the spatial and temporal variation in the groundwater discharge within the Canal. The method is based upon the monitoring of tracers that are greatly enriched in the discharging groundwater relative to coastal marine or estuarine waters such as ^{222}Rn, ^{226}Ra, and CH_4. These tracers are tracked using a network of monitoring stations installed within the Canal. The monitoring system consists of a submarine water intake pump, a radon air-water partitioning system (i.e., air-water gas exchanger or silicone radon diffusion tube), a RAD7 radon-in-air detector, and a METS CH_4 detector. Since monitoring of discrete locations provides local information, application at numerous locations throughout the Canal is required (Burnett et al., 2006).

Nested Piezometers

Nested piezometers can be used to determine vertical hydraulic gradients in groundwater discharge zones. Piezometers are installed at different sediment depths and measurements of sediment pore water pressure and Canal surface water elevations are collected to estimate if groundwater is discharging at that location. Data can be collected using transducers within the piezometers in order to estimate hydraulic gradient changes in relation to tidal stages. Optionally, transducers can be buried within the sediment to evaluate long term vertical gradient direction and magnitude.

6.3.1.2 Technologies to Quantify Groundwater Discharge and Velocity

The following provides a brief description of each of the identified technologies to be considered in the screening assessment.

Point Velocity Probe (PVP)

The PVP is a small probe (approximately 0.25 ft. in length) that is installed within soil or sediment to provide 3-D direction and magnitude of the average linear groundwater velocity vector at the centimeter scale. The PVP provides estimates of groundwater velocity based on the injection of a small, saline tracer and detection (via electrical conductivity sensors) along the outside casing of the probe. Additional testing will likely be required to evaluate the applicability of PVPs at Gowanus Canal, with the greatest concerns being tidal changes influencing the flow direction of the injected tracer and the background pore water electrical conductivity (Devlin et al., 2009).

Seepage Meters

The seepage meter is one of the most commonly used devices for making a direct measurement of the flux of water across the sediment-water interface. Typically, a chamber (e.g., half of a cut barrel or similar) is submerged in the surface water body and placed in the sediment to contain the seepage that crosses that cross-section of the sediment-water interface. Seepage flux can then be measured with a variety of methods by assessing either the temporal volumetric changes in water within an attached bag, the transport of injected heat pulses and dyes, the dilution of injected dyes, and the detection of flow using ultrasonic or electromagnetic methods. Seepage meters that measure flow using heat pulse, electromagnetic, or ultrasonic methods also offer the advantage of automated data collection with dataloggers and can assess seepage rates rapidly throughout tide cycles (Rosenberry and LaBlaugh, 2008).

Nested Piezometers

If nested piezometers are used to evaluate vertical gradients, then single-point hydraulic conductivity tests could be conducted at those locations. Hydraulic conductivity and gradient data could be used to estimate groundwater discharge rates over specific areas.

Acoustic Doppler Current Profiler (ADCP)

An ADCP measures water velocity profiles by transmitting short pulse pairs into the water and calculating the phase shift between the two acoustic return signals (Doppler Effect). High resolution ACDP sensors are small (typically < 0.7 m in length), lightweight, and can be installed directly onto the bottom of the Canal with the sensors oriented upward to assess the vertical groundwater velocity. This device can be deployed without the need for divers. The ACDP has a 0.7 cm resolution and a velocity range of up to 10 m/s with an accuracy of ± 0.005 m/s. The device can be left in place to characterize changes in vertical velocity across tidal cycles (Nortek USA, 2014). The flux can be determined by multiplying the vertical velocity by the discharge area (Glenn et al., 2012).

In-Situ Permeable Flow Sensor (ISPFS)

The ISPFS is a small probe that measures groundwater velocity in unconsolidated sediments. The ISPFS operates by measuring the temperature distribution on the surface of the probe surrounding a central heater. The upstream side of the probe will record relatively cooler temperatures while the downstream side of the probe will record relatively warmer temperatures. Processing of the temperature data is related to the groundwater velocity. The ISPFS can be installed in multiple locations of interest within the Canal to characterize the vertical groundwater velocity (Ballard, 1996).

6.3.2 Evaluate and Select Areas of Canal for Groundwater Upwelling Measurements

Various surveys have been conducted in the Gowanus Canal as part of the RI and as part of supplementary data collection, including side-scan sonar imaging, bathymetric surveys, qualitative identification of NAPL occurrences in bottom sediment, scour zones, and magnetometer targets. This sub-task includes compiling these data sets, geo-referencing them to a common datum, and generating an interactive site model to identify appropriate candidate areas to perform groundwater upwelling investigations in different portions of the Canal. Side-scan and magnetometer data, collected in collaboration with PD-3, will be used identify the presence and density of bottom debris. This will help identify areas of the Canal where physical obstacles would hinder the implementation of one or more of the identified technologies and the need to eliminate the area from testing or to focus debris removal. Locations with relatively little accumulation of soft sediment will also be identified as areas with enhanced potential for preferential flow-paths and increased groundwater upwelling. Specific datasets needed for this sub-task include, but are not limited to:

- Geo-referenced side-scan sonar data;
- NAPL detections in soft sediments and native sediments;
- Soft sediment scour locations;
- Magnetometer targets from the 2005 survey (GEI, 2007); and
- Updated bathymetry and sediment transport dynamics due to potential activation of the Flushing Tunnel.

Once the site model has been developed, it will be used to identify areas in which field implementation is applicable. Areas with saturated NAPL impacts and where bottom debris is not an obstacle to technology deployment will be considered a priority. Areas potentially subject to Flushing Tunnel impacts will be evaluated for applicability. Discussions with technology vendors will inform decisions regarding site conditions that are most appropriate for measurements.

Final selection of applicable areas for implementation will be communicated to EPA through a brief technical memorandum and presented in a technical workshop(s) as needed. It is anticipated that multiple technologies will be selected to provide independent and complementary lines of evidence that characterize the nature and extent of groundwater discharge into the Canal.

6.3.3 Site Visit and Inspection to Confirm Feasibility of Selected Technologies at Target Locations

Locations identified as areas to further assess groundwater discharge, both in NAPL impacted areas and non-NAPL impacted areas, will undergo field characterization to confirm feasibility with the applicable technologies. These additional steps may include high resolution bathymetry and side-scan sonar imaging as well as diver inspection to assess the current type and magnitude of debris density, as needed. It is anticipated that the high resolution bathymetry and side-scan sonar survey will be conducted within selected zones of interest (see PD-4) to collect debris data in areas not previously surveyed and, to a certain extent, confirm if present conditions are similar to those reported in the 2010 survey. Based on results of this evaluation, divers may be deployed to evaluate the zones of interest and assess whether the selected technologies can be successfully deployed. In addition, site visits by technology vendors and subcontractors, as applicable, will be conducted to verify implementation feasibility and logistics.

Based on the results of these assessments, a final map will be created that presents representative areas for study within the Canal where groundwater discharge can be confirmed and quantified. The areas will include those within and outside of known NAPL occurrences as well as areas where groundwater discharge rates are hypothesized to be high, average, and low.

6.3.4 Implement Selected Technologies to Assess Groundwater Upwelling Areas and Discharge Rates

Selected technologies will be deployed in locations that are of interest and feasible for determining groundwater discharge. These technologies will identify and confirm areas of relatively high and low groundwater discharge. During this implementation phase, multiple technologies will likely be used to provide independent and complementary lines of evidence that characterize the nature and extent of groundwater discharge into the Canal. The utility of an initial, demonstration-scale implementation step will be considered to obtain site-specific data in advance of a full-scale implementation for technologies warranting methods demonstration.

Once areas of groundwater discharge are identified, point measurements of groundwater discharge and groundwater velocity across tidal cycles will be evaluated. The number of specific point measurements that will be implemented will be dependent on results of the previous sub-tasks. Final determination of methods and approach will be communicated to EPA during technical workshops and communications.

6.3.5 Characterize the Hydraulic Conductivity between the Native and Soft Sediments

It is assumed that the groundwater discharge evaluation will occur in a setting in which the overlying soft sediment is present although it is targeted for later removal as part of the remedy. Groundwater upwelling into the Canal will first migrate through the deeper native sediments and then through the overlying soft sediment prior discharge. If the hydraulic conductivity of the overlying soft sediment is similar to or higher than that of the native sediment, the discharge rate calculated for the soft sediment is likely representative of discharge that will occur once the soft sediment is removed.

If the soft sediment has a lower hydraulic conductivity than the native sediment, it is possible that there may be horizontal groundwater migration through the native sediment to discrete, preferential flow locations. These preferential discharge points would likely be where the soft sediment is thinner, of higher hydraulic conductivity, or absent. In this scenario, direct measurements of groundwater discharge in soft sediments would not be an accurate assessment of likely groundwater discharge post-remedy.

If the soft sediment has a lower hydraulic conductivity, steps will be taken to collect groundwater discharge data in the soft sediment and model the groundwater discharge rate after the soft sediment is removed. Specifically, hydraulic conductivity data will be collected for both the native and soft sediment and will be input into the existing 3-D numerical model. The model will then be recalibrated to match current conditions and used to simulate discharge after the soft sediment was removed.

Possible methods for quantifying hydraulic conductivity values for the native and soft sediments include variations on cone penetrometer and slug testing, as indicated below:

- Hydraulic Profiling Tool (HPT) by Geoprobe® - The HPT injects water while pushing into the sediment. A log of injection pressure with depth can be correlated with formation permeability. It is possible to quantify hydraulic conductivity from HPT logs using an empirical relationship developed for the tool.

- Waterloo Advanced Profiling System (Waterloo^{APS})^{TM} – This system would provide only an index of hydraulic conductivity. However, combined with a subset of collocated core data, the relative signature of hydraulic conductivity of the native and soft sediments could be determined.

- Cone-penetrometer (CPT) In Situ Dissipation Testing – CPT testing utilizes a direct push probe outfitted with a steel cone tip and sensors attached to a friction sleeve that measure tip resistance, sleeve friction, and pore water pressures. Dissipation tests are conducted when the probe's advancement into the sediments is paused and the built-up pore pressure dissipates. The dissipation is related to the hydraulic conductivity through an empirical relationship. CPT is also being considered for field investigations under PD-8 (NAPL characterization).

- Slug testing with nested wells – This would include standard falling or rising manual slug testing methods conducted in piezometers installed with discrete screens in the soft sediment and native sediment.

A screening and selection of the most appropriate and informative technology will be conducted using the evaluation criteria of technical performance, implementability, and cost. Final selection of technologies and approach will be communicated to EPA through a brief technical memorandum and presented in a technical workshop(s).

6.3.6 Refine Groundwater CSM and Groundwater Model

Quantified groundwater discharge rates and identified spatial groundwater discharge patterns will be integrated into the overall Site-wide comprehensive CSM. This information will be compared to the 3-D groundwater model estimates for groundwater discharge. If the results are significantly different, these data will be used to recalibrate and further refine the 3-D model, regardless of the need to assess differences in discharge once the soft sediment is removed. Once updated, the 3-D model will be used to evaluate changes in seepage velocity within Canal sediments under a wide variety of possible remedial scenarios that include various bulkhead improvements and cap installations.

6.3.7 Data Management, Analysis, and Reporting

Data collected during field implementation will be managed in a manner that is consistent with EPA protocols. Results of data analysis and interpretation will be communicated with EPA in a timely manner. Reports from subtasks will include brief technical memorandums detailing the findings. A final report for the groundwater upwelling work element will be prepared to summarize the methodologies utilized and the findings. Reports will be prepared with EPA collaboration and concurrence.

7. PD-8: EVALUATION OF POTENTIALLY MOBILE NAPL IN NATIVE SEDIMENTS

This work element has been developed to improve understanding regarding the potential for upward NAPL mobility in native sediments of the Canal. The NAPL mobility work element builds upon information contained in the Site RI/FS reports, and refines and improves the Site-wide comprehensive CSM to direct remedial design activities, specifically ISS and capping.

7.1 Existing NAPL Mobility CSM

This section describes the CSM for NAPL mobility in native sediments as developed during the RI/FS phases for the Canal by EPA and its contractor, CH2M HILL. Generally, the CSM from the RI/FS assumes that NAPL originated and migrated from upland sites both vertically downwards but also laterally. The vertical downward migration stems from gravitational forces, as the NAPL has a higher density than water (i.e., a dense NAPL, or DNAPL).

The RI/FS notes the following three primary mechanisms that control NAPL migration into the Canal:

- Upward seepage via vertically upward hydraulic gradients associated with groundwater advection. The RI/FS concluded that the presence of NAPL saturation in a given location both above and below the native sediment/soft sediment interface indicates the potential for active upward NAPL migration from the native sediment to the soft sediment. The method used for this determination accounted for the balance of (i) gravitational force on the NAPL and (ii) upward force brought about by hydraulic pressure gradients. Confirmation of this conceptual mechanism requires consideration of other commonly recognized resistive forces associated with upward NAPL migration, such as (i) the pore entry pressure that is necessary for the NAPL to enter the overlying soft sediment pores, and (ii) the resistance due to the frictional forces of the viscosity of the NAPL. Inclusion of these forces will allow for better definition of the zones where upward migration of NAPL is occurring due to groundwater advection.

- Lateral seepage via spreading along the saturated/unsaturated zone interface. The spreading phenomenon is typical for light NAPL (LNAPL) releases but not as common for DNAPL releases given that DNAPL will preferentially migrate downwards due to gravity and will spread due to physical structure impediments, such as soil structure. The lateral spreading caused by the soil lithology could cause the NAPL to accumulate behind the bulkheads or spread beneath the Canal.

- Upward transport via ebullition due to biodegradation of organic matter or other processes (CH2M Hill, 2013). Ebullition-facilitated transport of NAPL occurs under anaerobic conditions in sediments which promote microbial gas generation (i.e., methanogenesis) and the formation of gas bubbles in the sediment. The gas bubbles rise through the sediment bed and into the water column, the process of which disturbs resident NAPL and can physically transport NAPL to the surface.

Another potential cause of the NAPL presence in the Canal that was not discussed in the RI/FS is historic operational practices of non-MGP sites. Discharge of NAPL from these sites including both DNAPL and LNAPL likely occurred based on operations, with weathered LNAPL potentially residing in the sediment. Over successive decades, these discharges to the Canal would have been followed by soft sediment layering above these NAPL zones, encapsulating the NAPL at depth. The qualitative observations of NAPL within the Canal indicate the presence of NAPL predominantly in the deeper native sediments as opposed to the soft sediments. The density of the NAPL may have driven vertical downward migration into the native sediments, as opposed to the upward mechanisms discussed earlier. This alternative conceptual mechanism will be considered during the implementation of work element PD-8 as it relates to the delineation of ISS boundaries. NAPL present in Canal sediments is subject to weathering and related changes in both the physical and chemical characteristics. Typically, NAPL in sediment environments will have undergone the following mechanisms of alteration:

- Increases in viscosity with age due to dissolution of lighter fractions of the NAPL;

- Variations in density due to potential water entrainment, which lowers density, and intrinsic source depletion mechanisms that remove more volatile components, thereby increasing density;

- Variations in interfacial tensions from the processes noted in the preceding bullet, allowing for easier entry into wetted pores; and,

- Enhanced weathering in sediment zones due to the presence of active microbial populations and biodegradation pathways which further alter the physical and chemical characteristics of the NAPL.

Overall, aging and weathering of NAPL results in increased viscosity and density, directly affecting its upward migration potential. A more viscous NAPL has a lower tendency to migrate in any direction, and a higher density NAPL has a lower tendency to be upwardly mobile due to vertical gradients.

For the purposes of this PDWP, the process of upward vertical transport within the Canal footprint is the area of focus; potential lateral transport into the Canal via bulkheads is addressed separately through upland remedial activities and possibly additional pre-design investigations. Field and laboratory work completed by EPA as part of the RI/FS provides an initial understanding of NAPL distribution and potential for upward mobility; however, in order to optimize the design of ISS and capping remedial measures, further refinement of the NAPL CSM is required to understand the mechanisms of NAPL mobility in the Canal. The primary CSM data needs related to upward NAPL mobility are as follows:

- The origin of the NAPL within the canal area; and
- The conditions under which NAPL can become upwardly mobile.

The NAPL has at least two suspected origins: (i) through the subsurface from the upland sites, or (ii) from overland discharge into the Canal. Both have different implications for NAPL mobility, NAPL distribution, and continuity of saturation levels for implementation of ISS. Better understanding of the origin of the NAPL will aid in understanding its distribution and will inform the delineation for the areas to target ISS and capping.

- If the NAPL originated from the upland sites via subsurface transport, then the NAPL saturation distribution would likely be biased towards the upland sites (i.e., higher saturations of NAPL closer to the upland sites and decreasing levels of saturation further away). In this scenario, the potential for vertical upward migration would be greater close to the upland sites where the NAPL saturation is suspected to be higher. Such an understanding would further refine the area requiring ISS and capping since the NAPL saturation levels would be predictably distributed in the Canal.
- Conversely, if the NAPL originated from overland discharges, then the NAPL distribution would be more random and dispersed. Delineation of potentially mobile NAPL (i.e., areas with high levels of NAPL saturation) is more challenging in this scenario as the NAPL saturation levels are not consistent and well bounded.

The existing CSM of NAPL transport in the Canal focuses on the driving forces for NAPL transport in areas of strong hydraulic gradients. This work element will refine the existing CSM through quantitative analysis of the relationship between hydraulic gradients, NAPL/water density differences, and flow potential. These factors, which are considered in the existing CSM, are relevant to the evaluation of NAPL transport. Additional factors that warrant inclusion are potential restrictions to flow, since upward NAPL flux in the Canal sediments must overcome density-driven gravitational forces, pore entry pressure, and viscous (frictional) forces of the NAPL. Each of these additional factors will be assessed in this work element and integrated into a refined NAPL mobility CSM.

7.2 Objectives of the NAPL Mobility Evaluation

The primary objectives of this work element are to (i) quantify the NAPL distribution within the canal, (ii) define areas of potentially mobile NAPL, and (iii) identify and characterize the controlling factors of NAPL mobility.

Results will be integrated into overall groundwater model (PD-12) and Site-wide comprehensive CSM (PD-25) and directly incorporated into evaluation of NAPL mobility. Several remedial design components (e.g., ISS, capping) require a detailed understanding of NAPL mobility.

7.3 NAPL Mobility Scope of Work

To meet the primary objectives of this work element, the following sub-tasks will be performed:

- Desktop evaluation of NAPL mobility and selection of appropriate field-screening technology(ies) and assessment locations;
- Implementation of field-based approaches to assess in situ NAPL distribution;
- Laboratory mobility testing and NAPL characterization; and,
- Data management, analysis, and reporting.

It is anticipated that activities described for this work element will be conducted in a dynamic manner with several decision steps required, potentially leading to modifications of the scope of work as it is implemented. If the scope should require modification during implementation, the scope changes will be appropriately documented and communicated to EPA.

Details of the sub-tasks are provided in the sections below.

7.3.1 Desktop Evaluation of NAPL Mobility and Selection of Appropriate Technologies and Assessment Locations

This sub-task involves the compilation of existing NAPL and transport-related data to understand the 3-D distribution of NAPL within the Canal. Qualitative observations of NAPL detections, chemical analysis results, sediment texture descriptions, and other observations and remarks noted during field investigations during the RI will be incorporated into the 3-D compilation. These multiple lines of evidence will be used to visualize NAPL distribution within the Canal and identify areas of saturated NAPL as well as areas requiring greater data density. To the extent practical, insights into groundwater flow and transport will be incorporated into this multiple lines of evidence approach to understand areas of elevated NAPL saturation relative to areas with higher potential seepage rates (PD-7). This will identify if there are areas with elevated NAPL observations overlapping with areas of elevated groundwater discharge.

As a part of this sub-task various NAPL field screening technologies will be screened for their ability to assess NAPL distribution in the Canal and for their potential applicability. This evaluation will focus on (i) the ability of Tar-specific Green Optical Screening Tool (TarGOST®, EPRI, 2006; EPRI, 2005) and similar tools to measure variability of saturation, and (ii) the ability of CPT and similar tools to measure variability in the sediment lithology. Similarly, laboratory methods to assess and measure NAPL mobility will be evaluated and screened to complement the field-screening tools.

Final selection of technologies for implementation in the field and laboratory will be communicated to EPA through a brief technical memorandum and presented in a technical workshop(s) as needed. It is possible that multiple technologies will be selected to provide independent and complementary lines of evidence that characterize NAPL mobility in native sediments.

7.3.2 Implementation of Field-Based Approaches to Assess In Situ NAPL Distribution

This sub-task involves field-based approaches and collection of undisturbed sediment cores for confirmatory laboratory analysis to assess the NAPL distribution in native sediments of the Canal. The field-based approaches will incorporate technologies selected from the preceding sub-task to measure the presence of NAPL in situ. It is anticipated that implementation of the technologies will require the use of a barge to allow access to the Canal sediments. Selected technologies will be calibrated to the Site conditions.

The desktop evaluation results will be used to focus the application of field-based approaches to locations which are anticipated to have the highest likelihood of vertical upward NAPL migration and/or the highest anticipated NAPL saturation. Within the focused areas, a series of smaller, initial target areas will be defined by the existing 3-D data distribution as initial areas of deployment to assess the efficacy of field-based approaches and laboratory analysis programs. Following the successful completion of initial deployment, the approach will be expanded to the larger objective of delineating and/or defining the areas of migrating NAPL below the Canal for remedy implementation.

During implementation of field-based approaches, additional sediment cores will be collected via Shelby tube, large acetate liner via direct push, or other similar method for laboratory analyses. The laboratory analyses will provide calibration and confirmatory data for the field-based approaches. The cores will be preserved using a method that minimizes sample disturbance. During the completion of the field collection of laboratory samples, samples of the NAPL and groundwater from the native sediments will be collected (where possible) for physical and chemical property testing.

Results of the field-based evaluation will do the following: (i) support refinement of the CSM, (ii) support identification of further NAPL delineation needs, (iii) aid in the selection of areas for further NAPL mobility assessment, and (iv) directly support future remedial design activities.

7.3.3 NAPL Characterization and Laboratory Mobility Testing

Undisturbed core samples will be collected from the Canal for laboratory analysis of mobility and to confirm observations from field-based approaches. The goal of the laboratory analysis is to understand (i) the vertical seepage velocity, among other factors, that is necessary to cause upward migration of the NAPL within the native sediments, and (ii) the confining pressure needed to impede this migration if it exists. The scope of work for the laboratory mobility testing includes (i) characterization analyses of the collected sediment core, NAPL, and groundwater samples, and (ii) empirical assessment of potential vertical NAPL mobility.

7.3.3.1 Laboratory NAPL Characterization Analysis

The sediment core samples collected will be analyzed using established laboratory-based NAPL mobility assessment methods. These may include but are not limited to the following:

- NAPL pore fluid saturation at a set vertical spacing, which be collocated with field-based assessments;
- Centrifuge and/or water flood of sediment samples to assess NAPL residual saturation and mobility potential;
- Drainage capillary pressure data (i.e., water retention curves) to understand the soil matrix and to develop the parameters to understand pore entry pressures;
- Potential photography of the core under white and ultraviolet (UV) light to provide an understanding of the vertical NAPL distribution and aid in defining vertical depths for further mobility assessment;
- Geotechnical parameters to confirm the field-based approach for soil/sediment texture observations; and
- The collected NAPL and groundwater samples will be analyzed for density, viscosity, and interfacial tension. The collected NAPL will also be analyzed for chemical composition.

The results of the NAPL characterization will be incorporated into the CSM and will directly support future remedial activities.

7.3.3.2 Laboratory Mobility Testing

A laboratory mobility testing method that mimics natural conditions will be used to assess the mobility of the NAPL within the sediments. The laboratory mobility testing method will be developed as part of the initial sub-task under this work element. The goal of the laboratory-scale work is to understand, among other factors, the vertical seepage velocity and hydraulic head gradients that are necessary to cause upward migration of the NAPL within the native sediments.

Various pressure gradients and seepage velocities will be tested to evaluate vertical migration potential under in situ conditions. If necessary, additional NAPL will be added to the sample to understand what NAPL saturation threshold is necessary at given velocities to cause vertical migration. As part of this testing, a sensitivity analysis will be completed to understand which parameters most strongly control mobility.

Results of the laboratory mobility testing will be incorporated into the CSM and will directly support future remedial activities.

7.3.4 Data Management, Analysis, and Reporting

The information from the desktop study, field-based approaches, results from NAPL characterization, and results from laboratory mobility testing will be incorporated into the database and data management for the Site. Data collected during field implementation will be managed in a manner that is consistent with EPA protocols. Results of data analysis and interpretation will be communicated with EPA in a timely manner. The reporting for the work element will occur through brief technical memoranda to EPA and technical workshop(s), as needed. A comprehensive Final NAPL Mobility Report will be prepared and submitted.

8. IMPLEMENTATION SCHEDULE

The Work Plans for pre-design work elements PD-3 through PD-8 are subject to review and approval by the EPA. The drafts of these Work Plans are to be shared with the EPA Project Team for their input and concurrence prior to finalization. At that time, a comprehensive schedule of the sequence of implementation of the various Work Plans will be developed by respondents to the ROD for approval by EPA.

9. REFERENCES

Advanced Geosciences Inc., http://www.agiusa.com/index.shtml accessed 3 December 2013.

ASTM D422, 2007, "*Standard Test Method for Particle-Size Analysis of Soils*," ASTM International, West Conshohocken, PA, 2007, DOI: 10.1520/D0422-63R07, www.astm.org.

ASTM D1586, 2011, "*Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*," ASTM International, West Conshohocken, PA, 2011, DOI: 10.1520/D1586-11, www.astm.org.

ASTM D1587, 2008, "*Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes*," ASTM International, West Conshohocken, PA, 2008, DOI: 10.1520/D1587-08R12E01, www.astm.org.

ASTM D2216, 2010, "*Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*," ASTM International, West Conshohocken, PA, 2010, DOI: 10.1520/D2216-10, www.astm.org.

ASTM D2487, 2011, "*Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System*," ASTM International, West Conshohocken, PA, 2011, DOI: 10.1520/D2487-11, www.astm.org.

ASTM D2488, 2009, "*Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*," ASTM International, West Conshohocken, PA, 2009, DOI: 10.1520/D2488-09A, www.astm.org.

ASTM D2850, 2007, "*Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils*," ASTM International, West Conshohocken, PA, 2003, DOI: 10.1520/D2850-03AR07, www.astm.org.

ASTM D4220, 2007, "*Standard Practices for Preserving and Transporting Soil Samples*," ASTM International, West Conshohocken, PA, 1995, DOI: 10.1520/D4220-95R07, www.astm.org.

ASTM D4318, 2010, "*Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*," ASTM International, West Conshohocken, PA, 2010, DOI: 10.1520/D4318-10, www.astm.org.

ASTM D4428, 2007, "*Standard Test Methods for Crosshole Seismic Testing*," ASTM International, West Conshohocken, PA, 2007, DOI: 10.1520/D4428_D4428M-07, www.astm.org.

ASTM D4767, 2011, "*Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils*," ASTM International, West Conshohocken, PA, 2011, DOI: 10.1520/D4767-11, www.astm.org.

ASTM D5753, 2010, "*Standard Guide for Planning and Conducting Borehole Geophysical Logging*," ASTM International, West Conshohocken, PA, 2005, DOI: 10.1520/D5753-05R10, www.astm.org.

ASTM D5778, 2012, "*Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils*," ASTM International, West Conshohocken, PA, 2012, DOI: 10.1520/D5778-12, www.astm.org.

ASTM D5882, 2007, "*Standard Test Method for Low Strain Impact Integrity Testing of Deep Foundations*," ASTM International, West Conshohocken, PA, 2007, DOI: 10.1520/D5882-07, www.astm.org.

ASTM D7263, 2009, "*Standard Test Methods for Laboratory Determination of Density (Unit Weight) of Soil Specimens*," ASTM International, West Conshohocken, PA, 2009, DOI: 10.1520/D7263-09, www.astm.org.

ASTM D7400, 2008, "*Standard Test Methods for Downhole Seismic Testing*," ASTM International, West Conshohocken, PA, 2008, DOI: 10.1520/D7400-08, www.astm.org.

Ballard, S., 1996. *"The in situ permeable flow sensor: A ground water flow velocity meter." Ground Water.* 34 (1996): 231-240.

Brown, A., July 2000. *"Gowanus Canal, Bulkhead Inventory Survey."*

Burnett, W.C., Aggarwal, P.K., Aureli, A., Bokuniewicz, H., Cable, J.E., Charette, M.A., et al., 2006. *"Quantifying submarine groundwater discharge in the coastal zone via multiple methods." Science of the Total Environment*, 367 (2006): 498-543.

CH2M Hill and HDR, January 2011. "*Gowanus Canal Remedial Investigation Report*."

CH2M Hill, December 2011. "*Draft Feasibility Study, Gowanus Canal*."

CH2M Hill, July 9, 2013. *"Technical Memorandum: Evaluation of Ebullition Potential to Transport Non-Aqueous Phase Liquids in the Gowanus Canal."*

Devlin, J.F., McGlashan, M.A., Tsoflias, G.P., Schillig, P.C., 2009. *"An inexpensive multilevel array of sensors for direct groundwater velocity measurement." Ground Water Monitoring and Remediation*, 29 (2009): 73-77.

Dolan Research, Inc., December 2010. *"Side Scan Sonar Report: Gowanus Canal Preliminary Bulkhead Study. Brooklyn, Kings County, NY."*

EAS Environmental Assessment Services., http://www.easbio.com accessed 3 December 2013.

EPRI, August 2005. *"Using TarGOST® to Delineate the Presence of Coal Tar in Subsurface Soils."*

EPRI, 2006. *"Development of a Characterization and Assessment Framework for Coal Tar at MGP Sites: Coal Tar Management Frameworks."*

GEI Consultants, Inc., April 2007. *"Draft Remedial Investigation Technical Report: Gowanus Canal Superfund Site, Brooklyn, New York."*

GEI and Mutch Associates, December 2011. *"Groundwater Model Report, Gowanus Canal, Superfund Site, Brooklyn, New York."*

GEI Consultants, Inc., March 8, 2012. *"Draft Bulkhead Summary: Gowanus Canal Superfund Site, Brooklyn, New York."*

GEI Consultants, Inc., 2013. *"Gowanus Canal–Web GIS Interface."*

lenn, C.R., Whittier, R.B., Daieler, M.L., Dulaiova, H., El-Kadi, A.I., Fackrell, J., Kelly, J.L., Waters, C.A., 2012. *"Lahaina groundwater tracer study – Lahaina, Maui, Hawaii: Final Interim Report."*

Majcher, E.H., Phelan, D.J., Lorah, M.M., and McGinty, A.L., 2007. *"Characterization of preferential ground-water seepage from a chlorinated hydrocarbon-contaminated aquifer to West Branch Cana Creek, Aberdeen Proving Ground, Maryland."*

Nortek USA., www.selkermetrics.com accessed 15 January 2014.

Ocean Surveys, Inc., August 2013. *"Multibeam Hydrographic Survey."*

Rosenberry, D.O., and LaBlaugh, J.W., 2008. *"Field techniques for estimating water fluxes between surface water and ground water: U.S. Geological Survey Techniques and Methods 4–D2."*

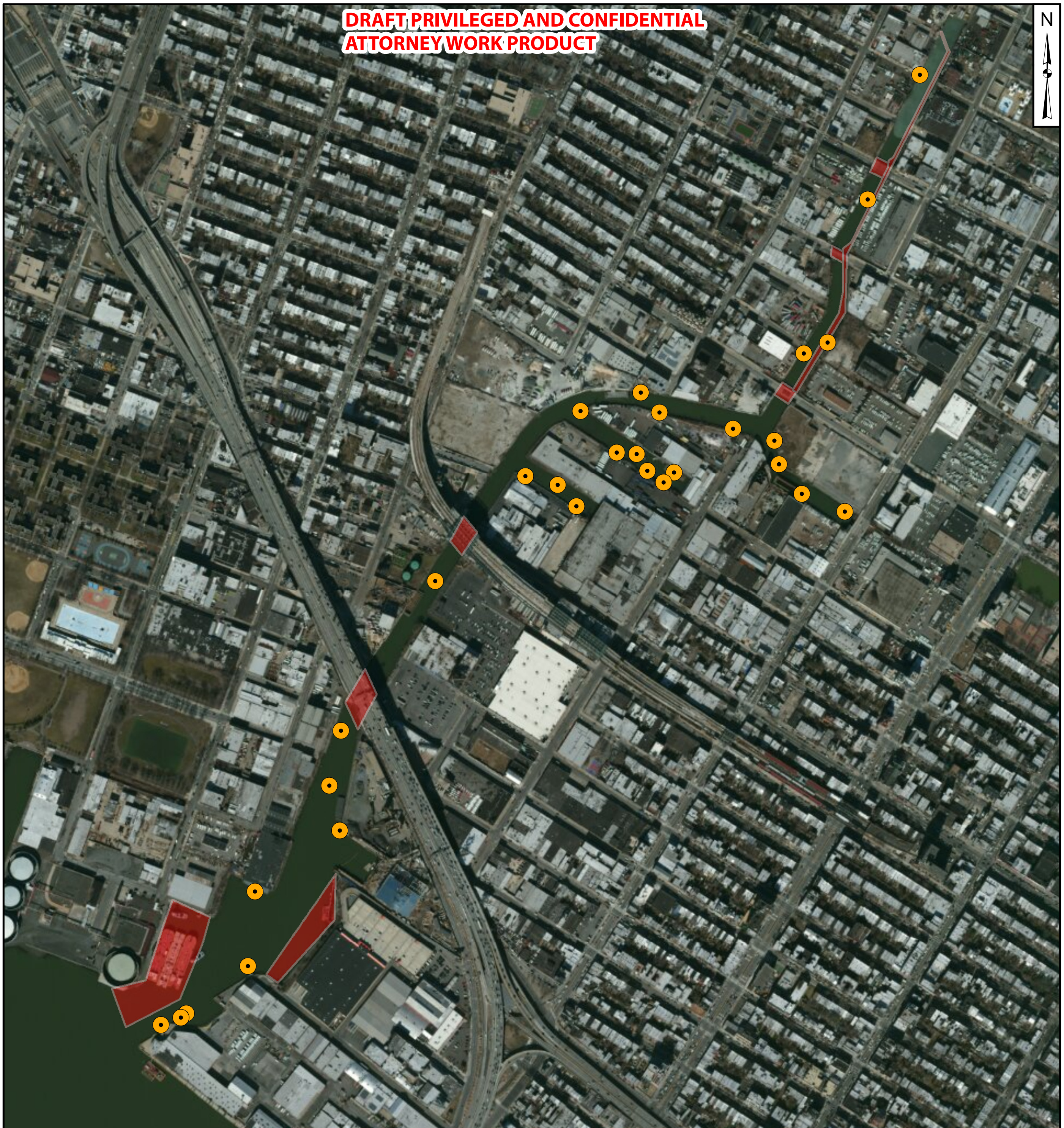
Selker Metrics., www.selkermetrics.com accessed 3 December 2013.

United States Environmental Protection Agency, September 2013. *"Record of Decision: Gowanus Canal Superfund Site, Brooklyn, King County, New York."*

Wang, L.T, McKenna, T.E., DeLiberty, T.L.. 2008. *"Locating ground-water discharge areas in Rehoboth and Indian River Bays and Indian River, Delaware using LANDSAT 7 imagery." Deleware Geological Survey Report of Investigations*, 74 (2008): 11.

Table A1. Summary of technologies to be considered in PD-7 to identify areas of groundwater upwelling and quantification of discharge volume and rates.

Technology	Identify GW Discharge	Quantify GW Discharge	Quantify Seepage Velocity	Description
Airborne Thermal Infrared Imaging	**X**			Cost effective technology that requires aircraft with sensor to detect temperature contrast at water surface that is the result of discharged groundwater. Best conducted at peak low tide during mid-winter.
Satellite Infrared Imaging	**X**			Data already exists and easy to implement. Best with low cloud cover, peak low tide and during either mid-winter or mid-summer. Spatial resolution may be low.
Distributed Temperature Sensing (DTS)	**X**			Uses fiber optic cables buried in sediment to sense temperature changes assumed to be groundwater discharge. Requires divers, but good for broad level screening. Bottom debris may hinder deployment.
Resistivity Array	**X**			Technique based on high resistivity contrast between groundwater discharge and marine water. Metallic debris could be a significant problem.
Trident Probe	**X**			Point measurement that utilizes a sub bottom coring device to collect sediment and pore water. Groundwater discharge areas evaluated using conductivity and temperature differentials between pore water and surface water.
Seepage Meters		**X**	**X**	Reliable method for groundwater discharge. Likely to require divers to implement.
Point Velocity Probes			**X**	New technique-monitors electrical conductivity breakthrough curves from injected saline tracer. R&D needed to implement technology in this setting.
Piezometer Nests	**X**	**X**		Although common, may be difficult due to water depth and canal traffic. Not a direct measurement of discharge compared to seepage meters
Acoustic Doppler Current Profiling		**X**	**X**	Rapid method to assess vertical submarine groundwater discharge. Method is applicable for measuring discharges above 0.005 m/s.
Natural Tracers	**X**			Uses naturally occurring, short-lived isotopic tracers that are enriched in groundwater relative to surface water to identify groundwater discharge. May require divers to install monitoring network infrastructure. Monitoring would include intake pumps, air-water gas exchangers, and tracer-specific detectors.
In Situ Permeable Flow Sensor (ISPFS)			**X**	Measures heat transport on thermistors that surround a central heating element to calculate groundwater velocity. Can be used to assess either horizontal or vertical flow depending on sensor orientation.



Identified Obstructions

Data Gaps

750 375 0 750 Feet

Locations of Sonar Targets for Additional Reconnaissance to be Performed under Work Element PD-3

Gowanus Canal Superfund Site
Brooklyn, New York

nationalgrid
HERE WITH YOU. HERE FOR YOU.

Geosyntec consultants

Figure **A1**

Kennesaw, GA

JANUARY 2014

Path: [Raleigh-01/Data] N:\Gowanus\GIS\MXDs\Figure1.mxd 28 January 2014 RED

RECORD OF DECISION

Gowanus Canal Superfund Site
Brooklyn, Kings County, New York

United States Environmental Protection Agency
Region II
New York, New York

September 2013

DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION

Gowanus Canal Superfund Site
Brooklyn, Kings County, New York

Superfund Site Identification Number: NYN000206222
Operable Unit: 01

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) documents the U.S. Environmental Protection Agency's (EPA's) selection of a remedy for the contaminated sediments and source controls at the Gowanus Canal Superfund site (the "Site"), chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), 42 U.S.C. §§ 9601-9675, and the National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300. This decision document explains the factual and legal basis for selecting a remedy to address the contaminated sediments at the Site. The attached Administrative Record Index (see Appendix III) identifies the items that comprise the Administrative Record upon which the selected remedy is based.

The New York State Department of Environmental Conservation (NYSDEC) was consulted on the proposed remedy in accordance with CERCLA Section 121(f), 42 U.S.C. § 9621(f), and it concurs with the selected remedy (see Appendix IV).

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from the Site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare or the environment.

DESCRIPTION OF THE SELECTED REMEDY

The selected remedy, which addresses contaminated sediment, includes the following components:

- Dredging of the entire column of hazardous substance-contaminated sediments which have accumulated above the native sediments in the upper and mid-reaches of the canal (referred to as "soft sediments").
- In-situ stabilization (ISS)[1] of those native sediments in select areas in the upper

[1] Mixing of materials, such as Portland cement, into the sediments to bind the contaminants

and mid-reaches of the canal contaminated with high levels of nonaqueous phase liquid (NAPL).[2]

- Construction of a multilayered cap in the upper and mid-reaches of the canal to isolate and prevent the migration of polycyclic aromatic hydrocarbons (PAHs) and residual NAPL from native sediments.
- Dredging of the entire soft sediment column in the lower reach of the canal.
- Construction of a multilayer cap to isolate and prevent the migration of PAHs from native sediments in the lower reach of the canal.
- Off-Site treatment of the NAPL-impacted sediments dredged from the upper and mid-reaches of the canal with thermal desorption,[3] followed by beneficial reuse off-Site (*e.g.,* landfill daily cover) if possible.
- Off-Site stabilization of the less contaminated sediments dredged from the lower reach of the canal and the sediments in the other reaches not impacted by NAPL, followed by beneficial reuse off-Site.
- Excavation and restoration of approximately 475 feet of the filled-in former 1st Street turning basin.
- Excavation and restoration of the portion of the 5th Street turning basin beginning underneath the 3rd Avenue bridge and extending approximately 25 feet to the east and the installation of a barrier or interception system at the eastern boundary of the excavation.
- Implementation of institutional controls incorporating the existing fish consumption advisories (modified, as needed), as well as other controls to protect the integrity of the cap.
- Periodic maintenance of the cap and long-term monitoring to insure that the remedy continues to function effectively.
- Combined sewer overflow (CSO)[4] controls as discussed below.

To prevent recontamination of the canal following the implementation of the above-described remedial actions, the upland sources of hazardous substances, including discharges from three former manufactured gas plants (MGPs), CSOs, other contaminated upland areas and unpermitted pipes along the canal, must be addressed prior to the commencement of, or in phased coordination with, the implementation of the selected remedy.

The former MGP facilities are being addressed by National Grid, a potentially responsible party (PRP) for these facilities and the Site, under NYSDEC oversight. Based upon the first NYSDEC-selected remedy at one of these former MGP facilities and NYSDEC guidance for presumptive remedies at former MGP facilities, it is assumed that a range of actions will be implemented at the facilities (that may include

---

physically/chemically.

[2] Concentrated liquid contamination, typically oil-like, that forms a separate phase and is not miscible with water.

[3] Utilization of heat to increase the volatility of organic contaminants so that they can be removed and destroyed.

[4] Combined sewers receive both sewage and stormwater flows and discharge to the canal when the sewer system's capacity is exceeded.

removal of mobile sources, construction of cut-off walls along the canal, and active recovery of NAPL near the cut-off walls for each of the former MGP facilities) which will prevent the migration of contamination from the former MGP facilities into the canal. The cleanup of the former MGP facilities will be completed in accordance with schedules agreed upon between the EPA and NYSDEC. In the unlikely event that timely and effective state-selected remedial actions are not implemented at a given former MGP facility, the EPA may implement actions pursuant to CERCLA to ensure the protectiveness of the selected remedy.

NYSDEC is currently overseeing work being performed by New York City (NYC) to reduce CSOs to the canal by approximately 34 percent in middle and lower canal outfalls. To significantly reduce overall contaminated solid discharges to the canal, the selected remedy also includes the following CSO control measures for the upper reach of the canal:

- Construction of in-line sewage/stormwater retention tanks to retain stormwater which currently discharges through outfalls RH-034 and OH-007. It is estimated that an 8-million gallon tank and a 4-million gallon tank will be required to address CSOs from outfalls RH-034 and OH-007, respectively. In addition, outfalls located in the vicinity of outfalls RH-034 and OH-007 that contribute smaller CSOs will be connected to the retention tanks. The location of the retention tanks will be determined during the remedial design. While the sizes of the tanks will be determined during the remedial design, they are expected to conform with the requirements of the Clean Water Act (CWA) and to accommodate projected additional loads to the combined sewer system that result from current and future residential development, as well as periods of high rainfall, including future rainfall increases that may result from climate change.
- In the event that the permanent measures described above are not implemented in a timely manner, interim controls, such as temporary solids capture and removal, will be implemented to mitigate sediment from the CSO discharges until the permanent measures have been implemented.[5]
- Implementation of appropriate engineering controls to ensure that hazardous substances and solids from separated stormwater, including from future upland development projects, are not discharged to the canal.

Current and future high density residential redevelopment along the banks of the canal and within the sewershed shall adhere to NYC rules for sewer connections (Chapter 31 of Title 15 of the Rules of the City of New York) and shall be consistent with current NYC Department of Environmental Protection (NYCDEP) criteria (NYCDEP, 2012) and guidelines to ensure that hazardous substances and solids from additional sewage loads do not compromise the effectiveness of the permanent CSO control measures by exceeding their design capacity.

Since the EPA is incorporating contaminated CSO solids control in the remedy

[5] It is unlikely that permanent measures to control the CSO discharges will be in place before the commencement of the remediation of the canal sediments.

selection, siting, remedial design and remedial action pursuant to the authority of CERCLA, certain CERCLA statutory authorities including, but not limited to, permit exemption and environmental impact statement functional equivalency apply. The EPA seeks to coordinate the CERCLA and CWA processes to the extent practicable, to ensure that the selected CERCLA remedy is implemented in an effective and timely manner.

The selected remedy also includes the following measures for discharges from upland sites (other than the former MGP facilities) and for unpermitted pipes along the canal:

- The EPA and NYSDEC will coordinate measures to control discharges from upland contaminated areas adjacent to the canal that have already been referred to NYSDEC for action. The schedule for these measures will conform to the schedules for the cleanup of the canal.
- Unpermitted pipe outfalls will be either controlled or eliminated.

The environmental benefits of the selected remedy may be enhanced by consideration, during the design, of technologies and practices that are sustainable in accordance with the EPA Region 2's Clean and Green Energy Policy and NYSDEC's Green Remediation Policy.[6] This will include consideration of green remediation technologies and practices.

The estimated present-worth cost of the selected remedy is $506 million.

The selected remedy will address source materials constituting principal threats by thermally treating the NAPL-impacted sediments dredged from the upper and mid-reaches of the canal, thereby satisfying the CERCLA preference for treatment.

DECLARATION OF STATUTORY DETERMINATIONS

The selected remedy meets the requirements for remedial actions set forth in CERCLA Section 121, 42 U.S.C. § 9621, because it: 1) is protective of human health and the environment; 2) meets a level or standard of control of the hazardous substances, pollutants and contaminants which at least attains the legally applicable or relevant and appropriate requirements under federal and state laws; 3) is cost-effective and 4) utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. In keeping with the statutory preference for treatment that reduces toxicity, mobility or volume of contaminated media as a principal element of the remedy, all of the contaminated sediments that are removed from the canal, as well as some contaminated sediments that remain in the canal, will be treated by implementing the selected remedy.

---

[6] See http://epa.gov/region2/superfund/green_remediation and http://www.dec.ny.gov/docs/remediation_hudson_pdf/der31.pdf.

Because this remedy will result in hazardous substances, pollutants or contaminants remaining on-Site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

ROD DATA CERTIFICATION CHECKLIST

The ROD contains the remedy selection information noted below. More details may be found in the attached Decision Summary and the Administrative Record file for this Site.

- Contaminants of concern and their respective concentrations (see ROD, Appendix II, Tables 3 and 4);
- Baseline risk represented by the contaminants of concern (see ROD, pages 31-34 and Appendix II, Tables 6-15);
- Cleanup levels established for contaminants of concern and the basis for these levels (see ROD, Appendix II, Table 15);
- Manner of addressing source materials constituting principal threats (see ROD, pages iv and pages 74-75);
- Current and reasonably-anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD (see ROD, pages 29-30);
- Potential land and groundwater use that will be available at the Site as a result of the selected remedy (see ROD, pages 83-84);
- Estimated capital, annual operation and maintenance and present-worth costs; discount rate; and the number of years over which the remedy cost estimates are projected (see ROD, page 82 and Appendix II, Tables 16 and 17); and
- Key factors used in selecting the remedy (*i.e.*, how the selected remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision)(see ROD, page 89).

AUTHORIZING SIGNATURE

Walter E. Mugdan, Director
Emergency and Remedial Response Division

September 27, 2013
Date

RECORD OF DECISION FACT SHEET
EPA REGION II

<u>Site</u>

Site name:	Gowanus Canal Site
Site location:	Brooklyn, Kings County, New York
HRS score:	50
Listed on the NPL:	March 2, 2010

<u>Record of Decision</u>

Date signed:	September 27, 2013
Selected remedy:	Dredging of accumulated sediments, capping, off-Site thermal treatment of dredged nonaqueous phase liquid (NAPL)-impacted sediments in the canal and existing turning basins, in-situ stabilization of native sediments with high levels of NAPL, excavation and restoration of a portion of the filled-in former 1st Street and a portion of the 5th Street turning basin beginning underneath the 3rd Avenue bridge, stabilization of sediments not impacted by NAPL and reuse off-Site, institutional controls and combined sewer overflow controls.
Capital cost:	$285,700,000
Treatment and Disposal cost:	$216,000,000
Annual operation, maintenance, and monitoring cost:	$4,400,000
Present-worth cost:	$506,100,000

<u>Lead</u>	EPA
Primary Contact:	Christos Tsiamis, Remedial Project Manager, (212) 637-4257
Secondary Contact:	Joel Singerman, Chief, Central New York Remediation Section, (212) 637-4258
<u>Main PRPs</u>	National Grid and New York City

<u>Waste</u>

Waste type:	PAHs, PCBs and heavy metals, including mercury, lead and copper
Waste origin:	Spills/disposal
Contaminated media:	Sediments

DECISION SUMMARY

Gowanus Canal Superfund Site
Brooklyn, Kings County, New York

United States Environmental Protection Agency
Region II
New York, New York
September 2013

TABLE OF CONTENTS

SITE NAME, LOCATION and DESCRIPTION

The Gowanus Canal[1] is a 1.8-mile-long, man-made canal in the Borough of Brooklyn in New York City (NYC), Kings County, New York (see Figure 1) (see Appendix I for figures).

To facilitate the assessment and management of the canal, it was divided into three Remediation Target Areas (RTAs) that correspond to the upper reach (RTA 1), middle reach (RTA 2) and lower reach (RTA 3) (see Figure 2).

There are five east–west bridge crossings over the canal, at Union Street, Carroll Street, 3rd Street, 9th Street and Hamilton Avenue. The Gowanus Expressway and a viaduct for NYC subway trains pass over head. North of Hamilton Avenue, the canal is approximately 5,600 feet long and 100 feet wide, with a maximum water depth of approximately 15 feet in the main channel at low tide. There are four short turning basins that branch to the east of the main channel at 4th Street, 6th Street, 7th Street and 11th Street. A former turning basin at 1st Street and an extension of the 4th Street turning basin that had been referred to as the 5th Street turning basin were filled in between 1953 and 1965 (Hunter Research *et al.*, 2004). An extension of the 7th Street turning basin has also been filled. South of Hamilton Avenue, the canal widens to a maximum of approximately 2,200 feet and ranges in depth from -15 to -35 feet mean lower low water (MLLW).[2] The Gowanus Canal has no remaining natural wetlands (various small, unconnected areas of vegetation and intertidal habitat exist) or natural shoreline. The vast majority of the shoreline of the canal is lined with retaining structures or bulkheads.

The canal is located in a mixed residential-commercial-industrial area. It borders several residential neighborhoods, including Gowanus, Park Slope, Cobble Hill, Carroll Gardens and Red Hook, with housing located within one block of the canal. The waterfront properties abutting the canal are primarily commercial and industrial. Re-zoning of canal-front parcels to high density residential began in 2009 and further such re-zoning is anticipated. During major storm events, canal flooding affects broad areas which are industrial, residential and commercial in nature.

A number of businesses use the canal for maritime commerce. All but two of the businesses are located south of 9th Street and none are located north of 4th Street. The canal is also regularly used by recreational boaters (primarily, canoers and kayakers). A limited number of people reside in houseboats on the canal.

---

[1] The Site's Superfund Site Identification Number is NYN000206222. The U.S. Environmental Protection Agency (EPA) is the lead agency; the New York State Department of Environmental Conservation (NYSDEC) is the support agency.

[2] As a tidally-influenced water body, the canal has two high tides and two low tides of unequal height each tidal day. MLLW is the lower low water height of the two low tides.

Despite a New York State Department of Health fish advisory covering the entire Gowanus Canal, posted warnings and public outreach efforts, the canal is regularly used for fishing, particularly subsistence fishing by communities with environmental justice concerns surrounding the canal.

SITE HISTORY AND ENFORCEMENT ACTIVITIES

Prior to being developed, the area around the Gowanus Canal was occupied by Gowanus Creek, its tributaries and lowland marshes. Before the mid-1840s, the creek and its tributaries were dammed and used primarily to power tide mills (Hunter Research *et al.*, 2004). By the mid-1840s, Brooklyn was rapidly growing and the Gowanus marshes were considered to be a detriment to local development. In 1848, the State of New York authorized construction of the Gowanus Canal to open the area to barge traffic, flush away sewage, receive stormwater and fill the adjacent lowlands for development. The canal was constructed in the mid-1800s by bulkheading and dredging.

The former 1st Street turning basin[3] was originally utilized to deliver coal via barges to the former Brooklyn Rapid Transit Power House. The Power House consumed large quantities of coal. During its operating era, large coal piles surrounded the building until the plant became obsolete and was removed from service. As was noted above, the 1st Street turning basin was filled in. Portions of the building were also torn down over time. By 1969, the 125-foot tall smokestack and dynamo sections of the Power House had been demolished and the currently extant section of the Power House was the only part of the original building still standing.

The 4th Street turning basin extends from the main channel east to the 3rd Avenue bridge; the 5th Street turning basin originally continued east from there nearly to 4th Avenue. Both basins were completed in the early 1870s, contemporaneously with the main channel of the canal. As was noted above, the 5th Street turning basin was filled in between 1953 and 1965. A portion of that fill extends underneath the 3rd Avenue bridge into the 4th Street turning basin. Sediment has further accumulated throughout much of the 4th Street turning basin.

Following its construction, the canal quickly became one of the nation's busiest industrial waterways, servicing heavy industries that included manufactured gas plants (MGPs), coal yards, cement manufacturers, tanneries, paint and ink factories, machine shops, chemical plants and oil refineries. The Gowanus Canal served as an open sewer when it was initially constructed in the late 1860s. As a result of the poor environmental practices typical of the era, large quantities of wastes from many of these operations were discharged directly into the canal. By the late 1870s, sewers

[3] The 1st and 4th Street turning basins are described in detail since they will be addressed under the selected remedy.

entering the canal carried a combination of household waste, industrial effluent from the MGPs and other industries and stormwater runoff (Hunter Research *et al.*, 2004). These discharges, which contained hazardous substances such as polycyclic aromatic hydrocarbons (PAHs) (a semi-volatile organic compound [SVOC]), polychlorinated biphenyls (PCBs), pesticides, metals and volatile organic compounds (VOCs), caused the canal to become one of New York's most polluted waterways.

The initial canal design recognized the likelihood of stagnant pollution problems and proposed various flushing solutions. These were not, however, implemented. Studies and commissions have repeatedly examined methods of addressing the contamination. A series of unsuccessful solutions were implemented, including directing additional sewage discharges to the canal in order to improve flow. In 1911, NYC began operating the Gowanus Canal flushing tunnel to address the canal's serious water quality issues. The flushing tunnel connects the head of the canal with Buttermilk Channel in Upper New York Bay. It was designed to improve circulation and flush pollutants from the canal by pumping water in either direction. The flushing tunnel starts at Degraw Street on Buttermilk Channel and ends on the west side of the canal at Douglass Street. The flushing tunnel operated until the mid-1960s, when it fell into disrepair.

The flushing tunnel was rehabilitated and reactivated in 1999 by the NYC Department of Environmental Protection (NYCDEP), pumping cleaner harbor water from Buttermilk Channel to the canal using a rebuilt version of the 1911 propeller-based pump system. Thereafter, NYCDEP determined that the 1990s flushing tunnel repairs were inadequate, because the pumping system was poorly designed, difficult to maintain and unable to function properly at low tide.

Direct discharges to the canal from industrial activities were substantially reduced or controlled over time because of declining industrial activity and the implementation of the Clean Water Act (CWA) in the early 1970s. Discharges from present-day industrial operations are regulated and permitted under the CWA's National Pollutant Discharge Elimination System (NPDES) and its state counterpart, the State Pollutant Discharge Elimination System (SPDES).

Although the level of industrial activity along the canal declined over the years as industry shifted away from the canal, high levels of hazardous substances remain in the sediments and upland sources. Discharges from upland contaminated areas adjacent to the canal, CSOs, storm sewers and unpermitted pipe outfalls continue to contribute contaminants to the canal. The history of these sources is summarized below.

Discharges from Upland Contaminated Areas Adjacent to the Canal

Contaminated areas adjacent to the Gowanus Canal are being investigated and remediated under the direction of NYSDEC. The EPA is coordinating with NYSDEC on these matters. Environmental investigations or cleanups are underway at the former Fulton Municipal Works Manufactured Gas Plant, Carroll Gardens/Public Place (formerly known as "Citizens Gas Works") (hereinafter, "Public Place")[4] and Metropolitan former MGP facilities along the canal. Until these sites are remediated, contaminants from them will continue to be transported into the Gowanus Canal primarily by the migration of nonaqueous phase liquid (NAPL)[5] through subsurface soils and groundwater discharge of dissolved-phase contaminants. PAHs are the primary contaminants of concern (COCs) from these sources.

The former MGP facilities are being addressed under the State Superfund and Brownfield Cleanup programs by National Grid, a potentially responsible party (PRP) for both these facilities and the canal. NYC owns a large portion of Public Place and Thomas Greene Park, a portion of the site where the former Fulton MGP facility operated. Together with National Grid, NYC is a signatory to the NYSDEC Brownfields cleanup order for Public Place. As the owner of these parcels, NYC may be considered a PRP for these facilities.

The EPA and NYSDEC have agreed to a coordinated schedule for the former MGP facilities and canal sediment cleanup efforts based on the anticipated timing of the dredging in the canal (which will commence at the head of the canal). In January 2012, NYSDEC directed National Grid to begin the expedited remedial design of a cutoff wall as an interim remedial measure for the former Fulton MGP facility, near the head of the canal. The purpose of this wall is to prevent subsurface migration of NAPL from the former Fulton MGP facility into the sediments at the bottom of the canal. For the Public Place former MGP facility, centrally situated near the curve in the canal (see Figure 2), the remedy includes a combination of excavation and a subsurface barrier wall and tar extraction wells. An investigation and partial source control cleanup was implemented at the former Metropolitan MGP facility, the third and most southerly former MGP facility, in 2003 under the State's Voluntary Cleanup program. Since there are potential source areas at this site that were not addressed by the actions taken in 2003, a remedial investigation (RI)[6] for this site is currently underway.

Based on the results of the EPA's RI, additional upland areas were found to have the potential to contribute contaminated groundwater and NAPL to the canal and were

[4] A remedy was selected for the Public Place former MGP in 2007. The design of the selected remedy is approximately 50% complete.

[5] Concentrated liquid contamination, typically oil-like, that forms a separate phase and does not dissolve in water.

[6] The purpose of an RI is to determine the nature and extent of contamination at a site.

referred to NYSDEC for investigation and, if necessary, remediation under the State Superfund or other remedial program. Remediation schedules will be coordinated with the schedule for the canal remedy. Relative to the former MGP facilities, these areas are much smaller potential sources and are, thus, expected to require only a fraction of the time and cost to address.

Discharges from Combined Sewer Overflows and Stormwater

Combined sewers (sewers that receive both sewage and stormwater flows) serve 92 percent of the Gowanus Canal watershed, storm sewers serve only 2 percent and direct runoff drains 6 percent (NYCDEP, 2008a). The Owls Head and Red Hook wastewater treatment plants (WWTPs) serve the area. When an appreciable amount of rainfall occurs, runoff enters the combined sewers and exceeds the capacity of the system and the Owls Head and Red Hook combined sewer systems overflow to the canal. There are ten active CSOs and three stormwater outfalls discharging to the Gowanus Canal (see Figure 3 for the locations). Four of the CSO outfalls account for 95 percent of the annual discharge. The greatest annual discharge volume is from outfall RH-034, located at the head of the canal (121 million gallons; NYCDEP, 2008a). The CSO discharges result in point source loading of high-organic-content solids and associated hazardous substances to the canal.

In 2008, NYCDEP prepared a *Gowanus Canal Waterbody/Watershed Facility Plan Report* (WB/WS Plan) as part of its City-Wide Long-Term CSO Control Planning Project (NYCDEP, 2008a). This work is being performed under an Administrative Order on Consent (AOC) between NYCDEP and NYSDEC.[7] The goal of that project is to implement a series of improvements to achieve compliance with water quality standards under the CWA. Specific objectives of the plan include eliminating odors, reducing floatables and improving dissolved oxygen concentrations to meet surface-water-quality standards. NYCDEP's planned improvements for the Gowanus Canal include continued implementation of programmatic controls, modernization of the Gowanus Canal Flushing Tunnel, reconstruction of the Gowanus Wastewater Pump Station, cleaning/inspection of the outfall OH-007 floatables/solids trap, repairs to the Bond-Lorraine Street sewer main, periodic water body floatables skimming and CSO sediment mound dredging.

In July 2010, the flushing tunnel was shut down by NYCDEP to perform facility improvements. This effort includes the installation of more efficient pumping systems, which will increase the volume of water by approximately 40 percent under a peak design flow. The reconstruction of the Gowanus Wastewater Pump Station, which began in February 2010, will increase the pumping capacity to deliver sewage to the Red Hook WWTP. All of these ongoing improvements are projected to decrease the

[7] NYSDEC Case No. CO2-20000107-8 dated January 14, 2005 and updated on April 14, 2008, September 3, 2009 and March 8, 2012.

overall discharge to the entire canal by approximately 34 percent.

However, the greatest changes in annual CSO discharge are concentrated in the middle and lower portions of the canal. Although outfall RH-034 at the head of the canal has been projected to experience fewer discharge events per year, its total annual flow is projected to increase approximately 5 percent. Annual CSO discharges from RH-034 and OH-007 will still contribute approximately 97 percent of the total annual CSO flow into the canal.

The completion of the flushing tunnel and pump station improvements is anticipated by September 2014. The cumulative impact of these projected flow reductions and flushing improvements on sediment transport and deposition throughout the canal cannot currently be predicted with a high degree of confidence, although preliminary modeling by National Grid indicates that contaminated CSO solids will still be trapped in the canal even with enhanced flushing tunnel flow. Following the upgrades to the flushing tunnel and pump station, NYCDEP will conduct post-construction monitoring and then will begin the planning and public participation related to a CWA Long-Term Control Plan (LTCP)[8] which will analyze the next stage of CSO-related improvements for the canal. The LTCP is to be submitted to NYSDEC in June 2015.

NYCDEP also plans a sewer separation project in a 96-acre area around Carroll Street for flood control purposes. It is projected that this effort will result in an additional overall CSO reduction of 5 percent when it is completed in 2022. However, the PAHs in the stormwater component of the CSO will still discharge to the canal.

NYCDEP is also undertaking a green infrastructure effort[9] that will result in an estimated 10 percent CSO reduction in stormwater discharges to the entire canal over an extended period of time (20-30 years) (NYCDEP, 2012). Two pilot projects for the control of street runoff along the Gowanus Canal (the DL and Studio's Sponge Park at 2nd Street, on the Carroll Gardens side of the canal and the Gowanus Conservancy green infrastructure at 2nd Avenue on the Park Slope side) are being supported by federal and NYC grants.

It should be noted that NYC's sewer system operations include the treatment and disposal of hazardous substances consistent with the categorical pretreatment

[8] An LTCP is a phased approach for control of CSOs that requires a permittee to develop and submit an approvable plan that will ultimately result in compliance with CWA requirements and New York State water quality standards.

[9] Green infrastructure is a network of open spaces and natural areas, such as rooftop gardens and vegetated swales, which naturally manage stormwater, thereby reducing storm runoff into the storm sewers.

standards promulgated under 40 CFR § 430.5, which limit the pollutant discharges to publically-owned treatment works from specific process wastewaters of particular industrial categories. Various industrial facilities within NYC, including those operating within the Gowanus Canal sewerage area, have historically discharged and continue to discharge hazardous substances to the NYC sewage system. As part of its water and sewer rates, NYC charges for such disposal through the sewers. NYC has operated an Industrial Pre-treatment Program (IPP), as required by federal regulations, since 1987 in order to help protect the sewers, the wastewater treatment plants and NYC's receiving waters. As part of the IPP, NYCDEP issues permits for and inspects IPP facilities. CSO events, however, may result in the discharge of sanitary sewage and hazardous substances disposed of by non-regulated users or picked up from captured stormwater. Some of these hazardous substances tend to bind to the organic solids present in the sewage.

The WB/WS Plan acknowledges that solids associated with CSO events will continue to be discharged to the canal following implementation of the current upgrades. In response, the WB/WS Plan includes an analysis which suggests that the upgraded flushing tunnel will disperse the solids more evenly throughout the canal and into the harbor than in the past (NYCDEP, 2007a). In conducting this analysis and describing future operations, the WB/WS Plan has effectively memorialized the canal's historic role as an extension of NYC's sewer system. The canal, particularly the upper canal, has and will continue to function as a sewage retention basin. Among other things, this historic and on-going usage has created CSO mounds located at the head of the canal. The WB/WS Plan again calls for dredging these mounds, a measure which has been authorized but not implemented since 1983 (NYCDEP, 2008a).

Unpermitted Pipe Outfalls

Nearly 250 outfalls were identified and inspected during the RI, most of which were pipes located on private property. In general, these are unused pipes associated with historic industrial activities. Twenty-five of these pipe outfalls were observed to be actively discharging during dry weather (about a third of these discharges may have been tidal backflow). The flow rate from all but one of the active outfalls was very small (the majority are estimated to be less than 1 liter/minute).

Permitted Pipe Outfalls

A review of NYSDEC and the EPA databases identified five active permitted discharges to the canal. During the RI, discharges were not observed in three of these permitted outfalls. Two of the permitted outfalls could not be clearly identified because of the large number of outfalls in their vicinity.

Prior Dredging of the Canal

The canal's narrow 100-foot width upstream of the Gowanus Expressway is the entire navigational channel, unlike many river and harbor sites where the shipping channel represents a fraction of the total area of the water body. In the upper two-thirds of the canal, NYC has primary responsibility for maintaining the navigational depths.

Limited recent dredging of the canal has been performed and documentation of historical dredging is sparse. There are no federal, state or local regulatory requirements related to the depth of the canal north of Hamilton Avenue. Below Hamilton Avenue, the U.S. Army Corp of Engineers (USACE) previously performed maintenance dredging.

While NYCDEP has obtained State approvals for successive water quality improvement-related dredging (1983, 1993 and 2008), no major dredging has been performed in the canal in three decades. The current plan for dredging the CSO mounds at the head of the canal is scheduled for completion in 2017.

Prior Studies

Since 1983, NYCDEP has compiled four separate major reports on water quality and CSOs controls for the canal, each of which was approved for implementation by NYSDEC. Since 2003, the USACE and National Grid have each issued about a dozen reports regarding the canal. National Grid has completed numerous reports regarding its former MGP facilities and studies and/or cleanups have been conducted at another dozen or more upland areas.

Listing on National Priorities List

In April 2009, the Gowanus Canal was proposed for inclusion on the National Priorities List (NPL) pursuant to the Superfund law at the request of NYSDEC. Following the proposal for inclusion on the NPL, the EPA commenced an RI. On March 2, 2010, the EPA placed the Gowanus Canal on the NPL.

In April 2010, the EPA entered into administrative consent orders with NYC and National Grid to perform work in support of the EPA's RI and feasibility study (FS).[10] The draft RI report was completed in January 2011 and the draft FS report was completed in December 2011. In connection with the release of these reports, the EPA conducted significant public outreach throughout 2011 and 2012. The outreach process included numerous public meetings with formal presentations, as well as informal question and answer sessions. An FS report addendum was completed in December 2012.

[10] An FS identifies and evaluates remedial alternatives to address the contamination.

HIGHLIGHTS OF COMMUNITY PARTICIPATION

Due to the technically complex issues at the Site and the significant public interest, the EPA greatly augmented its interaction with the community beyond what is typical for the Superfund remedy selection process. Specifically, while the EPA typically releases RI/FS reports simultaneously with the Proposed Plan[11] and conducts a public meeting to discuss the results of the investigation and the basis for the preferred remedy, for the Gowanus Canal site, the RI and FS reports were released separately at the time of their respective completion in order to facilitate their review and understanding by the public. The RI report was made available on the EPA's website in January 2011 and the FS report was made available on the EPA's website in December 2011. Following the release of each of these documents, the EPA held separate public meetings in the Carroll Gardens and Red Hook neighborhoods to present the findings. These meetings were announced in the local press. Several follow-up meetings to further discuss the technical issues and the community's concerns were held at the invitation of the Gowanus Canal Community Advisory Group (CAG), the local Community Boards and other local organizations.

On December 27, 2012, a press release was issued (which generated a number of on-line articles) and a number of e-mails were sent to the Site's mailing list re-announcing the availability of the RI and FS reports and announcing the availability of an FS addendum report and Proposed Plan on the EPA's website. On December 28, 2012, the RI report, FS report, FS addendum report and Proposed Plan were made available to the public at information repositories maintained at the Community Free Library, located at the Carroll Gardens Library, the Joseph Miccio Community Center in Red Hook and the EPA Region II Office in NYC. A notice of availability for the above-referenced documents was published in the *Courier Life*, *Red Hook Star-Revue* and *The Brooklyn Paper* on January 4, 2013. Notices were published in these papers again on January 18, 2013 to announce a revised starting time for the January 23, 2013 public meeting. On January 23, 2013 and January 24, 2013, the EPA conducted public meetings at Public School 58 (the Carroll School) and the Joseph Miccio Community Center, respectively, to present the Proposed Plan for the Site, including the preferred remedy, and respond to questions and comments from the approximately 200 attendees at the January 23, 2012 meeting and 100 attendees at the January 24, 2012 meeting.

Although serious concerns were expressed about a proposed on-Site confined disposal facility (CDF)[12] for the stabilized, lesser contaminated sediments at the January 24

[11] A Proposed Plan describes the remedial alternatives considered for a site and identifies the preferred remedy with the rationale for this preference.

[12] A secure structure designed to contain dredged sediments (in this case, after stabilization) within a waterway.

meeting, there was clear overall support for the major components of the proposed remedy, similar to the support expressed during the January 23 meeting..

Prior to the release of the Proposed Plan and the commencement of the public comment period, a member of the CAG expressed concern that a 30-day comment period would be too short to provide the CAG members and other stakeholders sufficient time to provide technically well-informed comments. Accordingly, a 90-day public comment period was announced at the time of the release of the Proposed Plan.

In response to a January 28, 2013 request from NYC that the public comment period be extended 30 days, the comment period was extended to April 27, 2013.

A notice announcing the extension of the public comment period to April 27, 2013 was published in the *Courier Life*, *Red Hook Star-Revue* and *The Brooklyn Paper* on March 22, 2013.

During the comment period, in addition to the two meetings discussed above, the EPA held informational meetings with the CAG in Carroll Gardens on February 11, 2013, and again with the Red Hook community on February 13, 2013, the residents of public housing located immediately north of the canal on March 27, 2013 and the Red Hook community on April 16, 2013, the CAG on April 23, 2013 and the residents of public housing again on April 25, 2013. The purpose of these meetings was to discuss, in more detail, the specifics of the Proposed Plan and to answer additional questions from the community. With the exception of the April 25, 2013 meeting which was attended by 25 people, all of the other follow up meetings were well attended.

The public generally supports the dredging, capping and CSO abatement components of the remedy. The CAG, which is comprised of approximately 50 members representing over 30 organizations and 20 non-organizational members, passed resolutions in support of the overall remedy, including 100% CSO control. Community Board Six, a municipal entity which represents the neighborhoods surrounding the canal, submitted comments supporting the overall remedy.

While 15 businesses and approximately 700 Red Hook residents located in close proximity to the proposed location of the CDF expressed support for its construction, approximately 900 parties located in other sections of Red Hook, elsewhere in New York State and in other states expressed strong opposition to the CDF option. In addition, No Toxic Red Hook submitted two similar petitions to the EPA containing approximately 2,500 original names and signatures from business owners, residents, users of the recreation area and concerned citizens. The petitions express opposition to the processing of contaminated sediments in Red Hook and their placement in a CDF.

Although various development interests filed formal comments in opposition to nomination of the Site for the NPL in 2009, no comments were filed in opposition to the Proposed Plan by the developers who have acquired property along the canal for residential, commercial and other redevelopment purposes since the Site was placed on the NPL.

Friends of Douglass Greene Park presented the EPA with a petition with 765 parties expressing opposition to the placement of an in-line sewage/stormwater retention tank beneath the Douglass and Degraw community pool. The petition also sought an assurance from the EPA that should any disruption or displacement to the pool be necessary as a result of the remediation, the park's facilities and services would be provided at a nearby location.

NYCDEP submitted 124 pages of comments, with approximately 300 pages of attachments. When read in their entirety, NYCDEP's comments state that the CSOs do not contribute to unacceptable impacts to the canal, lengthy additional studies are needed prior to remedy selection, further NAPL controls are needed and various project complexities effectively prevent addressing the contamination in the canal. National Grid submitted 43 pages of comments and 600 pages of attachments. National Grid, in sum, agreed that a cleanup of the canal can be done, despite significant technical challenges, asserted that even greater CSO controls were warranted and advocated for less dredging than indicated in the Proposed Plan. Comments questioning various aspects of the remedy were also submitted by various other PRPs and industry-related parties. Notably, NYC was alone in stating that no further CSO controls are warranted. Industry and other PRP commenters suggested that additional CSO controls beyond those set forth in the Proposed Plan are needed for an effective cleanup.

Responses to the questions and comments received at the public meetings and in writing (letters, postcards and emails) during the public comment period are included in the Responsiveness Summary (see Appendix V).

The areas adjacent to the canal historically have been residential, commercial and industrial. It is well known that significant redevelopment is anticipated around the canal, including high density residential redevelopment along the banks of the canal that has already been approved. Therefore, it was not necessary for the EPA to solicit the public's views on reasonably-anticipated future land use. Since the area is served by municipal water and the aquifer is already designated as a drinking water source (although it is not likely that the groundwater in the vicinity of the canal will be used for potable purposes in the foreseeable future), it was not necessary for the EPA to solicit the public's views on potential future beneficial groundwater uses.

The EPA has conducted extensive community outreach during the development of the

RI/FS and Proposed Plan and is committed to maintaining a transparent, proactive community interaction process during each cleanup phase, with informal comment opportunities on all key elements of the design and implementation. The EPA is committed to working with the community to minimize short-term impacts, including any temporary disruptions to public amenities.

SCOPE AND ROLE OF THE OPERABLE UNIT

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP), at 40 CFR Section 300.5, defines an operable unit as a discrete action that comprises an incremental step toward comprehensively addressing site problems. A discrete portion of a remedial response eliminates or mitigates a release, threat of a release or pathway of exposure. The cleanup of a site can be divided into a number of operable units, depending on the complexity of the problems associated with the site.

The Site is being addressed as a single operable unit.

The EPA has the primary responsibility under CERCLA for investigating and remediating the canal sediments. By agreement between the EPA and NYSDEC, NYSDEC has the primary responsibility for the investigation and response actions related to the upland properties adjacent to the canal and the CSOs under the CWA. Addressing ongoing contaminant contributions to the canal from active sources is a prerequisite to a sustainable remedy for canal sediments.

The primary objectives of the response action are to remediate the contaminated sediments in the Gowanus Canal in order to reduce or eliminate unacceptable human health and ecological risks from exposure to the contaminated sediments, and to prevent recontamination of canal sediments after the remedy is implemented.

Contaminated groundwater that is migrating to the canal from the upland sources is being addressed by a combination of federal and state response actions. Groundwater and NAPL source areas associated with the former MGP facilities are being addressed by NYSDEC, in coordination with the EPA, under existing and anticipated MGP program response action decisions.

The EPA screened other upland source areas to identify locations where NAPL may have the potential to migrate through the subsurface into the canal. Of the areas identified through this process, the EPA currently plans to address a portion of the 1st Street turning basin and the portion of the 4th Street turning basin located underneath the 3rd Avenue bridge through this response action decision, while 400 Carroll Street[13] will be addressed through a non-time-critical removal action consistent with this response action decision.

[13] A former oil terminal facility and location of a suspected coal tar hotspot.

Additional source areas (*e.g.,* Chemtura Corp.[14] and 627 Smith Street[15]) are already being addressed under various NYSDEC cleanup programs, such as the Resource Conservation and Recovery Act (RCRA) and state Brownfields redevelopment. The remainder of the EPA-identified upland groundwater source areas have been referred to NYSDEC for further investigation. These parcels will be addressed, as necessary, in separate response action decisions under NYSDEC authority, in coordination with the EPA. If any additional groundwater contamination source areas which threaten the effectiveness of the selected remedy are later identified, the EPA or NYSDEC will address such locations, as appropriate.

The cost of response actions, such as the former MGP facilities, Chemtura and Brownfields, which are being or will be addressed through separate decision documents, are not included in this decision document.

SUMMARY OF SITE CHARACTERISTICS

Site Hydrology

The Gowanus Canal is a tidally influenced, dead-end channel that opens to Gowanus Bay and Upper New York Bay (see Figure 1). The canal experiences a semidiurnal tidal cycle (*i.e.*, two high tides and two low tides of unequal height each tidal day), with a vertical tidal range from 4.7 to 5.7 feet. The only fresh surface water inflows to the canal are wet-weather CSO and stormwater discharges. Because of its narrow width, limited freshwater input and enclosed upper end, the canal has low current speeds and limited tidal exchange with Gowanus Bay. Circulation is enhanced by the addition of water from the flushing tunnel located at the head of the canal, when it is operating (NYCDEP, 2008a).

The canal upstream of the Gowanus Expressway has been designated “Use Class SD,” which indicates that the surface waters should be suitable for fish survival, as described in Title 6 NYCRR Part 701. The area downstream of the Gowanus Expressway is designated “Use Class I,” which indicates that the waters should be suitable for finfish propagation and survival as described in Title 6 NYCRR Part 701.

Site Hydrogeology

Four geologic units (in order of increasing depth and age) lie beneath the area surrounding the Gowanus Canal:

- Fill

---

[14] A former laboratory and chemical manufacturing facility located at 633 and 688 Court Street.
[15] The former Barrett Manufacturing Co. asphalt roofing facility.

- Alluvial/marsh deposits
- Glacial sands and silts
- Bedrock

Fill materials are associated with canal construction and subsequent industrialization and regrading of the area, much of which was originally marshland. The fill consists of silts, sands and gravels mixed with ash and fragments of brick, metal, glass, concrete, wood and other debris.

The alluvial/marsh deposits lie below the fill and are composed of sands (alluvial deposits from flowing water bodies), peat organic silts and clays (marsh deposits). These alluvial/marsh deposits are associated with the original wetlands complex (*i.e.,* native sediment) that was present when the area was settled.

A thick sequence of glacial deposits occurs below the alluvial/marsh deposits. The full thickness of the glacial deposits was not penetrated in the RI, but the observed glacial deposits were composed mostly of coarser grain sediments (sands and gravel) and occasional beds of silt. These glacial sands, silts and gravel were deposited as glacial ice melted during the retreat of the last ice age. At the base of the glacial sequence lies a layer of dense clay, deposited by the glacier or prior to glaciation.

Weathered and competent bedrock underlies the glacial deposits. The bedrock consists of a medium- to coarse-grained metamorphic rock known as the Fordham Gneiss (GEI, 2005).

The primary aquifer beneath the Gowanus Canal and surrounding uplands is identified as the Upper Glacial Aquifer, which generally occurs in the thick sequence of glacial deposits but may include sandy units in the alluvial/marsh sediments. The Upper Glacial Aquifer appears to be generally unconfined, although local beds of silt and clay may confine underlying sand beds. In the Upper Glacial Aquifer, regional groundwater flows to the west/southwest toward Gowanus Bay. Groundwater-bearing zones in the fill and alluvial/marsh deposits discharge to the canal.

The canal is located within the area designated for the Brooklyn Queens Sole Source Aquifer. Groundwater is not, however, used as a potable water supply in this part of Brooklyn.

Multiple lines of evidence were developed in the RI to characterize the hydraulic relationships between local groundwater and the canal. Potentiometric surfaces developed from the synoptic (instantaneous points in time) measurement events suggest that, at the water table, groundwater flows toward the canal. Potentiometric data from intermediate wells screened in the glacial deposits depict a more complex pattern, with groundwater generally flowing upward toward the canal, which is typical of a discharge area. Data from a five-day tidal evaluation indicate that at specific locations adjacent to the canal, canal elevations at high tide consistently exceeded groundwater elevations in the shallow fill/alluvium, creating hydraulic conditions for surface water to intermittently flow into shallow aquifer sediments.

Sediment Characteristics

The sediments in the canal consist of two distinct layers. The upper layer is referred to as "soft sediment." The soft sediment has accumulated in the canal over time since the canal was last dredged. The soft sediment layer ranges in thickness from approximately 1 foot to greater than 20 feet, with an average thickness of about 10 feet. The thickest deposits are found at the head of the canal and within the turning basins. The soft sediment consists, generally, of a dark gray to black sand/silt/clay mixture that contains variable amounts of gravel, organic matter (*e.g.,* leaves, twigs, vegetative debris)[16] and trash. Odors described as "organic," "septic-like," "sulfur-like," and "hydrocarbon-like" were commonly detected in the soft sediment during the RI, as were visible sheens. The soft sediments are underlain by the alluvial and marsh deposits of the Gowanus Creek complex that were present prior to the canal's construction. These deposits are referred to as "native" sediments and consist of brown, tan and light-gray sands, silts, silty sand, sandy clay, clay and peat.

Sediment coring data produced by the EPA and National Grid document the presence of high-organic content sediments that adsorb and retain contaminants, including PAHs. Many of these sediments also contain visible sheens, indicating the presence of undissolved petroleum hydrocarbons or coal tar. Specifically, the total organic carbon (TOC) content is substantially higher in Gowanus Canal surface sediments than in the Gowanus Bay and Upper New York Bay reference area sediments, with averages of 6.4 and 2.8 percent, respectively. The high TOC content of the surface of the soft sediment reflects the impact of CSO discharges to the canal. NYCDEP has estimated the loading of biochemical oxygen demand (BOD) to the canal and noted that CSOs dominate these loadings relative to stormwater runoff (NYCDEP, 2008a). BOD is another measure of organic matter in a sample. High concentrations of organic contaminants (*i.e.,* PAHs associated with NAPL) appear to have increased the TOC measurements in some samples. Other physical characteristics of each sediment type in the Gowanus Canal and Upper New York Bay reference area (*i.e.*, grain size distribution, percent solids, sulfide concentration and bulk density) are described in the FS report.

[16] While the soft sediments are comprised of mineral grains, naturally-occurring organic material and sewage, as is noted in the "Nature and Extent of Contamination" section, below, these sediments are heavily contaminated with PAHs, PCBs, metals and VOCs.

Shoreline and Bulkhead Characteristics

NYCDEP (NYCDEP, 2008b) has documented that the shorelines of the Gowanus Canal are entirely altered. While there are areas where the shoreline consists of riprap and piers, the shorelines are dominated by bulkheads (NYCDEP, 2008b).

A bulkhead inventory performed along the entire length of the canal by Brown Marine Consulting (2000) indicated that there are four primary types of bulkheads:

- Crib-type bulkheads, which are constructed of interlocking timbers or logs that are filled with backfill to form a type of gravity retaining structure.
- Gravity retaining walls, which are built so that the weight of the wall itself provides stability.
- Relieving platforms, which consist of a deck of timber or concrete supported on piles, typically timbers or logs, at an elevation high enough above the mean low water[17] line to not require underwater construction techniques but low enough to keep the pilings continuously submerged.
- Steel sheet-pile bulkheads, which are flexible walls constructed of steel sheets with interlocking joints. The steel is capped with concrete or masonry construction. Anchorage systems prevent outward movement and consist of tie-rods and anchors (*e.g.*, structures buried inshore of the bulkhead, such as massive concrete blocks or steel sheet-piles). The bulkheads north of Hamilton Avenue are generally constructed of wood or steel.

The survey concluded that the existing structures were sufficient only to support present loading conditions and that any type of dredging activity could threaten bulkhead stability due to the deteriorated condition of the structures. The survey was based only on visual examinations of structures without physical or laboratory testing and recommended that a more thorough investigation of bulkhead integrity be performed if dredging is planned. The report also noted that an estimated 42 percent of the bulkhead length was in fair condition or worse.

Hunter Research *et al.* (2004) quantified bulkhead conditions in 2003. In that survey, they evaluated bulkhead construction and determined that approximately 73 percent of the bulkheads along the main canal and turning basins were crib-type bulkheads with timber construction. Approximately 10 percent of the bulkheads consisted of concrete or bridge abutments and 17 percent were timber or steel sheet-piling-type barriers.

Limited environmental investigations of the shoreline were conducted immediately adjacent to the canal and beyond the limits of the upland source areas. These

[17] The average of all the low water heights.

investigations revealed the presence of coal tar at certain locations in the canal bank at the same elevation as the tar in the canal. These findings suggest that tar might have migrated along the canal and re-infiltrated into the bank at locations away from the original source areas. These areas of bank-stored tar may act as secondary sources of contamination to the canal.

Areas of Archaeological or Historical Importance

In 2006, the Gowanus Canal Historic District was found eligible for the National and State Registers of Historic Places by the New York State Historic Preservation Office (SHPO).[18] The district was identified as a result of an eligibility study undertaken by Hunter Research in 2004 for the USACE. Additional contributing resources were identified by the SHPO in 2008 following a cultural resources study undertaken in response to a proposed Toll Brothers project at 363-365 Bond Street.

The EPA supplemented this information during the RI/FS. Documentary research and a high-resolution side-scan sonar survey performed for the RI identified known historic resources in the form of the canal bulkheads, as well as anomalies on the canal bottom, which will be the subject of further investigation. The variety of bulkheads reflects an evolution of technology, a varied use of materials and an effective means of maintaining the function of the canal, thus ensuring its role in the commercial development of Brooklyn.

A historical and archaeological study of the Gowanus Canal was carried out as part of the FS to assist the EPA in meeting its obligations under Section 106 of the National Historic Preservation Act and its implementing procedures (36 CFR Part 800). The study's objectives were to establish prehistoric and historic contexts for identifying and evaluating potential subsurface features of interest that may have been buried following the draining and filling of the Gowanus Creek marsh during the construction of the canal from *circa* 1853 to 1870. As part of this report, a Historic American Engineering Record (HAER) narrative history of the Gowanus Canal was prepared.

One conclusion of the study was that sites of potential archaeological interest exist within the Gowanus Canal project area. These include an area of prehistoric potential from the former 1st Street turning basin up to Degraw Street, the sites of three tide mill complexes, two corridors of battle action from the Battle of Brooklyn during the

[18] The district is a linear corridor following the canal channel from a point opposite Percival and 17th Streets extending approximately 6,500 feet northeast to a point between Douglass and Butler Streets. It includes the canal channel and bulkheads and 13 related contributing buildings and structures, sharing a context within the industrial landscape that developed adjacent to the canal following its initial phase of construction and improvement from *circa* 1853 to 1870.

Revolutionary War and two potential sites of soldier burials.

A geotechnical evaluation of soil borings indicated that the likelihood for these sites to have survived intact is very low to low but not entirely without potential. Their state of integrity is unconfirmed, but if intact, they will be deeply buried at depths of at least 15 feet at the edges of the canal, with the greatest likelihood of intact survival existing just outside of the canal bulkheads (about 20 feet from the edge of the canal). Moving away from the canal, any surviving cultural stratigraphy generally will be buried less deeply (based on documented patterns of filling in the former tidal marshes) and have a much higher likelihood of having been disturbed by more than 150 years of intensive urban development.

Of greater certainty are the survival of archaeological resources associated with the Gowanus Canal itself and the industries that grew beside it in the mid- to late 19th century. The canal and its turning basins include more than two miles of timber cribwork bulkheads that have been identified as part of the canal's historic fabric and are likely to contain important information about the canal's design and construction. Within the canal itself are the remains of at least four shipwrecks and a high likelihood that several other ship hulls have survived within the fill of the former 1st Street turning basin. Canal-side industrial archaeology sites also have the potential to yield information related to specific industries and research questions about those industries' activities and their impact on the natural and human environment.

The study also identified recommendations for further archaeological studies and considerations to be included in the remedial design in order to avoid or mitigate remedy impacts on potential archaeological resources. Recommendations for additional cultural resources work during the remedial design phase include the refinement of the archaeological "Area of Potential Effect;" targeted research on canal-related, mid- to late-19th-century industrial sites that may be impacted by ground disturbances; additional, targeted geotechnical investigation; and archaeological monitoring of the removal/stabilization of timber cribwork bulkheads with documentation of sample bulkheads. Specifically related to the recommended monitoring, the additional effort will document the design and construction of the canal's timber cribwork and include the preparation of drawings as appropriate for inclusion in a supplemental HAER documentation package. Other resources identified for monitoring include any identified potential industrial archaeological resources, maritime resources identified by side-scan sonar in 2010, and the buried ships reportedly located in the former 1st Street turning basin. Further archeological studies may be required to avoid or mitigate potential remedy impacts related to siting of CSO controls and any temporary water treatment or staging facilities.

Should the bulkheads be subject to adverse effects as a result of cleanup actions, a wide range of mitigating measures could be implemented as part of the remedy. As noted above, the appropriate measures will likely include additional documentation of bulkhead characteristics and the incorporation of archaeological and architectural investigations. Where new bulkhead construction is required, bulkhead configurations that are in keeping with the historic character of the setting will be considered.

Further examination of anomalies on and within the sediments will need to be performed as remediation proceeds. This investigation will likely encompass further remote sensing and/or direct examination of items in the canal bottom.

RESULTS OF THE REMEDIAL INVESTIGATION

Based upon an analysis of the extensive prior studies and reports that were prepared for the canal and upland areas, the following additional work was performed as part of the RI: bathymetric survey; survey of outfall features, including identifying outfall features, collecting and analyzing outfall water samples and tracing outfall features to their origin; cultural resources survey, including a bulkhead study; sediment coring; surface sediment sample collection and analysis; surface water sample collection and analysis; fish and shellfish tissue sample collection and analysis; air sample collection and analysis; CSO sediment and water sample collection and analysis; and hydrogeological investigation, which included groundwater monitoring well installation and development, soil sampling, groundwater sampling, groundwater/surface water interaction sampling, synoptic measurements of water levels and tidal evaluation.

Geophysical Surveys

The bathymetry of the canal was measured by the USACE in a January 2010 survey using the same methodology as was used in the 2003 USACE bathymetry study performed in a joint investigation with NYCDEP. The measured bottom depth elevations ranged from approximately -0.13 feet to -38 feet North American Vertical Datum 1988 (NAVD88). The bottom depth elevations measured within the canal north of Hamilton Avenue were typically between -0.13 feet and approximately -18 feet NAVD88; much lower sediment surface elevations were measured south of Hamilton Avenue. The sediment surface at the head of the canal and in the eastern ends of many of the turning basins is exposed at low tide. Evidence of propeller scour in the form of a deeper sediment surface was noted in the southern portion of the canal; this area is subject to frequent tugboat activity to move and position oil and gravel barges at the various commercial terminals near the mouth of the canal.

Debris, such as tires, sunken barges, concrete rubble, timbers, gravel and general trash, is widespread throughout the canal. A debris survey was performed in late 2005 by National Grid using magnetometer, sub-bottom profiling and side-scan sonar technologies.

The combined observations from the 2003 and 2005 geophysical surveys, 2010 side-scan sonar survey and 2010 RI field observations were used to characterize the distribution of debris and obstructions in the canal. Detailed observations are provided in the RI/FS reports.

Extent of Contamination

Sediment

The horizontal and vertical distribution of contamination in surface sediment (0-to-6-inch depth interval), soft sediment (from a depth of 6 inches below the sediment surface to the contact with the native Gowanus Creek sediments) and native sediment (*i.e.*, original Gowanus Creek alluvial and marsh deposits) were characterized on the basis of field observations and chemical analysis of sediment samples.

The canal, especially the upper reach, is a water body contained in a constructed confined space of relatively regular geometry and relatively shallow depth. Water and suspended sediments from New York Harbor enter the canal through tidal exchanges from the south end and flushing tunnel flow at the northern end. Small amounts of direct stormwater runoff from areas adjacent to the canal also drain directly into the canal. Deposition of solids in the canal from these sources constitute the "background" level of contamination *(i.e*., regional contamination with no contribution from Gowanus Canal point sources of contamination), which should be within or slightly above the range of contaminant concentrations at the reference area sampling stations in the harbor. For the harbor reference stations sampled during the RI, PAH concentrations ranged from 1 mg/kg to 14 mg/kg. See Table 1 for a summary of the range and average concentrations for harbor reference data for PAHs, PCBs, copper and lead (see Appendix II for tables). Previous studies have shown that for the entire New York/New Jersey harbor system, total PAH[19] concentrations in the sediment ranged from 0.7 mg/kg to 22.1 mg/kg (EPA, 1998). Data recently collected from candidate reference areas for the Newtown Creek Superfund site RI indicate that PAH concentrations in enclosed and semi-enclosed industrial embayments without CSOs are comparable to the reference area concentrations measured in the Gowanus Canal RI.

All other major ongoing inputs of chemical contamination to the canal are from upland point sources of contamination to the canal, including the three former MGP facilities and the CSO and stormwater outfalls.

Canal sediments are affected by contaminants that are adsorbed to sediment particles and by the upwelling and horizontal transport of NAPL, which contains PAHs. In surface sediments (0-to-6-inch depth interval), PAHs, PCBs and seven metals (barium,

[19] Total PAH is defined as the sum of detected Priority Pollutant PAHs and 2-methylnaphthalene.

cadmium, copper, lead, mercury, nickel and silver) were found to be contributing to unacceptable ecological and human health risks. Concentrations of these constituents in surface sediment were statistically significantly higher in the canal than at reference locations in Gowanus Bay and Upper New York Bay. The average total PAH concentration in surface sediment from the canal is two orders of magnitude higher than the average concentration in reference area surface sediment. Average total PAH concentrations in subsurface soft and native sediment are three orders of magnitude higher than samples from the reference area.

Subsurface sediment sampling data indicated that VOCs, particularly benzene, toluene, ethylbenzene and xylene (BTEX), and total PAHs were frequently detected at high concentrations, with PAHs detected up to 48,000 mg/kg in both the soft and native sediment units. The highest PAH concentrations were measured in samples that contained NAPL. PCBs and metals were all frequently detected in the soft sediment, but were infrequently detected or detected at lower concentrations in the native sediments. In the subsurface soft sediment, VOCs (primarily BTEX), PAHs, PCBs and metals were all detected at substantially higher concentrations than those found in the surface sediments.

Table 2 summarizes the physical characteristics of surface, soft and native sediments in the canal and surface sediment in the reference area. Table 3 shows the average concentrations of selected constituents in surface, soft and native sediments in the canal and surface sediment in the reference area. Table 4 shows the average concentrations of selected constituents in surface sediment in the upper, middle and lower reaches of the canal.

The sediment coring effort showed that NAPL contamination is present in native sediments underneath the canal and at certain locations in the banks of the canal between the head of the canal and the Gowanus Expressway, in portions of the upper reach of the canal and in the overlying soft sediment primarily in the middle reach of the canal.

The NAPL from the three former MGP facilities is, primarily, coal tar waste. Some of this waste was discharged directly into the canal during the periods when the MGPs were operating. This NAPL, being heavier than water, settled to the bottom of the canal, and a portion of it might have been transported within the canal as a result of tidal currents and the action of the flushing tunnel when it was operating. Native sediments along nearly the entire length of the canal above the Gowanus Expressway became contaminated with coal tar. In some areas, this NAPL has moved downward to substantial depths below the canal and laterally into the banks of the canal.

Additional coal tar NAPL can be found in the subsurface soils near the former MGP facilities. This is tar which escaped from the subsurface structures at the former MGP facilities and seeped into the surrounding soils. Very high levels of coal tar contamination have been found at all three of the former MGP facilities. In some locations, the pore spaces of the soils near the former MGP facilities are saturated with coal tar. It is clear that in some cases, this tar is either still mobile or could be mobilized in the future by relatively minor subsurface disturbances. PAH and BTEX compounds are major constituents of coal tar.

In most areas north of the Gowanus Expressway, NAPL and high-PAH concentrations were found in sediment to the maximum depth of the investigation activities, which was targeted to be six feet below the interface between the soft and native sediment layers. Deep borings installed in the canal adjacent to the Public Place former MGP facility by National Grid in 2010 indicate that NAPL contamination extends to a depth in excess of 50 feet below the sediment surface. Adjacent land-based borings on the former MGP facility contained visible NAPL at depths of more than 100 feet.

While the NAPL from historic MGP operations accounts for the majority of the PAH mass and the highest PAH concentrations in canal sediments, PAH concentrations in the top six inches of the sediments (the bioactive zone) in the upper reach of the canal are primarily associated with contaminants introduced through more recent CSO discharges. Existing sediments in the canal are covered by newer contaminated CSO sediments and, to some extent, solids transported from the harbor through tidal transport or through the flushing tunnel when it is in operation. Thus, generally, surface sediments are newer and deeper sediments are older.

Some ongoing movement of coal tar NAPL into shallow sediments has been documented. In the vicinity of the Public Place former MGP facility, tar droplets can occasionally be seen rising to the water surface in the canal during low tide. It appears that this tar is being transported upward through the sediments by the ebullition of gas bubbles generated by microbial decay of organic material in the sediments.

Combined Sewer Overflows

The results for wet weather CSO water samples (*i.e.*, samples collected from the sewer system during wet weather overflow events) indicate that CSOs containing VOCs, PAHs, PCBs, pesticides and metals are discharged to the canal during wet weather events. The wet weather CSO water samples represent actual discharges to the canal. Samples were collected from the combined sewer regulators, approximately one block from the discharge points, to eliminate potential backflow (tidal intrusion) from the canal. Sampling results for residual CSO sediments collected from within sewer pipes indicate that, if mobilized during wet weather events, these will discharge VOCs, PAHs, PCBs, pesticides and metals to the canal.

Unpermitted Pipe Outfalls

As noted above, more than 250 unpermitted pipe outfalls were identified and inspected during the RI; 25 of these pipe outfalls were observed to be actively discharging during dry weather. Effluent from 14 of the 25 active outfalls identified during the RI could not be attributed to tidal drainage (*i.e.*, drainage of seawater that entered the pipe at high tide). Samples from 12 of these 14 outfall discharges contained VOCs, PAHs and metals (two of the discharges were not sampled due to low flow rates). Pesticides and PCBs were not detected. Contaminant loading from unpermitted outfalls was estimated to be very low since observed pipe discharges were intermittent and at very low flow rates (estimated to be less than 1 liter per minute). Based on these estimates and measurements (according to NYCDEP's 2008 study), these loadings are insignificant by comparison to other sources, such as the CSOs and the flushing tunnel.

Surface Water

VOCs, SVOCs and metals were detected in surface water samples collected from the canal under wet-weather and dry-weather conditions for the RI. Pesticides and PCBs were not detected in any surface water sample. BTEX compounds were the most common VOCs detected and PAHs were the most common SVOCs detected. Concentrations of contaminants, including benzene and PAHs in the Gowanus Canal surface water samples were significantly higher than their concentrations at the Gowanus Bay and Upper New York Bay reference locations during both dry- and wet-weather conditions.

High levels of bacteria are also present in the canal as a result of periodic discharges from the combined sewer outfalls. Although not considered for CERCLA remedy selection purposes, risk to child and adult recreational users and workers from CSO-related pathogen exposure is a significant issue, as was outlined in the draft Gowanus Canal Public Health Assessment.

Ambient Air

The sampling results for air samples collected from canoe-level and street-level locations along the length of the canal and from three background locations (two blocks west of the canal) indicate that the types and concentrations of VOCs and PAHs detected in air samples were similar, regardless of sample location. The detected constituents were typical of those found in urban environments and the VOC and PAH concentrations were either within the same order of magnitude (sampling round 1) or the same as those found in urban environments (sampling round 2).

Groundwater

Groundwater samples were collected from 44 shallow and 46 intermediate monitoring wells. With the exception of PCBs, all classes of contaminants that were sampled for (VOCs, SVOCs, PCBs, pesticides and metals) were detected in samples from both the shallow and intermediate groundwater throughout the length of the canal (PCBs were not detected in any of the sampled monitoring wells). Chemical concentrations in the groundwater were higher in wells where NAPL saturation was observed in the soil borings. VOC concentrations were higher than screening values in approximately 33 percent of the shallow monitoring wells and 67 percent of the intermediate monitoring wells along the canal. Similarly, SVOC concentrations were higher than screening values in approximately 33 percent of the shallow monitoring wells and in half of the intermediate monitoring wells. Pesticides, however, were detected in only one shallow monitoring well and in one intermediate monitoring well and exceeded the screening value at the intermediate monitoring well location. With regard to metals, all of the shallow and intermediate monitoring wells contained at least one metal (arsenic, barium, lead, nickel or sodium) above its screening value.

For the shallow groundwater, a number of PAHs (2-methylnaphtalene, acenaphthene, acenaphtylene, anthracene, fluoranthene, fluorine, naphthalene, phenanthrene and pyrene) were found in more than half of the collected shallow groundwater samples and 93.2% of all samples contained at least one PAH. The compounds that showed the most excursions of various applicable standards were the VOCs benzene, ethylbenzene, isopropylbenzene and xylene. The same general pattern is true for the intermediate groundwater with 98% of all intermediate groundwater samples containing at least one PAH.

The EPA analyzed the groundwater data to determine whether contaminated groundwater discharge to the canal could potentially lead to continuing sediment contamination. This evaluation was performed by calculating Equilibrium-Partitioning Sediment Benchmark Toxic Units (TUs) for PAHs in each groundwater sample collected along the canal during the RI. Briefly, the TUs were calculated by comparing PAH concentrations in groundwater samples to their corresponding Final Chronic Values (FCV) based on the EPA's National Water Quality Criteria (EPA, 2003). These FCVs represent the concentrations of the PAHs in water that are considered to be protective of the presence of aquatic life.

Estimates of total PAH mass flux were calculated. The analysis used both the median and mean concentrations for each RTA and the RTA-specific groundwater discharge rates and pore water concentrations provided by National Grid. The resulting estimates of total PAH flux to the canal, which are presented in Table 5, exhibit a wide variation in PAH discharge rates, ranging from 19 to 1,500 kilograms/year. The estimate developed using the mean groundwater concentration is significantly higher than the median groundwater concentration and both the median and mean pore water concentrations, but is not considered representative because it is biased by a few high values. The estimated mass discharge calculated using the median pore water concentration is considered the most representative of the four values. These concentrations represent the equilibrium PAH concentrations in near surface sediment associated pore water throughout the canal and are indicative of what may actually be fluxing into the surface water. Further, the data set includes a wide range of pore water concentrations, and has appropriate spatial coverage, including several samples in the central, most contaminated portion of the canal. Based on these data, the magnitude of the groundwater flux of total PAHs to the canal is relatively low compared to other sources.

Contaminant Fate and Transport

The conceptual site model (CSM)[20] for the Gowanus Canal summarizes and integrates the information presented above about historical and ongoing sources of contamination, the nature and extent of contamination, contaminant fate and transport mechanisms and risks to humans and wildlife from exposure to contaminated sediments in the Gowanus Canal. A schematic representation of the CSM for the Gowanus Canal is provided in Figure 4. This CSM is used as the basis for developing remedial action objectives (RAOs)[21] and remedial alternatives for canal sediments.

The EPA did not independently develop a hydrodynamic model as part of the RI/FS. Instead, the results of hydrodynamic modeling performed by the USACE for the Gowanus Bay and Canal Ecosystem Restoration Study (*i.e.,* maps showing velocities and shear stresses throughout the canal under existing conditions) were considered in the development of the CSM. The model results were used in conjunction with other data-based lines of evidence (*e.g.,* contaminant concentration gradients, bathymetric changes over time, sediment physical characteristics, radioisotope profiles, historical documentation about siltation in the canal) to develop the CSM. The results of three-dimensional hydrodynamic and sediment transport modeling recently performed by National Grid were also considered; these results are consistent with the data-based CSM developed for the RI/FS. While the CSM developed for the RI/FS is sufficient to establish the basis for a remedial action, additional data collection and modeling will be useful to confirm the CSM and prepare the remedial design.[22]

[20] A conceptual site model illustrates contaminant sources, release mechanisms, exposure pathways, migration routes and potential human and ecological receptors.

[21] RAOs, which are developed after site characterization, are specific goals to protect human health and the environment.

[22] In connection with its CWA compliance, NYCDEP developed a three-dimensional, time-variable, coupled hydrodynamic/water-quality model. Since NYCDEP has declined requests to provide its model to the EPA, the EPA has not been able to assess it.

Sediment Transport and Deposition

Many of the contaminants detected in canal sediments (*e.g.*, SVOCs, PCBs, high molecular weight PAHs and metals) have a low solubility and an affinity for fine-grained sediment particles and organic matter. Contaminants with a higher solubility and volatility (*i.e.*, VOCs and some of the low-molecular-weight SVOCs) tend to disperse in the water column. Therefore, the accumulation of soft sediments in the canal over time has resulted in the accumulation of high levels of persistent contaminants. Because of low current velocities and limited tidal exchange with Gowanus Bay, the contaminated sediments have accumulated in the canal rather than being flushed out to the bay. Bathymetric survey data indicate that one to three feet of sediment was deposited in the upper canal between 3rd Street and Sackett Street between 2003 and 2010. The upper canal is the reach most affected by the deposition of solids from CSO discharges. Radioisotope analyses of sediment cores from other areas of the canal (*i.e.*, south of 3rd Street) indicate net sediment accumulation rates on the order of one to two inches/yr (GEI, 2007), although most of the cores that were dated showed evidence of disturbances that reduce the accuracy of the age-dating estimates.

Since many of the contaminants that are present at high levels in the Gowanus Canal soft sediments have an affinity for fine-grained sediment particles and organic matter, the fate and transport of these contaminants are largely controlled by the fate and transport of the sediments. Sediments deposited in Gowanus Canal may be re-suspended by currents, propeller wash, dredging and other disturbances. The canal is a low-velocity environment, with average current velocities less than 0.5 feet per second. These current speeds are insufficient to substantially erode sediment deposits. Currents generated by the flushing tunnel apparently erode sediments near the outlet of the tunnel, but the sediments are most likely to settle out where the current velocities decrease farther down the canal between Sackett and 3rd Streets.

Sediments in the Gowanus Canal appear to be frequently re-suspended and mixed by propeller wash from vessel traffic. The effects of propeller wash are particularly evident in the reach between the Gowanus Expressway and 3rd Street, where minimal net sediment accumulation was observed between 2003 and 2010. This reach experiences frequent tugboat and barge traffic associated with the concrete plant at the end of 5th Street. Evidence of propeller scour was also seen near the southern end of the Gowanus Canal (*i.e.,* north of Bryant and 22nd Streets) in the 2010 bathymetric survey. Substantial sediment disturbance also can result from vessel groundings. High resolution bathymetric surveys performed by National Grid in 2010 and 2011 indicated that a barge grounding near the mouth of the 4th Street basin in 2011 resulted in the displacement of up to 10 feet of sediment.

Given the low current velocities in the canal, most of the sediments re-suspended by propeller wash likely settle out in the same reach of the canal. Finer-grained sediment particles that remain suspended in the water column for a longer period of time may, however, be transported out of the canal by tidal currents and dispersion. The amount of sediment transported out of or into the canal in typical weather conditions or during storm events has not been measured. However, a substantial drop in contaminant concentrations in surface sediments from the middle reach of the canal to the lower reach and the additional drop from the lower reach of the canal to the Gowanus Bay and Upper New York Bay reference locations indicate that much of the contaminated sediment remains within the canal, north of the Gowanus Expressway. Contaminated sediments that are transported out of the canal are mixed with and diluted by suspended sediments from New York Harbor.

Contaminated Solids Impacts from Combined Sewer Overflows

Contaminated CSO solids impacts are most apparent in the upper reach of the canal because the outfall at the head of the canal (RH-034) is the single largest contributor to CSO discharges. Solids from CSO discharges are transported down the canal and deposited as the velocity from the CSOs dissipates with increasing distance from the head of the canal. Currents from the flushing tunnel, when operating, may facilitate transport, but also dissipate with increasing distance from the head of the canal. This is consistent with NYCDEP's conclusions in its 2008 WB/WS Plan: "Historical discharges by CSOs and stormwater have impacted almost the entire canal bottom." In that report, NYCDEP concluded that "CSOs dominate the loadings of . . . total suspended solids . . . to Gowanus Canal," and that discharges from the outfall at the head of the canal (RH-034) "dominate the CSO impacts throughout the entire Canal."

Hazardous substance levels in surface sediments in the upper reach are less influenced by releases from the former MGP facilities than surface sediments in the middle reach. The sediments in the upper reach are less susceptible to re-suspension by propeller wash from vessel traffic or vessel groundings, due to the low levels of such traffic in the upper reach. As noted previously, bathymetric studies from 2003 to 2010 indicate that one to three feet of sediment was deposited between 3rd and Sackett Streets. These shallow sediments were deposited after the period of greatest industrial activity in the canal and are, therefore, more predominantly influenced by CSO and stormwater discharges than by legacy contamination from historical industrial activity.

Other sources of solids to the upper reach of the Gowanus Canal include inflow from Buttermilk Channel through the flushing tunnel (when it is operating) and tidal advection/dispersion from Upper New York Bay through Gowanus Bay at the south end of the project area (when the flushing tunnel is not operating). A portion of the suspended sediments in these inflows settles in the canal as the current velocities decrease to slack tide.

The mass of solids delivered by each source (CSO/stormwater discharges and inflow from Upper New York Bay) was not quantified in the RI/FS or in the water quality model developed by NYCDEP for its CSO control planning, although NYCDEP included modeling of TSS and separated TSS into outfall and background (*i.e.,* Upper New York Bay) components to distinguish between the heavier, more-settleable solids discharged from sewers and the lighter, less-settleable solids suspended in receiving waters (NYCDEP, 2007).

The EPA has concluded that multiple lines of physical and chemical evidence demonstrate that CSO and stormwater solids have a significantly greater influence on the quality of sediments in the 0-2-foot depth interval in the upper reach of the canal than incoming sediments from Upper New York Bay. These lines of evidence include:

- Contaminated CSO solids[23] have high TOC content. The TOC content of the surface sediment is about 6 percent. The TOC levels in Upper New York Bay sediments are, on average, about 3 percent (EPA, 1998 and the RI report). Accordingly, if suspended sediments in tidal inflow or flushing tunnel flows from Upper New York Bay were contributing the majority of the deposited mass, the TOC of the surface sediment would be closer to 3 percent.
- The concentrations of PAHs, copper and lead in the surface sediment and in the CSO solids are similar. The concentrations of these chemicals are much lower in the reference sediments in the harbor; therefore, deposition of suspended sediments in harbor water (or from the flushing tunnel which brings in harbor water) could not be the predominant source of PAHs, copper and lead in the canal surface sediments.
- Sewage indicators, such as fecal coliform (GEI, 2011a, 2012a and 2012b) and steroids (Kruge *et al.*, 2007), are found consistently in the surface sediment in the canal. The highest concentrations are located in the upper portion of the canal where most of the CSOs are located.
- The EPA's bathymetric study shows that most of the accumulation of sediment coincides with the canal location (upper reach) where most of the CSOs are located and the highest CSO volumetric discharges take place. It has been reported and visually noted that CSOs discharge heavier mass solids. These heavier solids are typically expected to settle to the bottom of the canal within a short distance from the point of discharge unless high horizontal velocities disperse the solids downstream.
- Overall, the surface sediments in the upper canal have higher sand content and lower silt and clay content than the Harbor reference locations. The sediments in the lower canal, closer to the Harbor, have similar silt and clay content to the reference stations. This indicates that the upper canal surface sediment is more influenced by the deposition of contaminated CSO solids than the area near the

[23] Contaminated CSO solids are the particles that are discharged to the canal during overflow events, whereas CSO sediment is the residual material found in the sewer pipes.

mouth of the canal. This is consistent with NYCDEP's conclusion that CSOs predominately contribute heavy grain sediments, while fine grain sediments are a mixture of CSO discharges and flushing tunnel and harbor tidal contributions.

The multiple lines of evidence summarized above strongly support the conclusion that surface sediment contaminant concentrations in the upper reach of the canal are significantly influenced by the accumulation of CSO solids. As a result, the EPA has concluded that the contaminated CSO solids are a source to the canal which must be controlled as part of this selected remedy. As discussed in further detail below, the estimated range of contaminated CSO solids control in the selected remedy incorporates an uncertainty factor which will be addressed during the remedial design. Further refinement of the sediment and contaminant mass balance is constrained by the constant variability in inputs, including the frequency, size and nature of storm events and infrastructure changes, such as the flushing tunnel and pump station upgrades, planned sewer separation project and on-going development. The EPA's CERCLA remedial design will be informed and refined by the results of additional sampling and modeling, as well as by coordination with NYSDEC and NYCDEP as they gather Post Construction Monitoring (PCM) data developed in accordance with EPA CSO guidance in advance of the LTCP submittal to address CWA compliance.

Nonaqueous Phase Liquid Fate and Transport

NAPL in the canal sediments can be transported upward through the sediments into the water column through several transport mechanisms, including ebullition, seep migration, sheen migration and groundwater advection. Ebullition is the production of gas due to anaerobic biological activity in sediment (Viana *et al.,* 2007a). Mineralization[24] of organic matter by bacteria in the sediment generates gases such as methane, nitrogen and carbon dioxide which cause ebullition (Reible, 2004). Ebullition is commonly observed in the soft sediments in the Gowanus Canal, which are rich in organic matter. The bubbles produced during ebullition tend to accumulate hydrophobic contaminants and colloids, such as NAPL sheen, on their surfaces (Viana *et al.*, 2007b). NAPL can then migrate through sediments and be adsorbed onto more newly deposited sediments or out of the sediment and upward through the water column and be deposited on the water surface as a sheen.

The EPA performed additional research on the potential for ebullition in the canal (EPA, 2013). The analysis concluded that ebullition is likely limited to the soft sediment, with RTA 1 and RTA 2 having the highest ebullition potential based on several factors:

- RTA 1 and RTA 2 had the highest TOC in the canal. Across all three reaches, the TOC in soft sediments was 4.2 to 15 times greater than the TOC in the native

[24] Mineralization is the decomposition or oxidization of the chemical compounds in organic matter into plant-accessible forms.

sediment.

- Shallower water depths reduce the hydraulic pressure that sequesters ebullition.
- NAPL droplets have been observed attached to gas bubbles rising to the water surface at the Public Place former MGP facility on numerous occasions. This process appears to reach its maximum in late summer, when the decay of organic matter in the canal sediments would be expected to reach its maximum. Upon reaching the surface, some of the NAPL generates a sheen which rapidly spreads on the water surface. In one extreme case, the entire canal water surface between Public Place and the 9^{th} Street bridge was covered.

A NAPL seep is defined as a NAPL discharge when one or more of the following occur:

- NAPL is moving under a sustained gradient.
- A source that provides the driving force is located at some distance from the seep.
- A recent or ongoing release is typically associated with the discharge.
- NAPL saturations are above residual levels.

Although NAPL seeps can migrate with groundwater through sediments that are not impacted by NAPL (*i.e.*, where NAPL is not coating the solid particle surfaces and occupies the smaller pore spaces), NAPL tends to migrate more readily through sediments previously impacted with NAPL (*i.e.,* NAPL is coating the solid particles). (Sale, 2011). Data from the former MGP facilities show that NAPL elevations are above the sediment elevation and that NAPL seep migration is occurring.

An analysis of NAPL impacts at the interface between native and soft sediments in the Gowanus Canal suggests that the hydrodynamic force from groundwater discharge is occurring at some locations. An analysis presented in the FS report indicates that upward groundwater velocities can potentially result in the upward NAPL migration under certain conditions.[25] This is essentially because the upward vertical groundwater velocity appears to be sufficient to overcome the downward density and capillary forces of the NAPL.

The EPA performed additional studies in early 2013 to determine if NAPL in native sediment could migrate upward from hydrodynamic force (EPA, 2013). It is concluded from the studies that low groundwater discharge velocities can mobilize NAPL upward in the more impacted areas of the canal.

"NAPL sheen" is defined as a NAPL discharge when one or more of the following

[25] The general Site conditions were used to approximate the potential for NAPL migration. The actual conditions at specific locations can vary substantially. Additional data collection and evaluation will be necessary to verify NAPL mobility at specific locations for purposes of remedial design.

occur:

- A very limited amount of oil is discharged as a sheen on the water surface.
- Ephemeral sheen behavior may be observed.
- Former seeps have occurred.
- NAPL saturations are close to or below residual levels.

NAPL sheens migrate as a result of the difference in the surface tensions that result in a positive spreading coefficient. In the upland area, NAPL spreads on the surface of the groundwater in the same way as the surface water sheen. In this way, the NAPL sheen spontaneously enters water-coated, air-filled pores on the surface of the water table and the NAPL migrates. The sheens may migrate into the canal where the groundwater surface intersects the canal. Sheens can also be transported to the canal in street runoff, originating in areas where vehicle maintenance activities are taking place or near petroleum handling facilities where delivery trucks are cleaned.

Droplets of NAPL can also be transported along the length of the canal by tidal currents and redeposited in areas some distance from the points where they originally entered the canal. Some transport of discrete NAPL droplets occurs in the canal, particularly in the vicinity of the Public Place former MGP facility. These droplets can be seen on the canal bottom, and can be moved along the bottom and redeposited by the same transport processes that control movement of solid sediment particles.

Overall, NAPL seep migration is considered the primary mechanism through which NAPL enters the canal from the former MGP facilities. A secondary source of potential seeps is NAPL that has migrated into the canal and re-infiltrated into the bank at certain locations other than the original source areas. Once in the sediment, hydraulic forces can drive the NAPL from the native sediment upward to the soft sediments. In the soft sediments, the hydraulic force continues, but ebullition increases the mobility of NAPL upward into the surface water.

CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

Land Use

The canal is located in a mixed residential-commercial-industrial area. The waterfront properties abutting the canal are primarily commercial and industrial. Rezoning of several canal-front parcels in the upper canal to high density residential occurred in 2009. In March 2013, NYC approved the Lightstone Group's development plans for 700 rental units on these parcels. Construction is anticipated to begin in fall 2013. NYC has also entered into a public-private partnership called Gowanus Green to construct 774 units of high density mixed income housing on NYC-owned portion of the Public Place former MGP facility. NYC postponed an area-wide rezoning effort as a result of the NPL nomination. However, further rezoning and land use changes have continued during the Superfund process. For example, a hardship rezoning was approved in February 2013 for a Whole Foods market on two canal-side parcels. Construction is under way, with an anticipated completion in fall 2013. In response to the on-going development pressures, Community Board Six formally requested that NYC restart the area-wide re-zoning process.

Through Community Board Six, the community has also received a grant from the New York State Department of State's (DOS's) Brownfield Opportunity Area (BOA) Program for a study to promote reuse and redevelopment of under-used properties in two large sections along the canal. Governmental participants in the ongoing BOA study include NYSDOS, NYSDEC, NYC Department of City Planning, the Mayor's Office of Environmental Remediation and the EPA.

As a result of development speculation, numerous parcels have been acquired along and near the canal for potential residential and commercial uses in anticipation of the cleanup and further rezoning. Public use along and on the canal is expected to increase significantly over time due to NYC waterfront zoning requirements which mandate public esplanades at redevelopment sites along the canal. Such esplanades are under construction or planned at the Whole Foods, Lightstone Group and Gowanus Green projects. In addition, moderate–to--large-scale commercial activities, such as outdoor nightclubs and flea markets, have operated or sought permits to operate at canal-side parcels.

The canal is regularly used by commercial barges at several facilities along the mid- and lower canal. Recreational boaters, primarily, canoers and kayakers, frequent the canal. A public boat launch where canoes are available is located at 2nd Street. This boat launch will be incorporated into the Lightstone Group project. The anticipated remediation and redevelopment will likely increase recreational boating use. A limited number of people reside in houseboats on the canal.

Despite posted warnings, the canal is regularly used for fishing, particularly subsistence fishing by several separate communities with environmental justice concerns surrounding the canal. A NYCDEP survey of residents indicated that fishing is the number one canal use by area residents (NYCDEP, 2008).

Groundwater Use

The area is served by municipal water. Local groundwater is not used in NYC as a source for potable public water, therefore, a completed exposure pathway does not exist. Additionally, the NYC Department of Mental Health and Hygiene has strict regulations regarding the installation of wells or the use of groundwater for any purpose.

SUMMARY OF SITE RISKS

The human health risk assessment (HHRA) for the Gowanus Canal evaluated potential current and future risks to recreational users, anglers, residents and industrial workers in and near the canal. The HHRA evaluated the potential human risks from exposure to surface water, sediment, ambient air and ingestion of fish and shellfish (crabs). The Gowanus Canal has no remaining natural wetlands (various small, unconnected areas of vegetation and intertidal habitat exist) or natural shoreline (the shoreline consists of bulkheads, riprap and piers). The community of potential ecological receptors using the canal includes fish-eating birds; dabbling ducks; invertebrates such as worms, amphipods and mollusks; and crabs and fish. The potential ecological risk to these receptors from exposure to surface water and sediment in the canal was evaluated in the ecological risk assessment (ERA).

Human Health Risk Assessment

A four-step human health risk assessment process was used for assessing Site-related cancer risks and noncancer health hazards. The four-step process is comprised of:

Hazard Identification: In this step, the chemicals of potential concern (COPCs) at the Site in the various media (sediment, surface water and air) are identified based on factors such as toxicity, fate and transport of the contaminants in the environment, concentrations of the contaminants in specific media and bioaccumulation. The contaminated media, concentrations detected and concentrations utilized to estimate potential risk and hazards for the chemicals of concern (COCs) at the Site are presented in Table 6.

Exposure Assessment: In this step, the different exposure pathways through which people might be exposed to the COPCs in the various media identified in the previous step are evaluated. Examples of exposure pathways include incidental ingestion of and dermal contact with contaminated surface water and sediment. The exposure pathways that were evaluated are presented in Table 7. Factors relating to the exposure assessment include, but are not limited to, the concentrations in specific media that people might be exposed to and the frequency and duration of that exposure. Using these factors, a "reasonable maximum exposure" scenario, which portrays the highest level of human exposure that could reasonably be expected to occur, is calculated.

Toxicity Assessment: In this step, the types of adverse health effects associated with chemical exposures and the relationship between magnitude of exposure and severity of adverse effects are determined. Potential health effects are chemical-specific and may include the risk of developing cancer over a lifetime or other noncancer health hazards, such as changes in the normal functions of organs within the body (e.g., changes in the effectiveness of the immune system). Some chemicals are capable of causing both cancer and noncancer health hazards. The toxicity values that were used to evaluate noncancer health hazards are presented in Table 8 and the toxicity values that were used to evaluate cancer risk are presented in Table 9.

Risk Characterization: This step summarizes and combines outputs of the exposure and toxicity assessments to provide a quantitative assessment of Site risks for all COPCs. Exposures are evaluated based on the potential risk of developing cancer and the potential for noncancer health hazards. The likelihood of an individual developing cancer is expressed as a probability. For example, a 10^{-4} cancer risk means a "one-in-ten-thousand excess lifetime cancer risk (ELCR)"; or one additional cancer may be seen in a population of 10,000 people as a result of exposure to Site contaminants under the conditions identified in the Exposure Assessment. Current Superfund regulations for exposures identify the range for determining whether remedial action is necessary as an ELCR of 10^{-4} to 10^{-6}, corresponding to a one-in-ten-thousand to a one-in-a-million excess cancer risk. For noncancer health effects, a "hazard index" (HI) is calculated. The key concept for a noncancer HI is that a threshold exists below which noncancer health hazards are not expected to occur (an HI less than 1 would indicate the threshold is not exceeded and a noncancer health hazard is not expected). These acceptable risk levels are defined in the NCP at 40 CFR 300.430(e)(2)(I)(A). Chemicals that contribute to a cancer risk that exceeds 10^{-4} or an HI to a specific target that exceeds 1 are typically those that will require remedial action at the Site.

The HHRA was conducted to evaluate the potential human health risks associated with direct contact (incidental ingestion and dermal contact) with surface sediment and surface water in the Gowanus Canal, ingestion of fish and crabs, direct contact (incidental ingestion and dermal contact) with sediment and surface water that overtop the canal during extreme tidal or storm surge conditions, and inhalation of volatile emissions from the canal into the ambient air near the canal.

For an adult, an adolescent and a child using the canal for recreational purposes, the risks associated with exposure to surface water and surface sediment (from exposed and near-shore locations) in the canal and from ambient air at canal level while swimming, boating, fishing or crabbing were evaluated. The HHRA assumed that recreational use/swimming in the canal would occur at frequencies, durations and exposures that are typical of most water bodies, even though the current actual use of the canal is likely lower given its current nature. The total reasonable maximum exposure (RME) noncarcinogenic hazard associated with exposure to surface water and sediment for all recreational users was within the EPA's acceptable risk levels (Table 10). However, exposure to surface water and sediment by recreating adults (3×10^{-4}), adolescents (2×10^{-4}) and children (8×10^{-4}), and lifetime recreational users (recreational users throughout their life as child, adolescent and adult; 1×10^{-3}) may result in a carcinogenic risk above the EPA's target risk range (Table 11). These risks are associated primarily with exposure to carcinogenic PAHs in the surface water and the surface sediment.

The risks associated with exposure to surface water and surface sediment from canal overflow and ambient air at street level were evaluated for residential adults and children and for industrial workers. RME noncarcinogenic hazards and carcinogenic risks associated with exposure to these media by the industrial worker are within acceptable levels. Exposure to surface sediment from canal overflow was above the EPA's target risk range (2.0×10^{-4}) for the lifetime resident (resident exposed during full life during childhood, adolescence and adulthood).

Although not considered for CERCLA remedy selection purposes, a screening level risk assessment for CSO pathogens that was performed by National Grid found significant risk to child and adult recreational users and workers from CSO-related pathogen exposure.

Exposure to ambient air at street level was within acceptable levels. The RME carcinogenic risk for the adult/child resident exceeding acceptable levels is associated with carcinogenic PAHs in sediment (with a smaller contribution from surface water).

Risks associated with ingesting fish and crabs from the Gowanus Canal were evaluated for adult, adolescent and child subsistence and recreational anglers.[26] The RME total noncarcinogenic hazards and/or carcinogenic risks for all receptors exceeded the EPA's acceptable levels as shown in Tables 10 and 11. Table 12 compares the risks associated with fish ingestion for recreational anglers and subsistence fishermen. The noncarcinogenic hazards and carcinogenic risks are associated with PCBs in fish and crabs. Because PAHs normally metabolize quickly in fish, the fish tissue samples were not analyzed for PAHs. To assess whether the canal's high levels of PAHs pose a risk in a scenario where PAHs were not metabolized before consumption, PAHs in fish tissue were estimated assuming that fish tissue concentrations of PAHs are similar to the concentrations of PAHs in crab tissue. The resulting estimated carcinogenic risks from ingestion of PAHs in fish were below the EPA's acceptable risk range. The concentrations of PCBs in the canal fish and crab samples were higher than the PCB concentrations in the reference area samples collected from Gowanus Bay and Upper New York Bay. However, the PCB concentrations in the reference samples would also result in noncarcinogenic hazards and carcinogenic risks above the EPA acceptable risk range, although lower than in

[26] The HHRA assumed fishing/crabbing and ingestion of the fish/crab from the canal at typical recreational angler fish/crab consumption rates. The FS report addendum provided a supplemental evaluation of subsistence fishing.

samples from the canal.

Ecological Risk Assessment

The overall ERA for the Site consisted of a combined screening level ecological risk assessment (SLERA) and baseline ecological risk assessment (BERA) performed in accordance with the EPA's (1997) *Ecological Risk Assessment Guidance for Superfund* and its updates. The survival and reproduction of the following receptor groups were selected for evaluation:

- Benthic (sediment)-dwelling macroinvertebrate communities.
- Water-column-dwelling aquatic life communities.
- Avian wildlife (aquatic herbivores, aquatic omnivores and aquatic piscivores).

The following summarizes the risk analysis and results for each receptor group based on data reported in the BERA.

Risks to benthic macroinvertebrate communities were evaluated primarily through the use of laboratory-based sediment bioassays (*i.e.*, toxicity tests), which were conducted with two sediment-dwelling invertebrates (amphipods and polychaetes) and through the comparison of sediment chemical concentrations to literature-based screening benchmarks. The analyses indicate the following:

- Sediment bioassays indicate a Site-related potential for adverse effects to benthic communities from chemicals in sediment, with the greatest potential for adverse effects occurring in the central portion of the canal, where contaminant levels are highest. The bioassay results also indicate the potential for less severe, but Site-related adverse effects to the benthic community at several other locations scattered throughout the canal.
- Chemical analysis indicates the presence of organic chemicals (primarily, PAHs and PCBs) and metals in sediment at concentrations that are likely to be causing the adverse effects observed in the sediment bioassays. The highest concentrations of those chemicals were detected primarily in the central portion of the canal, which coincides with the locations where the most severe effects to the sediment bioassay organisms were also observed.
- PAHs were consistently detected in sediment at the highest concentrations relative to their ecological screening benchmarks and are considered to represent the greatest Site-related risk to the benthic community. Other chemicals, most notably PCBs and seven metals (barium, cadmium, copper, lead, mercury, nickel and silver), were also detected at concentrations above their ecological screening benchmarks and at concentrations above those detected in reference area sediments and are also considered to represent a potential Site-related risk to the benthic community.

Risks to water-column-dwelling aquatic life communities were evaluated primarily through the comparison of surface water chemical concentrations to literature-based screening benchmarks. The surface water was sampled during both dry and wet (*i.e.,* while CSO outfalls were discharging) periods. Chemical concentrations in surface water indicate very little Site-related potential for adverse effects to water-column-dwelling aquatic life.

Risks to avian aquatic wildlife were evaluated by modeling the potential exposure of these receptors to chemicals ingested in food items including prey (*e.g.*, fish and crabs) and through the incidental ingestion of sediment. The analyses indicate the following:

- There is a potential risk to aquatic herbivores (represented by black duck) from exposure to PAHs. PAHs were detected on-Site (in sediments) at concentrations above those detected in reference area locations and represent a Site-related risk to aquatic herbivores.
- There is a potential risk to avian omnivores (represented by heron) from exposure to mercury and selenium. Mercury was the only metal that was frequently detected both in fish and crab tissues at elevated concentrations and that was also detected in canal sediments at a concentration above those detected in reference area locations. Although the BERA concluded that mercury poses a Site-related risk to omnivorous birds, additional analysis of the sediment and tissue data collected for the RI indicates that mercury levels in the Gowanus Canal are similar to those in the Gowanus Bay and Upper New York Bay reference areas. Therefore, risks to avian omnivores was dropped from further consideration.
- There is no potential unacceptable risk to avian piscivores, such as the double-crested cormorant, from the ingestion of fish in the canal.
- As indicated in the human health section, PAHs were not analyzed in fish tissue. Using an assumption that fish tissue concentrations of PAHs are similar to the concentrations of PAHs in crab tissue, food web modeling shows no unacceptable risk from PAHs to avian wildlife from the consumption of fish.

Uncertainties

The procedures and inputs used to assess risks in this evaluation, as in all such assessments, are subject to certain uncertainties for both the HHRA and the BERA.

Human Health Risk Assessment Uncertainties: The sampling conducted along the canal for use in the HHRA focused on areas where contact with the canal is most likely to occur (shallow and exposed sediment and surface water and air samples collected from similar locations) to estimate the most realistic exposure and risk to humans. Additional surface water and surface sediment samples were collected from locations where historic operations and discharges to the canal have most likely occurred. Only the surface sediment samples from the exposed and shallow areas were used to evaluate the recreational exposure risks, as this is the sediment that these receptors are most likely to contact. All of the surface water samples were included in the recreational scenario evaluations, since the receptors could be exposed to the water throughout the canal while boating. All of the surface water and surface sediment samples were used to evaluate risks to the residential and industrial worker receptors associated with exposure to canal overflow water and sediment. Therefore, the available data were evaluated in the HHRA in data groupings for each receptor group to estimate the more likely reasonable maximum exposures and risks for each receptor. The uncertainty associated with the data analysis is minimal. All of the data were validated prior to being used in the HHRA, and a data quality evaluation was performed on all analytical data evaluated in the HHRA.

A few constituents (mainly pesticides) were not detected in any of the fish or crab tissue samples but had detection limits above the human health risk-based screening level. This may result in slightly underestimating the risk associated with ingestion of fish and crab. However, it should be noted that risks above acceptable levels were identified for the fish and/or crab tissue and risks were primarily associated with the PCBs detected in the fish and crab tissue. The pesticides, when they were detected in the fish and crab tissue, did not contribute significantly to the risk. A comparison of data collected from the canal to data collected from the reference locations was not used to identify the COPCs for the canal media. This may result in including COPCs related to background conditions in the risk estimates. All of the canal data were screened against residential screening levels to select the COPCs. The use of residential screening levels is conservative, as not all the scenarios evaluated in the HHRA are residential (*i.e.,* the industrial worker scenario). This may result in including COPCs with small contributions to overall risk estimates.

The exposure factors used for quantifying exposure were conservative and reflect upperbound assumptions (RMEs). The reliability of the values chosen for the exposure factors also contributes substantially to the uncertainty of the resulting risk estimates. The most conservative recreational scenario (swimming) was used to evaluate potential exposure and risks for recreating adults, adolescents and children. Based on the current conditions of the canal, it is likely that this is an overestimate of actual exposure to recreational receptors. Although possible, it is not likely that a current recreational receptor would swim in the canal for 26 days per year for 2.6 hours per day. For the purposes of the risk assessment, the angler population was defined as those individuals who consume self-caught fish from the Gowanus Canal at least once per year, in the absence of a fishing ban or fish consumption advisories. While the risks associated with subsistence fishing would be expected to be higher than for a recreational angler, since actual consumption rates for subsistence fisherman were unknown, they had to be estimated. Sources of uncertainty in the PCB concentrations in fish used in the assessment include the fact that concentrations were averaged over location and weighted by species. The weighting of species intake in order to derive an average exposure point concentration in fish is a source of uncertainty because there are limited Site-specific data available to estimate the species ingestion preferences (*e.g.,* weighting factors). Cancer risks and noncancer health hazards were not specifically quantified for subsistence anglers or other subpopulations of anglers who may be highly exposed. There is some degree of uncertainty as to whether these subpopulations have been adequately addressed in the risk assessment. Reported cooking losses vary considerably among numerous studies. However, little information is available to quantify personal preferences among anglers for various preparation and cooking methods and other related habits (such as consumption of pan drippings). The assumption that there is no loss of PCBs during cooking or preparation, used in the RME cancer risk and noncarcinogenic hazard calculations is conservative and could overestimate cancer risks and noncarcinogenic hazards, depending on how the fish are prepared. The sediment/skin adherence factor represents the amount of sediment that adheres to skin and is available for dermal exposure. Because this value is likely to vary based on one's activity, the values used for this parameter, which are estimates from single activities, are somewhat uncertain.

For dermal contact with canal sediments, published adherence factors for adults gathering reeds and for children playing in wet soils were used as a surrogate for recreational children and adults and children. Although it is somewhat uncertain whether these scenarios are representative of contact with canal sediments, they appear to be a reasonable use of available data.

Commercial PCB mixtures tested in laboratory animals were not subject to prior selective retention of persistent congeners through the food chain, so there is a potential that carcinogenic risks and noncarcinogenic hazards have been underestimated. However, since the cancer slope factors (CSF) are based on animal exposures to a group of PCB mixtures (*i.e*., Aroclor 1260, 1254, 1242 and 1016) that contain overlapping groups of congeners spanning the range of congeners most often found in environmental mixtures, this source of potential uncertainty is unlikely to have a significant impact. The fact that any previous exposures (either background or past consumption of contaminated fish) may still be reflected in an individual's body burden today is an additional source of uncertainty, and may result in an underestimate of noncarcinogenic health hazards. The risk assessment assumed that people would consume both the combined muscle (edible portion) and hepatopancreas from blue crab. This may result in an overestimation of risk, as many crabbers do not consume the hepatopancreas, and some chemicals, such as PCBs and mercury, accumulate in the hepatopancreas. However, the hepatopancreas is small compared to the edible portion of the fish and, therefore, although concentrations may be higher in the hepatopancreas, it contributes a small amount of the total amount of crab consumed by the receptor. Therefore, it would not significantly change the total amount of contaminants consumed.

Dioxin-like PCB toxicity equivalent (TEQ) concentrations, non-dioxin-like PCB concentrations and total PCB concentrations were calculated for each sample using detected PCB congeners only. In general, if the nondetected dioxin congeners were included in the sample concentration calculations, the non-dioxin-like PCB concentrations and the total PCB concentrations would be similar to those used in the risk assessment and the resulting risks would not differ significantly. The dioxin-like PCB TEQ concentrations would not always be similar, since if the most toxic congener (3,3',4,4',5-pentachlorobipheny) was not detected in a sample, inclusion of this congener at the detection limit times the toxicity equivalency factor (TEF) would contribute significantly to the dioxin-like PCB TEQ, even if it was not detected. Therefore, this may result in an underestimation of actual risk if this congener was present in the sample at a concentration below the reporting limit. However, when this congener was detected in a sample, it was generally flagged as detected below the reporting limit, so it is unlikely that it would be present in the samples at concentrations similar to reporting limits, and it would likely be present at much lower concentrations and not contribute significantly to the dioxin-like PCB TEQ concentration for the sample. Additionally, congeners that were detected in a laboratory or field blank at a concentration similar to that in the sample were not included in the concentration calculation. There were a number of such samples, which may result in an underestimation of risk if these congeners are present in the samples at a concentration below the blank contamination level. However, the concentrations in these samples were generally below the reporting limits.

There are inherent limitations and uncertainties associated with estimating health risks on the basis of fish and crab consumption that should be considered when interpreting the results of the HHRA. Factors contributing to these uncertainties include game fish and blue crab ranges are not limited to the canal, but reflect cumulative uptake from all areas they traverse. Blue crab and some of the game fish species kept by anglers have relatively large home ranges, and those caught within the canal are likely, at least in part, to have inhabited areas outside the canal and therefore to have been potentially exposed to contaminants not related to the canal. However, differences between canal and reference concentrations of PCBs in fish and crab tissue and sediment were identified, with canal media having higher concentrations. Assumptions regarding fishing/crabbing frequency and fish/crab consumption rates are variable and affect the estimates of exposure and associated risk.

There is uncertainty associated with the noncarcinogenic toxicity factors. The EPA applies several uncertainty factors (UFs) to extrapolate doses from animal studies to humans. The UFs for the COPCs range from 1 to 3,000. Therefore, there is a high degree of uncertainty in the noncarcinogenic toxicity criteria based on the available scientific data. The noncarcinogenic toxicity factors used in the HHRA are expected to be overestimates of actual toxicity.

CSFs and inhalation unit risk factors developed by the EPA represent upper-bound estimates. Carcinogenic risks generated in this assessment should be regarded as an upper-bound estimate on the potential carcinogenic risks. The true excess lifetime cancer risk is likely to be less than the predicted value. Use of provisional or withdrawn toxicity factors increases the uncertainty of the quantitative hazard and risk estimates. Provisional toxicity values were used in the HHRA to provide a quantitative estimate rather than a merely qualitative risk discussion. The TEFs used to adjust the concentrations of the dioxin-like PCB congeners to TEQ of dioxin for the sediment and fish/crab also results in uncertainty in the risk assessment. In particular, although the TEF scheme and TEQ methodology is intended primarily for estimating exposure and risk through ingestion, it was also used to estimate exposure and risk through dermal contact.

Additionally, not using the dioxin-like PCB congener TEQ to evaluate noncarcinogenic risks may underestimate the noncarcinogenic hazard associated with exposure to the PCBs. However, there is a lot of uncertainty with use of this process, and even more uncertainty with use of it for noncarcinogenic hazards since the TEFs are based on the relationship of the PCB congeners to the carcinogenic risks associated with dioxin. Although, there is a large degree of uncertainty associated with use of this method for noncarcinogenic-hazard evaluation, noncarcinogenic hazards were estimated as part of the uncertainty evaluation. Noncarcinogenic hazards were calculated for the dioxin-like PCB TEQ concentrations for sediment and fish/crab using the reference dose (RfD) for 2,3,7,8-TCDD from the 1998 dioxin Agency for Toxic Substances and Disease Registry (ATSDR) toxicity profile. It should be noted that use of this RfD in itself presents a source of uncertainty, as the ATSDR toxicity profiles are a Tier 3 source of toxicity information.[27] Noncarcinogenic hazards were calculated for the non-dioxin-like PCB concentrations using the RfD for Aroclor 1254. The sum of the noncarcinogenic hazards associated with the dioxin-like PCB TEQ concentrations and the non-dioxin-like PCB concentrations for all receptors for sediment and fish/crab are below 1 and in most cases are less than the noncarcinogenic hazards associated with the total PCB concentration, which were estimated using the total PCB concentrations and the RfD for Aroclor 1254. Therefore, evaluation of the noncarcinogenic hazards for the dioxin-like PCB TEQ concentrations does not change the conclusions of the HHRA.

Ecological Risk Assessment Uncertainties: Uncertainties are present in all ERAs because of the limitations in the available data and the need to make certain assumptions and extrapolations based upon the collected information. In addition, the

[27] OSWER Directive 9285.7-53, Human Health Toxicity Values in Superfund Risk Assessments, December 5, 2003, recommends a hierarchy of toxicological sources of information for which risk assessors initially consider for site-specific risk assessments: Tier 1, EPA's Integrated Risk Information System; Tier 2, EPA's Provisional Peer Reviewed Toxicity Values and Tier 3, additional EPA and non-EPA sources of toxicity information with priority given to those sources of information that are the most current.

use of various models (for example, uptake and food web exposure models) introduce some associated uncertainty depending on how well the model reflects actual conditions. The primary uncertainties in the BERA for the Gowanus Canal are associated with the media sampled and the assumptions used in the risk analysis. Information on the eco-toxicological effects of constituent interactions is generally lacking, which requires (as is standard for ERAs, in general) that the constituents be compared individually to screening values. This could result in an underestimation of risk (if there are additive or synergistic effects among constituents) or an overestimation of risks (if there are antagonistic effects among constituents). For sediment and tissue, total PCB, dichlorodiphenyltrichloroethane and PAH concentrations were calculated and evaluated instead of addressing the individual compounds from these groups. In some cases, the detection limit for some non-detected chemicals exceeded applicable risk thresholds. The potential for risks associated with these chemicals cannot be fully evaluated and the risks associated with these chemicals may be underestimated.

There is some uncertainty as to whether chemical concentrations in fish and crab tissues can be attributed to the Gowanus Canal. The blue crabs and many of the fish species that were sampled represent transient populations that are only seasonally present in the canal. The body burden of these species is, therefore, likely to reflect chemical concentrations accumulated both from the Gowanus Canal and other locations.

Uncertainties related to the risk analysis include assumptions associated with modeling. Constituent concentrations in aquatic food items (*e.g.,* aquatic plants) were estimated by multiplying measured sediment concentrations by bioconcentration factors (BCFs) and were not directly measured in actual tissue (food). Therefore, the use of generic, literature-derived BCFs introduces some uncertainty into the resulting estimates. There is also some uncertainty associated with the receptors selected for the food web exposure assessment. Due to the urbanized setting and structure of the canal and surrounding area, only a limited number of upper trophic level receptors are expected to utilize this aquatic habitat. Therefore, it was assumed that the species most representative of the range of potential feeding groups using the canal included the green heron (omnivore), double-crested cormorant (piscivore) and black duck (herbivore). It was assumed that higher trophic level receptors received 100 percent of their dose from the Site. Assuming 100 percent of food and potential exposure is derived from the canal in the BERA is likely to overestimate actual risk. Data on the toxicity of some constituents to the upper trophic level receptor species were sparse or lacking, requiring the extrapolation of data from other wildlife species or from laboratory studies with non-wildlife species. Extrapolating is a typical limitation for ERAs because so few wildlife species have been tested directly for most constituents. The uncertainties associated with toxicity extrapolation were minimized by selecting the most appropriate test species for which suitable toxicity data were available. The factors considered in selecting a test species to represent a receptor species included taxonomic relatedness, trophic level, foraging method and similarity of diet.

This BERA considered multiple lines of evidence when evaluating the potential for adverse effects to the assessment endpoints that were evaluated. For example, risks to the benthic-dwelling community were evaluated using the results of two sediment bioassays along with chemical analytical data. Although the use of multiple lines of evidence does not eliminate the uncertainties inherent to the evaluation of ecological risk, it helps to substantiate the general outcomes and conclusions of the BERA. General agreement in the different lines of evidence evaluated for each of the ecological receptors increases the level of confidence in the final conclusions made in the BERA.

Summary of Human Health and Ecological Risks

The HHRA indicated completed human risk exposure pathways with unacceptable risk levels for surface water/sediment contact and fish consumption.

Human exposure to hazardous substances in surface water and surface sediment by recreating adults, adolescents and children may result in carcinogenic risks above the EPA's target risk range. These risks are associated primarily with exposure to carcinogenic PAHs in the surface water and the surface sediment. The total noncarcinogenic hazard for this pathway was within or below the EPA's acceptable risk levels.

Human exposure to surface water and surface sediment from canal overflow by residential adults and children may result in carcinogenic risks above the EPA's target risk range. The RME carcinogenic risk for the adult/child resident is associated with PAHs in sediment (with a smaller contribution from surface water).

The RME total noncarcinogenic hazards and/or carcinogenic risks for angler adult, adolescent and child receptors exceed the EPA's target risk range. The noncarcinogenic hazards and carcinogenic risks are associated with PCBs in fish and crab. The concentrations of PCBs in canal fish and crab samples were higher than the PCB concentrations in the reference area samples collected from Gowanus Bay and Upper New York Bay.[28] The HHRA showed that risk for airborne exposure from the canal was within the acceptable range.

Although not considered for CERCLA remedy selection purposes, a screening level risk assessment for CSO pathogens that was performed by National Grid found significant risk to child and adult recreational users and workers from CSO-related

[28] As was noted previously, the PCB concentrations in the reference samples also result in noncarcinogenic hazards and carcinogenic risks above the EPA's target risk range.

pathogen exposure.[29] By reducing CSO discharges, the selected CERCLA remedy will produce the tangential benefit of reducing pathogen exposure levels.

The key results of the BERA indicated that PAHs, PCBs and metals in the sediment are toxic to benthic organisms. PAHs represent the greatest Site-related risk to the benthic community. PCBs and seven metals (barium, cadmium, copper, lead, mercury, nickel and silver) were also detected at concentrations that are associated with potentially unacceptable risk and are significantly higher than those detected in reference area sediments. The observed toxicity in laboratory tests could have resulted from the effects of one or a combination of these contaminants. The toxicity test results cannot be used to distinguish which contaminants were causing the effects, although the results for simultaneously extracted metals/acid volatile sulfide (SEM/AVS) analyses presented in the BERA indicate that the bioavailability of metals is low; thus, it is likely that PAHs caused a significant portion of the observed toxicity in laboratory tests. However, potential Site-related risk to the benthic community from metals cannot be dismissed. PAHs were found to be a potential risk to aquatic herbivores (represented by the black duck) and mercury was found to be a potential risk to avian omnivores (represented by the heron).

Basis for Action

Based upon the quantitative human-health risk assessment and ecological evaluation, the EPA has determined that actual or threatened releases of hazardous substances from the Site, if not addressed by the response action selected in this ROD, may present a current or potential threat to human health and the environment.

REMEDIAL ACTION OBJECTIVES

As was noted above, RAOs are specific goals to protect human health and the environment. These objectives are based on available information and standards, such as applicable or relevant and appropriate requirements (ARARs), to-be-considered guidance, Site-specific risk-based levels and background (*i.e.,* reference area) concentrations.

The following RAOs were established for the Site:

- Reduce the cancer risk to human health from the incidental ingestion of and dermal contact with PAHs in sediment during recreational use of the canal or from

[29] Elevated HIs calculated for pathogens in National Grid's HHRA indicate an unacceptable risk of gastroenteritis from recreational contact with canal surface water, including light use contact. Therefore, the HHRA identified a significant risk to a child and adult recreational visitor from exposure to pathogens in canal surface water. See GEI, 2012a.

exposure to canal overflow to levels that are within or below the EPA's excess lifetime cancer risk range of 10^{-6} to 10^{-4}.

- Reduce the contribution of PCBs from the Gowanus Canal to fish and shellfish by reducing the concentrations of PCBs in Gowanus Canal sediment to levels that are within the range of Gowanus Bay and Upper New York Bay reference concentrations.
- Reduce the risks to benthic organisms in the canal from direct contact with PAHs, PCBs and metals in the sediments by reducing sediment toxicity to levels that are comparable to reference conditions in Gowanus Bay and Upper New York Bay;
- Reduce the risk to herbivorous birds from dietary exposure to PAHs.
- Eliminate the migration of NAPL into the canal so as to minimize NAPL serving as a source of contaminants, primarily PAHs, to the canal.

Preliminary Remediation Goals

Because there are no promulgated standards or criteria that apply to the cleanup of contaminated sediments in New York,[30] Site-specific, preliminary remediation goals (PRGs) for sediments in the Gowanus Canal were developed. PRGs are used to define the extent of cleanup needed to achieve the RAOs. A "clean" surface will be established at the bottom of the Gowanus Canal at the end of remedy construction. The PRGs will be used as performance targets for this "clean" surface.

It should be noted that for the following reasons, the PRGs that are being presented are unique to the Gowanus Canal. The canal, especially the upper portion, is a water body contained in a constructed confined space of relatively regular geometry and relatively shallow depth. The canal receives surface water and suspended sediment from New York Harbor through tidal exchanges from the south end of the canal and through flushing tunnel flow at the northern end.[31] Deposition of solids in the canal from the harbor and direct stormwater runoff from exposed soil, historic fill and rooftops will constitute the background level of contamination that should be within or slightly above the range of contaminant concentrations at the reference harbor sampling stations. As was noted above, the range of PAH concentrations in samples from the

[30] New York's Technical Guidance for Screening Contaminated Sediments (NYSDEC, 1999) states the following: "Sediments with contaminant concentrations that exceed the criteria listed in this document are considered to be contaminated and potentially causing harmful impacts to marine and aquatic ecosystems. These criteria do not necessarily represent the final concentrations that must be achieved through sediment remediation. Comprehensive sediment testing and risk management are necessary to establish when remediation is appropriate and what final contaminant concentrations the sediment remediation efforts should achieve."

[31] The flushing tunnel connects the head of the canal with Buttermilk Channel in Upper New York Bay.

harbor reference stations collected during the RI is 1 to 14 mg/kg. The post-remediation level of contamination that would be expected in the Gowanus Canal after all of the major canal-related sources of contamination have been reduced or controlled is likely to be at the upper end of the range because of ongoing contributions from uncontrolled surface water runoff and stormwater discharges. Data recently collected from candidate reference areas for the Newtown Creek Superfund site RI indicate that PAH concentrations in enclosed and semi-enclosed industrial embayments without CSOs are comparable to the reference area concentrations measured in the Gowanus Canal RI.

Human Health

Risk-based human health PRGs were developed to address the identified Site risk using information developed from the HHRA. PRGs were developed for six carcinogenic PAHs for exposure to near-shore surface sediment during recreational use of the canal by adults, adolescents and children. PRGs were not included for surface water because the concentrations of carcinogenic PAHs in canal surface water are not significantly different than concentrations in the Gowanus Bay and Upper New York Bay reference area. PRGs were calculated based on the Site-specific exposure data presented in the HHRA. The ratio between the target risk and the calculated risk was determined for each PAH and then the ratio was multiplied by the exposure point concentration from the HHRA to calculate the PRG. A 10^{-5} target risk level was used for each individual PAH so that the cumulative risk from exposure to all carcinogenic PAHs would not exceed 10^{-4}, which is the upper bound of the EPA's acceptable risk range. Additional PRGs were developed based on a cumulative cancer risk of 10^{-6}, which is the lower bound of the EPA's acceptable risk range. The PRGs for the recreational use scenario for sediment and surface water are presented in Table 13.

PRGs were not developed to address potential risk from exposure to sediment deposited adjacent to the canal after overflow events because sediment remediation based on the recreational use scenario would also address potential risks from canal overflow.

The HHRA results indicated potentially unacceptable risk from the consumption of PCB-contaminated fish and crabs from the Gowanus Canal. However, game fish and blue crabs do not forage solely in the canal and the PCB concentrations in their tissues reflect cumulative uptake from all of the areas that they inhabit. Therefore, the objective is to reduce the contribution of PCBs from the Gowanus Canal to fish and crab tissue by reducing the concentrations of PCBs in Gowanus Canal sediments to levels that are within the range of Gowanus Bay and Upper New York Bay reference concentrations. The maximum concentration in reference area surface sediment was selected as the PRG (see Table 13).

Ecological

PRGs were developed for the protection of benthic (sediment-dwelling) organisms and herbivorous birds. The PRGs and their basis are presented below.

<u>Protection of the Benthic Community</u>

PRGs for the protection of benthic organisms were derived from a graphical analysis based on the Site-specific toxicity test and co-located sediment chemistry data collected for the RI. Concentrations of PAHs, PCBs and metals (barium, cadmium, copper, lead, mercury, nickel and silver) were greater than screening values in many samples as shown in Table 14. The observed toxicity in laboratory tests could have resulted from the effects of one or a combination of these contaminants. The toxicity test results cannot be used to distinguish which contaminants were causing the effects, although the results for SEM/AVS analyses presented in the BERA (EPA, 2011a) indicate that the bioavailability of metals is low; thus, it is likely that PAHs caused a significant portion of the observed toxicity in laboratory tests. Therefore, target areas for remediation were developed based on PRGs for total PAHs and then checked to verify that the potential for adverse effects from exposure to PCBs and metals were also addressed.

Sediment toxicity data are available for two test species: a polychaete (*Nereis virens*) and an amphipod (*Leptocheirus plumulosus*). Survival and growth of the polychaete and survival, growth and reproduction of the amphipod were measured in sediment samples from 17 locations, five of which represented Gowanus Bay and Upper New York Bay reference conditions. Laboratory control sediment was also used in each test. Because greater responses were seen in the amphipod tests, only those results were used to derive PRGs. The incidence of amphipod toxicity in bioassays using canal sediment was also consistently observed in toxicity tests conducted by National Grid (GEI, 2011; GEI, 2012a and GEI 2012b) and NYCDEP (NYCDEP, 2013).

Both graphical and statistical approaches were used to derive a PRG for PAHs. Regression analysis was attempted, but the confidence intervals around the PRG estimates were large, indicating high variability of the dose-response relationships. Therefore, the EPA relied on the graphical approach and the regression analysis was used only to verify the PRGs that were developed using the graphical approach.

Using graphical analysis, two alternative potential PRG calculation approaches for total PAHs that represent different levels of protection were determined through graphical analysis of toxicity test results (*i.e.*, examination of plots of total PAH concentration versus toxicity for each station tested). The first potential PRG was determined by inspecting the graph of the dose-response relationships and identifying the lowest observed adverse effect concentration (LOAEC). The second potential PRG was determined by selecting the concentration immediately below the LOAEC, which is the greatest no observed adverse effect concentration (NOAEC). The potential PRGs based on the NOAEC ranged from 39 mg/kg for amphipod survival to 7.8 mg/kg for amphipod growth and reproduction. Potential PRGs based on the LOAEC for total PAHs ranged from 67 mg/kg for amphipod survival to 14 mg/kg for amphipod growth and reproduction.

Because of the sample size and the variability of the Site-specific dose-response relationships, there is uncertainty in the NOAECs and LOAECs identified above for each endpoint. This uncertainty was addressed using the following approach:

- Identify all potential NOAECs and LOAECs from the Site-specific data using graphical analysis.
- Normalize the potential NOAECs and LOAECs for TOC content because organic carbon is a key parameter influencing PAH bioavailability and the TOC content of samples from the key stations varied.
- Calculate the geometric means of the TOC-normalized NOAECs and LOAECs.
- Convert the geometric means of the TOC-normalized NOAECs and LOAECs to a dry weight basis using the mean canal-wide surface sediment TOC concentration of 6 percent.

The NOAEC represents the concentration assumed to not cause adverse effects based on the Site-specific data. The LOAEC represents the lowest concentration associated with measureable effects. The threshold where effects start can be assumed to fall between those two concentrations. This threshold is commonly calculated at the geometric mean of the NOAEC and LOAEC. Therefore, the PRG for total PAHs was calculated as the geometric mean of the LOAEC and the NOAEC (see Table 15).

Additional data and analyses from the RI were considered in evaluating the efficacy of the PRGs. Site-specific bioavailability of PAHs is important in interpreting sediment toxicity test results. The bioavailability and potential toxicity of total PAHs in Gowanus Canal sediments were evaluated using the Equilibrium-Partitioning Sediment Benchmark Toxic Unit approach (described in EPA, 2003a), which estimates the bioavailable and potentially toxic fraction of the total PAHs in the bulk sediment. The results indicate that the PAHs are generally bioavailable and potentially toxic in the canal samples. These results are consistent with recent sediment pore water sampling results presented in *Sediment and Surface Water Sampling Winter Report for the Gowanus Canal Superfund Site* (GEI, 2011). Calculated toxic units based on PAHs measured in sediment porewater samples show that PAHs are bioavailable and potentially toxic throughout the canal.

The RI also identified metals as contributing to unacceptable ecological risks to benthic organisms. Based on measured concentrations in sediment, copper and lead were identified as the metals most likely associated with adverse effects. However, geochemical analyses (*i.e.*, SEM/AVS) indicate that these metals currently are minimally bioavailable and should not cause toxicity. However, metals may become bioavailable in the future if geochemical conditions in the canal change and do not favor the formation of insoluble sulfides. Therefore, PRGs for copper and lead are necessary in the event that metals become bioavailable and toxic in the future. The maximum Gowanus Bay and Upper New York Bay concentrations for the reference stations that showed no toxicity were selected as the PRGs for copper and lead (see Table 15).

Protection of Herbivorous Birds

The BERA found unacceptable risks to herbivorous birds through dietary exposure to PAHs. A total PAH PRG for protection of herbivorous birds was derived using the food web model developed for the BERA. The model was used to estimate the total PAH concentration in sediment that would not pose an unacceptable risk to water fowl eating aquatic plants in the Gowanus Canal.

Preliminary Remediation Goals for Protection of Ecological Community

PRGs for the protection of the ecological community for the post-remedy clean surface are summarized in Table 15. The PRGs will be used as performance standards for the post-remedy “clean” surface.

The PAH PRG of 20 mg/kg is specific to this Site; it is based on a Site-specific risk analysis. As a comparison, it is also within the range of published and commonly accepted sediment quality values for PAHs (Ingersoll *et al*., 1996; Long and Morgan, 1991; MacDonald, 1994 and Swartz, 1999). While not intended for use as PRGs, these values have been shown to be broadly predictive of sediment toxicity. Refined techniques for directly measuring PAH toxicity and assessment methodology continue to develop (*e.g.,* Burgess, 2009). Data recently collected from candidate reference areas for the Newtown Creek Superfund site RI indicate that PAH concentrations in enclosed and semi-enclosed industrial embayments without CSOs are comparable to the reference area concentrations measured in the Gowanus Canal RI. As was noted above, the EPA evaluated toxicity tests conducted by National Grid in 2011 and 2012 and by NYCDEP in 2013 and concluded that amphipod toxicity was consistently observed in all of these bioassays using Gowanus Canal sediment.

The comparison of PAH concentrations in sediment to the PRGs shows that the entire soft sediment column throughout the project area needs to be addressed. In addition, PAH concentrations in the majority of native sediment underlying the soft sediment north of the Gowanus Expressway also exceed the PRGs. Additionally, NAPL is present in native sediment north of the Gowanus Expressway to at least the maximum depth investigated in the RI (*i.e.,* generally 6 feet below the interface between soft and native sediments). NAPL saturation was not observed in the native sediment south of the Gowanus Expressway.

The EPA has adopted the PRGs identified above as the final Remediation Goals (RGs) for the Site.

SUMMARY OF REMEDIAL ALTERNATIVES

CERCLA Section 121(b)(1), 42 U.S.C. Section 9621(b)(1), mandates that remedial actions be protective of human health and the environment, cost-effective, comply with ARARs and utilize permanent solutions, alternative treatment technologies and resource recovery alternatives to the maximum extent practicable. Section 121(b)(1) also establishes a preference for remedial actions which employ, as a principal element, treatment to reduce the volume, toxicity or mobility of the hazardous substances, pollutants and contaminants at a site permanently and significantly. CERCLA Section 121(d), 42 U.S.C. Section 9621(d), further specifies that a remedial action must attain a level or standard of control of the hazardous substances, pollutants and contaminants, which at least attains ARARs under federal and state laws, unless a waiver can be justified pursuant to CERCLA Section 121(d)(4), 42 U.S.C. Section 9621(d)(4). Remedial alternatives are described below for the sediment and source control.

Sediment Alternatives

Detailed descriptions of the remedial alternatives for addressing the contaminated sediments can be found in the FS report. Seven dredging and capping remedial alternatives were considered in the FS report:

- Alternative 1: no action.
- Alternative 2: partially dredge soft sediment and cap with isolation layer and armor layer.
- Alternative 3: partially dredge soft sediment and cap with treatment layer, isolation layer and armor layer.
- Alternative 4: dredge entire soft sediment column and cap with isolation layer and armor layer.
- Alternative 5: dredge entire soft sediment column and cap with treatment layer, isolation layer and armor layer.
- Alternative 6: dredge entire soft sediment column, stabilize top 3–5 feet of native sediment in targeted areas and cap with isolation layer and armor layer.
- Alternative 7: dredge entire soft sediment column, stabilize top 3–5 feet of native sediment in targeted areas and cap with treatment layer, isolation layer and armor layer.

Alternatives 1, 5 and 7 were retained for further development and detailed evaluation; Alternatives 2, 3, 4 and 6 were screened out for the following reasons: Alternatives 2 and 3 include only partial removal of the soft sediment column. Although it may be possible to cap soft sediments which are stable in their composition and aquatic environment, the soft sediment column within the canal does not exhibit these characteristics. The column is subject to decomposition due to its organic nature, which is highly influenced by contaminated CSO solids, and subject to disturbance from vessels, tidal and weather conditions, and flushing tunnel operation. Capping extremely soft, fine-grained sediments with high water content poses technical challenges due to the sediments' low bearing capacity (USACE, 2000). Evaluation of geotechnical data submitted by National Grid in 2013 showed that capping on top of native sediment would be much more reliable than capping on soft sediment due to settlement. Contaminant levels deeper within the soft sediment column are generally greater due to older historic discharges and the influence of NAPL infiltration. Partial removal would therefore leave a large volume of impacted sediments with a broad range and high levels of residual contamination. Ebullition potential from partially leaving the high organic content soft sediments would still exist, increasing the risks of cap failure. Partial removal would also result in shallower cap depth, increasing cap damage potential from navigation. Complete soft sediment removal will eliminate mobility of those hazardous substances. Following removal, the soft sediment can be treated. This is consistent with CERCLA's statutory preference for actions in which treatment permanently and significantly reduces the volume, toxicity or mobility of the hazardous substances.[32] Given these risk management considerations, all of the soft sediment would need to be removed in order to ensure that the remedy will be protective of human health and the environment.

Alternatives 2, 4 and 6 include installation of a two-layer cap, with isolation and armor layers. These alternatives were not retained because an armored sand cap is not sufficient to control the long-term flux of NAPL and dissolved-phase contaminants.

While the temporary draining of all or portions of the canal to facilitate implementation of the remedy was considered, it was ruled out for the entire canal for several reasons: removal of canal water could induce canal wall and bottom instabilities due to increased exerted pressures; draining of the canal for remedy implementation would limit remedial and commercial barge access and conflict with the current configuration for CSO and stormwater discharges; and odor control for such a large area of dewatered sediments would be difficult.

Factors which determine the necessary depth of dredging include the extent of

[32] "Remedial actions in which treatment which permanently and significantly reduces the volume, toxicity or mobility of the hazardous substances, pollutants, and contaminants is a principal element, are to be preferred over remedial actions not involving such treatment." See CERCLA Section 121(b)(1).

sediment chemical contamination and the presence of NAPL, navigational needs and remedy implementation needs, as described below. RTA 1 is no longer used for commercial navigation. However, this reach of the canal must have sufficient depth to operate the flushing tunnel and vessels will need to navigate this reach of the canal to perform cap monitoring and maintenance, as well as sewer system and flushing tunnel maintenance and bridge and bulkhead repairs. The final dredge depth would need to ensure that the final sediment surface remains submerged throughout the tidal cycle and minimize remedy implementation challenges (*e.g.,* allow sufficient water depth for construction work throughout the tidal cycle). In RTA 2, a navigation depth of -16 feet NAVD88 was used based on a 2009 dredging alternative analysis performed by the USACE which selected that depth for maintaining commercial navigation. The dredging depth in RTA 3 is in accordance with the federally-authorized navigation depth south of Hamilton Avenue--Hamilton to Sigourney Street, the authorized channel is 18 feet deep relative to MLLW; between Sigourney and Percival Street, the authorized depth increases to 30 feet deep relative to MLLW. These depths are equivalent to approximately -21 and -33 feet NAVD88, respectively.

Capping is a component of all alternatives, except the No- Action alternative, because NAPL-contaminated sediments are present to depths that exceed the practicable depth of removal. A capping-only alternative was not included since a cap in RTA 1 would further restrict the water depth in the canal and result in a relatively large area of exposed sediment at low tide, a cap in RTA 2 would compress soft sediments and mobilize the NAPL within them and a capping-only remedy would be incompatible with the continued use of the canal for commercial navigation.

The sediments dredged under any of the alternatives can be treated and/or disposed of using a variety of methods. The following treatment and disposal options for dredged sediments were identified and retained for further development and detailed evaluation:

- Option A: Off-Site thermal desorption and beneficial use.
- Option B: Off-Site disposal (landfill).
- Option C: Off-Site cogeneration and beneficial use.
- Option D: Off-Site stabilization and off-Site beneficial use.
- Option E: On-Site stabilization and on-Site beneficial use.
- Option F: Off-Site stabilization and placement in on-Site constructed CDF.
- Option G: On-Site stabilization and placement in on-Site constructed CDF.

Source Control Remedial Components and Costs

There are multiple sources of contamination causing on-going releases into the canal which must be controlled in order for the sediment remedy selected herein to be protective of human health and the environment and to be effective and sustainable. Therefore, implementation of control measures to address all other contaminant sources, either through state cleanup authorities or direct selection as part of this remedy, are common and integral to ensuring the effectiveness of both of the sediment action alternatives.

The primary on-going sources are the three former MGP facilities and the CSOs in the upper part of the canal (outfalls RH-034 and OH-007). Unlike more typical upland sources to sediment sites, the setting, volume and discharge pathways of these sources make addressing them fully integral to the selected remedy.

The three former MGP facilities are being addressed by National Grid pursuant to administrative orders with NYSDEC. The remedy selection for the three former MGP facilities is not within the scope of this decision document. However, significant portions of the remedial work for the three former MGP facilities are expected to occur in the canal, requiring coordination with the sediment remedy. As a result of the concentrated levels and widespread prevalence of MGP-related NAPL, the degree of MGP source control may also affect cap design for the sediment remedy. Finally, the cost of the MGP-related remedies is anticipated to be in a similar range as the selected sediment remedy. As a result, detailed information is provided below regarding the dynamic relationship between the selected sediment remedy and the remediation of the former MGP facilities to establish that appropriate consideration has been given to this integral, major source.

With regard to control of the CSOs, the other major, integral on-going contamination source to canal sediments, the selected remedy requires implementation of specific measures to significantly reduce contaminated CSO solids discharges to the upper canal. Although not considered for CERCLA remedy selection purposes, the remedy will also help address the presence of pathogens introduced into the canal by the ongoing CSO discharges.

Former Manufactured Gas Plant Source Control Measures and Costs – Concurrent Work under Separate State Authority

NYSDEC has not yet completed the remedy selection process for the former Fulton and Metropolitan MGP facilities. However, NYSDEC has selected a remedy for the Public Place former MGP facility. All of the major reports for the three former MGP facilities, including the screening of remedial alternatives for Public Place, have been reviewed by the EPA and are included in the EPA's Administrative Record. New York State guidance governing the State Superfund program requires source removal or control for all remedies. This will ensure that the remedies for the two other former MGP facilities will adequately address the sources. The costs for addressing the Public Place former MGP facility are estimated by National Grid at $175-200 million, based on NYSDEC's selected remedy and National Grid's remedial design work performed to date. It is assumed that the costs for the two other sites will each be in the same range or less.

CSO Solids Control Measures and Costs

To address the discharge of hazardous substances, such as PAHs associated with typical urban drainage, the following CSO control measures were screened based on effectiveness, implementability and cost (see the FS report addendum): no action; optimization of existing trap chamber in CSO OH-007; CSO sediment trap at CSO RH-034; silt curtains and/or netting facilities, maintenance dredging; sewer cleaning and CSO storage. The permanent installation of silt curtains was screened out based on the fact that they would not provide sufficient solids control and they would deteriorate and require extensive maintenance over the long term in large part due to the surface water velocities in the canal once the flushing tunnel is put back into operation. The temporary use of silt curtains during dredging operations will be evaluated as part of the remedial design, but silt curtains are not practicable as a permanent source control option.

As is noted above, to ensure continued protection of the canal remedy, future permanent CSO sediment controls are required. The only practicable, cost-effective measure for control of this volume of contaminated CSO solids is the use of retention tanks. Scientific literature suggests that it can be assumed that the “first flush” comprises approximately 20% of the total discharge volume and contains between 30% and 60% of the total PAH load of the discharge (Stein, 2006). The first flush phenomenon under urban settings with regard to the discharge of contaminants such as PAHs and metals has been studied in various geographic regions in the U.S. that experience different hydrologic patterns and various levels of urbanization. For example, studies have been performed in an ultra-urban area in Maryland and the District of Columbia (Flint and Davis, 2007), California (Lau *et al,.* 2009; Stenstrom and Kayhanian, 2005; Li *et. al.,* 2008), Ohio (Sansalone and Buchberger, 1997), Florida (Mitsova *et al.,* 2011); and across other countries/continents (Bertrand-Krajewski, 1998; Deletic, 1998; Larsen *et al.,* 1998; Lee *et Al*,. 2002; Nazahiyah, 2007 and Zhang *et. al.,* 2009). These studies demonstrate that first flush phenomenon is observed for various precipitation patterns and different chemical compositions, including those for metals and PAHs. In summary, the findings of these studies across the country are consistent with Stein *et al.* (2006), which states that “within individual storms, PAHs exhibited a moderate first flush with between 30% and 60% of the total PAH load being discharged in the first 20% of the storm volume.” Therefore, the first flush concept and taking advantage of it for controlling CSO discharges are directly applicable to the CSO controls developed for the Gowanus Canal.

A CSO solids reduction of 58 to 74 percent was preliminarily estimated to be needed at outfall RH-034 to meet the RGs of four contaminants (total PAH, copper, lead and total PCBs) including a 51 to 71 percent reduction needed for total PAHs. (see the FS report addendum). Similar reductions will be needed for outfall OH-007. That level of reduction would require capturing more than 20 percent of the initial CSO discharge volume when factoring in the first flush capture effect.

It is anticipated that capturing approximately twice the amount of the first flush of the design storm event from CSO outfalls RH-034 and OH-007 (WB/WS Plan)[33] can provide an initial estimate of the degree of control needed so that the protectiveness of the remedy is maintained. In order to achieve this minimum level of contaminated CSO solids control, based on the preliminary screening, in-line sewage retention tanks[34] would be constructed near outfalls RH-034 and OH-007 unless other technically viable alternatives are identified. Tank volumes of 6- to 8-million gallons and 3- to 4-million gallons were preliminarily selected for outfalls RH-034 and OH-007, respectively, on the basis of their capacity to reduce CSO volume and solids in an amount that will prevent recontamination of the canal after the implementation of the sediment cleanup components of the remedy.

For costing purposes, an 8-million-gallon in-line retention tank (estimated by the EPA to cost $46,429,000 to construct) would be installed for outfall RH-034 and a 4-million-gallon in-line retention tank (estimated by the EPA to cost $31,272,000) would be installed for outfall OH-007.[35] For the purpose of developing construction costs associated with CSO control, it was assumed that these tanks could be located on available NYC-owned land in the vicinity of the outfalls. The final selection of CSO control retention tank locations, as well as any further evaluations of measures to prevent recontamination of canal sediments, will be completed during the remedial design and in coordination with the contemporaneous LTCP development process.

NYCDEP's has stated that it costs $1 million per year to operate its Alley Creek CSO storage tank and $2 million per year to remove grit alone at its Flushing CSO storage

[33] The EPA recognizes that, in the future, there may be more frequent large rainfall events due to climate change.

[34] As was noted above, combined sewers receive both sewage and stormwater flows, and discharge to the canal when the sewer system's capacity is exceeded. Rather than discharging the sewage and stormwater to the surface water when the system's capacity is exceeded, the excess flow would be diverted to tanks, which would store it until the wet weather subsides, when it would be pumped to the WWTP.

[36] The cost includes $172,000,000 to address the contaminated sediments (this cost does not include treatment and disposal of dredged sediment which are dependent upon the disposal and treatment option selected), $77,701,000 to install in-line storage tanks for outfalls RH-034 and OH-007 (8 million gallons and 4 million gallons, respectively) and $20,000,000 for the excavation and restoration of the portion of the filled-in former 1st Street turning basin, the excavation and restoration of the portion of the 4th Street turning basin underneath the 3rd Avenue bridge and the installation of a barrier or interception system on the 5th Street turning basin side of the bridge. The cost does not include remedial measures, such as the installation of cut-off walls, source removal or groundwater/NAPL collection systems at the three former MGPs, which will be implemented under State authorities.

tank. Based on the sizes of those facilities alone (and not taking into account the frequency of use and actual volumes of CSO stored among other differentiating factors), the O&M cost is $0.20/million gallons per year (MG/yr) including $0.05/MG/year for grit removal. With that cost basis, the combined costs of operating two tanks at Gowanus Canal may be on the order of $2,400,000 per year ($1,600,000 for RH-034, $800,000 for OH-007).

NYC is under order with New York State to achieve the water quality goals of the CWA and must ultimately meet the "highest attainable use" per the EPA's LTCP guidance. The LTCP, which is due to the State in June 2015, is expected to address, at a minimum, the EPA's remedial performance goals as noted above, for further contaminated CSO solids control in the upper reach of the canal. The EPA and NYSDEC are committed to work together throughout the development of the remedial design and the contemporaneous LTCP development process to ensure that both the Superfund and CWA goals are met in a timely, cost-effective manner. The EPA seeks to coordinate the CERCLA and CWA processes to the extent practicable, to ensure that the selected CERCLA remedy is implemented in an effective and timely manner. Since the EPA is incorporating contaminated CSO solids control in the remedy selection, siting, remedial design and remedial action pursuant to the authority of CERCLA, certain CERCLA statutory authorities, including, but not limited to, permit exemption and environmental impact statement functional equivalency apply.

Since the design and construction of permanent long-term CSO controls for the Superfund remedy might not take place by the time remedial dredging is carried out, interim contaminated CSO solids control measures would need to be developed during the remedial design to control the discharges until the permanent measures are implemented.

Current and future high density residential redevelopment along the banks of the canal and within the sewershed would need to adhere to NYC rules for sewer connections (Chapter 31 of Title 15 of the Rules of the City of New York) and be consistent with recently adopted NYC criteria for on-Site stormwater control and green infrastructure (NYCDEP, 2012) so as to ensure that hazardous substances and solids from additional sewage loads do not compromise the effectiveness of the permanent CSO control measures by exceeding their design capacity. In addition, separated stormwater outfalls may also require source controls pursuant to applicable SPDES permits and best management practices. In particular, such separated stormwater outfalls would need to utilize appropriate engineering controls to minimize the discharges of hazardous substances and solids.

Additional Source Control Measures and Costs

The costs to address the other (non-MGP) upland sources will vary from parcel to parcel and will depend on source control options that may include excavation, cutoff walls and other measures. The EPA did not estimate the costs of remediating these additional parcels as part of the FS and, thus, those costs are not directly included in the overall remedy costs. However, the EPA believes that, in comparison to the overall anticipated canal remedy cost, the cost of addressing each of these parcels would be small. The EPA anticipates that separate cleanup determinations will be made for such parcels under the appropriate cleanup program. The appropriate remedial measures and costs of these non-MGP upland sources will be addressed in those separate cleanup determinations. Based upon discussions with property owners willing to implement such measures for redevelopment purposes voluntarily, such measures are likely to cost several million dollars or less per property. In the unlikely event that a timely and effective state-selected remedy is not implemented at a given non-MGP facility, the EPA may implement actions pursuant to CERCLA to ensure the protectiveness of the selected remedy.

The costs to address the non-CSO open pipes along the canal are expected to be minimal in comparison to the overall Site remedy costs and would involve either sealing the pipes or requiring the property owner to obtain the necessary permit to continue the discharge. To reduce sewer, stormwater and runoff contaminant inputs, the EPA and NYCDEP have also discussed the use of “Best Management Practices” by various business sectors (*e.g.,* auto repair, vehicle storage) near the canal. The EPA anticipates that these measures will be implemented in a phased manner over the course of the remedial action through compliance assistance efforts and, as appropriate, enforcement actions.

Sediment Dredging, Capping and Disposal Alternatives

The sediment dredging, capping and disposal alternatives described below also include the excavation and restoration of approximately 475 feet of the filled-in former 1st Street turning basin and the excavation and restoration of a portion of the 5th Street turning basin beginning underneath the 3rd Avenue bridge and extending the excavation approximately 25 feet to the east, and the installation of a barrier or interception system at the eastern boundary of the excavation.

The construction time of approximately six years for each alternative reflects only the time required to construct or implement the remedy and achieve the RAOs. This period does not include the time required to discuss the design and implementation of the remedy with PRPs and to prepare the enforcement agreement that will govern this work, the time required for the design of the remedy, including the procurement of contracts, and the time for the procurement of contracts for the implementation of the remedy. This period also does not include time needed for enforcement-related activities, including time to discuss and come to an enforcement agreement with PRPs for the operational details for the performance of the work.
The sediment dredging, capping and disposal remedial alternatives are:

Alternative 1: No Action

Capital Cost:	$0
Annual Operation and Maintenance (O&M) Cost:	$0
Present-Worth Cost:	$0
Construction Time:	0 months

The Superfund program requires that the "no-action" alternative be considered as a baseline for comparison with the other alternatives. The no-action remedial alternative does not include any physical remedial measures that address the contamination at the Site.

Because this alternative would result in contaminants remaining above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the Site be reviewed at least once every five years. If justified by the review, remedial actions may need to be implemented to remove, treat or contain the contaminated soils and sediments.

Alternative 5: Dredge Entire Soft Sediment Column; Cap with Treatment, Isolation and Armor Layers

Volume of Sediment Removed:	588,000 cubic yards (CY)
Capital Cost:	$270,000,000[36]
Annual O&M Costs:	$4,400,000[37]
Present-Worth Cost:	$272,000,000
Construction Time:	6 years

Under this alternative, all of the soft sediment within the canal would be removed and a cap would be placed on top of the native sediment surface.

[36] The cost includes $172,000,000 to address the contaminated sediments (this cost does not include treatment and disposal of dredged sediment which are dependent upon the disposal and treatment option selected), $77,701,000 to install in-line storage tanks for outfalls RH-034 and OH-007 (8 million gallons and 4 million gallons, respectively) and $20,000,000 for the excavation and restoration of the portion of the filled-in former 1st Street turning basin, the excavation and restoration of the portion of the 4th Street turning basin underneath the 3rd Avenue bridge and the installation of a barrier or interception system on the 5th Street turning basin side of the bridge. The cost does not include remedial measures, such as the installation of cut-off walls, source removal or groundwater/NAPL collection systems at the three former MGPs, which will be implemented under State authorities.

[37] This cost includes O&M related to the contaminated sediments and contaminated CSO solids controls (such as in-line storage tanks). It does not include O&M costs related to the three former MGPs.

The native sediment surface elevation is variable within the canal; therefore, there is not a single specific removal depth in RTAs 1 or 3 under this alternative. In RTA 1, the native surface elevation ranges from -11.8 to -25.6 feet NAVD88. In RTA 3, the native surface elevation—and therefore the target dredge elevation—ranges from -18.9 to -44.2 feet NAVD88. The removal of all the soft sediment would allow for the placement of the cap and, at the same time, meet maintenance considerations in RTA 1 and navigational needs in RTAs 2 and 3.

In RTA 2, a navigation depth of -16 feet NAVD88 was assumed based on present commercial navigational needs. Therefore, all of the soft sediment and some native sediment would be removed to accommodate the cap thickness and allow for continued commercial vessel use in this reach.

The cap for this alternative would consist of an armor layer, an isolation layer and an active treatment layer as follows from top to bottom:

- Armor layer: Stone sized to meet the erosion forces of the flushing tunnel and navigation impacts. Sufficient sand would be placed on top of the armor layer to fill in the voids between the stones and to establish sufficient depth of soft sediment in order to facilitate benthic recolonization.
- Isolation layer: Approximately 1 foot thick consisting of 0.5 feet of gravel and 0.5 feet of sand to provide transition and erosion protection of the treatment layer material from the overlying heavier armor layer.
- Treatment layer (represented in the FS by oleophilic clay): Conceptually consisting of 1 foot in RTA 1 and RTA 2 and 0.5 feet in RTA 3 of an oleophilic clay-sand mixture, with the exact configuration to be determined during the remedial design.

The cap would need to be designed to tolerate future maintenance dredging operations in the canal for the removal of contaminated solids that might settle on top of it. If possible, the treatment layer component of the cap would be designed to have an adequate life expectancy for absorbing NAPL without replacement. For areas with high NAPL or impacted groundwater discharge, treatment gates (*i.e.,* NAPL sump) will likely be needed where the treatment media can be removed without disturbing the cap outside these areas.

This alternative would include periodic maintenance of the cap and long-term monitoring to insure that the remedy continues to function effectively.

This alternative would also include institutional controls incorporating the existing fish consumption advisories (modified, as needed), as well as other controls to protect the integrity of the cap and limit construction within the canal, including bulkhead maintenance and navigation dredging within the canal.

Because this alternative would result in contaminants remaining on-Site above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the Site be reviewed at least once every five years.

Alternative 7: Dredge Entire Soft Sediment Column; Perform In-Situ Sediment Stabilization; Cap with Treatment, Isolation and Armor Layers

Volume Sediment Removed:	588,000 CY
Capital Cost:	$286,000,000[38]
Annual O&M Costs:	$4,400,000[39]
Present-Worth Cost:	$288,000,000
Construction Time:	6 years

Under this alternative, all of the soft sediment within the canal would be removed and ISS would be applied to targeted areas of native sediment to immobilize NAPL with upward migration potential. ISS would be performed to a depth of 3 to 5 feet and would consist of incorporating pozzolanic and/or adsorptive additives into the native sediment to stabilize the material. ISS would be applied to areas where data indicate the potential for active upward NAPL migration from the native sediment. The stabilization material would be delivered to the sediment in-situ from a barge using large augers without dewatering the canal. The area being stabilized would be surrounded by temporary sheet-piling to contain the contaminants that would be released when the augers are in use. Any impacted water would be treated as necessary.

The depth of removal for RTAs 1, 2 and 3 would be the same as Alternative 5.

The conceptual cap for this alternative would be the same as the cap described for Alternative 5, an armor layer, an isolation layer and a treatment layer (represented by oleophilic clay). In addition, treatment layer design will need to be incorporated into the

[38] The cost includes $188,000,000 to address the contaminated sediments (this cost does not include treatment and disposal of dredged sediment which are dependent upon the disposal and treatment option selected) and $77,701,000 to install in-line storage tanks for outfalls RH-034 and OH-007 (8 million gallons and 4 million gallons, respectively) and $20,000,000 for the excavation and restoration of the portion of the filled-in former 1st Street turning basin, the excavation and restoration of the portion of the 4th Street turning basin underneath the 3rd Avenue bridge and the installation of a barrier or interception system on the 5th Street turning basin side of the bridge. The cost does not include remedial measures, such as the installation of cut-off walls, source removal or groundwater/NAPL collection systems at the three former MGPs, which will be implemented under State authorities.

[39] This cost includes only O&M related to the contaminated sediments and contaminated CSO solids controls (such as in-line storage tanks). It does not include O&M costs related to the three former MGPs.

stabilized native sediment layer where stabilization is implemented. ISS will inhibit groundwater discharge in the treated areas and treatment gates will likely be needed where the treatment media can be removed without disturbing the cap outside these areas.

The cap would need to be designed to tolerate future maintenance dredging operations in the canal for the removal of contaminated solids that might settle on top of it. If possible, the treatment layer component of the cap would be designed to have an adequate life expectancy for absorbing NAPL without replacement. If this is not feasible, the alternative may include the replacement of portions of the treatment layer (replacing the treatment layer would also necessitate the removal and replacement of the overlying sand and armor layers).

This alternative would include periodic maintenance of the cap and long-term monitoring to insure that the remedy continues to function effectively.

This alternative would also include institutional controls incorporating the existing fish consumption advisories (modified, as needed), as well as other controls to protect the integrity of the cap and in-situ stabilized material and limit construction within the canal, including bulkhead maintenance and navigation dredging within the canal.

Because this alternative would result in contaminants remaining on-Site above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the Site be reviewed at least once every five years.

Treatment and Disposal Options

This section describes the treatment and disposal or beneficial-use options that may be utilized to address sediments removed through the above-noted dredging and capping alternatives. All treatment and disposal facility selection and beneficial use determinations would be subject to the EPA oversight and approval. Due to the differences in the extent of NAPL contamination in different areas of the canal, some of the treatment and disposal options are not applicable to all RTAs. The seven treatment and disposal options with the RTAs to which they apply (noted in parenthesis) are:

- Option A: Off-Site thermal desorption and beneficial use (RTAs 1, 2 and 3).
- Option B: Off-Site disposal (landfill; RTAs 1, 2 and 3).
- Option C: Off-Site cogeneration and beneficial use (RTAs 1, 2 and 3).
- Option D: Off-Site stabilization and off-Site beneficial use (RTAs 1 and 3).
- Option E: On-Site stabilization and on-Site beneficial use (RTAs 1 and 3).
- Option F: Off-Site stabilization and placement in on-Site constructed CDF (RTA 3).
- Option G: On-Site stabilization and placement in on-Site constructed CDF (RTA 3).

The relative cost rankings for these disposal and treatment options are influenced by tipping fees, specific treatment technology and transport distance required. The approximate costs for the treatment and disposal options range from approximately $170 to $320 per ton.

All of the treatment/disposal options include barging of the dredged sediment to a local, on-Site dewatering and transfer facility.

Additional treatability testing and sampling would be needed for all of the options. Further testing of stabilized sediment would be required to confirm that dredged sediment can be accepted by thermal desorption (Option A) and cogeneration (Option C) facilities. Utilization of Option B (off-Site landfill) would require testing of the stabilized dredged sediment to confirm that it would meet acceptance criteria. Options D, E, F and G would require further evaluations to determine the appropriate reagents and dosing required for stabilization and to assess the leachability of the stabilized material. Options D and E would further require a beneficial use to be identified and a determination as to whether the stabilized sediment would meet the associated beneficial-use requirements. A CDF would be constructed under Options F and G, if selected based upon community acceptance and approval by NYSDEC and other appropriate governmental regulatory authorities.

Option A: Off-Site Thermal Desorption and Beneficial Use

Option A consists of transporting dredged and dewatered sediments by barge to an off-Site commercial facility for stabilization, followed by transport of the stabilized sediment to another off-Site facility for treatment by thermal desorption. The treatment residuals would be destroyed in an afterburner and the treated sediment would be transported for beneficial use, such as daily cover at a landfill, or for another beneficial use at an off-Site location. To develop the estimated costs, the FS assumed that transport following stabilization would occur by truck. The total PCB and lead concentrations present in the sediment may preclude this treatment option for some areas of the canal.

Option B: Off-Site Disposal (Landfill)

Option B consists of transporting the stabilized sediment from the off-Site dredge material processing facility to an appropriate landfill. It is assumed that transport from the dredge-material-processing facility to the disposal facility would occur by truck. Disposal at a RCRA Subtitle D landfill is assumed for the stabilized sediment. Stabilization would be performed to the degree needed for the dredged sediment to pass the paint filter test.[40]

[40] This test method is used to determine the presence of free liquids in a representative sample of waste. A predetermined amount of material is placed in a paint filter. If any portion of the

Option C: Off-Site Cogeneration and Beneficial Use

Option C consists of transporting dredged, dewatered sediments that have been stabilized, as necessary, at the off-Site dredge-material-processing facility to an off-Site cogeneration electrical plant. The stabilized sediment would be mixed with coal and then burned to generate electricity, which would then be distributed to the receiving electrical grid. The organic contaminants in the sediment would be destroyed through burning of the sediments at high temperatures (greater than 1,400°C) during the co-generation process. The treated sediment would then be transported for use as daily cover at a landfill or other beneficial use. It is assumed that transport from the off-Site dredge-material-processing facility to the cogeneration plant and from the cogeneration plant to the location where the treated sediment would be beneficially used would occur by truck.

Additional bench-scale testing would be required to determine whether the sediment in all areas of the canal would provide sufficient energy value (in British Thermal Units, or BTUs) to make cogeneration a feasible treatment/disposal option for all of the dredge sediments and to determine which areas of the canal contain sediment with the appropriate BTU value. Bench testing would also be required to determine the amount of stabilization materials needed to reduce the moisture content of the material to approximately 20 percent (the desired limit for the receiving facilities).

Option D: Off-Site Stabilization and Beneficial Use

Option D consists of transporting dewatered sediments to an off-Site dredge material processing facility via barge, where the sediment would be stabilized to a greater degree than for mere disposal. The treated material would then be transported via truck or rail (assumed to be by truck) to the off-Site beneficial use location. Potential beneficial use options include the stabilized sediment's use as fill or landfill daily cover or incorporation into construction materials, such as concrete. A specific beneficial use applicant would need to be identified and further evaluations would be required to confirm the amounts and types of stabilizing agents that should be added to the sediment to result in the desired physical and chemical properties. Tests to assess the leachability of NAPL and other contaminants, as well as the material strength, would need to be performed on the stabilized material in order to determine whether it would meet the beneficial use requirements.

Option E: On-Site Stabilization and Beneficial Use

Option E includes stabilizing dredged sediment on-Site and beneficially using the

---

material passes through and drops from the filter within the 5-minute test period, the material is deemed to contain free liquids.

treated sediment in areas adjacent to the canal. As with Option D, the degree of stabilization necessary for direct on-Site beneficial use without further treatment would need to be more substantial than the stabilization under Options A through C, where the stabilization process would be utilized to prepare sediments for off-Site transport by truck to be followed by treatment before final disposition. A specific beneficial use has not been determined, but potential uses include fill or creation of concrete blocks. Additional physical and chemical testing and cost analyses would be required to evaluate potential beneficial uses. Sediments would need to be stabilized to a degree consistent with their beneficial use including considerations on the leachability of contaminants.

A beneficial use for this material would need to be identified; the limitations, additional data needs and further evaluations described for Option D also apply to Option E. It is assumed that the beneficial use would be in a permanently controlled environment (*e.g.*, long-term potential human and ecological direct contact exposures and contaminant release are appropriately limited) and that long-term monitoring would be performed. Permanent institutional controls would be required to ensure the long-term effectiveness of this option. A temporary on-Site stabilization facility would need to be constructed and a location for this facility would need to be identified.

Option F: Off-Site Stabilization and Disposal in On-Site-Constructed CDF

Lesser-contaminated, stabilized sediments could be placed in the CDF[41] if approved by NYSDEC and other appropriate governmental regulatory authorities,[42] which would be filled and covered to match the existing ground surface elevation.

Option F would apply only to sediments at RTA 3 contaminant levels. RTA 3 sediments are less contaminated and with fewer NAPL impacts than the RTA 1 and 2 sediments. For this reason, RTA 3 sediments are more suitable for treatment via stabilization and placement in a CDF. Limiting Option F to RTA 3 sediments (and, space permitting, equivalent low level sediments from other areas, especially in RTA 1, that may be identified during design sampling) would also limit the space requirements needed to construct a CDF. The disposal of the lesser contaminated sediments in a CDF is projected to result in cost savings relative to the off-Site disposal options.

This option consists of transporting the stabilized sediment from the off-Site treatment facility back to the Site by barge and then transferring the sediment into an on-Site constructed CDF. The CDF would border water on one side and land on three sides. The layout includes installing a single sheet- pile wall on the sides adjacent to land and

---

[41] The EPA previously identified a potential CDF location on privately-owned property at the Gowanus Bay Terminal on Columbia Street in Red Hook.

[42] The EPA will follow OSWER Directive 9355.7-03, *Permits and Permit "Equivalency" Processes for CERCLA On-Site Response Actions*.

installing a double sheet-pile wall on the side of the CDF adjacent to water. The void in the double sheet-pile wall would be filled with bentonite-augmented soil or a similar low-permeability material. Sufficient stabilization agents (*e.g.*, Portland cement) would be added to the dewatered sediment such that a monolithic mass would result. The material would be transferred into the CDF before it was completely hardened and would be placed using standard material-handling equipment. Once the treated sediment hardens, leaching is expected to be negligible, so a leachate collection system would not be necessary. Upon placement of the sediment in the CDF, the CDF would be capped. It is presumed that the top layer of the cap would be asphalt, allowing use of the surface. The CDF design would need to ensure long-term effectiveness in a coastal marine environment and be approved by NYSDEC and other appropriate governmental regulatory authorities. Surveys would be required on a regular basis to monitor the long-term integrity of the cap. Cap maintenance would include placement of additional clean materials/repaving to replace damaged areas of the cap.

For cost-estimating purposes, it was assumed that the CDF would accommodate the entire volume of sediment removed from RTA 3. The volume of in-situ sediment in RTA 3 has been estimated at 281,000 CY and an expansion factor of approximately 1.15 has been estimated for stabilized material, resulting in a CDF capacity of approximately 323,000 CY. If the CDF is constructed such that the thickness of stabilized sediment is 20 feet, the area required for the CDF would be 10 acres.

Bench-scale testing would be needed to determine the amounts of stabilizing agents that should be added to the sediment to result in the desired consistency. Tests to assess the leachability of contaminants would also need to be performed on the stabilized material in order to refine the CDF design. The design of the CDF would depend on its location and the characteristics of the stabilized sediment. Permanent institutional controls would be required to protect the long-term integrity of the CDF.

Option G: On-Site Stabilization and Disposal in On-Site-Constructed CDF

Option G consists of stabilizing dredged sediment on-Site and then transferring the sediment to a constructed on-Site CDF. The CDF would be the same as described in disposal Option F.

The disposal under Option G is the same as Option F, with the exception that the stabilization would be performed on-Site and transport of sediment to and from an off-Site stabilization facility would not be needed. It is assumed that an on-Site temporary stabilization facility would be constructed near or adjacent to the CDF location. Three concrete mixing facilities are located on the canal, of which two have expressed interest in providing stabilization services for the project.

The costs for the disposal options by RTA are summarized in Table 16.

COMPARATIVE ANALYSIS OF ALTERNATIVES

During the detailed evaluation of remedial alternatives, each alternative is assessed against nine evaluation criteria, namely, overall protection of human health and the environment, compliance with ARARs, long-term effectiveness and permanence, reduction of toxicity, mobility or volume through treatment, short-term effectiveness, implementability, cost, and state and community acceptance.

The evaluation criteria are described below.

- Overall protection of human health and the environment addresses whether or not a remedy provides adequate protection and describes how risks posed through each exposure pathway (based on a reasonable maximum exposure scenario) are eliminated, reduced or controlled through treatment, engineering controls or ICs.

- Compliance with ARARs addresses whether or not a remedy will meet all of the applicable or relevant and appropriate requirements of other federal and state environmental statutes and requirements or provide grounds for invoking a waiver.

- Long-term effectiveness and permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup goals have been met. It also addresses the magnitude and effectiveness of the measures that may be required to manage the risk posed by treatment residuals and/or untreated wastes.

- Reduction of toxicity, mobility or volume through treatment is the anticipated performance of the treatment technologies, with respect to these parameters, which a remedy may employ.

- Short-term effectiveness addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup goals are achieved.

- Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

- Cost includes estimated capital, O&M and present-worth costs.

- State acceptance indicates whether or not the State concurs with the selected remedy.

- Community acceptance refers to the public's general response to the results of RI and the alternatives described in the FS report, FS report addendum and Proposed Plan.

A comparative analysis of these alternatives based upon the evaluation criteria noted above follows.

Overall Protection of Human Health and the Environment

Alternative 1 would not provide overall protection of human health and the environment. This alternative would not achieve the RAOs for the canal. Contaminated sediments would remain and exposure to these sediments would continue to pose human health and ecological risks. NAPL migration from the sediment to the surface water would continue and the potential for direct contact with NAPL would remain.

Alternatives 5 and 7 are expected to be protective of human health and the environment. These alternatives would meet the RAOs by removing contaminated soft sediment and capping with an active treatment layer to reduce and control the long-term risks associated with the native sediment. Placing such an active cap over the contaminated native sediment remaining in the canal would prevent exposure to human and ecological receptors, thereby reducing and controlling toxicity to benthic organisms and eliminating the risks to herbivorous birds. The active cap would also prevent direct contact with NAPL and prevent NAPL migration to the surface water of the canal. Bench- scale testing performed by the EPA has demonstrated that ISS can sequester NAPL migration in native sediment. Implementation of ISS in targeted areas as part of Alternative 7 is expected to provide additional protectiveness against NAPL migration from the native sediment.

Implementation of Alternatives 5 or 7 would improve the surface water quality of the Gowanus Canal by controlling and eliminating NAPL migration and preventing contact of the surface water with the contaminated sediment.

Implementation of source controls to address CSO-related releases of hazardous substances associated with contaminated CSO solids, beyond those currently being implemented by NYCDEP, is necessary to provide overall protection of human health and the environment. In particular, such controls are necessary to protect the integrity of the canal remedy. By reducing discharges and accumulation of contaminated CSO solids, contaminant concentrations in surface sediments after remedy implementation are expected to meet the RGs, which are considered protective of human health and the environment. Absent additional controls, solids contaminated with hazardous substances will continue to be discharged through the CSOs, and will continue to adsorb and concentrate additional releases of hazardous substances, adversely affecting the sediments in the canal.

Compliance with ARARs

Below are the principal chemical-specific, action-specific and location-specific ARARs for the Site.

Since there are currently no federal or state promulgated standards for contaminant levels in sediments in New York, RGs for sediments in the Gowanus Canal were developed based on the results of the HHRA and BERA.

The EPA and New York State have promulgated surface water standards which are enforceable standards for various surface water contaminants. The New York State surface water quality standards are set forth at 6 NYCRR Part 703.

While Alternatives 5 and 7 would be expected to comply with all of the designated chemical-specific ARARs, Alternative 1 would not, since there would be no active remediation associated with the sediments.

During the implementation of Alternatives 5 and 7, any short-term excursions above surface water ARARs in the canal due to dredging and capping would be expected to be limited to the area in the vicinity of the work zone. Sufficient engineering controls would need to be put in place during dredging and capping to prevent excursions of surface water ARARs outside of the work zone.

Disposal of solids and liquid collected as part of contaminated CSO solids controls would be implemented in a manner that would achieve chemical-specific ARARs under the CWA. It is anticipated that any sewage stored in retention tanks would be processed by the existing WWTPs in accordance with each facility's permits at the conclusion of storm events. In the event that solids are generated for disposal at the contaminated CSO solids control (*e.g.,* via maintenance of an in-line CSO retention facility), such disposal would be implemented in a manner which complied with RCRA requirements.

The principal action-specific ARARs include CWA Sections 401, 402 and 404; the Rivers and Harbors Act Section 10; the New York Environmental Conservation Law (ECL) Article 15 Water Resources, Article 17 Water Pollution Control and Article 27 Collection, Treatment and Disposal of Refuse and Other Solid Waste; and associated implementing regulations. Consideration of a CDF would be subject to review by NYSDEC and other appropriate governmental regulatory authorities.

The CWA Section 401 Water Quality Certification (WQC) is implemented by NYSDEC through ECL Article 15 and the associated regulations in 6 NYCRR Part 608 Use and Protection of Waters. The WQC may establish conditions such as preventive measures to minimize re-suspension of sediment and water quality monitoring during dredging, so that the remedy would not exceed water quality standards. Placement of fill (such as a cap or construction of an in-water confined disposal facility) and temporary discharges of decanted waters from dredge barges into waters of the United States would also be addressed through a WQC. The dredging or placement of fill or structures such as bulkheads or in-water confined disposal facilities within navigable waters of the United States and other activities which may adversely affect aquatic ecosystems are regulated by the Rivers and Harbors Act Section 10. Similar activities in any waters of the United States are addressed by CWA Section 404 for which the USACE has jurisdiction.

CWA Section 402 is implemented by NYSDEC through the ECL Article 17 SPDES requirements, which regulate the discharge of pollutants into waters of the state. Pre-treatment or monitoring of decanted water may be imposed and would be applicable to dewatering of the sediment at an on-Site noncommercial facility.

RCRA is the federal law addressing the storage, transportation and disposal of solid and hazardous waste. NYSDEC implements RCRA in New York under ECL Article 27. The dredged sediment would be considered solid waste; however, it can be exempted from being solid waste through the WQC program. If not exempted, RCRA requirements would be applicable.

In addition to the ARARs described above, the principal location-specific ARAR is the Federal Coastal Zone Management Act administered by the National Oceanic and Atmospheric Administration, and the associated NYSDEC regulations which apply to placement of bulkhead, sheet-piling within the canal, barge/boat docks, barge offloading facilities, boat launches, bridge abutment bulkhead protection, utility protection and dredging. Since both of the action alternatives include dredging and active capping within the canal, the final design of the remedy must meet the substantive requirements of these regulations. Both action alternatives are expected to be able to comply with all of the designated location-specific and action-specific ARARs.

The CSO outfall source controls would comply with all of the designated chemical-specific, location-specific and action-specific ARARs.

If a CDF were to be constructed, the design would need to consider whether the substantive requirements of the following action-specific ARARs would be triggered and indicate how compliance would be achieved:

- Clean Water Act Section 401 certification.
- 6 NYCRR Part 608 Use and Protection of Waters, 6 NYCRR Part 701, Classifications-Surface Waters and Groundwaters Clean Water Act Section 404(b).
- 40 CFR Part 230 Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material.
- 40 CFR Part 122 EPA Administered Permit Programs: the National Pollutant Discharge Elimination System.
- 40 CFR Part 125 Criteria and Standards for the National Pollutant Discharge Elimination System.
- Clean Air Act, 40 CFR 50-99.
- New York State ECL Article 1 Title 1.
- New York State ECL Article 3 Title 3.
- New York State ECL Article 15 Title 5.
- New York State ECL Article 11, Title 5.
- New York State ECL Article 17, Title 5.
- New York State ECL Article 19, Title 3.
- 6 NYCRR Parts 200-257–Air Resources.
- NYSDEC - New York Guidelines for Soil Erosion and Sediment Control.

Long-Term Effectiveness and Permanence

Alternative 1 would not result in any significant change in risk associated with contaminated sediment or NAPL.

Alternatives 5 and 7 would result in significant, permanent reduction of the risks associated with contaminated canal sediments and would meet the RAOs. Both alternatives would provide long-term protection of human health and the environment. The risks associated with contaminated sediment and NAPL in the canal would be reduced over the implementation period of the alternatives as the sediments are removed from the canal. The NAPL-contaminated sediments constitute principal threat waste[43] for which removal and treatment is warranted.

The active cap would provide long-term control of the risks associated with the native sediment in the canal, provided that appropriate long-term cap monitoring and maintenance plans are implemented. Adsorptive caps to control NAPL migration can be designed for a set life expectancy where the NAPL migration rate is known. At the McCormick and Baxter Superfund site in Portland, Oregon, the NAPL discharge rate to

[43] Principal threat wastes are source materials that include or contain hazardous substances that act as a reservoir for the migration of contamination to groundwater, surface water or air, or act as a source for direct exposure. These materials are considered to be highly toxic or highly mobile and, generally, cannot be reliably contained.

the cap was estimated and a design life of more than 100 years established (Blischke and Olsta, 2009). NAPL discharge rates at the Gowanus Canal would need to be determined prior to cap design to establish the appropriate adsorptive cap thickness requirements.

Alternatives 5 and 7 are considered to have a high degree of effectiveness because all the soft sediment would be removed and the exposure risks associated with the native sediment would be controlled by the active cap. The application of ISS to targeted areas of native sediment in Alternative 7 would be expected to reduce further the NAPL mobility from the native sediment; pilot testing would need to be performed to determine the most effective, implementable form of ISS within the canal. In the event that ISS is not fully effective, the multilayer cap would provide a redundant level of protectiveness.

The seven treatment and disposal options were ranked with respect to long-term effectiveness and permanence. Options A, B and C rank high with respect to this criterion because the material would be transferred off-Site and treated or contained in a managed landfill, alleviating the associated risk. Options D and E (stabilization and beneficial use) are considered to have low to moderate long-term effectiveness. The effectiveness would depend on the actual beneficial use. Use as an off-Site landfill daily cover, as is assumed for Option D, would be effective and permanent since the material is used in a controlled, monitored environment. Use as on-Site fill or concrete blocks could potentially be effective and permanent, but would require testing to ensure that appropriate treatment is applied and would require a suitable, controlled, end-use location to be identified. Long-term monitoring would also be needed to assure that performance criteria continue to be achieved. Permanent institutional controls would be needed to ensure that long-term potential human direct contact exposures are appropriately limited. The institutional controls would need to restrict digging or construction activities within the fill material and may need to be applied to one or more properties, depending on where the material is used. Depending on the number of properties and where on the properties the fill is placed, more effort and coordination may be needed to ensure successful implementation and enforcement of these controls. Institutional controls would require sustained application and monitoring to assure their success.

Options F and G (stabilization and placement into a constructed CDF) are considered to have a moderate to high ranking for this criterion because the sediment would remain on-Site, but would be contained in an engineered CDF. Under Options F and G, the sediment would be permanently stabilized into a relatively impermeable monolithic mass, which is the primary mechanism for reducing or controlling long-term risk. As previously noted, the less-impacted sediments would be placed in the CDF. Long-term monitoring and periodic maintenance would be needed to assure that the CDF continues to function effectively. Institutional controls, which would be relatively straightforward to implement and maintain, would be required to assure that the CDF remains undisturbed.

The commingling of solids and associated PAHs and other chemical constituents from the CSO outfalls with sediment and chemical constituents in the canal would potentially impact the integrity and long-term effectiveness of each of the active alternatives. Contaminated CSO solids control would reduce the mass of solids accumulating in the canal and, thus, reduce the residual risk from contaminants in newly deposited sediments after remedy implementation. Treatment of any stored sewage material would occur at the WWTPs in accordance with each facility's permits at the conclusion of storm events. Contaminated CSO solids controls can be designed and implemented to provide reliable control of discharges at the selected design criteria, thus, reducing the potential for recontamination and the residual risk after remedy implementation.

The reliability of contaminated CSO solids control would require regular inspections and maintenance of the controls to ensure that they are operated in accordance with design criteria. Site management controls relating to future sewer capacity would be necessary to maintain the effectiveness of the CSO measures. Specifically, controls would be utilized to ensure that current and future high density residential redevelopment projects along the banks of the canal and within the sewershed would be constructed consistent with current NYC guidelines (NYCDEP, 2012) so as to not exceed the designed contaminated CSO solids control capacity, therefore avoiding the contribution of new sewage discharges to the canal that could compromise the remedy. Separated stormwater outfalls may also require discharge treatment controls.

NYCDEP's WB/WS Plan, which followed the EPA's LTCP guidance, was developed and approved by the State of New York on July 14, 2009 to achieve planned levels of CSO reductions for a typical rainfall year. The control technologies considered by NYCDEP for the WB/WS Plan are typical of reliable contaminated CSO solids control employed by NYCDEP and other cities around the world.

Monitoring of controls in support of the selected remedy can be integrated into NYCDEP's monitoring plans under the WB/WS and LTCP. Specifically, following the implementation of the WB/WS Plan, NYCDEP will perform post-construction monitoring to assess the effectiveness of its plan. Monitoring will consist of collecting relevant sampling data from the canal, as well as collecting relevant precipitation data and data characterizing the operation of the sewer system (NYCDEP, 2009). Analyses will be performed to assess compliance with water quality standards as a measure of the effectiveness of the WB/WS Plan. Using the collected information, NYCDEP will assess whether or not additional CSO controls are needed to achieve compliance with the CWA as part of an Adaptive Management Approach. NYCDEP will then submit in June 2015, an LTCP, which may include additional CSO controls needed for compliance with the CWA and requiring further long-term post-construction monitoring.

This monitoring will likely be added to NYCDEP's SPDES permits and can integrate the monitoring of controls implemented in support of the selected remedy for the canal.

Reduction in Toxicity, Mobility or Volume through Treatment

Alternative 1 would not result in the reduction in toxicity, mobility or volume of contaminants nor does it include a treatment component.

The treatment component included in the Alternatives 5 and 7 cap layout is represented by a granular oleophilic clay layer. The treatment layer would reduce the mobility of NAPL and is considered a treatment technology. The overall reduction of NAPL mobility expected to be achieved by the treatment layer is high. Alternative 7 is considered to have a higher ranking because, while the capping component is the same as that included in Alternative 5, its effectiveness is supplemented by ISS (also a treatment technology). The application of ISS to targeted areas of native sediment in Alternative 7 has been shown from bench-scale testing to reduce the NAPL mobility from the native sediment further; however, pilot testing would need to be performed to determine the effectiveness and implementability of ISS within the canal.

The reduction of toxicity, mobility and volume of the dredged sediment is dependent upon the treatment/disposal option selected; therefore, the four treatment/disposal options are evaluated and ranked. Thermal treatment (Option A) and cogeneration (Option C) are both ranked high. Both treatment options would significantly reduce or eliminate the toxicity, mobility and volume associated with the dredged sediment and both options would satisfy the statutory preference for treatment as a principal element of the alternative. Disposal Options B (off-Site landfill disposal), D and E (stabilization and beneficial use) and F and G (stabilization and placement into a constructed CDF) are all ranked as moderate for this criterion. Stabilization of the sediment would reduce contaminant mobility, but toxicity and volume would not be affected. Thermal treatment (Option A) and thermal destruction through cogeneration (Option C) are irreversible. The stabilization components of Options F and G are considered irreversible since the treated sediment would be placed in a controlled and monitored disposal facility. The irreversibility of stabilization for Options D and E (beneficial use) would be dependent upon the conditions where the material is placed and the degree of stabilization performed. Additional testing would be required to determine if an irreversible stabilization process can be developed on the basis of beneficial use.

Contaminated CSO solids control would reduce the volume of contaminants and adsorbent organic solids discharged to the canal. The controls would permanently reduce the mobility of contaminants by capturing and containing solids prior to being discharged to the canal. The captured solids would then undergo appropriate treatment and/or disposal, with the specific methods to be determined during the remedial design. It is assumed that stored sewage would be managed at the WWTPs in accordance with each facility's permits at the conclusion of storm events. The capture of the solids would be irreversible, since the solids would be prevented from discharging to the canal. The reduction of toxicity and volume achieved would be designed so that contaminated CSO solids control would result in surface sediment concentrations below the established RGs. CSO reductions needed to achieve the RGs in surface sediments after remedy implementation are estimated to be in the range of 58 to 74 percent.

Short-Term Effectiveness

Alternative 1, No Action, does not include any physical construction measures in any areas of contamination and, therefore, would not present any potential adverse impacts to on-Site workers or the community as a result of its implementation.

The preconstruction Site work, sediment removal and capping components of Alternatives 5 and 7 are considered to have moderate short-term effectiveness due to the construction duration and the potential construction-associated risks and short-term environmental impacts (traffic, odors, noise, etc.). Effective controls can be implemented to address short-term environmental impacts from temporary on-Site sediment handling and dewatering. Barges would be used for the transport of dredged sediment. Barges would also be used, to the extent possible, to limit traffic impacts related to the delivery of equipment and supplies and the transport of materials from the work area. Increased barge traffic may, however, result in vehicular traffic impacts as a result of more frequent drawbridge openings. Appropriate measures could be taken to limit noise, odors and other impacts associated with dredging and processing of the sediments. The short-term effectiveness of the treatment and disposal options is evaluated based on the potential short-term impacts to the Site associated with transportation and the transportation distance required. The short-term effectiveness is considered moderate to high for all of the treatment and disposal options that were evaluated.

The transportation distance of dredged material to the final treatment or disposal facility is an important consideration for short-term effectiveness. Distances were estimated in the FS for the purposes of comparing options and developing costs. Options E (on-Site stabilization and on-Site beneficial use) and G (on-Site stabilization and disposal in an on-Site CDF) do not require the dredged sediment to be transported off-Site, although stabilization reagents (*e.g.*, cement and blast furnace slag) would need to be transported to the on-Site facility. Of the remaining disposal options, Option F (off-Site stabilization and disposal in an on-Site CDF) offers the shortest transport distance for the dredged sediment (approximately 60 nautical miles round trip), all of it by barge. Disposal Option A (thermal treatment) consists of approximately 30 nautical miles of barge transport from the Site to the off-Site-dredge-material-processing facility and from there approximately 60 miles of transport by truck to the thermal treatment facility.

The transport distance for Option B (off-Site landfill) is estimated to be approximately 30 nautical miles by barge to the processing facility and then approximately 110 miles by truck to a disposal facility. Option C (cogeneration) is estimated to include approximately 30 nautical miles of transport to the processing facility and approximately 350 miles by truck to the cogeneration plant used as the example facility. The off-Site beneficial use for sediment under Option D has been assumed to be landfill daily cover; thus, it has been assumed that the material would need to be transported approximately 110 miles by truck from the off-Site stabilization facility to the disposal facility.

Contaminated CSO solids controls in the form of retention tanks can be designed, constructed and operated in a manner that does not present short-term implementation risks to the community and workers, manages environmental impacts and meets ARARs.

Ideally, contaminated CSO solids control would be in place before the implementation of the remedy for canal sediments. Alternatively, temporary CSO control measures may be needed to maintain remedy protectiveness while the permanent contaminated CSO solids controls are being implemented. At the time of the completion of the canal remedy, the canal surface would be “clean,” with surface sediment contaminant concentrations expected to increase over time as a result of new sediment deposition in the canal. However, as noted, the CSO control design criteria would be selected such that the deposition of solids from CSOs would not result in surface sediment concentrations above the RGs.

It is estimated that the design and construction of both action alternatives would take three years and six years, respectively.

Implementability

Alternative 1 is considered to be readily implementable because no remedial actions would be performed

Both Alternatives 5 and 7 would be administratively feasibile in terms of assuring that the off-site treatment/stabilization facilities have the required permits. The dredging and capping components of Alternatives 5 and 7 are considered moderately implementable. Both alternatives would require significant coordination between the EPA, USACE, NYSDEC, NYCDEP, PRPs and the property owners and tenants along the canal from the start of the design through completion of construction. The specific characteristics of the canal (*e.g.*, debris, degraded bulkheads, space limitations and the surrounding lively metropolitan residential and commercial community) and the large volumes of capping materials required would pose challenges to the remedy implementation. The amount of material required for the cap construction may require using several vendors, advanced planning and stockpiling material in advance of the construction to assure that enough material is available during the implementation period. It is anticipated that appropriate planning and engineering measures can address these issues. Alternative 5 is considered to have moderate overall implementability. Because there are more uncertainties associated with the ISS component of Alternative 7 and additional treatability and pilot testing are required to confirm the overall feasibility and effectiveness of this technology, Alternative 7 is considered to have moderate implementability, but to a lesser degree than Alternative 5. The location and construction of a temporary on-Site sediment handling and dewatering facility is considered to have moderate implementability.

The implementability of the different treatment and disposal options is more variable:

- Option A (off-Site thermal desorption and beneficial use): moderate
- Option B (off-Site land fill disposal): moderate to high
- Option C (off-Site cogeneration and beneficial use): moderate
- Option D (off-Site stabilization and off-Site beneficial use): moderate
- Option E (on-Site stabilization and on-Site beneficial use): moderate
- Option F (off-Site stabilization and disposal in on-Site constructed CDF): moderate
- Option G (on-Site stabilization and disposal in on-Site constructed CDF): moderate

Thermal treatment and cogeneration facilities (Options A and C, respectively) are limited within the geography, which would restrict the ability to competitively bid these services. The total PCB and lead concentrations in the soft sediment in some portions of the canal may also limit the potential for beneficial use after thermal treatment. Treatability testing would be needed to confirm that the available treatment facilities can accept the dewatered and stabilized sediment.

The availability of landfill facilities that would accept contaminated river sediment as waste and the existing capacity at these facilities within the geography is limited. Based on inquiries of Subtitle D landfills in the area, few facilities would accept materials originating from outside the county they serve and only a subset of these facilities would accept dredged material. Because Option B includes off-Site landfill disposal of the stabilized dredged sediment, the implementability of this option is reduced for disposal facilities in the area; however, additional disposal facilities are available outside of the area. Use of these facilities would result in increased transport costs. The beneficial use of treated sediment under Options A and C is expected to be readily implementable as long as treated sediment meets the end-use requirements.

The implementation of Options D and E (stabilization and beneficial use) would require identifying an off-Site or on-Site beneficial use of the stabilized material, as well as defining the performance standards for the end-use requirements. The stabilized material would need to meet the chemical and physical performance standards (*e.g.*, short- and long-term leachability and strength characteristics) in order for these options to be implemented. Additionally, on-Site use of the stabilized material would be dependent upon property owner acceptance and the sustained application of institutional controls. Due to these unknowns and challenges, these two disposal options are considered to have moderate implementability. The off-Site beneficial-use option has a slightly higher ranking due to the possibility of more beneficial-use applications. The on-Site beneficial-use option also is ranked slightly lower due to the potential difficulties associated with effective sustained implementation of institutional controls.

Implementation of disposal Options F and G (stabilization and on-Site CDF) is dependent on the acceptance from the community, review of NYSDEC and other appropriate governmental regulatory authorities and the sustained application of institutional controls. These options may be difficult to implement due to administrative considerations and, therefore, received a moderate ranking.

Various approaches to CSO solids control exist and have been successfully implemented elsewhere. NYCDEP has demonstrated that CSO discharges can be significantly reduced with the utilization of CSO retention tanks.

Cost

A summary of the estimated cost for each dredging and capping alternative and the associated treatment and disposal options, as well as the costs for the CSO retention tanks, is provided in Table 16.

Support Agency Acceptance

NYSDEC concurs with the selected remedy; a letter of concurrence is attached (see Appendix IV).

Community Acceptance

Comments received during the public comment period indicate that the public generally supports the dredging, capping and CSO abatement components of the selected remedy. While 15 local businesses and approximately 700 Red Hook residents located in close proximity to the proposed location of the CDF expressed support for its construction, approximately 900 parties located in other sections of Red Hook, elsewhere in New York State and in other states expressed strong opposition to the CDF option. In addition, two petitions containing over 3,000 signatures from business owners, residents, users of the recreation area, and concerned citizens expressing opposition to the processing of contaminated sediments in Red Hook and their placement in a CDF was presented to the EPA by "No Toxic Red Hook." The comments are summarized and addressed in the Responsiveness Summary, which is attached as Appendix V to this document.

PRINCIPAL THREAT WASTE

The NCP establishes an expectation that the EPA will use treatment to address the principal threats posed by a site wherever practicable (NCP Section 300.430 (a)(1)(iii)(A)). The "principal threat" concept is applied to the characterization of "source materials" at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants or contaminants that acts as a reservoir for the migration of contamination to groundwater, surface water or air, or acts as a source for direct exposure. Principal threat wastes are those source materials considered to be highly toxic or highly mobile and that generally cannot be reliably contained or will present a significant risk to human health or the environment should exposure occur. The decision to treat these wastes is made on a site-specific basis through a detailed analysis of alternatives, using the remedy-selection criteria that are described below. This analysis provides a basis for making a statutory finding that the remedy employs treatment as a principal element.

Elevated contaminant concentrations and visual evidence of the presence of NAPL exist in the canal. The RI indicated that the NAPL and contaminated sediments are mobile, at least when disturbed; have high concentrations of toxic compounds; and present significant risks. Therefore, they are characterized as principal threat wastes.

The selected remedy addresses source materials constituting principal threats by removing the entire accumulated sediment column, thermally treating the NAPL-impacted sediments dredged from the upper and mid-reaches of the canal and applying ISS in targeted NAPL areas of native sediment, thereby satisfying the preference for treatment.

SELECTED REMEDY

Summary of the Rationale for the Selected Remedy

Based upon consideration of the requirements of CERCLA, the results of the Site investigations, the detailed analysis of the alternatives and public comments, the EPA has determined that the following combination of alternatives[44] and treatment and disposal options satisfies the requirements of CERCLA Section 121, 42 U.S.C. § 9621, and provides the best balance of tradeoffs among the remedial alternatives with respect to the NCP's nine evaluation criteria at 40 CFR §300.430(e)(9):

[44] While remedial alternatives are typically compared against each other with the intent of selecting one alternative, due to the different conditions at each of the RTAs, both action alternatives will be utilized.

- Alternative 5: Dredge the entire soft sediment column and cap with treatment, isolation and armor layers for RTA 3.
- Alternative 7: Dredge the entire soft sediment column, targeted ISS of native sediment in areas with potential for active upward NAPL migration from the native sediment and cap with treatment, isolation and armor layers for RTAs 1 and 2.
- Excavation and restoration of a portion of the original filled-in 1st Street turning basin.
- Excavation and restoration of the portion of the 5th Street turning basin beginning underneath the 3rd Avenue bridge and extending approximately 25 feet to the east and the installation of a barrier or interception system at the eastern boundary of the excavation.
- Option A: Off-Site thermal desorption/beneficial use for the sediments removed from the NAPL-impacted areas in RTA 1 and RTA 2.
- Option D: Off-Site stabilization/beneficial use for the sediments removed from the non-NAPL impacted areas in RTA 3.
- Contaminated CSO solids control through the use of CSO retention tanks.

The rationale for selecting this remedy is as follows:

- Removal of all of the soft sediment will remove the PAHs and collocated metals and PCBs which are found only in the soft sediment at concentrations of concern and is the most appropriate approach to address the principal threat waste (*i.e.,* NAPL present within the accumulated sediments).
- Removal of all soft sediment will limit the potential for future contaminant transport through localized portions of the cap that might be eroded.
- With the removal of all soft sediment, sediment stabilization will be needed only in select areas where the native sediment is contaminated with NAPL so as to control NAPL mobility, and will provide additional partial treatment of this residual principal threat waste
- The native sediment will provide higher long-term reliability for supporting the cap than would placing the cap directly on the soft sediment.
- Removal of the soft sediment removes the high organic carbon content sediment from the canal that is the likely cause of ebullition, which is a significant NAPL transport mechanism, thereby minimizing the gas buildup under the cap that could lead to cap failure.
- If the soft sediment were left in place, stabilization of the soft sediment might be needed to provide the needed cap support along the entire canal, rather than only in areas of NAPL mobility in native sediment; widespread stabilization may alter groundwater flow and/or result in localized flooding and will require removal of swelled material produced during the stabilization process for disposal.
- Removal of the soft sediment will provide for deeper water depths to support current

navigation uses and will better protect the cap and prevent damages from barges.

- Removal of much of the soft sediment is necessary for implementation of the remedy and future maintenance of the remedy and canal infrastructure, such as bulkheads.
- Removal of the soft sediment will limit the risk of future contaminant transport caused by storm-related cap damage.
- Off-Site thermal desorption of the dredged NAPL-impacted sediments from RTA 1 and RTA 2 is irreversible and would eliminate the toxicity and mobility of the contaminants in the sediments.
- The utilization of the non-NAPL impacted stabilized sediments dredged from RTA 3 as off-Site landfill daily cover would provide a beneficial use for the sediments in a controlled, monitored environment.
- CSO retention tanks and the permitting or elimination of unpermitted pipes will prevent recontamination of the canal bottom.

The primary reason for the removal of the accumulated soft sediment is the removal and treatment of the principal threat waste represented by the grossly-contaminated accumulated sediments. Removal of the accumulated sediments will result in the removal of contaminants of concern in that stratum, thereby reducing the risk of recontamination in the event of a cap failure. In addition, the removal of the majority of the accumulated sediments is necessary for constructability reasons. Nearly half of the soft sediment must be removed to create sufficient depth for work boats that will implement the remedy (debris removal, installing/removing temporary sheet-pilings, dredging, disposal barges and cap placement), to maintain the cap and conduct future repairs to bulkheads and other infrastructure throughout the canal and to avoid propeller wash cap damage by existing commercial barge navigation in the lower two thirds of the canal.

Current and expected major development projects in the area will likely bring substantially more people to upland portions of the canal, adding to the number of people subject to the identified exposure pathways. NYC has previously identified such redevelopment pressures as justification for the timely implementation of a remedy. The EPA believes that the remedy can be initiated after approximately three years of design work, and would be implemented within six years of initiation.

The EPA has determined and NYSDEC agrees that the selected remedy is protective of human health and the environment, provides the greatest long-term effectiveness, is able to achieve ARARs more quickly than other alternatives and is cost-effective. The selected remedy utilizes permanent solutions, alternative treatment technologies and resource-recovery technologies to the maximum extent practicable. Furthermore, the selected remedy meets the statutory preference for the use of treatment as a principal element.

Description of the Selected Remedy

The selected remedy includes dredging of accumulated sediments, capping, off-Site thermal treatment of dredged NAPL-impacted sediments in the canal and existing turning basins, in-situ stabilization of native sediments with high levels of NAPL, excavation and restoration of a portion of the filled-in former 1st Street and a portion of the 5th Street turning basin beginning underneath the 3rd Avenue bridge, stabilization of sediments not impacted by NAPL and reuse off-Site, institutional controls and combined sewer overflow controls.[45] The specific components of the selected remedy are as follows:

Dredging, Capping and Treatment/Disposal

Because of the substantial amounts of debris in the canal and in order to facilitate the dredging of the contaminated sediment, debris removal from the canal bottom will be completed prior to the commencement of the dredging.

RTAs 1 and 2: Alternative 7 (dredge entire soft sediment column, targeted ISS of native sediment in areas with potential for active upward NAPL migration from the native sediment and cap with treatment, isolation and armor layers). The armor layer will consist of stone sized to meet the erosion forces of the flushing tunnel and navigation impacts. Sufficient sand will be placed on top of the armor layer to fill in the voids between the stones and to establish sufficient depth of soft sediment in order to facilitate benthic recolonization.

RTA 3: Alternative 5 (dredge entire soft sediment column and cap with treatment, isolation and armor layers).

Although the FS report used mechanical dredging as the representative method of sediment removal, flexibility will be allowed in the selection of the most appropriate dredging method during the remedial design.

The remedy will also include the excavation and restoration of approximately 475 feet of the filled-in former 1st Street turning basin and the excavation and restoration of the portion of the 5th Street turning basin beginning underneath the 3rd Avenue bridge and extending approximately 25 feet to the east, and the installation of a barrier or interception system at the eastern boundary of the excavation.[46] In addition to the

[45] See Figure 6 for an illustration of the selected remedy.

[46] Analytical data obtained during the RI in the former 1st Street turning basin showed the existence of significant contamination in soil and groundwater above cleanup standards. As with other former turning basins along the canal, it is believed that contaminated sediments within the 1st Street turning basin were left in place when it was filled in. In addition, there

removal of buried contaminated sediments which are ongoing contaminant source to the canal, the excavation of the turning basins will mitigate the loss of surface water area as a result of new bulkhead encroachment into the canal.

Addressing the contaminated sediments will remove PAHs and the other collocated risk-driving chemicals (PCBs and metals).

Approximately 307,000 CY of contaminated sediment would be dredged from RTA 1 and RTA 2 and approximately 281,000 CY of contaminated sediment would be dredged from RTA 3.

The cap would need to be designed to tolerate future maintenance dredging operations in the canal for the removal of contaminated solids that might settle on top of it. The specific type of the treatment layer will be selected during the remedial design, taking into consideration technological advances. If practicable, the treatment layer component of the cap will be designed to have an adequate life expectancy for absorbing NAPL without replacement. For areas with high NAPL or impacted groundwater discharge, treatment gates will likely be needed where the treatment media can be removed without disturbing the cap outside these areas.

Pilot testing will be performed to assess whether or not large-scale ISS of NAPL-impacted native sediments will have an adverse impact on groundwater flow and to provide information for the design of mitigation measures if results indicate that adverse impacts are expected.

Following on-Site dewatering, the disposition of the dredged sediments will be as follows:

RTA 1: NAPL Impacted Areas, Option A—Off-Site thermal desorption/beneficial use; Non-NAPL Impacted Areas, Option D—Off-Site stabilization/beneficial use.

RTA 2: Option A—Off-Site thermal desorption/beneficial use (NAPL impacts throughout RTA 2).

RTA 3: Option D—Off-Site stabilization/beneficial use.

Periodic maintenance of the cap and long-term monitoring will be performed to insure

---

are indications that the fill itself may have included waste materials. The filled-in 1st Street turning basin may also have been subject to later spills and dumping. The turning basin is hydraulically connected to the canal (with no bulkhead standing between the canal and the basin) such that contaminants within the basin are an on-going source of contamination. Finally, unlike the filled in portions of the other former turning basins (with the exception of the portion of the 4th Street turning basin located underneath the 3rd Avenue bridge), the 1st Street turning basin has no standing structures on or near it.

that the remedy continues to function effectively. The frequency and specific details of the maintenance and monitoring programs will be developed during the remedial design.

Source Controls

In order for the selected remedy in the canal to be effective, sources that could recontaminate the canal must be addressed. The upland sources of contamination, including the former MGP facilities, the CSO discharges in the upper part of the canal (particularly, outfalls RH-034 and OH-007), contaminated areas along the canal (including contaminated solids contributed by erosion from the surface and through bulkheads in disrepair) and the unpermitted pipes along the canal will be addressed prior to the commencement of, or in phased coordination with, the implementation of the selected remedy.

The former MGP facilities are being addressed by National Grid under NYSDEC oversight. Based upon the first NYSDEC-selected remedy at one of these sites and NYSDEC guidance for presumptive remedies at former MGP facilities, it is assumed that actions such as removal of mobile sources, construction of cut-off walls along the canal, and active recovery of NAPL near the cut-off walls for each of the former MGP facilities will be implemented to prevent the migration of contamination from the former MGP facilities into the canal. The cleanup of the former MGP facilities will be completed in accordance with schedules agreed upon between the EPA and NYSDEC (see Appendix VI). In the unlikely event that a timely and effective state-selected remedy is not implemented at a given former MGP facility, the EPA may implement actions pursuant to CERCLA to ensure the protectiveness of the selected remedy.

NYSDEC is currently overseeing work being performed by NYCDEP to reduce CSOs to the canal by approximately 34 percent in lower canal outfalls. Additional long-term CSO reductions are anticipated result from the NYCDEP sewer separation project for flood control purposes in a 96-acre area around Carroll Street, and from the NYCDEP green infrastructure effort (however, the stormwater component of the CSOs will still discharge to the canal after the sewer separation project). To significantly reduce overall contaminated solid discharges to the canal, the selected remedy includes the following CSO control measures for the upper reach of the canal:

- Construction of in-line sewage/stormwater retention tanks in the vicinity of outfalls RH-034 and OH-007. It is estimated that an 8-million gallon tank and a 4-million gallon tank will be required for outfalls RH-34 and OH-007, respectively. In addition, smaller CSOs in the vicinity of outfalls RH-034 and OH-007 will be connected to the retention tanks. The location and capacity of the retention tanks will be determined during the remedial design. The capacity of the retention tanks will need to accommodate the projected additional loads

to the combined sewer system as a result of current and future residential development, as well as a result of periods of high rainfall, including future rainfall increases that may result from climate change. The retention tanks will also need to conform with the requirements of the CWA and work in concert with NYC's wastewater treatment plants.
- In the event that the permanent measures described above are not implemented in a timely manner, implementation of interim controls, such as temporary solids capture and removal, to mitigate sediment from the CSO discharges until the permanent measures have been implemented.[47]

Since the EPA is incorporating contaminated CSO solids control in the remedy selection, siting, remedial design and remedial action, pursuant to the authority of CERCLA, certain CERCLA statutory authorities including, but not limited to, permit exemption and environmental impact statement functional equivalency apply. The EPA seeks to coordinate the CERCLA and CWA processes to the extent practicable, to ensure that the selected CERCLA remedy is implemented in an effective and timely manner.

The selected remedy also includes the following measures for discharges from upland Sites (other than the former MGP facilities) and for unpermitted pipes along the canal:

- The EPA and NYSDEC will coordinate measures to control discharges from upland contaminated areas adjacent to the canal that have already been referred to NYSDEC for action. The schedule for these measures will conform to the schedules for the cleanup of the canal.
- Under the selected remedy, unpermitted pipe outfalls will be either controlled or eliminated.

It is anticipated that temporary sheet-piling will be required for dredging and capping in locations where the condition of bulkheads warrants additional structural support. At the former MGP facilities, bulkhead replacement will likely be a component of the remedy. Other areas where significant NAPL is found at shallow depths in the banks of the canal may also require bulkhead replacement in conjunction with construction of subsurface barrier walls. Elsewhere, it is anticipated that bulkhead replacement will not be part of the remedy, unless a substandard bulkhead is judged to present an impediment to construction or a threat to the integrity of the remedy. Based on the anticipated interception walls for the former MGP facility cleanups and the EPA's current negotiations with various property owners along the canal for bulkhead upgrades, the EPA anticipates that a significant portion of the existing bulkheads will be upgraded to a standard before dredging so as to not require temporary shoring.

[47] It is unlikely that permanent measures to control the CSO discharges will be in place before the commencement of the remediation of the canal sediments.

A temporary on-Site facility may be necessary for dewatering, water treatment and/or transfer of dredged sediments. To the extent practicable, such operations may take place on barges.

Barges will be used for the transport of dredged sediment. The use of barges and other project-related watercraft (for sampling, support, etc.) during project operations will impact the use of other commercial and recreational water-based traffic on the canal. The EPA will establish plans to mitigate such impacts, though these impacts cannot be eliminated. Appropriate measures will be taken to limit noise, odors and other impacts associated with dredging and processing of the sediments. The EPA will continue to conduct community outreach to involve and inform the public and address public concerns during the design and implementation of the remedy.

Current and future high density residential redevelopment along the banks of the canal and within the sewershed shall adhere to NYC rules for sewer connections (Chapter 31 of Title 15 of the Rules of the City of New York) and shall be consistent with current NYCDEP criteria (NYCDEP, 2012) and guidelines to ensure that hazardous substances and solids from additional sewage loads do not compromise the effectiveness of the permanent CSO control measures by exceeding their design capacity. For example, redevelopment projects will need to take mitigation measures to prevent or offset additional sewer loadings. Separated stormwater outfalls will also require engineering controls to ensure that hazardous substances and solids are not discharged to the canal.

Pilot projects supported by federal and NYC grants are currently under way for the control of street runoff along the Gowanus Canal using green street ends.[48]

The environmental benefits of the selected remedy may be enhanced by consideration, during the design, of technologies and practices that are sustainable in accordance with the EPA Region 2's Clean and Green Energy Policy and NYSDEC's Green Remediation Policy.[49] This will include consideration of green remediation technologies and practices.

Because this remedy will result in contaminants remaining on-Site above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the Site be reviewed at least once every five years after the initiation of the action.

---

[48] Green street ends employ vegetation planted between the end of the street and the canal to prevent particulate matter and oils from discharging into the canal. The EPA supports the expanded use of such green street ends.

[49] See http://epa.gov/region2/superfund/green_remediation and http://www.dec.ny.gov/docs/remediation_hudson_pdf/der31.pdf.

As was noted in the "Scope and Role of the Operable Unit" section, above, contaminated groundwater that is migrating to the canal from upland areas will be investigated and addressed as part of the upland source remediation, as necessary.

Institutional Controls

Institutional controls are part of the selected remedy. Because of the anticipated unacceptable human health risk associated with the consumption of PCB-contaminated fish and shellfish after the remedy is implemented, the EPA will rely on existing New York State Department of Health (NYSDOH) fish consumption advisories. This existing fish consumption advisory for Upper New York Bay identifies PCBs as one of the contaminants of concern.

Institutional controls will also be used to protect the integrity of the cap and in-situ stabilized material. NYC owns the canal (with the exception of certain turning basins) and is among the government entities that regulates bulkhead construction. The institutional controls will include restrictions to prevent damage to the cap, limitations on construction within the canal, including bulkhead maintenance and navigation dredging within the canal. Where cutoff walls and other upland cleanup measures are implemented under NYSDEC or EPA oversight, appropriate protective easements or other deed restrictions would be implemented.

Summary of the Estimated Remedy Costs

The estimated capital cost is $285,700,000. The estimated treatment and disposal cost is $216,000,000. The estimated annual operation, maintenance and monitoring cost (using the federal standard seven percent discount rate and a 30-year interval) is $4,400,000 (the cost includes O&M related to the in-line retention tanks). The estimated present-worth cost is $506,100,000. Tables 17 and 18 provide the basis for the cost estimates for the selected remedy.

It should be noted that these cost estimates are order-of-magnitude engineering cost estimates that are expected to be within +50 to -30 percent of the actual project cost. These cost estimates are based on the best available information regarding the anticipated scope of the selected remedy. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedy.

Expected Outcomes of the Selected Remedy

The results of the HHRA indicate that the canal, if left unremediated, presents unacceptable risk levels for surface water/sediment contact and fish consumption. Human exposure to hazardous substances in surface water and surface sediment by recreating adults, adolescents and children may result in carcinogenic risks above the EPA's target risk range. These risks are associated primarily with exposure to carcinogenic PAHs in the surface water and the surface sediment. Human exposure to surface water and surface sediment from canal overflow may result in carcinogenic risks above the EPA's target risk range.

Despite a New York State Department of Health fish advisory covering the entire Gowanus Canal, posted warnings and public outreach efforts, the canal is regularly used for fishing, particularly subsistence fishing by communities surrounding the canal with environmental justice concerns. A NYCDEP survey of residents indicated that fishing is the number one canal use by area residents (NYCDEP 2008). The EPA believes that the selected remedy will reduce risks to these communities by reducing sources which contribute to these risks. However, because the selected remedy will not fully eliminate the need for fishing advisories due to contaminants from New York Harbor, the EPA intends to continue to coordinate fishing advisory education and awareness efforts with the appropriate governmental agencies.

The key results of the BERA indicated that PAHs, PCBs and metals in the sediment are toxic to benthic organisms. PAHs were detected in sediment at the highest concentrations relative to their ecological screening benchmarks and represent the greatest Site-related risk to the benthic community. PCBs and seven metals (barium, cadmium, copper, lead, mercury, nickel and silver) were also detected at concentrations above their ecological screening benchmarks and at concentrations significantly higher than those detected in reference area sediments and also represent a potential Site-related risk to the benthic community. PAHs were found to be a potential risk to aquatic herbivores (represented by the black duck) and mercury was found to be a potential risk to avian omnivores (represented by the heron).

The selected remedy will reduce the above-noted risks by reducing sources which contribute to these risks.

Implementation of the selected remedy will improve the surface water quality of the Gowanus Canal by controlling and substantially eliminating sheens and preventing contact of the surface water with the contaminated sediment.

It is estimated that it will require six years to construct the selected remedy and achieve the RAOs.

Source Control

The coordination of upland cleanups, CSO control and the sediment remedy is necessary for a comprehensive and sustainable remedy.

With respect to the former MGP facilities and other upland source areas, the EPA and NYSDEC are closely coordinating and the EPA is confident that these source areas can be appropriately addressed within the anticipated remedial approach and schedule for the canal remedy.

The EPA and NYSDEC have agreed to a coordinated schedule for the former MGP facilities and canal sediment cleanup efforts based on the anticipated timing of the dredging in the canal (which will commence at the head of the canal).

Because the upland contamination source areas which may impact groundwater have been referred to NYSDEC for investigation and remediation, if necessary, the EPA believes that a groundwater remedy is not required as part of this remedy. As a result, the selected remedy will not rely on dilution or dispersion of contaminated groundwater which is discharging into the canal.

CSO controls are needed to prevent the discharge and transport of contaminated CSO solids which are contaminated with comparatively low levels of hazardous substances associated with urban CSO discharges. These solids also serve to capture and concentrate other contaminants. Such controls will ensure the long-term viability of a restored canal.

As noted in the “Site Background” section, above, a number of planned sewer system improvements will decrease the overall CSO discharges to the canal. As a result, the EPA does not foresee a need for additional CSO controls in the lower reaches of the canal, where all of the reductions will occur from the CSO control improvements now underway. Although the WB/WS Plan will achieve an overall estimated 34 percent reduction of CSOs to the canal, discharges at outfall RH-034 at the head of the canal are estimated by NYCDEP to increase by 5 percent. Planned development in the area has the potential to increase sewage flows further, which can contribute to increases in CSO discharges.

The selected remedy will not be inconsistent with the LTCP and the CWA. The canal’s current uses, fishing and recreation, and the physical conditions which lead to frequent flooding with the potential to distribute sediments and sewage contaminated with hazardous substances, provide a further basis for implementing additional contaminated CSO solids controls. Significant residential and commercial redevelopment pressures that exist adjacent to the canal increase the need for sediment, upland and CSO remedy components. However, new construction would be subject to NYC building codes and stormwater rules, updated in 2012, which would help reduce the impacts of such development.

The EPA is committed to achieving cost savings by working closely with NYCDEP to accomplish an effective Superfund cleanup while also realizing CSO benefits necessary to effectively implement the remedy through synergies and economies of scale. NYCDEP will complete a full assessment of achieving CWA goals with submission of the LCTP pursuant to the CSO Consent Order. The LTCP, which is due to the State in June 2015, is expected to address, at a minimum, the EPA's remedial performance goals for further contaminated CSO solids control in the upper reach of the canal.

The design of this Superfund remedy will be informed by NYC's contemporaneous work in developing the LTCP. The EPA will work with NYC to advance both Superfund and CWA goals by allowing NYCDEP the opportunity to evaluate locating CSO control facilities in areas where upland Site-related source removal work might take place, creating a synergy between programs that potentially could save time in Site acquisition and permitting and save significant construction costs. While final selection of the CSO control locations will occur during the remedial design, the EPA has identified the western two-thirds of Thomas Greene Park and the NYC Department of Transportation storage lot located at 2nd Avenue and 5th Street (which is adjacent to the sewage system infrastructure) as potentially suitable locations due to such synergies. Both are owned by NYC, eliminating property acquisition costs. Both parcels are located near the major CSO outfalls, RH-034 and OH-007, which require control.

Thomas Greene Park is part of the former Fulton MGP State Superfund site. Gas storage tanks and other operations were located on the parcels from 1879 until approximately 1938. The coal tar at this parcel and surrounding parcels is a major ongoing source of NAPL to the canal. As an owner of the park, NYC may also be considered liable for its remediation. The eastern third of the park, where no contamination is present, was renovated in 2012-2013. National Grid's RI Report indicates that the western two-thirds of the park contains high levels of MGP contamination at depths of 8 feet or more below the ground surface. Although the RI found that contamination poses no risk to current users of the park, any future renovation project in this area that involved extensive excavation would encounter MGP contaminated soils, and in some places could encounter soils with free liquid tar. Although NYSDEC has not yet selected a remedy for the former Fulton MGP facility, such remedial work on or near the park would be expected to cause temporary disruptions to public use of the park. In the event that excavation of NAPL source areas is necessary at the park, co-location of a CSO retention tank would potentially reduce the costs of both the MGP facility cleanup and the tank construction. Based on other existing CSO retention tank projects, the EPA believes that CSO controls can be integrated into both of the potential tank locations while maintaining their current uses.

Since the EPA is incorporating contaminated CSO solids control in the remedy selection, siting, remedial design and remedial action pursuant to the authority of CERCLA, certain CERCLA statutory authorities including, but not limited to, permit exemption and environmental impact statement functional equivalency apply. The EPA seeks to coordinate the CERCLA and CWA processes to the extent practicable, to ensure that the selected CERCLA remedy is implemented in an effective and timely manner.

Remedy Considerations--Bulkhead Replacement

The condition and appearance of the bulkheads is a matter of significant concern to affected property owners and the public. The cost of temporary shoring of bulkheads is included in the selected remedy. Only limited permanent bulkhead replacement is expected to occur as a direct part of the remedy. Other bulkhead replacement is expected to occur as a result of remedial work conducted by National Grid under NYSDEC oversight, and through re-development projects such as by the Lightstone Group and other developers, as well as via upgrades by private property owners. To facilitate each of these approaches, the EPA has held talks with the USACE, NYSDEC and NYC about cooperative approaches to address bulkhead replacement and restoration along the canal. To the extent that bulkhead replacement occurs, appropriate consideration will be given to bulkhead preservation, aesthetics and the use of soft edges. The restoration effort at the two turning basins will mitigate the loss of surface water area as a result of new bulkhead encroachment into the canal.

The EPA is developing a standard approach which will ensure that the bulkheads are upgraded in a manner consistent with the canal remedy and the substantive requirements of NYSDEC and other agencies. This includes a standardized design, promoting coordination among interested owners to reduce their costs through economies of scale, and application of the CERCLA permit exemption. The EPA has met with several property owners who are interested in replacing their properties' bulkheads. It is expected that bulkhead replacement would be conducted under an appropriate settlement agreement with EPA oversight.

The EPA believes that there are a moderate number of locations where bulkheads are so deteriorated that they may fail when the temporary sheet-piling is removed after dredging. In such cases, the EPA intends to cooperate with NYC on inspection and enforcement of existing NYC bulkhead maintenance requirements and seek to reduce costs for affected bulkhead owners through use of the EPA's standardized approach for design and construction.

While the EPA will continue working with all of the stakeholders, it recognizes that it is not possible to insure that all of the bulkheads that need to be replaced will be replaced. Therefore, some substandard bulkheads may still remain. If the continued presence of such substandard bulkheads is judged to present a threat to the integrity of the canal remedy, available CERCLA authorities and/or resources will be used as necessary to ensure their repair.

STATUTORY DETERMINATIONS

Under CERCLA Section 121 and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Section 121(b)(1) also establishes a preference for remedial actions which employ treatment to permanently and significantly reduce the volume, toxicity or mobility of the hazardous substances, pollutants or contaminants at a site.

For the reasons discussed below, the EPA has determined that the selected remedy meets these statutory requirements.

Protection of Human Health and the Environment

The selected remedy is expected to be protective of human health and the environment. It will meet the RAOs by removing contaminated soft sediment and capping with an active treatment layer to reduce and control the long-term risks associated with the native sediment. Placing this type of active cap over the contaminated native sediment remaining in the canal will significantly reduce exposure to human and ecological receptors, thereby reducing and controlling toxicity to benthic organisms and significantly reducing the risks to herbivorous birds. The cap will also prevent direct contact with NAPL and prevent NAPL migration to the surface water of the canal.[50] Contingent upon the results of bench- and pilot-scale studies to determine the most effective, implementable form of ISS within the canal, the implementation of ISS in targeted areas is expected to provide additional protectiveness against NAPL migration from the native sediment. In the event that an area of ISS is not fully effective, the multilayer cap will provide a redundant level of protectiveness.

Implementation of the selected remedy will improve the surface water quality of the Gowanus Canal by controlling and substantially eliminating sheens and preventing contact of the surface water with the contaminated sediment.

The upland former MGP facility source controls (and other upland source areas) that have been or are anticipated to be selected by NYSDEC are expected to be protective of human health and the environment by controlling the primary source areas and minimizing the migration pathways into the canal.

Implementation of source controls to address CSO-related releases of hazardous

[50] If possible, the treatment layer would be designed to have an adequate life expectancy for absorbing NAPL without replacement. If this is not feasible, the remedy may include the replacement of portions of the treatment layer (replacing the treatment layer would also necessitate the removal and replacement of the overlying sand and armor layers).

substances associated with contaminated CSO solids, beyond those currently being implemented by NYCDEP, is necessary to provide overall protection of human health and the environment. In particular, such controls are necessary to protect the integrity of the canal remedy. By reducing discharges and accumulation of contaminated CSO solids, contaminant concentrations in surface sediments after remedy implementation are expected to meet the cleanup levels, which are considered protective of human health and the environment. Absent additional controls, solids contaminated with hazardous substances will continue to be discharged through the CSOs, affecting sediments in the canal. In addition, absent controls, such solids will continue to adsorb and concentrate any residual, uncontrolled hazardous substance releases, potentially leading to an excursion of the cleanup levels.

Compliance with ARARs and Other Environmental Criteria

A summary of the ARARs and “Other Criteria, Advisories or Guidance TBCs” that will be complied with during implementation of the selected remedy are presented in Table 19.

Cost-Effectiveness

A cost-effective remedy is one whose costs are proportional to its overall effectiveness (NCP §300.430(f)(1)(ii)(D)). Overall effectiveness is based on the evaluations of the following: long-term effectiveness and permanence; reduction in toxicity, mobility and volume through treatment, and short-term effectiveness. Based on the comparison of overall effectiveness (discussed above) to cost, the selected remedy meets the statutory requirement that Superfund remedies be cost-effective in that it is the least-costly action alternative and will achieve the remediation goals in the same amount of time in comparison to the more costly alternatives.

The relationship of the overall effectiveness of the selected remedy was determined to be proportional to its costs and, hence, this remedy represents a reasonable value for the money to be spent.

Each of the alternatives underwent a detailed cost analysis. In that analysis, capital and annual O&M costs were estimated and used to develop present-worth costs. In the present-worth cost analysis, annual O&M costs were calculated for the estimated life of the groundwater alternatives using a 7% discount rate and a 30-year interval.

The estimated capital cost is $285,700,000. The estimated treatment and disposal costs is $216,000,000. The estimated annual operation, maintenance and monitoring costs (using the federal standard 7% discount rate and a 30-year interval) is $4,400,000 (the cost includes O&M related to the in-line retention tanks). The estimated present-worth cost is $503,700,000.

Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The selected remedy provides the best balance of tradeoffs among the alternatives with respect to the balancing criteria set forth in NCP §300.430(f)(1)(i)(B), such that it represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the Site.

Dredging of the contaminated soft sediments, targeted ISS of native sediment in areas with potential for active upward NAPL migration from the native sediment and stabilization and thermal treatment of the dredged sediments prior to off-Site disposal provide a permanent remedy and employ treatment technologies to reduce the toxicity, mobility and volume of the contaminants.

Preference for Treatment as a Principal Element

Elevated contaminant concentrations and visual evidence of the presence of NAPL exist in the canal. The NAPL and contaminated sediments are mobile, at least when disturbed, have high concentrations of toxic compounds and present significant risks. Therefore, they are characterized as principal threat wastes. The EPA's statutory preference for treatment of principal threat materials has been considered as part of this remedy. The selected remedy addresses source materials constituting principal threats by thermally treating the NAPL-impacted sediments dredged from the upper and mid-reaches of the canal, and through the application of ISS to targeted NAPL areas of native sediment, thereby satisfying the preference for treatment.

Five-Year Review Requirements

Because this remedy will result in hazardous substances, pollutants or contaminants remaining on Site above levels that allow for unlimited use and unrestricted exposure to Site media, a statutory review will be conducted within five years after initiation of the remedial action. The five-year review will evaluate the results from monitoring programs established as part of this remedy and developed during the design to ensure that the remedy remains protective of human health and the environment.

DOCUMENTATION OF SIGNIFICANT CHANGES

During the public comment period, significant concerns were expressed about the option of stabilizating the lesser contaminated sediments dredged from RTA 3 and then placing them in an on-Site CDF. As a result of the concerns, this disposal option was eliminated from consideration. These sediments will be disposed of in the same manner as the RTA 1 non-NAPL impacted area sediments, utilizing Option D under which the sediments will be stabilized off-Site and beneficially reused to the extent possible.

Based upon suggestions made during the public comment period, the remedy will also include the excavation and restoration of the portion of the 5th Street turning basin beginning underneath the 3rd Avenue bridge and extending approximately 25 feet to the east and the installation of a barrier or interception system at the eastern boundary of the excavation. This parcel is a small part of an area that was previously referred by the EPA to NYSDEC for investigation as an additional upland source area.

References

AECOM Consultants. 2009. *Background Sediment Statistical Evaluation, Appendix O to Remedial Investigation East 21st Street Works Operable Unit 2 Site No. V00536.* July 2009

Brown Marine Consulting. 2000. Gowanus Canal Bulkhead Inventory Survey. Prepared for Gowanus Canal Community Development Corporation. July 2000.

Brown, J.S., E.D. Stein, D. Ackerman, J.H. Dorsey, J. Lyon and P.M. Carter. 2011. *Metals and Bacteria Partitioning to Various Size Particles in Ballona Creek Stormwater Runoff*. pp. 48-60 in: Kenneth Schiff and Karlene Miller (eds.), Southern California Coastal Water Research Project 2011 Annual Report. Southern California Coastal Water Research Project. Costa Mesa, CA.

Burgess, R.M. 2009. *Evaluating Ecological Risk to Invertebrate Receptors from PAHs in Sediments at Hazardous Waste Sites. EPA/600/R-06/162F. October 2009.*

Engstrom, A.M. 2004. *Characterizing Water Quality of Urban Stormwater Runoff: Interactions of Heavy Metals and Solids in Seattle Residential Catchments.* Thesis, Department of Civil and Environmental Engineering, University of Washington, Seattle, Washington. 117 pp.

EPA (U.S. Environmental Protection Agency). 1997. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*. Interim Final. OSWER 9285.7-25, EPA/540/R-97/006. June 1997.

EPA (U.S. Environmental Protection Agency). 1998. *Sediment Quality of the NY/NJ Harbor System. EPA/902-R-98-001*. March 1998.

EPA (U.S. Environmental Protection Agency). 2003. *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures*. EPA-600-R-02-013. Office for Research and Development.

Washington DC.

EPA (U.S. Environmental Protection Agency). 2003a. *Human Health Toxicity Values in Superfund Risk Assessments,* OSWER 9285.7-53, December 5, 2003.

EPA (U.S. Environmental Protection Agency). 2013. *Ebullition and NAPL Migration*, 2013.

GEI (GEI Consultants, Inc.) 2005. *Final Remedial Investigation Report, Carroll Gardens/Public Place, Brooklyn, New York, VCA Index No. A2-0460-0502*; Site No.V00360-2. October 2005.

GEI (GEI Consultants, Inc.). 2007. *Draft Remedial Investigation Technical Report, Gowanus Canal, Brooklyn, New York, ACO Index No. A2-0523-0705.* April 2007.

GEI (GEI Consultants, Inc.). 2011. *Sediment and Surface Water Sampling Winter Summary Report, Gowanus Canal Superfund Site, Brooklyn, New York, EPA ID No. NYN000206222.* Prepared for National Grid. October.

GEI (GEI Consultants, Inc.). 2012a. *Sediment and Surface Water Sampling Summer Summary Report, Gowanus Canal Superfund Site, Brooklyn, New York, EPA ID No. NYN000206222*. Prepared for National Grid. July.

GEI (GEI Consultants, Inc.). 2012b. *Sediment and Surface Water Sampling Spring Summary Report, Gowanus Canal Superfund Site, Brooklyn, New York, EPA ID No. NYN000206222*. Prepared for National Grid. December.

Grant, S.B., N. Rekhi, N. Pice, R. Reeves, M. Matsumoto, A. Wistrom. L. Moussa, S. Bay and M. Kayhanian. *A review of the Contaminants and Toxicity Associated with Particles in Stormwater Runoff*. Prepared for the California Department of Transportation, Sacramento, CA. 2003.

Hwang, H. and G.D. Foster. *Characterization of Polycyclic aromatic Hydrocarbons in Urban Stormwater Runoff Flowing into the Tidal Anacostia River, Washington, DC*, USA. Environmental Pollution (140), 416-426. 2005.

Hunter Research, Inc. *Final Report National Register of Historic Places Eligibility Evaluation and Cultural Resources Assessment for the Gowanus Canal , Borough of Brooklyn, Kings County, New York in Connection with the Proposed Ecosystem Restoration Study*. Prepared by Hunter Research, Rabner Associates and Northern Ecological Associates, December 2004.

New York City Department of Environmental Protection. 2007. *Receiving Water Quality*

Monitoring Report, Volume 4, Gowanus Canal. September 2007.

New York City Department of Environmental Protection. 2008b. *NYCDEP Shoreline Survey Report*. NYC Department of Environmental Protection. March 2008.

New York City Department of Environmental Protection. 2008a. *Gowanus Canal Waterbody/Watershed Facility Plan Report.* NYC Department of Environmental Protection, Bureau of Engineering Design and Construction. City-Wide Long Term CSO Control Planning Project. August 2008.

New York City Department of Environmental Protection. 2012. *Guidelines for the Design and Construction of Stormwater Management Systems.* July 2012.

New York City Department of Environmental Protection. 2013. *Amphipod Data Report* 2013.

Reible, Danny. *In Situ Sediment Remediation Through Capping: Status and Research Needs*. Invited Paper/Presentation for SERDP Workshop on Research Needs in Contaminated Sediments (Proceedings Published October 2004).

Sale, Tom/Department of Civil and Environmental Engineering, Colorado State University, Fort Collins. 2011. Personal communication with Jeff Gentry/CH2M HILL. January 1, 2011.

Stein, Eric D. *et al.*, “Watershed-Based Sources of Polycyclic Aromatic Hydrocarbons in Urban Stormwater,” *Environmental Toxicology and Chemistry*, Vol. 25, No. 2, pp. 373–385, 2006.

Viana, Priscilla, Ke Yin, Xiuhong Zhao and Karl Rockne. 2007b. *Active Sediment Capping for Pollutant Mixtures: Control of Biogenic Gas Production Under Highly Intermittent Flows--Land Contamination & Reclamation.* 15(4), 413-42. June 2007.

Prepared for

National Grid
One MetroTech Center
Brooklyn, NY 11201

REMEDIAL DESIGN WORK PLAN

GOWANUS CANAL SUPERFUND SITE
BROOKLYN, NEW YORK

Prepared by

Geosyntec consultants

engineers | scientists | innovators

Project Number HPH104

February 2014

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

TABLE OF CONTENTS (Continued)

LIST OF ACRONYMS

AOC	Administrative Order of Consent
APA	Air Pathway Analysis
AUD	Acceptable Use Determination
ARAR	Applicable or Relevant and Appropriate Requirements
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CQA	Construction Quality Assurance Plan
CRP	Community Relations Plan
CSM	Conceptual Site Model
CSO	Combined Sewer Overflow
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DEC	Department of Environmental Conservation
DOT	Department of Transportation
ECL	Environmental Conservation Law
EPA	Environmental Protection Agency
ERP	Emergency Response Plan
FS	Feasibility Study
FSP	Field Sampling Plan
FT	Flushing Tunnel
HASP	Health and Safety Plan
ISS	In-Situ Stabilization
MGD	Million Gallons per Day
MGP	Manufactured Gas Plant
MLLW	Mean Lower Low Water
MTA	Metropolitan Transit Authority
NAPL	Non-aqueous Phase Liquid
NJ	New Jersey
NJAC	New Jersey Administrative Code
NJPDES	New Jersey Pollutant Discharge Elimination System
NPL	National Priorities List
NY	New York
NYC	New York City
NYCDEP	New York City Department of Environmental Protection
NYD	New York District
NYSDEC	New York State Department of Environmental Conservation
NYS	New York State
OSWER	Office of Solid Waste and Emergency Response
PAH	Polycyclic Aromatic Hydrocarbons

TABLE OF CONTENTS (Continued)

PCB	Polychlorinated Biphenyls
PD	Pre-Design
PDWP	Pre-Design Work Plan
POTW	Publicly Owned Treatment Works
PRP	Potentially Responsible Party
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RA	Remedial Action
RAO	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RD/RA	Remedial Design/Remedial Action
RDWP	Remedial Design Work Plan
RI	Remedial Investigation
ROD	Record of Decision
RPM	Remedial Project Manager
RTA	Remediation Target Areas
SMP	Site Management Plan
SOW	Scope of Work
SPDES	State Pollutant Discharge Elimination System
TSCA	Toxic Substances Control Act
UAO	Unilateral Administrative Order
UFP	Uniform Federal Policy
USACE	Army Corps of Engineers
WQC	Water Quality Certification
WWTP	Wastewater Treatment Plant

1. INTRODUCTION

1.1 Terms of Reference

This Remedial Design Work Plan (RDWP) has been developed for the Gowanus Canal Superfund Site (the Site) under the Administrative Order and Settlement Agreement for Investigation, Sampling and Evaluation dated April 29, 2010, (AOC) as amended on January 24, 2014 (the AOC Amendment). The AOC Amendment covers only the development of those portions of the RDWP detailed in the scope of work (SOW) attached to the AOC Amendment (AOC Attachment A). The RDWP is a necessary step in developing the technical activities required by the Record of Decision (ROD) dated September 27, 2013 (EPA, 2013), and provides the framework needed to guide the remedial design.

Implementation and completion of the RDWP activities will be performed under a Unilateral Administrative Order (UAO) by a group of potentially responsible parties (PRP Group) identified by the United States Environmental Protection Agency (EPA). The RDWP work elements will be further developed under the UAO, and this RDWP does not commit any party to performing the work described herein.

Per the ROD, certain activities such as addressing CSOs and excavation of the First Street turning basin are being addressed by New York City (NYC) and are not a part of this RDWP.

1.2 Objectives of the RDWP

The goal of the RDWP is to provide a plan and guidance for conducting the remedial design for the risk mitigation remedy for the Site. Specific objectives of this RDWP include:

1. Comply with regulatory requirements for the remedial design (RD).
2. Provide a framework of the RD process.
3. Develop a shared understanding of the RD needs and process among the PRP Group and EPA for incorporation into the RD.

1.3 Overview of the RD Process

The AOC Amendment provides the basic framework for conducting the RD. The AOC Amendment specifies completing the RD in four phases of work:

1. 35% completion – preliminary design report
2. 65% completion – intermediate design report
3. 90% completion – pre-final design report
4. 100% completion – final design report

The contents of these submittals are described in Section 4. In addition, there are a number of pre-design and remedial design investigations and evaluations required for the Site RD. These tasks are also identified in Section 4.

Each phase of the RD includes a document submittal, i.e., a design report, and allows for EPA comment. At each phase, EPA comments on the design report will be incorporated into the submittals for the subsequent phase. The 100% submittal will reflect comments received on the 90% submittal and will be the final design submittal. This 100% submittal will be the basis of the bid documents issued to procure the remedial action (RA) implementation contractor(s).

The planned remedial action for the Site is a large and complex effort. The ROD remedy requires several key design components; these are identified in Section 3. The plan is to address these components in separate design efforts as described in Section 4. These design components may be combined into multi-component bid packages for bidding and execution.

1.4 Remedial Objectives

In the ROD, EPA established performance standards that include Remedial Action Objectives (RAOs) for the Site.

- Reduce the cancer risk to human health from the incidental ingestion of and dermal contact with polycyclic aromatic hydrocarbons (PAHs) in sediment during recreational use of the Canal or from exposure to Canal overflow to levels that are within or below the EPA's excess lifetime cancer risk range of 10^{-6} to 10^{-4}.

- Reduce the contribution of polychlorinated biphenyls (PCBs) from the Site to fish and shellfish by reducing the concentrations of PCBs in Site and sediment to levels that are within the range of Gowanus Bay and Upper New York Bay reference concentrations.

- Reduce the risks to benthic organisms in the Canal from direct contact with PAHs, PCBs, and metals in the sediments by reducing sediment toxicity to levels that are comparable to reference conditions in Gowanus Bay and Upper New York Bay.

- Reduce the risk to herbivorous birds from dietary exposure to PAHs.

- Eliminate the migration of non-aqueous phase liquid NAPL into the Canal so as to minimize NAPL serving as a source of contaminants, primarily PAHs, to the Canal.

1.5 Remedial Design Organization Structure

The Site RD and RA will be a collaborative effort between the PRP Group, EPA, and New York State Department of Environmental Conservation (NYSDEC). The general roles for these key entities implementing the RDWP are as follows:

- **EPA:** EPA is the lead governmental agency for the Site. EPA will oversee all aspects of the RD/RA. Mr. Christos Tsiamis is the Remedial Project Manager (RPM) for EPA.

- **EPA RD Oversight Contractor:** The EPA RD Oversight Contractor assists EPA with oversight of the RD, RD site activities, and other technical aspects of the completion of the RD. CH2M Hill will serve in this role.

- **NYSDEC:** NYSDEC is the support agency to EPA for the Site. NYSDEC will review and provide its input or concurrence as needed during completion of the RD/RA. Additionally, NYSDEC is the lead governmental agency for mitigation of upland sites adjacent to the Site and thus for oversight of upland source control design.

- **Respondents to UAOs:** The respondents to the UAOs are the PRP Group. The PRP Group is responsible for executing the RD.

- **Project Coordinator:** The Project Coordinator has yet to be identified. The Project Coordinator will act as a liaison between EPA, the PRP Group, and RD contractors and subcontractors. The Project Coordinator will verify that the RD activities are performed in accordance with the UAO and ROD.

- **RD Contractor:** The RD Contractor has yet to be identified. Geosyntec Consultants has prepared this RDWP as RD Contractor under the interim AOC. The RD Contractor will fulfill the requirements of the AOC and subsequent UAOs specific to RD of the EPA-selected remedy.

- **RD Subcontractors:** RD Subcontractors to the RD Contractor have yet to be identified.

1.6 Remedial Design Work Plan Organization

The RDWP is presented in eight sections, as introduced below.

- **Section 1. Introduction:** Information on the RDWP objectives, the RD process, EPA and Group objectives for the RA, the RD organizational structure, and an overview of the contents of the RDWP

- **Section 2. Background:** Summary of Site information (description and history), the ROD-specified remedy requirements, companion documents to the RDWP, a current list of guidance documents, and related efforts that will have an impact on the RA

- **Section 3. Remedy Description:** Overview of the remedy and description of specific design elements

- **Section 4. Remedial Design Submittals:** General description of the major design submittals (35%, 65%, 90%, and 100%)

- **Section 5. Regulatory Requirements:** Summary of the anticipated regulatory programs and requirements that apply to the RD and RA
- **Section 6. Implementation of Green Remediation Practices:** Overview of how green remediation practices will be incorporated into the RD and be implemented in the RA
- **Section 7. Remedial Design Milestones:** Current RD schedule
- **Section 8. References:** References cited in the RDWP

2. BACKGROUND INFORMATION

2.1 Site Description

The Gowanus Canal (the Canal) is a 1.8-mile-long man-made canal constructed within the former Gowanus Creek in the Borough of Brooklyn in New York City (NYC), Kings County, New York. The Canal is located in a mixed residential-commercial-industrial area. It borders several residential neighborhoods, including Gowanus, Park Slope, Cobble Hill, Carroll Gardens, and Red Hook, with housing located within one block of the Canal. The waterfront properties abutting the Canal are primarily commercial and industrial. Re-zoning of Canal-front parcels to high density residential began in 2009 and further such re-zoning is anticipated.

There are five east–west surface streets with bridges that cross over the Canal: Union Street, Carroll Street, 3rd Street, 9th Street, and Hamilton Avenue. Hamilton Avenue is a divided roadway with two bridges spanning the Canal. The Gowanus Expressway and a viaduct for Metropolitan Transit Authority (MTA) subway trains also pass overhead. The Gowanus Expressway is co-located with Hamilton Avenue bridges and the MTA viaduct is co-located with the 9th Street bridge.

North of Hamilton Avenue, the Canal is approximately 5,600 feet long with a maximum water depth of approximately -15 feet mean lower low water (MLLW) in the main channel. The Canal is approximately 100 feet wide though there are narrower sections. There are four short turning basins that branch to the east of the main channel at 5th Street, 6th Street, 7th Street, and 11th Street. A former turning basin at 1st Street and an extension of the 5th Street turning basin were filled in between 1953 and 1965, and an extension of the 7th Street turning basin has also been filled. South of Hamilton Avenue, the Canal widens to a maximum of approximately 2,200 feet and ranges in depth from -15 to -35 feet MLLW.

The Gowanus Canal has no remaining natural shoreline or natural wetlands, though various small, unconnected areas of vegetation and intertidal habitat exist. The vast majority of the shoreline of the Canal is lined with retaining structures or bulkheads. Additional details regarding Site location and background are provided in the Pre-Design Work Plan (PDWP) (Geosyntec Consultants, 2014).

2.2 Site History

While development of the Canal began as early as 1767 (Hunter Research, Inc., et al., 2004), the Canal was officially authorized in 1848 by the State of New York for the dual purposes of draining the wetlands of South Brooklyn and opening the area to development. The Canal was constructed between 1853 and 1869 and was designed as a conveyance channel for barges (NYC Department of City Planning, 1985). By 1869, the Canal was reported as being complete, with the current street configuration surrounding the Canal. The Canal enabled easy transportation and storage of bulk materials such as coal, petroleum, asphalt, and lumber to support the rapid growth of industry in Brooklyn and surrounding areas. The construction of the Gowanus Expressway in 1951 essentially eliminated the need for the Canal to be used for transportation purposes; however, it was still used for manufacturing and storage.

The Canal has also served in the conveyance of sewage and industrial wastes as part of the development and industrialization of the area. By 1889, the Canal waters were heavily impacted by sewage and industrial discharges and were considered a public health hazard and a hazard to travel in the Canal. In 1889, the City of Brooklyn constructed storm sewer outfalls that drained the Fort Greene section of Brooklyn to the head of the Canal in an effort to improve flow/tidal exchange within the Canal; however, the effort was unsuccessful and only contributed to water quality degradation in the Canal.

In 1911, the Gowanus Canal Flushing Tunnel (FT) was constructed to pull the relatively cleaner waters of Gowanus Bay into the Gowanus Canal while discharging impacted water at the head of the Canal to the Buttermilk Channel via a propeller and underground tunnel. The FT imported approximately 300 million gallons per day (mgd) of water from the Gowanus Bay into the Canal, and operated from 1911 until 1960 when mechanical failure rendered the pump inoperable (Hunter Research, Inc., et al., 2004). With the FT inoperable, siltation of the Canal occurred and Canal water quality returned to its degraded state. The FT has since gone through several periods of reactivation and closure and reversal of the flow to discharge waters out to Gowanus Bay. The most recent activation of the FT occurred in December 2013 and it is expected that that the FT will be active during remedial design for the Canal, as addressed in Section 2.6.2.

In April 2009, the Site was proposed for inclusion on the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at the request of NYSDEC. EPA commenced a remedial investigation (RI) following the proposal for inclusion on the NPL, and on March 2, 2010, EPA placed the Site on the NPL. EPA completed a feasibility study (FS) in December 2011 and issued an addendum to the FS in December 2012, along with the Proposed Remedial Action Plan for the Site (EPA, 2013).

2.3 ROD Remedy Requirements

The ROD for the Site documents EPA's selection of required remedial actions (RAs) for the contaminated sediments and source controls. To facilitate assessment and management, the Canal was divided into three remediation target areas (RTAs) that correspond to the upper reach (RTA 1), middle reach (RTA 2), and lower reach (RTA 3) as shown in Figure 2-1.

The RA components, as presented in the ROD, to address contaminated sediment include the following:

- Dredging of the entire column of hazardous substance-contaminated sediments that have accumulated above the native sediments in the upper and mid-reaches of the Canal (referred to as "soft sediments").

- In-situ stabilization (ISS) of native sediments in select areas in RTA 1 and RTA 2 of the Canal contaminated with high levels of NAPL that are upwardly mobile.

- Construction of a multilayered cap in the upper and mid-reaches of the Canal to isolate and prevent the migration of PAHs and residual NAPL from native sediments.

- Dredging of the entire soft sediment column in the lower reach of the Canal.

- Construction of a multilayered cap to isolate and prevent the migration of PAHs from native sediments in the lower reach of the Canal.

- Off-site treatment of the NAPL-impacted sediments dredged from the upper and mid-reaches of the Canal with thermal desorption, followed by beneficial reuse off-site (e.g., landfill daily cover) if possible.

- Off-site stabilization of the less contaminated sediments dredged from the lower reach of the Canal and the sediments in the other reaches not impacted by NAPL, followed by beneficial reuse off-site.

- Excavation and restoration of approximately 475 feet of the filled-in former 1st Street turning basin.

- Excavation and restoration of the portion of the 5th Street turning basin beginning underneath the 3rd Avenue bridge and extending approximately 25 feet to the east, and the installation of a barrier or interception system at the eastern boundary of the excavation.

- Implementation of institutional controls incorporating the existing fish consumption advisories (modified as needed), as well as other controls to protect the integrity of the cap.

- Periodic maintenance of the cap and long-term monitoring to ensure that the remedy continues to function effectively.

- Interim and permanent controls on combined sewer overflow (CSO) events.

The excavation of the 1st Street turning basin and the CSO controls are being directed by NYC and designs for those activities are not included in this RDWP.

2.4 AOC Amendment Requirements

The AOC Amendment provides requirements for the RD effort. This includes specific RD elements which are presented in Table 2-1. These tasks are referenced in the description of the remedial design and design reports provided in the Section 4 tables.

Table 2-1 includes a citation for each of the specific work elements referenced as RD tasks.

2.5 Companion Documents

Companion documents to this RDWP are listed in Table 2-2. This list of documents will be updated periodically throughout the RD process.

The listed documents include the Pre-design Work Plan (PDWP). The PDWP specifies pre-design activities (e.g., PD-5 - Bulkhead condition assessment study) that are cited in the RDWP for reference.

2.6 Key Guidance Documents

Key guidance documents to be utilized in the RD are presented in Table 2-3. This list of documents will be updated periodically throughout the RD process.

2.7 Related Efforts

2.7.1 Upland Site Remediation

Impacted upland areas along the Canal could cause recontamination post-remedy by erosion from the surface and through bulkheads in disrepair. Thus, the ROD requires that upland sources of hazardous substances be addressed prior to the commencement of, or in phased coordination with, the RAs listed in Section 2.3.

Upland sources include migration from three former manufactured gas plants (MGPs), discharges from CSOs, other contaminated upland areas, and unpermitted pipes along the Canal. Discharges from CSOs will be addressed by NYC. The selected RAs to address other contaminated upland areas (other than the former MGP facilities) will be coordinated between the EPA and NYSDEC.

National Grid is currently working with NYSDEC to design and implement remedies at former MGP facilities (the former Fulton, Metropolitan, and Citizens MGP sites) bordering the Canal. (Note: The former Citizens MGP Site is referred to as the Carroll Gardens and Public Place site in various regulatory documents.) Potential RAs include removal of mobile sources, construction of cut-off walls along the Canal, and active recovery of NAPL near the cut-off walls for each of the former MGP facilities. The remediation goal is to prevent migration of contamination from the former MGP facilities into the Canal. Cleanup of the former MGP facilities will be completed in accordance with schedules agreed upon among National Grid and NYSDEC.

2.7.2 Flushing Tunnel Operation

Through the Gowanus Facilities Upgrade project, the NYC Department of Environmental Protection (NYCDEP) is in the process of upgrading the FT from a single pump system to a three pump system. This upgrade is intended to provide additional capacity and necessary redundancy to maintain operation with one or two pumps out of service for maintenance or repairs, and allow for continuous operation throughout the tidal cycle. The projected flow range for the upgraded system is 175 mgd at low tide to 250 mgd at high tide, with an average flow of approximately 215 mgd. The upgraded system will incorporate variable frequency drives to allow the pump speed and flow rate to be adjusted according to the tides. With these upgrades, combined with the Gowanus Wastewater Pump Station improvements to increase the pumping capacity to the Red Hook Wastewater Treatment Plant (WWTP), the untreated wastewater effluent discharge to the Canal is predicted to decrease by approximately 34 percent (EPA, 2013). The FT and pump station improvements are anticipated to be completed by September 2014 (EPA, 2013).

Reactivation of the FT is expected to cause redistribution of contaminated solids from the upper portion of the Canal. This will impact and alter the distribution of contaminated sediment within the Canal and will affect the characteristics of future sediment deposition. Accordingly, pre-design activities will be performed to characterize the FT impacts, including a bathymetric survey, additional sediment sampling and data collection, and refinements of sediment and hydrodynamic models to reflect FT operation (Geosyntec Consultants, 2014). Additionally, NYCDEP is expected to perform post-construction monitoring to assess the impacts of the FT system upgrades on Canal sediments (EPA, 2013). Data and information collected after the FT activation to full capacity will be integrated into a revised conceptual site model (CSM) and used to refine sediment and hydrodynamics models to inform the remedial design as necessary (Geosyntec Consultants, 2014).

2.7.3 CSO Mitigation

CSO RAs are not addressed in this RDWP and it is expected that the RAs will be addressed by NYC.

There are ten active CSOs and three stormwater outfalls discharging to the Canal, four of which account for 95 percent of the annual discharge. The CSO discharges result in point source loading of high-organic-content solids and associated hazardous substances to the Canal (EPA, 2013).

The ROD requires CSO control measures for the Canal, including the construction of 8M gallon and 4M gallon in-line tanks to retain combined wastewater and stormwater which currently discharges through outfalls RH-034 and OH-007. The CSO retention tanks will also accommodate loads from current and future residential development and periods of high rainfall, and will comply with requirements of the Clean Water Act (CWA) and work in concert with

NYC WWTPs (EPA, 2013). The ROD requires the CSO control measures will be in-place prior to implementation of the Canal sediment remedies. If necessary, temporary CSO control measures may be implemented while the permanent CSO control measures are being completed.

2.7.4 First Street Turning Basin

The ROD requires excavation and restoration of a portion of the 1st Street turning basin. RAs for the 1st Street turning basin are not addressed in this RDWP and it is expected that the RAs will be addressed by NYC. Excavation and restoration activities will completed in phased coordination with the other Canal sediment remedies. These activities will need to be coordinated with the Site RD and RA activities.

Excavation of material in this area will remove contaminants, thereby reducing the risk of recontamination to the Canal, but is also necessary for the implementation of the sediment remedies and future maintenance of the remedy and Canal infrastructure. The restoration will mitigate the loss of surface water area as a result of new bulkhead encroachment into the Canal.

3. REMEDY DESCRIPTION

The ROD specifies RAs and source control measures for the Site, as summarized in Section 2.3. Specific RD components of the ROD remedy addressed in this RDWP are presented below and summarized in Table 3-1.

3.1 Bulkhead Repair or Replacement

The need for bulkhead repair and/or replacement along the Canal is anticipated in order to support sediment removal operations, control sources into the Canal, and prevent recontamination of the Canal following remedy implementation. It is anticipated that temporary sheet piling will be required for dredging and capping in locations where the condition of bulkheads warrants additional structural support. Although not part of the Site RA, at the former MGP facilities, bulkhead replacement will likely be a component of the upland site remedy. Other areas where significant NAPL occurs at shallow depths in the banks of the Canal may also require bulkhead replacement in conjunction with construction of subsurface barrier walls. Elsewhere, it is anticipated that bulkhead replacement will not be part of the remedy unless an existing bulkhead is judged to be unstable and present an impediment to construction or a threat to the integrity of the remedy. It is anticipated that a portion of the existing bulkheads will be upgraded before dredging so as to not require temporary shoring.

The bulkhead repair or replacement design process will be initiated through a series of pre-design investigations to assess bulkhead stability along the Canal and identify locations where bulkhead repair or replacement is needed. The design of bulkhead repair or replacement will be conducted under the RDWP by individual PRPs.

During the bulkhead repair or replacement design process, appropriate consideration will be given to bulkhead preservation and archeological significance. Replacement of bulkheads will likely involve driving sheet piles on the outboard side of the existing bulkheads thereby reducing the open water area of the Canal. However, the restoration efforts at the 1st Street and 5th Street turning basins will mitigate the loss of surface water area as a result of new bulkhead encroachment into the Canal.

According to the ROD, EPA is developing a standard approach that will ensure that the bulkheads are upgraded in a manner consistent with the Canal remedy and the substantive requirements of NYSDEC and other agencies. This includes a standardized design, promoting coordination among interested owners to reduce their costs through economies of scale, and application of the CERCLA permit equivalency. It is expected that bulkhead replacement will be conducted by individual property owners under separate settlement agreements with EPA oversight.

3.2 Excavation/Restoration of the 5th Street Turning Basin

The ROD-prescribed RA for the 5th Street turning basin is excavation and restoration beginning underneath the 3rd Avenue bridge and extending approximately 25 feet to the east. The footprint of the excavation area will be determined through the remedial design process during pre-design investigations in the target area. Excavated material will be managed as appropriate based on existing data and results from pre-design characterization investigations, as needed. A groundwater barrier or interception system at the eastern boundary of the excavation will be installed if warranted for source control. The specifications of the groundwater barrier will be dependent on groundwater modeling and treatment needs as determined during the remedial design process.

3.3 Dredging

Dredging of Canal bottom sediments from all three RTAs is required to remove sources of contamination and to provide water depths for navigational needs (EPA, 2013). The bases for specific removal efforts are outlined in Section 2.3. All soft sediment is to be removed from the Canal with some native sediment also removed to provide navigational depth. The native sediment surface elevation is variable within the Canal and ranges from -11.8 feet to -44.2 feet NAVD88; therefore, there is not a single specific removal depth for the Canal. In RTA 2, a navigation depth of -16 feet NAVD88 is assumed based on present commercial navigational needs. Therefore, all of the soft sediment and some native sediment would be removed to accommodate the cap thickness and allow for continued commercial vessel use in this reach.

The projected volumes of contaminated sediment to be removed as listed in the ROD are:

- 82,000 yd^3 from RTA 1;
- 225,000 yd^3 from RTA 2; and
- 281,000 yd^3 from RTA 3

The dredge prism will be refined prior to sediment removal operations as part of the design process. Total volumes of sediment and dredge depths will be verified though desktop and in-field confirmation pre-design steps. The dredge prism may be altered in each RTA due to Flushing Tunnel operations, which are predicted to mobilize and redistribute sediment from RTA 1. Hydrodynamics and sediment transport models will be used to refine dredge prism estimates.

Prior to sediment removal, debris reconnaissance and removal of large debris will be conducted to remove dredging obstructions from the waterway. The debris removal efforts are expected to include a pilot study to evaluate the most efficient and practical manner to remove the obstructions and limit sediment resuspension and water quality impacts. During debris reconnaissance and removal, appropriate consideration will be given to management and preservation of cultural resources. (Note: Debris removal is an integral part of the dredging effort and as such is included as a dredging activity even though it was discussed as a separate item in the PDWP.)

Sediment removal and post-removal management will be addressed as part of the design process.

3.4 Capping

A multilayered cap will be placed on top of the native sediment surface following sediment removal to limit NAPL and PAH transport in RTAs 1 and 2, and to limit PAH transport in RTA 3. The cap will consist of an armor layer, an isolation layer and an active treatment layer.

- Armor layer: Stone will be sized to resist the erosional forces of the Flushing Tunnel and navigation impacts. Sufficient sand will be placed on top of the armor layer to fill in the voids between the stones and to establish sufficient depth of soft sediment to serve as benthic habitat. Hydrodynamic modeling will be conducted to design the gradation of the armor layer and the stability of the benthic habitat layer.

- Isolation layer: Sand and gravel will provide transition and erosion protection for the treatment layer material from the overlying heavier armor layer. The ROD provides a conceptual thickness of this layer of approximately 1 foot thick, consisting of 0.5 feet of gravel and 0.5 feet of sand. The isolation layer will be designed together with the treatment layer to provide adequate treatment capacity and meet navigational depth requirements.

- Treatment layer: A chemical treatment layer will be designed to limit the transport of PAHs and NAPL through the cap in RTAs 1 and 2 and PAHs through the cap in RTA 3. The ROD specified oleophilic clay to address potential NAPL migration in RTAs 1 and 2; however, a site-specific design will be developed based on site material properties, contaminant flux, and the results of laboratory treatability studies. The ROD provided a conceptual thickness of 1 foot of oleophilic clay in RTA 1 and RTA 2 and 0.5 feet of an oleophilic clay-sand mixture in RTA 3, with the specific configuration to be determined during the remedial design. Geotechnical testing of the treatment layer materials will be conducted to assess the structural integrity of the materials upon loading with the isolation and armor layers.

The cap designs in RTAs 1 and 2 will be contingent upon performance evaluations of the ISS component of the remedy, the boundaries of the ISS remedy implementation, groundwater upwelling discharge rates, and modeled contaminant flux. As such, multiple cap designs may be developed for each RTA to address specific, localized conditions. NAPL expression upon cap loading will also be evaluated during design, and the sequence of cap placement operations will be critically evaluated to manage NAPL and pore water expression.

Geotechnical loading and stability analyses will be conducted to assess the bearing capacity and expected settlement of the underlying native sediment when loaded with caps of various design gradation and thicknesses.

A capping pilot study is anticipated as part of the remedial design to provide information on the implementability, construction practices, stability, performance, and monitoring approaches related to the multilayered cap. The pilot test will be conducted following laboratory treatability testing to select the most appropriate cap amendment technologies. The capping study will also include hydrodynamic and sediment transport modeling to support the cap design.

Periodic maintenance of the cap and long-term physical and chemical monitoring programs will be developed to monitor the integrity of the cap. The cap will be designed to accommodate future maintenance dredging operations in the Canal for the removal of contaminated solids that will be deposited during CSO events. The cap design will also consider appropriate institutional controls incorporating the existing fish consumption advisories (modified as needed) and controls to protect the integrity of the cap and limit construction within the Canal (such as bulkhead maintenance and navigation dredging).

3.5 <u>In Situ Stabilization</u>

For RTAs 1 and 2, ISS will be applied to targeted areas of native sediment to immobilize NAPL with upward migration potential. In-water ISS is relatively unprecedented for large sediment sites and pre-design investigations will be performed to evaluate ISS utility, determine the potential for NAPL mobility under measured specific groundwater upwelling discharge rates, and refine the boundaries of potential implementation. Further laboratory and field investigations will be conducted to delineate areas of potentially mobile NAPL as a result of groundwater upwelling.

The ROD states that ISS will be performed to a depth of 3 to 5 feet into the native sediment and would consist of in situ mixing of pozzolanic and/or adsorptive additives into the native sediment to stabilize NAPL in place. The horizontal and vertical boundaries of the ISS RA will be determined during the remedial design. ISS would be applied to areas where investigative data indicate the potential for active, upward NAPL migration from the native sediment. The stabilization material would be delivered to the sediment in situ from a barge using large augers (without dewatering the Canal). Water quality controls during implementation will be developed during the remedial design.

3.6 <u>Ex Situ Sediment Treatment</u>

Dredged sediment will undergo treatment and disposal for an approved end-use based on the properties of the sediment and treatment efficiencies. As described in the ROD, the planned disposition of the dredged sediments will be as follows:

- RTA 1: For sediment impacted with NAPL, off-site thermal desorption followed by beneficial use depending on the availability of technology. For sediment not impacted with NAPL, off-site stabilization followed by beneficial use.

- RTA 2: For sediment impacted with NAPL, off-site thermal desorption followed by beneficial use depending on the availability of technology. For sediment not impacted with NAPL, off-site stabilization followed by beneficial use.

- RTA 3: Off-site stabilization followed by beneficial use at a permitted facility location.

The thermal desorption approach is described in the ROD as consisting of transporting dredged and dewatered sediments by barge to an off-site commercial facility for stabilization, followed by transport of the stabilized sediment to another off-site facility for treatment by thermal desorption (if a separate thermal processing facility (from the stabilization facility is used). This description is not entirely accurate in terms describing the details of the necessary steps for each process. Stabilization and thermal desorption are two separate and different means of treating contaminated sediment. thermal desorption is a high-temperature destruction of all constituents found in the dredged material that produces a product that does not require disposal or further restrictions on its use according to the thermal desorption vendor referenced in the ROD.

Significant debris removal and dewatering must occur as a pre-cursor to any material being thermally treated. Stabilization is further described in the following paragraph. These treatment approaches will be evaluated during the remedial design process, including whether the methodologies are sufficient to treat to acceptable levels precluded due to contaminant concentrations in the in-situ sediment.

The off-site stabilization of sediments approach consists of transporting dewatered sediments, via barge, to a permitted off-site dredged material processing facility where the sediment would be stabilized. The treated material would then be transported to a permitted off-site beneficial use location. Potential beneficial use options for the stabilized sediment include use as fill or landfill daily cover or incorporation into construction materials, such as concrete.

A specific beneficial use applicant, facility, and/or location will be identified and further evaluations will be required to confirm the amounts and types of stabilizing agents to be added to the sediment to result in the desired physical and chemical properties. Prior to final design, the applicant, facility, and/or location will need to be fully permitted in the state in which it is located to accept this dredged material. Tests to assess the leachability of contaminants, as well as material strength, will need to be performed on the stabilized material during bench-scale and pilot testing in order to determine whether it will meet beneficial use requirements.

3.7 Dredge Decant Water Treatment

The discharge of decant water from and at the dredged areas is regulated under Section 401 of the federal Clean Water Act, Water Quality Certification (WQC), as discussed in Section 5. Any other surface water discharges from the handling, processing, and treatment of the sediment at designated permitted facilities are subject to the State Pollutant Discharge Elimination System (SPDES) (New York State) or New Jersey Pollutant Discharge Elimination System (NJPDES) federal Clean Water Act Section 402 discharge permitting requirements. The permits issued by the respective states will contain discharge conditions that are protective of surface waters.

Water treatment needs will be evaluated during the remedial design through laboratory testing and analytical testing of the decant water. Siting of potential water treatment facilities will also be evaluated during the design process.

3.8 Dredging and Capping Support Site Development

One or more staging and support sites will be selected and developed in the immediate vicinity of the Canal to support dredging and capping activities. The design will include providing utilities, access, and paved areas for staging materials to be used in the bulkhead repair and replacement, dredging (including temporary sheeting and shoring), and capping efforts and for temporary storage of and removed debris. Entrances, roadways, and loading areas will be constructed for delivery of supplies and materials, movement of construction equipment, and access by emergency response vehicles. Storage areas will be built to store supplies and materials necessary for dredging and capping activities. Space will be developed to stage labor and equipment for transfer from upland to marine facilities. Existing dock and wharf facilities will be upgraded or new facilities will be constructed to facilitate the movement of manpower and equipment. Fueling stations will be provided for marine and upland equipment that include necessary spill containment measures. In addition, facilities will be constructed for the storage and deployment of equipment to monitor water and air discharges. Utility services will be installed to supply the above facilities with power and lighting. Support facilities for the management of sanitary and solid waste from the site will also be provided.

The design will also include the construction of required project administration facilities. Office space will be provided for administrative, engineering, regulatory, and construction support personnel. Facilities will be provided to accommodate construction personnel during shift change, lunch, and breaks. Parking for workers and construction equipment will be developed or provided off-site.

4. REMEDIAL DESIGN SUBMITTALS

4.1 Introduction

The SOW in the AOC Amendment specifies RD submittals as listed in Section 1.3: specifically, the 35% preliminary design report, 65% intermediate design report, 90% pre-final design report, and 100% final design report. Given the complexity of the project, development of the remedy has been subdivided into eight major design components, listed below (and described in Section 3). The design of each major component will be detailed in a stand-alone remedial design report. The work may be contracted to one general contractor managing a group of specialty contractors, or alternatively, the RA may be implemented as individual components (or groups of components) tendered as stand-alone contracts. The latter approach would allow for flexibility in sequencing construction; implementing the construction of RA components in a logical manner. Currently, it is premature to identify the bid packages.

The identified major components designated as RD-1 in the tables are:

- Bulkhead Repair or Replacement
- Excavation/Restoration of the 5th Street turning basin
- Dredging
- Capping
- In situ stabilization of sediments
- Ex situ sediment treatment
- Dredge water treatment (if necessary)
- Dredging and capping support site development

Each of these design components includes a number of tasks to be completed involving additional evaluations as well as the above-noted design phases. Some of these tasks were identified specifically in the SOW to the AOC as predesign or remedial design activities. These SOW-specified tasks are presented as “PD-{number}” or “RD-{number}” (for pre-design and remedial design) in the tables presented in Section 4.3.

4.2 Description of the Major Design Submittals

Design of the major components will generally progress in parallel; however, design of certain components will likely be advanced sooner than others. The logic and efficiency of the design strategy will continue to be evaluated as the design moves from the preliminary to intermediate design phases. The approach may be altered such that design of some of the major components is combined, or additional discrete components may be broken out. Such modifications to the design approach will be implemented in consultation with EPA.

Design reports for the major design components will be submitted to EPA at progressive levels or percentages of completion: preliminary design (35%), intermediate design (65%), pre-final design (90%), and final design (100%). At each phase, EPA comments will be incorporated into the ongoing design and subsequent design reports.

In accordance with the SOW, the design report for each component will include, as appropriate, a discussion of the design criteria and objectives; design analyses; drawings, work plans, and technical specifications; and supporting calculations, testing results, study reports, and other data. Pre-design investigation submittals are described in Section 4.2.1. The anticipated contents of the various design reports are addressed in more detail in Sections 4.2.2 through 4.2.5.

4.2.1 Pre-Design Activities

Pre-design activities for the project are summarized in a PDWP, which was submitted to the EPA on January 28, 2014 (Geosyntec, 2014). The PDWP includes written scopes for the first eight pre-design activities. Scopes for the remaining 18 pre-design activities identified in the PDWP will be prepared under a separately negotiated UAO. In many cases the pre-design activities need to be completed in order to commence the design of a remedy component; however, in some instances the investigation and the design can be sequenced such that part of the design can proceed while the supporting pre-design investigations are being completed. The relationships between the pre-design activities and the various remedy components are described in Section 4.3.

4.2.2 35% Preliminary Design Report

A preliminary design report will be submitted separately for each remedy component when the design is approximately 35% complete. The intent of the submittals is to demonstrate the overall remedy approach and technical feasibility, which will allow for adjustments or modifications in approach to be made before extensive design efforts are expended. Each preliminary design report will include associated pre-design activity reports. It is envisioned that drawings submitted at this phase will include general layout and limited design details. Calculation packages will be included for key components of the work, with additional packages provided as part of later submittals. A list of specifications and a list of work plans to be prepared as part of the overall design will also be included in the preliminary design reports.

The documents anticipated to be included in the various preliminary design reports are outlined in Section 4.3.

4.2.3 65% Intermediate Design Report

The intermediate design reports will be submitted separately for each remedy component when the design for each is approximately 65% complete. The intermediate designs will include: drawings that have the layout well defined, with significant details and notes, but minor or supporting details to clarify for construction may be missing; the majority of calculation packages; draft specifications for all or almost all of the specifications; and outlines of work plans. It is possible that results of all pilot studies identified in the PDWP may not be incorporated into the 65% design report.

The documents anticipated to be included in the various intermediate design reports are outlined in Section 4.3.

4.2.4 90% Pre-final Design Report

Pre-final design reports will be submitted separately for each component when the design is approximately 90% complete. The pre-final design will be a complete design, including all drawings, calculations, specifications, and work plans. Results of all pilot studies will be incorporated into the pre-final design reports. Preparation of a construction cost estimate and construction schedule can begin using the pre-final design.

The documents anticipated to be included in the various pre-final design reports are outlined in Section 4.3.

4.2.5 100% Final Design Report

The final design reports will be a 100% submittal and will address comments on the pre-final design reports. The final design reports will be of sufficient quality and completeness to be included in bid packages prepared as part of RA.

The documents anticipated to be included in the various final design reports are outlined in Section 4.3.

4.3 Development of Remedial Design Components

The design development of the eight major components of the Site remedy is outlined below. Typically, the development starts with one or more or pre-design activities as noted in Section 4.2.1. The pre-design activities include desktop, laboratory, and field studies and evaluations. The information obtained through the pre-design activities will be used to support the preparation of calculations, drawings, and other design-related documents included in the design reports described in Section 4.2.

For each remedy component, a table has been prepared to summarize the information to be included in the design reports submitted at the 35%, 65%, 90%, and 100% levels of completion.

For each, an accompanying work flow schedule shows the sequencing of the various pre-design activities and Remedial design reports. In some cases, information from the development of one remedy component will be used to support the development of another remedy component. This interrelationship between design components is noted on the work flow schedules. The work flow schedules also note where site access and procurement will be required for the various activities. While not specifically listed, safety reviews for all field activities will be required.

4.3.1 Bulkhead Repair or Replacement Design

The documents to be included in the sequential design reports for bulkhead repair or replacement are summarized in Table 4-1. The general sequencing of work is outlined in the work flow schedule in Figure 4-1. While the work flow schedule shows a general sequence, it is envisioned that the work will be conducted separately for the upper and lower Canal. Separating the design in this manner allows for field activities associated with the upper Canal to be completed and the design commenced while field activities for the lower portion are underway.

It is envisioned that a number of the property owners will take responsibility for the design of their bulkheads. The design of the bulkheads will be submitted by the property owner to EPA for review and approval. It also envisioned that additional geotechnical investigation will be required at individual properties to complete the design. Defining and collecting this information will be the responsibility of the engineer preparing the bulkhead design for the property owner.

As part of the bulkhead pre-design activities, the need for upland source control will be investigated. While upland source control is not a direct part of the Site remedy, the goal is to identify where upland source control will be required so it can be accounted for in the bulkhead design if needed.

There are approximately 200 permitted and unpermitted outfall pipes along the Canal. Penetrations through replacement bulkheads are required for the permitted outfall pipes, and the unpermitted pipes need to be plugged. Pipe penetrations and pipe plugging should be accounted for in the bulkhead design.

4.3.2 Excavation/Restoration of 5th Street Turning Basin Design

The initial design of the excavation of the 5th Street turning basin will be addressed separately from the possible need for an interceptor system or barrier; however, it is envisioned that by the pre-final design phase, the design of the excavation and any control system will be integrated into one pre-final design report. The documents to be to be included in the sequential design reports for excavation and restoration of the 5th Street turning basin are summarized in Tables 4-2a and 4-2b for the design of the excavation and interceptor system or barrier, respectively. The general sequencing of work is outlined in the work flow schedules in Figures 4-2a and 4-2b. The impacts of the turning basin excavation/restoration on the hydrodynamics of the Canal will also be explored using the hydrodynamic and sediment transport models. This will allow for assessing the long-term performance of the excavation.

The removal action associated with the 5th Street turning basin differs from the rest of the Site removal activities as the turning basin has been filled-in and the removal will be done with a land-based excavator v. a barge-mounted machine. Accordingly, this activity will have unique material handling requirements. This has been accounted for in the activities in Table 4-2a.

4.3.3 Dredging Design

The documents to be to be included in the sequential design reports for dredging are summarized in Table 4-3. The general sequencing of work is outlined in the work flow schedule in Figure 4-3.

Part of the dredging design is debris removal. At this time, it is envisioned that one design report will be submitted that addresses dredging and debris removal. As the design is advanced, a separate design report for debris removal may be prepared.

4.3.4 Capping Design

The documents to be to be included in the sequential design reports for capping are summarized in Table 4-4. The general sequencing of work is outlined in the work flow schedule in Figure 4-4. The design of the cap is extensive as it requires both field and laboratory activities to assess the viability of the treatment layer within the cap. Also, a pilot-scale cap will be constructed and monitored prior to full-scale implementation. The design of the cap will also need to account for the in situ stabilization component described in Section 4.3.5.

The active cap requirements for RTA 3 (treatment of PAHs) are anticipated to be different from those in RTA 1 and RTA 2 (treatment of NAPL and PAHs). While all cap design will be based on the information from the pre-design investigations, it may be practical to develop a separate design report for the cap in RTA 3.

4.3.5 In Situ Stabilization Design

The documents to be to be included in the sequential design reports for in situ stabilization are summarized in Table 4-5. The general sequencing of work is outlined in the work flow schedule in Figure 4-5. The design process for in situ stabilization will require laboratory bench-scale testing and field pilot testing.

4.3.6 Ex Situ Sediment Treatment Design

The documents to be to be included in the sequential design reports for ex situ treatment of sediment are summarized in Table 4-6. The general sequencing of work is outlined in the work flow schedule in Figure 4-6. It is anticipated that ex situ sediment treatment will be performed at a permitted facility and that construction of an on-site sediment treatment facility will not be conducted for the majority of the waste. The need for on-site facilities to perform solidification prior to sending dredged sediment to a treatment facility or to manage small quantities of select waste (e.g., sediment with Toxic Substances Control Act [TSCA] levels of PCBs) will be evaluated as part of the design process. Various ex situ treatment methods will be evaluated, along with end-use options, based on sediment contaminant profiles and the results of laboratory treatability testing.

4.3.7 Dredge Water Treatment Design

The documents to be to be included in the sequential design reports for dredge water treatment are summarized in Table 4-7. The general sequencing of work is outlined in the work flow schedule in Figure 4-7. The possibility of discharging to publicly owned treatment works (POTW) and the establishment of likely discharge limits are key inputs into the design of treatment facilities. Dredge water treatment design is also dependent upon the selection of dredging equipment and the determination of influent flow rates. Data from laboratory treatability testing and the dredging pilot study will be used in the selection and design of water treatment processes and the sizing of equipment.

4.3.8 Dredging and Capping Support Site Development Design

The documents to be to be included in the sequential design reports for site support development are summarized in Table 4-8. The general sequencing of work is outlined in the work flow schedule in Figure 4-8. Identification of support site design requirements is dependent upon the selection of debris management, dredging, dredge water treatment, sediment treatment, and sediment transport and disposal technologies. Similarly, limited site availability could limit the ability to implement some technologies.

4.3.9 Source Control – Unpermitted Outfalls Mitigation Design

In order for the selected remedy in the Canal to be effective, sources that could recontaminate the Canal must be addressed. The upland sources of contamination, including unpermitted pipes along the Canal will be addressed prior to the commencement of, or in phased coordination with, the implementation of the selected remedy.

Nearly 200 outfalls were identified during the RI, most of which were pipes located on private property. In general, these are unused pipes associated with historic industrial activities.

The ROD also includes the following measures for discharges from upland and for unpermitted pipes along the Canal:

- The EPA and NYSDEC will coordinate measures to control discharges from upland contaminated areas adjacent to the Canal that have already been referred to NYSDEC for action. The schedule for these measures will conform to the schedules for the cleanup of the Canal.

- Unpermitted pipe outfalls will be either controlled (permitted) or eliminated.

The documents to be to be included in the sequential design reports for source control actions are summarized in Table 4-9. The general sequencing of work is outlined in the work flow schedule in Figure 4-9.

4.3.10 General Pre-Design and Design Tasks

In addition to the design efforts described above and in the referenced tables, there are general pre-design and design tasks to be conducted in support of the overall RD effort. This work is outlined in the work flow schedule in Figure 4-10.

5. REGULATORY REQUIREMENTS

This section addresses federal, state, and local requirements that may apply to design and implementation of the Site remedy. The anticipated regulatory requirements are listed in Table 5-1.

The RD/RA is being conducted under the EPA CERCLA program. As such, federal and state regulatory requirements are not strictly applied as permits/approvals but typically as "permit equivalents" as defined by the CERCLA statute. CERCLA response actions may be exempted by law from the requirement to obtain federal, state, and local permits related to activities conducted completely on the CERCLA site in question. However, it is EPA's policy to assure that all activities conducted on sites are protective of human health and the environment. This policy has been historically and consistently implemented by EPA to not remove or waive the requirement to meet the substantive provisions of permitting regulations that are applicable or relevant and appropriate requirements (ARARs.) In that context, the following permits or permit equivalents constitute the likely regulatory requirements for sediment and debris removal actions for the Site. The principal action-specific ARARs include federal Clean Water Act Sections 401, 402, and 404; the Rivers and Harbors Act Section 10; the New York Environmental Conservation Law (ECL) Article 15 Water Resources, Article 17 Water Pollution Control, and Article 27 Collection, Treatment and Disposal of Refuse and Other Solid Waste; and associated implementing regulations. Consideration of a confined disposal facility (CDF) would be subject to review by NYSDEC and other appropriate governmental regulatory authorities.

5.1 Federal Requirements

The two main federal permits are: 1) a Section 404 of the Clean Water Act (33 U.S.C. 1344) permit and 2) a Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403) permit. These two federal permits are issued by the New York District (NYD) of the Army Corps of Engineers (USACE). These two permitting authorities will be issued as one permit or permit equivalent and will contain all of the required and necessary permit conditions, from the federal perspective, that relate to regulated activities from the ROD. These include, but may not be limited to, the following:

- Removal of sediment or other materials from the water body (dredging);
- In-situ stabilization (ISS) of contaminated sediment;
- Construction of the multilayered cap in designated reaches of the Canal;
- Off-site transport, handling, treatment, and disposal of the dredged material;
- Excavation and restoration of the 5th Street turning basin; and

- Implementation of institutional controls, such as fish consumption advisories.

Typically, the NYD of the USACE is responsible for coordination of all federal agency comments within the context of evaluating and issuing the above referenced permits and approvals. For this project, it is envisioned that the EPA CERCLA Remedial Project Manager (RPM) will have a significant and leading role in the federal agency coordination effort.

The comments from the federal agencies contain the conditions under which the regulated activities must be implemented in order to be in compliance with the issuance of this federal permit action. The federal permit action is cross-referenced with any companion and required state permits, such as the Coastal Zone Permits issued by the state where the activity is occurring as well as the state where the material is handled in any way (including treatment) and the state where the treated or processed dredged material is properly disposed (or its final end-use location).

The state permit requirements are discussed in the Section 5.2. Section 307 of the federal Coastal Zone Management Act (CZMA) of 1972 is typically delegated to coastal states for implementation. This delegated federal authority also applies to Section 401 of the federal Clean Water Act of 1972 for Water Quality Certification (WQC) which regulates the discharges of fill or dredged material back into the waters of the United States (or within the delegated state.) This approved 401 WQC also regulates the discharge of supernatant or the water from the dewatering of dredged material back into the water body from which it originated. While these permit requirements stem from federal authority, they are typically delegated to approved states for oversight and implementation. Both New York and New Jersey are delegated states for CZMA and WQC authority.

5.2 State Requirements

The Site is located in New York State (NYS). However, it is envisioned that a significant portion of the sediments to be dredged will be transported to approved facilities in New Jersey (NJ) for material handling and processing. Therefore, this section addresses state regulatory requirements for both NYS and NJ. It is currently not clear where the processed dredged material will ultimately be disposed, so this RDWP does not contain state regulatory details for such disposal. Once a proposed disposal or permitted end-use site is identified, project documents will be updated and the proper permits or permit equivalents will be sought and obtained.

The Resource Conservation and Recovery Act (RCRA) is the federal law addressing the storage, transportation, and disposal of solid and hazardous waste. NYSDEC implements RCRA in New York under ECL Article 27. The dredged sediment would be considered solid waste; however, it can be exempted through the WQC program. If not exempted, RCRA requirements would be applicable.

5.2.1 New York

NYS is a CZMA delegated state and therefore has the authority to issue Federal Consistency (with the federal CZMA) Determinations through the issuance of state permits or permit equivalents. NYS typically regulates projects such as this through the issuance of a single permit action that includes three separate regulatory authorities:

1. Excavation and Fill in Navigable Waters;
2. Water Quality Certification; and
3. Tidal Wetlands.
4. State Historic Preservation Office (SHPO)

This single permit action is also the companion permit to the federal permit action described in Section 5.1 as these (federal and state) approvals cross-reference each other. As a result, the regulated activity for which approval is sought is not granted until and unless both federal and state permit actions have been issued by the proper federal and state authorities. In NYS, the authority is the NYS Department of Environmental Conservation (NYSDEC), Division of Environmental Permits, Region 2.

In summary, it is anticipated that the project will be regulated through a single permit action (with the above three regulatory authorities) by NYSDEC; this single permit action is the Federal Consistency (companion permit) to the federal permit action.

The CWA Section 401 Water Quality Certification (WQC) is implemented by NYSDEC through ECL Article 15 and the associated regulations in 6 NYCRR (NY Codes, Rules and Regulations) Part 608 Use and Protection of Waters. The WQC may establish conditions such as preventive measures to minimize resuspension of sediment and water quality monitoring during dredging, so that the remedy does not exceed water quality standards. Placement of fill (such as a cap), construction of an in-water CDF (if this is the selected disposal method), and temporary discharges of decanted waters from dredge barges into waters of the United States would also be addressed through a WQC.

5.2.2 New Jersey

New Jersey authorizes regulated activities such as dredging and all aspects of dredged material handling (including disposal) under the state's Waterfront Development Act (statute) and the Coastal Zone Permitting Rules (regulations). The overarching regulatory instrument for all of the operating conditions of the applicable NJ regulations is known as an Acceptable Use Determination (AUD). The AUD is part of the single permit action issued by NJ for any and all aspects of dredging and dredged material handling for any part of any project that is in NJ. The regulations that govern these activities in NJ are:

1. New Jersey Administrative Code (NJAC) 7:7: Amendments to the Coastal Permit Program Rules
2. NJAC 7:7A: Freshwater Wetlands Protection Act
3. NJAC 7:7E: Coastal Zone Management Rules
4. NJAC 7:13: Flood Hazard Area Control Act Rules

The single permit is based upon and inclusive of the above-referenced regulations, and the AUD is the single permit action issued by NJ that also constitutes its Federal Consistency with the federal CZMA.

5.3 City of New York Requirements

The City of New York (NYC) will have some jurisdiction for implementation of the ROD-required remedial actions. Since NYC is also a named PRP under the ROD, it is currently unclear what, if any, specific approvals need to be or will be issued by NYC. It is anticipated that the EPA RPM will exercise the authority granted to him under CERCLA and discuss directly with NYC what local approvals are necessary and identify the specific procedures and issuing authority (i.e., NYC or EPA).

6. IMPLEMENTATION OF GREEN REMEDIATION PRACTICES

6.1 Objectives and Guidance

The RD and subsequent RA will incorporate green remediation practices into the RA effort. The SOW specifies EPA Region 2 and NYSDEC guidance on green remediation; specific guidance documents are listed in Table 2-2.

The following excerpt from the EPA guidance (EPA, 2009) establishes that the goal of the Region 2 Clean & Green Policy is to enhance the environmental benefits of federal cleanup programs by promoting technologies and practices that are sustainable.

The objectives of Green Remediation are to:

- Protect human health and the environment by achieving remedial action goals
- Support human and ecological use and reuse of remediated land
- Minimize impacts to water quality and water resources
- Reduce air emissions and greenhouse gas production
- Minimize material use and waste production
- Conserve natural resources and energy

The EPA policy establishes a preference for use of:

- 100% use of renewable energy, and energy conservation and efficiency approaches including EnergyStar equipment
- Cleaner fuels and clean diesel technologies and strategies
- Water conservation and efficiency approaches including WaterSense products
- Sustainable site design
- Industrial material reuse or recycling within regulatory requirements
- Recycling applications for materials generated at or removed from the site
- Environmentally Preferable Purchasing
- Greenhouse gas emission reduction technologies

The following excerpt from the NYSDEC guidance (NYSDEC, 2011) stipulates:

The protection of public health and the environment threshold and programmatic requirements must always be met when undertaking investigation and remediation. Green remediation concepts and techniques must be considered during all phases of the remedial program, from site characterization through implementation of the remedy to long-term site management obligations, with the goal of improving the sustainability of the cleanup. Specific techniques are provided in Attachment 1 [To the NYSDEC guidance document]. The major green remediation concepts below are to be considered and used to the extent feasible by remedial parties and DEC's staff and contractors.

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

6.2 Implementation

The RD design team will assess green remediation opportunities throughout all phases of the design effort. Identified green technologies will be incorporated into the design specifications for implementation by the RA Contractor. The team will consult the cited guidance documents at the outset of the design process and look for opportunities throughout the process. These may include:

- Use of reclaimed sand or other capping material
- Use of green concrete in support site construction
- Beneficial reuse of treated dredged sediment

- Use of low-impact development technology in temporary construction areas
- Use of clean diesel fuels in construction equipment and trucks
- Opportunities to enhance habitat

7. REMEDIAL DESIGN MILESTONES

7.1 Work Flow Schedules

The Site RD is a multi-year and multi-activity effort. As described in Section 4, there are many pre-design field, laboratory, and desktop studies and evaluations that will be part of the overall RD effort. The schedules for each of the major design elements depicted as work flow are provided in Section 4 as listed below:

- Bulkhead design – Figure 4-1
- Design of the excavation/excavation of the 5th Street turning basin – Figure 4-2a
- Design of a barrier or interceptor system for the 5th Street turning basin – Figure 4-2b
- Dredging design – Figure 4-3
- Capping design – Figure 4-4
- In situ sediment stabilization design – Figure 4-5
- Ex situ sediment treatment design – Figure 4-6
- Dredge water treatment system design – Figure 4-7
- Dredging and capping support site design – Figure 4-8
- Source control – unpermitted outfalls mitigation – Figure 4-9
- General pre-design and design tasks – Figure 4-10

The design report efforts will not all be completed on the same schedule, but will be as logically sequenced as possible for remedy implementation. For example, bulkhead repair or replacement must be started before the dredging effort (which will require competent bulkheads to implement). The dredging and capping support site should be developed prior to the dredging and capping, including systems for dredge water treatment and ex situ sediment treatment (should these be land-based operations in whole or in part).

7.2 Coordination Issues and Uncertainties that Could Affect the Schedule

Coordination issues and uncertainties that could affect the scheduled performance of the work are listed below.

7.2.1 Coordination Issues with NYC, EPA, and Others

Key coordination points include:

- Coordination of work among responsible parties needs to be finalized before a workable schedule can be finalized.
- Coordination with EPA on any EPA-led RD activities.
- Coordination with upland remedial activities that limit implementation of the remedy.
- Planning of the work needs to account for access to upland properties. EPA has indicated that they will handle property access to support RD/RA activities including in-Canal PD work, RD/RA staging, bulkhead assessment, etc.
- Coordination with EPA for repair or replacement of third party bulkheads which may limit implementation of the remedy.
- Bridge stability assessment will be conducted by NYC and is not shown in the schedule. Remedial action is contingent upon confirmation of bridge stability during remedial design.
- Field work in RTA 1 and RTA 2 may be delayed by bridge clearance and is dependent on operational status of bridges.
- The effect of Flushing Tunnel Flow rates, schedule, and durations will be accounted for during design and may have impacts on the schedule.
- Need for NYC data to support the RD including design details for the turning basin, CSO management, etc. could delay schedule.
- Short-term and long-term CSO controls have not been included in the schedule and may require schedule adjustments to accommodate work in the Canal.
- Navigation that conflicts with commercial and industrial needs within the Canal may require schedule adjustments.
- Coordination with NYC CWA compliance activities that have the potential to delay implementation of work.
- Schedule adjustments may occur if maintenance dredging of the Canal or other changes in Site conditions occurs.
- Health and Safety issues adversely effecting personnel implementing the RDWP could affect schedule.

7.2.2 Project Uncertainties

Project uncertainties include:

- 5th Street turning basin scope is not well defined in the ROD. Design activities associated with the 5th Street turning basin are assumed for the purposes of schedule.
- Limited production or stop work for CSO discharges during large storms.
- Scope of pilot studies included in several design components are yet to be defined.

8. REFERENCES

EPA, 2009. *"PA Region 2's Clean and Green Policy, March 2009 and subsequent updates."* http://www.epa.gov/region02/superfund/green_remediation/policy.html

EPA, September 2013. *"Record of Decision, Gowanus Canal Superfund Site, Brooklyn, Kings County, New York."*

Geosyntec Consultants, January 2014. *"Pre-Design Work Plan, Gowanus Canal Superfund Site, Brooklyn, New York."*

Hunter Research Inc., Rabner Associates, Northern Ecological Associates, Inc., May 2004 [Revised December 2004]. *"Final Report National Register of Historic Places Eligibility Evaluation and Cultural Resource Assessment for The Gowanus Canal Borough of Brooklyn, King County, New York In Connection With The Proposed Ecosystem Restoration Study."*

NYSDEC, 2011. *"DER 31/Green Remediation"*, January 2011.

New York City Department of City Planning, October 1985. *"Gowanus: A Strategy for Industrial Retention."*

Table 2-1. AOC Amendment Required Remedial Design Elements.

Item	Remedial Design Work Element	Basis for Work Element
RD-1	Description of Remedy Components	EPA SOW
RD-2	35% Design Report	EPA SOW
RD-3	65% Design Report	EPA SOW
RD-4	90% Design Report	Design Team
RD-5	100% Design Report	EPA SOW
RD-6	Project schedule	EPA SOW
RD-7	Plan for sustainable and green remediation design and implementation	EPA SOW
RD-8	Updates to QAPP, HASP, FSP (if needed)	EPA SOW
RD-9	Capping pilot test	Responsiveness Summary (page v-39)
RD-10	ISS pilot test	EPA ROD (page 71); Responsiveness summary page v-54, v-55)
RD-11	Evaluate temporary use of silt curtains during sediment removal activities	ROD page 54; Responsiveness summary page v-29
RD-12	Selection of most appropriate dredging method	ROD page 81
RD-13	For periodic cap maintenance and long-term monitoring, development of frequency details for maintenance and monitoring programs	ROD page 82-83
RD-14	Determination regarding installation of a barrier or interception system on the 5th street turning basin side of the bridge	Responsiveness summary page v-25
RD-15	Addressing of operational challenges pertaining to dredging in the Canal	Responsiveness summary page v-27
RD-16	Addressing dredging design criteria in detail	Responsiveness summary page v-28
RD-17	Extensive confirmatory sampling pertaining to disposal of sediments	Responsiveness summary page v-32
RD-18	Identification of potential disposal facility	Responsiveness summary page v-32
RD-19	Air pathway analysis (APA) for remedial activities	Responsiveness summary page v-178
RD-20	Development of specific measures to control air emissions during the processing of the sediments	Responsiveness summary page v-47
RD-21	Consideration of wetland areas as part of remedial design	Responsiveness summary page v-142
RD-22	In case of sheet piling installation- noise and vibration background studies, survey of nearby structures	Responsiveness summary page v-155
RD-23	Dredging pilot test	Design Team
RD-24	Update to debris management plan	Design Team
RD-25	Institutional controls evaluation and recommendation	EPA SOW
RD-26	Selection of specific type of treatment layer for cap in RTA 1 and RTA 2	EPA SOW
RD-27	Evaluation of sediment resuspension and residuals during dredging	Responsiveness summary page v-28
RD-28	Odor and noise control measure evaluation	Responsiveness summary page v-46
RD-29	Further evaluation of measures to prevent recontamination of Canal sediments	Responsiveness summary page v-67-69, v-78, v-131

Table 2-2. Companion Documents to the Remedial Design Work Plan, Gowanus Canal Superfund Site, Brooklyn, New York

Companion Document	Key or Noteworthy Contents
EPA ROD, including the SOW	Specific requirements of the remedy and the RD.
EPA AOC, including the SOW (and amendments)	Specific requirements of the remedy and the RD.
Pre-Design Work Plan	Description of design-related activities including field efforts. This document includes pre-design activities referenced in the RDWP.
QAPP and Field Sampling Plan	Details of sampling and analytical methodologies to be performed during field and laboratory investigations associated with the PDWP and RDWP. The QAPP will be updated and resubmitted as details of the field and laboratory investigations are further developed.
HASP	Identifies site hazards associated with anticipated tasks to be performed during field investigations associated with the PDWP and RDWP. The HASP will be modified and resubmitted following PRP Group formation and prior to implementation of field work.

Table 2-3. Guidance Documents Relevant to the Remedial Design, Gowanus Canal Superfund Site, Brooklyn, New York

Guidance Document
Guidance Oversight of Remedial Designs and Remedial Actions Performed by Potentially Responsible Parties, OSWER Directive 9355.5-01, EPA/540/g-90-001, April 1990
Superfund Remedial Design and Remedial Action Guidance, OSWER Directive 93355.0-4A, June 1986
EPA Region 2's Clean and Green Policy, March 2009 and subsequent updates. http://www.epa.gov/region02/superfund/green_remediation/policy.html
NYSDEC DER 31/Green Remediation, January 2011.
NYCDEP Waterbody/Watershed Facility Plan Report
Contaminated Sediment Remediation Guidance for Hazardous Waste Sites OSWER 9335.0-85, EPA/540/R-05.012, December 2005
Sediment Cleanup, OSWER Directive 9200.1-90, July 2008
Monitored Natural Recovery at Contaminated Sediment Sites, ESTCP Project ER-0622, May 2009
Technical Guidelines for Environmental dredging of Contaminated Sediments, USACE ERDC/EL TR-08-29, September 2008
The Four Rs of Environmental Dredging: Resuspension, Release, Residual, and Risk, USACE ERDC/EL TR-08-4, January 2008
Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites, OSWER Directive 9285, February 2002
Use of Amendments for In Situ Remediation at Superfund Sediment Sites, OSWER Directive 9200.2-128FS, April 2013

Table 3-1. Remedial Design Components, Gowanus Canal Superfund Site, Brooklyn, New York

Remedial Design Components[1]	Description/Comments	Required Design Activities
Design Components		
Bulkhead Repair or Replacement (RD-1)	Assessment of current bulkhead conditions and design of improvements if necessary. Will be required for all properties fronting on the Canal in areas of dredging.	• Study of existing bulkhead data • Wetlands evaluation (RD-21) • Bulkhead work responsibility evaluation • Compliance plan for Federal and State archeological requirements (PD-14) • Archeological investigation (Phase 1 and 2, if necessary) • Geotechnical investigation associated with the bulkhead condition evaluation • Bulkhead condition assessment study (PD-5) • Noise and vibration background studies (RD-22) • Bulkhead adjacent building study (RD-22) • Upland areas evaluation for cut-off walls (PD-13) • Bridges stability assessment (to be done by NYC) • Evaluation of bulkhead stability during and after remedy implementation • Bulkhead design life assessment • Wind and wave analysis

Table 3-1. Remedial Design Components, Gowanus Canal Superfund Site, Brooklyn, New York

Remedial Design Components[1]	Description/Comments	Required Design Activities
		• Evaluate hydrodynamic impacts on bulkhead design • Potential a sheet pile corrosion study • Geotechnical investigation for bulkhead design • Bulkheads improvement design (35%, 65%. 90%, and 100%)
Excavation/Restoration of the 5th Street turning basin	The RD/RA will include excavation of impacted sediments in the 5th Street turning basin east of the 3rd Avenue bridge. Additionally, the RD/RA will include installation of a barrier or interceptor system if required to address potential on-going sources to the basin.	• Determination regarding installation of a barrier or interceptor system on the 5th Street side of the 3rd Street bridge (RD-14) • Pre-design investigations to address data gaps • Pre-design investigation to assess continuing sources • Evaluate the impacts of excavation on hydrodynamics in the Canal • Excavation design (35%, 65%. 90%, and 100%) • Barrier or interception system design (35%, 65%. 90%, and 100%)
Debris management (RD-1)	Debris removal/management is required as a precursor to dredging, ISS, and capping. Assessment of extent and nature of debris in the Canal and methods of addressing debris.	• Additional reconnaissance for debris removal (PD-3) • Debris Removal, Decontamination, and Disposal Plan (PD-4) • Update to debris management plan (RD-24) • Debris removal pilot test

Table 3-1. Remedial Design Components, Gowanus Canal Superfund Site, Brooklyn, New York

Remedial Design Components[1]	Description/Comments	Required Design Activities
Dredging (RD-1)	Development of a plan and design for dredging sediment as described in the ROD.	• Selection of the most appropriate dredging method (RD-12) • Address operational challenges pertaining to dredging in the Canal (RD-15) • Evaluate the use of temporary sheeting or shoring during dredging. • Evaluate the impacts of hydrodynamics and sediment transport in the Canal post dredging and pre-capping • Address dredging design criteria in detail (RD-16) • Air pathway analysis (APA) for Remedial activities (RD-19) • Consideration of wetland areas as part of the remedial design (RD-21) • Dredge volume field study (PD-23) • Dredging pilot test (RD-23) • Evaluate temporary use of silt curtains during sediment removal action (RD-11) • Evaluation of sediment resuspension and residuals during dredging (RD-27) • Odor and noise control measures evaluation (RD-28) • Bathymetric survey - post flushing tunnel operation (PD-22) • Hydrogeologic evaluation (including groundwater upwelling)

Table 3-1. Remedial Design Components, Gowanus Canal Superfund Site, Brooklyn, New York

Remedial Design Components[1]	Description/Comments	Required Design Activities
		• Compliance plan for Federal and State archeological requirements (PD-14) • Archeological investigation (Phase 1 and 2, if necessary) • Refined dredge volume study • Field investigation to refine dredging area • Geotechnical investigation for capping and dredging design (PD-18) • Dredging design (35%, 65%. 90%, and 100%)
Capping (RD-1)	Capping, with a thin-layer active cap, is an integral part of the ROD specified remediation.	• Ice scour analysis • Propeller wash and cap armoring study (PD-24) • Utilize the hydrodynamic and sediment transport models to evaluate the efficacy of the armoring cap design • Wind and wave analysis • Groundwater model update (PD-12) • NAPL expression evaluation • Cap flux modeling (for NAPL) • Cap design life assessment • Habitat layer assessment • Capping pilot test (RD-9) • Treatability testing of active cap layer materials (PD-17) • Geotechnical (laboratory) testing of active

Table 3-1. Remedial Design Components, Gowanus Canal Superfund Site, Brooklyn, New York

Remedial Design Components[1]	Description/Comments	Required Design Activities
		cap layer materials • Study of canal operations (PD-11) • Selection of specific type of treatment layer (RD-26) • Geotechnical investigation for capping and dredging design (PD-18) • Groundwater upwelling investigation for cap design (PD-7) • Development of frequency details for cap monitoring and maintenance programs (RD-13) • Cap pilot test (RD-9) • Capping design (35%, 65%. 90%, and 100%)
In situ stabilization (RD-1)	In situ stabilization of sediment within a water body is a developing concept that will require investigation in the literature, laboratory (treatability testing), and field (pilot studies).	• Laboratory evaluation of ISS performance (PD-19) • Laboratory evaluation of NAPL mobility (PD-15) • Evaluation of potentially mobile NAPL in the native sediments (PD-8) • ISS pilot test (RD-10) • ISS design (35%, 65%. 90%, and 100%)
Ex situ sediment treatment (RD-1)	The ROD specifies ex situ treatment of dredged sediment by dewatering followed by stabilization or thermal desorption of	• Confirmation sampling pertaining to the disposal of sediments (RD-17) • Identification of potential disposal

Table 3-1. Remedial Design Components, Gowanus Canal Superfund Site, Brooklyn, New York

Remedial Design Components[1]	Description/Comments	Required Design Activities
	contaminants depending on the level of impacts. The selection of the specific treatment methods will involve laboratory treatability testing of technologies.	facility/facilities (RD-18) • Air pathway analysis (APA) for Remedial activities (RD-19) • Odor and noise control measures evaluation (RD-28) • Treatability testing (bench scale) of sediment dewatering (PD-21) • Treatability testing (bench scale) of dewatered sediment stabilization (PD-10) • Treatability testing (bench scale) of dewatered sediment thermal desorption • Development of specific measures to control air emissions during sediment processing (RD-20) • Sediment treatment design (35%, 65%. 90%, and 100%)
Dredge water treatment system (RD-1)	Dredge water treatment requirements will be dependent on influent water quality characteristics and specified discharge criteria. Required treatment can vary from solids removal to dissolved constituent removal. Depending on the stipulated discharge criteria, laboratory treatability testing and pilot testing may be required.	• Evaluation of the potential to discharge to the NYC POTW • Treatability testing (bench scale) of dredge water treatment • Field investigation to define water treatment system influent • Dredge water treatment pilot test • Dredge water treatment design (35%, 65%.

Table 3-1. Remedial Design Components, Gowanus Canal Superfund Site, Brooklyn, New York

Remedial Design Components[1]	Description/Comments	Required Design Activities
		90%, and 100%)
Dredging and capping support site development (RD-1)	Evaluation, selection, and design of a site or sites to support the RA activities including bulkhead repair or replacement, dredging, and capping. Will include laydown areas and project management trailers.	• Development of a plan for staging site selection and implementation (PD-6) • Property ownership and availability evaluation • Staging site evaluation • Odor and noise control measures evaluation (RD-28) • Dredging and capping support site design (35%, 65%. 90%, and 100%)
Source control (RD-1)	Evaluation and development of a plan followed by design of measures to mitigate unpermitted outfalls discharging to the Canal.	• Survey and assessment of unpermitted outfalls • Development of plans for closure of unpermitted outfalls • Closure of the unpermitted outfalls design (35%, 65%. 90%, and 100%)
Other Design Elements		
Mobilization of water and land based construction equipment	Development of a construction sequencing plan along with access requirements (e.g., identifying	

Table 3-1. Remedial Design Components, Gowanus Canal Superfund Site, Brooklyn, New York

Remedial Design Components[1]	Description/Comments	Required Design Activities
(RD-1)	the need and time for bulkhead repairs or replacement).	
Staging and project infrastructure needs (RD-1)	See dredging and capping support site development, above	
Dredged material management (RD-1)	See ex situ sediment treatment and dredge water treatment system above	
Geotechnical and hydrodynamic stability (RD-1)	See geotechnical investigations cited for bulkhead repair or replacement, dredging, and capping cited above	
Material procurement (RD-1)	Material procurement for pre-design evaluations will be identified in the various work plans and material will be procured during the procurement tasks identified in the project schedule. Material procurement for the RA will be identified in the plans and specifications and will be implemented by the selected RA Contractor.	
Design Stages/Submittals		
Basis of Design Report (PD-26)	A summary of key design criteria.	
35% design report (RD-2)	See Tables 4-1 to 4-8	
65% design report (RD-3)	See Tables 4-1 to 4-8	

Table 3-1. Remedial Design Components, Gowanus Canal Superfund Site, Brooklyn, New York

Remedial Design Components[1]	Description/Comments	Required Design Activities
90% design report (RD-4)	See Tables 4-1 to 4-8	
100% design report (RD-5)	See Tables 4-1 to 4-8	
Project schedule (RD-6)	Included as work flow schedules in Section 4 of this RDWP	
Plan for sustainable and green remediation design and implementation (RD-7)	The planned approach to including and implementing green remediation practices in the RD and RA is presented in Section 6 of this RDWP. The actual methods for including green remediation practices in the RA will be part of the design reports for the RA components, primarily in the RA projects specifications.	
Updates to QAPP, HASP, FSP (if needed) (RD-8)	The QAPP, HASP, and FSP will be reviewed and updated (if required) as part of the work plan preparation for each pre-design investigation effort. The selected RA Contractor will be required to submit a construction HASP as part of the preconstruction submittals.	
Pre-construction plans	Preconstruction plans will be prepared for each bid package, i.e., groupings of work comprised of one or more 100% final design reports for the elements of work. (Note: The bid packages will be determined after completion of 35% design	• Project Sustainability Plan (RD-7) • Construction Work Plan • Construction Sampling and Analysis Plan o Construction Field Sampling Plan (FSP)

Table 3-1. Remedial Design Components, Gowanus Canal Superfund Site, Brooklyn, New York

Remedial Design Components[1]	Description/Comments	Required Design Activities
	of all RA elements). The RA Consultant will prepare a Construction HASP for their activities. The selected RA (construction) Contractor will prepare a Construction HASP for their construction activities.	o Construction QAPP (sampling related) • Construction Quality Assurance Plan (CQA Plan) • Community Relations Plan (CRP) • Construction Emergency Response Plan (ERP) • Construction Health and Safety Plan • Construction Site Management Plan (SMP)
Procurement packages for site restoration, hydrographic surveying, and environmental monitoring	Site restoration will be part of the various RA Contractors' scopes of work. Hydrographic surveying and environmental monitoring during RA implementation will be described in the Construction Quality Assurance Plan (CQA Plan) cited above.	

Table 4-1. General Contents of the Design Reports for the Bulkhead Repair or Replacement Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Pre-Design Investigations Associated with the Bulkhead Repair or Replacement Design[1]					
Wetlands areas evaluation (RD-21)	X				Will be common with other design components
Compliance plan for federal and state archeological requirements (PD-14)	X				Will be common with other design components
Phase 1 archeological investigation	X				Will be common with other design components
Phase 2 archeological investigation		X			Implement if required based on the Phase 1 Investigation Will be common with other design components
Study of existing bulkhead data					
Bulkhead condition assessment study (PD-5)	X				
Bulkhead work responsibility evaluation	X				
Bulkhead adjacent building study (RD-22)	X				
Bridges stability analysis	X				
Bulkhead design life assessment	X				May be included in the 65% design report
Hydrodynamic and sediment transport analysis for	X				

Table 4-1. General Contents of the Design Reports for the Bulkhead Repair or Replacement Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
bulkhead and cap design					
Steel sheet pile corrosion assessment		X			To be conducted and included only if required
Detailed survey and assessment of existing bulkheads for remedy implementation (PD-5)	X				
Geotechnical investigation associated with the bulkhead condition evaluation	X				
Evaluation of bulkhead stability during and post remedy implementation		X			
Noise and vibration background study and survey of nearby structures (RD-22)	X				
Upland areas evaluation for cut-off walls (PD-13)	X				Will be common with other design components
Bulkhead Repair or Replacement Design Calculation Packages					
Summary of subsurface stratigraphy and material properties	X	X	X	X	
Temporary stabilization of bulkheads during remedy construction	X	X	X	X	
Stability assessment of existing NYC DOT bridges	X	X	X	X	

Table 4-1. General Contents of the Design Reports for the Bulkhead Repair or Replacement Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Global slope stability analysis	X	X	X	X	
Geostructural design and stability analyses	X	X	X	X	
Tieback and tie rod anchor and wale design	X	X	X	X	
Seepage analysis	X	X	X	X	
Durability analysis		X	X	X	
Limitations on wall design and construction			X	X	
Bulkhead Repair or Replacement Design Drawings					
Cover Sheet	X	X	X	X	
Drawing Legend			X	X	
General Notes			X	X	
General Site Plan	X	X	X	X	
Detail Site Plans		X	X	X	
Cross Sections Along Walls	X	X	X	X	
Cross Sections Perpendicular to Walls	X	X	X	X	
Sheet Pile, Anchor, and Wale Details		X	X	X	

Table 4-1. General Contents of the Design Reports for the Bulkhead Repair or Replacement Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Temporary Stabilization of Bulkheads during Remedy Construction	X	X	X	X	
Sheet Pile Wall Pipe Penetration Details (need varies by property)			X	X	
Bulkhead Repair or Replacement Design Specifications					
Site Preparations (including Clearing and Grubbing)		X	X	X	
Sheet Pile Wall Laydown Area		X	X	X	
Sheet Pile Bulkhead Wall Construction		X	X	X	
Tieback Anchors and Tie Rods		X	X	X	
Earthwork		X	X	X	
Addressing Bank Tar if Encountered		X	X	X	
Other Design Elements					
Basis of Design Report	X				May be common with other design components
Preliminary Cost Estimate	X	X	X		
Final Engineer’s Cost Estimate				X	
Preliminary Construction Schedule	X	X	X	X	

Table 4-1. General Contents of the Design Reports for the Bulkhead Repair or Replacement Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Land Acquisition/Easement Requirements	X	X			
Bulkhead Repair or Replacement Construction Plans					
Project Sustainability Plan (RD-7)			X	X	Will be included as a general plan for all design components
Construction Work Plan			X	X	May be common with other design components
Construction Sampling and Analysis Plan • Construction Field Sampling Plan • Construction Quality Assurance Project Plan			X	X	May be common with other design components
Construction Quality Assurance Plan			X	X	May be common with other design components
Construction Emergency Response Plan			X	X	May be common with other design components
Construction Site Management Plan			X	X	May be common with other design components

Notes:

1. Pre-design investigation and evaluation reports may be included in the design reports or be included by reference.

Table 4-2a. General Contents of the Design Reports for the Excavation/Restoration of the 5th Street Turning Basin Design, Gowanus Canal Superfund Site, Brooklyn, New York – Excavation Design

Design Report	35%	65%	90%	100%	Comments
Pre-Design Investigations Associated with the Excavation/Restoration of the 5th Street Turning Basin[1]					
Wetlands areas evaluation (RD-21)	X				Will be common with other design components
Pre-design investigations to address data gaps associated with the excavation/restoration of the 5th Street turning basin	X				Will be a study and report used for both the excavation and barrier or interception system design
Pre-design investigations to address data gaps	X				
Geotechnical Investigation of Site Conditions	X				May be performed as part of assessment of bulkhead conditions
Hydrodynamic and sediment transport analysis for the excavation design and implementation	X				
Assessment of contaminants in zone of excavation	X				
Material, transport and disposal requirements	X				Upland location does make it conducive to construction form the water.
Identify long-term storm water management requirements	X				

Table 4-2a. General Contents of the Design Reports for the Excavation/Restoration of the 5th Street Turning Basin Design, Gowanus Canal Superfund Site, Brooklyn, New York – Excavation Design

Design Report	35%	65%	90%	100%	Comments
Water Quality Standards demonstration	X				Zone east of 3rd St bridge will receive little to no flow from canal, which has potential to turn into a stagnant water body.
5th Street Turning Basin Excavation Design Calculation Packages					
Temporary Support of Adjacent Buildings	X	X	X	X	Design calculation packages may be updated on each subsequent design submittal
Long-term Term Slope or Bulkhead Design	X	X	X	X	
Bridge Stability Assessment	X	X	X	X	
Excavation and construction material quantities		X	X	X	
Temporary storm water management design		X	X	X	
Permanent Storm-water management design		X	X	X	
5th Street Turning Basin Excavation Design Drawings					
Cover Sheet	X	X	X	X	
Drawing Legend			X	X	
General Notes			X	X	

Table 4-2a. General Contents of the Design Reports for the Excavation/Restoration of the 5th Street Turning Basin Design, Gowanus Canal Superfund Site, Brooklyn, New York – Excavation Design

Design Report	35%	65%	90%	100%	Comments
General Site Plan	X	X	X	X	
Detail Site Plans		X	X	X	
Material Staging Areas	X	X	X	X	
Traffic Control Plan		X	X	X	
Temporary Building Support Plan	X	X	X	X	
Excavation Limits and Grades	X	X	X	X	
Slope or Bulkhead Support Drawings	X	X	X	X	
Temporary E&S Controls		X	X	X	
Permanent Storm-water Management		X	X	X	
5th Street Turning Basin Excavation Design Specifications					
Temporary E&S		X	X	X	
Site Facilities		X	X	X	
Traffic Control		X	X	X	
Air Monitoring		X	X	X	
Clearing and Grubbing		X	X	X	
Excavation		X	X	X	

Table 4-2a. General Contents of the Design Reports for the Excavation/Restoration of the 5th Street Turning Basin Design, Gowanus Canal Superfund Site, Brooklyn, New York – Excavation Design

Design Report	35%	65%	90%	100%	Comments
Temporary Building Support		X	X	X	
Bulkhead System		X	X	X	
Permanent Stormwater Management		X	X	X	
Other Design Elements					
Basis of Design Report	X				May be common with other design components
Preliminary Cost Estimate	X	X	X		
Final Engineer’s Cost Estimate				X	
Preliminary Construction Schedule	X	X	X	X	
Land Acquisition/Easement Requirements	X	X			
5th Street Turning Basin Excavation Construction Plans					
Project Sustainability Plan (RD-7)			X	X	Will be included as a general plan for all design components
Construction Work Plan			X	X	May be common with other design components

Table 4-2a. General Contents of the Design Reports for the Excavation/Restoration of the 5th Street Turning Basin Design, Gowanus Canal Superfund Site, Brooklyn, New York – Excavation Design

Design Report	35%	65%	90%	100%	Comments
Construction Sampling and Analysis Plan • Construction Field Sampling Plan • Construction Quality Assurance Project Plan			X	X	May be common with other design components
Construction Quality Assurance Plan			X	X	May be common with other design components
Construction Emergency Response Plan			X	X	May be common with other design components
Construction Site Management Plan			X	X	May be common with other design components

Notes:

1. Pre-design investigation and evaluation reports may be included in the design reports or be included by reference.

Table 4-2b. General Contents of the Design Reports for the Excavation/Restoration of the 5th Street Turning Basin Design, Gowanus Canal Superfund Site, Brooklyn, New York – Barrier or Interception System Design

Design Report	35%	65%	90%	100%	Comments
Pre-Design Investigations Associated with the Barrier/Interceptor System Design[1]					
Wetlands areas evaluation (RD-21)	X				Will be common with other design components
Determination regarding installation of a barrier or interceptor system on the 5th Street side of the 3rd Street Bridge (RD-14)	X				
Pre-design investigations to address data gaps associated with the excavation/restoration of the 5th Street turning basin	X				Will be a study and report used for both the excavation and barrier or interception system design
Pre-design investigations to assess continuing sources impacting the 5th Street turning basin	X				
5th Street Turning Basin Barrier or Interception System Design Calculation Packages					
Design of Barrier or Interceptor System	X	X	X	X	Design calculation packages may be updated on each subsequent design submittal
5th Street Turning Basin Barrier or Interception System Design Drawings					
Cover Sheet	X	X	X	X	
Drawing Legend			X	X	
General Notes			X	X	

Table 4-2b. General Contents of the Design Reports for the Excavation/Restoration of the 5th Street Turning Basin Design, Gowanus Canal Superfund Site, Brooklyn, New York – Barrier or Interception System Design

Design Report	35%	65%	90%	100%	Comments
General Site Plan	X	X	X	X	
Detail Site Plans		X	X	X	
Barrier or Interceptor Details			X	X	Drawing List to be fully developed once nature of system established
5th Street Turning Basin Barrier or Interception System Design Specifications					
Site Preparation		X	X	X	
Site Restoration		X	X	X	
Barrier (or Interceptor) Construction		X	X	X	
Other Design Elements					
Basis of Design Report	X				May be common with other design components
Preliminary Cost Estimate	X	X	X		
Final Engineer's Cost Estimate				X	
Preliminary Construction Schedule	X	X	X	X	
Land Acquisition/Easement Requirements	X	X			
5th Street Turning Basin Barrier or Interception System Construction Plans					

Table 4-2b. General Contents of the Design Reports for the Excavation/Restoration of the 5th Street Turning Basin Design, Gowanus Canal Superfund Site, Brooklyn, New York – Barrier or Interception System Design

Design Report	35%	65%	90%	100%	Comments
Project Sustainability Plan (RD-7)			X	X	Will be included as a general plan for all design components
Construction Work Plan			X	X	May be common with other design components
Construction Sampling and Analysis Plan • Construction Field Sampling Plan • Construction Quality Assurance Project Plan			X	X	May be common with other design components
Construction Quality Assurance Plan			X	X	May be common with other design components
Construction Emergency Response Plan			X	X	May be common with other design components
Construction Site Management Plan			X	X	May be common with other design components

Notes:

1. Pre-design investigation and evaluation reports may be included in the design reports or be included by reference.

Table 4-3. General Contents of the Design Reports for the Dredging Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Pre-Design Investigations Associated with the Dredging Design[1]					
Selection of the most appropriate dredging method (RD-12)	X				
Address operational challenges pertaining to dredging in the Canal (RD-15)	X				
Address dredging design criteria in detail (RD-16)	X				
Wetlands areas evaluation (RD-21)	X				Will be common with other design components
Compliance plan for federal and state archeological requirements (PD-14)	X				Will be common with other design components
Phase 1 archeological investigation	X				Will be common with other design components
Phase 2 archeological investigation		X			Implement if required based on the Phase 1 Investigation Will be common with other design components
Field investigation to refine dredging area	X				
Refined dredge volume study (including hydrodynanmic and sediment transport analysis)	X				

Table 4-3. General Contents of the Design Reports for the Dredging Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Resuspension and residuals recommendations (RD-27)		X			
Evaluate temporary use of silt curtains during sediment removal action (RD-11)			X		
Air pathway analysis (APA) for Remedial activities (RD-19)	X				Will be common with other design components
Odor and noise control evaluation (RD-28)	X				Will be common with other design components
Plan for debris removal, decontamination, and disposal (PD-4)	X				
Dredge volume field study (PD-23)	X				
Geotechnical characterization for dredging and capping design (PD-18)	X				Will be common with the capping design component
Bathymetric survey after flushing tunnel operation (PD-22)	X				Will be common with other design components
Hydrodynamic and sediment transport analysis for the excavation design and implementation	X	X			
Additional reconnaissance for debris removal (PD-3)	X				

Table 4-3. General Contents of the Design Reports for the Dredging Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Debris removal, decontamination, and disposal plan (PD-4)		X			
Update to debris management plan (RD-24)		X			
Debris removal pilot test	X				
Dredging pilot test (RD-23)	X				
Upland evaluation for cut-off walls (PD-13)	X				Will be common with other design components
Dredging Design Calculation Packages					
Summary of subsurface stratigraphy and material properties	X	X	X	X	
Global slope stability analysis	X	X	X	X	
Dredge prisms		X	X	X	
Dredging Design Drawings					
Cover Sheet	X	X	X	X	
Drawing Legend			X	X	
General Notes			X	X	
General Site Plan	X	X	X	X	

Table 4-3. General Contents of the Design Reports for the Dredging Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Site Key Map		X	X	X	
Existing Bathymetry Plans	X	X	X	X	
Existing Debris Plans	X	X	X	X	
Dredging Depth of Cut Plans		X	X	X	
Dredging Sections & Profiles		X	X	X	
Dredging Details		X	X	X	
Bridge Plans		X	X	X	
Bridge Elevations			X	X	
Sediment & Floatables Containment Plan		X	X	X	
Sediment & Floatables Containment Sections			X	X	
Sediment & Floatables Containment Details			X	X	
Environmental Monitoring Details			X	X	
Dredging Design Specifications					
Debris Management		X	X	X	
Mechanical Dredging		X	X	X	
Residuals Management		X	X	X	

Table 4-3. General Contents of the Design Reports for the Dredging Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Dredged Material Transport and Disposal		X	X	X	
Sediment Resuspension Control		X	X	X	
Environmental Monitoring (Air & Water)		X	X	X	
Other Design Elements					
Basis of Design Report	X				May be common with other design components
Preliminary Cost Estimate	X	X	X		
Final Engineer's Cost Estimate				X	
Preliminary Construction Schedule	X	X	X	X	
Land Acquisition/Easement Requirements	X	X			
Dredging Construction Plans					
Project Sustainability Plan (RD-7)			X	X	Will be included as a general plan for all design components
Construction Work Plan			X	X	May be common with other design components

Table 4-3. General Contents of the Design Reports for the Dredging Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Construction Sampling and Analysis Plan • Construction Field Sampling Plan • Construction Quality Assurance Project Plan			X	X	May be common with other design components
Construction Quality Assurance Plan			X	X	May be common with other design components
Construction Emergency Response Plan			X	X	May be common with other design components
Construction Site Management Plan			X	X	May be common with other design components

Notes:

1. Pre-design investigation and evaluation reports may be included in the design reports or be included by reference.

Table 4-4. General Contents of the Design Reports for the Capping Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Pre-Design Investigations Associated with the Capping Design[1]					
Wetlands areas evaluation (RD-21)	X				Will be common with other design components
Compliance pan for federal and state archeological Requirements (PD-14)	X				Will be common with other design components
Phase 1 archeological investigation	X				Will be common with other design components
Phase 2 archeological investigation		X			Implement if required based on the Phase 1 Investigation Will be common with other design components
Ice scour analysis	X				
Propeller wash and cap armoring study (PD-24)	X				
Wind and wave analysis	X				
Groundwater model update (PD-12)	X				Will be common with other design components
NAPL expression evaluation	X				
Cap flux modeling (for NAPL)	X				

Table 4-4. General Contents of the Design Reports for the Capping Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Cap design life assessment	X				Identify the design life for the cap design effort
Habitat layer assessment	X				
Treatability testing of active cap layer materials (PD-17)	X				
Geotechnical (laboratory) testing of active cap layer materials	X				
Study of canal operations (PD-11)	X				
Selection of specific type of treatment layer (RD-26)		X			
Geotechnical characterization for dredging and capping design (PD-18)	X				Will be common with the dredging design component
Bathymetric survey after flushing tunnel operation (PD-22)	X				Will be common with other design components
Update hydrodynamic and sediment transport models to evaluate long term impacts of FT operation	X				
Groundwater upwelling investigation for cap design (PD-7)	X				

Table 4-4. General Contents of the Design Reports for the Capping Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Capping pilot test (RD-9)		X			
Upland evaluation for cut-off walls (PD-13)	X				Will be common with other design components
Evaluation of potentially mobile NAPL in native sediments (PD-8)	X				Shared with ISS design component
Laboratory evaluation of NAPL mobility (PD-15)	X				Shared with ISS design component
Laboratory evaluation of ISS performance (PD-19)	X				Shared with ISS design component
Development of frequency details for cap monitoring and maintenance programs (RD-13)			X		
Capping Design Calculation Packages					
Summary of subsurface stratigraphy and material Properties	X	X	X	X	
Global slope stability analysis	X	X	X	X	
Summary of geotechnical design parameters	X	X	X	X	
Static slope stability analysis of cap	X	X	X	X	
Analysis of bearing capacity of sediments below cap	X	X	X	X	
Settlement analysis under cap loading scenarios	X	X	X	X	

Table 4-4. General Contents of the Design Reports for the Capping Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Chemical modeling for treatment layer thickness and material selection		X	X	X	
Hydrodynamic modeling and stability analysis for armor layer gradation requirements	X	X	X	X	
Hydrodynamic modeling and stability analysis for habitat layer gradation requirements		X	X	X	
Groundwater upwelling discharge rate	X	X	X	X	
Capping Design Drawings					
Cover Sheet	X	X	X	X	
Drawing Legend			X	X	
General Notes			X	X	
General Site Plan	X	X	X	X	
Detail Site Plans		X	X	X	
Cap Cross Sections per Various Capping Scenarios (e.g., per RTA)	X	X	X	X	
Cap Treatment Layer Details per Various Capping Scenarios (e.g., per RTA)		X	X	X	

Table 4-4. General Contents of the Design Reports for the Capping Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Cap Construction Specifications		X	X	X	
Cap Placement and Construction Sequencing Details		X	X	X	
Cap Material Staging Site Plans		X	X	X	Shared with dredging and capping support site design component
Capping Design Specifications					
Cap Construction and Thickness		X	X	X	
Materials for Treatment Layer(s), Armor Layer, and Habitat Layer		X	X	X	
Environmental Protection		X	X	X	
Cap Material Staging and Transport		X	X	X	Will be common with other design components
Cleanup and Site Restoration		X	X	X	Will be common with other design components
Other Design Elements					
Basis of Design Report	X				May be common with other design components
Preliminary Cost Estimate	X	X	X		
Final Engineer's Cost Estimate				X	

Table 4-4. General Contents of the Design Reports for the Capping Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Preliminary Construction Schedule	X	X	X	X	
Land Acquisition/Easement Requirements	X	X			
Capping Construction Plans					
Project Sustainability Plan (RD-7)			X	X	Will be included as a general plan for all design components
Construction Work Plan			X	X	May be common with other design components
Construction Sampling and Analysis Plan • Construction Field Sampling Plan • Construction Quality Assurance Project Plan			X	X	May be common with other design components
Construction Quality Assurance Plan			X	X	May be common with other design components
Construction Emergency Response Plan			X	X	May be common with other design components
Construction Site Management Plan			X	X	May be common with other design components

Notes:

1. Pre-design investigation and evaluation reports may be included in the design reports or be included by reference.

Table 4-5. General Contents of the Design Reports for the In-situ Sediment Stabilization Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Pre-Design Investigations Associated with the In-situ Sediment Stabilization Design[1]					
Evaluation of potentially mobile NAPL in the native sediments (PD-8)	X				Shared with capping design component
Laboratory evaluation of ISS performance (PD-19)	X				Shared with capping design component
Laboratory evaluation of NAPL mobility (PD-15)	X				Shared with capping design component
ISS pilot test (RD-10)	X				Follow-up testing may be required in 65% phase
In-situ Sediment Stabilization Design Calculation Packages					
Summary of subsurface stratigraphy and material properties	X	X	X	X	
ISS mix design (strength, hydraulic conductivity, NAPL mobility/leaching)	X	X	X	X	Follows bench-scale testing and ISS Pilot Study
Structural performance of ISS under cap	X	X	X	X	
Global slope stability analysis	X	X	X	X	
In-situ Sediment Stabilization Design Drawings					
Cover Sheet	X	X	X	X	
Drawing Legend			X	X	

Table 4-5. General Contents of the Design Reports for the In-situ Sediment Stabilization Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
General Notes			X	X	
General Site Plan	X	X	X	X	
ISS Column Layout Plans (per each RTA)	X	X	X	X	
Cross Sections		X	X	X	Coordinate with Dredging Plans and Sections
Construction Sequencing Plans		X	X	X	Coordinate with Dredging Plans and Sections
Testing and Sampling Plans		X	X	X	Developed following ISS Pilot Study
In-situ Sediment Stabilization Design Specifications					
ISS Mix Design		X	X	X	
ISS Construction		X	X	X	
ISSQA/QC, Verification, and Testing		X	X	X	
Other Design Elements					
Basis of Design Report	X				May be common with other design components
Preliminary Cost Estimate	X	X	X		
Final Engineer's Cost Estimate				X	

Table 4-5. General Contents of the Design Reports for the In-situ Sediment Stabilization Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Preliminary Construction Schedule	X	X	X	X	
In-situ Sediment Stabilization Construction Plans					
Project Sustainability Plan (RD-7)			X	X	Will be included as a general plan for all design components
Construction Work Plan			X	X	May be common with other design components
Construction Sampling and Analysis Plan • Construction Field Sampling Plan • Construction Quality Assurance Project Plan			X	X	May be common with other design components
Construction Quality Assurance Plan			X	X	May be common with other design components
Construction Emergency Response Plan			X	X	May be common with other design components
Construction Site Management Plan			X	X	May be common with other design components

Notes:

1. Pre-design investigation and evaluation reports may be included in the design reports or be included by reference.

Table 4-6. General Contents of the Design Reports for the Ex-situ Sediment Treatment Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Package	35%	65%	90%	100%	Comments
Pre-Design Investigations Associated with the Ex-situ Sediment Treatment Design[1]					
Air pathway analysis (APA) for Remedial activities (RD-19)	X				Will be common with other design components
Odor and noise control measures evaluation (RD-28)	X				
Data review of types and concentrations of contaminants	X				
Confirmation sampling pertaining to the disposal of sediments (RD-17)	X				
Identification of potential disposal facility/facilities (RD-18)	X				
Identification of sampling locations for treatability testing	X				
Treatability (bench scale) testing of sediment dewatering (PD-21)	X				
Treatability (bench scale) testing of dewatered sediment stabilization (PD-10)	X				
Treatability (bench scale) testing of dewatered sediment thermal desorption	X				

Table 4-6. General Contents of the Design Reports for the Ex-situ Sediment Treatment Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Package	35%	65%	90%	100%	Comments
Development of specific measures to control air emissions during sediment processing (RD-20)		X			
Ex-situ Sediment Treatment Design Calculation Packages					
Estimate type and quantities of treatment additives required	X				
Summary of available thermal treatment facilities, acceptance criteria, and capacity	X				
Evaluate results from treatment of sediment removed in dredge pilot test	X				
Identification of space requirements, for additive storage and other ex-treatment activities	X				
Identification of beneficial uses of thermally treated sediment		X			
Identification of disposal options for treated sediment not suitable for beneficial re-use		X	X		
Results from leachability testing of untreated and treated sediments	X	X	X		
Geotechnical properties of treated sediment	X	X	X		

Table 4-6. General Contents of the Design Reports for the Ex-situ Sediment Treatment Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Package	35%	65%	90%	100%	Comments
Ex-situ Sediment Treatment Design Drawings					
Cover Sheet	X	X	X	X	
Drawing Legend			X	X	
General Notes			X	X	
General Site Plan	X	X	X	X	
Details of Sediment Treatment Process Diagram	X	X	X	X	
Storm Water Management		X	X	X	
Ex-situ Sediment Treatment Design Specifications					
Ex-Situ Dewatering		X	X	X	Will be common with the dredging design
Ex-Situ Solidification		X	X	X	
Ex-Situ Treatment		X	X	X	
Beneficial Re-use Restrictions		X	X	X	
Material Transport and Disposal		X	X	X	
Other Design Elements					
Basis of Design Report	X				May be common with other design components

Table 4-6. General Contents of the Design Reports for the Ex-situ Sediment Treatment Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Package	35%	65%	90%	100%	Comments
Preliminary Cost Estimate	X	X	X		
Final Engineer's Cost Estimate				X	
Preliminary Construction Schedule	X	X	X	X	
Land Acquisition/Easement Requirements	X	X			
Ex-situ Sediment Treatment Construction Plans					
Project Sustainability Plan (RD-7)			X	X	Will be included as a general plan for all design components
Construction Work Plan			X	X	May be common with other design components
Construction Sampling and Analysis Plan • Construction Field Sampling Plan • Construction Quality Assurance Project Plan			X	X	May be common with other design components
Construction Quality Assurance Plan			X	X	May be common with other design components
Construction Emergency Response Plan			X	X	May be common with other design components
Construction Site Management Plan			X	X	May be common with other design components

Notes:

1. Pre-design investigation and evaluation reports may be included in the design packages or be included by reference.

Table 4-7. General Contents of the Design Reports for the Dredge Water Treatment System Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Pre-Design Investigations Associated with the Dredge Water Treatment System Design[1]					
Evaluation of potential to discharge to NYC POTW	X				
Establish discharge criteria	X				
Treatability (bench scale) testing of dredge water treatment	X				
Field investigation to define dredge water treatment system influent conditions	X				
Dredge water treatment pilot test		X			
Dredge Water Treatment System Design Calculation Packages					
Influent flow and schedule	X	X	X	X	
Equipment sizing	X	X	X	X	
Unit operation treatment efficiency	X	X	X	X	
Dredge Water Treatment System Design Drawings					
Cover Sheet	X	X	X	X	
Drawing Legend			X	X	
General Notes			X	X	

Table 4-7. General Contents of the Design Reports for the Dredge Water Treatment System Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
General Site Plan	X	X	X	X	
Water Treatment Plan	X	X	X	X	
Process Flow Diagram	X	X	X	X	
Process & Instrumentation Diagram		X	X	X	
Hydraulic Gradient Profile		X	X	X	
Water Treatment System Sections			X	X	
Water Treatment System Details			X	X	
Dredge Water Treatment System Design Specifications					
Dredge Water Treatment Requirements	X	X	X	X	
Dredge Water Treatment Equipment Installation		X	X	X	Specific specifications sections will depend on the unit processes selected in design Will be common with the dredging design
Other Design Elements					
Basis of Design Report	X				May be common with other design components

Table 4-7. General Contents of the Design Reports for the Dredge Water Treatment System Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Preliminary Cost Estimate	X	X	X		
Final Engineer's Cost Estimate				X	
Preliminary Construction Schedule	X	X	X	X	
Dredge Water Treatment System Construction Plans					
Project Sustainability Plan (RD-7)			X	X	Will be included as a general plan for all design components
Construction Work Plan			X	X	May be common with other design components
Construction Sampling and Analysis Plan • Construction Field Sampling Plan • Construction Quality Assurance Project Plan			X	X	May be common with other design components
Construction Quality Assurance Plan			X	X	May be common with other design components
Construction Emergency Response Plan			X	X	May be common with other design components
Construction Site Management Plan			X	X	May be common with other design components

Notes:

1. Pre-design investigation and evaluation reports may be included in the design reports or be included by reference.

Table 4-8. General Contents of the Design Reports for the Dredging and Capping Support Site Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Pre-Design Investigations Associated with the Dredging and Capping Support Site Design[1]					
Development of a plan for staging site selection and implementation (PD-6)	X				
Wetlands areas evaluation (RD-21)	X				Will be common with other design components
Compliance plan for federal and state archeological requirements (PD-14)	X				Will be common with other design components
Phase 1 archeological investigation	X				Will be common with other design components
Phase 2 archeological investigation		X			Implement if required based on the Phase 1 Investigation Will be common with other design components
Odor and noise control measures evaluation (RD-28)	X				
Property ownership and availability evaluation	X				
Utilities availability evaluation	X				
Road and rail access evaluation	X				
Dredging and Capping Support Site Design Calculation Packages					

Table 4-8. General Contents of the Design Reports for the Dredging and Capping Support Site Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Electrical load		X	X	X	
Other utility requirements		X	X	X	
Traffic estimates		X	X	X	
Dredging and Capping Support Site Design Drawings					
Cover Sheet	X	X	X	X	
Drawing Legend			X	X	
General Notes			X	X	
General Site Plan	X	X	X	X	
Preconstruction Sampling Plan		X	X	X	
Staging Area Plan	X	X	X	X	
Staging Area Sections		X	X	X	
Civil Utility Plan		X	X	X	
Civil Utility Sections		X	X	X	
Civil Utility Profiles			X	X	
Civil Utility Details			X	X	

Table 4-8. General Contents of the Design Reports for the Dredging and Capping Support Site Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Dock and Wharf Plan	X	X	X	X	
Dock and Wharf Sections		X	X	X	
Dock and Wharf Details			X	X	
Traffic Plan		X	X	X	
Admin Area/Parking Plan		X	X	X	
Admin Area/Parking Sections & Details			X	X	
Fencing Section & Details			X	X	
Debris Management Pad Plan		X	X	X	
Debris Management Pad Section & Details			X	X	
Site Restoration Plan		X	X	X	
Site Restoration Sections & Details			X	X	
Dredging and Capping Support Site Design Specifications					
Temporary Facilities and Controls (including security)		X	X	X	
Temporary Erosion and Sediment Control		X	X	X	
Equipment Testing and Facility Startup		X	X	X	

Table 4-8. General Contents of the Design Reports for the Dredging and Capping Support Site Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Site Preparation		X	X	X	
Subgrade Preparation		X	X	X	
Excavation		X	X	X	
Aggregate Base Courses		X	X	X	
Geosynthetics		X	X	X	
Asphalt Paving		X	X	X	
Concrete		X	X	X	
Sheet Piling		X	X	X	
Piping		X	X	X	
Electrical		X	X	X	
Soil Preparation		X	X	X	
Planting		X	X	X	
Site Restoration		X	X	X	
Other Design Elements					
Basis of Design Report	X				May be common with other design components

Table 4-8. General Contents of the Design Reports for the Dredging and Capping Support Site Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Preliminary Cost Estimate	X	X	X		
Final Engineer's Cost Estimate				X	
Preliminary Construction Schedule	X	X	X	X	
Land Acquisition/Easement Requirements	X	X			
Dredging and Capping Support Site Construction Plans					
Project Sustainability Plan (RD-7)			X	X	Will be included as a general plan for all design components
Construction Work Plan			X	X	May be common with other design components
Construction Sampling and Analysis Plan • Construction Field Sampling Plan • Construction Quality Assurance Project Plan			X	X	May be common with other design components
Construction Quality Assurance Plan			X	X	May be common with other design components
Construction Emergency Response Plan			X	X	May be common with other design components
Construction Site Management Plan			X	X	May be common with other design components

Notes:

1. Pre-design investigation and evaluation reports may be included in the design reports or be included by reference.

Table 4-9. General Contents of the Design Reports for the Source Control – Unpermitted Outfalls Mitigation Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Pre-Design Investigations Associated with the Source Control – Unpermitted Outfalls Mitigation Design[1]					
Unpermitted outfalls survey and evaluation	X				
Unpermitted outfalls mitigation plan	X				
Source Control – Unpermitted Outfalls Mitigation Design Calculation Packages					
Required calculations for mitigating unpermitted outfalls		X	X	X	
Source Control – Unpermitted Outfalls Mitigation Design Drawings					
Cover Sheet	X	X	X	X	
Drawing Legend			X	X	
General Notes			X	X	
General Site Plan	X	X	X	X	
Detailed Site Plan (Each Identified Outfall)		X	X	X	
Mitigation Measures Plan (Each Identified Outfall)	X	X	X	X	
Mitigation Measures Sections (Each Identified Outfall)		X	X	X	
Mitigation Measures Details		X	X	X	
Source Control – Unpermitted Outfalls Mitigation Design Specifications					

Table 4-9. General Contents of the Design Reports for the Source Control – Unpermitted Outfalls Mitigation Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Temporary Erosion and Sediment Control		X	X	X	
Site Preparation		X	X	X	
Subgrade Preparation		X	X	X	
Excavation		X	X	X	
Asphalt Paving		X	X	X	
Concrete		X	X	X	
Sheet Piling		X	X	X	
Piping		X	X	X	
Site Restoration		X	X	X	
Other Design Elements					
Basis of Design Report	X				May be common with other design components
Preliminary Cost Estimate	X	X	X		
Final Engineer's Cost Estimate				X	
Preliminary Construction Schedule	X	X	X	X	
Land Acquisition/Easement Requirements	X	X			

Table 4-9. General Contents of the Design Reports for the Source Control – Unpermitted Outfalls Mitigation Design, Gowanus Canal Superfund Site, Brooklyn, New York

Design Report	35%	65%	90%	100%	Comments
Source Control – Unpermitted Outfalls Mitigation Construction Plans					
Project Sustainability Plan (RD-7)			X	X	Will be included as a general plan for all design components
Construction Work Plan			X	X	May be common with other design components
Construction Sampling and Analysis Plan • Construction Field Sampling Plan • Construction Quality Assurance Project Plan			X	X	May be common with other design components
Construction Quality Assurance Plan			X	X	May be common with other design components
Construction Emergency Response Plan			X	X	May be common with other design components
Construction Site Management Plan			X	X	May be common with other design components

Notes:

1. Pre-design investigation and evaluation reports may be included in the design reports or be included by reference.

Table 5-1. Regulatory Requirements for the Remedial Design and Remedial Action, Gowanus Canal Superfund Site, Brooklyn, New York

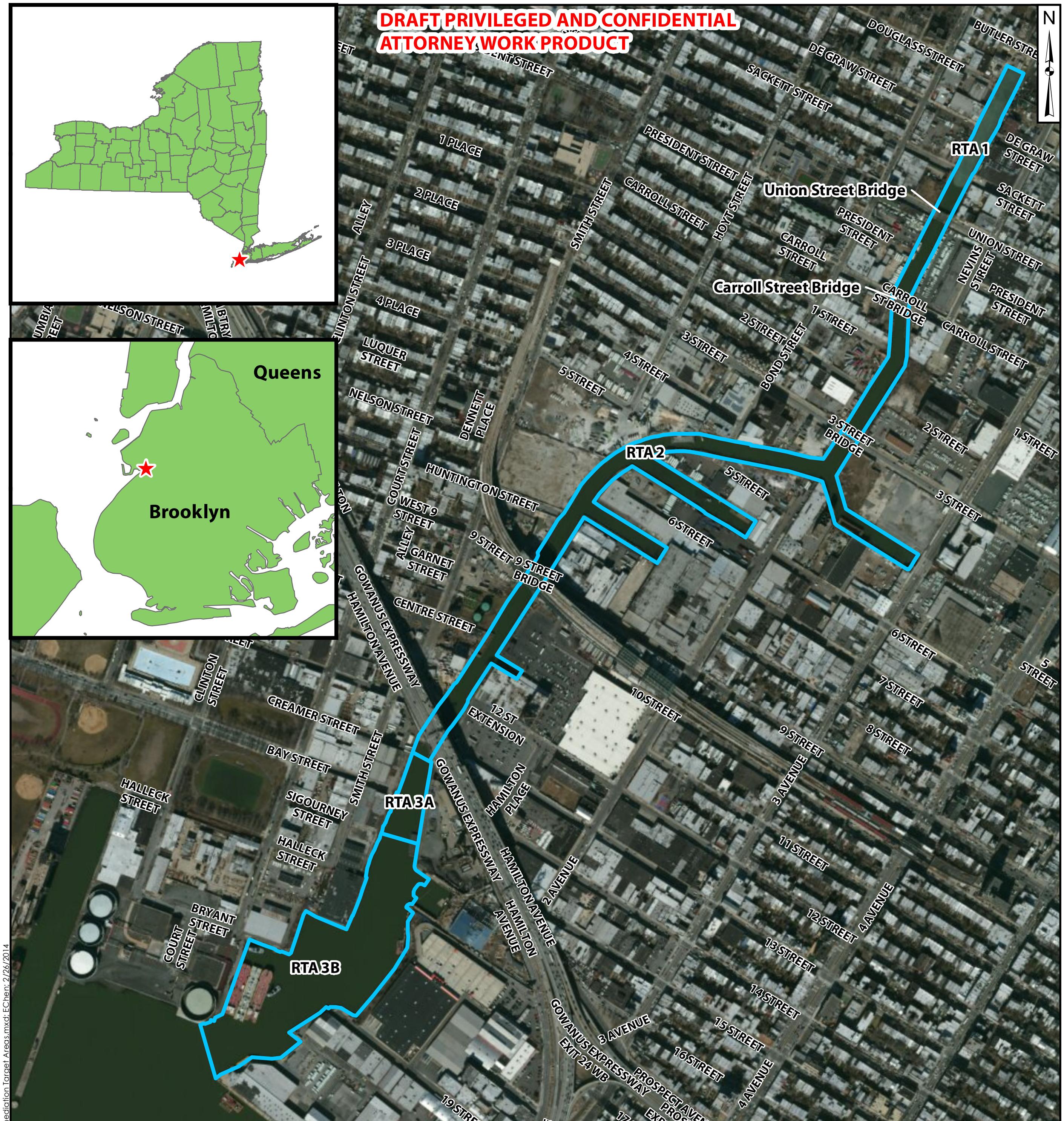
Remedial Action	Regulatory Program	EPA Approval?	Requirements and Comments
Dredging	**Federal** Section 404 of the Clean Water Act (33 U.S.C. 1344) permit and a Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403) permit	Yes	Two main Federal Authorities issued as one permit action. EPA, rather than USACE, can act as coordinator of federal resource agencies.
	State (NY) • Excavation and Fill in Navigable Waters • Water Quality Certification • Tidal Wetlands. • Federal Consistency • State Historic Preservation Office requirements	Yes	Companion Permit to Federal Permit Action
	State (NJ) • Acceptable Use Deter-mination (AUD)	Yes	NJ's permitting authority for any part of the dredging and disposal cycle occurring within their state boundaries

Table 5-1. Regulatory Requirements for the Remedial Design and Remedial Action, Gowanus Canal Superfund Site, Brooklyn, New York

Remedial Action	Regulatory Program	EPA Approval?	Requirements and Comments
Bulkheads Repair or Replacement	Same Permits as above. Can have separate sections of or stand-alone applications for each regulated activity (remedial action.)	Yes	Same regulatory authority for different regulated activities. Both the federal and state agencies will attempt to combine as many regulated activities into a single permit action as practical. The agencies will entertain separate application sections or stand-alone applications per activity and structure the approval accordingly
Capping	Same Permits as above. Can have separate sections of or stand-alone applications for each regulated activity (remedial action.)	Yes	As above
Excavation and Restoration of the 5th Street Turning Basin	Same Permits as above. Can have separate sections of or stand-alone applications for each regulated activity (remedial action.)	Yes	As above
In Situ Sediment Stabilization of Sediment	Same Permits as above. Can have separate sections of or stand-alone applications for each regulated activity	Yes	As above

Table 5-1. Regulatory Requirements for the Remedial Design and Remedial Action, Gowanus Canal Superfund Site, Brooklyn, New York

Remedial Action	Regulatory Program	EPA Approval?	Requirements and Comments
	(remedial action.)		
Ex-Situ Sediment Treatment	Since it is assumed this remedial activity will be performed in NJ, an AUD is required. Will need to provide above referenced permits to NJ as a precursor for NJ approval	Unclear. No for a NJ issued AUD but NJ is in EPA Region 2, so undetermined	NJ has traditionally accepted NYS dredged material that meets their acceptance and placement criteria that can be demonstrated through bench-scale and pilot-study testing. CERCLA material may be a different matter.
Dredge Material Decant Water Treatment	Section 401 of the CWA; Water Quality Certification	Yes	WQC condition of other federal and state permit actions.



N:\N\National Grid\Gowanus\Tasks and Deliverables\PDWP Figures\Figure 2-2 Remediation Target Areas.mxd; EChen; 2/26/2014

800 400 0 800 Feet

RTA

Site Map and Remediation Target Areas (RTAs)

Gowanus Canal Superfund Site
Brooklyn, New York

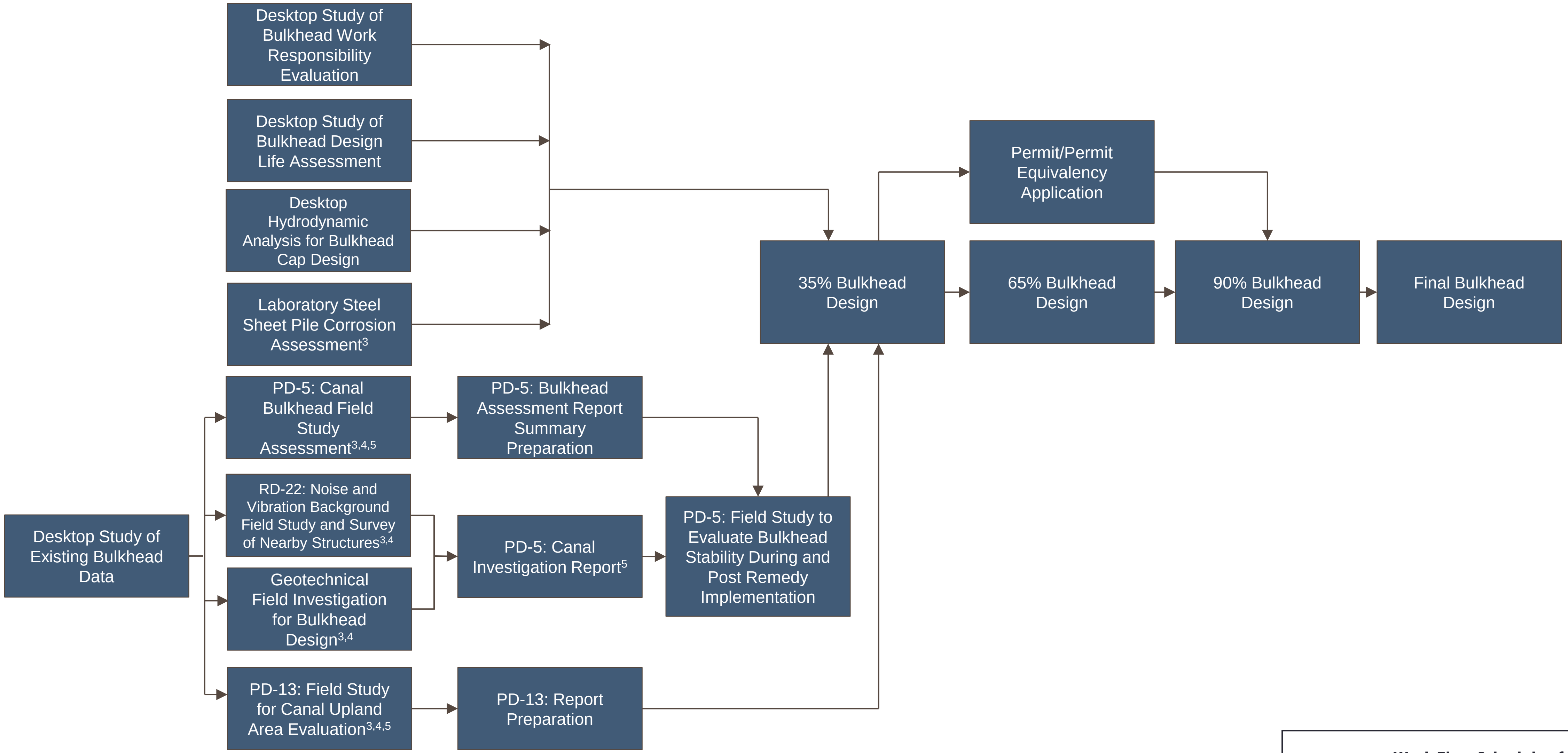
nationalgrid
HERE WITH YOU. HERE FOR YOU.

Geosyntec consultants

Kennesaw, GA

February 2014

Figure
2-1



Notes:

1. All tasks require work plan preparation prior to initiation.
2. Construction cost estimates will be performed for all design components after the final design.
3. Procurement of subcontractors and/or laboratories is included in the task.
4. Access agreements are required for implementation of the task.
5. Bulkhead design is anticipated to be broken into upper and lower portions of the Canal to allow the upper Canal design to be developed during field work on the lower Canal.
6. Refer to Section 7 of the RDWP for additional notes regarding coordination issues and potential schedule impacts.

Work Flow Schedule of Bulkhead Repair and Replacement Design[1,2]

Gowanus Canal Superfund Site, Brooklyn, New York

nationalgrid HERE WITH YOU. HERE FOR YOU.

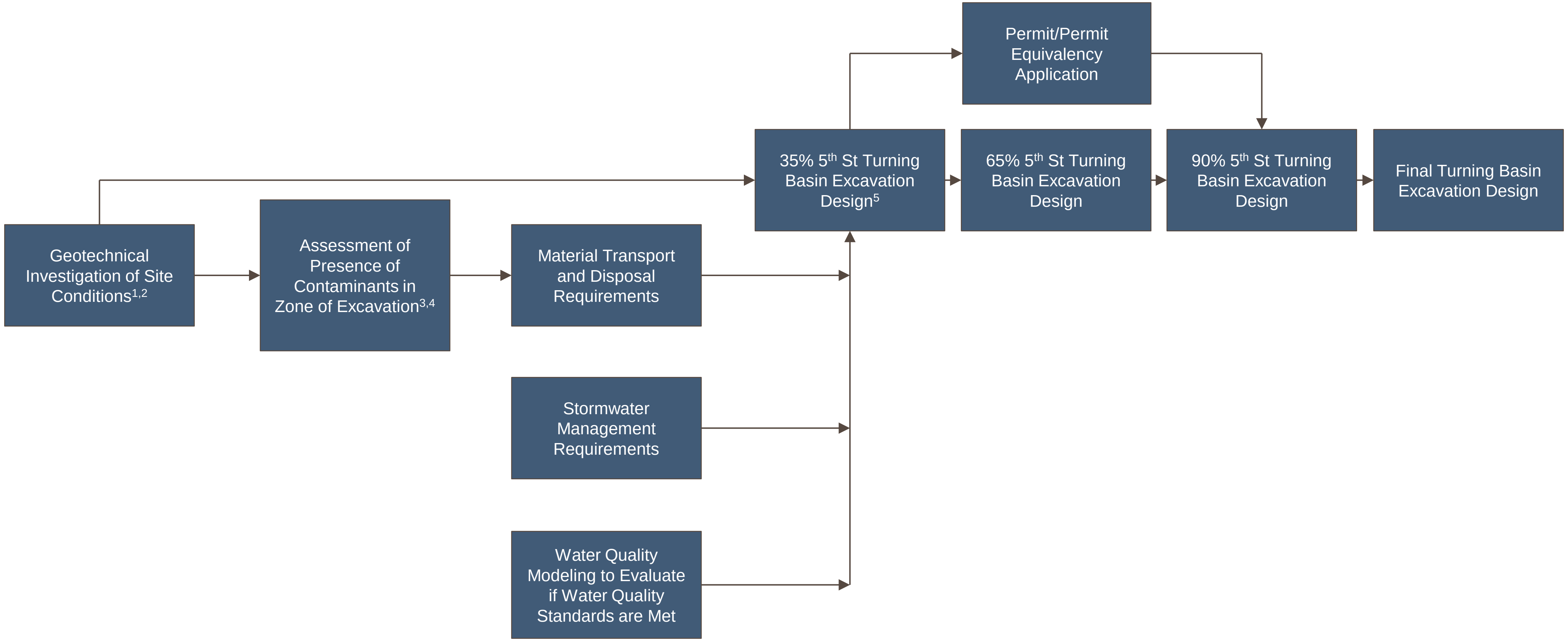
Geosyntec consultants

Figure **4-1**

February 2014

Ewing, NJ

P:\PRJ1\HPH104 - Gowanus Canal\Figures



Notes:

1. All tasks require work plan preparation prior to initiation.
2. Construction cost estimates will be performed for all design components after the final design.
3. Procurement of subcontractors and/or laboratories is included in the task.
4. Access agreements are required for implementation of the task.
5. Initiation of this task is contingent upon the completion of RD-22: Noise and Vibration Background Field Study and Survey of Nearby Structures of the Bulkhead design component.
6. Refer to Section 7 of the RDWP for additional notes regarding coordination issues and potential schedule impacts.

Work Flow Schedule of Excavation/Restoration of the 5th Street Turning Basin Design – Excavation Design[1,2]

Gowanus Canal Superfund Site, Brooklyn, New York

nationalgrid
HERE WITH YOU. HERE FOR YOU.

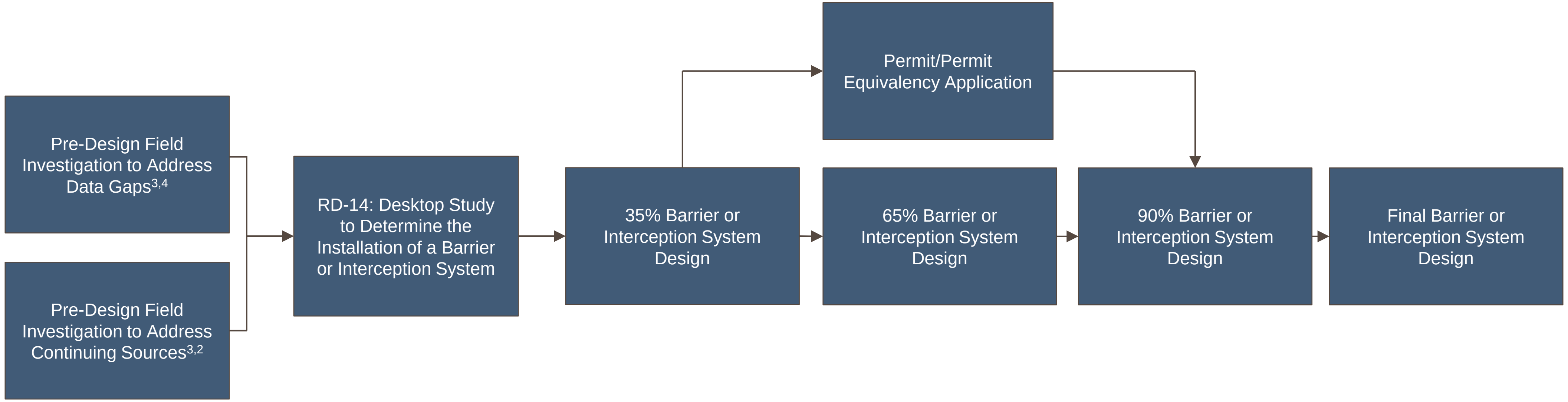
Geosyntec consultants

Figure **4-2a**

February 2014

Ewing, NJ

P:\PRJ1\HPH104 - Gowanus Canal\Figures



Notes:

1. All tasks require work plan preparation prior to initiation.
2. Construction cost estimates will be performed for all design components after the final design.
3. Procurement of subcontractors and/or laboratories is included in the task.
4. Access agreements are required for implementation of the task.
5. Refer to Section 7 of the RDWP for additional notes regarding coordination issues and potential schedule impacts.

Work Flow Schedule of Excavation/Restoration of the 5th Street Turning Basin Design – Barrier or Interceptor System Design[1,2]

Gowanus Canal Superfund Site, Brooklyn, New York

nationalgrid
HERE WITH YOU. HERE FOR YOU.

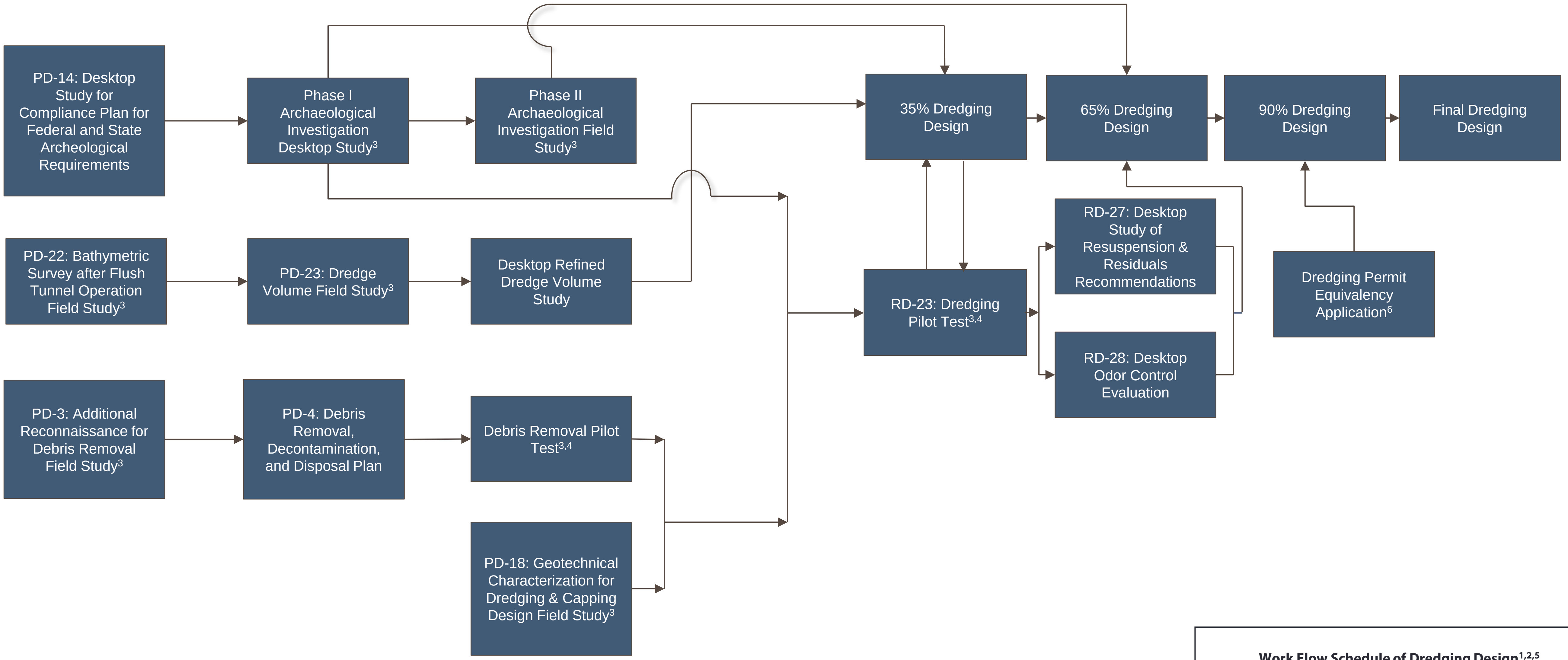
Geosyntec consultants

Figure **4-2b**

February 2014

Ewing, NJ

P:\PRJ1\HPH104 - Gowanus Canal\Figures



Work Flow Schedule of Dredging Design[1,2,5]

Gowanus Canal Superfund Site, Brooklyn, New York

nationalgrid
HERE WITH YOU. HERE FOR YOU.

Geosyntec
consultants

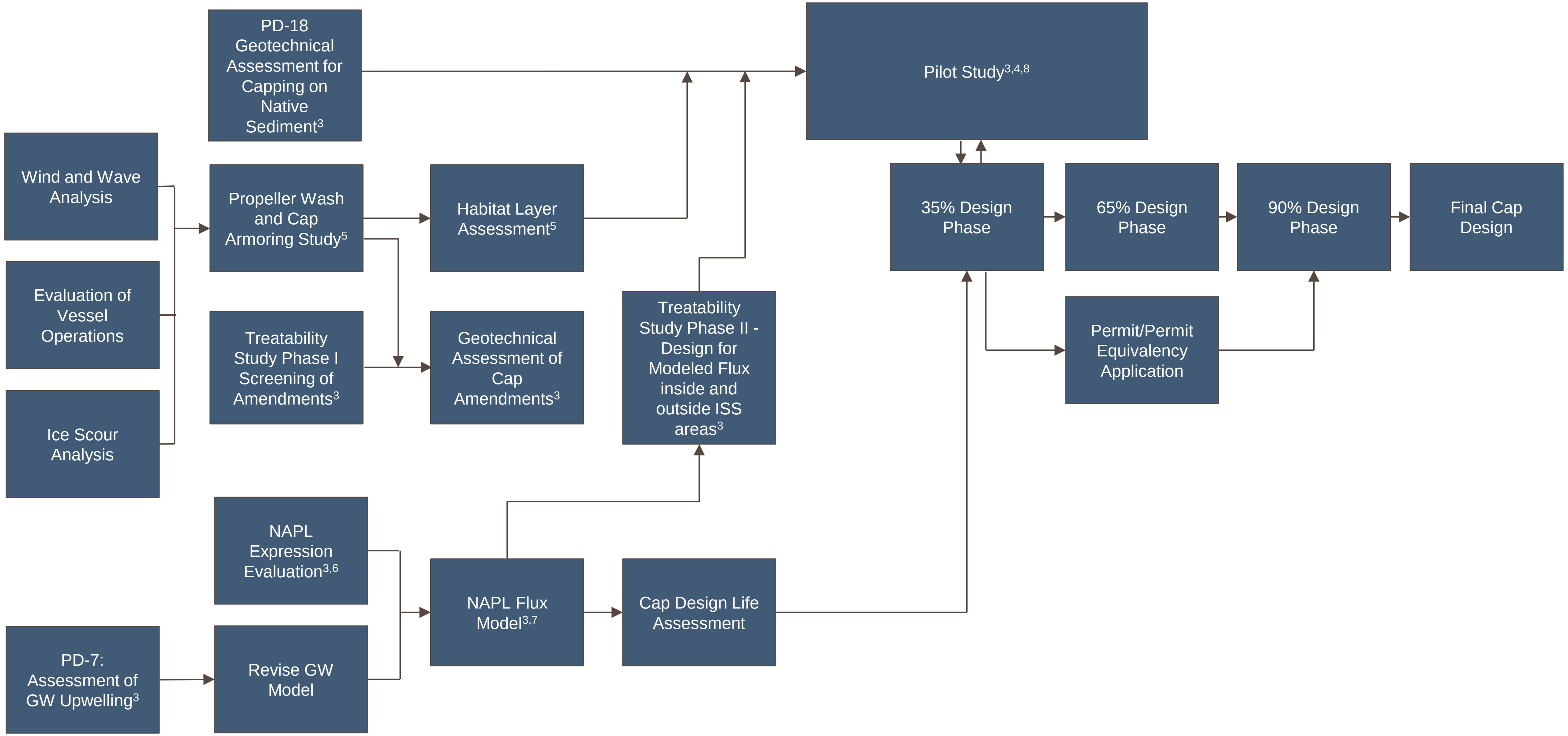
Figure **4-3**

February 2014

Ewing, NJ

Notes:

1. All tasks require work plan preparation prior to initiation.
2. Construction cost estimates will be performed for all design components after the final design.
3. Procurement of subcontractors and/or laboratories is included in the task.
4. Access agreements are required for implementation of the task.
5. Initiation of this task is contingent upon the selection of dredging technology.
6. Initiation of this task is contingent upon the completion of the 35% Dredging Design component.
7. Refer to Section 7 of the RDWP for additional notes regarding coordination issues and potential schedule impacts.



Notes:

1. All tasks require work plan preparation prior to initiation.
2. Construction cost estimates will be performed for all design components after the final design.
3. Procurement of subcontractors and/or laboratories is included in this task.
4. Access agreements are required for implementation of the task
5. Initiation of this task is contingent upon the completion of Revision of Hydrodynamic Model (PD-16) of the General Design component.
6. Initiation of this task is contingent upon the completion of NAPL Mobility Evaluations (PD-8) of the ISS Design component.
7. Initiation of this task is contingent upon the completion of NAPL Mobility Evaluations (PD-8; PD-15) of the ISS Design component.
8. Initiation of this task is contingent upon the completion of the Dredging Pilot Test (RD-23).
9. Refer to Section 7 of the RDWP for additional notes regarding coordination issues and potential schedule impacts.

Work Flow Schedule of Capping Design[1,2]

Gowanus Canal Superfund Site, Brooklyn, New York

nationalgrid
HERE WITH YOU. HERE FOR YOU.

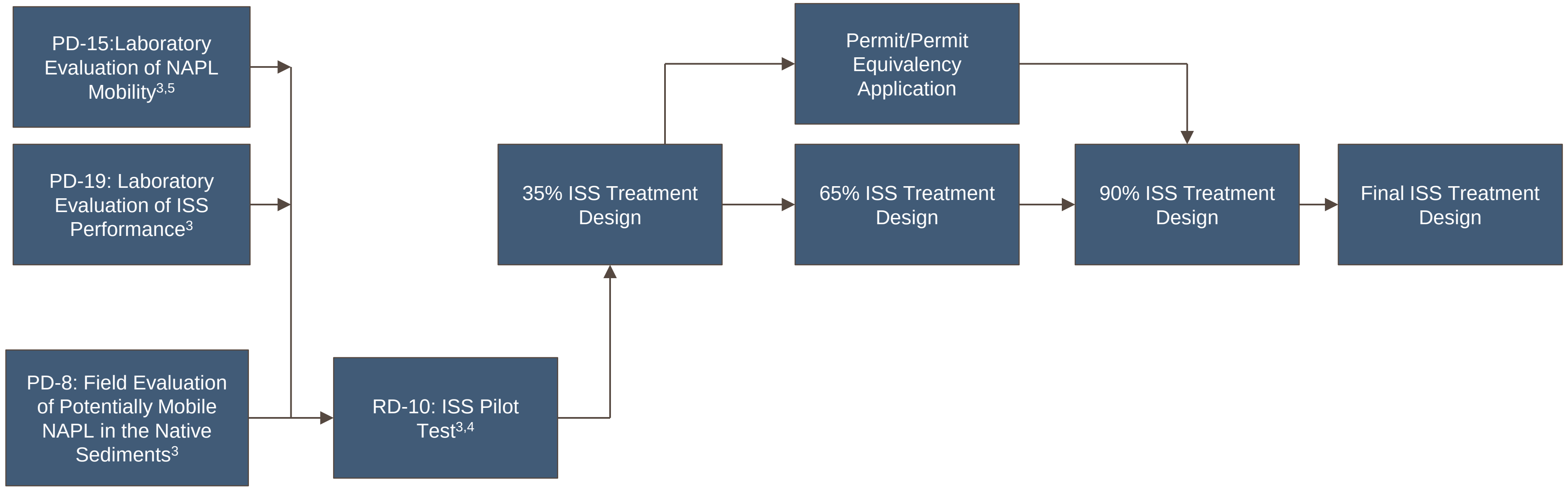
Geosyntec consultants

Figure **4-4**

February 2014

Ewing, NJ

P:\PRJ1\HPH104 - Gowanus Canal\Figures



Notes:

1. All tasks require work plan preparation prior to initiation.
2. Construction cost estimates will be performed for all design components after the final design.
3. Procurement of subcontractors and/or laboratories is included in the task.
4. Access agreements are required for implementation of the task.
5. Initiation of this task is contingent upon the completion of the Assessment of PD-7: Field Investigation of Groundwater Upwelling. Discharge Rates of the Cap design component.
6. Refer to Section 7 of the RDWP for additional notes regarding coordination issues and potential schedule impacts.

Work Flow Schedule of In Situ Stabilization of Sediment Design[1,2]

Gowanus Canal Superfund Site, Brooklyn, New York

nationalgrid
HERE WITH YOU. HERE FOR YOU.

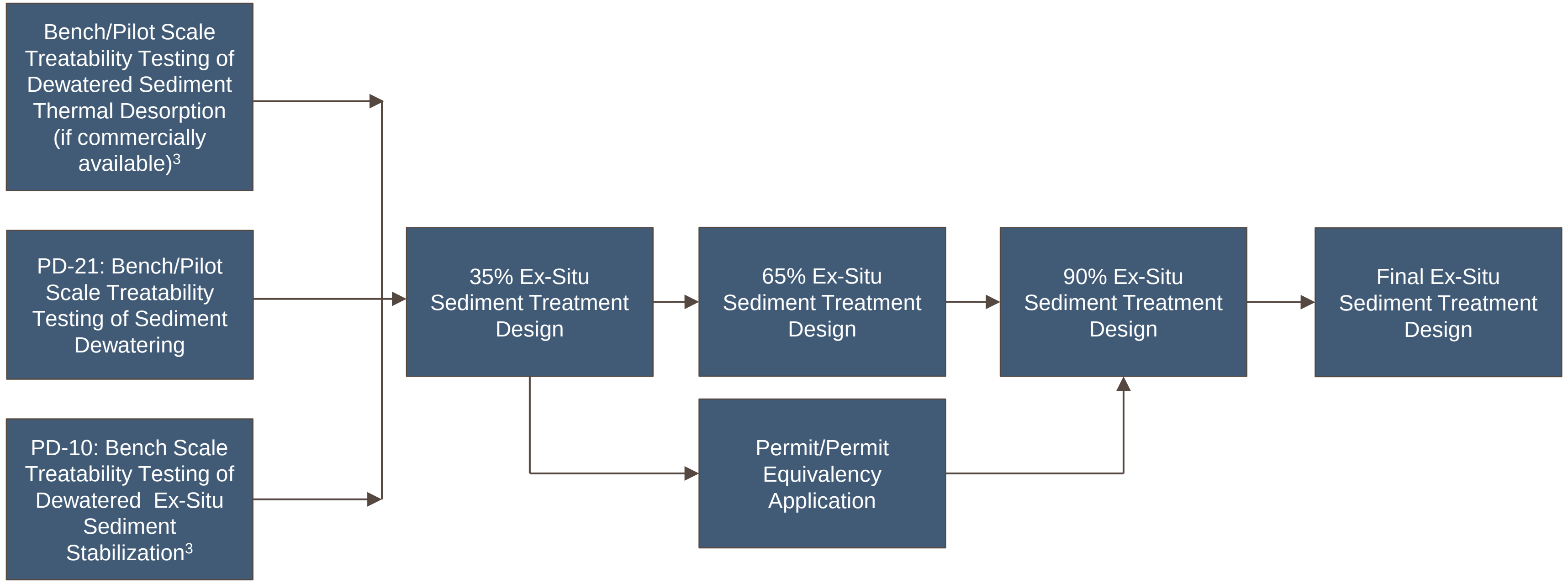
Geosyntec consultants

Figure **4-5**

February 2014

Ewing, NJ

P:\PRJ1\HPH104 - Gowanus Canal\Figures



Notes:

1. All tasks require work plan preparation prior to initiation.
2. Construction cost estimates will be performed for all design components after the final design.
3. Procurement of subcontractors and/or laboratories is included in the task.
4. Refer to Section 7 of the RDWP for additional notes regarding coordination issues and potential schedule impacts.

Work Flow Schedule of Ex Situ Treatment of Sediment Design[1,2]

Gowanus Canal Superfund Site, Brooklyn, New York

nationalgrid HERE WITH YOU. HERE FOR YOU.

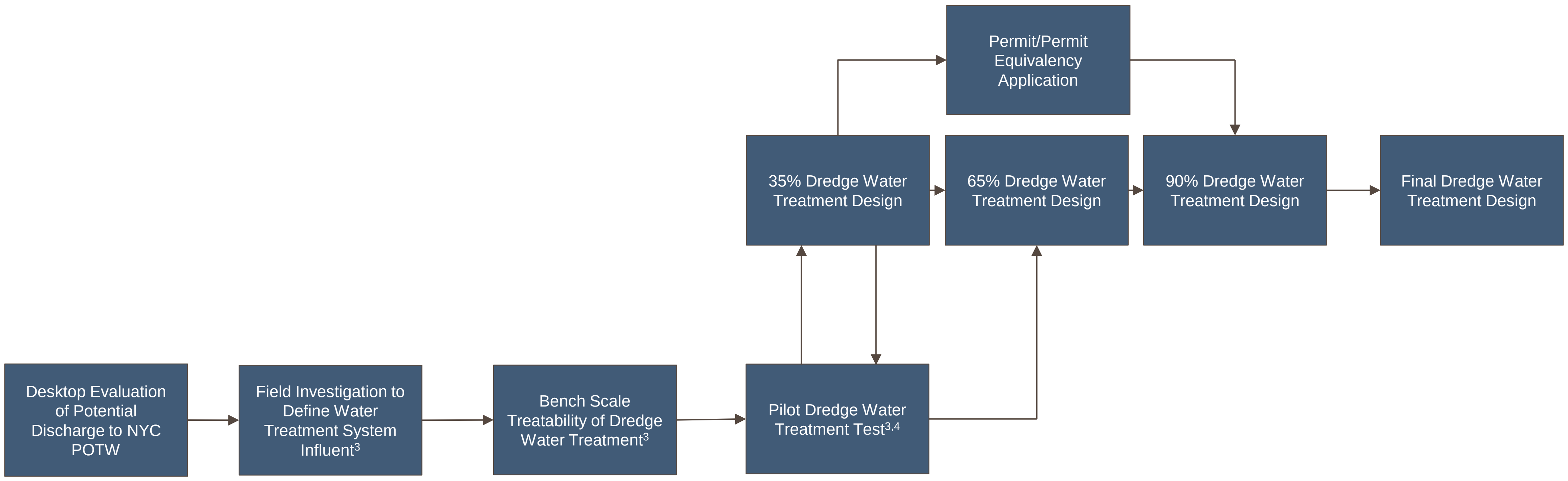
Geosyntec consultants

Figure **4-6**

February 2014

Ewing, NJ

P:\PRJ1\HPH104 - Gowanus Canal\Figures



Notes:

1. All tasks require work plan preparation prior to initiation.
2. Construction cost estimates will be performed for all design components after the final design.
3. Procurement of subcontractors and/or laboratories is included in the task.
4. Access agreements are required for implementation of the task.
5. Initiation of this task is contingent on the selection of the dredging technology.
6. Refer to Section 7 of the RDWP for additional notes regarding coordination issues and potential schedule impacts.

Work Flow Schedule of Dredge Water Treatment System Design[1,2,5]

Gowanus Canal Superfund Site, Brooklyn, New York

nationalgrid HERE WITH YOU. HERE FOR YOU.

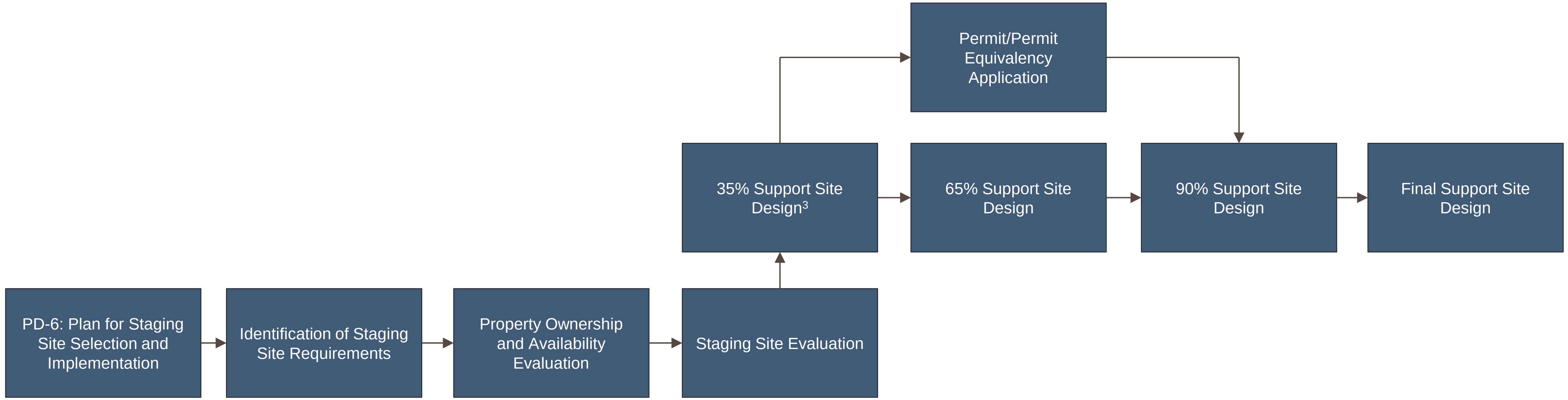
Geosyntec consultants

Figure **4-7**

February 2014

Ewing, NJ

P:\PRJ1\HPH104 - Gowanus Canal\Figures



Notes:

1. All tasks require work plan preparation prior to initiation.
2. Construction cost estimates will be performed for all design components after the final design.
3. Contingent upon EPA gaining appropriate site access.
4. Refer to Section 7 of the RDWP for additional notes regarding coordination issues and potential schedule impacts.

Work Flow Schedule of Support Site Design[1,2]

Gowanus Canal Superfund Site, Brooklyn, New York

nationalgrid
HERE WITH YOU. HERE FOR YOU.

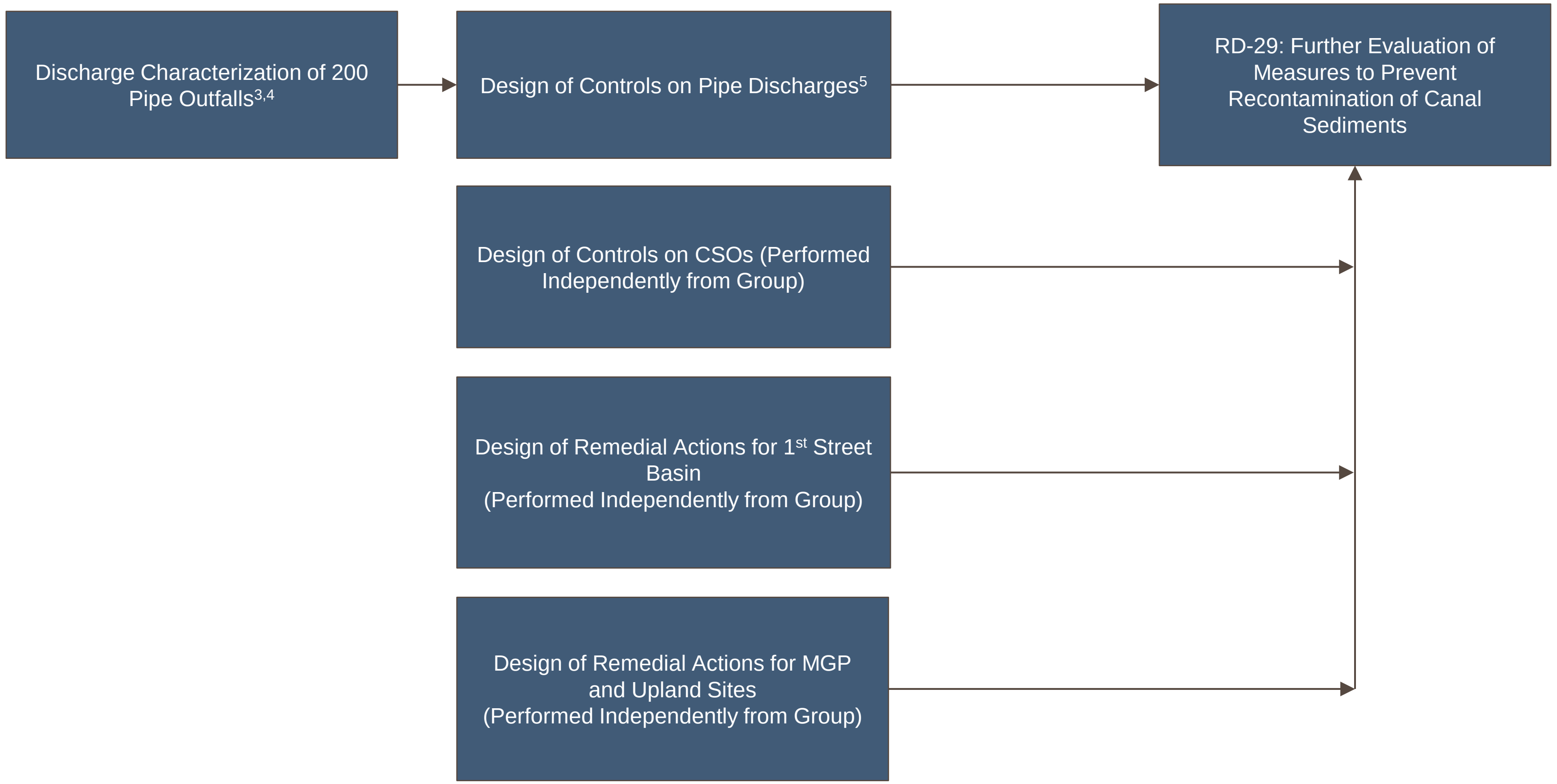
Geosyntec consultants

Figure 4-8

February 2014

Ewing, NJ

P:\PRJ1\HPH104 - Gowanus Canal\Figures



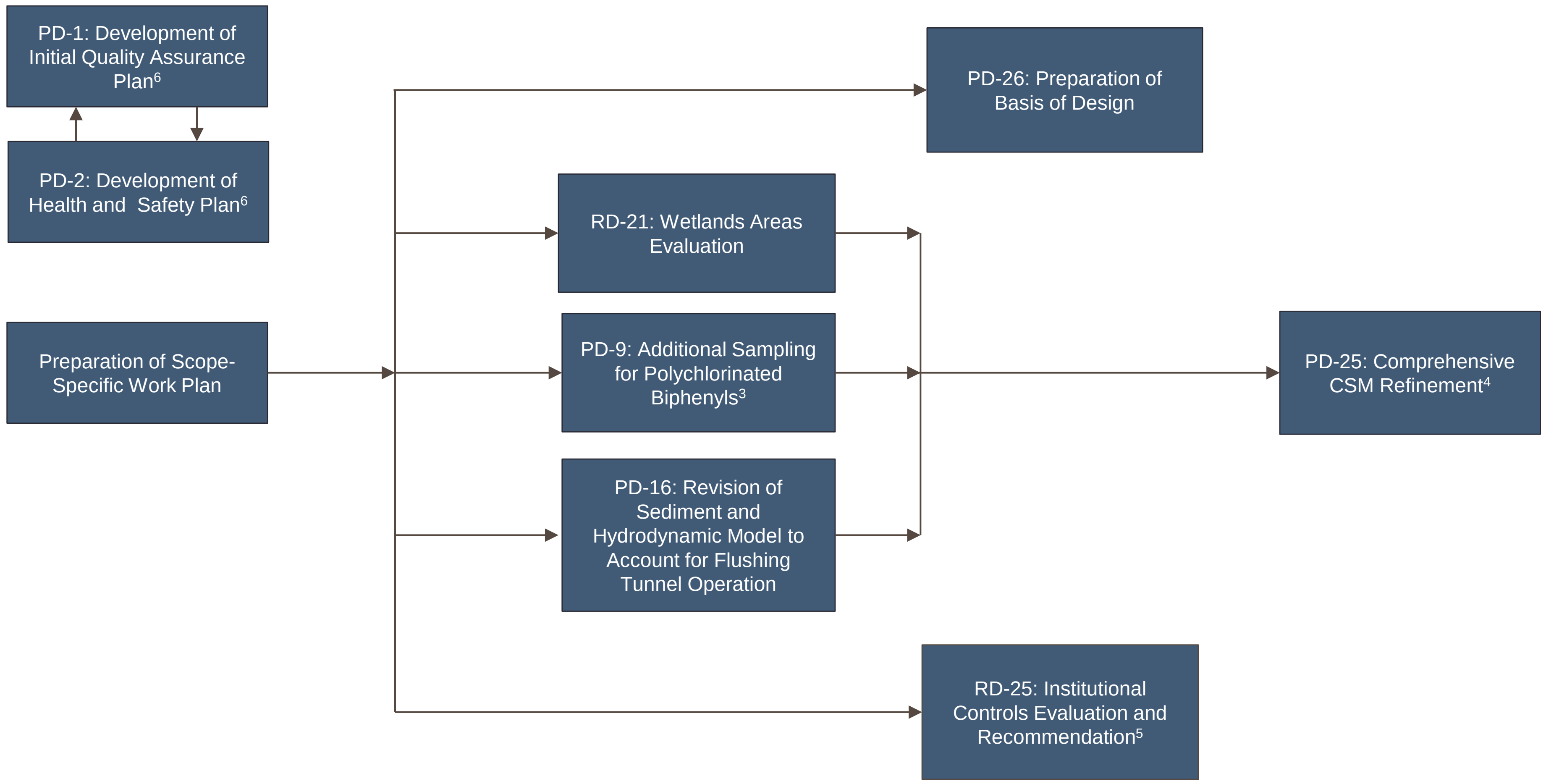
Notes:

1. All tasks require work plan preparation prior to initiation.
2. Construction cost estimates will be performed for all design components after the final design.
3. Procurement of subcontractors and/or laboratories is included in the task.
4. Access agreements are required for implementation of the task.
5. Initiation of this task is contingent upon the completion of 35% Design task of the Bulkhead design component.
6. Refer to Section 7 of the RDWP for additional notes regarding coordination issues and potential schedule impacts.

Work Flow Schedule of Source Control Actions Design[1,2]

Gowanus Canal Superfund Site, Brooklyn, New York

nationalgrid HERE WITH YOU. HERE FOR YOU.	Geosyntec consultants	Figure **4-9**
February 2014	Ewing, NJ	



Notes:
1. All tasks require work plan preparation prior to initiation.
2. Construction cost estimates will be performed for all design components after the final design.
3. Procurement of subcontractors and/or laboratories is included in the task.
4. Commencement of this task is contingent upon the completion of all pre-design efforts.
5. Commencement of this task is contingent upon the completion of the 65% Cap Design.
6. These items will be revised throughout the design process.
7. Refer to Section 7 of the RDWP for additional notes regarding coordination issues and potential schedule impacts.

Work Flow Schedule of General Pre-Design and Design Tasks[1,2]

Gowanus Canal Superfund Site, Brooklyn, New York

nationalgrid HERE WITH YOU. HERE FOR YOU.	Geosyntec consultants	Figure 4-10
February 2014	Ewing, NJ	

P:\PRJ1\HPH104 - Gowanus Canal\Figures

QAPP Worksheet #1 – Title and Approval Page

QUALITY ASSURANCE PROJECT PLAN AND FIELD SAMPLING PLAN
Gowanus Canal Superfund Site, Brooklyn, New York
Brooklyn, Kings County, New York

February 2014

Prepared by:
Geosyntec consultants

Review Signatures:

____
Howard Cumberland / Date
Team Project Manager – Geosyntec Consultants

____
Julia Caprio / Date
Quality Assurance Manager – Geosyntec Consultants

____
Ted Leissing / Date
National Grid Project Director

____
Andrew Prophete / Date
National Grid Project Manager

Approval Signatures:

____
Joel Singerman/Date
Project Officer – EPA Region 2

____
Christos Tsiamis/Date
Project Manager – EPA Region 2

____
Name/Date
Quality Assurance Manager – EPA Region 2

EXECUTIVE SUMMARY

This Quality Assurance Project Plan (QAPP) and accompanying Field Sampling Plan (FSP) are being developed for the Gowanus Canal Superfund Site (the Site) to accompany the Pre-Design Work Plan (PDWP) under the Administrative Order and Settlement Agreement for Investigation, Sampling and Evaluation dated April 29, 2010, as amended on January 24, 2014 (the AOC). A Site Map is provided as PDWP Figure 2-1. The AOC covers only the development of those portions of the PDWP detailed in the scope of work (SOW) attached to the AOC Amendment (AOC Attachment A). This QAPP and FSP are developed as companion documents to the PDWP.

This QAPP and accompanying FSP specifically address sample collection, analysis, and data management methods and procedures of the following pre-design (PD) work elements:

- Additional reconnaissance of the Gowanus Canal (the Canal) bottom for pre-construction debris removal (PD-3, SOW Table 1);

- A plan for debris removal, decontamination, and disposal (PD-4, SOW Table 1);

- A survey and assessment, as it relates to the implementation of the remedy, of the integrity of existing bulkhead along the canal and a determination of the extent of temporary bulkhead installation required for remedy implementation (PD-5, SOW Table 1);

- A plan for staging site selection and implementation of staging operations (PD-6, SOW Table 1);

- Data collection for the evaluation of potential groundwater upwelling at the Canal bottom, including identification of groundwater discharge areas and measurement of discharge rates (PD-7, SOW Table 1); and,

- Evaluation of native sediments in the Canal to identify areas of potentially mobile non-aqueous phase liquid (NAPL) to define the in situ stabilization (ISS) treatment boundaries (PD-8, SOW Table 1).

LIST OF WORKSHEETS

ACRONYM LIST

ATTACHMENTS

ACRONYM LIST

%R	percent recovery
µg/L	micrograms per liter
CA	corrective action
CAS	Chemicals Abstracts Service
CCC	calibration check compounds
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
cm	centimeters
CPT	cone penetrometer test
CSM	conceptual site model
CSO	combined sewer overflow
CU	consolidated undrained
CVAA	cold vapor atomic absorption
DQA	data quality assessment
DQAR	Data Quality Assessment Report
DQI	data quality indicator
DQO	data quality objective
EDD	electronic data deliverable
ft	feet
GC	gas chromatography
GC/ECD	gas chromatography electron capture detector
GC/MS	gas chromatography mass spectrometry
GPS	global positioning system
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCl	hydrochloric acid
HNO_3	nitric acid
ICB	initial calibration blank
ICP	inductively coupled plasma
ICP/MS	inductively coupled plasma mass spectrometry
ICP-AES	inductively coupled plasma atomic emission spectroscopy
ICV	initial calibration verification
ISS	in situ stabilization
LCS	laboratory control sample
LCS/LCSD	laboratory control sample/laboratory control sample duplicate
LCSD	laboratory control sample duplicate
MDL	method detection limit
mL	milliliter
MPC	methods, procedures and contracts
MQO	measurement quality objectives
MS	matrix spike
MS/MSD	matrix spike/matrix spike duplicate

ACRONYM LIST

MSD	matrix spike duplicate
N/A	not applicable
NAPL	non-aqueous phase liquid
NCM	nonconformance memo
NELAP	National Environmental Laboratory Accreditation Program
ºC	degrees Celsius
OSHA	Occupational Safety and Health Administration
PARCCS	precision, accuracy, representativeness, completeness, comparability, and sensitivity
PCBs	polychlorinated biphenyls
PDWP	Pre-Design Work Plan
PM	Project Manager
QA	quality assurance
QC	quality control
QL	quantitation limit
RF	response factor
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit
ROD	Record of Decision
RPD	relative percent difference
RPM	Remedial Project Manager
RSD	relative standard deviation
RT	retention time
RTA	remediation target area
SDG	sample delivery group
SOP	standard operating procedure
SPCC	system performance check compounds
SSHO	Site Safety and Health Officer
SVOC	semi-volatile organic compound
TAL	Target Analyte List
TBD	to be determined
TCL	Target Compounds List
USCS	United Soil Classification System
UU	unconsolidated undrained
VOA	Volatile Organic Analysis
VOC	volatile organic compound
WS	worksheet

QAPP Worksheet #2 – QAPP Identifying Information

Site Name/Project Name: Gowanus Canal Superfund Site
Site Location: Brooklyn, Kings County, New York
Site No./Code: NYN000206222
Operable Unit: 01
Contractor Name: Gowanus Canal Consultant Team
Contract Title: N/A
Work Assignment No.: N/A
N/A - not applicable

1. **Identify guidance used to prepare QAPP:**
   - Administrative Order on Consent (AOC Index No. A2-0523-0705) dated 29 April 2010.
   - AOC Amendment dated 24 January 2014.
   - Record of Decision (ROD) signed on 27 September 2013.
   - Uniform Federal Policy for Quality Assurance Plans, (UFP-QAPP) (USEPA 2005)
   - EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS (USEPA 2002)
   - Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs, the American National Standards Institute/American Society for Quality Control Standard E4 (ANSI/ ASQC E4, 1994)
   - Guidance on Systematic Planning Using the Data Quality Objectives Process, USEPA QA/G-4
   - Requirements for the Preparation of Sampling and Analysis Plans, USACE EM 200-1-3, 2001
   - Contract Laboratory Program Guidance for Field Samplers, OSWER 9240.0-44, EPA 540-R-07-06, USEPA 2007

2. **Identify Regulatory Program:** The work is being completed pursuant to the above-referenced AOC and ROD issued under the CERCLA Remedial Branch.

3. **Identify Approval Entity:** USEPA Region 2

4. **This QAPP is:** project-specific

5. **List dates of scoping sessions that were held:** 08 January 2014, 23 January 2014, 12 February 2014

6. **List dates and titles of any QAPP/FSP documents written for previous Site work that are relevant to the current investigation.**

   - GEI Consultants, Inc., 2005a. Draft Field Sampling Plan, Gowanus Canal, Brooklyn, New York,
   - GEI Consultants, Inc., 2005b. Draft Quality Assurance Project Plan, Gowanus Canal, Brooklyn, New York,

7. **List organizational partners (stakeholders) and connection with lead organization:**
   - USEPA Region 2 (lead agency)
   - New York State Department of Environmental Conservation (NYSDEC) (support agency)
   - Gowanus Canal PRP Group (to be formed)
   - Geosyntec Consultants (interim oversight)
   - Task Subcontractors (to be determined [TBD])
   - Analytical Laboratories (TBD, fixed off-site analytical laboratory)

8. **List Data Users:**
   - USEPA Region 2
   - New York State Department of Environmental Conservation (NYSDEC)

- Gowanus Canal PRP Group (to be formed)

9. **If any required QAPP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted QAPP elements and provide an explanation for their exclusion below:** N/A

QAPP/FSP Identifying Information
Required Elements

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Cross Reference to Related Documents
Project Management and Objectives		
2.1 Title and Approval Page	- Title and Approval Page	WS #1
2.2 Document Format and Table of Contents 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.4 QAPP Identifying Information	- Table of Contents - QAPP/FSP Identifying Information	WS #1 WS#1, WS#2 Attachment A
2.3 Distribution List & Personnel Sign-off 2.3.1 Distribution List 2.3.2 Project Personnel Sign-off Sheet	- Distribution list - Personnel sign-off Sheet	WS #3 WS #4
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification	- Project Organizational Chart - Communication Pathways - Personnel Responsibilities & Qualifications Table - Special Personnel Training Requirements & Certification Table	WS #5 WS #6 WS #7 WS #8
2.5 Project Planning/Problem Definition 2.5.1 Project Planning (Scoping) 2.5.2 Problem Definition, Site History, and Background	- Project Planning Session Documentation (including Data Needs Table) - Project Scoping Session Participants Sheet - Conceptual Site Model - Site History & Background - Site Maps (historical & present)	WS #9 WS #9 WS #10 PDWP and PDWP Figures
2.6 Project Quality Objectives & Measurement Performance Criteria 2.6.1 Development of Project Quality Objectives using the Systematic Planning Process 2.6.2 Measurement Performance Criteria	- Project Data Quality Objectives - Measurement Performance Criteria Table	WS#11 WS #12
2.7 Secondary Data Evaluation	- Sources of Secondary Data & Information - Secondary Data Criteria & Limitations Table	WS #13 WS #13
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule	- Summary of Project Tasks - Reference limits and Evaluation Table - Project Schedule/Timeline Table	WS #14 WS #15 WS #16

QAPP Worksheet #2 – QAPP Identifying Information (continued)

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Cross Reference to Related Documents
Measurement/Data Acquisition		
3.1 Sampling Tasks 3.1.1 Sampling Process Design & Rationale 3.1.2 Sampling Procedures & Requirements 3.1.2.1 Sample Collection Procedures 3.1.2.2 Sample Containers, Volume & Preservation 3.1.2.3 Equipment/Sample Containers Cleaning & Decontamination Procedures 3.1.2.4 Field Equipment Calibration, Maintenance, Testing and Inspection Procedures 3.1.2.5 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures	- Sampling Design & Rationale - Sample Location Map - Sampling Locations & Methods/SOP Requirements - Analytical Methods/ SOP Requirements Table - Field Quality Control Sample Summary Table - Sampling SOPs - Project Sampling SOP References Table - Field Equipment Calibration, Maintenance, Testing & Inspection table	WS #17 Attachment A PDWP Figures WS #18 WS #19 WS #20 Attachment B WS #21 WS #22
3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument & Equipment Maintenance, Testing & Inspection Procedures 3.2.4 Analytical Supply Inspection & Acceptance Procedures	- Analytical SOPs - Analytical SOP References Table - Analytical Instrument Calibration Table - Analytical Instrument & Equipment Maintenance, Testing & Inspection Table	TBD WS #23 WS #24 WS #25
3.3 Sample Collection Documentation, Handling, Tracking & Custody Procedures 3.3.1 Sample Collection Documentation 3.3.2 Sample Handling and Tracking System 3.3.3 Sample Custody	- Sample Collection Documentation, Handling, Tracking & Custody SOPs - Sample container Identification - Example chain of custody form and seal	WS #26 WS #27 WS#19 TBD
3.4 Quality Control Samples 3.4.1 Sampling Quality Control Samples 3.4.2 Analytical Quality Control Samples	- QC Samples Table	WS #28
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables 3.5.3 Data Reporting Formats 3.5.4 Data Handling & Management 3.5.5 Data Tracking & Control	- Project Documents & Records Table - Analytical services table	WS #29 WS #30

QAPP Worksheet #2 – QAPP Identifying Information (continued)

Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Cross Reference to Related Documents
Assessment		
4.1 Assessment & Response Actions 4.1.1 Planned Assessments 4.1.2 Assessment Findings & Corrective Action Responses	- Assessments and Response Actions - Planned Project Assessments Table - Assessment Findings & Corrective Action Responses Table	WS #31 WS #31 WS #32
4.2 QA Management Reports	- QA Management Reports Table	WS #33
4.3 Final Project Report		WS#33
Data Review		
5.1 Overview		
5.2 Data Review Steps 5.2.1 Step I: Verification 5.2.2 Step II: Validation 5.2.2.1 Step IIa Validation Activities 5.2.2.2 Step IIb Validation Activities 5.2.3 Step III: Usability Assessment 5.2.3.1 Data Limitations & Actions from Usability Assessment 5.2.3.2 Activities	- Verification (Step I) Process Table - Validation (Steps IIa & IIb) Process Table - Validation (Steps IIa & IIb) Summary Table - Usability Assessment	WS #34 WS #35 WS #36 WS #37
5.3 Streamlining Data Review 5.3.1 Data Review Steps to be Streamlined 5.3.2 Criteria for Streamlining Data Review 5.3.3 Amounts and Types of Data Appropriate for Streamlining	- A specific percentage of data will be streamlined based on project specific requirements	WS #36

QAPP Worksheet #3 – Distribution List

The following persons will receive a copy of the approved QAPP/FSP, subsequent QAPP/FSP revisions, addenda and amendments:

QAPP Recipients	Title	Organization	Telephone Number	E-mail Address
Joel Singerman	EPA Region 2 Project Officer	EPA	(212) 634-4258	Singerman.Joel@epa.gov
Christos Tsiamis	EPA Region 2 Project Manager	EPA	(212) 637-4257	Tsiamis.Christos@epa.gov
TBD	EPA Region 2 Quality Assurance Manager	EPA	TBD	TBD
Ted Leissing	National Grid Project Director	National Grid	(516) 545-2563	Theodore.Leissing@nationalgrid.com
Andrew Prophete	National Grid Project Manager	National Grid	(516) 790-1654	Andrew.Prophete@nationalgrid.com
Julianna Hess	Oversight Project Manager	CH2M Hill	(973) 316-3520	Juliana.Hess@CH2M.com
Jeff Gentry	Oversight Technical Lead	CH2M Hill	(503) 736-4390	Jeff.Gentry@CH2M.com
TBD	Project Director	TBD	TBD	TBD
TBD	Gowanus Canal Consultant Team Project Manager	TBD	TBD	TBD
TBD	Health and Safety Manager	TBD	TBD	TBD
TBD	Quality Assurance Manager	TBD	TBD	TBD
TBD	Engineering Manager	TBD	TBD	TBD
TBD	Assistant Project Manager	TBD	TBD	TBD
TBD	Debris Reconnaissance and Removal Task Manager	TBD	TBD	TBD
TBD	Bulkhead Assessment Task Manager	TBD	TBD	TBD
TBD	Staging Site Task Manager	TBD	TBD	TBD
TBD	Groundwater Upwelling Investigation Task Manager	TBD	TBD	TBD
TBD	Evaluation of NAPL Migration Task Manager	TBD	TBD	TBD
TBD	Gowanus Canal Field Team Leader	TBD	TBD	TBD

QAPP Worksheet #3 – Distribution List (continued)

QAPP Recipients	Title	Organization	Telephone Number	E-mail Address
TBD	Gowanus Canal Field Staff	TBD	TBD	TBD

NAPL = non-aqueous phase liquid
TBD = to be determined

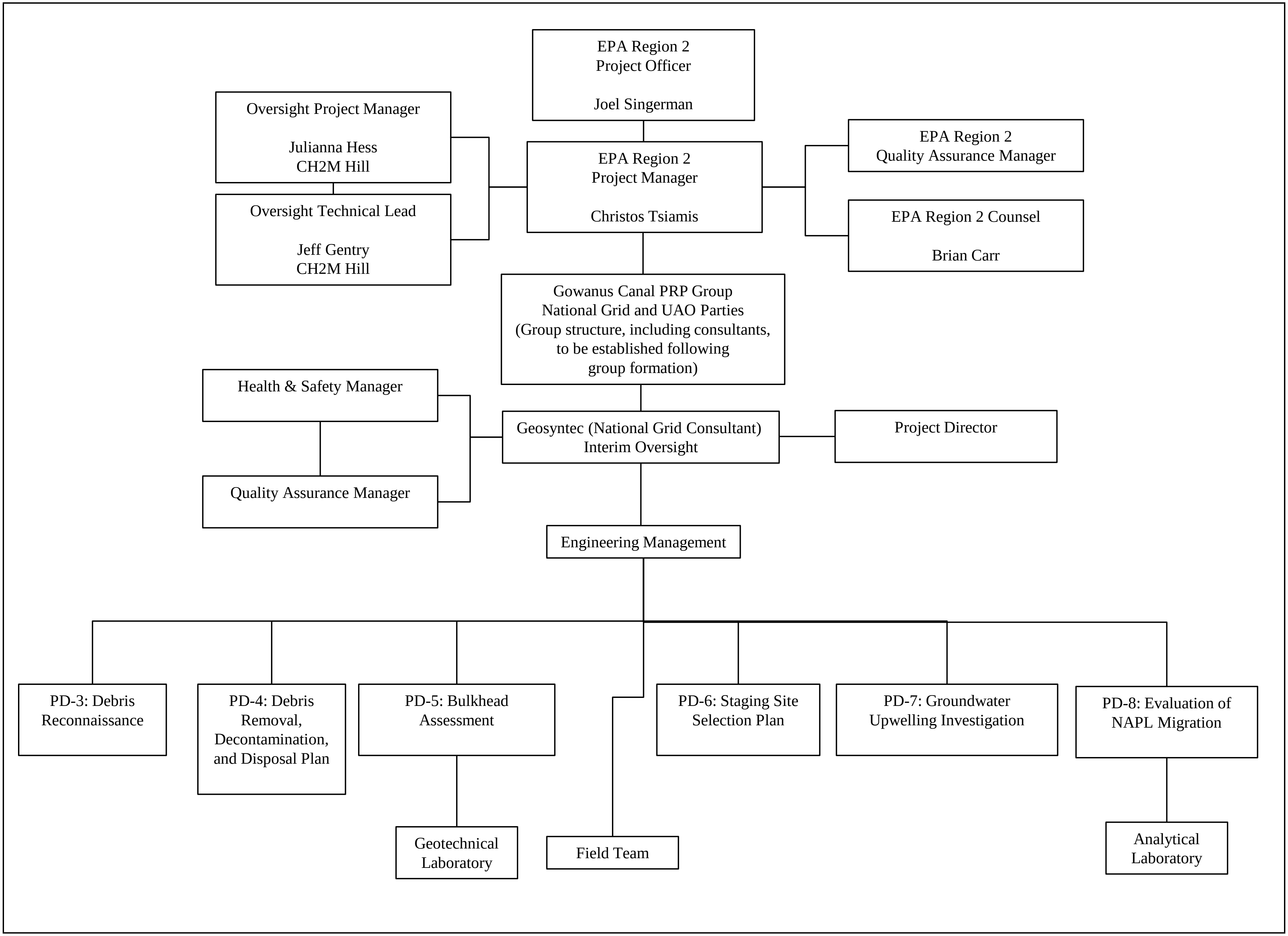
QAPP Worksheet #4 – Project Personnel Sign-Off Sheet

Project Personnel	Organization/Title/Role	Telephone Number	Signature	Date QAPP Read
Julianna Hess	Oversight Project Manager	(973) 316-3520		
Jeff Gentry	Oversight Technical Lead	(503) 736-4390		
TBD	Health and Safety Manager	TBD		
TBD	Engineering Manager	TBD		
TBD	Assistant Project Manager	TBD		
TBD	Debris Reconnaissance and Removal	TBD		
TBD	Bulkhead Assessment Task Manager	TBD		
TBD	Staging Site Task Manager	TBD		
TBD	Groundwater Upwelling Investigation Task Manager	TBD		
TBD	Evaluation of NAPL Migration Task Manager	TBD		
TBD	Gowanus Canal Field Team Leader	TBD		
TBD	Gowanus Canal Field Staff	TBD		
TBD	Laboratory Project Manager	TBD		

NAPL = non-aqueous phase liquid
TBD = to be determined

[1] Signature indicates personnel have read applicable QAPP sections and will perform the work as indicated herein.

QAPP Worksheet #5 – Project Organization Chart for Pre-Design Work Plan



QAPP Worksheet #6 – Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and e-mail	Procedure
Approval of amendments to the QAPP	Consultant Team	Team Project Manager (TPM): TBD Engineering Manager (EM): TBD National Grid PM: Andrew Prophete	TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	Obtain initial approval from TPM. Submit documented amendments within 10 working days for transmittal to the National Grid PM for submission to the EPA Remedial Project Manager (RPM) for approval.
Approval of activities deviating from QAPP	Consultant Team	TPM: TBD EM: TBD National Grid PM: Andrew Prophete	TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	Obtain initial approval from TPM. Submit request for deviation within 10 working days for transmittal to the National Grid PM for submission to the EPA RPM for approval.
Document control	Consultant Team	TPM: TBD EM: TBD Quality Assurance (QA) Manager: TBD National Grid PM: Andrew Prophete	TBD TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	All reports and formal correspondence will be reviewed by TPM prior to transmittal to the National Grid PM for submission to the EPA RPM. Documents prepared by TPM for submittal to National Grid and EPA will be reviewed by QA Manager or other team member prior to submittal to the National Grid PM for submission to the EPA.
Stop work and initiation of corrective action	Consultant Team Health and Safety	TPM: TBD EM: TBD	TBD TBD	The TPM will communicate work stoppages to the National Grid PM within 24 hours. Note that all field personnel will have stop work authority if an unsafe condition is

QAPP Worksheet #6 – Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and e-mail	Procedure
	(H&S) Manager Site Safety and Health Officer (SSHO)	H&S Manager: TBD SSHO: TBD National Grid PM: Andrew Prophete	TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	encountered.
Real time modifications, notifications, and approvals	Consultant Team	TPM: TBD EM: TBD	TBD TBD	Real-time modifications to the project will require the approval of the EM and TPM and will be documented within 5 working days.
Reporting of health and safety issues	Consultant Team	TPM: TBD H&S Manager: TBD EM: TBD National Grid PM: Andrew Prophete	TBD TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	All H&S issues involving an injury, a "near miss," or a condition that may result in an incident must be reported to the H&S Manager immediately. The H&S Manager will forward this information on to the TPM using telephone and email as soon as possible. The TPM will notify the EM or designee, who will notify the National Grid PM and EPA RPM of any serious health and safety incident/issue within 24 hours of occurrence. Non-serious incidents/issues may be forwarded from the EM to the National Grid PM who may submit to the EPA RPM on a monthly basis within the monthly progress reports.
Reporting of issues related to ROD requirements	Consultant Team	TPM: TBD EM: TBD	TBD TBD	All serious issues will be reported to the TPM and EM immediately.

QAPP Worksheet #6 – Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and e-mail	Procedure
Community relations	EPA	EPA RPM: Christos Tsiamis TPM: TBD EM: TBD National Grid PM: Andrew Prophete	tsiamis.christos@epa.gov (212) 637-4257 TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	All community relations will be reported to the EM, who will coordinate with the National Grid PM and the EPA RPM.
Schedule changes	Consultant Team	TPM: TBD EM: TBD National Grid PM: Andrew Prophete	TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	Changes to EPA-approved schedules (e.g., field sampling schedule) will be communicated to the EM, who will in turn communicate changes to the TPM for discussion with the National Grid PM and the EPA RPM.
Data release	Consultant Team	TPM: TBD QA Manager : TBD EM: TBD National Grid PM: Andrew Prophete	TBD TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	All data will be reviewed by the QA Manager and TPM prior to being provided to the National Grid PM for submission to the EPA RPM.

QAPP Worksheet #6 – Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and e-mail	Procedure
Notification of delays or changes to field work	Consultant Team	Field Team Leader(s): TBD TPM: TBD EM: TBD National Grid PM: Andrew Prophete	TBD TBD TBD andrew.prophete@nationalgrid.com (516) 790-1654	Delays or changes to the approved work plan will require approval by the EM and TPM and will be reported by the TPM to the National Grid PM who will report to the EPA RPM within 24 hours of the occurrence.
Real time changes to sample collection or analysis procedures	Consultant Team	Field Team Leader(s): TBD Lab PM: TBD TPM: TBD EM: TBD	TBD TBD TBD TBD	Conditions requiring variation to sampling and analysis procedures will be reported to the Field Team leader within 24 hours of the condition requiring the modification. The Field Team Leader will report variations to the EM and TPM as appropriate.
Reporting of issues related to data quality, including inability to meet reporting limits	Laboratory	Lab PM: TBD	TBD	Problems with data quality will be reported to the TPM and the QA Manager within 24 hours of laboratory results.

QAPP Worksheet #6 – Communication Pathways (continued)

Communication Drivers	Responsible Affiliation	Name	Phone Number and e-mail	Procedure
Corrective Action	Consultant Team	QA Manager: TBD	TBD	Corrective Action Subjects: • Field Safety Audit; • Technical System Internal Audit or Field Sampling Procedure; • Offsite Laboratory Technical Systems Audit; • Offsite Laboratory Technical Systems Audit: Laboratory Personnel; • Data Quality Assessment; • Project Documentation Audit

EM = Engineering Manager
H&S = health and safety
PM = Project Manager
TPM = Team Project Manager
RPM = Remedial Project Manager
TBD = to be determined

QAPP Worksheet #7 – Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organization	Responsibilities	Educational and/or Experience Qualifications
Joel Singerman	EPA Region 2 Project Officer	EPA Region 2	Project Oversight and Management	
Christos Tsiamis	EPA Region 2 Project Manager	EPA Region 2	Project Oversight and Management	
TBD	EPA Region 2 Quality Assurance Manager	EPA Region 2	Project Quality Assurance and Quality Management	
Julianna Hess	Oversight Project Manager	CH2M Hill	Project Oversight and Management	PE
Jeff Gentry	Oversight Technical Lead	CH2M Hill	Project Technical Oversight and Management	PE
Ted Leissing	PRP Group Project Director	National Grid	Project Oversight and Management	
Andrew Prophete	PRP Group Project Manager	National Grid	Project Oversight and Management	MBA
TBD	Project Director	TBD	Final Project Oversight	TBD
TBD	Gowanus Canal Consultant Team Project Manager	TBD	Project Management	TBD
TBD	Health and Safety Manager	TBD	Health and Safety Management	TBD
TBD	Quality Assurance Manager	TBD	Quality Assurance/Quality Control	TBD
TBD	Engineering Manager	TBD	Management of Engineering Tasks	TBD
TBD	Assistant Project Manager	TBD	Project Management	TBD
TBD	Debris Reconnaissance and Removal Task Manager	TBD	Task Manager	TBD
TBD	Bulkhead Assessment Task Manager	TBD	Task Manager	TBD
TBD	Staging Site Task Manager	TBD	Task Manager	TBD
TBD	Groundwater Upwelling Investigation Task Manager	TBD	Task Manager	TBD
TBD	Evaluation of NAPL Migration Task Manager	TBD	Task Manager	TBD
TBD	Gowanus Canal Field Team Leader	TBD	Field Activity Management	TBD

TBD = to be determined

QAPP Worksheet #8 – Special Personnel Training Requirements Table

The following table is used to identify and describe any specialized and/or non-routine project specific training requirements or certifications needed by personnel to successfully complete the project or task.

Project Contributor	Specialized Training By Title or Description of Course	Personnel / Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records / Certificates
Field Supervisor	8-Hour OSHA Supervisor training Project-specific SOP training	Field Team Leaders	TBD	Footnote 1
Field Team	Boater Safety Course 40-Hour OSHA HAZWOPER training	Field Personnel	TBD	Footnote 1
	Project-specific SOP training	Personnel as required		Field Office
Analytical Laboratory	NELAP Certification	Lab Personnel	TBD	Selected Laboratories

NELAP = National Environmental Laboratory Accreditation Program
OSHA HAZWOPER = Occupation Safety and Health Administration's Hazardous Waste Operations and Emergency Response[i]
SOP = standard operating procedure
TBD = to be determined

[1] Documentation for training is maintained at home office of employee and is available upon request.

QAPP Worksheet #9 – Project Scoping Session Participants Sheet

Project Name: Gowanus Canal Superfund Site **Date of Session:** 8 January 2014 **Scoping Session Purpose:** Scoping discussions for development of the PDWP and RDWP	**Site Name:** Gowanus Canal Superfund Site **Site Location:** Brooklyn, Kings County, New York

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Christos Tsiamis	Project Manager	EPA	(212) 637-4257	Tsiamis.Christos@epa.gov	Remedial Project Manager
Brian Carr	Assistant Regional Counsel	EPA	(212) 637-3170	Carr.Brian@epa.gov	EPA Counsel
Joel Singerman	Section Chief	EPA	(212) 634-4258	Singerman.Joel@epa.gov	EPA
Juliana Hess	Project Manager	CH2M Hill	(973) 316-3520	Juliana.Hess@CH2M.com	EPA Oversight Contractor – Project Manager
Jeff Gentry	Senior Technical Consultant	CH2M Hill	(503) 736-4390	Jeff.Gentry@CH2M.com	EPA Oversight Contractor – Project Manager
Ted Leissing	Manager – Site Investigation & Remediation	National Grid	(516) 545-2563	Theodore.Leissing@nationalgrid.com	National Grid Project Director
Andrew Prophete	Project Manager	National Grid	(516) 790-1654	Andrew.Prophete@nationalgrid.com	National Grid Project Manager
Allen Hecht	Sr. Counsel	National Grid	(516) 545-3795	Allen.Hecht@nationalgrid.com	National Grid Counsel
Bonnie Barnett	Partner	Drinker Biddle	(215) 988-2916	Bonnie.Barnett@dbr.com	External Counsel
Howard Cumberland	Principal	Geosyntec Consultants	(971) 271-5898	HCumberland@geosyntec.com	Geosyntec Project Manager
Jay Beech	Senior Consultant	Geosyntec Consultants	(678) 202-9506	JBeech@geosyntec.com	Geosyntec Task Manager
Richard DeWan	Senior Consultant	Geosyntec Consultants	(609) 493-9018	RDewan@geosyntec.com	Geosyntec Task Manager
Dave Himmelheber	Environmental Engineer	Geosyntec Consultants	(609) 493-9012	DHimmelheber@geosyntec.com	Geosyntec Task Manager
Roger Hathaway	Vice President	GEI Consultants	(860) 368-5316	RHathaway@geiconsultants.com	GEI Task Manager

Scoping Session Summary:

- Project Organization
  - Decision for EPA to lead the project with respect to in situ stabilization (ISS) pilot test, staging, bulkheads, pilot studies, and coordination of bridge movement with New York City (NYC).
  - National Grid (Grid) leading PRP Group efforts in the Canal.

- Submittal Process
  - Project submissions will follow the standard process. The January 10th date was extended to January 15th for Pre-Design Work Plan (PDWP) Outline.

- Bridge Clearance Issues
  - Discussion of bridge restrictions including operational heights, ability to open and close, timing and applicable city codes.
    - **Action Item**: Waiting for NYC to cooperate with bridge operation.

- Debris Removal and Management
  - Agreed on need for flexibility during this process.
    - **Action Item**: PDWP submission planned for January 28, 2014. Remedial Design Work Plan (RDWP) outline submission planned for February 6, 2014.
  - EPA and Grid noted the need for cultural resource management.

- Bulkheads
  - EPA is currently in coordination with landowners regarding upgrades to bulkheads.

- Implementation Plan and Staging Site Selection and Logistics for Project
  - Grid to manage PRP group in identifying potential properties; EPA to provide final selection and obtain property.
  - EPA to manage and lead community relations.

- Groundwater Upwelling
  - EPA noted that highest rates of groundwater upwelling in the Canal are expected in RTA 1.
  - Fulton Cutoff Wall: Discussed desire to schedule Canal remedial action to coordinate with cutoff wall installation.
    - **Action Item**: EPA to schedule more frequent meetings with NYSDEC.

- NAPL mobility: Flow Rates
  - EPA requested to initiate NAPL mobility study in RTA 1 which is expected to have the highest rates of groundwater flux.

- Pilot Studies
  - Discussed need for flexibility during pilot study process.
    - **Action item**: Future meeting to discuss in situ stabilization (ISS) Pilot at 7th Street Basin. Pilot study tentatively scheduled for Summer 2014.

- Future Workshops and meetings
    - Meeting with NYC scheduled for January 22nd. NYC has committed to considering tanks and tank siting. Noted need for coordination with NYC regarding remedial actions and tank installation.
    - Plan to discuss PDWP including Work Plan and Table 1 (items PD-3 through PD-8) on January 23rd.
    - Plan to discuss RDWP on February 12th.

Project Name: Gowanus Canal Superfund Site Date of Session: 23 January 2014 Scoping Session Purpose: Scoping discussions for development of the PDWP and RDWP	Site Name: Gowanus Canal Superfund Site Site Location: Brooklyn, Kings County, New York

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Christos Tsiamis	Project Manager	EPA	(212) 637-4257	Tsiamis.Christos@epa.gov	Remedial Project Manager
Brian Carr	Assistant Regional Counsel	EPA	(212) 637-3170	Carr.Brian@epa.gov	EPA Counsel
Joel Singerman	Section Chief	EPA	(212) 634-4258	Singerman.Joel@epa.gov	EPA
Hank Willems	Project Manager	NYSDEC	(518) 402-9662	HTWillem@gw.dec.state.ny.us	NYSDEC Project Manager
Juliana Hess	Project Manager	CH2M Hill	(973) 316-3520	Juliana.Hess@CH2M.com	EPA Oversight Contractor – Project Manager
Jeff Gentry	Senior Technical Consultant	CH2M Hill	(503) 736-4390	Jeff.Gentry@CH2M.com	EPA Oversight Contractor – Project Manager
Ted Leissing	Manager – Site Investigation & Remediation	National Grid	(516) 545-2563	Theodore.Leissing@nationalgrid.com	National Grid Project Director
Andrew Prophete	Project Manager	National Grid	(516) 790-1654	Andrew.Prophete@nationalgrid.com	National Grid Project Manager
Carolyn Rooney	Counsel	National Grid	(516) 545-3795	Carolyn.Rooney@nationalgrid.com	National Grid Counsel
Howard Cumberland	Principal	Geosyntec Consultants	(971) 271-5898	HCumberland@geosyntec.com	Geosyntec Project Manager
Jay Beech	Senior Consultant	Geosyntec Consultants	(678) 202-9506	JBeech@geosyntec.com	Geosyntec Task Manager
Richard DeWan	Senior Consultant	Geosyntec Consultants	(609) 493-9018	RDewan@geosyntec.com	Geosyntec Task Manager
Dave Himmelheber	Environmental Engineer	Geosyntec Consultants	(609) 493-9012	DHimmelheber@geosyntec.com	Geosyntec Task Manager
Roger Hathaway	Vice President	GEI Consultants	(860) 368-5316	RHathaway@geiconsultants.com	GEI Task Manager

QAPP Worksheet #9 – Project Scoping Session Participants Sheet (continued)

<u>Scoping Session Summary:</u>

- <u>Pre-Design Work Plan (PDWP)</u>
  - o Grid provided the PDWP annotated outline to EPA on 1/15/2014.
  - o Grid will provide the PDWP text to EPA on 1/28/2014 in accordance with agreed upon scope.
  - o EPA will provide written comments and memo to Grid once reviewed.

- <u>Bridge Clearance Issues</u>
  - o Discussion of bridge restrictions including operational heights, ability to open and close, timing and applicable city codes.
    - **Action Items**:
      - Grid will addressing these issues as they arise and develop a tracking chart to send to EPA. Chart will include a date of when Grid predicts a need for the bridges to be open to be further discussed a February 12 Workshop.

- <u>Cultural Research Management</u>
  - o Site Historical Preservation Office (SHPO) historic reviews of the sonar data of sunken ships in the Canal indicate that the ships are considered potential "historic resources."
  - o Former EPA archaeologist (John Vetter) is assisting EPA and attended the Community Action Group (CAG) meeting.

- <u>Insurance</u>
  - o Brian Carr asked if National Grid is a self-insured company
  - o Grid is self-insured, but they are exploring options and are not sure how this will play into PRPs and other Gowanus issues.

- <u>Debris Removal and Management</u>
  - o Discussion on the debris impacts with an acknowledgement by all parties that there is a significant amount of debris in all RTAs and that debris is a major issue that will impact operations and schedule.
  - o Agreement that debris needs to be further mapped in RTA 1 because air (oxygenation) pipe interfered with the first survey conducted.
  - o Agreement that there is a need to develop a pilot study to determine removal impacts on contamination liberation, decontamination technologies, transport and disposal.
  - o Debris may need to be dated for SHPO.

- <u>Bulkheads</u>
  - o The goal of the Bulkhead Investigations is to complete sonar images of the bulkheads in order to increase understanding of structural foundations, the water line at the bottom of the Canal, and other relevant data.
  - o NYC Bridge investigators will work with bulkhead investigators to search city historical records for information about bulkhead foundations and bridge foundations in order to gather information for necessary repairs or replacements as the process continues.
  - o EPA and the PRP Group will need to coordinate with NYC for all drilling activities, including drilling around bridge foundations.

- EPA will send Grid details on the bulkhead replacements that have already started (e.g., Lightstone).
  - Lightstone will have a sealed bulkhead. Grid will email EPA a request for bulkhead information.
  - Citizens Gate Station is considering a new bulkhead, new Federal Emergency Management Agency guidelines, etc.
    - **Action Item**: Grid to send EPA drafts of designs to know what to use, how to build, etc.
- EPA is to work directly with property owners to determine bulkhead needs, designs, etc.
- EPA to plan additional meeting with Grid soon to discuss bulkheads.

- <u>Implementation Plan and Staging Site Selection and Logistics for Project</u>
  - Grid to manage PRP Group in determining needs for project implementation.
  - EPA/City to help determine what property is available.
  - Need staging area in order to gain access to sites.
    - Grid to manage PRP Group in determining specific needs and then EPA will aid in gaining property access.
      - **Action Item**: Grid to propose sites to EPA for further discussion at the February 12th workshop.

- <u>Groundwater Upwelling</u>
  - Identifying upwelling areas is important for understanding fate and transport, cap design, and ISS design.
  - The groundwater study will consider various technologies for evaluating groundwater upwelling rates.
  - The study will seek to locate the most appropriate locations and technologies that work for each area.
    - This evaluation is needed to adequately address the debris and the Flushing Tunnel inhibiting factors.
    - **Action Item**: Brainstorming and planning calls to include Christos.
  - Grid to evaluate the use of the 7th Street Basin as a possible location for evaluations and pilot testing due to its lack of interference with NYC management of bridge operations and Flushing Tunnel issues.
    - Grid to evaluate seepage changes when removing soft sediments.
  - Fulton Cutoff Wall: Meeting in 2-3 weeks with EPA, DEC, and Grid.

- <u>NAPL mobility: Flow Rates</u>
  - EPA to send all Flushing Tunnel information in their possession to Grid.
    - Baird model indicates there is a significant amount of sediment movement as result of flow.
  - Agreement that not all NAPL is mobile.
  - Agreement that there is a need to conduct more studies to understand NAPL distribution and mobility within the Canal.

- <u>Implementation Schedule for ROD</u>
  - Schedule not yet proposed, Grid is producing a schedule as part of the RDWP.
    - Schedule is moving forward and progressing well as part of the RDWQ.

        - **Action Item: Per Christos:** Grid was granted an extension to complete the schedule until February 14th.
        - At this point, Christos is satisfied with how the schedule is progressing.
- PDI (Pre Design Investigation) Schedule
    - EPA will manage third party involvement.
    - Allows EPA to consider dividing ROD assignments to specific parties.

Worksheet #9 – Project Scoping Session Participants Sheet (continued)

Project Name: Gowanus Canal Superfund Site **Date of Session:** 12 February 2014 **Scoping Session Purpose:** Scoping discussions for development of the PDWP and RDWP	**Site Name:** Gowanus Canal Superfund Site **Site Location:** Brooklyn, Kings County, New York

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Christos Tsiamis	Project Manager	EPA	(212) 637-4257	Tsiamis.Christos@epa.gov	Remedial Project Manager
Brian Carr	Assistant Regional Counsel	EPA	(212) 637-3170	Carr.Brian@epa.gov	EPA Counsel
Juliana Hess	Project Manager	CH2M Hill	(973) 316-3520	Juliana.Hess@CH2M.com	EPA Oversight Contractor – Project Manager
Jeff Gentry[1]	Senior Technical Consultant	CH2M Hill	(503) 736-4390	Jeff.Gentry@CH2M.com	EPA Oversight Contractor – Project Manager
Ted Leissing	Manager, Site I & R	National Grid	(516) 545-2563	Theodore.Leissing@nationalgrid.com	National Grid Project Director
Andrew Prophete	Project Manager	National Grid	(516) 790-1654	Andrew.Prophete@nationalgrid.com	National Grid PM
Allen Hecht	Sr. Counsel	National Grid	(516) 545-3795	Allen.Hecht@nationalgrid.com	National Grid Counsel
Russ Selman	Outside Counsel National Grid	Schiff Hardin	(312) 258-5527	rselman@schiffhardin.com	National Grid Outside Counsel
Howard Cumberland	Principal	Geosyntec Consultants	(971) 271-5898	HCumberland@geosyntec.com	Geosyntec Project Manager
Jay Beech	Senior Consultant	Geosyntec Consultants	(678) 202-9506	JBeech@geosyntec.com	Geosyntec Task Manager
Richard DeWan	Senior Consultant	Geosyntec Consultants	(609) 493-9018	RDewan@geosyntec.com	Geosyntec Task Manager
Dave Himmelheber	Environmental Engineer	Geosyntec Consultants	(609) 493-9012	DHimmelheber@geosyntec.com	Geosyntec Task Manager
Darrell Nicholas	Senior Consultant	Geosyntec Consultants	(865) 330-9949	DNicholas@Geosyntec.com	Geosyntec Task Manager
Roger Hathaway	Vice President	GEI Consultants	(860) 368-5316	RHathaway@geiconsultants.com	GEI Task Manager

[1] By conference call

Scoping Session Summary:

- EPA discussions with NYCDEP
  - New York City Department of Environmental Protection (NYCDEP) and EPA had met primarily about the schedule for CSO holding tank siting and the process and tasks required to perform the tank siting. EPA received a schedule that EPA deemed to be unacceptable. EPA and NYCDEP will continue to discuss the tank siting plans.
  - Data needs and the 1st Street Turning Basin were not part of the discussions.

- Bridge Clearance Issues
  - EPA and NYCDOT met about the operability of the bridges over Gowanus Canal. NYCDOT stated that following Hurricane Sandy, many of the bridges are either no longer operational or have not been tested. NYCDOT is concerned with failure during operation; specifically, that the bridges will lodge in the open position. Current status is understood as follows:
    - Carroll St. is operational;
    - Union St. is operational (requires manual operation), but has not been manually opened in a number of years; and
    - 3rd St. is unoperational.
  - NYCDOT estimates that a minimum of 10 months is needed to ensure the bridge operability, with assessments being the first step. Note that the bridge at Union St. has approximately 9 feet of clearance at low tide. Grid stated that land-based access and mobilization of heavy equipment into the Canal is not expected to meet company health and safety standards and that water-based access (under the bridge) is required.

- Debris Removal and Management
  - Discussions regarding the removal of NYCDEP's in-Canal aeration pipe led to EPA and CH2M Hill stating that the removal plan submitted by NYCDEP to EPA did not contain details on the specifics of the removal operations. Brian Carr indicated that it is possible that concrete anchors would be left in place in the Canal and would be considered debris and would add to the debris reconnaissance and debris removal scopes of work.

- Implementation Plan and Staging Site Selection and Logistics for Project
  - Discussions of the location and sizing of staging sites included consideration of equipment laydown areas, access and egress points, material storage, handling and treatment areas, construction trailers, and employee parking.
  - Grid stated that they have been giving site selection considerable thought and staging site needs will be incorporated into the RDWP.

- Pilot Studies
  - EPA stated that they will do an ISS pilot study in the 7th Street Turning Basin.
  - EPA specified that Grid will perform any additional needed pilot studies.
  - EPA requested the information from bench-scale studies and pilot tests be made available sooner than at the 90% design level and that all of Grid's Work Plans should now reflect this schedule.

- <u>Data Needs</u>
  - EPA and NYCDEP discussed Flushing Tunnel operations. The Flushing Tunnel has been operating at up to approximately 70% of flow capacity. EPA will provide the daily/weekly reports on Flushing Tunnel discharges received from NYC as part of EPA's response to Grid's information request table.
  - According to EPA, EPA requested certain deliverables from NYC and NYC declined to provide them. EPA will prepare and issue a demand letter for these deliverables.
  - Treatability and field pilot studies that are needed during the PDWP to advance the remedial design were discussed.
    - Grid consistently and clearly stated that many of the pre-design pilot studies are needed to further develop the remedial design. Needed pilot studies include groundwater flux and modeling, capping, ISS, debris removal, dredging, dredged material treatment, and water treatment.

- <u>Sequencing</u>
  - Grid led a discussion with EPA to determine general concurrence on the sequencing of Remedial Design and Implementation activities by remediation target area (RTA) and a discussion on the design need similarities and differences. The discussion included:
    - Design needs:
      - RTA 1:
        - ISS, other capping alternatives, groundwater, Flushing Tunnel, bulkheads, pre-design investigations,
        - Treatability and Pilot studies,
        - Source Controls - CSOs, Storm Sewers, unpermitted discharges, etc.
      - RTA 2:
        - ISS, other capping alternatives, groundwater, Flushing Tunnel, bulkheads, pre-design investigations, more debris, turning basins and Navigation issues,
        - Treatability and Pilot studies,
        - Source Controls – CSOs, Storm Sewers, unpermitted discharges, etc.
      - RTA 3:
        - Different (better) logistics, simpler, faster dredging production rates, no amendments in cap (clean cover) little to no groundwater issues, functioning navigation channel.
    - Construction needs in RTAs:
      - Access, logistics, site staging, clearance.
    - The Need to model effect of sequencing on sediment transport and hydrodynamics.

- <u>EPA Comments on Submittals</u>
  - PDWP:
    - EPA will provide written comments on PDWP and a memo to Grid.
    - EPA requested that the following pre-design efforts be performed in the summer of 2014:
      - ISS Pilot Study
      - Groundwater flux study.

        - Locations were discussed which could be accessed without the need for bridge operation, and there was general consensus that studies would need to be conducted where bridge operability is not a concern.
  - RDWP:
    - RDWP Outline was submitted on 2/6/14, no significant comments were discussed by EPA.
    - CH2M Hill and EPA requested a flow diagram to show how the remedial design will be implemented. Grid/Geosyntec responded that is in development and will be included.

- Proposed NYC Sediment Removal Action
  - Geosyntec inquired of EPA if they had any discussions with NYC during their meeting on a proposed removal action by the City that is the subject of the Public Notice (# NAN-2012-01342-EHA) issued by the New York District (NYD) of the US Army Corps of Engineers (USACE.) on January 28,2014.
    - EPA is aware of the proposed action. EPA did not provide details about their specific plans to address this proposed sediment removal action except to say that they will act to make sure the proposed removal action does not happen.
    - EPA did encourage Grid to submit comments under the public notice.
    - EPA implied that they have a copy of the public notice but do not have a copy of the full application. However, there still seemed to be some uncertainty on what exactly EPA has and doesn't have with regards to NYC's proposed sediment removal action in RTA 1. Grid will add this request to the Request Table.

- Future Workshops and meetings
  - Discussions with NYC Department of Transportation (DOT) regarding the 1st Street Turning Basin are needed.
  - EPA and Grid discussed the need for pre-design task workshops including: groundwater flux modeling, Flushing Tunnel impacts, hydrodynamic model outputs, and staging/access areas, locations, and logistics.

QAPP Worksheet #10 – Conceptual Site Model

The problem definitions are provided in the following worksheets:

QAPP Worksheet #10a – PD-3: Additional Debris Reconnaissance

QAPP Worksheet #10b – PD-4: Development of Debris Removal and Management Plan

QAPP Worksheet #10c – PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation

QAPP Worksheet #10d – PD-6: Staging Site Selection and Implementation Plan

QAPP Worksheet #10e – PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates

QAPP Worksheet #10f – PD-8: Evaluation of NAPL Mobility in Native Sediments

QAPP Worksheet #10a – PD-3: Additional Debris Reconnaissance

Background Information:

This work element has been developed to perform additional debris reconnaissance in the Canal to identify and characterize Site conditions, anomalies, obstructions, and potential submerged cultural resources in areas where debris identification was not performed in the December 2010 study or where survey results require confirmation. Note that debris will consist of non-sediment material.

Sources of Known or Suspected Hazardous Wastes:

Debris in the Canal may have originated in upland areas or may have been deposited in the Canal from vessels on the waterway. Debris consists of a variety of materials, some of which may be hazardous, such as discarded containers of household hazardous waste.

Debris may also be saturated with surface water or be heavily coated in sediment which contains contaminants.

Known or Suspected Contaminants or Classes of Contaminants:

Debris may be coated with sediments contaminated with target compound list (TCL) volatile organic compounds (VOCs), TCL semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and target analyte list (TAL) metals. Debris may be saturated with surface water contaminated with TCL VOCs, TCL SVOCs, TAL metals, and bacteria.[1]

Primary Release Mechanism:

Debris in the Canal may have originated in upland areas and traveled to the Canal via many mechanisms which include erosion, dumping, and transport through the combined sewer overflows (CSOs). Additional debris may have been accidentally released or dumped off of waterway vessels.

Secondary Contaminant Migration:

As debris is removed, sediment may be disturbed and suspend in the water column. Contaminants may migrate via water currents and become available for biouptake by biota in the Canal.

Fate and Transport Considerations:

If contaminants migrate away from their origin in the Canal there is potential for contamination to spread to other areas and impact surface water, sediment, and biota which are currently unaffected by contamination in the Canal.

Potential Receptors and Exposure Pathways:

Humans and biota may be exposed to contaminants though contact with surface water or sediment or through consumption.

Land Use Considerations:

Land Use is shifting in waterfront properties along the Canal from mostly commercial-industrial to more residential. High density housing units are planned for several parcels along the Canal with increased residential growth anticipated in the future.

The Canal is regularly used by commercial barges at several facilities along the mid- and lower Canal. Recreational boaters, primarily, canoers and kayakers, frequent the Canal. A public boat launch where canoes are available is located at 2nd Street. The anticipated remediation and redevelopment will likely increase recreational boating use. A limited number of people reside in houseboats on the Canal.

Key Physical Aspects of Site:

There were areas of the Canal which were unable to be evaluated during the high-frequency side-scan sonar study conducted in December 2010 due to interferences, however these areas need to be scanned as part of this reconnaissance effort. Previous interferences will be addressed by the following measures:

- The oxygen transfer system will be removed prior to the additional reconnaissance activities;
- The activities will be coordinated to occur when the mouth of the Canal is free of construction and work barges;
- Alternatives to side-scan sonar may be used, such as a tripod-mounted, high-resolution, 360-degree scanning sonar which can be deployed adjacent to hard-to-reach areas to generate plan-view sonar imagery; and,
- Physical verification of significant debris fields identified during this survey and previous surveys.

Current Interpretation of Nature and Extent of Contamination Expected to Influence Project-Specific Decision Making:

Debris could be present throughout the length of the Canal. Locations determined to contain debris during the 2010 study will be confirmed during this task.

[1]Note that analytical samples are not planned for collection during this task.

QAPP Worksheet #10b – PD-4: Development of Debris Removal and Management Plan

Background Information:

This work element has been prepared to properly and lawfully plan and manage the identification, removal, testing and disposal of all non-sediment materials present in the Canal. The overall objective of this work element is to develop a plan (Debris Plan) to govern the removal and/or management of identified debris such that the underlying targeted sediment can be efficiently and effectively dredged and/or remediated.

Sources of Known or Suspected Hazardous Wastes:

Debris in the Canal may have originated in upland areas or may have been deposited in the Canal from vessels on the waterway. Debris consists of a variety of materials, some of which may be hazardous, such as discarded containers of household hazardous waste.

Debris may also be saturated with surface water or be heavily coated in sediment which contains contaminants.

Known or Suspected Contaminants or Classes of Contaminants:

Debris may be coated with sediments contaminated with TCL VOCs, TCL SVOCs, PCBs, and TAL metals. Debris may be saturated with surface water contaminated with TCL VOCs, TCL SVOCs, TAL metals, and bacteria.[1]

Primary Release Mechanism:

Debris in the Canal may have originated in upland areas and traveled to the Canal via many mechanisms which include erosion, dumping, and transport through the CSOs. Additional debris may have been accidentally released or dumped off of waterway vessels.

Secondary Contaminant Migration:

As debris is removed, sediment may be disturbed and suspend in the water column. Contaminants may migrate via water currents and become available for biouptake by biota in the Canal.

Fate and Transport Considerations:

If contaminants migrate away from their origin in the Canal there is potential for contamination to spread to other areas and impact surface water, sediment, and biota which are currently unaffected by contamination in the Canal.

Potential Receptors and Exposure Pathways:

Humans and biota may be exposed to contaminants though contact with surface water or sediment or through consumption of other contaminated species in the food chain.

Land Use Considerations: Land Use is shifting in waterfront properties along the Canal from mostly commercial-industrial to more residential. High density housing units are planned for several parcels along the Canal with increased residential growth anticipated in the future. The Canal is regularly used by commercial barges at several facilities along the mid- and lower Canal. Recreational boaters, primarily, canoers and kayakers, frequent the Canal. A public boat launch where canoes are available is located at 2nd Street. The anticipated remediation and redevelopment will likely increase recreational boating use. A limited number of people reside in houseboats on the Canal.
Key Physical Aspects of Site: Due to a general lack of available real estate on or close to the Canal, as well as intent to minimize impact of remedial operations on residential neighborhoods, it is anticipated that debris removal and management activities will be performed in or upon the water. Notwithstanding the completion of PD-6 to identify potential staging sites, it is not anticipated that a shoreline staging area will be available, so removed debris will be placed onto a transfer barge. The barge or series of barges will serve as a management staging area, where debris will be sorted based on material composition.
Current Interpretation of Nature and Extent of Contamination Expected to Influence Project-Specific Decision Making: Debris location information gathered during PD-3 will inform the conceptual site model (CSM) for PD-4 implementation prior to field activities and debris removal.

[1]Note that analytical samples are not planned for collection during this task.

QAPP Worksheet #10c – PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation

Background Information:

The overall objectives of the bulkhead survey and assessment work element are to provide a plan for performing a preliminary assessment of the stability of existing bulkheads during and after remedy implementation, and to create a preliminary design of temporary and permanent bulkhead support systems. There is limited available information on the construction practices, as-built conditions, and design of the existing bulkheads. Furthermore, there is limited available geotechnical design data for the Canal. The bulkhead survey, which includes a Bulkhead Investigation and Geotechnical Site Investigation, is required to address the data gaps.

Results from the bulkhead survey and assessment will be used to refine the comprehensive CSM (PD-25) and will directly support the remedial design and remedial activities.

Sources of Known or Suspected Hazardous Wastes:

Sediments are known to be contaminated with TCL VOCs, TCL SVOCs, PCBs, and TAL metals. Surface water is known to be contaminated with TCL VOCs, TCL SVOCs, TAL metals, and bacteria.[1]

Known or Suspected Contaminants or Classes of Contaminants:

Drilling activities may disturb sediment and cause sediment suspention in the water column. Contaminants may migrate via water currents or may be consumed by biota present in the Canal.

Primary Release Mechanism:

Contaminants in the sediment may have originated in upland areas and traveled to the Canal via many mechanisms which include erosion, dumping, and transport through CSOs. Additional contaminants may have been accidentally released or dumped off of waterway vessels.

Secondary Contaminant Migration:

As debris is removed, sediment may be disturbed and suspended in the water column. Contaminants may migrate via water currents and become available for biouptake by biota in the Canal.

Fate and Transport Considerations:

If contaminants migrate away from their origin in the Canal there is potential for contamination to spread to other areas and impact surface water, sediment, and biota which are currently unaffected by contamination in the Canal.

Potential Receptors and Exposure Pathways:

Humans and biota may be exposed to contaminants though contact with surface water or sediment or through consumption of other contaminated species in the food chain.

Land Use Considerations:

Land Use is shifting in waterfront properties along the Canal from mostly commercial-industrial to more residential. High density housing units are planned for several parcels along the Canal with increased residential growth anticipated in the future.

The Canal is regularly used by commercial barges at several facilities along the mid- and lower Canal. Recreational boaters, primarily, canoers and kayakers, frequent the Canal. A public boat launch where canoes are available is located at 2nd Street. The anticipated remediation and redevelopment will likely increase recreational boating use. A limited number of people reside in houseboats on the Canal.

Several properties towards the mouth of the Canal will continue to be industrial.

Key Physical Aspects of Site:

Bulkheads exist along both sides of the Canal. There are no available documents or construction as-builts that provide the bottom of the foundations of the existing bulkheads. Bulkheads have been assessed based on assumed foundation depths inferred from assumed construction practices as follows:

- Crib bulkheads are built on top of native soil (elevation determined from nearby cone penetrometer tests (CPTs) and borings);
- Steel and timber piles are driven approximately 5 feet (ft) into medium dense to dense glacial till deposits with a maximum pile length of 50 ft. (elevation determined from nearby CPTs and borings); and
- Embankments are built directly on sediments.

Current Interpretation of Nature and Extent of Contamination Expected to Influence Project-Specific Decision Making:

All of the bulkheads will be investigated and analyzed for stability.

QAPP Worksheet #10d – PD-6: Staging Site Selection and Implementation Plan

Background Information: The remedial actions listed in the Record of Decision will require the mobilization of manpower, machinery, and supplies to the area. Staging areas will be required to facilitate the movement of labor, equipment, and material between upland areas to and from the Canal. This work element has been developed to provide a framework for the preparation of a Site Staging and Implementation Plan to govern infrastructure, construction, and site staging operations at the Site. To meet the stated objective of this work element, a plan will be developed to include, but not be limited to: • Evaluation of Construction Phasing and Sequencing; • Analysis of Labor, Equipment, and Materials Needs; • Identification of Staging Site Requirements; • Staging Site Identification; • Staging Site Evaluation; and • Implementation of Staging Site Activities.
Sources of Known or Suspected Hazardous Wastes: Soils, groundwater and sediments of the Canal have been impacted by commercial and industrial activities along the Canal since industrialization of the area began.
Known or Suspected Contaminants or Classes of Contaminants: While specific sites have not selected or evaluated yet, groundwater in the area is impacted by non-aqueous phase liquids (NAPL) and has also demonstrated impacts of VOCs, SVOCs, and metals. Previous industrial activities may have affected individual properties in the area with the same contaminants.[1]
Primary Release Mechanism: Since properties have not been evaluated, the mechanism for any given property is unknown. However, spills and discharges from past industrial practices are known to have occurred in the area.
Secondary Contaminant Migration: Unknown.

Fate and Transport Considerations: If contaminants migrate away from their origin in the Canal there is potential for contamination to spread to other areas and impact surface water, sediment, and biota which are currently unaffected by contamination in the Canal.
Potential Receptors and Exposure Pathways: Humans may be exposed to contaminants though contact with surface water, soils, or sediment during Site evaluation and development activities.
Land Use Considerations: Land Use is shifting in waterfront properties along the Canal from mostly commercial-industrial to more residential. High density housing units are planned for several parcels along the Canal with increased residential growth anticipated in the future. The Canal is regularly used by commercial barges at several facilities along the mid- and lower Canal. Recreational boaters, primarily, canoers and kayakers, frequent the Canal. A public boat launch where canoes are available is located at 2nd Street. The anticipated remediation and redevelopment will likely increase recreational boating use. A limited number of people reside in houseboats on the Canal.
Key Physical Aspects of Site: Staging site selection will seek to identify one or more properties adjacent to the Canal which can be used. Due to limited availability of real estate close to the Canal and a desire to minimize impact of remedial operations on residential neighborhoods, it may be necessary to conduct some activities on barges located in the Canal. However, staging areas will be necessary to transfer labor and equipment from the land to marine equipment. Administrative areas for construction will be needed along with stockpile areas for materials, parking areas for vehicles, and docking for workboats. Properties with both land and marine transportation access are desired. The high degree of urbanization will affect the ability to find suitable properties.
Current Interpretation of Nature and Extent of Contamination Expected to Influence Project-Specific Decision Making: The nature and extent of potential contamination will be evaluated during the site selection process. Sites could be eliminated from consideration based upon the nature and extent of contamination.

[1]Note that analytical samples are not planned for collection during this task.

QAPP Worksheet #10e – PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates

Background Information:

This work element has been developed to investigate the occurrence of groundwater upwelling within the Gowanus Canal and measure representative groundwater discharge rates associated with upwelling areas. The groundwater upwelling work element builds upon information contained in the Remedial Investigation/Feasibility Study (RI/FS) reports for the Site and refines and improves the Site-wide comprehensive CSM to support remedial design activities.

In order to better characterize groundwater discharge rates into the Canal, and the impact on remedial design for *in situ* stabilization (ISS), capping, and bulkheads, field data are needed to identify groundwater upwelling areas and discharge rates.

To meet the primary objectives of this work element, the following sub-tasks will be performed:

- Evaluate and select applicable technologies for locating groundwater discharge areas and quantifying discharge rates;
- Evaluate and select areas of the Canal for groundwater upwelling measurements;
- Inspect Site to confirm feasibility of selected technologies at target locations;
- Implement selected technologies to assess groundwater upwelling areas and discharge rates;
- Characterize the hydraulic conductivity between the native and soft sediments;
- Refine the groundwater CSM and groundwater model; and
- Data management, analysis, and reporting.

Sources of Known or Suspected Hazardous Wastes:

Groundwater has been impacted by commercial and industrial activities along the Canal since industrialization of the area began. [1]

Known or Suspected Contaminants or Classes of Contaminants:

Groundwater is impacted by NAPL and has also demonstrated impacts of VOCs, SVOCs, and metals.

Primary Release Mechanism:

Contaminant sources to groundwater were identified from previous releases and industrial activity during the RI Site work.

Secondary Contaminant Migration:

The RI/FS notes the following three mechanisms that control NAPL migration into the Canal:

- Upward seepage via vertically upward hydraulic gradients associated with groundwater advection.
- Lateral seepage via spreading along the saturated/unsaturated zone interface.
- Upward transport via ebullition due to biodegradation of organic matter or other processes (CH2M Hill, 2013).
- NAPL and other contaminants in groundwater have the potential to migrate out of the Canal after they are released through upwelling.
- Contaminants may migrate via water currents and become available for biouptake by biota in the Canal.

Fate and Transport Considerations:

If contaminants migrate away from their origin in the Canal there is potential for contamination to spread to other areas and impact surface water, sediment, and biota which are currently unaffected by contamination in the Canal.

Potential Receptors and Exposure Pathways:

Humans and biota may be exposed to contaminants though contact with surface water or sediment or through consumption of other contaminated species in the food chain.

Land Use Considerations:

Land Use is shifting in waterfront properties along the Canal from mostly commercial-industrial to more residential. High density housing units are planned for several parcels along the Canal with increased residential growth anticipated in the future.

The Canal is regularly used by commercial barges at several facilities along the mid- and lower Canal. Recreational boaters, primarily, canoers and kayakers, frequent the Canal. A public boat launch where canoes are available is located at 2nd Street. The anticipated remediation and redevelopment will likely increase recreational boating use. A limited number of people reside in houseboats on the Canal.

Key Physical Aspects of Site:

Side-scan and magnetometer data, collected in collaboration with PD-3, will be used identify the presence and density of bottom debris. This will help identify areas of the Canal where physical obstacles would hinder the implementation of one or more of the identified technologies and the need to eliminate the area from testing or to focus debris removal. Locations with relatively little accumulation of soft sediment will also be identified as areas with enhanced potential for preferential flow-paths and increased groundwater upwelling.

Current Interpretation of Nature and Extent of Contamination Expected to Influence Project-Specific Decision Making:

A detailed evaluation will be conducted to assess the distribution of NAPL within Canal sediments. Results of this evaluation will aid in determining where in the Canal groundwater upwelling will be assessed. Measurements will be more densely focused in areas of greater anticipated NAPL distribution.

QAPP Worksheet #10 – Conceptual Site Model (continued)

Specific sampling locations and number of samples have not yet been identified.

[1]Note that analytical samples are not planned for collection during this task.

QAPP Worksheet #10f – PD-8: Evaluation of NAPL Mobility in Native Sediments

Background Information:

This work element has been developed to improve understanding regarding the potential for upward NAPL mobility in native sediments within the Canal. The NAPL mobility work element builds upon information contained in the Site RI/FS reports and refines and improves the Site-wide comprehensive CSM to direct remedial design activities, specifically ISS and capping.

Sources of Known or Suspected Hazardous Wastes:

Groundwater and sediments of the Canal have been impacted by commercial and industrial activities along the Canal since industrialization of the area began.

Known or Suspected Contaminants or Classes of Contaminants:

Groundwater and sediments are both known to be impacted by NAPL, TCL VOCs, TCL SVOCs, and TAL metals. Sediments also have demonstrated PCB impacts. For the purposes of this work element, TCL VOCs, TCL SVOCs, and TAL metals in NAPL and groundwater are the focus of study.

Primary Release Mechanism:

The NAPL has at least two suspected origins:

- Through the subsurface from the upland Sites; and/or
- From overland discharge into the Canal.

Secondary Contaminant Migration:

NAPL and its associated contaminants may migrate under the following pathways:

- NAPL migration from deep sediments to shallower sediments near the surface, through the following mechanisms:
    - Upward seepage via vertically upward hydraulic gradients associated with groundwater advection;
    - Lateral seepage via spreading along the saturated/unsaturated zone interface; or
    - Upward transport via ebullition due to biodegradation of organic matter or other processes (CH2M Hill, 2013)
- Dissolved-phase solute migration in groundwater after dissolution from NAPL.
- Contaminants may migrate via water currents and become available for biouptake by biota in the Canal.

Fate and Transport Considerations:

If contaminants migrate away from their origin in the Canal there is potential for contamination to spread to other areas and impact surface water, sediment, and biota which are currently unaffected by contamination in the Canal.
Potential Receptors and Exposure Pathways: Humans and biota may be exposed to contaminants through contact with surface water or sediment or through consumption of other contaminated species in the food chain.
Land Use Considerations: Land Use is shifting in waterfront properties along the Canal from mostly commercial-industrial to more residential. High-density housing units are planned for several parcels along the Canal with increased residential growth anticipated in the future. The Canal is regularly used by commercial barges at several facilities along the mid- and lower sections of the Canal. Recreational boaters, primarily, canoers and kayakers, frequent the Canal. A public boat launch where canoes are available is located at 2nd Street. The anticipated remediation and redevelopment will likely increase recreational boating use. A limited number of people reside in houseboats on the Canal.
Key Physical Aspects of Site: Sampling activities associated with this task will take place on the water and will have to go through the water column. Samples collected of native sediment will also have to pass through the full column of soft overlying sediments.
Current Interpretation of Nature and Extent of Contamination Expected to Influence Project-Specific Decision Making: For the purposes of the PDWP, the process of upward vertical transport of NAPL within the Canal footprint is the area of focus; potential lateral transport of NAPL into the Canal via bulkheads is addressed separately through upland remedial activities and possibly additional pre-design investigations. Field and laboratory work completed by EPA as part of the RI/FS provides an initial understanding of NAPL distribution and potential for upward mobility; however, in order to optimize the design of ISS and capping remedial measures, further refinement of the NAPL CSM is required to understand the mechanisms of NAPL mobility in the Canal. The primary CSM data needs related to upward NAPL mobility are as follows: • The origin of the NAPL within the Canal area; and • The conditions under which NAPL can become upwardly mobile. Specific sampling locations and number of samples have not yet been identified.

CPT = cone penetrometer test
CSM = conceptual site model
CSO = combined sewer overflow
ISS = *in situ* stabilization
ft = feet
NAPL = non-aqueous phase liquid

PCBs = polychlorinated biphenyls
RI/FS = Remedial Investigation/Feasibility Study
SVOCs = semi-volatile organic compound
TAL = Target Analyte List
TCL = Target Compound List
VOC = volatile organic compound

QAPP Worksheet #11 – Project Data Quality Objectives/Systematic Planning Statements

The following worksheets describe the project data quality objectives (DQOs). Note that specific analytical methods for samples are provided in WS#18 – Sampling Locations and Methods/SOP Requirements Table.

The project DQOs and data needs are presented in the 7-step DQO process provided in the following worksheets.

QAPP Worksheet #11a – PD-3: Additional Debris Reconnaissance

QAPP Worksheet #11b – PD-4: Development of Debris Removal and Management Plan

QAPP Worksheet #11c – PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation

QAPP Worksheet #11d – PD-6: Staging Site Selection and Implementation Plan

QAPP Worksheet #11e – PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates

QAPP Worksheet #11f – PD-8: Evaluation of NAPL Mobility in Native Sediments

QAPP Worksheet #11 – Project Data Quality Objectives/Systematic Planning Statements (continued)

QAPP Worksheet #11a – PD-3: Additional Debris Reconnaissance

STEP 1: State the Problem

Debris exists in the Canal which may interfere with remedy implementation. Some areas of the Canal have already been investigated for debris, but other areas of the Canal have not yet been scanned.

STEP 2: Identify the Goals of the Study

This work element has been developed to perform additional debris reconnaissance for debris removal in the Canal in areas not previously surveyed or where survey results require confirmation.

STEP 3: Identify the Information Inputs

1. A high-frequency side-scan sonar study of the Canal was conducted in December 2010. Information gathered during that event will be confirmed during this event.
2. High-frequency side-scan sonar to confirm findings of the 2010 study and investigate new areas not covered in the 2010 study.

STEP 4: Define the Study Boundaries

The study boundary is the surface of the sediment located within the full length of the Canal. The Record of Decision (ROD) further divides the Canal into 3 Remediation Target Areas (RTAs) known as RTA-1, RTA-2, and RTA-3. This task has not yet been scheduled so there is no defined temporal boundary.

STEP 5: Develop the Analytic Approach

- If debris is encountered, then it will be characterized and added to the scope of the Plan for Debris Removal, Decontamination, and Disposal (PD-4). To the extent practical, the debris will be quantified by volume per designated area and categorized into 1 of 4 main types of debris: metal, concrete, tires, or wood.

STEP 6: Specify Performance Criteria

The sonar scan must meet the professional standard of performance and be performed by trained subcontractors. When debris is encountered, it will be evaluated and scheduled for removal per PD-4 - Development of Debris Removal and Management Plan.

STEP 7: Optimize the Design for Obtaining Data

Significant debris identified prior to this survey will be verified.

The interferences that previously prevented the completion of the high-frequency side-scan sonar activities in these areas will be addressed by the following measures:

- The oxygen transfer system will be removed prior to the additional reconnaissance activities;
- The activities will be coordinated to occur when the mouth of the Canal is free of construction and work barges;
- Alternatives to side-scan sonar may be used, such as a tripod-mounted, high-resolution, 360-degree scanning sonar which can be deployed adjacent to hard-to-reach areas to generate plan-view sonar imagery; and,

QAPP Worksheet #11 – Project Data Quality Objectives/Systematic Planning Statements (continued)

- Significant debris fields identified during this survey and previous surveys will be verified.

The debris reconnaissance will be optimized as appropriate during field implementation.

QAPP Worksheet #11b – PD-4: Development of Debris Removal and Management Plan

STEP 1: State the Problem

Debris in the Canal needs to be removed and/or otherwise managed such that it does not interfere with the remedy.

STEP 2: Identify the Goals of the Study

This work element has been prepared to plan and manage the identification, removal, testing and disposal of all non-sediment materials present in the Canal. The overall objective of this work element is to develop a plan (Debris Plan) to govern the removal and/or management of debris such that the underlying targeted sediment can be efficiently and effectively dredged and/or remediated. Elements of the Debris Plan will include debris removal, debris decontamination, debris handling and disposal, and cultural resources management.

STEP 3: Identify the Information Inputs

1. Information gathered regarding the location of debris in PD-3will be used to develop the Debris Removal and Management Plan.
2. Information gathered in the 2010 high frequency side-scan sonar will also be used.

STEP 4: Define the Study Boundaries

The study boundary is the surface of the sediment located within the full length of the Canal. The ROD further divides the Canal into 3 RTAs known as RTA-1, RTA-2, and RTA-3. This task has not yet been scheduled so there is no defined temporal boundary.

STEP 5: Develop the Analytic Approach

- A technical scope will be developed for removing debris located within the Canal such that media disturbance is minimized during debris removal.
- An environmental monitoring plan will be developed for implementation during debris removal. Corrective measures will be proposed to mitigate possible disturbances.

STEP 6: Specify Performance Criteria

The debris management plan must meet the professional standard of performance and be performed by individuals with appropriate training and credentials.

STEP 7: Optimize the Design for Obtaining Data

Not applicable.

QAPP Worksheet #11c – PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation

STEP 1: State the Problem

Existing bulkheads along the Canal will be impacted during the remedy implementation. A survey is needed to determine which bulkheads require reinforcement or replacement to avoid failure during dredging operations.

STEP 2: Identify the Goals of the Study

This work element has been developed to survey and assess bulkhead conditions along the Canal for the purpose of evaluating their anticipated integrity during remedial implementation. As part of this task, a bulkhead and Geotechnical Site Investigation will be performed. Data collected from the Investigation will be used to evaluate the bulkheads' temporary stability during remedial implementation and long-term stability for the post remedial condition. For bulkheads which do not meet the minimum credible structural standards for either temporary or long-term conditions, temporary support or permanent reinforcements or replacements will be designed.

STEP 3: Identify the Information Inputs

1. Previous research:
    a. Information contained in the Remedial Design/Feasibility Study reports for the Site
    b. Brown, A., "Gowanus Canal, Bulkhead Inventory Survey," July 2000.
    c. GEI Consultants, Inc., "Draft Bulkhead Summary, Gowanus Canal Superfund Site, Brooklyn, New York," March 8, 2012.
    d. GEI Consultants, Inc., Gowanus Canal–Web GIS Interface, 2013.
    e. Ocean Surveys, Inc., Multibeam Hydrographic Survey, August 2013.
    f. United States Environmental Protection Agency, "Record of Decision, Gowanus Canal Superfund Site, Brooklyn, King County, New York," September 2013.
2. Review of any available as-builts of existing bulkheads.
3. Subsurface Investigation of Existing Bulkhead Foundations to be completed as part of this task.
4. Geotechnical Site Investigation to be completed as part of this task (WS#18 provides a list of the analytical methods).

STEP 4: Define the Study Boundaries

All bulkheads along the length of the Canal. This task has not yet been scheduled so there is no defined temporal boundary.

STEP 5: Develop the Analytic Approach

- If bulkheads along the Canal do not meet minimum credible structural standards to implement the remedy, then temporary or permanent reinforcements or replacements will be designed.
- If bulkheads along the Canal do not meet minimum credible structural standards for the post remedy condition, then permanent reinforcements or replacements will be designed.

STEP 6: Specify Performance Criteria

Analytical samples must meet the applicable quality control acceptance criteria, meet the professional standard of performance, and be analyzed by accredited institutions or professions as applicable.

STEP 7: Optimize the Design for Obtaining Data

It is possible that multiple testing methodologies will be selected to accomplish the goals of this task. Technologies and sampling locations may be adjusted based on field conditions.

QAPP Worksheet #11 – Project Data Quality Objectives/Systematic Planning Statements (continued)

QAPP Worksheet #11d – PD-6: Staging Site Selection and Implementation Plan

STEP 1: State the Problem

A staging site is needed to meet construction needs in order to assemble and transfer labor, equipment, supplies, and material during remedial activities.

STEP 2: Identify the Goals of the Study

The objective of this work element is to develop a plan describing the means to:

- Identify project infrastructure needs;
- Determine necessary staging site requirements;
- Identify potential staging sites; and
- Evaluate staging sites.

STEP 3: Identify the Information Inputs

1. Evaluation of Construction Phasing and Sequencing;
2. Analysis of Labor, Equipment, and Materials Needs;
3. Identification of Staging Site Requirements;
4. Staging Site Identification; and
5. Staging Site Evaluation

STEP 4: Define the Study Boundaries

Staging site selection will be considered in areas on, near to, or adjacent to the Canal and will incorporate consideration for work for each of the RTAs. This task has not yet been scheduled so there is no defined temporal boundary.

STEP 5: Develop the Analytic Approach

- If sites are evaluated which meet the acceptance criteria for site selection, then EPA will make the final decision regarding which site to use and will aid in acquiring site access.
- If potential staging sites identified are inappropriate based on site visits, additional sites will be considered.
- If sites with unacceptable characteristics cannot be acceptably mitigated, then they will be removed from further consideration.

STEP 6: Specify Performance Criteria

Site selection should be able to accommodate requirements determined during the selection process. If site visits indicate site is inadequate to meet project needs and the issues cannot be rectified, sites will be removed from consideration.

STEP 7: Optimize the Design for Obtaining Data

- A desktop study will be conducted first using interviews, available zoning information, and aerial mapping tools prior to site visits. Following site visits, if investigated sites are not appropriate, further desktop review will be conducted prior to the next site visit.

QAPP Worksheet #11 – Project Data Quality Objectives/Systematic Planning Statements (continued)

QAPP Worksheet #11e – PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates

STEP 1: State the Problem

Groundwater upwelling is a potential source of contaminant migration, and it will affect the installed remedy. Understanding areas of upwelling and quantifying discharges rates are required to appropriately design a permanent remedy.

STEP 2: Identify the Goals of the Study

Two primary objectives of this work element are to determine the approximate areas of significant groundwater upwelling in the Canal and, for those areas where upwelling is identified, to estimate the rate and velocity of this discharge.

STEP 3: Identify the Information Inputs

1. Evaluate and select applicable technologies for locating groundwater upwelling areas and quantifying discharge rates;
2. Evaluate and select areas of Gowanus Canal for groundwater upwelling measurements;
3. Inspect locations within the Canal to confirm feasibility of selected technologies at target locations;
4. Implement selected technologies to assess groundwater upwelling areas and discharge rates;
5. Characterize the hydraulic conductivity between the native and soft sediments;
6. Refine the groundwater conceptual site model (CSM) and groundwater model; and
7. Data management, analysis, and reporting.

STEP 4: Define the Study Boundaries

The entire length of the Canal will be considered in the study. This task has not yet been scheduled so there is no defined temporal boundary.

STEP 5: Develop the Analytic Approach

Analytical approaches are included for the initial screening of technologies, the evaluation of locations to implement the technologies, and the selection of technologies following evaluation of locations.

1. Numerous technologies will be evaluated through an initial screening process for their potential to identify groundwater upwelling areas and where identified, quantify groundwater discharge rates. If a technology appears to be appropriate and feasible based on the current CSM, then that technology will be retained for further consideration.
2. Locations within the Canal will be evaluated by considering previously acquired side-scan survey data conducted as part of the Remedial Investigation. A secondary step of performing current site surveys to confirm historical or determine current conditions, if changed, will be implemented. If these locations are considered feasible for the implementation of the retained technologies based on surface access and bottom debris, then those locations will be retained for further investigation.
3. Areas deemed feasible based on steps 1 and 2 will be evaluated to select the appropriate technology for evaluation of upwelling and groundwater discharge.
4. In locations where groundwater discharge is quantified, additional investigation will characterize the hydraulic conductivity between the native and soft sediments.
5. If the groundwater upwelling areas and measured discharge rates are significantly different than anticipated based on results from the 2011 flow model, or if the contrast in hydraulic conductivities between the native and soft sediments are significantly different than the current hydraulic conductivity value used for the sediment in the 2011 flow model, then the flow model will be further refined and re-calibrated.

STEP 6: Specify Performance Criteria

Both non-aqueous phase liquid (NAPL) impacted and non-NAPL impacted areas that are considered feasible for evaluation based on surface and bottom conditions will undergo field characterization to confirm feasibility with the applicable technologies.

During this implementation phase, multiple technologies will likely be used to provide independent and complementary lines of evidence that characterize the nature and extent of groundwater upwelling into the Canal. The utility of an initial, demonstration-scale implementation step will be considered to obtain Site-specific data in advance of a full-scale implementation for technologies warranting methods demonstration. This will be true for both for evaluating upwelling areas and quantifying discharge rates. The performance criteria for evaluating upwelling will be to confirm the upwelling with a quantifiable groundwater discharge rate. If it is determined that upwelling is occurring in a specified area, but no discharge able to be measured, an additional technology to quantify discharge will be attempted. If no discharge is measured with the second technology then further evaluation of the groundwater upwelling results will be considered.

All data will be collected by knowledgeable, experienced staff for the particular technology implemented.

STEP 7: Optimize the Design for Obtaining Data

It is anticipated that activities described for this work element will be conducted in a dynamic manner with several decision steps required, potentially leading to modifications of the scope of work as it is implemented. If the scope should require modification during implementation, the scope changes will be appropriately documented and communicated to EPA.

QAPP Worksheet #11 – Project Data Quality Objectives/Systematic Planning Statements (continued)

QAPP Worksheet #11f – PD-8: Evaluation of NAPL Mobility in Native Sediments

STEP 1: State the Problem

NAPL mobility in the Canal could reduce the effectiveness of the remedy after installation. The distribution of NAPL within the Canal and the potential for NAPL mobility must be understood to account for potential NAPL loading due to mobilization in the in situ stabilization (ISS) and/or capping remedial design.

STEP 2: Identify the Goals of the Study

The primary objectives of this work element are to (i) quantify the NAPL distribution within the Canal, (ii) define areas of potentially mobile NAPL, and (iii) quantify and characterize the controlling factors of NAPL mobility.

STEP 3: Identify the Information Inputs

1. Desktop evaluation of NAPL mobility and selection of appropriate field-screening technology(ies) and assessment locations.
2. Implementation of field-based approaches to assess in situ NAPL distribution.
3. Laboratory groundwater and NAPL characterization and mobility testing. Analytical testing includes TCL VOCs, TCL SVOCs, and TAL metals.

STEP 4: Define the Study Boundaries

The results of the desktop evaluation will select one or more focus areas within the Canal for assessment of the field-screening technology(ies). If the results of the focus area(s) are positive, than a larger area that will not be larger than the length of the Canal may be investigated. While the program may be phased and dynamic in nature to allow for refinement, overall is planned to be a one-time investigative program. This task has not yet been scheduled so there is no defined temporal boundary.

STEP 5: Develop the Analytic Approach

The desktop evaluation will provide the information needed to select the field-screening technology(ies) and assessment area(s) and locations to assess the NAPL distribution and potential NAPL mobility. If the desktop study shows that the planned methods (e.g., TarGOST, cone penetrometer testing, acetate core liners, etc.) are generally effective in settings similar to the Canal, then they will be used in the performance of the PD-8 work element.

The in situ NAPL distribution will be assessed using the field-based screening approaches. If the distribution of NAPL differs from what is currently understood, then the remedial design will be modified to reflect the refined footprint of NAPL contamination.

Based upon the field-screening technology(ies) results, collocated undisturbed sediment cores will be collected from a sub-set of the assessment locations for confirmatory laboratory analysis. These undisturbed cores will be analyzed by methods to understand and confirm the field-screening technology(ies) for NAPL saturation, soil physical parameters (i.e., geotechnical), and other parameters to help understand NAPL distribution (i.e., saturation). If significant differences in the findings between the field screening measures and laboratory-based measures of NAPL saturation are observed, the two different datasets will be critically reviewed to select the most accurate depiction of NAPL presence for the purposes of the remedial design.

A laboratory mobility testing method that mimics natural conditions will be used to assess the mobility of the NAPL within the sediments. The goal of the laboratory-scale work is to understand, among other factors, the vertical seepage velocity and hydraulic head gradients that are necessary to cause upward migration of the NAPL within the native sediments. If upward migration of the NAPL within the native sediments occurs during testing, then the remedial design will be focused in these areas to provide appropriate measures of NAPL interception.

STEP 6: Specify Performance Criteria

Inaccurate conclusions regarding similarities or differences between analytical sample values or field measurements are possible due to dataset variability (i.e., Types I/Type II error.) This will be managed by assessing variability in each dataset with respect to the magnitude of differences between readings to evaluate the extent to which conclusive decisions can be made about the (dis)similarity in the datasets.

Samples collected as part of this task must meet the applicable quality control acceptance criteria, meet the professional standard of performance, and be analyzed by accredited institutions or professions as applicable.

It is anticipated that activities described for this work element will be conducted in a dynamic manner with several decision steps required, potentially leading to modifications of the scope of work as it is implemented. If the scope should require modification during implementation, the scope changes will be appropriately documented and communicated to EPA.

STEP 7: Optimize the Design for Obtaining Data

It is possible that multiple technologies will be selected to provide independent and complementary lines of evidence that characterize NAPL mobility in native sediments. These technologies will be selected based on the results desktop study.

CSM = conceptual site model
NAPL = non-aqueous phase liquid

RTA = remediation target area
ROD = Record of Decision
SVOC = semi-volatile organic compounds
TAL = Target Analyte List
TCL = Target Compound List
VOC = volatile organic compound

QAPP Worksheet #12 – Measurement Performance Criteria Table

Measurement Performance Criteria listed below applies only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Laboratory: To be determined (TBD)
Matrix: Water
Analytical Group: **TCL VOCs**
Sampling Procedure: TBD
Analytical Method/SOP Reference: SW846 8260B/ See Worksheet 23
Concentration Level: Low

QC Sample	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method detection limit (MDL)	Per NELAP Certification requirements	Sensitivity	Must meet criteria specified in Appendix B to 40CFR Part 136, Definition and Procedure for the Determination of the Method Detection Limit	A
Tune standard BFB (4-Bromofluorobenzene)	Each 12-hour time period. The 12-hour time period begins at the moment of injection of BFB.	Sensitivity	Must meet the abundance criteria listed in per Laboratory standard operating procedure (SOP) when selected	A
Initial Calibration	Prior to sample analysis	Accuracy	The % RSD of the calibration check compounds (CCC) must be less than 30%. If none of the CCCs are required analytes, project specific calibration specifications must be agreed with the client. The 5 system performance check compounds (SPCC) are checked for a minimum average response factor (RF). Where a target compound is ≤15% RSD average RF may be used. If the 15% RSD criteria are exceeded, the linear curve, quadratic curve or polynomial curve must have a correlation coefficient of ≥ 0.995. Compound list will be divided into 2 lists: List 1 (reliable performers) and List 2 (poor performers). List 1 compounds should always have a %RSD less than 30% or correlation coefficient of 0.995 with an allowance of up to 2 sporadic marginal failures. Sporadic marginal failures for these compounds should be ≤ 40% or 0.990. For List 2 analytes, where the %RSD is ≤15% an average response factor will be used. For %RSDs >15% and ≤60% the best fit curve will be selected.	A
Initial calibration verification	Analyzed with each initial calibration.	Accuracy	The acceptance criteria are 75-125% for most compounds and 50-150% for poor method performers. The poor performers are footnoted in SOP Tables 3 and 4. Any compound not listed will fall into the 50-150% criteria until knowledge of the compound can be developed.	A

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory: To be determined (TBD)
Matrix: Water
Analytical Group: **TCL VOCs**
Sampling Procedure: TBD
Analytical Method/SOP Reference: SW846 8260B/ See Worksheet 23
Concentration Level: Low

QC Sample	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Continuing calibration verification	Must be analyzed every twelve hours		CCCs must be ≤20 %diff. List 1 compounds that are non-CCCs must be ≤25 %diff or drift. Up to 2 compounds that are List 1 analytes may exceed the 25% criteria, but must be ≤40%. List 2 analytes including Appendix IX compounds must have % diff or % drift ≤50%.	A
Method blank	With each batch of samples. The method blank is analyzed after the calibration standards, normally before any samples.	Sensitivity	The method blank must not contain any analyte of interest ≥ PQL (except common laboratory contaminants, methylene chloride, acetone, 2-butanone) or at or above 5% of the measured concentration of that analyte in the associated samples, whichever is higher. Common laboratory contaminants < 5 times the PQL.	A
Laboratory Control Sample (LCS)	With each batch of samples. The LCS is analyzed after the calibration standard, and normally before any samples.	Accuracy	Control analytes and surrogates must be within historical control limits.	A
Matrix spike/matrix spike duplicate (MS/MSD)	With each QC batch	Accuracy & Precision	Percent recovery & Relative Percent Difference (RPD) within laboratory historical control limits.	S & A
Performance Testing Sample	Prior to each phase of the study	Accuracy	Results must be within vendor specified acceptance criteria	A
Trip Blank	1 per cooler containing aqueous VOC samples; not required for sediment	Sensitivity	No analytes > PQL	S
Field Duplicate	1 per 20 Samples	Precision	RPD should be < 40% for solids/sediment/tissue and <30% for surface water	S
Source Blank	1 per lot of source water	Sensitivity	No analytes > PQL	S

Laboratory: TBD
Matrix: Water
Analytical Group: **TCL SVOCs**
Sampling Procedure: TBD
Analytical Method/SOP Reference: SW846 8270C/ See Worksheet 23
Concentration Level: Low

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method detection limit (MDL)	Per specification of NELAC	Sensitivity	Must meet criteria specified in Appendix B to 40CFR Part 136, Definition and Procedure for the Determination of the Method Detection Limit	A
Tune standard Deca-fluorotriphenylphosphine (DFTPP)	At the beginning of every twelve hour shift, including calibration and when analyses are to be performed	Sensitivity	Per the specifications of the laboratory SOP once selected	A
Initial Calibration	Prior to sample analysis	Accuracy	System Performance Check Compounds (SPCCs): The minimum average RF for SPCCs is 0.050. Calibration Check Compounds (CCCs): The %RSD of the RFs for each CCC in the initial calibration must be less than 30%. If none of the CCCs are required analytes, project specific calibration specifications must be agreed with the client. Where a target compound is ≤15% RSD, an average RF may be used. If the 15% RSD criteria is exceeded for a non-CCC target compound, the linear, quadratic or polynomial fit must have R ≥0.995. Where a target compound is ≥15% but ≤30% an average RF may still be used if the analyst shows that the average RF is an acceptable fit over the range of use. Com-pound list will be divided into two lists: List 1 (reliable performers) and List 2 (poor performers). List 1 com-pounds should always have a %RSD less than 30% or correlation coefficient of 0.995 with an allowance of up to 4 sporadic marginal failures. Sporadic marginal failures for these compounds should be ≤40% or 0.990. For List 2 analytes, where the %RSD is ≤15% an average RF will be used. For %RSDs >15% and ≤60% the best fit curve will be selected.	A
Initial calibration verification (ICV)	Analyzed after each initial calibration.	Accuracy	The ICV must be within +/- 30% of its expected value.	A

Laboratory: TBD
Matrix: Water
Analytical Group: **TCL SVOCs**
Sampling Procedure: TBD
Analytical Method/SOP Reference: SW846 8270C/ See Worksheet 23
Concentration Level: Low

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Continuing calibration verification	At the start of each 12-hour period, after the DFTPP	Accuracy	The SPCC compounds must have a response factor of > 0.05. The percent difference or drift of the CCC compounds from the initial calibration must be ≤20%. List 1 compounds that are non-CCC's must be <25% differences or drift with the allowance of up to four which must be ≤40%. List 2 target compounds including Appendix IX will be accepted where the % difference or drift is <50%. Where a List 2 target compound is out high by > 50% and the compound is ND in the samples, the samples may be reported with narration. If a list 1 compound is not found in the sample, a CCV (out high) of up to 50%D or drift, may be accepted with narration subject to determination that it is acceptable for the specific project. Any compound with a %D or Drift >25% must be narrated. The internal standard response must be within 50-200% of the response in the mid level of the initial calibration. The internal standard retention times must be within 30 seconds of the retention times in the mid-level of the initial calibration. If none of the CCCs are required analytes, project specific calibration specifications must be agreed with the client.	A
Method blank	Prepared and analyzed with each batch of 20 or fewer samples.	Sensitivity	The method blank must not contain any analyte of interest at or above the PQL (except common laboratory contaminants, phthalate esters) or at or above 5% of the measured concentration of that analyte in the associated samples, whichever is higher. The method blank must have acceptable surrogate recoveries.	A

Laboratory: TBD
Matrix: Water
Analytical Group: **TCL SVOCs**
Sampling Procedure: TBD
Analytical Method/SOP Reference: SW846 8270C/ See Worksheet 23
Concentration Level: Low

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Instrument blank	During each 12 hour analytical run before samples are analyzed. This may be accomplished by analysis of a method blank. If a method blank is not available, an instrument blank must be analyzed.	Sensitivity	The instrument blank must not contain any analyte of interest at or above the PQL (except common laboratory contaminants, phthalate esters) or at or above 5% of the measured concentration of that analyte in the associated samples, whichever is higher. The instrument blank must have acceptable surrogate recoveries.	A
Laboratory Control Samples (LCS)	Prepared and analyzed with each batch of 20 or fewer samples.	Accuracy	All control analytes must be within established control limits.	A
Matrix spike/matrix spike duplicate (MS/MSD)	Prepared and analyzed with every batch of 20 or fewer samples.	Accuracy and precision	Compare the % recovery & RPD to that in the laboratory specific, historically generated limits.	S & A
Performance Testing Sample	Prior to each phase of the study	Accuracy	Results must be within vendor specified acceptance criteria	A
Field Duplicate	1 per 20 Samples	Precision	RPD should be < 40% for solids/sediment/tissue and <30% for surface water	S
Source Blank	1 per lot of source water	Sensitivity	No analytes > PQL	S
Equipment Blank	1 per 20 samples not to exceed 1 per day	Sensitivity	No analytes > PQL	S
Filter Blank (Surface Water only)	1 per lot of filters	Sensitivity	No analytes > PQL	S

Laboratory TBD
Matrix Water
Analytical Group **Mercury**
Sampling Procedure See Worksheet 21
Analytical Method/SOP
Reference SW846 Method 7470B
Concentration Level Medium

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method detection limit (MDL)	Prior to the analysis of any samples	Sensitivity	Must meet criteria specified in Appendix B to 40CFR Part 136, Definition and Procedure for the Determination of the Method Detection Limit	A
Initial calibration	Must be performed daily (every 24 hours) and each time the instrument is set up.	Accuracy	The calibration curve must have a correlation coefficient of ≥0.995	A
Initial Calibration Verification and Initial Calibration Blank (ICV/ICB)	Immediately after the initial calibration.	Accuracy and sensitivity	The ICV result must fall within 10% of the true value for that solution. The ICB result must fall within +/- the PQL from zero.	A
Continuing Calibration Verification and Continuing Calibration Blank (CCV/CCB)	After every 10 samples and at the end of the run.	Accuracy and sensitivity	The CCV result must fall within 20% of the true value for that solution. The CCB result must fall within +/- PQL from zero.	A
Method blank	One method blank must be processed with each preparation batch up to 20 samples.	Sensitivity	The method blank should not contain any analyte of interest at or above the PQL, or above 10% of either the measured concentration of that analyte in associated samples or the regulatory limit.	A
Laboratory control sample (LCS)	One LCS must be processed with each preparation batch up to 20 samples.	Accuracy	In-house control limits are 80 - 120% recovery.	A
Matrix spike/matrix spike duplicate (MS/MSD)	One MS/MSD pair must be processed for each preparation batch up to 20 samples.	Accuracy and precision	Until in-house control limits are established, control limits of 75-125% recovery & 20% RPD must be applied to the MS/MSD.	S & A
Performance Testing Sample	Prior to each phase of the study	Accuracy	Results must be within vendor specified acceptance criteria	A

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory TBD
Matrix Water
Analytical Group **Mercury**
Sampling Procedure See Worksheet 21
Analytical Method/SOP
Reference SW846 Method 7470B
Concentration Level Medium

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Field Duplicate	1 per 20 Samples	Precision	RPD should be < 40% for solids/sediment/tissue and <30% for surface water	S
Source Blank	1 per lot of source water	Sensitivity	No analytes > PQL	S
Equipment Blank	1 per 20 samples not to exceed 1 per day	Sensitivity	No analytes > PQL	S

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory: TBD
Matrix: Water
Analytical Group: **TAL Metals**
Sampling Procedure: See Worksheet 21
Analytical Method/SOP Reference: SW846 6020/ See Worksheet 23
Concentration Level: Low

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method detection limit (MDL)	Per NELAC certification specifications	Sensitivity	Must meet criteria specified in Appendix B to 40CFR Part 136, Definition and Procedure for the Determination of the Method Detection Limit	A
Tuning Standard	Daily	Sensitivity	Analyze the tuning solution containing elements representing all of the mass regions of interest. The relative standard deviations must be ≤ 5% after running the tuning solution a minimum of four times.	A
Mass Calibration Check and Mass Resolution Check	Daily	Sensitivity	The mass calibration results must be within 0.1 amu from the true value. The resolution must be verified to be < 0.9 amu full width at 10% peak height.	A
Initial calibration	Daily and each time the instrument is set up.	Accuracy	For a linear multi-point calibration curve, the correlation coefficient must be ≥ 0.995. Report the average of at least two integrations for both calibration and sample analysis.	A
Initial Calibration Verification (ICV) [also called Quality control Standard]	Immediately after initial calibration	Accuracy	The ICV must fall within 10% of the true value.	A
Initial Calibration Blank (ICB)	After ICV	Sensitivity	The ICB/CCB must fall within +/- the practical quantitation limit from zero	A
RL Verification Standard	Immediately after the ICV/ICB	Accuracy	The results should be within the range 50-150% recovery for all analytes.	A
Interference Check Solutions (ICSA/ICSAB)	At the beginning of every analytical run and every 12 hours thereafter	Accuracy	Control limits of spiked analytes in the ICSA/ICSAB solution are ± 50% of true value. Control limits of non-spiked analytes are ± two times the practical quantitation limit or less than 1 ug/L.	A
CCV/CCB	After the CRI, following every 10 samples and at the end of the run.	Accuracy and sensitivity	Results for the CCV must be within the range 90-110% recovery. The ICB/CCB must fall within +/- the practical quantitation limit from zero.	A

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory: TBD
Matrix: Water
Analytical Group: **TAL Metals**
Sampling Procedure: See Worksheet 21
Analytical Method/SOP Reference: SW846 6020/ See Worksheet 23
Concentration Level: Low

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method blank	One method blank must be processed with each preparation batch.	Sensitivity	The method blank must not contain any analyte of interest at, or above, the practical quantitation limit (exception: common laboratory contaminants) or at, or above, 5% of the measured concentration of that analyte in associated samples, whichever is higher (sample result must be a minimum of 20x higher than the blank contamination level).	A
Laboratory Control Samples (LCS)	One LCS from an independent source must be processed with each preparation batch.	Accuracy	All analytes must be within laboratory established historical control limits.	A
Matrix spike/matrix spike duplicate (MS/MSD)	MS/MSD is prepared and analyzed with every batch of samples.	Accuracy and precision	The percent recovery and RPD within the historically generated limits.	A
Post digestion spike (PDS)	If the serial dilution fails to meet the acceptance criteria, a PDS must be performed as follows.	Accuracy	An analytical spike added to a portion of a prepared sample, or its dilution, should be recovered within 75 - 125% of the known value.	A
Serial dilution	One serial five-fold dilution must be analyzed per batch for each matrix.	Accuracy	If the analyte concentration is within linear range of the instrument and sufficiently high (generally, a factor of 100 times above the practical quantitation limit), the serial dilution must agree within 10% of the original analysis.	A
Field Duplicate	1 per 20 Samples	Precision	RPD should be < 40% for solids/sediment/tissue and <30% for surface water	S
Source Blank	1 per each lot of decontamination water or carboy of water	Sensitivity	No analytes > PQL	S

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory: TBD
Matrix: Water
Analytical Group: **TAL Metals**
Sampling Procedure: See Worksheet 21
Analytical Method/SOP Reference: SW846 6020/ See Worksheet 23
Concentration Level: Low

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Equipment Blank	1 per 20 samples not to exceed 1 per day	Sensitivity	No analytes > PQL	S
Filter Blank (Surface Water only)	1 per lot of filters	Sensitivity	No analytes > PQL	S

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory: TBD
Matrix: Water
Analytical Group: **Metals**
Sampling Procedure: See Worksheet 21
Analytical Method/SOP
Reference: SW846 6010B/ See Worksheet 23
Concentration Level: Medium

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Method detection limit (MDL)	Per SOP	Sensitivity	Must meet criteria specified in Appendix B to 40CFR Part 136, Definition and Procedure for the Determination of the Method Detection Limit	A
Instrument Detection Limit	Initially and as specified in SOP	Sensitivity	Each measurement must be performed as though it were a separate analytical sample (i.e., each measurement must be followed by a rinse and/or any other procedure performed between the analysis of separate samples).	A
Linear Range	Must be verified every 6 months	Accuracy	The standards used to verify the linear range limit must be analyzed during a routine analytical run, and must read within 10% of the expected value.	A
Initial calibration	Daily and each time the instrument is set up.	Accuracy	Profile and calibrate the instrument according to the instrument manufacturer's recommended procedures.	A
Initial Calibration Verification (ICV)	Immediately after initial calibration	Accuracy	The ICV must fall within 10% of the true value for that solution. For Method 6010B, the relative standard deviation must be $\leq$5% from replicate (minimum of two) exposures.	A
Initial Calibration Blank (ICB)	After ICV	Sensitivity	The ICB/CCB must fall within +/- the practical quantitation limit from zero	A
Interference Check Solutions (ICSA/ICSAB)	At the beginning of every analytical run	Accuracy	The ICSAB results for the interferents must fall within 80 - 120% of the true value. If any ICSAB interferent result fails criteria, the analysis must be terminated, the problem corrected, the instrument recalibrated, and the samples rerun. ICSA results for the non-interfering elements with practical quantitation limits $\leq$ 10 ug/L must fall within $\pm$ 2 times the PQL from zero. ICSA results for the non-interfering elements with PQLs > 10 µg/L must fall within $\pm$ 1 times the PQL from zero	A

QAPP Worksheet #12 – Measurement Performance Criteria Table (continued)

Laboratory: TBD
Matrix: Water
Analytical Group: **Metals**
Sampling Procedure: See Worksheet 21
Analytical Method/SOP Reference: SW846 6010B/ See Worksheet 23
Concentration Level: Medium

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
CRI (Practical quantitation limit standard)	At the beginning of every analytical run	Accuracy and sensitivity	Evaluate associated samples based upon advisory limits of ± 50% of true value.	A
CCV/CCB	After the ICV/ICB, following every 10 samples and at the end of the run.	Accuracy and sensitivity	Results for the CCV must be within the range 90-110% recovery. For Methods 6010B, and 200.7, the relative standard deviation must be $\leq$5% from replicate (minimum of two) exposures. The ICB/CCB must fall within +/- the practical quantitation limit from zero.	A
Method blank	One method blank must be processed with each preparation batch.	Sensitivity	The method blank must not contain any analyte of interest at, or above, the practical quantitation limit (exception: common laboratory contaminants) or at, or above, 5% of the measured concentration of that analyte in associated samples, whichever is higher (sample result must be a minimum of 20x higher than the blank contamination level).	A
Laboratory Control Samples (LCS)	One LCS must be processed with each preparation batch.	Accuracy	Unless in-house control limits are established, a control limit of 80 - 120% recovery must be applied.	A
Matrix spike/matrix spike duplicate (MS/MSD)	MS/MSD is prepared and analyzed with every batch of samples.	Accuracy and precision	Control limits of 75-125% recovery and 20% RPD or historical acceptance criteria must be applied to the MS/MSD.	A
Dilution test	One sample per preparation batch must be processed as a dilution test	Accuracy	The results of the diluted sample after correction for dilution must agree within 10% of the original sample determination when the original sample concentration is greater than 50 times the IDL.	A
Field Duplicate	1 per 20 Samples	Precision	Relative Percent Difference (RPD) <30% for surface water.	S

Laboratory: TBD
Matrix: Water
Analytical Group: **Metals**
Sampling Procedure: See Worksheet 21
Analytical Method/SOP Reference: SW846 6010B/ See Worksheet 23
Concentration Level: Medium

QC Sample	Frequency	DQIs	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Source Blank	1 per each lot of decontamination water or carboy of water	Sensitivity	No analytes > PQL	S
Equipment Blank	1 per 20 samples not to exceed 1 per day	Sensitivity	No analytes > PQL	S

Practical Quantitation limit (PQL) is the same as the reporting limit (RL).

CCC = calibration check compounds
CFR = Code of Federal Regulations
DQI = data quality indicator
ICB = initial calibration blank
ICV = initial calibration verification
LCS = laboratory control sample
MDL = method detection limit
MS/MSD = matrix spike/matrix spike duplicate
NELAP = National Environmental Laboratory Accreditation Program
PQL = practical quantitation limit (same as reporting limit)
QC = quality control
RF = response factor
RPD = relative percent difference
RSD = relative standard deviation
SOP = standard operating procedure
SPCC = system performance check compounds
SVOC = semi-volatile organic compound
TAL = target analyte list

TBD = to be determined
TCL = target compounds list
VOC = volatile organic compound

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table

Secondary Data	**Data Source** (originating organization, report title and date)	**Data Generator(s)** (originating organization, data types, data generation / collection dates)	**How Data Will Be Used**	**Limitations on Data Use**
Chemical and physical characterization of non-native sediments for location 01A through 106D.	**GEI Consultants** for KeySpan Corporation *Remedial Investigation (RI) Technical Report, April 2007*	**GEI Consultants** Sediment samples (279) were collected between 2005 and 2006 analyzed for the following chemical and physical parameters using methods indicated in parentheses: VOCs (EPA 8260B) SVOCs (EPA 8270C) TAL metals Cyanide (EPA 9012) PCBs (EPA 8082A) Pesticides (EPA 8081A) Herbicides (EPA 8151A) TOC (EPA 9060) Anions (sulfate, nitrate, nitrite) (EPA 300.0) bulk density (ASTM D2937) water content (ASTM D2216) grain size (ASTM 4464-00). A subset (104) of these samples were also analyzed for polycyclic aromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPH).	For Phase 2 RI/FS to assist in defining the nature and extent of sediment contamination in the Canal.	None
Geophysical survey	**GEI Consultants** for KeySpan Corporation *Remedial Investigation Technical Report, April 2007*	**Ocean Surveys Inc.** for GEI Consultants Side scans and magnetometer surveys of the Gowanus Canal were conducted between October and November 2005	For identifying obstructions in the Canal and areas of debris	All debris in the Canal may not have been accounted for by the surveys; Since the surveys were conducted, additional debris may have deposited in the Canal.

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table (continued)

Secondary Data	**Data Source** (originating organization, report title and date)	**Data Generator(s)** (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Sediment core logs	**GEI Consultants** for KeySpan Corporation *Remedial Investigation Technical Report, April 2007*	**GEI Consultants** Sediment coring logs describe information collected between December 2005 and January 2006 on sediment types and depths in the Gowanus Canal	For estimating thickness of soft sediment, depth between soft sediments and underlying native sediments, depth of vibracore refusal, and presence of non-aqueous phase liquid (NAPL) in sediments	Changes may have occurred in the thickness of soft sediment and distribution of NAPL may have changed since 2005-2006; Locations of new cores may not be exactly the same as the locations of previous cores
Canal Investigation, 2005 - 2006	**GEI Consultants**, *Gowanus Canal Investigation*, 2009	**GEI Consultants** Samples (100) of surficial sediments were collected and analyzed from October to November 2005. Sediment cores (103) were advanced and sediment samples (279) were collected and analyzed between December 2005 and January 2006. Borings (5) were advanced adjacent to the Canal and subsurface samples (10) were collected and analyzed in June 2006. Surface water samples (138), outfall discharge samples (56) and outfall sediment samples (10) were also collected and analyzed	For supplementing background information to enhance conceptual understanding	Changes may have occurred in the bathymetry and constituent distribution in the sediment column since the time of sampling

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table (continued)

Secondary Data	**Data Source** (originating organization, report title and date)	**Data Generator(s)** (originating organization, data types, data generation / collection dates)	**How Data Will Be Used**	**Limitations on Data Use**
Bathymetric survey	**CR Environmental, Inc.** for HDR *Bathymetric Survey Report, April 2010* EPA RI Report Appendix B, 2010	**CR Environmental, Inc.** for HDR Bathymetry survey was conducted in January 2010 and measurements of depth/ elevation, water column temperature, and conductivity were collected to generate map of seabed elevations and morphometry.	For tasks associated with Canal bottom reconnaissance and debris remove	Since the surveys were conducted, changes in bathymetry of the Canal may have occurred.

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table (continued)

Secondary Data	**Data Source** (originating organization, report title and date)	**Data Generator(s)** (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Field Documentation	**CH2M HILL** For EPA *Field Documentation, 2010* EPA RI Report Appendix D	**AquaSurvey, Inc. for CH2M HILL** Conducted a Sediment Investigation Survey in which sediment cores were collected during March and April 2010 from 88 previously sampled transect locations,21 new transect locations, 17 new non-transect locations, and 9 contingency sampling locations. Samples were analyzed for VOCs, SVOCs, pesticides, PCBs, total metals, mercury, cyanide, TOC, total sulfide, and grain size Elevation of sediment surface was additionally determined Samples for waste characterization were collected from 22 cores along with two composite samples of investigation derived waste. These were analyzed for toxicity characteristic leaching procedure (TCLP), reactivity, corrosively, and ignitibility Sediment core logs described additional information on sediment composition Surface sediment and water sampling forms, and soil boring logs provide additional information	For evaluating potential groundwater upwelling at Canal bottom and areas of potentially mobile NAPL	Changes may have occurred in the bathymetry and constituent distribution in the sediment column since the time of sampling

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table (continued)

Secondary Data	**Data Source** (originating organization, report title and date)	**Data Generator(s)** (originating organization, data types, data generation / collection dates)	**How Data Will Be Used**	**Limitations on Data Use**
Tidal survey	**CH2M HILL** For EPA *Evaluation of Results of Tidal Survey* EPA RI Report Appendix E, 2010	**CH2M HILL** Tidal survey was conducted at 6 stations in August 2010 to obtain measurements of tidal fluctuations, groundwater levels, and barometric pressure	For evaluating potential groundwater upwelling at Canal bottom and for staging site selection	None
Groundwater / surface water interaction	**CH2M HILL** For EPA *Evaluation of Groundwater / Surface Water Interaction* EPA RI Report Appendix F, 2010	**National Grid, New York City, and EPA** Groundwater samples from 14 shallow and intermediate monitoring wells and surface water samples from 8 adjacent stations were collected from June to July 2010. Samples were analyzed for metals and general water quality parameters	For evaluating potential groundwater upwelling at Canal bottom	None
Outfall survey	**CH2M HILL** For EPA *Survey of Outfall Features to the Gowanus Canal* EPA RI Report Appendix G, 2010	**CH2M HILL** Phase 1 and phase 2 surveys were conducted and information regarding outfall features and active discharges to the Gowanus Canal were collected. 12 features were sampled for additional information	For staging site selection and bulkhead assessment	Additional data may be needed to characterize discharge under different conditions and determine the origin of the outfalls

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Analytical data	**CH2M HILL** For EPA *Analytical Data* EPA RI Report Appendix I, 2010	**CH2M HILL** Data on concentrations of VOCs, SVOC, PCBs, pesticides, metals, cyanide, TOC, sulfide, TCLP, and physical characteristics such as grain size of soft and native sediments in the Gowanus Canal Data on similar measurements obtained for surface water and groundwater including geochemical measurements Data on similar measurements obtained for pipe outfalls, and combined sewer overflow sediments Data on concentrations of VOCs, SVOCs, PAHs, and PCBs in air samples Data on concentrations of VOCs, SVOC, PCBs, pesticides, metals, and cyanide in aquatic organisms in the Canal	For evaluating potential groundwater upwelling at Canal bottom and areas of potentially mobile NAPL	None

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table (continued)

Secondary Data	**Data Source** (originating organization, report title and date)	**Data Generator(s)** (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Ecological risk assessment	**CH2M HILL** For EPA *Ecological Risk Assessment* EPA RI Report Appendix K, 2010	**CH2M HILL** Concentrations of VOCs, SVOC, PCBs, pesticides, metals, and cyanide were measured in sediments and in crab and fish samples collected during the Phase 3 Investigation and used in Baseline Ecological Risk Assessment. Additionally, sediment samples were analyzed for acid volatile sulfide and simultaneously extractable metals		Changes may have occurred in the bathymetry and constituent distribution in the sediment column since the time of sampling
Human risk assessment	**CH2M HILL** For EPA *Human Health Risk Assessment* EPA RI Report Appendix L, 2010	**CH2M HILL** Surface sediment and water samples were collected between Jun and July 2010 and analyzed for constituents in TCL and TAL. Additional sediment samples were collected for PCB analysis Ambient air samples were collected in July 2010 and analyzed for VOCs, PAHs, and PCBs Fish and crab tissue samples were collected between June and July 2010	For evaluating potential groundwater upwelling at Canal bottom and areas of potentially mobile NAPL	Changes may have occurred in the bathymetry and constituent distribution in the sediment column since the time of sampling

QAPP Worksheet #13 – Secondary Data Criteria and Limitations Table (continued)

Secondary Data	**Data Source** (originating organization, report title and date)	**Data Generator(s)** (originating organization, data types, data generation / collection dates)	How Data Will Be Used	Limitations on Data Use
Bulk head study and side Scan Sonar	**HDR, Inc.** For EPA *Historic Preservation, December 2010* EPA RI Report Appendix M, 2010	**John Milner Associates, Inc.** for HDR, Inc. and EPA, December 2010 Information on types of bulkheads that line the Gowanus; information of bulkhead preservation and mitigation strategies. **Dolan Research, Inc.** for HDR, Inc. and EPA Side scan sonar data were collected and assessed for Site conditions, obstruction, anomalies, and potential submerged cultural resources	For bulkhead survey and assessment and debris reconnaissance	Data on bulkhead conditions below the water line were not collected; Areas of the Canal were not surveyed during debris reconnaissance
Sediment depth profiles	**CH2M HILL** For EPA *Sediment Core Depth Profiles* EPA RI Report Appendix N, 2010	**CH2M HILL** Depth profiles of totals PAHs, total PCBs, and lead in sediment cores	For evaluating potential areas of potentially mobile NAPL	Changes may have occurred in the bathymetry and constituent distribution in the sediment column since the time of sampling
Soil and groundwater analytical result summaries for properties along the Canal	**CH2M HILL** For EPA *Upland Investigation Summary* EPA RI Report Appendix O, 2010	**CH2M HILL** Soil and groundwater samples were collected from properties adjoining the Canal and analyzed for VOCs, SVOCs, pesticides, PCBs, and metals	For evaluating potential groundwater upwelling at Canal bottom and areas of potentially mobile NAPL	None

NAPL = non-aqueous phase liquid
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
RI = Remedial Investigation
SVOC = semi-volatile organic compound
TAL = Target Analyte List
TCL = Target Compound List
TCLP = toxicity characteristic leaching procedure
TOC = total organic carbon
TPH = total petroleum hydrocarbon
VOC = volatile organic compound

QAPP Worksheet #14 - Summary of Project Tasks

QAPP Worksheet #14a – PD-3: Additional Debris Reconnaissance

QAPP Worksheet #14b – PD-4: Development of Debris Removal and Management Plan

QAPP Worksheet #14c – PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation

QAPP Worksheet #14d – PD-6: Staging Site Selection and Implementation Plan

QAPP Worksheet #14e – PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates

QAPP Worksheet #14f – PD-8: Evaluation of NAPL Mobility in Native Sediments

PD-3: Additional Reconnaissance for Debris Removal

Sampling Tasks: High frequency side-scan sonar of the full length of the Canal. See Worksheet #18 for sample locations
Analytical Tasks: No analytical samples will be collected.
Quality Control (QC) Tasks: All applicable QC criteria for calibration of instrumentation will be followed per the manufacturer's instructions and/or relevant standard operating procedures (SOPs). QC activities will be documented in field forms and/or field log books.
Secondary Data: Previous data reports and spreadsheets. See Worksheet #13.
Data Management Tasks: Data are generated primarily though field activities. Data are entered into in electronic format in accordance with the project protocols. Data generated during field activities are recorded using a field log book and field forms. The Site Manager reviews these forms for completeness and accuracy. Pertinent data from the field forms are entered into the project database. Hard copy field records are stored in a secure project file. Hard copies of field forms and data are filed in a secure storage area. Project data will be archived for 15 years in an electronic format.
Documentation and Records: In association with field data collection, field personnel are required to document all pertinent data, including date, time, location (coordinates), field personnel, weather conditions, instrument identification, and any other factors that may affect data quality. Chain of custody procedures in Worksheet #27 are followed for all samples as applicable. All hard copy data (e.g., field note books; photos; hard copies of chain of custody forms; and other items) are housed at the Contractor offices and kept in the project files.
Assessment/Audit Tasks: Review of SOPs relating to field and project activities is required prior to project start.
Data Review Tasks: Peer and senior review of all documentation will occur prior to data interpretation and final reports. Senior and peer reviews are documented with the date and signature of the reviewer.

QAPP Worksheet #14 - Summary of Project Tasks (continued)

PD-4: Development of Debris Removal and Management Plan

Sampling Tasks: Not applicable.
Analytical Tasks: No analytical samples will be collected.
QC Tasks: Not applicable.
Secondary Data: Results of work done in PD-3, previous data reports, and spreadsheets. See Worksheet #13.
Data Management Tasks: Not applicable
Documentation and Records: Not applicable
Assessment/Audit Tasks: Not applicable
Data Review Tasks: Peer and senior review of all documentation will occur prior to issuance of the final plan. Senior and peer reviews are documented with the date and signature of the reviewer.

PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation

Sampling Tasks:

- Subsurface Investigation of Existing Bulkhead Foundations
- Geotechnical Site Investigation

See Worksheet #18 for sample locations

Analytical Tasks:

- Geotechnical borings with disturbed and undisturbed sample recovery, standard penetrometer test blow count measurements (ASTM D1586), and geotechnical visual soil classifications (ASTM D2487/D2488);
- CPT soundings (ASTM D5778) with shear wave testing performed at select locations (ASTM D7400);
- Crosshole seismic testing (ASTM 4428) at select locations;
- Downhole seismic testing (ASTM D7400) at select locations;
- Induction testing (adaptation of ASTM 5753 and ASTM 6726) at select locations;
- Low strain impact integrity testing (ASTM D5882) at select locations; and
- Geotechnical laboratory testing.
  - Moisture contents (ASTM D2216);
  - Atterberg Limits (ASTM D4318);
  - Unit weight (ASTM D7263);
  - Grain size distribution (ASTM D422);
  - Consolidated undrained triaxial shear testing (ASTM D4767); and
  - Undrained unconsolidated shear testing (ASTM D2850).

QC Tasks:

All testing will be performed according to the applicable methodology or SOP incorporating the QC measurements associated with the specific test. QC measurement results shall fall within the specified acceptance criteria.

Secondary Data:

Previous data reports and spreadsheets. See Worksheet #13.

Data Management Tasks:

Data are generated from two primary pathways: i) data derived from field activities; and ii) geotechnical laboratory data. Data are entered into in electronic format in accordance with the project protocols.

Data generated during field activities are recorded using a field log book and field forms. The Site Manager reviews these forms for completeness and accuracy. Pertinent data from the field forms are entered into the project database. Hard copy field records are stored in a secure project file.

Data generated during geotechnical analysis are recorded in hard copies, electronic reports in pdf format, and in electronic data deliverables (EDDs) after the samples have been analyzed.

Hard copies of field forms, data, and chain of custody forms are filed in a secure storage area. Laboratory data packages and reports are archived at Contractor offices for 15 years. Laboratories that generated the data archive data for a minimum of 5 years.

Documentation and Records: In association with sample collection, field personnel are required to document all pertinent data, including date, time, location (coordinates), field personnel, weather conditions, instrument identification, and any other factors that may affect data quality. Chain of custody procedures in Worksheet #27 are followed for all samples. All hardcopy data (e.g., field note books; photos; hard copies of chain of custody forms; and other items) are housed at the Contractor offices and kept in the project files.
Assessment/Audit Tasks: Review of SOPs relating to field, lab, data validation, and project activities is required prior to project start. Audit records and accreditations of the laboratories are maintained by the laboratory and available upon request.
Data Review Tasks: Peer and senior review of all documentation will occur prior to data interpretation and final reports. Senior and peer reviews are documented with the date and signature of the reviewer. All engineering reports will be reviewed and stamped by the engineer of record.

PD-6: Staging Site Selection and Implementation Plan

Sampling Tasks: No samples will be collected during this task.
Analytical Tasks: No analytical samples will be collected.
QC Tasks: Not applicable.
Secondary Data: Previous data reports and spreadsheets. See Worksheet #13.
Data Management Tasks: Not applicable
Documentation and Records: Not applicable
Assessment/Audit Tasks: Not applicable
Data Review Tasks: Peer and senior review of all documentation will occur prior to issuance of the final plan. Senior and peer reviews are documented with the date and signature of the reviewer.

PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates

Sampling Tasks:

- Implement selected Site characterization technologies to assess upwelling areas and groundwater discharge rates.

See Worksheet #18 for sample locations

Analytical Tasks:

No analytical samples are anticipated for collection during this task.

QC Tasks:

All measurements and QC will be performed in accordance with specific methodologies adapted for each technology.

Secondary Data:

Previous data reports and spreadsheets. See Worksheet #13.

Data Management Tasks:

Data are generated primarily though field activities. Data are entered into in electronic format in accordance with the project protocols. Electronic data collected by subcontractors or field personnel during technology implementation will be backed up to secure project directories as soon as possible.

Data generated during field activities are recorded using a field log book and field forms. The Site Manager reviews these forms for completeness and accuracy. Pertinent data from the field forms are entered into the project database. Hard copy field records are stored in a secure project file.

Hard copies of field forms and data are filed in a secure storage area. Project data will be archived for 15 years in an electronic format.

Documentation and Records:

In association with sample collection, field personnel are required to document all pertinent data, including date, time, location (coordinates), field personnel, weather conditions, instrument identification, and any other factors that may affect data quality. Chain of custody procedures in Worksheet #27 are followed for all samples. All hardcopy data (e.g., field note books; photos; hard copies of chain of custody forms; and other items) are housed at the Contractor offices and kept in the project files. Electronic files will be saved to a secure project directory.

Assessment/Audit Tasks:

Review of SOPs relating to field and project activities is required prior to project start.

Data Review Tasks:

Peer and senior review of all documentation will occur prior to data interpretation and final reports. Senior and peer reviews are documented with the date and signature of the reviewer.

PD-8: Evaluation of Non-Aqueous Phase Liquid (NAPL) Mobility in Native Sediments

Sampling Tasks:

- Implementation of field-based approaches to assess in situ NAPL distribution.
- Collection of undisturbed sediment cores for confirmatory laboratory analysis to assess the NAPL distribution in native sediments of the Canal.
- Collection of NAPL from native sediments.
- Collection of groundwater samples from native sediments.
- Laboratory mobility testing to assess mobility of NAPL within the sediments.

See Worksheet #18 for sample locations

Analytical Tasks:

- Sediment cores will be analyzed for the following:
  - NAPL pore fluid saturation at set vertical spacing, which will be collocated with field-based assessments;
  - Centrifuge and/or water flood of sediment samples to assess NAPL residual saturation and mobility potential;
  - Drainage capillary pressure data (i.e., water retention curves) to understand the soil matrix and to develop the parameters to understand pore entry pressures;
  - Potential photography of the core under white and ultraviolet light to provide an understanding of the vertical NAPL distribution and aid in defining vertical depths for further mobility assessment; and
  - Geotechnical parameters to confirm the field-based approach for soil/sediment texture observations.
- Collected NAPL and groundwater samples will be analyzed for density, viscosity, and interfacial tension. The collected NAPL will also be analyzed for contaminants as specified in Worksheet #15.
- Laboratory mobility testing (test specifics to be determined during desktop evaluation)

QC Tasks:

All applicable QC protocols will be performed according to the methodology and the SOPs. All specified QC criteria will be met and documented.

Secondary Data:

Previous data reports and spreadsheets. See Worksheet #13.

Data Management Tasks: Data are generated from three primary pathways: i) data derived from field activities; ii) laboratory analytical data; and iii) validated data. Data from all three pathways are entered into an electronic format in accordance with the project protocols. Data generated during field activities are recorded using a field log book and field forms. The Site Manager reviews these forms for completeness and accuracy. Pertinent data from the field forms are entered into the project database. Hard copy field records are stored in a secure project file. Data generated during laboratory analysis are recorded in hard copies, electronic reports in pdf format, and in EDDs after the samples have been analyzed. These data are then submitted for data validation. Data validation is performed in accordance with Worksheets #33, #34, #35, #36, and #37. Hard copies of field forms, data, and chain of custody forms are filed in a secure storage. Laboratory data packages and reports are archived at Contractor offices for 15 years. Laboratories that generated the data archive data for a minimum of 5 years.
Documentation and Records: In association with sample collection, field personnel are required to document all pertinent data, including date, time, location (coordinates), field personnel, weather conditions, instrument identification, and any other factors that may affect data quality. Chain of custody procedures in Worksheet #27 are followed for all samples. All hardcopy data (e.g., field note books; photos; hard copies of chain of custody forms; and other items) are housed at the Contractor offices and kept in the project files.
Assessment/Audit Tasks: Review of SOPs relating to field, lab, data validation, and project activities is required prior to project start. Audit records of the laboratories are maintained by the laboratory and available upon request.
Data Review Tasks: Peer and senior review of all documentation will occur prior to data interpretation and final reports. Senior and peer reviews are documented with the date and signature of the reviewer. Laboratory data will undergo data validation and verification.

EDD = electronic data deliverable
NAPL = non-aqueous phase liquid
QC = quality control
SOP = standard operating procedure

Laboratory: TBD
Matrix: Water
Analytical Group: TCL VOCs/8260
Concentration Level: Low

					Analytical Method[2]		Achievable Lab Limits	
Analyte	CAS Number	Marine Water Project Action Limit (µg/L)[1]	Fresh Water Project Action Limit (µg/L)[1]	Project Quantitation Limit (µg/L)	MDLs	Method QLs	MDLs (µg/L)	QLs (µg/L)
Benzene	71-43-2	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Bromobenzene	108-86-1	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Bromochloromethane	74-97-5	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Bromodichloromethane	75-27-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Bromoform	75-25-2	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Bromomethane	74-83-9	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
n-Butylbenzene	104-51-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
sec-Butylbenzene	135-98-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
tert-Butylbenzene	98-06-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Carbon tetrachloride	56-23-5	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Chlorobenzene	108-90-7	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Chlorodibromomethane	124-48-1	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Chloroethane	75-00-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Chloroform	67-66-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Chloromethane	74-87-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
2-Chlorotoluene	95-49-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
4-Chlorotoluene	106-43-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2-Dibromo-3-chloropropane	96-12-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2-Dibromoethane	106-93-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Dibromomethane	74-95-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2-Dichlorobenzene	95-50-1	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,3-Dichlorobenzene	541-73-1	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,4-Dichlorobenzene	106-46-7	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Dichlorodifluoromethane	75-71-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,1-Dichloroethane	75-34-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2-Dichloroethane	107-06-2	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,1-Dichloroethene	75-35-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
cis-1,2-Dichloroethene	156-59-2	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
trans-1,2-Dichloroethene	156-60-5	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2-Dichloropropane	78-87-5	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
2,2-Dichloropropane	594-20-7	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,3-Dichloropropane	142-28-9	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,1-Dichloropropene	563-58-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD

QAPP Worksheet #15 - Reference Limits and Evaluation Table (continued)

Laboratory: TBD
Matrix: Water
Analytical Group: TCL VOCs/8260
Concentration Level: Low

					Analytical Method[2]		Achievable Lab Limits	
Analyte	**CAS Number**	**Marine Water Project Action Limit (µg/L)[1]**	**Fresh Water Project Action Limit (µg/L)[1]**	**Project Quantitation Limit (µg/L)**	**MDLs**	**Method QLs**	**MDLs (µg/L)**	**QLs (µg/L)**
Ethylbenzene	100-41-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Hexachlorobutadiene	87-68-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Isopropylbenzene	98-82-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
p-Isopropyltoluene	99-87-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Methylene chloride	75-09-2	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Naphthalene	91-20-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
n-Propylbenzene	103-65-1	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Styrene	100-42-5	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,1,1,2-Tetrachloroethane	630-20-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,1,2,2-Tetrachloroethane	79-34-5	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Tetrachloroethene	127-18-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Toluene	108-88-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2,4-Trichlorobenzene	120-82-1	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2,3-Trichlorobenzene	87-61-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,1,1-Trichloroethane	71-55-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,1,2-Trichloroethane	79-00-5	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Trichloroethene	79-01-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Trichlorofluoromethane	75-69-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2,3-Trichloropropane	96-18-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,2,4-Trimethylbenzene	95-63-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
1,3,5-Trimethylbenzene	108-67-8	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Vinyl chloride	75-01-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
o-Xylene	95-47-6	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
m-Xylene	108-38-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
p-Xylene	106-42-3	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Methyl-t-butyl ether	163-40-44	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD
Dichlorofluoromethane	75-43-4	TBD	TBD	TBD	See EPA Method 8260B	See EPA Method 8260B	TBD	TBD

[1]These compounds will be analyzed according to the method, but results will not be compared to any reference standards at this time.
[2]Analytical method MDLs and QLs are those documents in published methods shown.

QAPP Worksheet #16 - Project Schedule Timeline Table

The Work Plans for pre-design work elements PD-3 through PD-8 are subject to review and approval by the EPA Region 2 Project Team. The drafts of these Work Plans are to be shared with the EPA Project Team for their input and concurrence prior to finalization. Implementation and completion of the PDWP activities will be performed under a Unilateral Administrative Order (UAO) by a group of potentially responsible parties (PRP Group) identified by the EPA. Coordination of work amongst responsible parties needs to be finalized before a workable schedule can be finalized.

	Anticipated Project Dates			
Activities	**Initiation**	**Completion**	**Deliverable**	**Deliverable Due Date**
Submission of Pre-Design Work Plan (PDWP)	N/A	N/A	PDWP	1/28/14
Submission of Remedial Design Work Plans (RDWP)	N/A	N/A	RDWP	2/27/14
Submission of QAPP and Field Sampling Plan (FSP)	N/A	N/A	QAPP	2/27/14
Submission of Health and Safety Plan (HASP)	N/A	N/A	RDWP	2/27/14
A work flow schedule for currently identified pre-design and remedial design activities is included in the Remedial Design Work Plan. Please refer to Geosyntec Consultants, February 2014. "Remedial Design Work Plan, Gowanus Canal, Brooklyn, New York."				

QAPP Worksheet #17 – Sampling Design and Rationale

The following worksheets describe the sampling program rationale and design. Specific sampling and collection details are provided in:

- Worksheet (WS)#15 – Reference Limits and Evaluation Table;
- WS#18 – Sampling Locations and Methods/SOP Requirements Table;
- WS#20 – Field Quality Control Sample Summary Table; and
- WS#21 – Project Sampling SOP Reference Table.

QAPP Worksheet #17a – PD-3: Additional Debris Reconnaissance - Sampling Design and Rationale

QAPP Worksheet #17b – PD-4: Development of Debris Removal and Management Plan - Sampling Design and Rationale

QAPP Worksheet #17c – PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation - Sampling Design and Rationale

QAPP Worksheet #17d – PD-6: Staging Site Selection and Implementation Plan – Sampling Design and Rationale

QAPP Worksheet #17e – PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates - Sampling Design and Rationale

QAPP Worksheet #17f – PD-8: Evaluation of NAPL Mobility in Native Sediments - Sampling Design and Rationale

QAPP Worksheet #17a - PD-3: Additional Debris Reconnaissance - Sampling Design and Rationale

Sampling Rationale
Visual observations and instrumentation readings per instrument protocol.
Sampling Design
The full length of the Canal will be examined per field instrumentation protocol.

QAPP Worksheet #17 – Sampling Design and Rationale (continued)

QAPP Worksheet #17b – PD-4: Development of Debris Removal and Management Plan - Sampling Design and Rationale

Sampling Rationale
Not Applicable
Sampling Design
Not Applicable

QAPP Worksheet #17c – PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation - Sampling Design and Rationale

Sampling Rationale

Subsurface Investigation of Existing Bulkhead Foundations

A Bulkhead Investigation will be performed to evaluate the depth and elevation of the bulkhead foundations along the length of Gowanus Canal (Canal). Prior to a Site-wide implementation of the Bulkhead Investigation, a methods development program will be performed to evaluate the feasibility and relative accuracy of investigation methods being considered for determining the location of the bottom of the bulkheads. Investigation methods being considered include: (i) downhole seismic testing; (ii) crosshole seismic testing; (iii) induction testing; and (iv) and low strain impact testing. These investigation methods are evaluated through tests at select locations where the depth to bottom of the bulkhead is known. Whichever methods are found to be most accurate in evaluating the depth to the bottom of the bulkhead foundations will be implemented Site-wide.

The selected investigation methods will be implemented at frequencies (discussed below) to allow for a comprehensive understanding of the typically implemented bulkhead construction practices along the Canal. Understanding previous design practices will allow for relatively accurate estimates of bulkhead foundation depths where access for bulkhead exploration is not possible.

Geotechnical Site Investigation

A Geotechnical Investigation will be performed to evaluate design soil properties and parameters and to develop subsurface stratigraphy along the length of the Canal. The selected locations and frequency of Geotechnical Investigation borings and Cone Penetrometer Testing (CPTs) will allow for the development of a subsurface geotechnical model to aid in evaluating existing wall conditions, analyzing temporary systems, and developing design of permanent wall systems. The selected investigation frequency will seek to capture variations in the geotechnical subsurface with enough redundancy so that borings can be shifted or eliminated if there are any unavoidable physical obstructions or access limitations.

Sampling Design

Subsurface Investigation of Existing Bulkhead Foundations

Sample locations for the Bulkhead Investigation will be attempted (i) wherever an upland geotechnical boring can be performed within 5 feet (ft) of the bulkhead edge allowing for either downhole seismic testing or induction testing; or (ii) wherever an investigation point can be accessed within 5 ft of the bulkhead edge from the Canal-side of the bulkhead, allowing for either downhole seismic testing, crosshole seismic testing, or induction testing. A Bulkhead Investigation will be performed as access allows at an approximate frequency of one investigation point per 100 ft of bulkhead length. The selected investigation methods for each bulkhead type will be based the results of the methods development program completed prior to this task. Where access is available and if the method is determined to be effective, low strain impact testing may be performed on select bulkheads if the method.

Bulkhead Investigation testing may be eliminated at some locations if research and review of as-builts and design reports of existing bulkheads become available.

Geotechnical Site Investigation

Sampling locations will be selected at approximately 100 ft intervals along the length of the bulkheads. Sampling locations will consist of two points oriented perpendicularly to the bulkhead under investigation with one sample collected approximately 10 ft laterally from the bulkhead and one sample collected approximately 50 ft laterally from the bulkhead:

- One “shallow” boring will be collected to a depth 10 ft deeper than the estimated bottom of the bulkhead based on the desktop study. These borings will be offset approximately 10 ft laterally

from the bulkhead so that they pass through fill material.
- One CPT sounding will be attempted to a target depth of 70 ft bgs except where “deep” borings will be performed. CPT locations will be offset approximately 50 ft laterally from the bulkhead in line with the “shallow” borings. If a CPT cannot be completed to the target depth, then the boring depth will be altered to match that of the nearby “shallow” sample. Shear wave testing will be performed at select CPT locations.
- One “deep” boring will be collected to a target depth of 70 ft. These borings will be collected in place of CPT samples approximately every 400 ft along the length of the bulkheads and will be offset approximately 50 ft laterally from the bulkhead.

The second investigation point is designed so that a soil profile perpendicular to the bulkhead can be generated for use in design. Note that upland borings close to the bulkhead will be referred to as “shallow” borings and borings further from the bulkhead will be referred to as “deep” borings.

Target depths for the “shallow” borings will be 10 ft below the assumed foundation of the bulkhead based on the desktop study. The target depth of the “deep” borings and CPTs will be 70 ft. This is designed such so as to encounter and identify the depth of target soil layers for developing anchor design. Target depths may be adjusted in the field based on observed conditions during the Investigation.

Sampling Locations

Target Geotechnical Investigation borings and CPTs locations will be laid out on a location map based on spacing rules discussed above and to account for any known obstructions or access limitations. However, it is expected that there will be physical impediments to reaching some of the selected locations. The Field Engineer retains the right to select the final test locations. If needed, upland investigation points may be moved up to 25 ft from the original target location while maintaining the intent and function of the investigation point. Investigation points on the Canal-side of the bulkhead will be limited to 5 ft while maintaining the intent and purpose of the investigation point. If an investigation point cannot be relocated within the stated limits, then it will be abandoned.

If a CPT encounters an obstruction prior to reaching the target depth, then one CPT reattempt (located within 3 to 5 ft of the original location) will be performed, if possible. If a reattempt is not possible or the reattempt encounters an obstruction prior to reaching target depth, then the CPT may be replaced with a boring (located within 5 ft of the original location) or abandoned, at the discretion of the Field Engineer. If a boring encounters early refusal, then the boring will be reattempted within 5 ft of the original location. If the second boring encounters early refusal, no additional exploration will be performed and the investigation location will be abandoned. Any recovered samples or data will be included in the geotechnical models.

Disturbed soil samples will be recovered and standard penetration test blow counts will be recorded on a regular basis. Undisturbed samples will be selected in the field based on observed soil conditions, and one undisturbed sample will be attempted per each cohesive soil strata encountered within the anticipated zone of influence at each upland boring location.

Geotechnical Investigation points may be eliminated if research and review of as-builts and design reports of existing bulkheads become available.

QAPP Worksheet #17 – Sampling Design and Rationale (continued)

QAPP Worksheet #17d – PD-6: Staging Site Selection and Implementation Plan – Sampling Design and Rationale

Sampling Rationale

Not Applicable

Sampling Design

Not Applicable

QAPP Worksheet #17e – PD-7: Evaluation of Groundwater Upwelling Areas and Measurements of Discharge Rates - Sampling Design and Rationale

Sampling Rationale

To collect a sufficient amount of data to adequately identify areas of groundwater upwelling and characterize groundwater discharge rates in representative areas within Gowanus Canal.

Sampling Design

Sampling design for collecting groundwater discharge rate data will be determined based upon the results from surveys that identify potential areas of groundwater upwelling and locations deemed feasible for implementing technologies capable of assessing groundwater discharge rates.

QAPP Worksheet #17 – Sampling Design and Rationale (continued)

QAPP Worksheet #17f – PD-8: Evaluation of Non-Aqueous Phase Liquid (NAPL) Mobility in Native Sediments - Sampling Design and Rationale

Sampling Rationale

Implementation of field-based approaches selected as appropriate from a desktop evaluation to assess in situ NAPL distribution

The field-based approaches will incorporate technologies selected from the desk-top evaluation to measure the presence of NAPL in situ. Specifically, sub-tasks anticipated to be performed are as follows:

1. Field-based approaches to assess NAPL distribution in native sediments in the Canal in concert with characterization of sediment texture and geotechnical parameters (e.g., CPT) at all locations;
2. Collection of undisturbed sediment cores for confirmatory laboratory analysis to assess the NAPL distribution in native sediments of the Canal from a sub-set of the sampling locations;
3. Collection of undisturbed sediment cores for performance of laboratory mobility testing from the areas of highest observed NAPL saturation based upon field methods; and
4. Collection of groundwater and NAPL samples from the native sediment.

NAPL characterization and laboratory mobility testing

The goal of the laboratory analysis of undisturbed sediment cores is to understand (i) the vertical seepage velocity, among other factors, that is necessary to cause upward migration of the NAPL within the native sediments, and (ii) the confining pressure needed to impede this migration if it exists. The scope of work for the laboratory mobility testing includes (i) characterization analyses of the collected sediment core, NAPL, and groundwater samples, and (ii) empirical assessment of potential vertical NAPL mobility.

Sampling Design

Results of the desktop evaluation will be used to focus the application of field-based approaches to locations which are anticipated to have the highest likelihood of vertical upward NAPL migration and/or the highest anticipated NAPL saturation. Within the focused areas, a series of smaller, initial target areas will be defined by the existing 3-D data distribution as initial areas of deployment to assess the efficacy of field-based approaches and laboratory analysis programs. Following the successful completion of the initial deployment, the approach will be expanded to the larger objective of delineating and/or defining the areas of migrating NAPL below the Canal for remedy implementation.

For the NAPL distribution assessment, the coring device will be advanced to capture the profile of observed TarGOST® readings above background, which is anticipated to be approximately 10 ft of material below the soft sediments/native sediments interface. The actual length of core collected will depend upon the TarGOST® readings and may be more or less than 10 ft. A subset of these collected cores will be used to assess the NAPL mobility using the material below the soft sediments/native sediments interface in the zone of highest observed TarGOST® response. If necessary, an additional undisturbed sediment core will be collected for the NAPL mobility assessment to minimize sample disturbance prior to testing.

Where possible, samples of NAPL and groundwater will be collected from the native sediments in the general vicinity of the sediment sampling area. Groundwater and NAPL samples will be collected by advancing a temporary well into the native sediments and allowing sufficient media to collect inside the screen prior to sampling. Methods for temporary well advancement and sampling will be specified in a forthcoming SOP.

CPT = cone penetrometer testing
ft = feet
NAPL = non-aqueous phase liquid
SOP = standard operating procedure
Worksheet = WS

QAPP Worksheet #18 – Sampling Locations and Methods/SOP Requirements Table

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group	Concentration Level	Number of Samples (identify field dups)	Sampling SOP Reference[1]	Rationale for Sampling Location
Laboratory NAPL Characterization Samples	Sediment	TBD	API RP40 (pore fluid sat., permeability product, permeability/conductivity), [Centrifuge], ASTM D6386, ASTM D5079, ASTM D4222, ASTM D4318	N/A	TBD	TBD	TBD
Laboratory NAPL Mobility Testing	Sediment	TBD	TBD	N/A	TBD	TBD	TBD
NAPL from Native Sediments	NAPL	TBD	Density (ASTM D1217), viscosity (ASTM D445), and interfacial tension (ASTM D971), TCL VOCs (8260B), TCL SVOCs (8270C), and TAL metals (6010C/6020A)	N/A	TBD	TBD	TBD
Groundwater from Native Sediments	Groundwater	TBD	Density (ASTM D1217), viscosity (ASTM D445), and interfacial tension (ASTM D971), TCL VOCs (8260B), TCL SVOCs (8270C), and TAL metals (6010C/6020A)	N/A	TBD	TBD	TBD
Bulkhead foundation investigation testing, typically performed from the Canal-side of the bulkhead, approximately 5 ft from the bulkhead edge (at select bulkheads TBD)	Bulkhead material	Investigation depth based on assumed bulkhead foundation depths plus 10 ft.	Divers, downhole seismic testing (ASTM D7400), crosshole testing (ASTM D4428), low strain impact integrity testing (ASTM D5882), Induction testing (ASTM D6726 and ASTM D5753)	N/A	One test per 100 ft of bulkhead. Number and exact spacing TBD in the field based on Site accessibility and encountered conditions.	SOP for divers TBD, ASTM D7400, ASTM D4428, ASTM D5882, adaptation of ASTM D6726 and ASTM D5753 TBD	Need to understand the depth of foundation for all bulkheads as all are constructed differently

QAPP Worksheet #18 – Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group	Concentration Level	Number of Samples (identify field dups)	Sampling SOP Reference[1]	Rationale for Sampling Location
Bulkhead foundation investigation borings, typically performed from the Canal-side of the bulkhead, approximately 5 ft from the bulkhead edge (at select bulkheads TBD)	Subsurface soils	Investigation depth based on assumed bulkhead foundation depths plus 10 ft.	UU triaxial (ASTM D2850), CU triaxial (ASTM D4767), moisture content (ASTM D2216), unit weight (ASTM D7263), Atterberg limit (ASTM D4318), grain size (ASTM D422), USCS classification (ASTM D2487)	N/A	One boring to be performed approximately per 100 ft of bulkhead. Number and exact spacing TBD in the field based on Site accessibility and encountered conditions. Soils samples selected for testing TBD by the Engineer after boring completion.	ASTM D2850, ASTM D4767, ASTM D2216, ASTM D7263, ASTM D4318, ASTM D422, ASTM D2487	Bulkhead foundation investigation borings needed as part of the borehole preparation for the bulkhead foundation investigation testing
Bulkhead foundation investigation CPTs, typically performed from the Canal-side of the bulkhead, approximately 5 ft from the bulkhead edge (at select bulkheads TBD)	Subsurface soils	Investigation depth based on assumed bulkhead foundation depths plus 10 ft.	CPT sounding (ASTM D5778)	N/A	One CPT to be performed approximately per 100 ft of bulkhead. Number and exact spacing TBD in the field based on Site accessibility and encountered conditions.	ASTM D5778	Bulkhead foundation investigation CPT needed as part of the bulkhead foundation investigation testing
Geotechnical investigation “shallow” borings performed upland of bulkheads, approximately 10 ft from bulkhead edge (attempted at all bulkheads)	Subsurface soils	Investigation depth based on assumed bulkhead foundation depths plus 10 ft.	UU triaxial (ASTM D2850), CU triaxial (ASTM D4767), moisture content (ASTM D2216), unit weight (ASTM D7263), Atterberg limit (ASTM D4318), grain size (ASTM D422), USCS classification (ASTM D2487)	N/A	One boring to be performed approximately per 100 ft of bulkhead. Number and exact spacing TBD in the field based on Site accessibility and encountered conditions. Soils samples selected for testing TBD by the Engineer after boring completion.	ASTM D2850, ASTM D4767, ASTM D2216, ASTM D7263, ASTM D4318, ASTM D422, ASTM D2487	“Shallow” borings needed as part of the bulkhead foundation investigation, to determine the bottom of fill materials, and to characterize soils behind the bulkheads

QAPP Worksheet #18 – Sampling Locations and Methods/SOP Requirements Table (continued)

Sampling Location/ID Number	Matrix	Depth (units)	Analytical Group	Concentration Level	Number of Samples (identify field dups)	Sampling SOP Reference[1]	Rationale for Sampling Location
Geotechnical investigation "deep" borings performed upland of bulkheads, approximately 50 ft from bulkhead edge (at select bulkheads TBD)	Subsurface soils	70 ft investigation depth.	UU triaxial (ASTM D2850), CU triaxial (ASTM D4767), moisture content (ASTM D2216), unit weight (ASTM D7263), Atterberg limit (ASTM D4318), grain size (ASTM D422), USCS classification (ASTM D2487)	N/A	One boring to be performed approximately per 400 ft of bulkhead. Number and exact spacing TBD in the field based on Site accessibility and encountered conditions. Soils samples selected for testing TBD by the Engineer after boring completion.	ASTM D2850, ASTM D4767, ASTM D2216, ASTM D7263, ASTM D4318, ASTM D422, ASTM D2487	CPTs needed for bulkhead replacement/repair design
Geotechnical investigation CPTs performed upland of bulkheads, approximately 50 ft from bulkhead edge (at select bulkheads TBD)	Subsurface soils	70 ft investigation depth.	CPT sounding (ASTM D5778)	N/A	One CPT to be performed approximately per 100 ft of bulkhead. Number and exact spacing TBD in the field based on Site accessibility and encountered conditions.	ASTM D5778	Bulkhead foundation investigation CPT needed as part of the bulkhead foundation investigation testing

CPT = cone penetrometer test
CU = consolidated undrained
ft = feet
N/A = not applicable
NAPL = non-aqueous phase liquid
SOP = standard operating procedure
SVOC = semi-volatile organic compound
TAL = Target Analyte List
TBD = to be determined
TCL = Target Compounds List
USCS = United Soil Classification System
UU = unconsolidated undrained
VOC = volatile organic compound

[1]Specify the appropriate letter or number from the Project Sampling SOP References table (WS#21).

QAPP Worksheet #19 – Analytical SOP Requirements Table

Analytical SOP Requirements listed below apply only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Matrix	Analytical Group	Analytical and Preparation Method (1)	Sample Volume/Mass per Analysis	Containers (number, size, and type)	Preservation Requirements (chemical, Temperature, light protected) (2)	Maximum Holding Time (preparation/ analysis)
Water	TCL VOCs	EPA SW846 8260B/8260C	40 mLs	(3) 40-mL VOA glass vials(with Teflon lined septum)	Cool to $\leq 6^oC$, pH <2, HCL, No headspace	14 days
Water	TCL SVOCs	EPA SW846 8270C	1 liter	(2) 1 L amber glass	Cool to $\leq 6^oC$	7 days to extraction; 40 days to analysis
Water	TAL Metals	EPA SW846 6010C/6020A	50 mLs	250 mL polyethylene	Cool to $\leq 6^oC$, pH <2 HNO3	6 months
Water	Mercury	EPA SW846 7470A	50 mls	250 mL polyethylene	Cool to $\leq 6^oC$, pH <2 HNO3	28 days

HCl = hydrochloric acid
HNO_3 = nitric acid
mL = milliliter
SVOC = semi-volatile organic compound
TAL = Target Analyte List
TCL = Target Compounds List
VOA = Volatile Organic Analysis
VOC = volatile organic compound

(1) Analytical and preparation method SOP references provided in Worksheet #23.
(2) The sample containers used for each chemical parameter must be certified as clean or decontaminated by the laboratory. All coolers must contain a temperature blank to verify that temperature preservation requirements are being met.

QAPP Worksheet #20 – Field Quality Control Sample Summary Table

Field Quality Control Samples listed below apply only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Matrix	Analytical Group	Conc. Level	Analytical and Preparation SOP Reference[1]	No. of Sampling Locations[2]	No. of Field Duplicate Pairs	No. of MS/MSD	No. of Field Blanks	No. of Equip. Blanks	No. of Trip Blanks	Total No. of Samples to Lab
Water	TCL VOCs	low	TBD	TBD	1 per 10 samples.	1 pair per 20 samples	TBD	TBD	1 per cooler	TBD
Water	TCL SVOCs	low	TBD	TBD	1 per 10 samples.	1 pair per 20 samples.	TBD	TBD	N/A	TBD
Water	TAL Metals	low	TBD	TBD	1 per 10 samples.	1 pair per 20 samples	TBD	TBD	N/A	TBD
Water	Mercury	low	TBD	TBD	1 per 10 samples.	1 pair per 20 samples	TBD	TBD	N/A	TBD

MS/MSD = matrix spike/matrix spike duplicate
N/A = not applicable
QC = quality control
SOP = standard operating procedure
SVOCs = semi-volatile organic compounds
TAL = Target Analyte List
TBD = to be determined
TCL = Target Compounds List
VOCs = volatile organic compounds

[1]Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

[2]If samples will be collected at different depths at the same location, count each discrete sampling depth as a separate sampling location or station.

QAPP Worksheet #21 – Project Sampling SOP References Table

Reference Number	Title, Revision Date and / or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments
TBD	Monitoring Well Construction and Development	TBD	Refer to SOP	N	N/A
TBD	Collection of Groundwater Samples	TBD	Refer to SOP	N	N/A
TBD	Operation of Multiparameter Water Sonde	TBD	Refer to SOP	N	N/A
TBD	Manual Collection of Surface Water Samples	TBD	Refer to SOP	N	N/A
TBD	Sediment Sampling	TBD	Refer to SOP	N	N/A
TBD	Recording Station Location Position with a GPS	TBD	Refer to SOP	N	N/A
TBD	Decontamination Procedure for Sampling Equipment	TBD	Refer to SOP	N	N/A
TBD	Field Documentation, Sample Designation, Custody and Handling Procedures	TBD	Refer to SOP	N	N/A
TBD	Procedure to Prepare Samples for Shipment	TBD	Refer to SOP	N	N/A
TBD	Management and Disposal of Investigation Derived Waste	TBD	Refer to SOP	N	N/A
TBD	Air Monitoring	TBD	Refer to SOP	N	N/A
TBD	Procedure to Conduct a Technical System Field Audit	TBD	Refer to SOP	N	N/A
TBD	All other applicable field SOPs	TBD	Refer to SOP	N	N/A

N/A = not applicable
SOP = standard operating procedure
TBD = to be determined

QAPP Worksheet #22 – Field Equipment Calibration, Maintenance, Testing, and Inspection Table

THERMOMETER
Parameters: Thermometers will be used to measure temperatures inside sample storage refrigerators and freezers. Thermometers will measure temperature in degrees Celsius (ºC). The thermometer will be used to ensure environmental samples are held at ≤6 ºC (refrigerators) or below 0 ºC (freezers).
Calibration: Thermometers used for the BCSA RI/FS will be certified calibrated from the manufacturer. Refrigerator thermometers will be capable of measuring temperatures to the nearest 1 ºC for a minimum range of negative 2 to 10 ºC. Freezer thermometers will be capable of measuring temperatures to the nearest 1 ºC for a minimum range of negative 25 to negative 5 ºC. Thermometers must be rated for continuous operation at temperatures of less than 0 ºC.
Maintenance: All maintenance activities should be appropriately documented in a logbook that is dedicated to maintenance for this instrument type (i.e., multiple instruments of the same type can be logged in one logbook).
Testing: Accuracy of thermometers may be tested using a second certified calibrated thermometer to verify temperature readings. Testing results should be recorded as appropriate.
Inspection: Thermometers should be inspected for signs of damage.
Frequency: Thermometers should be inspected prior to storage of environmental samples in field office refrigerators or freezers. Maintenance and inspection results should be recorded and stored in the field office.
Acceptance: During testing, certified thermometers should display readings within 1 ºC of each other. Refrigerators should be maintained at temperatures of ≤6 ºC. Freezers should be maintained at temperatures below 0 ºC.
Corrective Action: If thermometers do not meet acceptance criteria they should be replaced.
Responsible Person: Field Team Leader
SOP Reference: NA

QAPP Worksheet #22 – Field Equipment Calibration, Maintenance, Testing, and Inspection Table (continued)

REFRIGERATORS/FREEZERS
Application: Refrigerators/freezers are used for temporary storage of project environmental samples. Food and beverages will not be stored in refrigerators/freezers where environmental samples are stored.
Maintenance: Sample storage refrigerators will be maintained in a clean condition. The temperature of the refrigerator will be adjusted to 4 ºC and the temperature of freezers will be less than 0 ºC.
Acceptance: During testing, refrigerators should be ≤6 ºC and freezers should be less than 0 ºC, as monitored by a certified thermometer. Monitoring is performed daily when samples are being stored.
Corrective Action: Refrigerators will be cleaned prior to storage of environmental samples.
Responsible Person: Field Team Leader
SOP Reference: NA

SIDE SCAN SONAR INSTRUMENTATION
Application: Instrumentation will be used to identify debris in the Canal. Specific instrumentation has not yet been selected.
Maintenance: TBD
Acceptance: TBD
Corrective Action: TBD
Responsible Person: TBD
SOP Reference: TBD

GROUNDWATER UPWELLING INSTRUMENTATION
Application: Instrumentation will be used to identify location of groundwater upwelling and to quantify discharge rates. Specific instrumentation has not yet been selected.
Maintenance: TBD
Acceptance: TBD
Corrective Action: TBD
Responsible Person: TBD
SOP Reference: TBD

FILED BASED NAPL DISTRIBUTION ASSESSMENT INSTRUMENTATION
Application: TarGOST ® or similar instrumentation will be used to assess NAPL distribution in the field. Specific technology will be selected during the desktop study.
Maintenance: TBD
Acceptance: TBD
Corrective Action: TBD
Responsible Person: TBD
SOP Reference: TBD

ºC = degrees Celsius
NAPL = non-aqueous phase liquid
TBD = to be determined

QAPP Worksheet #23 – Analytical SOP References Table

Analytical SOP References listed below apply only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Reference Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? (Y/N)
TBD	TBD	Definitive	TCL VOCs/water	GC/MS	TBD	N
TBD	TBD	Definitive	TCL SVOCs/water	GC/MS	TBD	N
TBD	TBD	Definitive	TAL Metals/water	ICP/MS	TBD	N
TBD	TBD	Definitive	TAL Metals/water	ICP	TBD	N
TBD	TBD	Definitive	Mercury/water	CVAA	TBD	N

CVAA = cold vapor atomic absorption
GC/MS = gas chromatography–mass spectrometry
ICP/MS = inductively coupled plasma mass spectrometry
SOP = standard operating procedure
SVOC = semi-volatile organic compound
TBD = to be determined
TAL = Target Analyte List
TCL = Target Compounds List
VOC = volatile organic compound

QAPP Worksheet #24 – Analytical Instrument Calibration Table

Analytical instrumentation calibration information listed below apply only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
ICP	TBD	TBD	TBD	TBD	Lab Manager / Analyst	TBD
ICP/MS	TBD	TBD	TBD	TBD	Lab Manager / Analyst	TBD
GC/MS	TBD	TBD	TBD	TBD	Lab Manager / Analyst	TBD
CVAA	TBD	TBD	TBD	TBD	Lab Manager / Analyst	TBD

CA = corrective action
CVAA = cold vapor atomic absorption
GC/MS = gas chromatography mass spectrometry
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma mass spectrometry
SOP = standard operating procedure
TBD = to be determined

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Analytical instrument and equipment maintenance, testing, and inspection information listed below applies only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS	• Clean sources, maintain vacuum pumps	Tuning	Instrument performance and sensitivity	Service vacuum pumps twice per year, other maintenance as needed	Tune and CCV pass criteria	Recalibrate instrument	Laboratory Chemist	TBD
GC/MS	• Change septum, clean injection port, change or clip column, install new liner, change trap	Sensitivity check	Instrument performance and sensitivity	Daily or as needed	Tune and CCV pass criteria	Re-inspect injector port, cut additional column, reanalyze CCV, recalibrate instrument	Laboratory Chemist	TBD
ICP	• Increase rinse time • Clean or replace tip • Clean or replace torch • Clean or replace sample tubing • Clean or replace nebulizer • Clean or replace mixing chamber	Normal analysis	High blanks are noticed	As needed	Acceptable Calibration Check	Clean and replace parts	Laboratory Chemist	TBD

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
ICP	• RF not cooling properly • Replace torch (Crack) • Clean or replace nebulizer (blockage) • Check room temperature (changing) • Replace pump tubing • Room humidity too high • Clean torch tip (salt buildup) • Check for argon leaks • Adjust sample carrier gas • Replace PA tube	Initial and continuing calibration	Instrument Drift is noted	As needed	Acceptable Calibration Check	Clean and/or replace parts	Laboratory Chemist	TBD
ICP	• Check for argon leaks • Adjust sample carrier gas • Replace tubing (clogged) • Check drainage(back pressure changing) • Increase uptake time (too short) • Increase flush time (too short) • Clean nebulizer, torch or spray chamber • Increase sample volume introduced • Check that autosampler tubes are full • Sample or dilution of sample not mixed • Increase integration time (too short) • Realign torch • Reduce amount of tubing	Normal analysis	Erratic Readings, Flickering Torch or High RSD	As needed	Acceptable Calibration Check	Clean and/or replace parts	Laboratory Chemist	TBD

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
	connectors							
ICP/MS	• Increase rinse time • Clean or replace tip • Clean or replace torch • Clean or replace sample tubing • Clean or replace nebulizer • Clean or replace mixing chamber	Normal analysis	High blanks are noticed	As needed	Acceptable Calibration Check	Clean and replace parts	Laboratory Chemist	TBD
ICP/MS	• RF not cooling properly • Replace torch (Crack) • Clean or replace nebulizer (blockage) • Check room temperature (changing) • Replace pump tubing • Room humidity too high • Clean torch tip (salt buildup) • Check for argon leaks • Adjust sample carrier gas • Replace PA tube	Initial and continuing calibration	Instrument Drift is noted	As needed	Acceptable Calibration Check	Clean and/or replace parts	Laboratory Chemist	TBD

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
ICP/MS	• Check for argon leaks • Adjust sample carrier gas • Replace tubing (clogged) • Check drainage(back pressure changing) • Increase uptake time (too short) • Increase flush time (too short) • Clean nebulizer, torch or spray chamber • Increase sample volume introduced • Check that autosampler tubes are full • Sample or dilution of sample not mixed • Increase integration time (too short) • Realign torch • Reduce amount of tubing connectors	Normal analysis	Erratic Readings, Flickering Torch or High RSD	As needed	None	Clean and/or replace parts	Laboratory Chemist	TBD
ICP/MS	• Remove and Clean Cones	Normal analysis	Erratic Readings, Flickering Torch or High RSD	As needed	Acceptable Calibration Check	Clean and/or replace parts	Laboratory Chemist	TBD

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table (continued)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
CVAA	• Check burn head	Calibration and calibration checks	Erratic readings	Daily	Calibration check standards pass	Clean or replace	Laboratory Chemist	TBD
CVAA	• Check Nebulizer	Calibration and calibration checks	Erratic readings	Weekly	Calibration check standards pass	Clean or replace	Laboratory Chemist	TBD
CVAA	• Check for leaks	Calibration and continuing calibration checks	Erratic readings	As needed	Calibration check standards pass	Replace Tygon Tubing	Laboratory Chemist	TBD

CCV = continuing calibration verification
CVAA = cold vapor atomic absorption
GC/MS = gas chromatography mass spectrometry
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma mass spectrometry
RF = response factor
RSD = relative standard deviation
SOP = standard operating procedure
TBD = to be determined

QAPP Worksheet #26 – Sample Handling System

Sample Collection, Packaging, and Shipment
Sample Collection (Personnel/Organization): Field Team Leader, TBD
Sample Packaging (Personnel/Organization): Field Team Leader, TBD
Coordination of Shipment (Personnel/Organization): Field Team Leader, TBD
Type of Shipment/Carrier: Courier and overnight shipping: Commercial Courier
Sample Receipt and Analysis
Sample Receipt (Personnel/Organization): Sample Receiving Personnel, Laboratory TBD
Sample Custody and Storage (Personnel/Organization): Sample Receiving Personnel, Laboratory TBD
Sample Preparation (Personnel/Organization): Sample Receiving Personnel, Laboratory TBD
Sample Determinative Analysis (Personnel/Organization): Sample Receiving Personnel, Laboratory TBD
Sample Archiving
Sample Extract/Digestate Storage (Number of days from extraction/digestion): Sample extracts (as applicable) will be stored in the lab for 30 days unless notified by the client to archive for a longer period of time
Biological Sample Storage (No. of days from sample collection): TBD as applicable
Sample Disposal
Personnel/Organization: Sample Receiving Personnel, Sample Receiving Personnel, Laboratory TBD
Number of Days from Analysis: Field Samples are stored for 30 days after submittal of the completed data package.

TBD = to be determined

QAPP Worksheet #27 – Sample Custody Requirements Table

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):

The following procedures will be implemented when samples collected during this project are shipped:

- Confirm that sample labels are securely affixed to sample containers.
- Check the caps on the sample containers to confirm that they are properly sealed.

Complete the chain of custody form with the required sampling information and confirm that the recorded information matches the sample labels. The appropriate personnel will sign and date the chain of custody form to document the sample custody transfer.

- Wrap sample containers in bubble wrap or other cushioning material.
- Place cushioning material at the bottom of the cooler.
- Place the sealed sample containers and a temperature blank in the cooler.
- Place a sufficient amount of wet ice in the cooler to maintain a sample temperature of $\leq$6°C.
- Fill the remaining space in the cooler with cushioning material.
- Place chain of custody forms in plastic bags and seal. Tape the forms to the inside of the appropriate cooler lid.
- Close the cooler lid and secure with tape.
- Wrap tape around both ends of the cooler and attach Custody Seals to cooler and cover with clear protective tape.

Mark the cooler on the outside with the following information: shipping address, return address, “Fragile” labels, and arrows indicating “this side up.” Place a signed custody seal over the cooler lid.

The coolers will be delivered to the laboratory (to be determined). Coolers will be marked to indicate refrigeration is needed and placed in a cooler at the cargo facility if held overnight before receipt from the project laboratory. Multiple coolers may be sent in one shipment to the laboratory.

Laboratory Sample Custody Procedures (receipt of samples, archiving, and disposal):

Laboratory chain of custody begins when samples are received and continues until samples are discarded. The laboratory should designate a specific individual as the sample custodian. The custodian will receive all incoming samples, sign the accompanying custody forms, and retain copies of the forms as permanent records. The laboratory sample custodian will record all pertinent information concerning the samples, including the persons delivering the samples, the date and time received, sample condition at the time of receipt (sealed, unsealed, or broken container; temperature; or other relevant remarks), the sample identification numbers, and any unique laboratory identification numbers for the samples. This information should be entered into a computerized laboratory information management system (LIMS). When the sample transfer process is complete, the custodian is responsible for maintaining internal logbooks, tracking reports, and other records necessary to maintain custody throughout sample preparation and analysis.

The laboratory will provide a secure storage area for all samples. Access to this area will be restricted to authorized personnel. The custodian will confirm that samples requiring special handling, including samples that are heat- or light-sensitive, radioactive, or have other unusual physical characteristics, will be properly stored and maintained prior to analysis. Laboratory standard operating procedures for sample custody, tracking, archiving and disposal are located at the laboratory and the Consultant project office and will be available upon request.

Sample Identification Procedures:

A unique sample identification number will be assigned to each sample collected during this project. The sample numbering system allows each sample to be uniquely identified and provides a means of tracking the sample from collection through analysis. A distinction is made between the actual physical location of sampling (point identification) and the various methods of collecting the sample.

Below is an example of a unique numbering scheme that consists of a combination of Site and sampling activity information, as follows:

Sample Location Identifier

- Type of sample, to be determined during task development
    - e.g. WWC to indicate waterway core

Sample location at each Site

- Four digit sample location code (e.g. 1000)

Depth Interval (if applicable)

- Depth below ground surface (centimeters [cm])
    - Shallow interval listed first (dash) deep interval listed second
    - e.g. 2-4 would indicate 2cm below ground surface to 4 cm below ground surface.

Sample Matrix

- WS – Surface Water
- WP – porewater
- WG – Groundwater
- LN - NAPL
- SE – Sediment
- SO – Soil
- TA – biota – will also require a species designation (e.g., TA-Crab-…)
- AA – air monitoring
- IDW – investigation derived waste
- Note that sample matrix codes are compliant with the EPA Region 2 Electronic Data Deliverables (EDD) Valid Values list

Sampling Event (Date as YYMMDD)

- August 15, 2014 would be: 140815

An example of identification of a sample collected from ….:

- WWC-1000-2-4-SD-140815

Sample Labels

A sample label will be affixed to all sample containers appropriate for the Site and sample location. The label will be completed with the following information:

- Project name;
- Sample identification number;
- Date and time of sample collection;
- Sample matrix (e.g., sediment, soil);
- Preservative used (if applicable);
- Sample collector's initials; and
- Analysis required.

Sample Documentation

Documentation during sampling is essential to confirm proper sample identification. Field personnel will adhere to the following general guidelines for maintaining field documentation:

- Documentation will be completed in permanent ink.
- All entries will be legible.
- Errors will be corrected by crossing out with a single line and then dating and initialing the lineout.
- Any serialized documents will be maintained in the project file and referenced in the Site logbook.
- Unused portions of pages will be crossed out, and each page will be signed and dated.

Chain-of-Custody Procedures:

Field sample personnel will use standard sample custody procedures to maintain and document sample integrity during collection, transportation, storage, and analysis. A sample will be considered to be in custody if one of the following statements applies.

- It is in a person's physical possession or view.
- It is in a secure area with restricted access.
- It is placed in a container and secured with an official seal so that the sample cannot be reached without breaking the seal.

Chain of custody procedures provide an accurate written record that traces the possession of individual samples from the time of collection in the field to the time of acceptance at the laboratory. The chain of custody record will also be used to document all samples collected and the analyses requested. Information that the field personnel will record on the chain of custody record includes:

- Project name and number;
- Sampling location;
- Name and signature of sampler;
- Destination of samples (laboratory name);
- Sample identification number;
- Date and time of collection;
- Number and type of containers filled;
- Analysis requested;
- Preservatives used (if applicable);
- Filtering (if applicable);
- Sample designation (grab or composite);
- Signatures of individuals involved in custody transfer, including the date and time of transfer; and
- Project contact and phone number.

Field personnel will sign chain of custody records that are initiated in the field, and the air bill number will be recorded. The record will be placed in a waterproof plastic bag and taped to the inside of the shipping container used to transport the samples. Signed air bills will serve as evidence of custody transfer between field personnel and the courier, and between the courier and the laboratory. Copies of the chain of custody record and the air bill will be retained and filed by field personnel before the containers are shipped.

QAPP Worksheet #28 – QC Samples Table

QC Samples listed below apply only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Matrix	Water
Analytical Group	**TCL VOCs**
Concentration Level	Low
Sampling SOP	See worksheet 21
Analytical Method / SOP Reference	SW8260B SOP-TBD
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
Number of Sample Locations	See WS#18

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
Method blank	1 per batch of 20 or fewer samples	< ½ RL. If the analyte is a common laboratory contaminant (i.e., methylene chloride, acetone, 2-butanone, ethyl ether, acetonitrile and hexane), the data may be reported with qualifiers if the concentration of the analyte is less than the RL.	If the analyte is a common laboratory contaminant, the data may be reported with qualifiers if the concentration of the analyte is less than the RL. Such action must be taken in consultation with the client. Reanalysis of samples associated with an unacceptable method blank is required when reportable concentrations are determined in the associated samples. If there is no target analyte greater than the ½ the RL in the samples associated with an unacceptable method blank, the data may be reported with qualifiers. Such action should be done in consultation with the client. If surrogate recoveries in the blank are not acceptable, the data must be evaluated to determine if the method blank has served the purpose of demonstrating that the analysis is free of contamination. If surrogate recoveries are low and there are reportable analytes in the associated	Analyst	Sensitivity	< ½ RL. If the analyte is a common laboratory contaminant (i.e., methylene chloride, acetone, 2-butanone, ethyl ether, acetonitrile and hexane), the data may be reported with qualifiers if the concentration of the analyte is less than the RL.

Matrix	Water
Analytical Group	**TCL VOCs**
Concentration Level	Low
Sampling SOP	See worksheet 21
Analytical Method / SOP Reference	SW8260B SOP-TBD
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
Number of Sample Locations	See WS#18

QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
			samples, re-extraction of the blank and affected samples will normally be required. Consultation with the client should take place. If reanalysis of the batch is not possible due to limited sample volume or other constraints, the method blank is reported, all affected analytes in the associated samples are flagged with a "B," and appropriate comments may be made in a narrative to provide further documentation.			
Laboratory Control Sample /Laboratory Control Sample Duplicate (LCS/LCSD)	1 LCS per batch of 20 or fewer samples. Analyze an LCSD if an MS/MSD is not analyzed	%R and RPD within laboratory control limits	If any analyte or surrogate is outside established control limits, the system is out of control and corrective action must occur. Corrective action will normally be re-preparation and reanalysis of the batch. If the batch is not re-extracted and reanalyzed, the reasons for accepting the batch must be clearly presented in the project records (via NCMs and the case narrative) and in the final report. Examples of acceptable reasons for not reanalyzing might be that the MS and MSD are acceptable, and sample surrogate	Analyst	Accuracy & Precision	%R and RPD within laboratory control limits

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**TCL VOCs**
Concentration Level	Low
Sampling SOP	See worksheet 21
Analytical Method / SOP Reference	SW8260B SOP-TBD
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
Number of Sample Locations	See WS#18

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
			recoveries are good, demonstrating that the problem was confined to the LCS. This type of justification should be reviewed and documented with the client before reporting. If re-extraction and reanalysis of the batch is not possible due to limited sample volume or other constraints, the LCS is reported, all associated samples are flagged, and appropriate comments are made in a report narrative.			
MS/MSD	1 pair batch of 20 or fewer samples	%R and RPD within laboratory control limits	The initial corrective action will be to check the recovery of that analyte in the LCS. Generally, if the recovery of the analyte in the LCS is within limits, then the laboratory operation is in control and analysis may proceed. The reasons for accepting the batch must be documented. If the recovery for any component is outside QC limits for both the MS/MSD and the LCS, the analysis is out of control and corrective action must be taken. Corrective action will normally include reanalysis of the batch, except in cases	Analyst	Accuracy & Precision	%R and RPD within laboratory control limits

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**TCL VOCs**
Concentration Level	Low
Sampling SOP	See worksheet 21
Analytical Method / SOP Reference	SW8260B SOP-TBD
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
Number of Sample Locations	See WS#18

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
			where a high bias is indicated and no target is detected above the RL in any associated sample. If an MS/MSD is not possible due to limited sample, then a LCSD should be analyzed. The RPD between the LCS and LCSD are compared to the established acceptance limit.			
Surrogates		Within laboratory historical limits	Check all calculations for error, ensure that instrument performance is acceptable, recalculate the data and/or reanalyze if either of the above checks reveal a problem, re-prepare and reanalyze the sample or flag the data as "Estimated Concentration" if neither of the above resolves the problem. The decision to reanalyze or flag the data should be made in consultation with the client. It is necessary to re-prepare/ reanalyze a sample only once to demonstrate that poor surrogate recovery is due to matrix effect, unless the analyst believes that the repeated out of control results are not due to matrix effect. If the surrogates are out of control for the sample, MS/MSD,	Analyst	Accuracy	Within laboratory historical limits

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**TCL VOCs**
Concentration Level	Low
Sampling SOP	See worksheet 21
Analytical Method / SOP Reference	SW8260B SOP-TBD
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
Number of Sample Locations	See WS#18

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
			then matrix effect has been demonstrated for that sample and re-preparation/reanalysis is not necessary. If the sample is out of control and the MS and/or MSD is in control, then reanalysis or flagging of the data is required. Re-analysis is not necessary if obvious matrix effect is shown in the chromatograms or were noted in sample prep. A NCM is generated stating the reason for not re-analyzing the affected sample.			

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**TCL SVOCs**
Concentration Level	Low
Sampling SOP	See worksheet 21
Analytical Method / SOP Reference	SW8270C/SOP-TBD
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
Number of Sample Locations	See WS#18

QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Method blank	1 per batch of 20 or fewer samples	< RL or < 10% of the concentration found in the associated samples	Re-preparation and reanalysis of all associated samples. If the analyte was not detected in the samples, the data may be reported with qualifiers and it must be addressed in the project narrative.	Analyst	Sensitivity	< RL or < 10% of the concentration found in the associated samples
LCS/LCSD	1 LCS per batch of 20 or fewer samples. Analyze an LCSD if an MS/MSD is not analyzed	%R and RPD within laboratory control limits	If the LCS recovery is high and there are non-detect samples. An NCM is initiated. If data is to be reported, it must be authorized by the client via a variance on a site by site basis. If the batch is not re-extracted and reanalyzed, the reasons for accepting the batch must be clearly presented in the project records and the report. If re-extraction and reanalysis of the batch are not possible due to limited sample volume or other constraints, the LCS is reported, all associated samples are flagged, and appropriate comments are made in a narrative.	Analyst	Accuracy & Precision	%R and RPD within laboratory control limits
MS/MSD	1 pair batch of 20 or fewer samples	%R and RPD within laboratory control limits	If the recovery for any analyte fails acceptance criteria for the MS, MSD, and the LCS, corrective action will normally include re-preparation and reanalysis of the batch. If it is not	Analyst	Accuracy & Precision	%R and RPD within laboratory control limits

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**TCL SVOCs**
Concentration Level	Low
Sampling SOP	See worksheet 21
Analytical Method / SOP Reference	SW8270C/SOP-TBD
Sampler's Name	TBD
Field Sampling Organization	TBD
Analytical Organization	TBD
Number of Sample Locations	See WS#18

QC Sample	Frequency / Number	Method / SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Measurement Performance Criteria
			possible to prepare both an MS and MSD due to limitations of sample amount, then a duplicate LCS should be prepared and analyzed. The RPD between the LCS and LCSD must be less than or equal to the RPD limit established for the MS/MSD.			
Surrogates		Within laboratory historical limits	Check all calculations for error. Ensure that instrument performance is acceptable. Recalculate the data and/or reanalyze the extract if either of the above checks reveals a problem. Re-extract and reanalyze the sample or flag the data as "Estimated Concentration" if neither of the above resolves the problem.	Analyst	Accuracy	Within laboratory historical limits

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**Mercury**
Concentration Level	Low and medium
Sampling Procedure	See Worksheet 21
Analytical Method/SOP Reference	SW846 7470A SOP-TBD
Samplers name	TBD
Field sampling organization	TBD
Laboratory Organization	TBD
No. of sample locations	See Worksheet 18

QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Method blank	One method blank must be processed with each preparation batch of up to 20 samples.	The method blank should not contain any analyte of interest at or above the RL or above 10% of either the measured concentration of that analyte in associated samples or the regulatory limit.	Re-preparation and reanalysis of all samples associated with an unacceptable method blank is required when reportable concentrations are determined in the samples (see exception noted above). If there is no analyte greater than the RL in the samples associated with an unacceptable method blank, the data may be reported with qualifiers. Such action must be taken in consultation with the client and must be addressed in the project narrative. If the above criteria are not met and reanalysis is not possible, then the sample data must be qualified. This anomaly must be addressed in the project narrative and the client must be notified.	Laboratory Analyst	Sensitivity	Same as Method / SOP QC Acceptance Limits
Laboratory control sample (LCS)	One LCS must be processed with each preparation batch of up to 20 samples.	In-house control limits are 80 - 120%	In the instance where the LCS recovery is > 120% and the sample results are < RL, the data may be reported with qualifiers. Such action must be taken in consultation with the client and must be addressed in the case narrative. Corrective action will be re-preparation and reanalysis of the batch unless the client agrees that other corrective action		Accuracy	

			is acceptable.			
MS/MSD	One MS/MSD pair must be processed for each preparation batch of up to 20 samples.	Until in-house control limits are established, a control limit of 75-125 % recovery & 20% RPD must be applied to the MS/MSD.	If analyte recovery or RPD falls outside the acceptance range, the recovery of that analyte must be in control for the LCS. If the LCS recovery is within limits, then the laboratory operation is in control and the results may be accepted. If the recovery of the LCS is outside limits, corrective action must be taken. Corrective action will include re-preparation and reanalysis of the batch. MS/MSD results which fall outside the control limits must be addressed in the narrative. If the native analyte concentration in the MS/MSD exceeds 4 times the spike level for that analyte, the recovery data are reported as NC (i.e., not calculated). If the reporting software does not have the ability to report NC then the actual recovery must be reported and narrated as follows: “Results outside of limits do not necessarily reflect poor method performance in the matrix due to high analyte concentrations in the sample relative to the spike level.”		Accuracy	

Matrix	Water
Analytical Group	**TAL Metals**
Concentration Level	Low and medium
Sampling Procedure	See Worksheet 21
Analytical Method/SOP Reference	SW846 6010C/6020A / SOP-TBD
Samplers name	TBD
Field sampling organization	TBD
Analytical Organization	TBD
No. of sample locations	See Worksheet 18

QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Method blank	One method blank must be processed with each batch of 20 or fewer samples.	The method blank must not contain any analyte of interest at or above the reporting limit (except common laboratory contaminants, (copper, iron, zinc), or at or above 10% of the measured concentration of that analyte in the associated samples, whichever is higher.	If the analyte is a common laboratory contaminant (copper, iron, zinc), the data may be reported with qualifiers if the concentration of the analyte in the method blank is less than five times the RL. Such action must be documented in the NCM program. Re-preparation and reanalysis of any samples with reportable concentrations of analytes less than 10 times the value found in the method blank is required unless other actions are agreed with the client. If there is no target analyte greater than the RL in the samples associated with an unacceptable method blank, the data may be reported. This must be documented in the NCM program. If reanalysis of the batch is not possible due to limited sample volume or other constraints, the method blank is reported, all positive results in associated samples are flagged with a "J," and appropriate comments may be made in a narrative to provide further documentation.	Laboratory Analyst	Sensitivity	Same as Method / SOP QC Acceptance Limits
Laboratory	LCS is	All analytes must be within	If any analyte in the LCS is outside the		Accuracy	

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**TAL Metals**
Concentration Level	Low and medium
Sampling Procedure	See Worksheet 21
Analytical Method/SOP Reference	SW846 6010C/6020A / SOP-TBD
Samplers name	TBD
Field sampling organization	TBD
Analytical Organization	TBD
No. of sample locations	See Worksheet 18

QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
Control Samples (LCS)	prepared and analyzed with every batch of 20 or fewer samples	laboratory established historical control limits.	laboratory established historical control limits, corrective action must occur: Check calculations, check instrument performance, reanalyze the LCS, and if still outside of control limits, evaluate the data, and/or re-prepare and reanalyze all samples in the QC batch. Data may be reported with an anomaly in the following cases: The LCS recoveries are high and the analyte of concern is not detected in field samples, all target requested analytes are within control, but other LCS compounds are out of control, if no sample preparation is performed (e.g., dissolved metals), the LCS may be re-prepared and reanalyzed within the same sequence. The analyst should evaluate the anomalous analyte recovery for possible trends. If the batch is not re-extracted and reanalyzed, the reasons for accepting the batch must be clearly presented in the project records and the report. If re-extraction and reanalysis of the batch is not possible due to limited sample volume or other constraints, the LCS is reported, all			

QAPP Worksheet #28 – QC Samples Table (continued)

Matrix	Water
Analytical Group	**TAL Metals**
Concentration Level	Low and medium
Sampling Procedure	See Worksheet 21
Analytical Method/SOP Reference	SW846 6010C/6020A / SOP-TBD
Samplers name	TBD
Field sampling organization	TBD
Analytical Organization	TBD
No. of sample locations	See Worksheet 18

QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
			associated samples are flagged, and appropriate comments are made in a narrative to provide further documentation.			
MS/MSD	MS/MSD is prepared and analyzed with every batch of 20 or fewer samples	The percent recovery and RPD within the historically generated limits.	If any individual recovery or RPD falls outside the acceptable range, corrective action must occur. The initial corrective action will be to check the recovery of that analyte in LCS. Generally, if the recovery of the analyte in the LCS is within limits, then the laboratory operation is in control and analysis may proceed. The reasons for accepting the batch must be documented. If the recovery for any component is outside QC limits for both the MS/MSD and the LCS, the process is out of control and corrective action must be taken. Corrective action will normally include re-preparation and reanalysis of the batch. If the amount of an analyte found in the unspiked sample is greater than 4 times the amount of spiked analyte added, then routine control limits do not apply and recoveries are not evaluated.		Accuracy and precision	
Post digestion	One every 20	The spike recovery from	If a result is outside the required range,		Accuracy	

Matrix	Water
Analytical Group	**TAL Metals**
Concentration Level	Low and medium
Sampling Procedure	See Worksheet 21
Analytical Method/SOP Reference	SW846 6010C/6020A / SOP-TBD
Samplers name	TBD
Field sampling organization	TBD
Analytical Organization	TBD
No. of sample locations	See Worksheet 18

QC Sample	**Frequency / Number**	**Method / SOP QC Acceptance Limits**	**Corrective Action**	**Person(s) Responsible for Corrective Action**	**Data Quality Indicator**	**Measurement Performance Criteria**
spike	samples	the post digestion spiked sample should be within the range 75-125% where the spike value is greater than 25% of the indigenous analyte concentration.	the data should be assessed carefully and samples may require reanalysis.			
Serial dilution	One every 20 samples	The results of the serial dilution sample after dilution correction should be within the range 90-110% of the original sample, if the result for the original sample is greater than 50 times the MDL.	If a result is outside the required range, the data should be assessed carefully and samples may require reanalysis.		Accuracy	
Duplicate sample (DUP)	One every 20 samples	Results of the DUP must be within ±20% RPD of the results of the original sample, where the result is greater than or equal to 5 times the RL.	If a result is outside the required range, the data should be assessed carefully and samples affected may need to be reanalyzed where the project requires it.		Precision	

%R = percent recovery
LCS/LCSD = laboratory control sample/laboratory control sample duplicate
NCM = nonconformance memo
QC = quality control
RL = reporting limit

RPD = relative percent difference
SOP = standard operating procedures
SVOC = semi-volatile organic compound
TAL = Target Analyte List
TBD = to be determined
TCL = Target Compounds List
VOC = volatile organic compound

QAPP Worksheet #29 – Project Documents and Records Table

Document	Where Maintained
Field Records: Field logbooks, chain of custody records/forms, QAPP deviations, communications and reports, photographs, GPS printouts	Maintained at Consultant's office, TBD, until after completion of the project. Files will be archived at Consultant's office, TBD, and submitted to EPA Region 2 for archive.
Laboratory Analytical Records: Raw and summary data, chain of custody and sample receipt forms, sample and instrument logs	Maintained at Consultant's office, TBD, until after completion of the project. Files will be archived at Consultant's office, TBD, and submitted to EPA Region 2 for archive.
Data Assessment and QA Records: Data validation report, independent technical review forms, CA communications and reports	Maintained at Consultant's office, TBD, until after completion of the project. Files will be archived at Consultant's office, TBD, and submitted to EPA Region 2 for archive.
Reports: Drafts, final reports, communications of progress and deviations	Maintained at Consultant's office, TBD, until after completion of the project. Files will be archived at Consultant's office, TBD, and submitted to EPA Region 2 for archive.

Documents and Records

Documentation is critical for evaluating the success of any environmental data collection activity. The following sections discuss the requirements for documenting field activities and for preparing laboratory data packages. This worksheet also lists documents and reports that will be generated as a result of this project.

Field Documentation

Complete and accurate documentation is essential to demonstrate that field measurement and sampling procedures are carried out as described in the QAPP. Field personnel will use permanently bound field logbooks with sequentially numbered pages to record and document field activities. The logbook will list the contract name and number, the Site name, and the names of subcontractors, the service client, and the Project Manager. At a minimum, the following information will be recorded in the field logbook:

- Name and affiliation of all onsite personnel or visitors;
- Weather conditions during the field activity;
- Summary of daily activities and significant events;
- Notes of conversations with coordinating officials;
- References to other field logbooks or forms that contain specific information;
- Discussions of problems encountered and the resolution;
- Discussions of deviations from the QAPP or other governing documents; and
- Description of all photographs taken.

If significant changes to the sampling program are needed because of unanticipated Site conditions, the QAPP will need to be amended and submitted to the EPA Region 2 for review and approval. If the changes are not significant (e.g., a sample or boring location is moved a few feet from the planned location, or additional samples are collected that were not specified in the QAPP), the EPA Region 2 will be notified in the weekly activity report. The field logbook will provide documentation of the deviation from the QAPP with a brief rationale.

QAPP Worksheet #29 – Project Documents and Records Table (continued)

Laboratory Documentation and Data Packages

The analytical laboratories that are performing analyses will provide full data packages, which contain all information required for validation. All data packages must contain any of the following elements that are applicable to the analysis to enable validation:

- Title page;
- Table of contents;
- Data package narrative;
- Final data report tables;
- Analytical records:
  - Instrument tuning (GC/MS methods);
  - Degradation control (only for pesticide analyses);
  - Retention Times (RTs) and RT windows for GC/ECD analyses (level 4 validation samples only);
  - Calibration data;
  - Calibration verifications;
  - Surrogate recoveries (GC/MS and GC methods);
  - Internal standard RT checks and area counts for GC/MS analyses (Level 3 and Level 4 validation samples);
  - All QC data required by the analytical method or the QAPP (blanks, LCS/LCSD, MS/ MSD, and duplicates);
  - Chromatograms for GC/ECD and GC/MS samples, calibrations, and QC samples (Level 4 validation samples and associated calibrations and QC samples);
  - Mass spectra for GC/MS analyses regardless of hits or non-detects samples (Level 4 validation samples and associated calibrations and QC samples);
  - Required supporting information;
  - Entire package of sample custody documentation, including sample receipt forms;
  - Sample processing and spiking records;
  - Copies of standard preparation logs for each standard used in sample preparation and instrument calibration;
  - Run logs;
  - Raw data associated with field and QC data;
  - Chromatograms;
  - Sources of control limits for surrogates and LCS; and
  - Source of LCS.
- Description of manual integration procedures; and
- List of current method detection limits for the preparation and analysis methods used for sample processing.

Data Package Format

The subcontracted laboratory will provide electronic data deliverables (EDDs) for all analytical results. An automated LIMS must be used to produce the EDDs. Manual creation of the deliverable (data entry by hand) is unacceptable. The laboratory will verify EDDs internally before they are issued. The EDDs will correspond exactly to the hard-copy data. No duplicate data will be submitted. EDDs will be delivered in the EPA Region 2 format. Results that should be included in all EDDs are as follows:

- Target analyte results for each sample and associated analytical methods requested on the chain of custody form;
- Method and instrument blanks and preparation and calibration blank results reported for the sample delivery group (SDG);

- Percent recoveries for the spike compounds in the MS, MSDs, blank spikes, or LCSs;
- Matrix duplicate results reported for the SDG; and
- All re-analysis, re-extractions, or dilutions reported for the SDG, including those associated with samples and the specified laboratory QC samples.

Electronic and hard-copy data must be retained for a minimum of 3 and 10 years, respectively, after final data have been submitted.

Reports Generated

A Final Report compiling all of the results will be submitted to EPA Region 2 upon completion of the Project Tasks.

EDD = electronic data deliverable
GC = gas chromatography
GC/ECD = gas chromatography electron capture detector
GC/MS = gas chromatography mass spectrometry
GPS = global positioning system
LCS = laboratory control sample
LCSD = laboratory control sample duplicate
MS = matrix spike
MSD = matrix spike duplicate
QA = quality assurance
QC = quality control
RT = retention time
SDG = sample delivery group

QAPP Worksheet #30 – Analytical Services Table

Analytical services listed below apply only to PDWP element PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments.

Matrix	Analytical Group	Concentration Level	Sample Locations/ID Number	Analytical SOP	Data Package Turnaround Time	Laboratory / Organization (name and address, contact person and telephone number)	Backup Laboratory / Organization (name and address, contact person and telephone number)
Water	TCL VOCs	Low	See WS#18	TBD	Standard	TBD	TBD
	TCL SVOC	Low					
	TAL Metals	Low/Medium					
	Mercury	Medium					

NAPL = non-aqueous phase liquid
PDWP = Pre-Design Work Plan
SVOCs = semi-volatile organic compounds
TAL = Target Analyte List
TBD = to be determined
TCL = Target Compounds List
VOCs = volatile organic compounds
WS = worksheet

QAPP Worksheet #31 – Planned Project Assessments Table

Identify the type, frequency, and responsible parties of planned assessment activities that will be performed for the project.

Assessment Type	**Frequency**	**Internal or External**	**Organization Performing Assessment**	**Person(s) Responsible for Performing Assessment** (title and organizational affiliation)	**Person(s) Responsible for Responding to Assessment Findings** (title and organizational affiliation)	**Person(s) Responsible for Identifying and Implementing Corrective Actions (CA)** (title and organizational affiliation)	**Person(s) Responsible for Monitoring Effectiveness of CA** (title and organizational affiliation)
Field Safety Audit	At project start up. Periodically during field activity. Daily tailgate safety meeting.	Internal	TBD	Task Field PM SSHO	Task PM	Task PM Task Field PM	Task PM Task Field PM SSHO
Technical System Internal Inspections of Field Sampling Procedures	Daily during Field Sampling Activities	Internal	TBD	Task Field PM	Task PM	Task PM Task Field PM	Task PM Task Field PM
Offsite Laboratory Technical Systems Audit	Per Laboratory QA Manual	Internal	Laboratory	Per Laboratory QA Manual	Per Laboratory QA Manual	Laboratory Personnel	Per Laboratory QA Manual
Data Quality Assessment	Upon receipt of analytical data packages	Internal	TBD	QA Manager	Laboratory PM	Laboratory PM	QA Manager

PM = Project Manager
QA = quality assurance
SSHO = Site Safety and Health Officer

QAPP Worksheet #32– Assessment Findings and Corrective Action Responses

For each type of assessment describe procedures for handling QAPP and project deviations encountered during the planned project assessments.

Assessment Type	**Nature of Deficiencies Documentation**	**Individual(s) Notified of Findings** (name, title, organization)	**Timeframe of Notification**	**Nature of Corrective Action Response Documentation**	**Individual(s) Receiving Corrective Action Response** (name, title, organization)	**Timeframe for Response**
Field Safety Audit	Audit Report	Task PM Team PM National Grid PM	Within one week of audit	Memo	Task Field PM SSHO	Within one week of receiving the audit report
Technical System Internal Audit of Field Sampling Procedures	Audit Report	Task PM	Within two weeks of audit	Memo	Task PM Task Field PM	Within one week of receiving the audit report
Offsite Laboratory Technical Systems Audit	Internal Audit Report	Laboratory Manager/ Laboratory Technical Director/ Laboratory Operations Manager	Annual audit	Per Individual Laboratory QA Manual	QA Manager	Per Individual laboratory QA Manual
Data Quality Assessment	Data Quality Assessment Report (DQAR)	QA Manager	Upon receipt of analytical data package	Non-conformance memos	QA Manager	Within two weeks of issuance of DQAR

DQAR = Data Quality Assessment Report
PM = Project Manager
QA = quality assurance
SSHO = Site Safety and Health Officer

1.0 ASSESSMENT

This worksheet addresses assessment of the effectiveness of the project implementation and the associated QA/QC activities.

1.1. Field Assessment and Response Actions

To monitor the capability and performance of the field activities, field inspections will be performed as follows. QC is the means by which compliance with contract requirements is ensured. QC practices will cover both onsite and offsite activities that are relevant to the project.

The Field PM will inspect all work activities to ensure that they are performed in accordance with plans and specifications. The Field PM will prepare weekly activity reports attesting to this fact. Any problems or concerns will be immediately discussed with the EPA Region 2, and the appropriate CA determined and addressed.

1.1.1.1 Equipment Inspections

Inspections will be performed daily on all equipment prior to and during their use to ensure the equipment is in safe operating condition. The Field PM will perform these inspections along with the operator.

All preventative maintenance procedures recommended by the manufacturer will be followed. Any equipment found to be unsafe will be flagged and its use prohibited until unsafe conditions have been corrected.

1.2. Verification and Testing Procedures

1.2.1. Non-conformance/Corrective Action (CA)

Non-conforming items and activities are those that do not meet the project requirements. When such a condition is identified, Consultant will implement a CA program to:

- Document the non-conforming item or procedure and determine the cause of the non-conformance and its effect on project performance and the integrity of completed work;
- Correct or replace the non-conforming item in the most efficient and effective manner; and
- Verify and document that the corrective action taken is successful.

1.2.2. Documentation of Non-Conforming Items

The Field PM will document any non-conformance item in the field logbook and summarize it in the weekly activity report. This list will clearly state what is not complying, the date the noncompliance was originally discovered, and the date the work was corrected.

1.2.3. Implementation of CA

Consultant will stop work on any item or feature pending satisfactory correction of the deficiency noted by the PM or the EPA Region 2 RPM. The PM and Field PM will have the authority to stop work until CAs are implemented. In some cases, the CA may be obvious and may be implemented immediately upon identification of the non-conformance. Others may require additional input from technical and/or operations staff, additional equipment and/or materials, or changes in existing structures or completed work. The PM and Field PM will not allow work to be added to or built upon non-conforming work unless the EPA Region 2 RPM concurs that the correction can be made without disturbing continuing work.

1.2.4. Verification and Documentation of CA

The Field PM will verify successful completion of CAs for non-conformances on a follow-up inspection. The Weekly Activity Report will reflect all CAs completed. The Field PM will also update the re-work item list with the CA taken and the date the CA was completed. Recurring non-conformances of similar nature will be investigated to determine the root cause of the problem so as to eliminate or minimize future occurrences of the non-conformance.

2.0 INTERNAL LABORATORY AUDITS

As part of its QA program the laboratory QA/QC manager will conduct periodic checks and audits of the analytical systems to verify that the systems are working properly and personnel are adhering to established procedures and documentation practices. These checks and audits will also assist in determining or detecting where problems are occurring. In addition to conducting internal reviews and audits, as part of its established QA program, the laboratory is required to take part in regularly scheduled Performance Evaluations and laboratory audits from State and Federal agencies for applicable tests. Each laboratory selected to support this project must maintain current NELAP or Federal certifications and EPA Region 2 approval, as appropriate.

2.1 Verification and Documentation of CA

2.1.1 Non-Conformance/QC Reporting

A non-conformance is defined as an identified or suspected deficiency or discrepancy with regard to an approved document (e.g., improper sampling procedures, improper instrument calibration, calculation, computer program); or an item where the quality of the end product itself or subsequent activities using the document or item would be affected by the deficiency; or an activity that is not conducted in accordance with the established plans or procedures.

Any team member engaged in project work that discovers or suspects a non-conformance is responsible for informing the PM or Field PM. The PM will evaluate each non-conformance and provide a disposition, which describes the actions to be taken.

The PM or Field PM will verify that no further project work that is dependent on the non-conforming item or activity is performed until the situation has been corrected back to the original condition intended by the project documentation. Documentation of the non-conformance and CA, along with the appropriate verification and approval signatures, will be included in the project file. Copies of the non-conformances will be maintained by the PM.

2.1.2 Laboratory CAs

QAPP Worksheet #32 – Assessment Findings and Corrective Action Responses (continued)

If a particular laboratory analysis is deemed “out of control,” CA will be taken by the laboratory to maintain continued data quality.

Each laboratory must adhere to their in-house CA policy. The coordinator of the laboratory’s analytical section will be responsible for initiating laboratory CA when necessary.

CA = Corrective Action
NELAP = National Environmental Laboratory Accreditation Program
PM = Project Manager
QA = Quality Assurance
QC = Quality Control
RPM = Remedial Project Manager
SSHO = Site Safety and Health Officer

QAPP Worksheet #33 – QA Management Reports Table

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (title and organizational affiliation)	Report Recipient(s) (title and organizational affiliation)
Field Safety Audit Report	Initial, at project start up, and periodically throughout the duration of field activities	Two weeks after audit	SSHO	Task PM Project PM National Grid PM Project file
Daily Activity Reports	Daily throughout duration of field activities	Daily	Task Field PM	Task PM Project PM Project file
Weekly Activity Reports	Weekly	Beginning of each week	Task Field PM	Task PM Project EM National Grid PM EPA Region 2 RPM Project file
Monthly Status Reports	Monthly	End of each month	Task Field PM	Task PM Project PM National Grid PM EPA Region 2 RPM Project file
Data Validation Reports	On-going upon receipt of data deliverables	Three weeks after receipt of data deliverable	QA Manager	Task PM Project PM EPA Region 2 RPM Project file
Corrective Action Reports	As identified	Immediately upon identification	Team member identifying non-conforming activity or item Team Field PM	Task PM Project PM National Grid PM EPA Region 2 RPM Project file
Final Project Report	At the completion of the assigned project tasks	Per project schedule	Team Field PM	Task PM Project PM National Grid PM National Grid PD EPA Region 2 RPM Project file

Periodic QA Management reports ensure that managers and stakeholders are updated on project status and the results of all QA assessments. Efficient communication of project status and problems allows PMs to implement timely and efficient corrective actions so that the data meets the data quality objectives for the project. EPA Region 2 will receive several types of management reports. These will include the results of any corrective action items and data validation reports. In addition, each report will contain a section on quality control. Problems or issues that arise between regular reporting periods may be identified to program management at any time. Information included in a progress report will include but not be limited to the following:

- Results of technical systems audits conducted during the period.
- An assessment of any problems.
- A listing of the non-conformance reports including Stop-Work Orders issued during the period, related CA undertaken, and an assessment of the results of these actions.
- Identification of significant QA problems and recommended solutions, as necessary.

PM = Project Manager
QA = quality assurance
RPM = Remedial Project Manager
SSHO = Site Safety and Health Officer

QAPP Worksheet #34 – Verification (Step I) Process Table

Verification Input	Description	Internal/External	Responsible for Verification
Planning Documents	QAPP documents will be evaluated prior to implementation. Examples of items for review will include personnel, training, laboratories, methods, SOPs, performance requirements, data quality objectives, forms, QAPPs, location maps, naming conventions, and project specific analytes.	I/E	PM and QA Manager Task Manager Field PM EPA Region 2 RPM Project file
Field Activity Documentation	The Field PM will review all documentation recorded by the field team during all field activities. This will include field log books, field data forms (electronic and paper), calibration records, sampling location plans, decontamination records, and daily reports.	I	Task PM Field PM
Field Data	The data generated in the field to support the project will be checked as completed against the requirements of the QAPP documents, specific data collection requirements and applicable field SOPs. The data will be reviewed by the technical lead(s) prior to being included in the associated task.	I	Task PM Field PM Task Leader (designated during activity)
Chain of Custody Documentation	The Chain of Custody documents will be peer-reviewed in the field prior to shipping of samples. The Chain of Custody will also be reviewed upon receipt by the laboratory personnel and again by the data reviewers and validation team upon receiving the analytical data packages.	I	Field PM Task Leader (designated during activity) QA Manager

QAPP Worksheet #34 – Verification (Step I) Process Table (continued)

Verification Input	Description	Internal/External	Responsible for Verification
Corrective Action (CA) and Non-Conformance documentation	CA and non-conformance reports will be checked as completed with the CA in place.	I	Task PM QA Manager Field PM
Analytical Data Packages	Analytical data results will be checked as completed against the requirements of the QAPP, specific method requirements and laboratory SOPs. Analytical data packages will be reviewed by the laboratory prior to release and by the validation team upon receipt of the data.	E/I	QA Manager
EDDs	The EDDs will be developed and provided by the laboratories. EDDs will be text files and include, at a minimum, all required data fields described in the EPA Region 2 EDD requirements. Concentration and detection limit data will be delivered as string (as opposed to numeric) field types to ensure that the precision (i.e., number of significant digits) intended by the laboratory is represented in the EDDs. EDDs will be reviewed by the laboratory prior to release of the data and by data management and the validation team upon receipt.	I	Task PM QA Manager
QC Summary Report	A summary of all laboratory QC sample results will be verified for completeness by the QA team upon receipt of data packages from the laboratory.	I	QA PM Field Leader
Data Handling	The following operations will be evaluated for completeness and accuracy: electronic or manual data transfer, entry, use, and reporting of data for computer models, algorithms, and data bases; correlation studies between variables, and data plotting.	I	Task PM QA Manager

QAPP Worksheet #34 – Verification (Step I) Process Table (continued)

Data Verification

During the data verification process, the laboratory data will be reviewed for each analytical test to evaluate the completeness of the data set to each reference method and/or to the project requirements. This review will include all of the data received from the laboratory. Depending on the level of receivables, these records should include the sample preparation procedure, instrument calibration data and continuing calibration data, QC sample results, sample identification, chains of custody, and indicate holding times. These records should also include the completion of all records to identify the analyst(s) who performed the testing and the dates and times of sample preparation and analysis. Each type of calculation will be reviewed as to its completeness. It is the job of the data qualifier to thoroughly review the data package and to record any deviations that may have occurred.

Data Review Process (Steps I, IIa, and IIb)

Data Review Process Inputs		Step I Verification	Step IIa Compliance	Step IIb Comparison	Step III Usability
Planning Documents					
1	Evidence of required approval of plan (QAPP)	X			Uses Outputs from Previous Steps
2	Identification of personnel (those involved in the project and those conducting verification steps)	X			
3	Laboratory name	X			
4	Methods (sampling and analysis)	X	X		
5	Performance requirements (including QC criteria) for all inputs	X	X	X	
6	Project quality objectives	X		X	
7	Reporting forms	X	X		
8	Sampling plans, location, maps, grids, and sample ID numbers	X	X		
9	Site identification	X			
10	SOPs (sampling and analytical)	X	X		
11	Staff training and certification	X			
12	List of project-specific analytes	X	X		
Analytical Data Package					
13	Case narrative	X	X	X	Uses Outputs
14	Internal laboratory chain of custody	X	X		

QAPP Worksheet #34 – Verification (Step I) Process Table (continued)

Data Review Process Inputs		Step I Verification	Step IIa Compliance	Step IIb Comparison	Step III Usability
15	Sample condition upon receipt, and storage records	X	X		from Previous Steps
16	Sample chronology (time of receipt, extraction, and analysis)	X	X		
17	Identification of QC samples (sampling or lab, temporal, and spatial)	X	X		
18	Associated (batch or periodic) Performance Testing sample results	X	X	X	
19	Communication logs	X	X		
20	Copies of laboratory notebook, records, prep sheets	X	X		
21	CA reports	X	X		
22	Definitions of laboratory qualifiers	X	X	X	
23	Documentation of CA results	X	X	X	
24	Documentation of individual QC results (e.g., spike, duplicate, LCS)	X	X	X	
25	Documentation of laboratory method deviations	X	X	X	
26	EDDs	X	X		
27	Instrument Calibration Reports	X	X	X	
28	Laboratory name	X	X		
29	Laboratory sample identification numbers	X	X		
30	QC sample raw data	X	X	X	
31	QC summary report	X	X	X	
32	Raw data	X	X	X	
33	Reporting forms, completed with actual results	X	X	X	
34	Signatures for laboratory sign-off (e.g., laboratory QA/QC Manager)	X	X		
35	Standards traceability records (to trace standard source from National Institute of Standards and Technology (NIST), for example)	X	X	X	
Sampling Documents					

QAPP Worksheet #34 – Verification (Step I) Process Table (continued)

Data Review Process Inputs		Step I Verification	Step IIa Compliance	Step IIb Comparison	Step III Usability
36	Chain of custody	X	X		
37	Communication logs	X	X		
38	CA reports	X	X	X	
39	Documentation of CA results	X	X	X	
40	Documentation of deviation from methods	X	X	X	
41	Documentation of internal QA review	X	X	X	
42	EDDs	X	X		
43	Identification of QC samples	X	X	X	
44	Meteorological data from field (e.g., wind, temperature)	X	X	X	
45	Sampling instrument decontamination records	X	X		
46	Sampling instrument calibration logs	X	X		
47	Sampling Location and Plan	X	X	X	
48	Sampling notes and drilling logs	X	X	X	
49	Sampling report (from Field PM to PM describing sampling activities)	X	X	X	
External Reports					
50	External audit report	X	X	X	Uses Outputs from Previous Steps
51	External proficiency testing sample results	X	X		
52	Laboratory certification	X	X		
53	Laboratory QA plan	X	X		
54	Method Detection Limit study information	X	X	X	
55	NELAP accreditation	X	X		

CA = corrective action

EDD = electronic data deliverable

NELAP = National Environmental Laboratory Accreditation Program

PM = Project Manager

QA = quality assurance

QC = quality control

RPM = Remedial Project Manager
SOP = standard operating procedure

QAPP Worksheet #35 – Validation (Steps IIa and IIb) Process Table

Step IIa / IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIa	Methods	Check that the methods used were those specified by the QAPP.	Data Validation/Chemist, Field PM
IIa/IIb	Performance Requirements	Check that the performance requirements specified by the QAPP are met.	Data Validation/Chemist, Field PM
IIa	Report Forms	Check that the report forms are filled out completely and as required by the QAPP, method, or guidance documents.	Data Validation/Chemist, Field PM
IIa	Sampling plans, location, maps, grids, and sample ID numbers	Check that the specifications for these items were met as described by the project planning documents and work instructions.	Data Validation/Chemist, Field PM, PM, Sampling Team peer review
IIa	SOPs (sampling and analytical)	Check that the requirements as specified by these documents were met and that the methods and SOPs referenced and contained in the QAPP were applied to the data.	Laboratory personnel, Data Validation/Chemist, Field PM
IIa	Project specific analytes	Check that the project specific analytes were reported as listed in the planning documents, specifically the QAPP.	Laboratory personnel, Technical PM, Data Validation/Chemist
IIa/IIb	All required elements of the data package	Check that all of the required reporting elements are present in the laboratory data package.	Laboratory personnel, Data Validation/Chemist
IIa/IIb	Sampling /Field Documents	Check that all of the required criteria and specifications for field practices surrounding sample collection, shipping, and handling are met as specified by the project planning documents. All field documentation will be reviewed including but not limited to: chains of custody, communication logs, CA reports, documentation of field and method variances, documentation of internal QA review, EDDs review, field logs, forms, and notebook review, field calibration records, and daily field reports.	Field PM, Data Validation/Chemist, PM
IIa/IIb	External Reports	Check that external reports created for and by the project such as external audit reports, laboratory assessment, performance testing, and NELAP accreditation support the requirements of the QAPP.	Data Validation/Chemist

QAPP Worksheet #35 – Validation (Steps IIa and IIb) Process Table (continued)

Data Validation

During data validation, the evaluation of the data will extend beyond method, procedural, or contractual compliance (verification) to check the analytical quality of the specific data set. The data will be evaluated with regard to compliance to the DQOs and measurement quality objectives. During data validation, data qualifiers will be assigned to provide the basis of describing data quality. Should non-conformance issues be generated from the laboratory the validation procedure evaluates the impacts of the nonconformance(s) on the quality and usability of the data set.

Step IIa denotes a list of validation activities which include the following and are associated with Methods, Procedures, and Contracts (MPC):

- Data Deliverables – Check that all required information on sampling and analysis are provided.
- Analytes – Check that all analytes were reported as required.
- Chain of custody – Evaluate traceability of data and examine against procedural requirements.
- Holding times – Check holding times for analysis.
- Sample Handling – Check that sample preservation, handling, and storage procedures were met.
- Sampling Methods and Procedures – Check that field measurement and performance criteria were met, or documented if they did not meet specifications. Check that required sampling methods were used.
- Field Transcription – Check transcription accuracy of sampling data where applicable.
- Analytical Methods and Procedures – Evaluate whether the required methods and procedures were performed.
- Data Qualifiers – Check that the laboratory qualifiers were used correctly.
- Laboratory Transcription – Check accuracy of transcription where applicable.
- Proficiency Testing – Evaluate acceptance of proficiency testing sample results against performance requirements as specified by the project.
- Standards – Check that standards are traceable and meet project and contract requirements.
- Communication – Check that required communication procedures were followed by field and laboratory personnel.

Step IIb denotes a list of validation activities which include the following and are associated with comparison with MPC in the QAPP:

- Data Deliverables and QAPP – Check that data report from Step IIa was provided.
- Field Sampling Plan – Check whether the sampling plan was executed as specified.
- Sampling Procedures – Evaluate whether sampling procedures were followed with respect to equipment and proper sampling support.
- Co-located Field Duplicates – Compare results of collocated field duplicates with criteria established in the QAPP.
- Project Quantitation Limits – Check that quantitation limits were achieved as outlined in the QAPP and that the laboratory successfully analyzed a standard at the quantitation limit.
- Confirmatory Analysis – Evaluate the agreement of the laboratory results.
- Performance Criteria – Evaluate QC data against project specific performance criteria in the QAPP (i.e. evaluate quality parameters beyond those outlined in the methods).
- Data Qualifiers – Check that the data qualifiers applied in Step IIa were those specified in the QAPP and that any deviations were specified.
- Step IIb Validation Report – Summarize outcome of comparison of data to MPC in the QAPP, and include qualified data and explanation of all data qualifiers.

CA = corrective action
DQO = data quality objective
MPC = methods, procedures and contracts
NELAP = National Environmental Laboratory Accreditation Program
PM = Project Manager
QA = quality assurance
QC = quality control
SOP = standard operating procedure

QAPP Worksheet #36 – Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator (title and organizational affiliation)
IIa/IIb	All matrices collected per the QAPP	All analytical parameters	N/A	Criteria cited in the QAPP, EPA Region 2 Validation Criteria, Method and SOP criteria, and the current National Functional Guidelines for Data Validation.	Validation Team, QA Manager (TBD)

[1]Concentration Range "ICP-AES" includes mercury by CVAA and cyanide by spectrophotometer as per EPA CLP ILM05.4 .

Data Validation

Analytical data will be validated per the validation standard operating procedures listed by EPA Region 2 under the Resource Conservation and Recovery Act and the Comprehensive Engironmental Response, Compensation, and Liability Act Field and Data Validation Standard Operating Procedures (http://www.epa.gov/region2/qa/documents.htm), the National Functional Guidelines for Contract Laboratory Program Data Review, and against the specific laboratory supplied analytical and sample preparation standard operating procedures. Field data will also be validated against the standard operating procedures and acceptance criteria contained in the project specific Uniform Federal Policy QAPP.

The proposed validation approach will include 100% (full) data validation for the data collected under the current scope of the PDWP. Full Contract Laboratory Program (CLP) or CLP-like data packages will be received for all of the analytical data regardless of the level of validation being performed on the data. This will ensure full hard copy back up of all reported data results.

CLP = Contract Laboratory Program
CVAA = cold vapor atomic absorption
ICP-AES = inductively coupled plasma atomic emission spectroscopy
N/A = not applicable
PDWP = Pre-Design Work Plan
QA = quality assurance
SOP = standard operating procedures
TBD = to be determined

QAPP Worksheet #37 – Usability Assessment

To the extent possible, the Consultant will follow EPA's data quality assessment (DQA) process to verify that the type, quality, and quantity of data collected are appropriate for their intended use. DQA methods and procedures are outlined in EPA QA/G-9R Data Quality Assessment, A Reviewer's Guide, February 2006. The DQA process includes five steps: 1) review the data quality objectives (DQOs) and sampling design; 2) conduct a preliminary data review; 3) select a statistical test; 4) verify the assumptions of the statistical test; 5) draw conclusions from the data.

After the data are received from the fixed based laboratory, data validation of the data will occur as described in Worksheet #36. During validation, where necessary, validation qualifiers will be applied to the data indicating that it has limited use, should perhaps be examined more closely, or has dramatically failed one or more data quality indicator criteria and has been rejected. This information will be supplied to the project team via a validation report and to the data manager through updates to the data base. A DQA Report will be prepared on a periodic basis summarizing the overall quality of the data including field data, field quality control (QC) data, laboratory QC data, and laboratory data. This will further illustrate the limitations of any qualified data that may have resulted during data validation.

It is incumbent on the project team to then utilize the data in an appropriate manner based on any limitations that have been identified.

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

Data usability is the process of evaluating the data validation results and determining the confidence with which any data point(s) may be used. Usability is determined by evaluating the data validation qualifier applied and the laboratory QC results. Concentration values may be considered to have a high degree of confidence because the associated method performance criteria were achieved. Estimated concentration results are evaluated with respect to the bias contributed to the value by the associated QC result. Bias direction can be estimated for data quality impacts due to surrogate recoveries, matrix spike (MS) recoveries, and laboratory control sample (LCS) recoveries. Sample concentration results that are rejected during data validation are not used in the decision-making process and should not be reported.

Describe the evaluative procedures used to assess overall measurement error associated with the project:

Data usability is evaluated with respect to the DQOs developed in this QAPP to check that the opportunity for incorporating unacceptable and manageable error into the decision-making process is minimized to the extent possible. The DQOs for this project are contained in Worksheet #11.

All analytical data, data validation qualifiers, and QC results will be evaluated to determine the confidence with which the analytical data can be used in the project decision-making process. The criteria used in the data usability summary are presented as follows using the data quality indicator criteria required for this project and measured as precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS).

1.0 PARCCS Overview

1.1 Introduction

This quality assurance (QA) program addresses both field and laboratory activities. QA objectives are formally measured through the computation of performance measures known as data quality indicators (DQIs), which are in turn compared to pre-defined measurement quality objectives (MQOs) specific to the project objectives. The DQIs for measurement data are expressed in terms of PARCCS. Evaluation of DQIs provides the mechanism for on-going control and evaluation of data quality throughout the project and ultimately will be used to define the data quality achieved for the various measurement parameters. The field QA/QC program will be accomplished through the collection of field duplicates and trip blanks. The analytical QA/QC program will be assessed through the internal laboratory QC performed, including method blanks, LCS recoveries, surrogate recoveries, and matrix spike/matrix spike duplicate (MS/MSD) recoveries. The following sections describe the DQIs in greater detail, with a discussion of the associated MQOs.

1.2 Precision

Precision refers to the reproducibility or degree of agreement among duplicate measurements of a single analyte. The closer the numerical values of the measurements, the more precise the measurement. Poor precision stems from random errors (i.e., mechanisms, which can cause both high and low measurement errors at random). Precision is usually stated in terms of standard deviation, but other estimates, such as the coefficient of variation, range (maximum value minus minimum values), and relative range are common, and may be used pending review of the data.

Precision will be checked through the collection of field duplicates and the analysis of MS/MSD and laboratory control sample/laboratory control sample duplicates (LCS/LCSD) samples for the work performed at the Site. The overall precision of measurement data is a mixture of sampling and analytical factors. Analytical precision is much easier to control and quantify than sampling precision; there are more historical data related to individual method performance, and the "universe" is not limited to the samples received in the laboratory. In contrast, sampling precision is unique to the project. Sampling precision will be measured through the laboratory analysis of field duplicate samples. Laboratory precision will be measured through the analysis of MS/MSD and LCS/LCSD samples.

During the collection of data using field methods and/or instrumentation, precision is checked by reporting several measurements taken at one location and comparing the results. Precision will be determined from duplicate samples and will be expressed as the RPD between replicate/duplicate sample results, computed as follows:

$$RPD = \frac{X_1 - X_2}{\left(X_1 + X_2\right)/2} \times 100$$

where X_1 and X_2 are reported concentrations for each replicate sample and subtracted differences represent absolute values. For field duplicates, the precision goals for this project are RPD = 30% for water samples. For laboratory duplicates, the RPD goals are dictated by the specific analytical and laboratory QC acceptance criteria.

1.3 Accuracy and Bias

Accuracy refers to the degree of difference between measured or calculated values and the true value. The closer the numerical value of the measurement comes to the true value, or actual concentration, the more accurate the measurement. The converse of accuracy is bias, in which a systematic mechanism tends to consistently introduce errors in one direction or the other. Bias in environmental sampling can occur in one of three ways; these mechanisms and their associated diagnostic and management methods are as follows:

- High bias, which can stem from cross-contamination of sampling, packaging, or analytical equipment and materials. Cross-contamination is monitored through blank samples, such as equipment blanks, trip blanks, and method blanks. These samples assess the potential for cross-contamination from, respectively, sampling equipment, ambient conditions, packaging and shipping procedures, and laboratory equipment. Data validation protocols described in Worksheet #36 present a structured approach for data qualification based on blank samples.

- Low bias, which can stem from the dispersion and degradation of target analytes (e.g., volatilization of chlorinated solvents during field sampling). The effects of these mechanisms are difficult to quantify. Sampling accuracy can be maximized, however, by the adoption and adherence to a strict field QA program. Specifically, sampling procedures will be performed following standard protocols described in the QAPP. Through regular review of field procedures, deficiencies will be documented and corrected in a timely manner.

- High or low bias may occur due to poor recoveries, poor calibration, or other system control problems. The effects of these mechanisms on analytical accuracy may be expressed as the % recovery of an analyte that has been added to the environmental sample at a known concentration before analysis. Analytical accuracy in the laboratory will be determined through the analysis of LCSs and MS/MSDs. As with blank samples, data validation protocols provide a structured formula for data qualification based on erroneously high or low analyte recoveries.

Accuracy, when potentially affected by high or low recoveries as described in the third bullet above, is presented as percent recovery (%R), defined as:

$$\%\,R = \frac{Spiked\ Sample\ Concentration - Sample\ Concentration}{Spike\ Concentration} \times 100$$

Accuracy goals are presented as upper and lower control limits for percent recovery and are generated through the compilation of control charts and referenced in each laboratory method SOP attached to this QAPP.

1.4 Representativeness

Representativeness is defined by the degree to which the data accurately and precisely describe a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. If the results are reproducible, the data obtained can be said to represent the environmental condition. Representativeness is evaluated by collecting sufficient numbers of samples of an environmental medium, properly chosen with respect to place and time. The precision of a representative set of samples reflects the degree of variability of the sampled medium, as well as the effectiveness of the sampling techniques and laboratory analysis.

1.5 Completeness

Completeness is defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is essentially the same for all data uses in that sufficient amounts of valid data are to be generated.

There are limited historical data on the completeness achieved by individual methods. However, the Contract Laboratory Program data have been found to be 80 to 85% complete on a nationwide basis. The percent completeness for each set of samples will be calculated as follows:

$$\%\ Completeness = \frac{Valid\ Data}{Total\ Data\ Planned} \times 100$$

The QA objective for completeness for all parameters will be 90%.

1.6 Comparability

Comparability expresses the confidence with which one data set can be compared to another data set measuring the same property. Comparability is evaluated through the use of established and approved analytical methods, consistency in the basis of analysis (e.g., wet weight, volume), consistency in reporting units (μg/L, mg/L), and analysis of standard reference materials. By using standard sampling and analytical procedures, data sets will be comparable.

1.7 Sensitivity

Sensitivity refers to the minimum magnitude at which analytical methods can resolve quantitative differences among sample concentrations. If the minimum magnitude for a particular analytical method is sufficiently below an action level or risk screening criterion, then the method sensitivity is deemed sufficient to fully evaluate the dataset with respect to the desired reference values. Frequently, risk-based screening levels fall below the sensitivity of even the most sensitive analytical methods. In such cases, it is necessary to review the qualifications of several laboratories, both from the standpoint of sensitivity as well as other DQIs, to select the best laboratory for the project.

The MDL is a theoretical limit determined through an MDL study, in which the concentration of a spiked solution is tested at least seven times. The standard deviation of the recovered concentrations (σ_{rec}) is computed and multiplied by the t-distribution value to arrive at the MDL. In practice, to allow for matrix interferences variability in instrument control, a reporting limit of 2.5 to 5 times the MDL is typically selected.

Analytical sensitivity is readily evaluated by comparing method reporting limits to risk-based screening values. The results of this analysis are presented in Worksheet #15, which demonstrate the suitability of the selected methods to the project requirements.

1.7.1 Identify the personnel responsible for performing the usability assessment:

Data usability is first evaluated by the laboratory performing the fixed base analysis, the data validation team, and the QA Manager. Usability of data collected in the field is first determined by the field team and Field PM. Once the data are validated the usability of the data are determined by the project team, specifically the technical leaders for the project and the PM.

1.7.2 Describe the documentation that will be generated during usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

Data usability will be documented through validation reports as well as through the issuance of DQA Reports, which will summarize how the data reflect the specific criteria for the data quality indicators assigned to the project.

DQA = data quality assessment
DQO = data quality objective
DQI = data quality indicator
LCS = laboratory control sample
LCSD = laboratory control sample duplicate
MS = matrix spike
MSD = matrix spike duplicate
MQO = measurement quality objectives
PARCCS = precision, accuracy, representativeness, completeness, comparability, and sensitivity
PM = Project Manager
QA = quality assurance
QC = quality control

ATTACHMENT A

FIELD SAMPLING PLAN

Prepared for

National Grid
One MetroTech Center
Brooklyn, NY 11201

ATTACHMENT A
FIELD SAMPLING PLAN

GOWANUS CANAL SUPERFUND SITE
BROOKLYN, NEW YORK

Prepared by

Geosyntec consultants

engineers | scientists | innovators

Project Number HPH104

February 2014

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ACRONYMS

AOC	Administrative Order and Settlement Agreement
CPT	Cone penetration test
EPA	Environmental Protection Agency
FS	Feasibility Study
FSP	Field Sampling Plan
ft	feet
GPS	Global Positioning System
ID	identification
NAPL	non-aqueous phase liquid
NYC	New York City
NYSDEP	New York State Department of Environmental Protection
OTS	oxygen transfer system
PAH	polycyclic aromatic hydrocarbon
PD	pre-design
PDWP	Pre-Design Work Plan
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RTA	Remediation Target Area
SOP	Standard Operating Procedure
SOW	Scope of Work
SVOC	semi-volatile organic compound
TAL	target analyte list
TCL	target compound list
TarGOST ®	Tar-specific Green Optical Screening Tool
UV	ultraviolet
UVOST ®	Ultraviolet Optical Screening Tool
VOC	volatile organic compound

SECTION 1

OVERVIEW

This Field Sampling Plan (FSP) has been prepared by Geosyntec Consultants, Inc. (Geosyntec) in consultation with National Grid for the Gowanus Canal Superfund Site (the Site) under the Administrative Order and Settlement Agreement for Investigation, Sampling and Evaluation dated April 29, 2010, as amended on January 24, 2014 (the AOC) by the United States Environmental Protection Agency (EPA). This FSP addresses only those portions of the Pre-Design Work Plan (PDWP) detailed in the scope of work (SOW) attached to the AOC Amendment (Geosyntec Consultants, 2014). This FSP is a necessary step in the initial development of the technical activities required by the Record of Decision (ROD) dated September 27, 2013, and provides the framework needed to guide field activities associated with pre-design (PD) tasks PD-3 through PD-8 of the PDWP.

This FSP, which serves as Attachment A to the Quality Assurance Project Plan (QAPP), is a companion to the PDWP. The FSP describes field activities for the pre-design work to be completed at Gowanus Canal. The rationale for the field activities is provided in the PDWP and Worksheet #17 of the QAPP. Revisions to this FSP are anticipated for additional phases of work and will be submitted to the EPA and the New York State Department of Environmental Protection (NYSDEP) for review and approval.

1.1 Site Setting and Background

Gowanus Canal is located in Kings County, New York (PDWP Figure 2-1). The EPA Feasibility Study (FS, CH2M Hill, 2011) divided the Canal into three remediation target areas (RTAs) that correspond to the upper reach (RTA 1), middle reach (RTA 2), and lower reach (RTA 3) of the Canal in order to facilitate the assessment and management of the Canal (PDWP Figure 2-2).

Additional details regarding the Site setting and background are found in Section 2 of the PDWP.

1.2 Field Sampling Plan Organization

This FSP describes each of the major components of the field investigation program to be conducted during the PDWP implementation and includes PD investigations PD-3 through PD-8 as listed below:

- PD-3: Additional Reconnaissance for Debris Removal;
- PD-4: A Plan for Debris Removal, Decontamination, and Disposal;
- PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation;

- PD-6: A Plan for Staging Site Selection and Implementation;
- PD-7: Evaluation of Potential Groundwater Upwelling Areas and Measurement of Groundwater Discharge Rates; and
- PD-8: Evaluation of Potentially Mobile non-aqueous phase liquids (NAPL) in Native Sediments.

While field characterization will be performed for each of these tasks as is described in general terms in this FSP, the exact scope is dependent upon information gathered in desktop studies and field conditions and hence has yet to be developed fully; the resulting scope of work will be discussed with EPA. FSP revisions will be submitted as needed to address additional items.

QAPP Worksheet #18 provides a format for listing sampling locations, nomenclature, and analytical program by task and subtask. QAPP Worksheet #19 provides information relating to analytical sample container, sample volume, preservation, and holding time requirements. QAPP Worksheet #20 summarizes the field Quality Assurance/Quality Control (QA/QC) sample requirements. These worksheets will be more completely populated following further task development.

This FSP document refers to Standard Operating Procedures (SOPs) for specific instructions for the completion of several tasks. The SOPs are located in Attachment B of the QAPP and include the following:

- Standard Operating Procedure No. 100: Recording Station Location Position with a Global Positioning System (GPS);
- Standard Operating Procedure No. 101: Field Documentation, Sample Designation, Custody and Handling Procedures;
- Standard Operating Procedure No. 102: Procedure to Prepare Samples for Shipment;
- Standard Operating Procedure No. 103: Decontamination Procedure for Sampling Equipment;
- Standard Operating Procedure No. 104: Management and Disposal of Investigation-Derived Waste; and
- Standard Operating Procedure No. 105: Procedure to Conduct a Technical System Field Audit.

Additional SOPs will be developed upon further development of each task.

SECTION 2

PD-3: ADDITIONAL RECONNAISSANCE FOR DEBRIS REMOVAL

The PD-3: Additional Reconnaissance for Debris Removal work element (hereafter referred to as PD-3) will seek to perform additional debris reconnaissance for debris removal in the Canal in areas not previously surveyed or where survey results require confirmation.

During the December 2010 Remedial Investigation/Feasibility Study (RI/FS) side-scan sonar study, several areas of the Canal were not evaluated due to interferences which resulted in data gaps in the current understanding of debris conditions existing at the Canal (Dolan Research, 2010). This debris reconnaissance work element will be performed to address the areas of the Canal not previously evaluated in the December 2010 study to identify and characterize Site conditions, anomalies, obstructions, and potential submerged cultural resources in these areas.

The areas of the Canal which were unable to be previously evaluated due to interferences and related mitigating measures are presented in Table 1.

Table A1 – Mitigating Measures to Evaluate Debris

Previous Interference	Mitigating Measure
Various locations between the 3rd Street Bridge and head of the Canal could not be investigated due to the presence and operation of the oxygen transfer system (OTS).	The OTS system will be removed prior to the additional reconnaissance activities.
Double-berthed construction and work barges prevented comprehensive acoustic coverage at several locations at the mouth of the Canal.	The activities will be coordinated to occur when the mouth of the Canal is free of construction equipment and work barges.
Differential Global Positioning System limitations while navigating under the five bridges created fragmented sonar coverage at these locations.	Alternatives to side-scan sonar may be used, such as a tripod-mounted, high-resolution, 360-degree scanning sonar which can be deployed adjacent to hard-to-reach areas to generate plan-view sonar imagery.

Verification will be performed for significant debris fields identified during this effort and in previous surveys. As obstructions are identified during the supplemental reconnaissance/side-scan sonar study, they will be characterized as appropriate by material (e.g. timber, metal, concrete, or tires). The obstructions will then be added to the scope of the Plan for Debris Removal, Decontamination, and Disposal (PD-4) as well as the subject of future cultural resources assessments if warranted.

A qualified subcontractor will conduct the additional reconnaissance activities.

SECTION 3

PD-4: A PLAN FOR DEBRIS REMOVAL, DECONTAMINTATION, AND DISPOSAL

The overall objective of this work element is to develop a plan to govern the removal and/or management of debris such that the underlying targeted sediment can be efficiently and effectively dredged and/or remediated. Details of each component are addressed in the sections below.

3.1 Debris Removal and Management

Debris removal and management will be conducted with an adaptive management approach in the field. Material removed will be identified during a reconnaissance phase, to the extent practical, and a plan for the equipment and removal methods will be created in advance. The dredging contractor will retain the flexibility to make real-time field decisions in coordination with the consultant field team leader as additional data become available during debris removal operations. The specifics of what debris will be removed prior to remedial dredging and what debris will be removed by the dredge itself may be modified to address real-time field conditions encountered during debris removal and/or dredging.

Debris removal operations will be accomplished through the use of barge-mounted cranes and/or excavators using various types of attachments, such as environmental buckets, grapples, clam shells, and rakes.

To the extent possible, and after any cultural resources have been addressed, all the debris present at the targeted locations identified in the 2010 sonar study (Dolan Research, 2010) and supplemental debris investigations will be raked at a minimum.

Media separation (sediment and water) will be required for much of the debris removed. Debris found to be coated in sediment residue will be suspended over the water in the area from which it originated and rinsed using Site water via an engine driven pump with an attached fire hose. Sufficient rinse time will be allowed to remove residual sediment, or the debris will be placed on a rack (i.e., grizzly screen) where it can be raked to remove hardened sediment.

3.2 Debris Handling and Disposal

To the extent possible, debris removal and management activities will be performed in or upon the water. Removed debris will likely be placed onto a transfer barge, and the barge or series of barges will serve as a management staging area where debris will be sorted based on material composition and size prior to offloading. Ideally, debris will be transported by barge to the permitted processing facility or facilities.

Debris removed from the Canal will be subjected to the conditions of the operating permits of the off-loading, processing, treatment and transfer facility or facilities that will be engaged and/or retained as part of this project. Regulated debris collected during operations will be handled by trained personnel and disposed of in accordance with all federal, state and local regulations and ordinances.

Several emission mitigation steps will be identified and implemented as needed to minimize the generation of odors. These mitigation strategies may include:

- Application of odor suppressants/foaming agents;
- Covering of the debris stockpiles on barges;
- Minimization of debris storage/stockpiling areas on barges or near shorelines; and
- Covering of debris trucks/containers during transport from the barge offloading area to the sediment consolidation area.

3.3 Cultural Resources Management

The primary objective of cultural resource management, as it pertains to the remedy implementation, is to remove any cultural resources so the resources can be preserved, to the extent practical, and to ensure that targeted sediment can be efficiently and effectively remediated. If removal of cultural resources is not feasible, the resource may require management in place.

SECTION 4

PD-5: DETAILED SURVEY AND ASSESSMENT OF EXISTING BULKHEADS FOR REMEDY IMPLEMENTATION

The overall objectives of the bulkhead survey and assessment work element are to assess the expected stability of existing bulkheads during and after remedy implementation, and to create a design of temporary and permanent bulkhead support systems.

To meet the stated objectives, several sub-tasks with a field work component have been identified that will be performed under this work element including subsurface investigation of existing bulkhead foundations and Geotechnical Site Investigations. Details of each sub-task are provided in the sections below.

4.1 Subsurface Investigation of Existing Structures

4.1.1 Subsurface Investigation of Existing Bulkhead Foundations and Conditions

This sub-task has been developed to address the data gaps related to bulkhead foundation depth and bulkhead conditions below the water-line. The condition of existing bridge foundations and abutments will also be determined as part of the investigation, although their assessment will be deferred to New York City (NYC).

The bulkheads along the Canal have been divided into four category types: (1) timber cribs; (2) timber pile foundations; (3) steel sheet piles; and (4) embankments and failed bulkheads. Several subsurface exploration methods will be used in the subsurface investigation of the bulkhead foundations, including:

- **Divers performing physical inspection and probing**: Divers allow for an accurate estimate of the integrity and condition of bulkheads below the water level and above the sediment/mud line. Probing may allow divers to determine approximate bottom of timber cribbing bulkheads. This exploration method will be performed at select locations along the Canal. Divers will document the conditions of each bulkhead and follow an SOP that will be developed prior to the start of the task.

- **Downhole seismic testing:** Downhole seismic testing (ASTM D7400) will be performed at timber pile bulkheads and steel sheet pile bulkheads as a means of determining the location of the bottom of foundations. For each test, one boring or cone penetration test (CPT) with a horizontal shear wave receiver will be performed within approximately 5 feet (ft) from either the Canal-side or upland of the bulkhead pile being investigated. The test is performed by inducing a seismic source at the top of the bulkhead pile being investigated while a downhole receiver is deployed at selected depths to detect the arrival of horizontal shear waves emitting from the source pile. The depth at which there is significant loss of shear wave energy (reduction or complete loss of signal in the receiver) should coincide with the bottom of the bulkhead pile foundation.

Due to the potential existence of buried timber bulkhead structures on the upland side of the bulkhead, results will likely be improved by performing tests on Canal side of the bulkheads. If a CPT is performed, the procedure will follow ASTM D5778. Borings will be drilled and logged as discussed in ASTM D6151, ASTM D5783, and ASTM D5753. All recovered soil samples will be labeled and handled as discussed in ASTM D4220. Laboratory testing of recovered samples will be performed as part of the Geotechnical Site Investigation, Section 4.2. All CPT results, boring logs, and the soil test data will be included as part of the Geotechnical Site Investigation. Note that Site access restrictions or existing obstructions may limit test performance.

- **Crosshole seismic testing**: Crosshole seismic testing (ASTM D4428) will be performed at timber cribbing bulkheads, timber pile bulkheads, and steel sheet pile bulkheads to determine the location of the bottom of the bulkhead foundations. The testing will performed at two borings located 5 to 10 ft away from and surrounding the bulkhead of investigation. A seismic source will generate waves at a selected depth down one of the borings, and downhole receivers in the other boring will be used to detect the arrival of the seismic waves. The time required for the shear wave to travel from the source to the receivers is used to calculate the shear wave velocity through the soil and bulkhead. Sharp variations in the shear wave velocity with depth should correspond with the bottom of the bulkhead foundation.

  At least two borings will be drilled and logged per test location as discussed in ASTM D6151, ASTM D5783, and ASTM D5753. All recovered soil samples will be labeled and handled as discussed in ASTM D4220 and per SOP 101. Laboratory testing of recovered samples will be performed as part of the Geotechnical Site Investigation, Section 4.2. Borings and soil test data will be included as part of the Geotechnical Site Investigation. Note that Site access restrictions or existing obstructions may limit test performance.

- **Low strain impact integrity testing of deep foundations:** Low strain impact integrity testing (ASTM D5882) will be performed at timber pile and steel sheet pile bulkheads as a means to determine the depth of the pile tips. A hand held hammer or similar impact source with a trigger will be used to generate a force pulse at the top of the pile. This impact may be induced either axially and/or perpendicularly to the head of the pile. Transducers will be placed at the head of the pile to measure velocity and force response of the pile. The velocity and force response will be recorded as a function of time and can be used to provide an indication of the pile length based on pile material assumptions. This test method requires unobstructed access to the top of the piles; therefore, existing field conditions may limit test performance.

- **Borehole induction method**: This exploration method will be performed at steel sheet pile bulkheads as a means to determine the depth of the pile tips. An adaptation of ASTM D6726 and ASTM D5753 that will be developed as an SOP prior to the start of the task will be followed. The test will be performed within a radius of 5 ft from either the Canal-side or upland of the bulkhead pile under investigation. A drilled borehole or a CPT probe will be used to insert an induction probe into the subsurface to create a magnetic field and induce eddy currents in surrounding material. The probe measures the secondary magnetic field created by the eddy currents in order to determine the resistivity of the material. This test is performed with depth and sharp variations in the resistivity should indicate the bottom of the steel sheet pile foundation.

  Due to the potential existence of buried timber bulkhead structures upland of the bulkhead, results will likely be improved by performing tests on Canal-side of the bulkheads. If a CPT is performed, the procedure will follow ASTM D5778. Borings will be drilled and logged as discussed in ASTM D6151, ASTM D5783, and ASTM D5753. All recovered soil samples will be labeled and handled as discussed in ASTM D4220 and per SOP 101. Laboratory testing of recovered samples will be performed as part of the Geotechnical Site Investigation, Section 4.2. All CPT results, boring logs, and the soil test data will be included as part of the Geotechnical Site Investigation. Note that Site access restrictions or existing obstructions may limit test performance.

Due to high levels of uncertainty associated with the effectiveness of each technique, a methods development program is being designed to determine which technique will be applied for each bulkhead type. For each bulkhead category, the following subsurface exploration methods will be attempted as part of the pilot for the field investigation:

- **Type 1: Timber cribs**: Divers performing physical inspection and probing and crosshole seismic testing;

- **Type 2: Timber piles**: Divers performing physical inspection, crosshole seismic testing, downhole seismic testing, and low strain impact integrity testing of deep foundations;

- **Type 3: Steel sheet piles**: Divers performing physical inspection, crosshole seismic testing, downhole seismic testing, and borehole induction method; and

- **Type 4: Embankments and failed bulkheads**: No further inspection of foundation, assumed to require a permanent replacement bulkhead.

The current investigation plan is based on the assumption that each bulkhead requires investigation. SOPs adapted from listed ASTMs may be developed, or existing SOPs may be revised to address issues observed during the methods development program. New or revised SOPs will be prepared prior to commencing the Site-wide bulkhead investigation. At least one technique will be used at each bulkhead identified as requiring investigation. Target investigation locations will determined prior to commencing this task.

4.1.2 Subsurface Investigation of Bridge Foundations and Conditions

Five surface streets cross over the Canal with bridges (five streets accounts for the divided Hamilton Avenue crossing). The condition of bridge foundations and abutments will be included in this study.

Appropriate NYC representatives will be contacted for information on the bridge foundations and abutments. If sufficient information is available a field investigation may not be warranted; otherwise the methods described herein will be used to investigate the bridges and abutments. Final assessment of bridge stability during remedial actions will be the responsibility of NYC.

4.1.3 Combined Sewer Overflow Investigation

Various pipe discharge outfalls identified by EPA in Appendix G of the RI (CH2M Hill and HDR, 2011) will be verified and their conditions noted during the field investigation.

4.2 Geotechnical Site Investigation

Geotechnical Site Investigation subsurface exploration methods include borehole drilling and CPT sounding. Borings will be performed in accordance to the procedures discussed in ASTM D6151 and/or ASTM D5783. CPTs will be performed in accordance with the procedure discussed in ASTM D5778.

The Geotechnical Site Investigation includes the following:

- Sampling locations will be selected at approximately 100 ft intervals along the length of the bulkheads. Sampling locations will consist of two points oriented perpendicularly to the bulkhead under investigation with one sample collected approximately 5 ft laterally from the bulkhead (located either upland of the bulkhead or Cana-side of the bulkhead) and one sample collected approximately 50 ft laterally upland from the bulkhead:
    - One “shallow” boring will be collected to a depth 10 ft deeper than the estimated bottom of the bulkhead based on the desktop study. These borings will be offset approximately 10 ft laterally from the bulkhead so that they pass through fill material.
    - One CPT sounding will be attempted to a target depth of 70 ft bgs except where “deep” borings will be performed. CPT locations will be offset approximately 50 ft laterally from the bulkhead in line with the “shallow” borings. If a CPT cannot be completed to the target depth, then the boring depth will be altered to match that of the nearby “shallow” sample. Shear wave testing will be performed at select CPT locations.
    - One “deep” boring will be collected to a target depth of 70 ft. These borings will be collected in place of CPT samples approximately every 400 ft along the length of the bulkheads and will be offset approximately 50 ft laterally from the bulkhead.

Boring samples will be recovered and logged according to ASTM D5753. Sample documentation includes: (i) field soil classification of each recovered sample; (ii) photo documentation of each recovered soil sample; and (iii) hand written boring log for each boring including descriptions of soil samples, observations made during drilling, drilling recoveries, blow counts, and any irregularities experienced during drilling.

For all borings and CPT soundings performed, the proposed locations may require adjustment depending on Site access restrictions and subsurface obstructions. All holes created during boring collection will be backfilled with a tremie-placed grout-bentonite mixture and all CPT holes will be backfilled with hydrated bentonite.

A laboratory testing program will be performed on select samples. Disturbed soil samples for geotechnical testing will be recovered via split spoon sampling and collected in jars labeled with the boring identification (ID), sample ID, sample depth, standard penetration test blow counts, and sample recovery, as discussed in ASTM D4220. Undisturbed sampling locations will be selected at the discretion of the Field Engineer based on encountered field conditions. Undisturbed samples will target cohesive materials and will be recovered via piston pushed thin tubes, logged, and labeled with boring ID, sample ID, sample depth, and sample recovery as discussed in ASTM D4220 and per SOP 101. The laboratory testing program will include:

- Unconsolidated undrained triaxial testing will be performed on select undisturbed cohesive samples to determine their undrained shear strength. The testing procedure is discussed in ASTM D2850.

- Consolidated undrained triaxial testing will be performed on select undisturbed cohesive samples to determine their undrained shear strength at various effective loading conditions and drained shear strength parameters. The testing procedure is discussed in ASTM D4767.

- Moisture content testing will be performed on select disturbed and undisturbed samples, from which moisture content profiles can be created for all borings. The testing procedure is discussed in ASTM D2216.

- Atterberg limit testing will be performed on select disturbed and undisturbed samples. This testing will be used to determine the plasticity and soil classification of the samples. The testing procedure is discussed in ASTM D4318.

- Unit weight testing will be performed on select undisturbed samples, from which unit weight profiles can be created for all borings. The testing procedure is discussed in ASTM D7263.

- Grain size distribution tests will be performed on select disturbed and undisturbed samples. This testing will be used to determine soil classifications of the samples. The testing procedure is discussed in ASTM D422.

Laboratory samples will be determined based on observed and encountered field conditions and will therefore be determined by the Field Engineer after samples have been recovered. Laboratory samples will be distributed such that soil parameters are evaluated for each identified soil layer and zone along the Canal. Information from soil borings, CPTs, field observations, and laboratory data results of selected soil test parameters will be included in existing graphical information system databases and the conceptual site model to support remedial design and decisions.

SECTION 5

PD-6: A PLAN FOR STAGING SITE SELECTION AND IMPLEMENTATION

No field work will be completed for this task prior to selecting a staging site.

SECTION 6

PD-7: EVALUATION OF POTENTIAL GROUNDWATER UPWELLING AREAS AND MEASUREMENT OF DISCHARGE RATES

The two primary objectives of this work element are to determine the approximate areas of significant groundwater upwelling in the Gowanus Canal and, for those areas where upwelling is identified, to measure the groundwater discharge rate and velocity. The term upwelling refers to general areas where groundwater discharge is occurring and the term discharge rate is used with reference to quantification of rates.

To meet the primary objectives of this work element, the following sub-tasks will be performed:

- Evaluation and selection of applicable technologies for locating groundwater upwelling areas and quantifying discharge rates;
- Evaluation and selection of areas of the Canal for groundwater upwelling measurements;
- Inspection of selected areas to confirm feasibility of selected technologies at target locations;
- Implementation of selected technologies to assess groundwater upwelling areas and discharge rates; and
- Characterization of the hydraulic conductivity between the native and soft sediments.

It is anticipated that activities described for this work element will be conducted in a dynamic manner with several decision steps required, potentially leading to modifications to the scope of work during implementation. If the scope should require modification during implementation, the scope changes will be appropriately documented and communicated to EPA per Worksheet #6 of the QAPP.

6.1 Evaluate and Select Applicable Technologies

Various technologies for assessing groundwater discharge will be screened for applicability in the Canal. These technologies will be evaluated for their anticipated ability to identify potential areas of groundwater upwelling and quantify groundwater discharge rates. Additionally, the detailed screening will evaluate the feasibility of implementation in the Canal and costs of implementation. Table A2 presents technology options for evaluating where groundwater upwelling may be occurring, quantifying discharge rates, and evaluating groundwater seepage velocity.

Table A2. Summary of Technologies Used to Identify and Quantify Groundwater Upwelling and Discharge Rates

Technology	Identify GW Upwelling	Quantify GW Discharge	Quantify Seepage Velocity	Description
Airborne Thermal Infrared Imaging	X			Cost effective technology that requires aircraft with sensor to detect temperature contrast at water surface that is the result of discharged groundwater. Best conducted at peak low tide during mid-winter.
Satellite Infrared Imaging	X			Data already exists and easy to implement. Best with low cloud cover, peak low tide and during either mid-winter or mid-summer. Spatial resolution may be low.
Distributed Temperature Sensing	X			Uses fiber optic cables buried in sediment to sense temperature changes assumed to be groundwater upwelling. Requires divers, but good for broad level screening. Bottom debris may hinder deployment.
Resistivity Array	X			Technique based on high resistivity contrast between groundwater upwelling and marine water. Metallic debris could be a significant problem.
Trident Probe	X			Point measurement that utilizes a sub bottom coring device to collect sediment and pore water. Groundwater upwelling areas evaluated using conductivity and temperature differentials between pore water and surface water.
Seepage Meters		X	X	Reliable method for quantifying groundwater discharge rates. Likely to require divers to implement.
Point Velocity Probes			X	New technique-monitors electrical conductivity breakthrough curves from injected saline tracer. R&D needed to implement technology in this setting.
Piezometer Nests	X	X		Although common, may be difficult due to water depth and Canal traffic. Not a direct measurement of discharge compared to seepage meters
Acoustic Doppler Current Profiling		X	X	Rapid method to assess vertical submarine groundwater discharge. Method is applicable for measuring discharges above 0.005 meters per second.
Natural Tracers	X			Uses naturally occurring, short-lived isotopic tracers that are enriched in groundwater relative to surface water to identify groundwater upwelling. May require divers to install monitoring network infrastructure. Monitoring would include intake pumps, air-water gas exchangers, and tracer-specific detectors.
In Situ Permeable Flow Sensor			X	Measures heat transport on thermistors that surround a central heating element to calculate groundwater velocity. Can be used to assess either horizontal or vertical flow depending on sensor orientation.

6.2 Evaluate and Select Areas of Canal for Groundwater Upwelling Measurements

Various surveys have been conducted in the Canal as part of the RI and supplementary data collection. This sub-task includes compiling these data sets, geo-referencing them to a common datum, and generating an interactive Site model to identify appropriate candidate areas to perform groundwater upwelling investigations in different portions of the Canal.

Specific datasets needed for this sub-task include, but are not limited to:

- Geo-referenced side-scan sonar data;
- NAPL detections in soft sediments and native sediments;
- Soft sediment scour locations;
- Magnetometer targets from the 2005 survey (GEI, 2007); and
- Updated bathymetry and sediment transport dynamics models due to potential activation of the Flushing Tunnel.

Discussions with technology vendors will inform decisions regarding Site conditions that are most appropriate for measurements. The Site model, following its development, will be used to identify areas in which field implementation is applicable. Target areas will include those within and outside of known NAPL impacts as well as areas where groundwater discharge rates are hypothesized to be high, average, and low. Areas with saturated NAPL impacts and where bottom debris is not an obstacle to technology deployment will be considered a priority. Areas potentially subject to Flushing Tunnel impacts will be evaluated for applicability. Locations with relatively little accumulation of soft sediment will be identified as areas with enhanced potential for preferential flow-paths and increased groundwater upwelling.

Side-scan and magnetometer data, collected in collaboration with PD-3, will be used to identify the presence and density of bottom debris. These data will aid in identifying areas of the Canal where physical obstacles may hinder the implementation of one or more of the identified technologies so that these locations can be avoided during field screening.

6.3 Site Visit and Inspection to Confirm Feasibility of Selected Technologies at Target Locations

Locations identified as areas to further assess groundwater upwelling, both in NAPL impacted areas and non-NAPL impacted areas, will undergo field characterization to confirm feasibility with the applicable technologies. Field characterization may include high resolution bathymetry, side-scan sonar imaging (see PD-3), and, depending on results of these surveys, diver inspection to assess the current type and magnitude of debris density and evaluate the zones of interest in order to assess whether the selected technologies can be successfully deployed. In addition, Site visits by technology vendors and subcontractors will be conducted to verify implementation feasibility and logistics as applicable.

A figure will be created which presents representative areas for study within the Canal where groundwater upwelling can be confirmed and quantified.

6.4 Implement Selected Technologies to Assess Groundwater Upwelling Areas and Discharge Rates

Technologies selected for screening will be deployed in feasible locations of interest with the intent to identify areas in which groundwater upwelling is occurring. During the implementation phase, multiple technologies will likely be used to provide independent and complementary lines of evidence to identify and characterize areas of groundwater upwelling into the Canal. The use of an initial, demonstration-scale implementation step will be considered in order to obtain Site-specific data in advance of a full-scale implementation for technologies warranting methods demonstration.

Following identification of areas of groundwater upwelling, point measurements of groundwater discharge rates and velocities across tidal cycles will be evaluated. The number of specific point measurements that will be collected will be dependent on results of the previous sub-tasks. Final determination of methods and approach will be communicated to EPA during technical workshops and or through written communications.

Detailed procedures for implementing selected technologies will be provided following the selection process.

6.5 Characterize the Hydraulic Conductivity between the Native and Soft Sediments

Possible methods for quantifying hydraulic conductivity values for the native and soft sediments include variations on CPT and slug testing as discussed in the PDWP and include:

- Hydraulic Profiling Tool by Geoprobe®;
- Waterloo Advanced Profiling System (Waterloo^{APS})^{TM};
- CPT in situ Dissipation; and
- Slug testing with nested wells.

A screening and selection of the most appropriate and informative technology will be conducted using the evaluation criteria of technical performance, implementability, and cost. Selected technologies will be implemented as discrete measurements and it is likely that more than one of these technologies will be implemented.

SECTION 7

PD-8: EVALUATION OF POTENTIALLY MOBILE NAPL IN NATIVE SEDIMENTS

The primary objectives of this work element are to (i) quantify the NAPL distribution within the Canal, (ii) define areas of potentially mobile NAPL, and (iii) identify and characterize the controlling factors of NAPL mobility.

To meet the primary objectives of this work element, the following field tasks will be performed:

- Implementation of field-based approaches selected as appropriate from a desktop evaluation to assess in situ NAPL distribution; and

- NAPL characterization and laboratory mobility testing.

Activities described for this work element are anticipated to be conducted in a dynamic manner with several decision steps required, potentially leading to modifications of the scope of work during implementation. The ultimate number of testing and sampling locations will be determined based on the following considerations and we will be added to Worksheet #18 of the QAPP: (i) the findings of the field methods desktop study (e.g., precision and sensitivity considerations); (ii) the program sequencing; and (iii) refinement of pre-design objectives. Final testing and sampling locations will be appropriately documented and communicated to EPA per Worksheet #6 of the QAPP.

7.1 Implementation of Field-Based Approaches to Assess In Situ NAPL Distribution

The field-based approaches will incorporate technologies selected from the desk-top evaluation to measure the presence of NAPL in situ. Specifically, sub-tasks anticipated to be performed are as follows:

1. Field-based approaches to assess NAPL distribution in native sediments in the Canal in concert with characterization of sediment texture and geotechnical parameters (e.g., CPT) at all testing locations;

2. Collection of undisturbed sediment cores for confirmatory laboratory analysis to assess the NAPL distribution in native sediments of the Canal from a sub-set of the sampling locations;

3. Collection of undisturbed sediment cores for performance of laboratory mobility testing from the areas of highest observed NAPL saturation based upon field methods; and

4. Collection of groundwater and NAPL samples from the native sediment.

A barge will be employed to access sampling locations. The field evaluation method(s) selected from the desktop evaluation will be employed at each location, and the sub-tasks will be completed as necessary for a given testing location. The sub-tasks will be discussed in the following sections.

The geospatial location of the sampling locations will be recorded using mapping-grade GPS as described in SOP 100.

QAPP Worksheet #18 will provide a comprehensive listing of the sampling locations, nomenclature, and analytical program for this task once determined. QAPP Worksheet #19 provides information relating to appropriate sample container, sample volume, preservation, and holding time requirements for the standard analytical tasks for NAPL and groundwater. QAPP Worksheet #20 summarizes the field QA/QC sample requirements for this task. Frequency of field QC samples will be added in a subsequent revision of the QAPP.

7.1.1 Field-Based NAPL Distribution Assessment

The Tar-specific Green Optical Screening Tool (TarGOST®) (or similar, as selected in the desktop study) will be used to assess NAPL distribution in the field. The TarGOST® is a modification of the Ultraviolet (UV) Optical Screening Tool (UVOST®) and is a laser-induced fluorescence screening tool designed to detect NAPL through sensing the fluorescence of polycyclic aromatic hydrocarbons (PAHs) found in NAPLs. The TarGOST® system is a continuous measurement fluorometer which is coupled via fiber optics to a probe that is advanced into the subsurface such that the operator can evaluate NAPL distribution in situ in real-time. Cut sheets and the SOP for the selected technologies will be developed and provided prior to field deployment. The TarGOST® will be advanced in concert with a screening tool for sediment texture and geotechnical parameters (e.g., CPT). Sediment cores will be collected at select locations immediately adjacent to the TarGOST® deployment to verify and calibrate results, as described below in Section 7.1.2.

7.1.2 Collection of Undisturbed Sediment Cores for Laboratory Analysis

Undisturbed sediment cores are needed to evaluate the NAPL distribution and to assess the NAPL mobility. It is anticipated that sediment cores will be collected using a Shelby Tube or acetate liner collection apparatus to be advanced by non-vibratory method, though this methodology may be modified based on results of the desktop evaluation. Methods for sediment core collection will be specified in a forthcoming SOP.

For the NAPL distribution assessment, the coring device will be advanced to capture the profile of observed TarGOST® readings above background, which is anticipated to be approximately 10 ft of material below the soft sediments/native sediments interface. The actual length of core collected will depend upon the TarGOST® readings and may be more or less than 10 ft. A subset of these collected cores will be used to assess the NAPL mobility using the material below the soft sediments/native sediments interface in the zone of highest observed TarGOST®

response. If necessary, an additional undisturbed sediment core will be collected for the NAPL mobility assessment to minimize sample disturbance prior to testing.

For both the NAPL distribution and mobility assessment, the collected sediment cores will be preserved using a method that minimizes sample disturbance and will be sent to a laboratory for assessment.

Laboratory analytical methods applied to the sediment cores are discussed in Sections 7.2.1 and 7.2.2.

7.1.3 Groundwater and NAPL Collection

Where possible, samples of NAPL and groundwater will be collected from the native sediments in the general vicinity of the sediment sampling area. Groundwater and NAPL samples will be collected by advancing a temporary well into the native sediments and allowing sufficient media to collect inside the screen prior to sampling. Methods for temporary well advancement and sampling will be specified in a forthcoming SOP. The collected NAPL and groundwater samples will be analyzed for density (ASTM D1217), viscosity (ASTM D445), and interfacial tension (ASTM D971) at three different temperatures. The collected groundwater and NAPL samples will also be analyzed for chemical composition (Target Compound List volatile organic compounds [TCL VOCs] via EPA Method 8260B, TCL semi-volatile organic compounds [SVOCs] via EPA Method 8270C, and Target Analyte List [TAL] metals via EPA 6010C/6020A).

7.1.4 Sample Locations

Results of the desktop evaluation will be used to focus the application of field-based approaches to locations which are anticipated to have the highest likelihood of vertical upward NAPL migration and/or the highest anticipated NAPL saturation. Within the focused areas, a series of smaller, initial target areas will be defined by the existing 3-D data distribution as initial areas of deployment to assess the efficacy of field-based approaches and laboratory analysis programs. Following the successful completion of the initial deployment, the approach will be expanded to the larger objective of delineating and/or defining the areas of migrating NAPL below the Canal for remedy implementation.

7.2 NAPL Distribution and Laboratory Mobility Testing (Specialty Testing Laboratory)

The goal of the laboratory analysis of undisturbed sediment cores is to understand (i) the vertical seepage velocity, among other factors, that is necessary to cause upward migration of the NAPL within the native sediments, and (ii) the confining pressure needed to impede this migration if it exists. The scope of work for the laboratory mobility testing includes (i) characterization analyses of the collected sediment core, NAPL, and groundwater samples, and (ii) empirical assessment of potential vertical NAPL mobility.

7.2.1 Laboratory NAPL Distribution Analysis

The undisturbed sediment core samples collected for NAPL distribution assessment will be analyzed using established laboratory-based NAPL mobility assessment methods. These may include but are not limited to the following:

- Pore fluid saturation via Dean-Stark (API RP40) at a set vertical spacing, which will be collocated with field-based assessments to confirm the NAPL vertical distribution from the field readings;
- Centrifuge and/or water flood of sediment samples to assess NAPL residual saturation and mobility potential (proprietary method);
- Drainage capillary pressure data (i.e., water retention curves) to understand the soil matrix and to develop the parameters to understand pore entry pressures (ASTM D6836);
- Potential photography of the core under white and UV light to provide an understanding of the vertical NAPL distribution and aid in defining vertical depths for further mobility assessment (ASTM D5079); and
- Geotechnical parameters to confirm the field-based approach for soil/sediment texture/geotechnical observations (Sieve by ASTM D4222, intrinsic permeability to Product (NAPL) by API RP40, intrinsic permeability/hydraulic conductivity by API RP40, Atterberg Limits by ASTM D4318).

7.2.2 Laboratory Mobility Testing

As noted, a sub-set of the undisturbed sediment cores will be used for laboratory mobility testing. A laboratory mobility testing method that mimics natural conditions will be used to assess the mobility of the NAPL within the sediments. The laboratory mobility testing method will be developed as part of the desktop study under this work element. The goal of the laboratory-scale work is to understand, among other factors, the vertical seepage velocity and hydraulic head gradients that are necessary to cause upward migration of the NAPL within the native sediments.

Various pressure gradients and seepage velocities will be tested to evaluate vertical migration potential under in situ conditions. If necessary, additional NAPL will be added to the sample to understand what NAPL saturation threshold is necessary at given velocities to cause vertical migration. As part of this testing, a sensitivity analysis will be completed to understand which parameters most strongly control mobility.

SECTION 8

DOCUMENTATION, SAMPLE PACKING, AND SHIPPING

8.1 Field Documentation

Field visits and sample collection programs will be documented using a combination of field log books and specific field log forms as described in SOP 101.

The log book(s) will provide a comprehensive overview of all Gowanus Canal activities throughout the PD work; the level of detail of documentation within each log book entry will depend upon the duration of an individual visit and the applicability of field forms to the tasks performed. Dedicated log books will be used for each type of field instrument.

8.2 Sample Nomenclature

Sample nomenclature and duplicate nomenclature will be developed prior to collection of field samples for inclusion in Worksheet #18 of the QAPP.

8.3 Sample Packing and Shipping

8.3.1 Sample Custody

Sample collection and sample custody procedures are designed so that field custody of samples is maintained and documented. These procedures provide identification and documentation of the sampling event and the sample chain of custody from shipment of sample containers, through sample collection, to receipt of the sample by the subcontracted laboratory. When used in conjunction with the laboratory's custody procedures and the sample bottle documentation, these data establish full legal custody and allow complete tracking of a sample from preparation and receipt of sample bottleware to sample collection, preservation, and shipping through laboratory receipt, sample analysis and data validation. The chain of custody is defined as the sequence of persons who have the item in custody.

Field custody procedures are described below and in SOP 101. Sample collection procedures concerning sample identification and documentation, field log book, sample containers, sample packing, and sample shipping are described.

8.3.2 Chain of Custody

The field chain of custody Record is used to record the custody of all samples or other physical evidence collected and maintained. This form shall not be used to document the collection of duplicate samples. Duplicate sample information will be documented in field log books. The chain of custody Record also serves as a sample logging mechanism for the analytical laboratories' sample custodian.

The following information must be supplied in the indicated spaces in detail to complete the field chain of custody Record:

- The project number;
- The project name;
- The signatures of all samplers and/or the sampling team leader in the designated signature block;
- The sampling station number, date, and time of sample collection, grab or composite sample designation, and sample preservation type must be included on each line (each line shall contain only those samples collected at a specific location);
- The sampling team leader's name should be recorded in the right or left margin of the chain of custody Record when samples collected by more than one sampling team are included on the same form;
- The total number of sample containers must be listed in the indicated space for each sample. The total number of individual containers must also be listed for each type of analysis under the indicated media or miscellaneous columns. Note that it is impossible to have more than one media type per sample;
- The field investigator and subsequent transferee(s) must document the transfer of the samples listed on the chain of custody in the spaces provided at the bottom of the form. Both the person relinquishing the samples and the person receiving them must sign the form; the date and time that this occurred must be documented in the proper space on the form. Usually, the last person receiving the samples or evidence should be a laboratory sample custodian; and
- The remarks column at the bottom of the form is used to record air bill numbers or registered or certified mail serial numbers.

Once the Record is completed, it becomes an accountable document and must be maintained in the project file. The suitability of any other form for chain of custody should be evaluated upon its inclusion of all of the above information in a legible format.

8.3.3 Sample Packing and Shipping

Per SOP 102, samples are packed for shipping in watertight packaging within ice chests and coolers or similar containers. Depending upon container type, the sample containers may be individually sealed in Zip-loc® or other similar plastic bags, prior to packing them in the cooler with bubble wrap or Styrofoam packing. Wet ice will be bagged in zipper-top plastic bags and placed with the samples in the cooler to maintain the samples at a temperature of $\leq 6°C$ during shipping.

The chain of custody Record identifies the samples is signed as "relinquished" by the principal sampler or responsible party. This Record is sealed in a waterproof plastic bag and is placed inside the cooler, typically by taping the bag to the inside lid of the cooler. A duplicate copy of the chain of custody Record will be maintained by the Field Team Leader.

Following packing, the cooler lid is sealed with packing tape. A custody seal is signed, dated, and affixed from the cooler lid to the cooler body and is additionally covered with clear tape. This ensures that tampering with the cooler contents will be immediately evident.

The sample coolers will be shipped by overnight express courier to the laboratory. A copy of the shipping invoice is retained by the Field Team Leader and becomes part of the sample custody documentation.

The Field Team Leader should contact the laboratory ahead of time to inform laboratory personnel of the number of samples, analytes, courier service, and other pertinent information to ensure the integrity of sample results. All shipping procedures will comply with Department of Transportation regulations (49 CFR 173 to 177) and the International Air Transportation Association.

SECTION 9

REFERENCES

CH2M Hill, December 2011. "*Draft Feasibility Study, Gowanus Canal*."

CH2M Hill and HDR, January 2011. *"Gowanus Canal Remedial Investigation Report."*

Dolan Research, Inc., December 2010. *"Side Scan Sonar Report: Gowanus Canal Preliminary Bulkhead Study. Brooklyn, Kings County, NY."*

Geosyntec Consultants, January 2014. *"Pre-Design Work Plan, Gowanus Canal."*

GEI Consultants, Inc., April 2007. *"Draft Remedial Investigation Technical Report: Gowanus Canal Superfund Site, Brooklyn, New York."*

ATTACHMENT B

STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE NO. 100
RECORDING STATION LOCATION POSITION WITH A GPS

SECTION 1 INTRODUCTION

1.1 Objective

The objective of this standard operating procedure (SOP) is to establish standard procedures for recording sample location position with a global positioning system (GPS). Recording the location of field acquired data is essential to understanding contaminant distribution and necessary if returning to the location of collection is necessary during future sampling activities.

This SOP provides basic steps to guide the process of collecting, editing, and reporting accurate spatial data using Global Positioning System (GPS) technology. The intended audience of this document includes all personnel involved in planning and conducting GPS surveys, as well as processing and reporting GPS data sets. This SOP is not intended as a detailed user manual for specific brands of GPS receivers, operating systems or software applications.

1.2 GPS Receiver Types

There are three classes of GPS receivers:

- Recreational "hand-held" receivers: for basic navigation; accurate to within 15 meters with a 95% confidence.
- Mapping-grade receivers: for storing mappable features; accurate in the 1 to 5 meter range; allow for post-collection differential correction.
- Geodetic-grade receivers: for applications that require extremely high accuracy, often to less than a centimeter.

The project-specific needs will determine the type of GPS receiver that is required to be used. A geodetic-grade receiver is not covered in this SOP, as it use would be limited to a surveyor specifically trained and subcontracted to the project for this purpose. Use of the hand-held receiver and mapping receiver are covered; however, the specific unit's owner's manual should additionally be consulted. Generally, fixed locations, such as soil and sediment samples, will be captured using a mapping-grade GPS and mobile resources, such as general areas of surface water collection or biota surveys, will be captured using a hand-held GPS.

1.3 Equipment

- GPS receiver and antenna
- GPS owner's manual

- Writing tools (pencils, Sharpie®)
- Field log book
- Spare batteries and/or battery charger
- Compass
- Tape measure

SECTION 2 PLANNING AND IMPLEMENTING A GPS SURVEY

The following sections outline the basic steps involved in systematic planning and conducting a GPS survey. In order to complete a successful GPS survey, several steps must be taken prior to using the receiver in the field. These steps will apply to the use of any of the various GPS receivers.

Field teams are encouraged to ensure that personnel are cross-trained to perform GPS coordination activities. Alternatively, field team may consider appointing and training interested staff members to serve as GPS coordinators. Most of the steps in the pre-survey and post-survey process will be conducted in conjunction with, or entirely by, the GPS coordinator. Equipment may be on loan to those employees who have been trained on the use of the GPS receiver. Those who require training or feel that retraining is necessary must notify the GPS coordinator well in advance of a proposed GPS survey so arrangements can be made for training.

2.1 Preplanning Activities

The Field Team Leader should develop the following planning items in cooperation with the GPS coordinator.

1. **Define Objectives of the Survey**

   It is important to initially establish the ultimate objectives of a GPS survey, including Data Quality Objectives (DQOs). Recognition of these objectives early in the project planning process will help to focus the rest of the planning phase. The accuracy requirements for the positional data must be defined and should be consistent with available program guidance on positional accuracy. In the absence of published program guidance on positional accuracy tiers to meet specific program needs, the following Interim Quality Categories provide benchmarks for establishing quality controls based on the intended use. Data collections for Category I use would dictate more stringent quality controls and potentially higher accuracies than Category IV use.

   Category I: For enforcement, litigation, direct support of rules & regulations, projects of national significance and highly influential scientific assessment

Category II: Development of rules & regulations and influential scientific information

Category III: Validation, general applications and feasibility studies

Category IV: Screening, exploratory and pure knowledge

From the discussion above, some distinct survey objectives may include:

- Registration of remotely sensed photography or imagery with ground control locations to support enforcement actions.
- Evaluation of locational data quality of existing data to validate survey maps, and
- Collection of new data following precise coordinates in a monitoring plan to support rule development.

NOTE: On a case-by-case basis, the user should consider the impact of various factors when determining the appropriate QA Category. These factors include, but may not be limited to:

- National Geospatial Data Policy (NGDP) Accuracy Tiers
- Dwell Time
- Number of Monuments, etc.
- QA categorization of Dilution of Precision (DOP) is provided as a suggestion/example below - section (7) Equipment Testing and Logistics.

2. **Define Project Area**

This step is designed to establish the overall project area and define the limits of the survey. Maps and/or aerial photos should be utilized extensively to familiarize the crew with the area prior to the actual field work. For identifying the study area and surrounding environment, 7.5-minute topographic maps are ideal. For locating particular sites by address, a local street map will be required. A complete understanding of the transportation network in the project area will also enable the field crew to maximize the effectiveness of their field time. Much of this information may already be available in digital form and may be used directly in conjunction with GPS site planning as well as validating the capture of the GPS locations.

3. **Determine Observation Window and Schedule of Operations**

This step involves determining the precise window of satellite availability and scheduling accordingly. With approximately 31 GPS satellites and 9 GLONASS satellites available for use, satellite links generally are restricted for very short periods of time (usually less than 40 minutes in a continuous block of time and less than 1 hour during a 12-hour time period) during the day, in open environments. However, in cities with many nearby tall buildings, GPS signals may be difficult to receive. Updated satellite configuration and orbit information can be accessed via the Internet. "Trimble Planning Software" from Trimble Navigation is an easy-to-use software program which provides information critical to the various components of planning a GPS survey: satellite availability, elevations, azimuths, and Geometric Dilution of Precision (GDOP) calculations. However, there are many other easy to use software programs to assist users in updating. Some sites may be specifically designed for desktop, laptop, or handheld devices. Site sources and URLs may change frequently, therefore, users are encouraged to find the best site for their hardware and purpose, and ensure that the source of update is recorded in a notebook. For differential corrections against a base station, the rover must "see" the same satellites as the base. Accuracy is heavily dependent upon the amount of observation time and number of observations taken at each point. It is generally agreed that observation time can be reduced by increasing the quality of observation, i.e., observing a maximum number of satellites during viewing periods.

NOTE: "Trimble Planning Software" [2.74 (.zip file)] can be downloaded from

http://www.trimble.com/planningsoftware_ts.asp

Download and install "Installation Program for Planning" software. Download the GPS satellite almanac from Trimble GPS Data Resources. If you are in an area with obstructions, select File-Station and click obstacles to enter the elevation and azimuth to define the obstruction. You should then be able to display the DOP relating to that location to better plan your survey. If you are occupying multiple stations at the same time, use File - Multistation in addition to defining the information for each station.

4. Establish Control Configuration

For high accuracy work, generally sub-meter range, known control points and/or benchmarks should be located for both horizontal and vertical control. This is usually accomplished by researching the records of various federal, state, and local agencies such as the National Geodetic Survey (NGS) or the state geodetic survey. It is advisable to have, if possible, at least two control points each for both vertical and horizontal positions so that there is a double check for all control locations. Vertical accuracy is typically half of the horizontal accuracy. Any additional control points may be done by using centimeter GPS. NGS benchmark information can be obtained at http://www.ngs.noaa.gov. NOTE: When high accuracy readings, such as sub-meter range, are required for a project, such as a Category I, the user must have substantial technical know-how, perhaps high-end GPS hardware and definitely advance preparation. For the Category I project types, users may consider contracting for professional land surveyor services. Data obtained by non-certified personnel may be inadmissible in litigation. Project Officers are encouraged to contact their local Office of General Council for consultation regarding concerns of admissibility.

It is important that the reference datum within which the monument is located be defined. For horizontal coordinates, the North American Datum of 1927 (NAD 27) or the newer Datum of 1983 (NAD 83) will be specified. For vertical control coordinates, the National Geodetic Vertical Datum of 1929 (NGVD 29) or the new North American Vertical Datum of 1988 (NAVD 88) will be referenced. If the NGS has redefined the benchmark coordinates to correspond to the newer datums, coordinates will be available for both datums. In translating GPS elevations to vertical elevations, the geoid used should be identified.

5. Select Survey Locations

Obtain a list of the facilities or features targeted for data collection. One suggested approach is to organize the site lists alphabetically by city and alphabetically by street name within each city as well as by zip code. This approach will facilitate initial route planning to visit each survey location and serve as a master list. If possible, plot the general location on a field map and highlight a local street map to serve as a general navigation aid. Similarly, project personnel should also plot potential base stations to serve as control points on a 7.5-minute topographic map and local street map. The survey points/areas should have continuous and direct line-of-site to the path of the satellites in the sky. If the survey point to be obtained is located on private property, care should be taken to pursue appropriate notification and access protocol. This includes preparation of a letter of introduction and formal contact with the property owner/manager.

6. Co-ordinate Pre-Survey Plans

The Field Team Leader should contact the GPS Coordinator to identify and discuss the following items prior the GPS survey:

- **Objectives.** Objectives of the survey, particularly Data Quality Objectives since DQOs will highlight required data accuracies (sub-meter, 1-5 meters) and in turn, dictate the type of equipment needed. Identification. Identification of the numbers of features to be mapped and time allotted for the survey.
- **Availability.** The availability of the GPS equipment for the required dates. Features. What features will be mapped, sample point location identification, and how they should be represented (points, lines, areas).

- **Checklist.** A checklist of each feature to be mapped so that none will be overlooked in the field.
- **Site Maps.** Site maps for determining survey location with the identification features to be mapped and mapping sequence.
- **Reconnaissance.** Determine the presence of any obstructions to satellite signals such as buildings or tree canopies.
- **Data Format and Storage.** Data capture requirements and data format to facilitate postprocessing at the conclusion of the survey.

7. **Equipment Testing and Logistics**

Action items for equipment testing and logistics include determination of equipment availability (laptop PDA, GPS units, and transport vehicle), checking equipment for necessary repair and maintenance (batteries charged in PDA and GPS unit, laptop or PDA loaded with necessary software and map data), and ensuring that the receiver is functioning properly. Operation manuals provided by the vendor should be referenced to complete system checks on the equipment.

Modern GPS units contain many settings that can serve as quality checks during data acquisition. For instance, a minimum number of visible satellites can be specified for data acquisition. The unit will provide a warning signal if less than the minimum specified are available. Four satellites in view are the minimum required, but additional satellites can provide the receiver with stronger signals to select from and perhaps better geometry for calculation. GPS receivers can also calculate a DOP value for horizontal (HDOP), for time (TDOP) and general position (PDOP). Position Dilution of Precision (PDOP) is most often referenced with lower values leading to more accurate measures. PDOP values of 6 or less are generally acceptable and limits on PDOP can be programmed into the unit or software that interfaces with the receiver. See table titled DOP Values in Relation to Data Quality Categories below:

DOP Values in Relation to Quality Categories

DOP Value	Rating	Description	Suggested for Quality Category
1	Ideal	Highest possible confidence level.	I
2-3	Excellent	Meets all but most demanding	I or II

		needs.	
4-6	Good	Appropriate for most needs.	II, III, or IV
7-8	Moderate	For less demanding uses. Positional measurements could be used for calculations, but the fix quality could still be improved. A more open view of the sky is recommended.	IV
9-20	Fair	Low confidence level. Positional measurements should be discarded or used only to indicate a very rough estimate of the current location.	Not recommended
>20	Poor	Very low confidence level. Measurements are inaccurate by as much as half a football field and should be discarded	Not recommended

2.2 Survey Execution

The actual GPS survey consists of:

1. **Establishing a Schedule of Operations**

   This step involves determining the window of satellite configuration availability and scheduling the GPS sessions. The schedule is dependent on the size of the crew, the level of accuracy desired, and the logistics of setup and travel between control points. Maximum data quality and collection efficiency can be obtained by arranging data collection periods to coincide with periods of 3-D or better satellite visibility.

2. **Pre-Survey: The Day Before**

   Charge all batteries, make note if GPS unit(s) can be charged through the automobile. Many GPS collection systems utilize a battery system which requires either 8-hour or overnight charging. Review the travel routes to survey sites and base stations, if required, and coordinate with local personnel. Review use of unfamiliar equipment and understanding of procedures.

3. Pre-data Collection: Establishing a Base Control Station(s)

The type of survey will dictate if any base control stations in the field are required. If required and the location(s) is not secure or if the data collection period is particularly long, part of the survey crew may be required to remain at the site. Logistical considerations will need to be scheduled, i.e., shut down periods for downloading files, changing battery packs, and when to terminate collection. Once a setup at a base station begins, the GPS units will need to be initialized. Depending upon the location and familiarity with equipment, this activity can take anywhere from a few minutes to a couple of hours.

4. Data Collection: Performing the GPS Survey

The crew must warm up, check, and program the receiver for proper operation. Most vendors currently recommend collecting fixes for discrete point data for a period of 3-5 minutes, at 1-or 2-second intervals. Vendor documentation should be consulted for the recommended time on station and sample interval to obtain the most accurate results. Depending on the unit being utilized, sufficient battery power must be available. For high accuracy work, the receiving antenna should be leveled on a tripod and centered exactly over the control point location. Log sheets containing critical information on position, weather, timing, height of instrument, and local coordinates must be maintained. Once the session is completed, the receiving equipment must be disassembled and stored. The log and tape files should then be documented and saved. If the survey to be performed will span numerous days, it is likely that the data will be transferred from the GPS to a laptop PC with some regularity. Data from the base station as well as the roving unit will need to be collected with equal frequency.

2.3 Data Assessment, Processing and Validation

Post-processing should be conducted after returning from the field. Tools for post-processing are more easily used and controlled in an office environment. The common steps in post-processing are transferring the data from the field to office workstations, conducting the initial stages of processing, computation of the solutions for critical factors, data conversion for use in a GIS, and the final documentation and reporting. Each of these stages is discussed in detail below. Data assessment and validation should integrate in each stage.

1. Data Transfer

There are currently two common methods of collecting data in the field: using a GPS unit with a data logger or using a GPS unit attached to a laptop/notebook/PDA computer. With the latter method some users subsequently perform all processing directly on the same device. More commonly, data are transferred into a computer. This consists of reading the raw data from the GPS unit into a structured data base for processing. As with any computer data, backup copies should be made immediately. Validation should consist of reviewing the contents of the data logger or computer file against the survey plan and field notes to ensure that the data transfer has occurred properly and that file and directory names are adequate to link the data to specific field operations or features.

2. Data Assessment and Initial Processing

The electronic GPS data stream may not be immediately useable. It normally consists of satellite navigation messages, phase measurements, user input field data and other information that must be transferred to various files for processing before computations can be accomplished. Depending upon the hardware and software vendor, many of these operations are transparent to the user.

In some instances, depending on the type of maintenance and upgrades that are going on to the NAVSTAR constellation at the time of the survey, utilization of the actual ephemeris rather than the ephemeris projected prior to the survey date may improve solution accuracy. Actual ephemerides are available 2 weeks after a given survey date.

In the data screening and editing, there are at least three considerations that might be taken in editing. Outlier position data can be removed from a data file. This editing should be guided by establishing an absolute deviation threshold, using the mean coordinate as a reference. The threshold criteria might be varied to determine the sensitivity of the solutions to this editing. Data points collected immediately after a break in the data stream, such as in the event of masking, should be edited out because these positions will be less reliable.

The majority of processing operations are typically performed "automatically" by the application software. Occasionally, the scientist (or operator) may need to override automatic computer operations. In these instances, scientist (or operator) should document the judgments made and identify the manual operations in the appropriate notebook.

3. Computation

This component uses the preprocessed data to compute the network of sites and give a full solution showing geographical coordinates (latitude, longitude and ellipsoidal height), distances of the vectors between each pair of sites in the network, and several assessments of accuracy of the various transformations and residuals of critical computations. This is usually accomplished by the vendor post-processing software and may be transparent to the user.

4. **Data Conversion to GIS**

   Data conversion is accomplished by use of data export utilities provided by the GPS vendor. These utilities should accompany the data processing software packaged with the GPS equipment. Example formats are: ArcView, ArcGIS, dBase, ASCII, MapInfo, AutoCAD, etc. Before exporting, ensure that the correct coordinate system and datums are chosen. The default coordinate system should be the Geographic Coordinate System which provides unprojected latitude/longitude values. The default datum is NAD83 for horizontal coordinates and NAVD88 for vertical coordinates. Note that GPS units initially capture data using the WGS84 horizontal datum but can be usually converted to the NAD83 datum during the data export process. Care should be taken in reporting the proper datum upon completion of the conversion process.

SECTION 3 TYPICAL RECORDING PROCEDURES

This section provides the typical procedures to be followed when recording the location of field acquired data.

1. Turn GPS on outside in an open area. Wait for antenna to receive satellite signals. Continue to wait until a minimum number of satellites are acquired to achieve an appropriate PDOP (see Section 2.1 for ranges).
2. Move the GPS to the location of the sample. Try to remain still or if on a boat ensure that the boat is still. Press the appropriate key strokes to mark a waypoint (see Owner's Manual).
3. Record the waypoint name in the field logbook. It is good practice to also record the coordinates (latitude and longitude). If the GPS is capable of downloading waypoint names and associated coordinates to a file readable by PC, then recording the coordinates in the logbook may be skipped.
4. If the GPS cannot be placed on the location of the sample record the distance and compass direction to the location as an "offset". This information should be recorded in the field logbook and used to correct the position at a later time.
5. At the end of each day, if equipped, the data file should be downloaded to a PC and transmitted to the project data manager for incorporation into the project geographic information system (GIS).
6. If the coordinates are recorded by hand in the field log book, they should be entered into a spreadsheet with the sample location name and submitted to the project data manager for incorporation into the project GIS.

STANDARD OPERATING PROCEDURE NO. 101
FIELD DOCUMENTATION, SAMPLE DESIGNATION, CUSTODY AND HANDLING PROCEDURES

SECTION 1 INTRODUCTION

The integrity of each sample from the time of collection to the point of data reporting must be maintained throughout the study. Proper record keeping will be implemented in the field to allow samples to be traced from collection to final disposition. All information relevant to field operations must be properly documented to ensure that activities are accounted for and can be reconstructed from written records. Several types of logbooks will be used for this purpose and should be consistently used by field crews (e.g., field logbooks, field data sheets). This document describes the procedures to be followed for field documentation, sample designation, handling, and custody.

1.1 Referenced Documents and SOPs

- Health and Safety Plan (HASP),
- Quality Assurance Project Plan (QAPP)
- Field Sampling Plan (FSP)
- SOP 102 Procedure to Prepare Samples for Shipment

SECTION 2 FIELD DOCUMENTATION

2.1 Field Documentation

During field sampling events, field logbooks and field data sheets are used to record all daily field activities. The purpose of the field logbook is to document events that occur and record data measured in the field.

Data entry will be made in a bound, waterproof field logbook with consecutively numbered pages using indelible ink for each sampling event; all entries will be signed and dated and no erasures will be made. All corrections should consist of a single line-out deletion, followed by the sampler's initials and the date. The sampler will sign and date the last page at the end of each day, and a line will be drawn through the remainder of the page.

The project name, site name and location, and dates of sampling activity should be written on the cover of the field logbook. If more than one logbook is used during a single sampling event, then the upper right hand corner of the logbook will be annotated (e.g., 1 of 2, 2 of 2) to indicate the number of logbooks used during the field event. Alternatively, multiple logbooks could be used for different sampling activities (e.g., one logbook for surface water sampling and one for groundwater sampling). When multiple logbooks are used for a single sampling activity (e.g., 2 or more sampling teams operating simultaneously during a single surface water sampling event) logbooks should be annotated alphabetically to indicate which of those books is the primary, secondary, etc. logbook for that sampling activity, followed by the number of the logbook. For example if surface water sampling requires 3 teams and each have a logbook to record daily activity over the sampling event then the primary book will be labeled "Log Book A-1" and the others as "B-1" and "C-1." When only one team is on site, they will use the primary (A) logbook. Field logbooks will be stored in a secure manner when not in use in the field.

In addition to the field logbook, supplementary field data forms may be used during a field sampling event (e.g., Station/Sample Log, Groundwater Monitoring Form, Sediment Core Profile Form) to record the relevant sample information collected during a sampling event. At a minimum, the sampler will record the following information daily in the field logbook or on a field sampling form, as applicable:

- Project name, project location, and project number
- Project start date and end date
- Date and time of entry (24-hour clock)
- Time and duration of daily sampling activities
- Weather conditions at the beginning of the field work and any changes that occur throughout the day, including the approximate time of the change
- Name of person making entries and other field personnel, including the times that they are present
- Onsite visitors, if any, including the times that they are present
- The name, agency, and telephone number of any field contacts
- The sample number and analysis code for each sample to be submitted for laboratory analysis
- All field measurements made (unless specific data sheets are available for this purpose), including the time that the measurement was collected
- The sampling location name, date, gear, water depth (if applicable), and sampling location coordinates
- Type of sample gear used (e.g., pump type or model, gill net mesh size, size of core barrel)
- The location and description of the work area, including sketches and map references, if appropriate
- Specific information on each type of sampling activity
- The sample type (i.e., groundwater, soil, surface sediment), and sample number

- Cross-references of numbers for duplicate samples
- A description of the sample (source and appearance, such as soil or sediment type, color, and odor)
- Log of photographs (number taken, photo number on roll or memory card, brief description of photo) taken at the sampling location, if any
- Variations, if any, from specified sampling protocols and reasons for deviation
- References to other logbooks used to record information (e.g., field data sheets, health and safety log).
- The signature of the person making the entry.

Monitoring or sampling equipment information, including installation information, any maintenance performed on each piece of equipment, calibration information, and other observations relating to the operation or condition of the equipment, will be recorded on field forms, in field logbooks, and/or in a separate field logbook maintained for a specific type of monitoring or sampling equipment. Upon completion of the field sampling event, the field team leader will be responsible for submitting all field logbooks and field data forms to the project data manager to be copied. Hard copy and an electronic copy shall be maintained in the project files.

SECTION 3 SAMPLE DESIGNATION AND HANDLING

3.1 Sample Labels

A self-adhesive, non-removable label will be affixed to each sample container and completed with an indelible marker prior to sample collection. Sample labels will contain the following information:

- Site name;
- project number;
- a unique sample identification number (see project-specific FSP for correct sample designation nomenclature);
- initials of sample collector(s);
- time and date collected;
- analysis required; and
- sample preservative (if applicable).

If samples are likely to contain high concentrations of VOCs or other analytes, the samples will be identified on the chain-of custody forms. Field duplicate or replicate samples will require special procedures for sample designation to ensure that they are submitted as blind samples to the laboratory. The well identification or sample location will not be included in the sample identification number and the collection time will be left blank but recorded in the field log book. The sample and corresponding field QC sample information will be documented in the field records.

3.2 Sample Handling

Each sample container will be sealed in a separate plastic bag following collection. Samples will then be stored in an insulated cooler containing ice packs or ice sealed in a plastic bag. If samples are not immediately shipped to the laboratory, they may be stored in a securerefrigerator/freezer and maintained at the proper temperature. Samples selected for laboratory analysis will be transferred to insulated coolers for overnight shipment to the laboratory. All samples shipped will be carefully checked against the chain-of-custody form (discussed below). Each cooler will be packed in a manner that will prevent damage to sample containers during shipment in accordance with SOP 102.

3.3 Sample Custody and Documentation

Chain-of-custody forms will be used to trace the possession and handling of all samples, from their collection, through analysis, until their final disposition. These forms will document the names of the relinquishing and receiving parties, the time and date of the transfer of custody, and the reason for the transfer of custody. One chain-of-custody form will accompany each cooler shipped to the laboratory. In the event that multiple coolers of samples are being sent to the same location, a unique, task specific, sample shipment group identifier and the number of coolers will be added to the top and special instructions portions of each chain-of-custody. The identifier will include the sample task (e.g., SW for surface water, SED for sediment), sample shipment group (SSG), date (year followed by day of year), and cooler destination (e.g., PITT for Test America Pittsburgh, NC for Test America North Canton). The chain-of-custody form will be placed in a sealed plastic bag inside the cooler. A custody seal will be placed on each cooler after packing and prior to shipment. For multiple cooler shipments, the sample shipment group identifier listed on the chain-of-custody will be written on the custody seal, as well as the cooler number designation (e.g., cooler 1 of 2, cooler 2 of 2). Shipping of samples to the laboratory will be accomplished by Federal Express or equivalent overnight service. Samples will remain in the custody of the sampling team until custody is relinquished to the courier service that will transfer the samples to the laboratory. Each sample shipment will be tracked via the courier weigh bill number to ensure that prompt delivery of the shipment to the laboratory has occurred.

Upon receipt by the laboratory sample custodian , the Sample Custodian will note on the form whether the custody seal is intact, the cooler temperature, the presence of air bubbles in any of the water samples submitted for VOC analysis, any damaged sample containers and/or discrepancies between the sample label and information on the form, and sign and date the form. A copy of the chain-of-custody form will then be transmitted to the Project Manager or their designate for their records.

STANDARD OPERATING PROCEDURE NO. 102
PROCEDURE TO PREPARE SAMPLES FOR SHIPMENT

SECTION 1 INTRODUCTION

1.1 Objective

The objective of this standard operating procedure (SOP) is to establish packaging and shipping requirements and guidelines for environmental sample shipping. Proper packaging and shipping is necessary to ensure the protection of the integrity of environmental samples shipped for analysis.

1.2 Referenced Documents and SOPs

- Health and Safety Plan (HASP)
- Quality Assurance Project Plan (QAPP)
- Field Sampling Plan (FSP)

1.3 Task-Specific Equipment

- Coolers with an appropriate return address taped to the inside lid
- Heavy-duty, large plastic garbage bags
- Plastic Zip-lock bags, small and large
- Writing tools (pencils, Sharpie®, etc.)
- Fiber tape
- Duct tape
- Packing peanuts (optional)
- Bubble wrap (optional for plastic sample containers; required for glass sample containers)
- Wet ice or dry ice (depending on sample requirements and availability)
- Chain-of-Custody seals
- Completed Chain-of-Custody record or CLP custody records if applicable
- Completed Bill of Lading

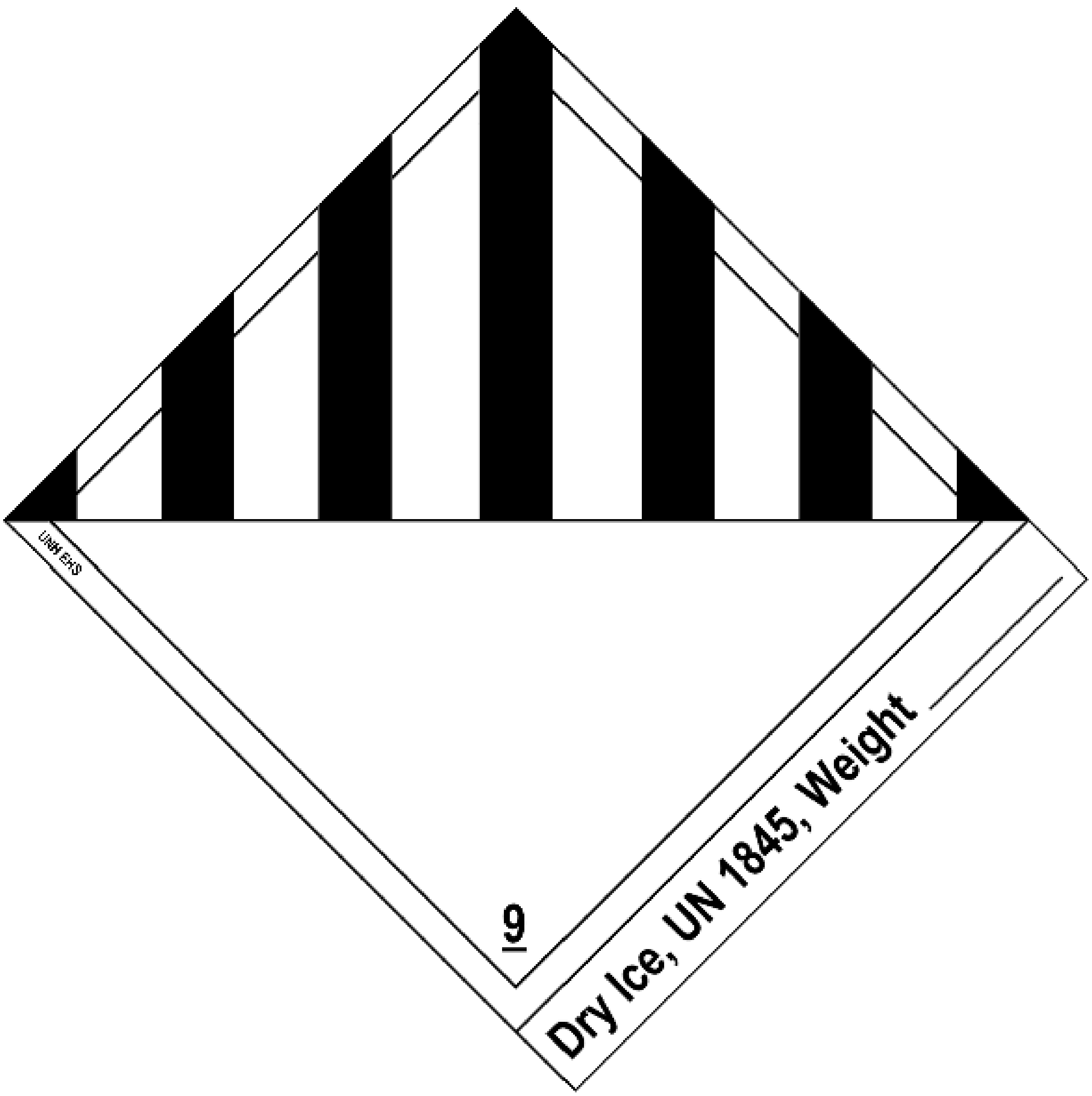
The term "Environmental Sample" refers to any sample that has less than reportable quantities of any hazardous constituents according to Department of Transportation (DOT) 49 CFR - Section 172.

SECTION 2 PROCEDURES

The following steps must be followed when packing for shipment by air:

1. Select a sturdy cooler in good repair. Secure and tape the drain plug (inside and outside) with duct tape.
2. Be sure the caps on all bottles are tight (will not leak); check to see that labels and chain-of-custody records are completed properly.
3. Place all bottles in separate and appropriately sized plastic zip-top bags and close the bags. Up to three VOA vials may be packed in one bag. Glass bottles will be wrapped in bubble wrap. All sample bottles and jars will be placed in the cooler vertically. Due to the strength properties of a glass container, there is much less chance for breakage when the container is packed vertically rather then horizontally.
4. Place two inches of bubble wrap or packing peanuts into the heavy-duty, large garbage bag in the cooler and then place the bottles and cans in the bag with sufficient space to allow for the addition of ice between the bottles, jars, and cans.
5. Put ice in large plastic zip-top bags (double bagging the zip-tops is preferred) and properly seal. Place these ice bags on top of, or between, the samples. Place a temperature blank in the cooler. If necessary, any additional space in the cooler (after sufficient ice has been included) should be filled with more bubble wrap or packing peanuts to prevent the samples from shifting within the cooler during shipping.. Securely fasten the top of the large garbage bag with tape (preferably duct tape).
6. Place the completed Chain-of-Custody Record for the laboratory into a plastic zip-top bag, close the bag and tape it to the inner side of the cooler's lid, and then close the cooler.
7. Completed Chain-of-Custody seals are affixed to the top opposite sides of the cooler. Wrap clear tape over custody seals. Fiber tape shall be wrapped around the cooler opening and around the width of the cooler a minimum of two times half on the fiber tape so that the cooler cannot be opened without breaking the seal.
8. The shipping containers must be marked with FRAGILE, THIS END UP, and arrow labels, which indicate the proper upward position of the container. A label containing the name and address of the shipper shall be placed on the outside of the container. Labels used in the shipment of hazardous materials (such as Cargo Only Air Craft, Flammable Solids, etc.) are not permitted to be on the outside of the container used to transport environmental samples and shall not be used. The exception to this is for samples that are to be shipped frozen on dry ice. These sample containers must labeled with the proper dry ice label (see attached) with the quantity of dry ice indicated.

9. The sample coolers are typically shipped by overnight express courier to the laboratory. Securely attach the courier's shipping label with tracking number to the outside of the cooler. A copy of the shipping invoice is retained by the Site Manager and becomes part of the sample custody documentation.
10. The field manager should contact the laboratory ahead of time to inform laboratory personnel of the number of samples, analytes, courier service, and other pertinent information to ensure the integrity of sample results. All shipping procedures will comply with DOT regulations (49 CFR 173 to 177) and the International Air Transportation Association (IATA).



Dry ice label to be affixed to all coolers containing dry ice.

STANDARD OPERATING PROCEDURE NO. 103
DECONTAMINATION PROCEDURE FOR SAMPLING EQUIPMENT

SECTION 1 INTRODUCTION

This Standard Operating Procedure (SOP) was prepared to direct field personnel in the methods for decontamination of field equipment used in the investigation of sites with chemical Constituents of Potential Concern (COPCs).

1.1 Objective

The objective of equipment decontamination is to remove potential contaminants from a sampling device or item of field equipment prior to, between, and after collection of samples for laboratory analysis and limit personnel exposure to residual contamination that may be present on used field equipment.

1.2 Referenced Documents and SOPs

- Health and Safety Plan (HASP)
- Quality Assurance Project Plan (QAPP)
- Field Sampling Plan (FSP)
- SOP 104 Management and Disposal of Investigative Derived Waste

1.3 Task-Specific Equipment

The following equipment may be utilized when decontaminating equipment. Site-specific conditions may warrant the use or deletion of items from this list.

- Alconox, liquinox or other non-phosphate concentrated laboratory grade soap;
- Distilled/deionized water from the analytical laboratory
- Pump sprayers
- 1-pint squeeze bottles
- Pesticide-grade acetone
- 10 percent nitric acid
- One (1) percent nitric acid
- Five large plastic wash basins (i.e., 24 inches by 30 inches by 6 inches deep)
- Coarse scrub brushes

- Small wire brushes
- Aluminum foil
- Polyethylene sheeting
- High pressure portable steam cleaner and power supply
- Personal protective equipment (PPE) as required by HASP

SECTION 2 PROCEDURES

2.1 General

The following procedures should be used for decontaminating field equipment. Procedures will vary with equipment used and potential contaminants present at the site.

2.2 Procedure for Non-Aqueous and Aqueous Sampling Equipment

Soil and sediment sampling equipment, such as grab samplers, split spoon samplers, dredges, shovels, augers, trowels, spoons, bowls, and spatulas will be cleaned using the following procedure. (New, unused core liners should be rinsed with site water at the sample location prior to deployment.) Larger sample equipment such as the box corer and devices which employ a sample liner will be decontaminated per Section 2.3. Aqueous sampling equipment is to be cleaned in the same manner, although if the aqueous samplers will be used to trace level mercury analysis, all materials must be decontaminated in the laboratory according to EPA Method 1669.

1. Place five wash basins in an established decontamination area that has a low permeability liner (e.g., polyethylene) and secondary containment. The decontamination area must be of sufficient size to allow placement of the five plastic wash basins in a line, and provide an air drying area for equipment. Decontamination aboard marine vessels will need to follow the same procedures; however, the use of five staged wash bins may not be feasible due to space issues.
2. Fill the first wash basin with potable tap water. Add sufficient soap powder or solution to cause suds to form in the basin. Do not use an excessive amount of the soap or rinsing the soap residue off the equipment will be difficult.
3. Using a clean coarse scrub brush, wash the sampling equipment in the soap solution in the first basin, removing all traces of visible dirt. Be sure to wash inside surfaces of equipment as well as the exterior surfaces. Allow excess soap to drain off the equipment when finished.

4. Rinse the equipment with tap water in the second basin, using a clean coarse scrub brush or pressure sprayer to aid in the rinse, if necessary.
5. If the equipment is being used to sample for metals, rinse the equipment with nitric acid in the third basin. A 10 percent solution is used on stainless steel equipment. A one percent solution is used on all other equipment. If no metals sampling is being performed, this step may be omitted.
6. Spray down the equipment in the third basin, using potable tap water. Collect rinsate for disposal per SOP 104.
7. Spray down the equipment in the fourth basin, using pesticide-grade acetone, if sampling for organic compounds is to be performed. Collect any excess acetone for disposal per SOP 104. If no samples for organic compounds are being collected, this step may be omitted.
8. Allow the equipment to completely air dry on clean polyethylene sheeting.
9. Rinse the equipment in the fifth basin, using distilled/deionized water received from the analytical laboratory.
10. Allow the equipment to completely air dry on clean polyethylene sheeting.
11. Reassemble equipment, if necessary, and wrap completely in clean, unused aluminum foil, shiny side out for transport. Only immediate re-use of equipment on the same day without wrapping in foil is acceptable.
12. Spent cleaning solutions shall be drummed for disposal along with any other contaminated fluids generated during the field investigation for disposal per SOP 104.
13. Record the decontamination procedure in the field logbook or on appropriate field form.

Note that if temperature or humidity conditions preclude air drying equipment, sufficient spares should be available so that no item of sampling equipment need be used more than once. Alternatively, the inability to air dry equipment completely prior to reuse should be noted in the field logbook. In this case, additional rinses with distilled/deionized water should be used and recorded.

2.3 Procedure for Large Heavy Equipment

Because heavy equipment pieces (e.g., ATVs, drill rigs) are much larger than sampling equipment and generally come in less direct contact with sampling aliquots, a modified decontamination procedure is appropriate. The following steps outline the decontamination protocol for heavy equipment:

1. Place plastic sheeting on the ground large enough to accommodate equipment to be decontaminated. A decontamination pad may be necessary. The wash pad may consist of

a bermed area lined with plastic sheeting with a sump at one corner. A sump pump should be used to remove water from the sump and transfer it to a drum.

2. Use a high-pressure portable steam cleaner to remove potentially contaminated material from the equipment.
3. Scrub equipment with detergent and water to clean soiled surfaces.
4. Thoroughly rinse all surfaces.

STANDARD OPERATING PROCEDURE NO. 104
MANAGEMENT AND DISPOSAL OF INVESTIGATION DERIVED WASTE

SECTION 1 INTRODUCTION

This Standard Operating Procedure (SOP) establishes protocols for testing, storage, and disposal of Investigative Derived Waste (IDW). Disposal of laboratory test equipment and supplies will be handled in accordance with the laboratory QAPP.

1.1 Objective

IDW generated during this RI/FS may include:

- Sediments
- Surface water
- Biological tissues
- Personal Protective Equipment (PPE)
- Disposable sampling equipment
- Spent decontamination liquids
- Plastic sheeting, containers, etc.

The management of these IDW will be conducted to limit exposure of site personnel to hazardous materials and to prevent introduction of contaminated materials to uncontaminated environmental media at the site.

1.2 Referenced Documents and SOPs

- Health and Safety Plan (HASP)
- Quality Assurance Project Plan (QAPP)
- Field Sampling Plan (FSP)

SECTION 2 GENERAL MEDIA

All IDW identified as potentially contaminated with hazardous materials will be collected at the point of generation and later stored in a designated and clearly marked IDW management area. All containers/drums will also be clearly labeled to indicate the source of the IDW. The IDW storage area will be inspected daily to ensure that storage procedures are adequate to keep the

IDW isolated and contained. Potentially contaminated IDW will be identified based on its origin and olfactory and visual evidence (e.g., presence of NAPL). Laboratory testing will be required to determine the proper disposition of these IDW.

The volume of waste will be minimized whenever applicable. Soil, liquid, and personal PPE IDW will be segregated and separately containerized. The PPE and plastic sheeting will be disposed of as nonhazardous waste unless it has been grossly contaminated. Spent decontamination liquids will be containerized in drums and tested to determine the proper disposal method.

STANDARD OPERATING PROCEDURE NO. 105
PROCEDURE TO CONDUCT A TECHNICAL SYSTEM FIELD AUDIT

SECTION 1 INTRODUCTION

1.1 Objective

The objective of this standard operating procedure (SOP) is to establish standard procedure by which a technical field audit is performed. A technical audit is a systematic and objective examination of a program to determine whether the field activities used for the collection of environmental data comply with the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP) in order to meet the data quality objectives for the project. Technical audits may also be used as an investigative tool when problems are suspected. Technical audits will typically be announced but may be unannounced. The QAPP will be the basis for planning and conducting the technical audits.

The following types of technical field audits may occur:

- Readiness reviews are conducted before specific technical activities (e.g., sample collection, field work, and mobile lab analysis) are initiated to assess whether procedures, personnel, equipment, and facilities are ready for environmental data to be collected according the QAPP and FSP.
- Technical systems audits (TSAs) qualitatively document the degree to which the procedures and processes specified in the approved QAPP and FSP are being implemented.
- Surveillance is used to continuously or periodically assess the real-time implementation of an activity or activities to determine conformance to established procedures and protocols.

1.2 Referenced Documents and SOPs

- Health and Safety Plan (HASP)
- Quality Assurance Project Plan (QAPP)
- Field Sampling Plan (FSP)

1.3 Authority

The authority and independence of auditors, and the limits on their authority, must be clearly defined in the Quality Management Plan (QMP) and the project-specific QAPP. Prior to an audit, it is important to establish whether the auditors have the authority to stop or suspend work if they observe conditions that present a clear danger to personnel health or safety or that adversely affect data quality. Auditors should have sufficient authority, access to programs and managers, and organization freedom to:

- Identify and document problems that affect quality;
- Identify and cite noteworthy practices that may be shared with others to improve the quality of their operations and products;
- Propose recommendations (if requested) for resolving problems that affect quality;
- Independently confirm implementation and effectiveness of solutions; and
- When problems are identified, provide documented assurance (if requested) to line management that further work performed will be monitored carefully until the deficiencies are suitably resolved.

Auditors may be accompanied by EPA personnel as determined by the responsible organization and the contracting officer. However, if accompanied by EPA personnel, clear definition of the EPA representative's role and responsibility during the technical field audit shall be established prior to the audit.

1.4 Qualification

Auditors must have established qualifications in order to conduct a field technical audit. Three standards of qualifications follow:

- The auditor(s) assigned to conduct a specific audit should possess (individually or collectively) adequate professional proficiency to audit. This proficiency includes both technical and auditing skills necessary for the audit (this proficiency may be established by using more than one auditor).
- The auditor(s) shall be free from personal and external barrier to independence, organizationally independent, and able to maintain an independent attitude and appearance. This standard applied such that the audit findings will be both objective and viewed as objective by knowledgeable third parties.
- The auditors should use due professional care in conducting the audit and in preparing related reports. Auditors should use sound professional judgment in determining the standards that are to be applied to the audit. Exercising due professional care means using sound judgment in establishing scope, selecting the methodology, and choosing the tests and procedures for the audit. The same sound judgment should be applied in conducting the audit and in reporting findings.

ISO 10011-2-1994 states: "Auditor candidates should have a minimum of four years full-time appropriate practical workplace experience (not including training), at least two years of which should have been in quality assurance activities."

SECTION 2 PROCEDURES

The following steps must be followed when preparing, implementing, and reporting the results from a field technical audit:

2.1 Pre-audit activities

1. Planning – prior to implementing a technical field audit decisions should be made regarding what specific aspects of the project to assess, what type of audit to perform, and when and how often to perform the audit within the context of the QMP and the project-specific QAPP.
2. Audits should be performed early in a project to identify and correct deficiencies. Discovery of deficiencies at the beginning of a project may eliminate the need for re-sampling and analysis later on.
3. Select the type of audit to be performed. The graded approach should be used to guide audit planning decisions and to achieve the desired information. This ensures that audit resources are used effectively and efficiently where they are needed most. The level of effort in a technical audit is determined by the level of complexity and detail of the quality assurance and quality control procedures described in the project QAPP.
4. Selection of the audit team once the type of audit has been determined. Most audit teams consist of two individuals, a lead auditor supported by a supporting team audit member. However, audits may be performed by one auditor depending on the size and scope of the audit. Technical audits may be performed by auditors from Geosyntec or by independent, outside auditors.
5. Planning for an audit is critical for a satisfactory assessment performance. Audits should be properly planned to achieve quality results. The auditor or audit team shall review all pertinent project-specific documents (QAPP, FSP, Work Plan) prior to the audit. Also the following decisions should be made prior to an audit:
   - The authority for the audit,
   - The purpose and scope of the audit,
   - The type of audit to be conducted,
   - The performance standards of the audit,
   - The expected audit report format,
   - Any requirement for conclusions, recommendations, and suggested corrective actions,
   - The confidentiality and dissemination of the audit results,

- The identification of the client,
- The expected budget for the audit, and
- The schedule for the audit and its documentation/report.

6. The on site project personnel should be contacted regarding the upcoming audit.
7. An audit plan may be prepared prior to the audit depending on the complexity and scope of the audit.
8. Special forms and checklists may also be prepared prior to the audit. The use of a project specific checklist is recommended and should be developed as dictated by the needs of the project. All checklists should provide the following information regardless of the format or other content:
   - Identification of the auditor(s)
   - The audit date, and
   - The audit site.

2.2 <u>Audit activities</u>

1. Audit protocol shall be observed throughout the course of an audit. Auditors shall remain calm and professional at all times, particularly during interviews. It is the responsibility of the auditor(s) to establish an atmosphere of trust and cooperation.
2. An opening meeting should be conducted once on site. This meeting should be attended by the auditor(s), and all site personnel responsible for environmental data collection. The lead auditor will brief the attendees regarding the purpose and schedule of the audit.
3. A site tour should be completed prior to the beginning of project personnel interviews or work observation.
4. Work observation and project personnel interviews will be performed. This will include the following at a minimum:
   - Observation of the completion of documentation practices
   - Observation of the collection of samples
   - Observation of the calibration of field instrumentation
   - Observation of the handling, packaging, storage, and shipment of samples.
   - Document review.
5. Compilation of objective evidence during the audit will be achieved in the form of audit notes, copies of notebook pages, logs, and completed checklists.

6. The auditor shall evaluate the findings and observations against the specification of the project documents.
7. A closing meeting will be held at the end of the audit to brief the key field project personnel with regard to the findings and observations from the audit. During this meeting, project personnel will have the opportunity to address the findings and observations.
8. A draft audit report is submitted to the project manager. The draft audit report will summarize the findings and observation from the audit referenced against the project specifications and data quality objectives.
9. A final report will be prepared by the auditor once comments have been received and corrective actions implemented based on the draft audit report. The final report will be submitted to the project manager and copies will be distributed as specified by the QAPP.
10. Once all of the corrective actions have been verified and documented, the audit will be documented as "closed" through the issuance of an audit close-out letter.

National Grid
1 MetroTech Center
Brooklyn, New York 11201

HEALTH AND SAFETY PLAN

PRE-DESIGN WORK PLAN ACTIVITIES
GOWANUS CANAL SUPERFUND SITE
BROOKLYN, NEW YORK

Prepared by

Project Number:

February 2014

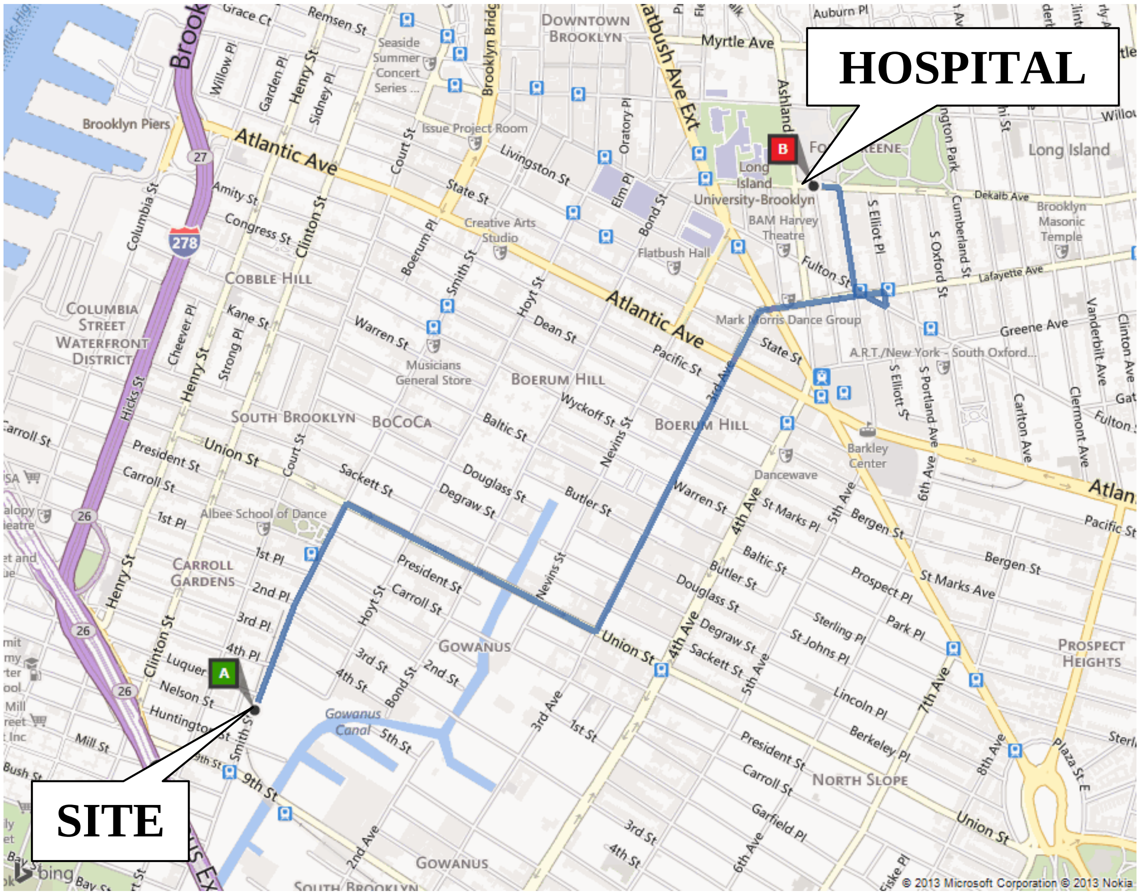
TABLE OF CONTENTS

APPENDICES

EHS Incident Response Procedures Flowchart

[Consultant/Engineer to insert Company-specific flowchart]

ROUTE TO HOSPITAL



BROOKLYN HOSPITAL CENTER

(718) 250-8000

121 DeKalb Avenue.

Brooklyn, New York 11205

Directions to Hospital from the Site:

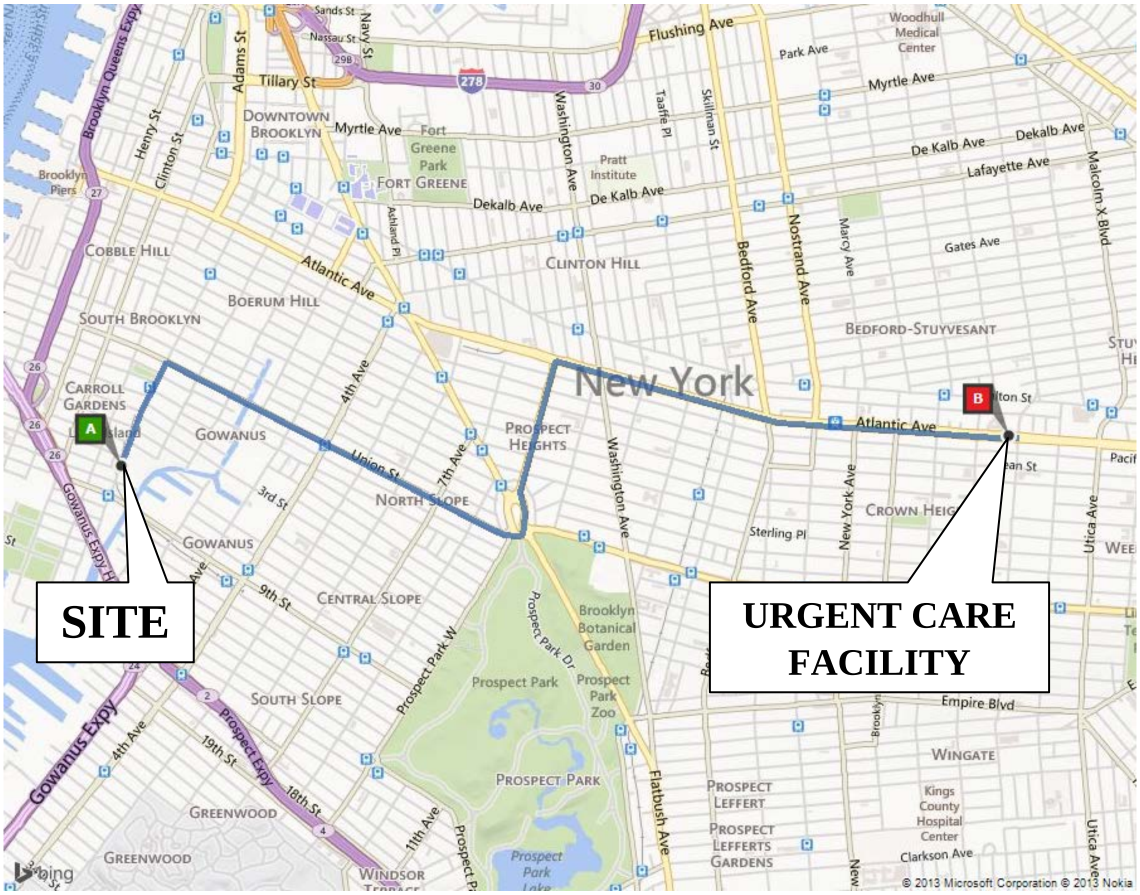
Starting at 455 Smith Street, Brooklyn, New York

1. Depart Smith Street toward Luquer Street (0.4 mi).
2. Turn right onto Union Street (0.5 mi).
3. Turn left onto 3rd Avenue (0.7 mi).
4. Keep straight onto Lafayette Avenue (0.2 mi).
5. Turn right onto South Elliot Place/South Elliott Street and then immediately turn right onto Fulton Street (482 ft).
6. Turn right onto Brooklyn Tech Place/Fort Greene Place (0.2 mi).
7. Turn left onto DeKalb Avenue (230 ft).
8. Arrive at 121 DeKalb Avenue, Brooklyn, New York 11201.

   The last intersection is Brooklyn Tech Place/Fort Greene Place.

   If you reach St. Fleix Street, you've gone too far.

ROUTE TO URGENT CARE FACILITY



INTERFAITH MEDICAL CENTER

(718) 613-4988

1545 Atlantic Avenue

Brooklyn, New York 11213

Directions to Urgent Care Facility from the Site:

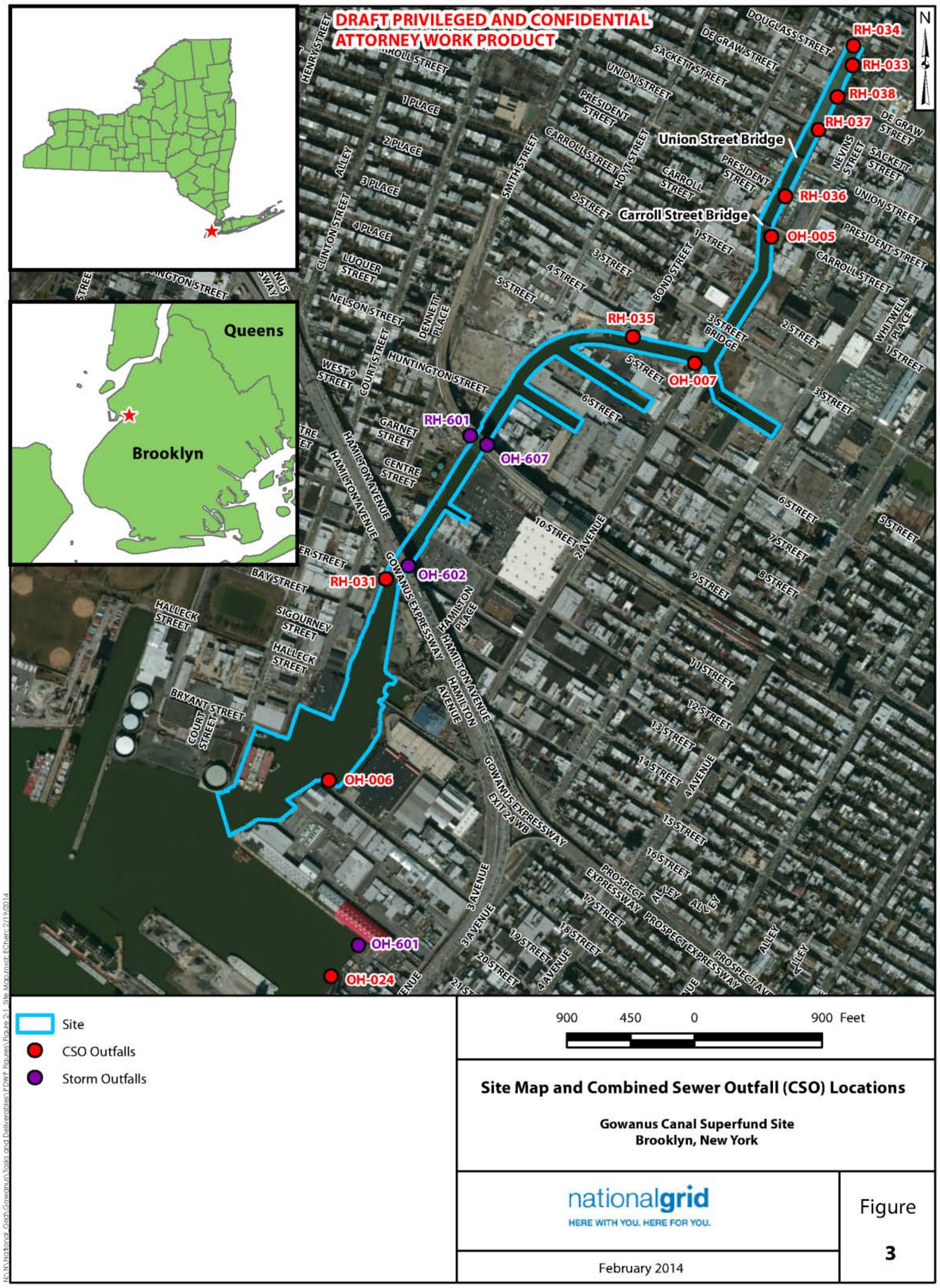
Starting at 455 Smith Street, Brooklyn, New York

1. Depart Smith Street toward Luquer Street (0.4 mi).
2. Turn right onto Union Street (1.4 mi).
3. Bear left onto Grand Army Plaza (16 ft).
4. Turn left to stay on Grand Army Plaza (0.1 mi).
5. Keep right onto Vanderbilt Avenue (0.5 mi).
6. Turn right onto Atlantic Avenue (McDonald's on the corner) (1.6 mi).
7. Keep right to stay on Atlantic Avenue (404 ft).
8. Make a U-turn at Troy Avenue (233 ft).
9. Arrive at 1545 Atlantic Avenue, Brooklyn, New York 11213 on the right.

   The last intersection is Troy Avenue.

   If you reach Albany Avenue, you've gone too far.

SITE MAP


DRAFT PRIVILEGED AND CONFIDENTIAL
ATTORNEY WORK PRODUCT
Queens
Brooklyn
RH-034
RH-033
RH-038
RH-037
Union Street Bridge
RH-036
Carroll Street Bridge
OH-005
RH-035
3 STREET BRIDGE
OH-007
RH-601
OH-607
OH-602
RH-031
OH-006
OH-601
OH-024
Site
CSO Outfalls
Storm Outfalls
900 450 0 900 Feet
Site Map and Combined Sewer Outfall (CSO) Locations
Gowanus Canal Superfund Site
Brooklyn, New York
nationalgrid
HERE WITH YOU. HERE FOR YOU.
February 2014
Figure
3

1. INTRODUCTION

This site-specific Health and Safety Plan (HASP) was prepared to address project-specific hazards known or suspected to be present associated with the existing conditions and work to be performed at the work site(s). This HASP was prepared to meet the requirements specified in Occupational Safety and Health (OSHA) Hazardous Waste Operations Emergency and Response (HAZWOPER) program, [Consultant/Engineer]'s Health and Safety (H&S) Procedures, and the H&S requirements of the client.

2. SIGNATURES

2.1 Preparers and Reviewers

This HASP must be maintained onsite when field work is being performed. The Site Health and Safety Officer (SHSO) can change or amend this document, in agreement with the Health and Safety Coordinator (HSC) and Project Manager (PM). Amendments (e.g., changes in personal protective equipment, addition of tasks, etc.) must be documented in Section 19 and in Appendix A. This HASP must be reviewed and amended on an annual basis for projects if field activities extend beyond one year.

Prepared by:

____
SHSO Date

Reviewed by:

____
HSC Date

Approved by:

____
Project Manager Date

This HASP has been given to the following H&S approved subcontractor(s).

Subcontractor:	____________	Representative:	____________	Date:	__________
Subcontractor:	____________	Representative:	____________	Date:	__________
Subcontractor:	____________	Representative:	____________	Date:	__________

2.2 Site Workers

This HASP must be reviewed by personnel prior to Site work. Workers not in attendance at the initial meeting must be trained by the SHSO on the information covered in the pre-entry briefing. After reading the HASP and attending a pre-entry briefing, [Consultant/Engineer] employees and other parties covered under this HASP must sign the following acknowledgment statement.

"I have read, understand, and will perform my work in accordance with the information set forth in this HASP."

Signature	Printed Name	Date

3. EMERGENCY CONTACT INFORMATION

Contact	***Telephone Numbers***	
	Office	***Alternate (Type)***
Fire Department		
Police Department		
Site Emergency Response (if applicable)		
Hospital -		
Director of H&S -		
H&S Regional Manager -		
Project Manager -		
Site Health & Safety Officer -		
H&S Coordinator -		
Principal- or Associate-in-Charge -		
Utility Emergencies	811	
Occupational Health Care Provider -		
Facility Contact -		
Client Contact -		
Subcontractor -		
Subcontractor -		
Other -		

4. APPLICABILITY OF THIS HASP

This HASP was prepared in accordance with [Consultant/Engineer]'s H&S Procedures for use by [Consultant/Engineer]'s project staff and subcontractors. Subcontractors, at minimum, shall ensure that their employees, and those of their lower tier subcontractors, comply with these procedures and other health, safety and security provisions in the Subcontract. Subcontractors shall be responsible for examining all stated requirements within this HASP, determining if additional or more stringent health, safety, and security provisions are appropriate for their portion of the work, and implementing any modifications accordingly. This document and its contents should not be used prior to review by the health and safety managers of any group or individual performing any work at this Site.

5. SITE/TASK/HAZARD DESCRIPTION

5.1 Site Background

The following is a brief description of the Site, its location, approximate size, previous usage, and current usage. A description of the tasks to be performed is also presented.

- Site Location: Brooklyn, New York
- Approximate Size of Site: 1.8-mile-long, man-made canal
- Previous Site Usage: Conveyance channel for barges. Conveyance channel for sewage and industrial wastes.
- Current Site Usage: Conveyance channel for barges. Conveyance channel for combined sewer overflows (CSOs).
- Description of Surrounding Property/Population:

North	Boerum Hill neighborhood	East	Park Slope neighborhood
South	Gowanus Bay	West	Carroll Gardens and Red Hook neighborhoods

- Summary of previous site investigations:

Since 1983, the NYC Department of Environmental Protection (NYCDEP) has compiled four separate reports on water quality and CSO controls for the Canal, each of which was approved by the New York State Department of Environmental Conservation (NYSDEC) for proposed further actions. Since 2003, the United States Army Corps of Engineers (USACE) has issued about a dozen reports regarding the Canal. National Grid has completed numerous reports regarding its former MGP sites, and studies and/or cleanups have been conducted at another dozen or more upland areas.

In April 2009, the Gowanus Canal was proposed for inclusion on the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at the request of NYSDEC. EPA commenced a remedial investigation (RI) following the proposal for inclusion on the NPL, and on March 2, 2010, EPA placed the Canal on the NPL.

In April 2010, EPA entered into Administrative Orders of Consent with NYC and National Grid to perform work in support of EPA's remedial investigation/feasibility study (RI/FS). The RI Report was completed in January 2011 and the draft FS Report was completed in December 2011. An FS addendum report was completed in December 2012.

5.2 Task Descriptions

Task 1: PD-3: Additional Reconnaissance for Debris Removal

The overall objective of this work element is to identify and characterize debris present in the areas not included in the high-frequency side-scan sonar study completed in December 2010. If needed, areas of uncertainty in the previous survey will be revisited for confirmation. This additional debris reconnaissance builds upon information contained in the RI for the Site. Information from this work element will assist in refining and improving the comprehensive Site-wide CSM and prepare for future remedial activities.

The results of PD-3, coupled with previous work, will be used to develop the plan for PD-4: A Plan for Debris Removal, Decontamination, and Disposal. The work element will also provide information to support design components related to equipment mobilization, staging and project infrastructure needs, and logistics.

Task 2: PD-4: A Plan for Debris Removal, Decontamination, and Disposal

The overall objective of this work element is to develop a Debris Removal, Decontamination, and Disposal Plan to govern the removal and/or management of debris such that the underlying targeted sediment can be efficiently and effectively dredged and/or remediated.

Key components of the Debris Plan will include but not limited to:

- Debris removal;
- Debris decontamination;
- Debris handling and disposal; and
- Cultural resources management.

The results of PD-4 will be used specifically to develop the remedial design component associated with debris management. The work element will also provide information to support design components related to sediment dredging, dredge material management, transport off-Site, dewatering and water treatment, and archeological methodologies to address cultural resources in debris removal and dredging.

Task 3: PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation

The overall objectives of the bulkhead survey and assessment work element are to provide a plan for performing a preliminary assessment of the stability of existing bulkheads during and after remedy implementation, and to create a preliminary design of bulkhead support systems. The proposed field exploration program will collect data to be used as the basis for design of bulkhead support systems. It is anticipated that supplemental information will be required for the design of property-specific support systems.

The activities that are planned as part of PD-5 include:

- Subsurface investigation of existing bulkhead foundations;
- Geotechnical site investigation;
- Factual bulkhead investigation report;
- Evaluation of existing bulkhead stability during remedy implementation;
- Evaluation of final conditions for bulkheads; and
- Assessment and recommendation of existing bulkhead report.

The results of PD-5, coupled with previous work, will be used to develop the bulkhead stabilization design components. The work element will also provide information to support design components related to capping, amendment layer design, ISS, and archeological methodology.

Task 4: PD-6: A Plan for Staging Site Selection and Implementation Plan

This work element has been prepared to describe the approach and methods to be used to select sites for the staging activities necessary to assemble and transfer labor, equipment, supplies, and material during remedial activities. The objective of this work element is to develop a plan describing the means to:

- Identify project infrastructure needs;
- Determine necessary staging site requirements;
- Identify potential staging sites; and,
- Evaluate staging sites.

It is anticipated that candidate sites will be re-evaluated throughout the design process as project infrastructure needs are refined. The results of PD-6 will be used to develop several design components, including equipment mobilization, staging, sediment handling, transport off-site, dewatering and water treatment, and logistics. The work element will also provide information to support the design component related material procurement.

Task 5: PD-7: Evaluation of Potential Groundwater Upwelling Areas and Measurement of Discharge Rates

Two primary objectives of this work element are to determine the approximate areas of significant groundwater upwelling in the Gowanus Canal and, for those areas where discharge is identified, to estimate the rate and velocity of this discharge.

The activities that are planned as part of PD-7 include:

- Evaluate and select applicable technologies for locating groundwater discharge areas and quantifying discharge rates;
- Evaluate and select areas of the Canal for groundwater upwelling measurements;
- Inspect Site to confirm feasibility of selected technologies at target locations;
- Implement selected technologies to assess groundwater upwelling areas and discharge rates;
- Characterize the hydraulic conductivity between the native and soft sediments;
- Refine the groundwater CSM and groundwater model; and
- Data management, analysis, and reporting.

The results of PD-7, coupled with previous work, will be used to develop the design elements related to capping, the capping amendment layer, ISS, and bulkheads. The work element will also provide information to support design components related to material procurement.

Task 6: PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments

The primary objectives of this work element are to (i) quantify the coal tar NAPL distribution within the canal, (ii) define areas of potentially mobile NAPL, and (iii) identify and characterize the controlling factors of NAPL mobility.

The activities that are planned as part of PD-8 include:

- Desktop evaluation of NAPL mobility and selection of appropriate fieldscreening technology(ies) and assessment locations;
- Implementation of field-based approaches to assess in situ NAPL distribution;
- Laboratory mobility testing and NAPL characterization; and,
- Data management, analysis, and reporting.

The results of PD-8, coupled with previous work, will be used to develop the design component for ISS. The work element will also provide information to support design components related to bulkhead stabilization, capping, and material procurement.

Task 7: PD-9: Additional Sampling for Polychlorinated Biphenyls (PCBs)

Mitigation of ongoing PCB sources will be a key component of a sustainable remedial design. Additional sampling is needed in areas with elevated PCB concentrations to determine if there are upland PCB sources that require controls. Hydrodynamic and sediment modeling will also be used to provide an additional line of evidence of upland PCB sources. The additional sampling data will also support the waste disposal component.

Task 8: PD-10: Stabilized Material Use and Treatability Testing

The ROD referenced the potential beneficial reuse of dredged material as landfill cover. This option will be evaluated during treatability testing to determine the optimal amount of stabilization agents (e.g., pozzolonics) needed in order for the amended dredged material to reliably meet the acceptance criteria of a permitted end-use/disposal site such as a landfill or similar facility.

Task 9: PD-11: Study of Canal Operations

A detailed evaluation of vessel operations in the Canal will be undertaken to refine sizing needs of the cap armoring layer in different RTAs. The conceptual layout of the armor layer provided in the FS did not include the influences of twin propellers and rudders which could result in larger bottom velocities and the need for larger armor layers. The refined understanding of vessel operations and armor layer needs will be incorporated into PD-24: Propeller Wash and Cap Armoring Study and will directly support cap design.

Task 10: PD-12: Groundwater Model Update

Estimates of groundwater upwelling (discharge) in the Canal using the existing numerical groundwater model are based on a calibration to various inputs, including measured hydraulic conductivity of subsurface formations outside the Canal, measured groundwater elevations outside the Canal, and mean sea level in the Canal. The model's simulation of sediments within the Canal is approximated using fitted sediment hydraulic conductivity estimates. New data to be collected as part of PD-7: Evaluation of Potential Groundwater Upwelling Areas and PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments will include identification of groundwater discharge areas, quantification of discharge rates in selected areas, lithology descriptions, and possibly hydraulic conductivity values for the soft sediment and native sediments. Incorporation of these data into the groundwater model followed by a recalibration to match groundwater discharge rates (if necessary) will refine the model and enable it to be used for predictive assessment of NAPL mobility as well as potential groundwater gradients and elevations due to implementation of bulkhead stabilization, ISS, and capping.

Task 11: PD-13: Upland Area Evaluation for Cut-off Walls

A land-side survey will be conducted along the Canal side-walls to identify upland locations requiring cut-off walls or other remedial measures due to NAPL that has migrated to upland locations. Follow-up investigations to evaluate the extent (depth, length) of the cut-off walls will be conducted. Mitigation of ongoing NAPL sources will be a key component of a sustainable remedial design.

Task 12: PD-14: Compliance Plan for Federal and State Archeological Requirements

A plan will be developed to comply with applicable Federal and State archeological requirements. The plan will be referenced in the remedial design for sediment and debris removal.

Task 13: PD-15: Laboratory Evaluation of NAPL Mobility

Additional laboratory evaluations will be conducted to assess the potential mobility of NAPL under in situ conditions. This work element will build upon and expand the bench-scale work completed by EPA and will complement PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments. An expanded number of tests to provide more representative data and confirmation of results are needed to support ISS boundary delineation. The work element addresses a CSM data gap and is directly related to ISS and capping design components.

Task 14: PD-16: Revisions to Sediment and Hydrodynamic Models

Sediment and hydrodynamic models will be revised to incorporate recently collected sediment and water data. The model updates are of particular importance as they relate to of activation of the Flushing Tunnel. This work element will include updating the models based on recent data collection and refinement of the model grid or other features to ensure they are well suited for remedial design needs. The models will be used to evaluate the Flushing Tunnel impacts as well and can be used to inform the remedial design.

Task 15: PD-17: Evaluation of Active Cap Treatment Technologies

Laboratory evaluation of active cap treatment technologies is needed to screen and validate potential amendments and amendment mixes to address contaminants that are present and mobile in the sediment matrix. Amendments will be evaluated under scenarios representative of in situ conditions in different RTAs to collect data on design parameters (e.g., sorption potential). Results will be incorporated directly into the remedial design for capping.

Task 16: PD-18: Geotechnical Characterization for Cap Design

Additional field characterization of geotechnical parameters to support cap design will be conducted to improve data density in several areas and to further refine understanding of cap stability, consolidation, and strength gain over time. Additional testing will be conducted to assess the potential to accommodate potentially larger armor layer diameters as a result of a refined understanding of armor layer needs from PD-11: Study of Canal Operations. The results will directly support cap design over both soft and native sediments.

Task 17: PD-19: Laboratory Evaluation of ISS Performance

Additional laboratory studies will be conducted to evaluate and optimize the performance of materials and mixture ratios for the ISS design. This work element will build upon the bench-scale work completed by EPA and will expand the number of tests to provide more representative data and confirmation of results. The work element directly supports ISS and capping remedial design components, including providing information to help optimize mix design and determining the appropriate remedy (capping or ISS) in various areas of the canal.

Task 18: PD-20: Technical Workshops

Periodic technical workshops with EPA will be conducted to develop agreement on predesign task scoping and share results in an expedited and direct manner. Periodic in-person meetings will be augmented with teleconference and videoconference meetings as the need arises. The technical workshops with EPA are intended to be mutually beneficial and maintain a productive remedial design schedule.

Task 19: PD-21: Sediment Stabilization and Treatment Technologies Treatability Studies

Laboratory treatability studies of sediment stabilization and treatment technologies will be conducted to evaluate various approaches to optimize sediment dewatering and to identify material-specific pozzolonic mixing ratios to optimize the binding of the contaminants into a stable matrix. From these stabilization and treatability studies, the laboratory mixtures will be subjected to leachability studies to determine compliance with acceptability criteria at various disposal and/or permitted end-use facilities. Cost and performance data will be developed to screen approaches and support dredging design.

Task 20: PD-22: Bathymetric Survey after Flushing Tunnel Operation

A bathymetric survey will be conducted after the Flushing Tunnel activation to assess sediment transport as a result of increased flow velocities and the potential need for sediment chemical of potential concern (COPC) re-characterization. Results from the bathymetric survey will be incorporated into sediment and hydrodynamic model updates planned as part of PD-16, to ensure the models are relevant and accurate for remedial design activities, including dredge and cap design.

Task 21: PD-23: Dredge Volume Field Study

A refined dredge volume field study will be conducted to confirm the bathymetric survey and native sediment elevations. Results from the field study will be used to refine and confirm sediment and hydrodynamic model updates and finalize dredge and cap design, including dredge prism delineation.

Task 22: PD-24: Propeller Wash and Cap Armoring Study

Evidence of vessel disturbance on the sediment bed is apparent in the high resolution multi-beam bathymetric surveys performed in 2010 and 2011, and needs to be accounted for in the design. A refined propeller wash and cap armoring study will be conducted after Flushing Tunnel operation. Hydrodynamic and sediment transport models will be used to evaluate impacts of propeller wash. Detailed assessment of flow velocities induced by propeller wash, as predicted by the modeling, will be quantified and incorporated into the cap armor layer design.

Task 23: PD-25: CSM Refinement

The Site-wide comprehensive CSM must be refined so that the remedial design can account for all physical and chemical Site processes that have bearing on remedial effectiveness. Results of the pre-design investigations and post-Flushing Tunnel activation studies will be integrated into the CSM to guide remedial design needs and enable predictive modeling of remedial actions.

Task 24: PD-26: Basis of Design Report

The basis of design (BOD) is an integral step in the planning, scoping, and execution of the technical studies and engineering design required to develop a comprehensive remedial approach for contaminated sediments in the Gowanus Canal. The BOD will also be used to develop the project schedule and budget requirements. The BOD is a "living document" that is initiated at the beginning of the design effort and develops the design principals. The final BOD is completed later in the project, once the final design is completed, and synthesizes all project information, including defining and detailing the remedial approach and associated remedial design parameters that are developed, tested, and agreed to during the remedial design.

Task Hazard Analyses (THAs) associated with these tasks are presented in Appendix B.

5.3 Chemical Hazards

The classes of chemicals that are known or suspected to be present that may be encountered while performing Site work include the following:

- Petroleum hydrocarbons, including benzene, toluene, ethylbenzene, xylenes (BTEX)
- Polycyclic aromatic hydrocarbons (PAHs)
- Polychlorinated biphenyls (PCBs)
- Hydrogen sulfide
- Hazardous metals

Controls for these hazards are presented in the THAs included in Appendix B. A summary of these chemical hazards is presented in Appendix C.

5.4 Physical Hazards

The following physical hazards have been identified associated with the work to be performed and the Site conditions.

- Boating
- Cold Stress
- Compressed Gases
- Drilling (including Indoor)
- Drum and Container Handling
- Electrocution
- Eye Injury
- Flash Flood

- Hand/Foot Injury
- Heat Stress
- Heavy Equipment
- Knives/Blades
- Lifting Heavy Loads
- Loud Noise/Vibration
- Portable Power/Hand Tool
- Slips, Trips, and Falls
- Severe Weather/Thunderstorms
- Thoroughfares/Traffic
- Urban Environments
- Utility Protection

Controls for these hazards are presented in the THAs included in Appendix B.

5.5 Biological Hazards

The following biological hazards have been identified associated with the work to be performed and the Site conditions.

- Biting/stinging insects
- Sewerage
- Waste water

Controls for these hazards are presented in the THAs included in Appendix B.

6. GENERAL SAFE WORK PRACTICES

The following general safe work practices must be adhered to while performing Site work:

- Level D (modified) personal protective equipment (PPE) shall be the default PPE to be worn during all field work performed on the Site. This will include hard hats, safety glasses, hard-toed boots, and high-visibility vests. If conditions allow, the requirement for hard hats and hard-toed boots may be reduced with approval of the SHSO and PM. Upgraded PPE will be used as Site conditions dictate (see Appendix D), or at the discretion of the SHSO and PM.
- Minimize contact with impacted materials. Do not place equipment on the ground. Do not sit or kneel on potentially contaminated surfaces.
- Smoking, eating, or drinking after entering the work zone and before personal decontamination is not allowed.
- Workers taking prescribed medication that may cause drowsiness shall not operate heavy equipment and are prohibited from performing tasks where Level C or B personal protective equipment is required. Employees who are suspected of being under the influence of illegal drugs or alcohol will be removed from the Site.
- Good housekeeping will be practiced to minimize physical and chemical hazards.
- Use of contact lenses is not allowed under certain hazardous working conditions.
- The following practices must be observed when operating a motor vehicle:
    - Use of seat belts is mandatory
    - Use of headlights is mandatory during periods of rain, fog, or other adverse weather or low-light conditions
    - A backup warning system or use of vehicle horn is mandatory when the vehicle is engaged in a backward motion
    - Posted traffic signs and directions from flagmen must be observed
    - Equipment and/or samples transported in vehicles must be secured from movement
    - The use of vehicles acquired by [Consultant/Engineer] by non-[Consultant/Engineer] personnel is prohibited
- In an unknown situation, always assume the worst reasonable conditions.
- Be observant of your immediate surroundings and the surroundings of others. It is a team effort to notice and warn of dangerous situations. Withdrawal from a hazardous situation to reassess procedures is the preferred course of action.
- Should unanticipated conflicts arise concerning safety requirements and working conditions, the SHSO and PM will provide rapid resolution of the situation to establish consistent safety policies.

- Unauthorized breaches of specified safety protocol are not allowed. Workers unwilling or unable to comply with established procedures will be asked to leave the work site.

7. EMERGENCY RESPONSE

This section discusses emergency response procedures and response equipment to be maintained on Site. A table presenting a list of contacts and telephone numbers for the applicable local and off-Site emergency responders is provided in Section 3 of this HASP.

7.1 Injury and Emergency Response Procedures

In the event of an **injury** to an employee, the instructions for injury response and reporting, located in the front of this HASP, must be implemented immediately. In the event that an **emergency** develops, the following procedures are to be implemented:

The Site Health and Safety Officer (SHSO), or designated alternate, should be immediately notified via the on-Site communication system. The SHSO assumes control of the emergency response.

- If applicable, the SHSO must immediately notify off-Site emergency responders (e.g., fire department, hospital, police department, etc.) and must inform the response team of the nature and location of the emergency on Site.
- If applicable, the SHSO may call for evacuation of the Site. Site workers should move to their respective refuge stations using the evacuation routes provided on the Site Map.
- For small fires, flames should be extinguished using the appropriate type of fire extinguisher. Large fires should be handled by the local fire department.
- If a worker is injured, the procedures presented in "Instructions for Injury Response", located in the front of this HASP, must be implemented immediately.
- After an incident has stabilized, the procedures presented in "Instructions for Incident Reporting", located in the front of this HASP, must be followed.

7.2 Emergency Response Equipment

Emergency response equipment will be maintained in the work area as necessary for this project. Examples of emergency response equipment include first aid kits, fire extinguishers (Type ABC), and eyewash bottles.

8. KEY PERSONNEL AND HEALTH AND SAFETY RESPONSIBILITIES

Project personnel and their responsibilities in regard to health and safety concerns on this project are as follows:

Project Manager (PM): [Insert name of PM here]

- Approve this HASP and amendments, if any;
- Monitor the field logbooks for health and safety work practices employed;
- Coordinate with SHSO so that emergency response procedures are implemented;
- Confirm that corrective actions are implemented;
- Confirm and document that qualified personnel receive this plan and are aware of its provisions and potential hazards associated with Site operations, and that they are instructed in safe work practices and familiar with emergency response procedures; and
- Provide appropriate monitoring, personal protective equipment, and decontamination materials.

Site Health and Safety Officer (SHSO): [Insert name of SHSO here]

- Prepare and implement project HASP and amendments, if any;
- Report to the Project Manager for action if deviations from the anticipated conditions exist and authorize the cessation of work if necessary;
- Confirm that Site personnel meet the training and medical requirements detailed in Section 9;
- Conduct pre-entry briefing and daily tailgate safety meetings;
- Ensure that general safety and first aid equipment (e.g. first-aid kits, fire extinguishers, AED, etc.) are available to Site staff and in working order;
- Confirm that monitoring equipment and personal protective equipment are operating correctly according to manufacturer's instructions and such equipment is utilized by on-Site personnel. Calibrate or check calibration of monitoring equipment and record results;
- Confirm that decontamination procedures are being implemented;
- Implement Site emergency response and follow-up procedures;
- Notify the HSC in the event an emergency occurs; and
- Perform and document weekly inspections.

Health and Safety Coordinator: [Insert name of HSC here]

- Review and audit HASP and amendments;
- Notify Director of Health & Safety when an emergency occurs;
- Assist with the implementation of the corporate health and safety program; and
- Consult with staff on health and safety issues.

Site Workers

- Provide verification of required health and safety training and medical surveillance prior to arriving at the Site;

- Notify supervisors of workplace accomodation requirements as the result of physical limitations or medical conditions;
- Attend pre-entry briefings and daily tailgate safety meetings;
- Immediately report accidents and/or unsafe conditions to the SHSO;
- Be familiar with and abide by the HASP; and
- Be ultimately responsible for his or her own safety.

9. WORKER TRAINING AND MEDICAL SURVEILLANCE

Personnel involved in field activities subject to OSHA HAZWOPER 29 CFR 1910.120 will be required to participate in both a health and safety training program that complies with criteria primarily set forth by the OSHA HAZWOPER in 29 CFR 1910.120(e) and a medical surveillance program covered under 29 CFR 1910.120(f), or equivalent regulations based on the jurisdiction in which the project is performed.

9.1 Pre-Assignment and Annual Refresher Training

Prior to arrival on-Site, the [Consultant/Engineer]'s SHSO will be responsible for confirming that their staff meet the requirements of pre-assignment training. In addition, personnel must be able to document dates of attendance at an annual 8-hour refresher and three days of fieldwork under a qualified supervisor. Failure to provide this documentation will prohibit entry to the active work area(s).

Additionally, any specialized training required to perform work at the Site (boating safety courses, equipment operation training, etc.) will be completed prior to arrival at the Site. Documentation of the completion of training will be provided to the SHSO.

9.2 Site Supervisor Training

Consistent with OSHA 29 CFR 1910.120 (e)(4), prior to arrival on Site, individuals designated as Site supervisors require an additional eight hours of specialized training. Documentation of this training will be provided to the SHSO.

9.3 Initial Site Safety Orientation and HASP Review

In addition to complying with 29 CFR 1910(e), Site personnel will attend an initial safety orientation during which the HASP and applicable THAs will be reviewed prior to initiating field activities. This review will include the following:

- Site personnel roles and responsibilities regarding health and safety;
- Specific hazards related to the Site and Site operations, including chemical and physical hazards;

- Training in the proper use, maintenance, and decontamination protocol of PPE and Level(s) of Protection;
- Appropriate work practices and engineering controls to reduce/eliminate exposures to Site hazards;
- Means for normal and emergency Site communication;
- Air monitoring strategies, including the frequency and types of air monitoring employed at the Site, action levels, sampling techniques, and pre/post calibration techniques;
- Unique/Site specific medical surveillance requirements that need to be considered based on Site hazards;
- Site control measures, work zones, and proper decontamination procedures for personnel/tools/vehicles, etc. to reduce the potential for both on- and off-Site contamination;
- Rapid, effective emergency response procedures; and
- Confirmation of specialized training for personnel involved in specific hazardous activities, such as confined space entry, drum handling, sampling unknowns, etc.

9.4 Baseline Medical Surveillance Exam

The baseline medical examination is used to identify physical capabilities and certain medical limitations that may have an impact on the candidate's ability to perform in the position and/or job activity for which he/she is being considered, as well as to establish certain baseline medical parameters. The initial test results can then be compared against future periodic or project-specific monitoring results.

9.5 Periodic/Annual/Biennial Medical Exam

The periodic medical examination is used to evaluate an employee's continued fitness for duty and to assess possible impact(s) occupational exposures may have had on their health status. The periodic examination includes an update to the medical and work history, results of previous occupational exposure assessments, and a detailed medical exam tailored to the job description.

The Medical Director from [Occupational Health Care Provider] determines the frequency of the periodic medical exams based on regulatory requirements, the position/work activities of the employee, and the level of exposure to physical, chemical, and biological agents.

9.6 Exposure/Activity/Project-Specific Medical Testing

Exposure-specific medical tests and/or evaluation of biological indices may be conducted to establish a baseline for certain project-specific parameters, to monitor the effectiveness of hazard controls, and/or to assess the impact of occupational exposures associated with a particular work activity or project. The Medical Director, in coordination with the EHS Department, will require or recommend an exposure-specific exam when deemed appropriate based on knowledge of project hazards, occurance of employee health symptoms, or an unexpected exposure event. Requests for exposure-specific examinations will be forwarded to the EHS Department, who will process the requests in collaboration with the Medical Director. The Medical Director will determine the type and frequency of the exposure-specific medical exams for employees designated to participate based on sound medical practice, toxicology information, and regulatory requirements.

9.7 Exit Exam

An exit medical examination is offered when an employee leaves the medical surveillance program, either because of termination of employment with [Consultant/Engineer] or because of reassignment to a position not designated or identified to participate in the medical surveillance program. This optional exit examination may be used to assess potential changes in medical status that have occurred during the course of employees' previous work activities, and to establish a medical baseline at the time of departure.

10. MAPS AND SITE CONTROL

10.1 Routes to Hospital and Urgent Care Facility

A hospital and an urgent care facility near the Site have been identified. Maps with written directions to the hospital and urgent care facility are included after the Table of Contents of this HASP. Both figures also include the facility name and phone number. These maps and directions should be accessible to Site workers at all times.

10.2 Site Map

A Site map is located inside the cover of this HASP. The Site map is intended to show the location of the work zone(s), to provide on-Site orientation, and to delineate evacuation routes. Changes may be made to the Site map by the SHSO based on changing Site activities or conditions. The Site map should be accessible to Site workers at all times.

10.3 Buddy System

The buddy system is required at all times when work is performed on-Site. The buddy system includes maintaining regular contact with one or more on-Site [Consultant/Engineer] personnel, clients, and/or contractors such that each employee is observed by (or in verbal contact with) at least one other employee in the work group. For field visits with only one employee on Site, the buddy system shall be implemented via periodic telephone contact with off Site [Consultant/Engineer] personnel.

10.4 Controlled Work Zones

Applies to Task:

☐ 1	☐ 2	☒ 3	☐ 4	☐ 5	☒ 6	☒ 7	☐ 8	☐ 9	☐ 10
☐ 11	☐ 12	☐ 13	☐ 14	☐ 15	☒ 16	☐ 17	☐ 18	☐ 19	☐ 20
☐ 21	☐ 22	☐ 23	☐ 24	☐ 25	☐ 26			☐ Not Applicable	

Delineation of three controlled work zones (Exclusion Zone, Contaminant Reduction Zone, and Support Zone) are required for the Tasks indicated above. The Exclusion Zone is defined as the area on Site where contamination is suspected and tasks are to be performed. The Contaminant Reduction Zone is defined as the area where equipment and workers are to be decontaminated as they leave the Exclusion Zone. The Support Zone is defined as the command area and may serve as a staging and storage area for supplies. For Sites or Tasks that do not require the three controlled work zones, the area where work is to be performed will be called the Work Zone. [Consultant/Engineer] employees must not be allowed into the Contaminant Reduction Zone or Exclusion Zone or the Work Zone until they have received the proper personal protective equipment (PPE) and they have read, understand, and meet the requirements outlined in this HASP. The location and extent of the work zones may be modified as necessary as Site investigation information becomes available.

Visitors to the Site must be continually escorted for safety purposes. Visitors under [Consultant/Engineer]'s direction must check in with the SHSO upon visiting the Site.

For the tasks identified above, the boundaries of the Exclusion Zone, Contaminant Reduction Zone, and Support Zone (or if appropriate, the Work Zone), shall be marked using warning tape, signs, traffic cones, fencing, or other appropriate means.

10.5 Site Access

Certain Site areas require controlled access to the work area. Examples of access controls include sign in/sign out logs, check-in with posted guards, and identification badges for worker verification. [Consultant/Engineer] personnel will adhere to the Site-specific access requirements and monitor that subcontractors and other [Consultant/Engineer] visitors abide by Site-specific access control requirements.

10.6 Inspections

☒ APPLICABLE ☐ NOT APPLICABLE

Based on the hazards identified for the project, periodic health and safety inspections may be performed. Records should be kept on file at the project Site. The frequency for periodic inspections is:

☐ Weekly

☐ Monthly

☐ Other: _____

11. TAILGATE MEETINGS

Tailgate meetings must be held daily prior to starting work to discuss important health and safety issues concerning tasks to be performed. Non-[Consultant/Engineer] Site workers should also communicate health and safety concerns associated with the tasks they will be performing. Topics discussed in the tailgate meetings must be documented in the field logbook.

12. STOP WORK AUTHORITY

[Consultant/Engineer] personnel and subcontractor personnel have the authority and responsibility to issue a Stop Work Order if unsafe actions or conditions are identified. The Stop Work Authority process involves a stop, notify, correct, and resume approach for resolving observed unsafe work actions or conditions. The person issuing the work stoppage will first notify workers engaged in or affected by the unsafe activity or condition and require that associated work be stopped. After this Stop Work Order is issued, the [Consultant/Engineer] project manager and the supervisors for affected or concerned contractors will also be notified. The [Consultant/Engineer] project manager will document the issuance of the Stop Work Order. Work will not resume until the issues and concerns of the Stop Work Order have been adequately addressed.

13. AIR MONITORING

Applies to Task:

☐ 1	☐ 2	☒ 3	☐ 4	☐ 5	☒ 6	☒ 7	☐ 8	☐ 9	☐ 10
☐ 11	☐ 12	☐ 13	☐ 14	☐ 15	☒ 16	☐ 17	☐ 18	☐ 19	☐ 20
☐ 21	☐ 22	☐ 23	☐ 24	☐ 25	☐ 26			☐ Not Applicable	

Air monitoring will be performed to evaluate airborne chemical and/or dust exposure levels within the breathing zone of Site workers. Hazardous conditions may include airborne concentrations that may cause acute or chronic illness, oxygen deficient environments, or explosive environments. Air monitoring may also be performed to evaluate the adequacy of engineering, administrative, and/or PPE controls. Air monitoring may be "real-time" (the instrument provides immediate results at the project), using multi-gas meters, photoionization detectors (PIDs), or colorimetric tubes, or may be performed by collecting samples and forwarding to a laboratory for analysis and quantification.

The type(s) of air monitoring equipment required and associated action levels are outlined in Appendix D. Monitoring equipment must be calibrated based on the manufacturer's requirements. Calibration results and air monitoring measurements must be documented. Based on the results noted, Site activities, or scope of work changes, the frequency of air monitoring may be adjusted by the SHSO with the consent of the Project Manager and communication with the HSC.

14. PERSONAL PROTECTIVE EQUIPMENT

The levels of PPE required for each task are presented in Appendix E. Required equipment and types of protective clothing materials, as well as an indication of the initial level of protection to be utilized, are listed. The level of protection may be upgraded or downgraded by the SHSO according to controls requirements in Appendix E or according to action levels provided in Appendix D.

If respirators are worn, workers must abide by the company's Respiratory Protection Program.

15. DECONTAMINATION

The SHSO and Project Manager will determine the type and level of decontamination procedures for both personnel and equipment based on evaluation of specific work activities in the controlled work zones. Medical treatment will take precedence over decontamination in the event of a life threatening and/or serious injury/illness. Personnel will perform decontamination in designated areas upon leaving Zones where the potential exists for exposure to hazardous chemical, biological, or environmental conditions.

Decontamination of personnel in Level D (modified) will consist of proper containerization and disposal of coveralls, disposable boots, and gloves (if applicable).

Decontamination of personnel in Level C, will consist, at minimum, of:

- Removal and cleaning/disposal of boot covers, coveralls, and outer gloves;
- Removal, cleaning, and storage of respiratory protection;
- Washing of non-disposable PPE suspected of being contaminated using a soap solution followed by a water rinse; and
- Removal and disposal of inner gloves.

Decontamination of higher PPE levels will be outlined in detail should Site conditions require their use.

Hand tools and sampling equipment shall be decontaminated as needed by washing in decontamination basins with appropriate solutions, or, if possible, by dry decontamination. Wash solutions and PPE may require disposal at a licensed waste facility.

16. SPILL CONTAINMENT

The Tasks performed for this project may involve the handling of drums or containers which contain stored chemicals, hazardous materials, or wastes. Containers shall be inspected and their integrity assured prior to being moved or handled. If the integrity of the container is in question, the container shall be overpacked or its contents transferred to an appropriate container in satisfactory condition. Operations shall be organized and coordinated to minimize movement of containers. Where spills, leaks, or ruptures may potentially occur, a supply of sorbents shall be located in the storage area. Additional spill prevention measures include:

- UN-approved 55-gallon drums, bins, and Baker tanks will be inspected for visible defects upon delivery to the Site;
- UN-approved 55-gallon drums will be inspected to ensure each drum includes a resealable lid with a small resealable sampling port near the top or on the side of the drum, and that the enclosure is not deformed or distorted;
- Containers will not be completely filled to allow for possible expansion of liquid;
- Containers will be stored on wooden pallets to facilitate transport by forklift;
- Containers in the storage area will be inspected for leaks while the containers are being filled, immediately after a relocation to a temporary on-Site storage area, and weekly while being stored; and
- Flat areas will be selected for temporary storage away from high-traffic work areas/zones and storm/sewer drains.

In the event of a release or spill of unknown or hazardous substances, the Site supervisor will designate personnel who will support the spill containment, control, and/or clean-up procedures. The team will request additional off-Site emergency response assistance if necessary based on the type of spill, volume, potential toxicity, etc.

The spill area will be isolated and restricted to only authorized personnel designated to assist with the containment, control, or clean-up activity. Authorized personnel will be trained to contain and clean spills from typical materials and quantities used at the project location. Physical barriers will be set up to warn unauthorized personnel to avoid the affected area. The spill, leak, or incident will be assessed by the team and characterized to determine the appropriate course(s) of action(s) to consider:

- Small spills (i.e., maximum volume of 55 gallons of a liquid or 100 pounds of a solid) may be remediated using absorbent materials by designated personnel;
- Large spills (i.e., liquid volumes > 55 gallons or solid weights > 100 pounds) and/or spills of highly toxic materials may require assistance by off-Site hazardous materials (HAZMAT) teams;
- Attempts shall be made to identify and stop the source(s) of release immediately after donning proper PPE (based on action levels) and performing air monitoring;
- The Site supervisor will direct spill-response operations and stay at the spill area until it has been cleaned, inspected, and cleared for re-entry; and
- The Site supervisor will prepare a spill incident and clean-up report and will communicate findings to the Project and Branch Manager and EHS Department.

17. CONFINED SPACE ENTRY

☐ APPLICABLE ☒ NOT APPLICABLE

If Tasks for this project involve confined-space entry, workers must abide by the Company's Confined Space Entry Program.

18. GLOBALLY-HARMONIZED SYSTEM FOR HAZARD COMMUNICATION

☒ APPLICABLE ☐ NOT APPLICABLE

The following procedures must be followed for chemicals brought onto the Site (e.g. decontamination solution, sampling preservatives, etc.) by [Consultant/Engineer] personnel or by subcontractors while performing the tasks of this project:

- Labels on primary chemical containers must be legible and in good condition;
- Chemicals must be stored in appropriate storage containers;
- Secondary containers and storage cabinets must be correctly and clearly labeled;
- Chemicals incompatible with one another must not be stored together; and
- Workers must receive training on chemical hazards.

When chemicals are used on Site, workers must abide by [Consultant/Engineer]'s GHS Hazard Communication Program. Safety Data Sheets for chemicals used on-Site are provided in Appendix F.

19. HASP AMENDMENTS

Over the course of this project, it is possible that the project-specific hazards and working conditions will change. This HASP may be reviewed and amended as necessary to effectively describe the changing working conditions and measures to mitigate the potential health and safety issues that may arise during the project. Amendments to the HASP should be briefly described in the following spaces provided. The full text of the amendments should be provided in Appendix A. Additional supporting materials (THAs, SDS, etc) should be added to the relevant sections or appendices of this document.

AMENDMENT 1:

Date: ___________ Project Manager: _____________ HSC: _____________________
Brief description of amendment:

____
____
____
____
____

AMENDMENT 2:

Date: ___________ Project Manager: _____________ HSC: _____________________
Brief description of amendment:

____
____
____
____
____

AMENDMENT 3:

Date: ___________ Project Manager: _____________ HSC: _____________________
Brief description of amendment:

____
____
____
____
____

Appendix A: HASP Amendments

Discuss details of amendments to this HASP here. Include amendment number, date, and details of amendments.

Appendix B: Task Hazard Analyses

		Driving/Vehicles	Reconnaissance & Mobilization/Demobilization	Work Near Water	Work On Boats	Sediment Core Collection & Monitoring Equipment Deployment and Retrieval	Work Around Heavy Equipment	Sediment & Soil Core Logging and Sampling	Waste Characterization Sampling & Drum Handling
Task 1:	PD-3: Additional Reconnaissance for Debris Removal	X		X	X	X			
Task 2:	PD-4: A Plan for Debris Removal, Decontamination, and Disposal								
Task 3:	PD-5: Detailed Survey and Assessment of Existing Bulkheads for Remedy Implementation	X	X	X	X	X	X	X	X
Task 4:	PD-6: A Plan for Staging Site Selection and Implementation Plan	X	X						
Task 5:	PD-7: Evaluation of Potential Groundwater Upwelling Areas and Measurement of Discharge Rates	X		X	X	X			
Task 6:	PD-8: Evaluation of Potentially Mobile NAPL in Native Sediments	X		X	X	X	X	X	X
Task 7:	PD-9: Additional Sampling for Polychlorinated Biphenyls (PCBs)	X		X	X	X	X	X	X
Task 8:	PD-10: Stabilized Material Use and Treatability Testing								
Task 9:	PD-11: Study of Canal Operations	X		X	X				
Task 10:	PD-12: Groundwater Model Update								
Task 11:	PD-13: Upland Area Evaluation for Cut-off Walls	X	X	X					
Task 12:	PD 14: Compliance Plan for Federal and State Archeological Requirements								
Task 13:	PD-15: Laboratory Evaluation of NAPL Mobility								
Task 14:	PD-16: Revisions to Sediment and Hydrodynamic Models								
Task 15:	PD-17: Evaluation of Active Cap Treatment Technologies								
Task 16:	PD-18: Geotechnical Characterization for Cap Design	X		X	X	X	X	X	X
Task 17:	PD-19: Laboratory Evaluation of ISS Performance								
Task 18:	PD-20: Technical Workshops								
Task 19:	PD-21: Sediment Stabilization and Treatment Technologies Treatability Studies								
Task 20:	PD-22: Bathymetric Survey after Flushing Tunnel Operation	X		X	X	X			
Task 21:	PD-23: Dredge Volume Field Study	X		X	X	X			
Task 22:	PD-24: Propeller Wash and Cap Armoring Study								
Task 23:	PD-25: CSM Refinement								
Task 24:	PD-26: Basis of Design Report								

THAs for these tasks are presented in the following pages

PRE-WORK THA

THA Title:	**Driving/Vehicles Task Hazard Analysis**	**Date:**	**18 February 2014**
Project Name:	**Gowanus Canal Superfund Site**	**Client Name:**	**National Grid**
Project Number:		**Client Project Manager:**	
Project Location:	**Brooklyn, New York**	**[Consultant/Engineer] Project Manager:**	
Scope of Work Summary:	The Pre-Design Work will involve personnel driving both to and from the Site, as well as around the Site.		

Work Steps	**Process or Activity**	**Hazards**	**Hazard Control**
• Driving to/from/around the Site		• Traffic/road hazards	• Plan your route to and from the Site • Park only in safe locations, out of the flow of traffic • Avoid having to back up out of a parking space • Be careful when entering and exiting roadways - be aware of traffic, cyclists, and pedestrians • Pull over to use your cell phone - do not use your cell phone while driving • Wear a high visibility vest when working near traffic • Remember that turning right on a red light is not allowed in New York City • When driving on properties, be aware the there may be uneven ground and tire hazards and choose routes carefully - always walk new routes first
		• Work near water	• Avoid driving vehicles near the edge of the Canal
		• Crime	• Always lock vehicles if parked on the street • Avoid leaving valuables in vehicles overnight • Keep valuables left in vehicles covered or out of sight (i.e., in the trunk)
•		•	•

Min. Personal Protective Equipment (PPE):	• Hardhat • Safety glasses • Gloves • Steel-toed/hard-toed boots • Hearing protection when working around loud noises • Traffic vest when working around vehicles or heavy equipment • Coast Guard-approved Personal Floatation Device (PFD) when working on or near water • Tyvek suits may be worn if desired to protect against getting contaminated water or sediment on clothing or skin

Individuals Must Sign the last page of this THA after review.

PRE-WORK THA

HAZARD		HAZARD CONTROLS (check all that apply and comment as required)
WALKING/WORKING SURFACES		
☒	☒ Uneven terrain ☒ Slippery surfaces	☒ Walkways are cleared of equipment, vegetation, excavated material, tools and debris ☒ Pits and floor openings are covered or otherwise guarded ☒ Work areas are illuminated adequately; field operations are not conducted before sunrise or after sunset unless adequate lighting is provided. ☐ Spills are cleaned up promptly ☒ Salt applied to icy areas, snow cleared from walkways
☐	LADDERS / STAIRS ☐ Extension Ladders ☐ Step Ladders ☐ Fixed Ladders ☐ Stairs	☐ Employees trained in safe ladder use at safety meeting ☐ Extension ladders are properly footed, secured at top, and setup at proper angle ☐ Stepladders are set on level ground or properly shimmed with spreaders locked. ☐ Stairs have proper rise over run and stairs >4 steps or 4' have guardrails. ☐ Never use a step ladder as a straight ladder. All straight ladders shall be extended three rungs past leading edge. Never use metal ladders while working with electricity. **Ladders/Stairs Comments: _____**
☐	MANLIFT used to reach work ☐ Scissor Lift ☐ Extensible Boom ☐ Articulated Boom ☐ Vertical Lift ("Genie")	☐ Operators are sufficiently trained, experienced and qualified. ☐ Equipment is inspected after mobilization and is in good condition. ☐ Harness & Lanyard worn whenever operating the lift (scissor lifts may be excepted) ☐ Overhead and surface obstructions are reviewed with operators prior to use. **Manlift Comments: _____**
WORKING ALONE		
☒	☒ Getting injured or incapacitated with no one else around to help ☒ Falling victim to crime	☒ Someone else knows your whereabouts, what you're doing and when you should be expected back to their office or project site location. This will be accomplished by communicating three (3) times at a minimum with the supervisor or the project manager 1 – Upon Arrival 2 – Midway through the day 3 – Upon Departure ☒ Ensure the area has wireless coverage; summon alternate communication method if wireless phones are not operable. ☒ Checked the weather forecast to avoid being caught up in bad weather conditions; ☒ Ensured that vehicle has sufficient fuel and is well maintained; ☒ Allowed self sufficient time for the trip so that you are not rushing; ☒ Drive with any bags, records and equipment hidden so that you are not seen hiding them as you park. **Working Alone Comments: _____**
EXCAVATIONS / TRENCHING/UNDERGROUND HAZARDS		
☐	☐ Max Depth ≥ 20' ☐ Max Depth ≥ 5' ☐ Max Depth <5' with potential cave-in hazard ☐ Potential permit-required confined space at depth ≥ 4' ☐ Underground utilities ☐ Structures/foundations ☐ Falls into excavations	☐ Sloping & shoring for excavations ≥20' are approved by a professional engineer ☐ Sloping & shoring for excavations ≥5' when persons are exposed to cave-in. (specify below) ☐ Sloping & shoring for shallow (<5') excavations with cave-in hazard (specify below) ☐ Excavations ≥ 4' are classified as a non-permit confined space ☐ Excavations ≥ 4' are classified as Alternate Entry or Permit-Required (see confined space) ☐ Underground utilities have been identified and marked. ☐ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☐ Hand digging within 3' of utility locations. ☐ Excavations are protected by perimeter fencing (not barricade tape): (☐ Rigid fence - chain link or wood, ☐ safety fence 6' from edge.) **Excavation Comments: _____**

PRE-WORK THA

CONFINED SPACES		

☐	☐ No <u>Serious</u> Hazards
	☐ Toxic atmosphere
	  ☐ Carbon monoxide
	  ☐ Hydrogen sulfide
	  ☐ _____
	☐ Flammable atmosphere
	☐ Low oxygen
	☐ Combustible dust
	☐ Other Serious Hazard: _____
		☐ Confined space is altered so that it is no longer a confined space. (describe below)
		☐ Confined space is downgraded to a non-permit confined space. (identify which spaces below)
		☐ Alternate Entry is used. (Identify which space qualify for confined space entry below)
		☐ Full permit-required confined space entry is used due to presence of serious hazards.
		☐ Rescue team has been notified (☐ Paid FD ☐ Volunteer FD ☐ Plant Rescue)
		Rescue team: _____ Phone number: _____
		☐ All entrants and attendants for Alternate Entry and Permit-Required Entry have confined space entry training.
		
		Confined Space Comments: _____

BOAT OPERATIONS/WORKING ON or NEAR WATER and ICE		
☐	☐ Drowning ☐ Hypothermia	☐ Only qualified employees are operating the boat ☐ Coast Guard-approved Personal Flotation Device (PFD), sized and adjusted to the wearer, is worn by all when involved in boat operations. ☐ A float plan is completed prior to leaving dock. ☐ Emergency equipment like ring buoy, flares and fire extinguishers are present **Boat, Water Operations Comments: _____**
DRILLING		
☐	☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ Underground utilities, aboveground ☐ Spills	☐ Contractor inspected the drill rig ☐ High visibility vests, hard hats are being worn near the equipment ☐ Operators and helpers will maintain a safe distance to moving parts. All those working near moving or rotating parts will secure loose hair, clothing, and equipment. ☐ Drill rigs will only be moved with masts lowered. Masts will be erected with outriggers fully extended when equipped with outriggers. ☐ Max. safe slope for rig will be followed ☐ Spinning parts of the rig are guarded when possible, no loose clothing being worn near the rig ☐ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☐ IDW is being managed as per regulations ☐ Area is surveyed for overhead utilities ☐ Hearing protection is used when working near the rig ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill Kit Located: _____ **Drilling Operations Comments: _____**
HEAVY EQUIPMENT [other than cranes]		
☐	☐ Max. safe slope for each vehicle will be followed ☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ Bulldozer ☐ Excavator ☐ Front Loader ☐ Mini Skid Steer (Bobcat) ☐ Mini Excavator ☐ Dump Truck ☐ Drill/Boring Rig ☐ Lull / Material Handler ☐ Forklift ☐ Manlift - specify type(s) ☐ Land Clearing loader	☐ Qualified persons operate all heavy equipment. (certificate is required for forklift and lull operators) ☐ Equipment will be inspected upon mobilization ☐ All leaks or defective safety equipment will be repaired before use. ☐ Operators will be reminded of seatbelt use by: _____ ☐ Eye contact with the operator is made prior to approaching near equipment or swing radius ☐ High visibility vests are required ☐ Max. safe slope for each vehicle will be followed ☐ Counterweight swing radius will be barricaded. ☐ Rigging directly to the forks of a lull, forklift, or front loader equipped forks is prohibited. Crane hook attachments will be used (specify): _____ ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____

PRE-WORK THA

CRANES		
☐	☐ Overhead hazards – utility lines, swing radius, falling objects, wire ropes and hoisting equipment ☐ Overbalancing – high winds, outrigger placement, overloading, safe slope ☐ Wire rope failure – condition, loading, safety lines ☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ _____ ☐ _____ ☐ _____	☐ Only qualified persons operate cranes (certificate required). ☐ A Critical Lift Plan will be developed and approved prior to mobilization. ☐ Equipment will be inspected prior to mobilization and a Crane Pre-Operational Safety Checklist will be completed and signed. ☐ A Critical Lift Checklist will be completed and signed prior to crane mobilization. ☐ Rigging, wire rope and hoisting equipment will be inspected and maintained on a weekly basis. ☐ Crane operator will remain at the controls at all times during operation. ☐ Crane operation must be performed under the direction of an appointed signal person at all times. ☐ Communication between crane operator and signal person will be maintained through standard hand signals or voice communication equipment. Radio equipment, if used, will be equipped with a discrete channel. ☐ Lifting or lowering will not exceed 100ft/minute. Lowering must be controlled i.e. no free fall. ☐ Stop work will be issued whenever hoisting equipment is exposed to winds exceeding 35mph. Hoisting equipment will be re-inspected and confirmed to be in operable condition prior to re-use. ☐ Cranes will not travel with personnel on the platform. Note that [Contractor] personnel are prohibited from entering the immediate vicinity of the crane during operation, unless prior approval has been obtained from the Corporate EHS Dept. ☐ Outriggers will be fully extended/locked with a firm footing within the maximum safe slope (<1%). ☐ Total weight of the load will not exceed 50% of the rated capacity for the crane radius and configuration. ☐ Crane hooks will be moused or provided with safety latches. ☐ Eye contact with the operator is made prior to approaching near equipment or swing radius ☐ High visibility vests are required ☐ Max. safe slope (<1%) will be followed ☐ Counterweight swing radius will be barricaded. ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____ **Crane Hazards Comments: _____** [Consultant/Engineer] personnel are prohibited from suspended personnel lifting.
ENVIRONMENTAL HAZARDS (NON CHEMICAL)		
☐	☐ Heat Stress ☐ Cold Stress ☐ Insects, spiders, ticks ☐ Wild animals ☐ Mold, fungi ☐ Poisonous plants ☐ Hazardous noise	☐ Heat/Cold stress are monitored in accordance with [Consultant/Engineer] procedures ☐ Fluids are provided to prevent worker dehydration ☐ Types and injury potential of snakes, insects, spiders are reviewed with workers ☐ Insect repellant is used, PPE is used to protect against sting/bite injuries. ☐ All potentially poisonous plants such as poison ivy, poison oak, poison sumac are identified, long sleeve shirt or Tyvek is worn or a barrier cream is used when near these plants ☐ Hearing protection is used when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period) **Environmental Hazards Comments: _____**
POWER TOOLS, HAND TOOLS, and EXTENSION CORDS		
☐	Eye injury, hand/arm cuts, electrical shock, strains, foot injuries, dust ☐ Grinders ☐ Needle Gun ☐ Chop saw ☐ Chain saw ☐ Trimmer ☐ Concrete/asphalt saw	☐ All tools and electrical cords will be inspected upon mobilization by: _____ ☐ All tools and electrical cords in-use will be inspected daily by: _____ ☐ Grinder speeds will not exceed grinding wheel ratings. ☐ Water or wet cutting performed to control dust ☐ Respirators used to prevent exposure to dust (respirator type: _____) ☐ Thorough utility survey conducted prior to any concrete cutting, coring ☐ Face shield <u>and</u> safety glasses used (required for all grinders, jackhammers, chain saws, etc.) ☐ Kevlar chaps and jacket (required for all chainsaw work) ☐ Hearing protection required for which tools or areas: _____ ☐ All extension cords are in good condition with no cuts through outer insulation, ground plugs are present, and no "vinyl tape" repairs. **Tool & Cord Comments: _____**

PRE-WORK THA

MANUAL MATERIAL HANDLING / MATERIAL STORAGE / HOUSEKEEPING		
☐	Back or shoulder strain, struck by falling objects, trips and falls, incompatible materials (fire or explosion) ☐ Hvy manual lifting (>30 lbs) ☐ Chemical storage ☐ Compressed gas storage ☐ Tall storage greater than 2 pallets stacked. ☐ Material & equipment laydown areas ☐ Debris removal	☐ Mechanical lifting equipment used to reduce manual material handling: (☐ Forklift/Lull ☐ Heavy Equipment ☐ Chainfall ☐ _____) ☐ Manual lifting more than 50 lbs by a single person will be avoided. ☐ Good manual lifting techniques will be reviewed prior to site work. ☐ Incompatible chemicals will be separated by 20' ☐ Secondary containment will be provided for the following chemicals: _____ ☐ Safety equipment will be located near chemical storage. ☐ Spill Kit ☐ Emergency Shower ☐ Eyewash ☐ Drench Hose ☐ Splash PPE ☐ Flammable gases and oxygen will be separated by 20'. ☐ All compressed gas cylinders will be transported vertically and secured upright. ☐ Equipment and materials will not be stored on site ☐ Debris will be moved daily and placed in designated areas. **Material Handling & Housekeeping Comments:** _____
TRAFFIC & SIDEWALK OBSTRUCTION		
☒	☒ Vehicle accidents ☒ Pedestrians struck by vehicles or heavy equipment ☒ Pedestrians falls ☐ Pedestrian struck-by falling objects	☐ DOT signal devices will be used to re-route vehicles around excavations or busy site entrances/exits that affect road traffic. ☐ Flaggers will be used and have DOT Flagger Training ☐ Pedestrian traffic will be safely routed around or over excavations. ☐ Pedestrian traffic will be safely routed around or under overhead work. **Traffic & Sidewalk Comments:** <u>Be careful when entering and exiting roadways - be aware of traffic and pedestrians. Pull over to use your cell phone - do not use your cell phone while driving. Wear a high visibility vest when working near traffic.</u>
HAZARDOUS WASTE SITE WORK		
☐	☐ Exposure to hazardous vapors or dust, contact with contaminated materials, fire, and explosion. Contaminants of Concern and hazardous chemicals include: ☐ Volatile organic compounds (describe: _____) ☐ Semivolatile organic cmpds (describe: _____) ☐ Metal dusts (describe _____) ☐ PCBs ☐ Caustic (NaOH) ☐ Acid (H_2SO_4, HCl) ☐ Other hazardous waste site hazards are covered elsewhere in the HASP)	☐ Site workers with a potential for contact with contaminated materials will have OSHA 40-hour training, current 8-hour refresher, and medical exam. ☐ No intrusive work activities or areas are anticipated with current scope of work. Intrusive work activities include: _____ The perimeter of intrusive work areas are identified by: _____ Decontamination of personnel or equipment is <u>not</u> anticipated with the current scope of work. ☐ Decontamination of personnel and small tools will be conducted as follows: _____ ☐ Decontamination of heavy equipment will be conducted as follows: _____ ☐ Heavy equipment leaving the site will be inspected by: _____ ☐ Work area monitoring is not anticipated with the current scope of work. ☐ Work Area Air Monitoring as follows for (dust, VOCs, etc.) **OR** see attached. _____ to _____ Level C: Tyvek, boot covers, nitrile gloves, half or full face respirator with _____ cartridges changed daily _____ to _____ Level B: Same as above except supplied air respirator _____ to _____ STOP work, contact EHS Department ☐ Community Air Monitoring is not anticipated with the current scope of work. ☐ Community Air Monitoring is required per the attached document. **Comments/Other:** _____

PRE-WORK THA

EMERGENCY RESPONSE (911 Service is Available ☒ Yes ☐ No)			
Emergency Medical Treatment - Hospital Name: Hospital Address:	Brooklyn Hospital Center 121 DeKalb Avenue Brooklyn, New York 11205	**Phone:**	718-250-8000
Non-Emergency Med. Treatment - Clinic Name: Occupational Clinic Address:	Interfaith Medical Center 1545 Atlantic Avenue Brooklyn, New York 11213	**Phone:**	718-613-4988
Fire Department Name	New York Fire Department	**Phone:**	911
Spill Response:	New York Fire Department	**Phone:**	911
Client Representative Name::		**Office:** **Cell:**	
[Consultant/Engineer] Project Manager Name:		**Office:** **Cell:**	
[Consultant/Engineer] Corporate H&S Name:		**Office:** **Cell:**	
Emergency Response Comments:			

Date:	
Project Name:	**Gowanus Canal Superfund Site**
THA Title:	**Driving/Vehicle Task Hazard Analysis**
Subcontractor Name:	
[Consultant/Engineer] Representative (reviewed by):	
Subcontractor Foreman/Supervisor Signature (authorize):	
Crew Signatures (acknowledge):	
Print Name	**Signature**

PLEASE RETURN A COPY OF THIS SIGNED PAGE TO [CONTRACTOR] PROJECT MGR., SUPERINTENDENT UPON REVIEW AND ACKOWLEDGMENT BY THE CREW MEMBERS. ALL NEW CREW MEMBERS SHALL BE ORIENTATED THE SAME AND A SUBMITTAL OF A NEW SIGN IN SHEET SHALL BE COMPLETED.

PRE-WORK THA

THA Title:	**Reconnaissance & Mobilization/Demobilization Task Hazard Analysis**	**Date:**	**18 February 2014**
Project Name:	**Gowanus Canal Superfund Site**	**Client Name:**	**National Grid**
Project Number:		**Client Project Manager:**	
Project Location:	**Brooklyn, New York**	**[Consultant/Engineer] Project Manager:**	
Scope of Work Summary:	The Pre-Design Work will involve personnel performing reconnaissance and mobilization/demobilization activities at properties along and near the Gowanus Canal.		

Work Steps	**Process or Activity**	**Hazards**	**Hazard Control**
• Driving to/from/around the Site		• Traffic/road hazards	• Plan your route to and from the Site • Park only in safe locations, out of the flow of traffic • Avoid having to back up out of a parking space • Be careful when entering and exiting roadways - be aware of traffic, cyclists, and pedestrians • Pull over to use your cell phone - do not use your cell phone while driving • Wear a high visibility vest when working near traffic • Remember that turning right on a red light is not allowed in New York City • When driving on properties, be aware the there may be uneven ground and tire hazards and choose routes carefully - always walk new routes first
• Walking on properties around the Site		• Uneven ground and slip, trip, fall hazards	• Whenever possible, choose walking paths that avoid uneven ground and slip, trip, fall hazards • Point out hazards to fellow field team members
		• Work near water	• Whenever possible, avoid walking near to the edge of the Canal • If going near to the edge of the Canal is necessary, wear a PFD
• Drop off and pick up of heavy machinery, equipment, and supplies, and site setup		• Work around heavy equipment and large vehicles	• Wear a high visibility vest when working around large vehicles and heavy equipment • If necessary, only approach large vehicles/heavy equipment after making contact with the operator • Never approach large vehicles/heavy equipment out of the line of sight of the operator • Ensure that entrance and egress routes for large vehicles provide sufficient space for vehicles to maneuver safely • Ensure that large vehicles/heavy equipment avoid overhead hazards • Avoid having large vehicles/heavy equipment travel over soft ground or uneven terrain
•		•	•

Min. Personal Protective Equipment (PPE):	• Hardhat • Safety glasses • Gloves • Steel-toed/hard-toed boots • Hearing protection when working around loud noises • Traffic vest when working around vehicles or heavy equipment • Coast Guard-approved Personal Floatation Device (PFD) when working on or near water • Tyvek suits may be worn if desired to protect against getting contaminated water or sediment on clothing or skin

Individuals Must Sign the last page of this THA after review.

PRE-WORK THA

HAZARD		HAZARD CONTROLS (check all that apply and comment as required)
WALKING/WORKING SURFACES		
☒	☒ Uneven terrain ☒ Slippery surfaces	☒ Walkways are cleared of equipment, vegetation, excavated material, tools and debris ☒ Pits and floor openings are covered or otherwise guarded ☒ Work areas are illuminated adequately; field operations are not conducted before sunrise or after sunset unless adequate lighting is provided. ☒ Spills are cleaned up promptly ☒ Salt applied to icy areas, snow cleared from walkways
☐	LADDERS / STAIRS ☐ Extension Ladders ☐ Step Ladders ☐ Fixed Ladders ☐ Stairs	☐ Employees trained in safe ladder use at safety meeting ☐ Extension ladders are properly footed, secured at top, and setup at proper angle ☐ Stepladders are set on level ground or properly shimmed with spreaders locked. ☐ Stairs have proper rise over run and stairs >4 steps or 4' have guardrails. ☐ Never use a step ladder as a straight ladder. All straight ladders shall be extended three rungs past leading edge. Never use metal ladders while working with electricity. **Ladders/Stairs Comments: _____**
☐	MANLIFT used to reach work ☐ Scissor Lift ☐ Extensible Boom ☐ Articulated Boom ☐ Vertical Lift ("Genie")	☐ Operators are sufficiently trained, experienced and qualified. ☐ Equipment is inspected after mobilization and is in good condition. ☐ Harness & Lanyard worn whenever operating the lift (scissor lifts may be excepted) ☐ Overhead and surface obstructions are reviewed with operators prior to use. **Manlift Comments: _____**
WORKING ALONE		
☒	☒ Getting injured or incapacitated with no one else around to help ☒ Falling victim to crime	☒ Someone else knows your whereabouts, what you're doing and when you should be expected back to their office or project site location. This will be accomplished by communicating three (3) times at a minimum with the supervisor or the project manager 1 – Upon Arrival 2 – Midway through the day 3 – Upon Departure ☒ Ensure the area has wireless coverage; summon alternate communication method if wireless phones are not operable. ☒ Checked the weather forecast to avoid being caught up in bad weather conditions; ☒ Ensured that vehicle has sufficient fuel and is well maintained; ☒ Allowed self sufficient time for the trip so that you are not rushing; ☒ Drive with any bags, records and equipment hidden so that you are not seen hiding them as you park. **Working Alone Comments: _____**
EXCAVATIONS / TRENCHING/UNDERGROUND HAZARDS		
☐	☐ Max Depth ≥ 20' ☐ Max Depth ≥ 5' ☐ Max Depth <5' with potential cave-in hazard ☐ Potential permit-required confined space at depth ≥ 4' ☐ Underground utilities ☐ Structures/foundations ☐ Falls into excavations	☐ Sloping & shoring for excavations ≥20' are approved by a professional engineer ☐ Sloping & shoring for excavations ≥5' when persons are exposed to cave-in. (specify below) ☐ Sloping & shoring for shallow (<5') excavations with cave-in hazard (specify below) ☐ Excavations ≥ 4' are classified as a non-permit confined space ☐ Excavations ≥ 4' are classified as Alternate Entry or Permit-Required (see confined space) ☐ Underground utilities have been identified and marked. ☐ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☐ Hand digging within 3' of utility locations. ☐ Excavations are protected by perimeter fencing (not barricade tape): (☐ Rigid fence - chain link or wood, ☐ safety fence 6' from edge.) **Excavation Comments: _____**

PRE-WORK THA

CONFINED SPACES		
☐	☐ No <u>Serious</u> Hazards ☐ Toxic atmosphere ☐ Carbon monoxide ☐ Hydrogen sulfide ☐ _____ ☐ Flammable atmosphere ☐ Low oxygen ☐ Combustible dust ☐ Other Serious Hazard: _____	☐ Confined space is altered so that it is no longer a confined space. (describe below) ☐ Confined space is downgraded to a non-permit confined space. (identify which spaces below) ☐ Alternate Entry is used. (Identify which space qualify for confined space entry below) ☐ Full permit-required confined space entry is used due to presence of serious hazards. ☐ Rescue team has been notified (☐ Paid FD ☐ Volunteer FD ☐ Plant Rescue) Rescue team: _____ Phone number: _____ ☐ All entrants and attendants for Alternate Entry and Permit-Required Entry have confined space entry training. **Confined Space Comments: _____**
BOAT OPERATIONS/WORKING ON or NEAR WATER and ICE		
☐	☐ Drowning ☐ Hypothermia	☐ Only qualified employees are operating the boat ☐ Coast Guard-approved Personal Flotation Device (PFD), sized and adjusted to the wearer, is worn by all when involved in boat operations. ☐ A float plan is completed prior to leaving dock. ☐ Emergency equipment like ring buoy, flares and fire extinguishers are present **Boat, Water Operations Comments: _____**
DRILLING		
☐	☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ Underground utilities, aboveground ☐ Spills	☐ Contractor inspected the drill rig ☐ High visibility vests, hard hats are being worn near the equipment ☐ Operators and helpers will maintain a safe distance to moving parts. All those working near moving or rotating parts will secure loose hair, clothing, and equipment. ☐ Drill rigs will only be moved with masts lowered. Masts will be erected with outriggers fully extended when equipped with outriggers. ☐ Max. safe slope for rig will be followed ☐ Spinning parts of the rig are guarded when possible, no loose clothing being worn near the rig ☐ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☐ IDW is being managed as per regulations ☐ Area is surveyed for overhead utilities ☐ Hearing protection is used when working near the rig ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill Kit Located: _____ **Drilling Operations Comments: _____**
HEAVY EQUIPMENT [other than cranes]		
☐	☐ Max. safe slope for each vehicle will be followed ☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ Bulldozer ☐ Excavator ☐ Front Loader ☐ Mini Skid Steer (Bobcat) ☐ Mini Excavator ☐ Dump Truck ☐ Drill/Boring Rig ☐ Lull / Material Handler ☐ Forklift ☐ Manlift - specify type(s) ☐ Land Clearing loader	☐ Qualified persons operate all heavy equipment. (certificate is required for forklift and lull operators) ☐ Equipment will be inspected upon mobilization ☐ All leaks or defective safety equipment will be repaired before use. ☐ Operators will be reminded of seatbelt use by: _____ ☐ Eye contact with the operator is made prior to approaching near equipment or swing radius ☐ High visibility vests are required ☐ Max. safe slope for each vehicle will be followed ☐ Counterweight swing radius will be barricaded. ☐ Rigging directly to the forks of a lull, forklift, or front loader equipped forks is prohibited. Crane hook attachments will be used (specify): _____ ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____

PRE-WORK THA

CRANES		
☐	☐ Overhead hazards – utility lines, swing radius, falling objects, wire ropes and hoisting equipment ☐ Overbalancing – high winds, outrigger placement, overloading, safe slope ☐ Wire rope failure – condition, loading, safety lines ☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ _____ ☐ _____ ☐ _____	☐ Only qualified persons operate cranes (certificate required). ☐ A Critical Lift Plan will be developed and approved prior to mobilization. ☐ Equipment will be inspected prior to mobilization and a Crane Pre-Operational Safety Checklist will be completed and signed. ☐ A Critical Lift Checklist will be completed and signed prior to crane mobilization. ☐ Rigging, wire rope and hoisting equipment will be inspected and maintained on a weekly basis. ☐ Crane operator will remain at the controls at all times during operation. ☐ Crane operation must be performed under the direction of an appointed signal person at all times. ☐ Communication between crane operator and signal person will be maintained through standard hand signals or voice communication equipment. Radio equipment, if used, will be equipped with a discrete channel. ☐ Lifting or lowering will not exceed 100ft/minute. Lowering must be controlled i.e. no free fall. ☐ Stop work will be issued whenever hoisting equipment is exposed to winds exceeding 35mph. Hoisting equipment will be re-inspected and confirmed to be in operable condition prior to re-use. ☐ Cranes will not travel with personnel on the platform. Note that [Contractor] personnel are prohibited from entering the immediate vicinity of the crane during operation, unless prior approval has been obtained from the Corporate EHS Dept. ☐ Outriggers will be fully extended/locked with a firm footing within the maximum safe slope (<1%). ☐ Total weight of the load will not exceed 50% of the rated capacity for the crane radius and configuration. ☐ Crane hooks will be moused or provided with safety latches. ☐ Eye contact with the operator is made prior to approaching near equipment or swing radius ☐ High visibility vests are required ☐ Max. safe slope (<1%) will be followed ☐ Counterweight swing radius will be barricaded. ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____ **Crane Hazards Comments: _____** [Consultant/Engineer] personnel are prohibited from suspended personnel lifting.
ENVIRONMENTAL HAZARDS (NON CHEMICAL)		
☒	☒ Heat Stress ☒ Cold Stress ☒ Insects, spiders, ticks ☐ Wild animals ☐ Mold, fungi ☐ Poisonous plants ☐ Hazardous noise	☒ Heat/Cold stress are monitored in accordance with [Consultant/Engineer] procedures ☒ Fluids are provided to prevent worker dehydration ☒ Types and injury potential of snakes, insects, spiders are reviewed with workers ☒ Insect repellant is used, PPE is used to protect against sting/bite injuries. ☐ All potentially poisonous plants such as poison ivy, poison oak, poison sumac are identified, long sleeve shirt or Tyvek is worn or a barrier cream is used when near these plants ☐ Hearing protection is used when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period) **Environmental Hazards Comments: _____**
POWER TOOLS, HAND TOOLS, and EXTENSION CORDS		
☐	Eye injury, hand/arm cuts, electrical shock, strains, foot injuries, dust ☐ Grinders ☐ Needle Gun ☐ Chop saw ☐ Chain saw ☐ Trimmer ☐ Concrete/asphalt saw	☐ All tools and electrical cords will be inspected upon mobilization by: _____ ☐ All tools and electrical cords in-use will be inspected daily by: _____ ☐ Grinder speeds will not exceed grinding wheel ratings. ☐ Water or wet cutting performed to control dust ☐ Respirators used to prevent exposure to dust (respirator type: _____) ☐ Thorough utility survey conducted prior to any concrete cutting, coring ☐ Face shield <u>and</u> safety glasses used (required for all grinders, jackhammers, chain saws, etc.) ☐ Kevlar chaps and jacket (required for all chainsaw work) ☐ Hearing protection required for which tools or areas: _____ ☐ All extension cords are in good condition with no cuts through outer insulation, ground plugs are present, and no "vinyl tape" repairs. **Tool & Cord Comments: _____**

PRE-WORK THA

MANUAL MATERIAL HANDLING / MATERIAL STORAGE / HOUSEKEEPING		
☒	Back or shoulder strain, struck by falling objects, trips and falls, incompatible materials (fire or explosion) ☒ Hvy manual lifting (>30 lbs) ☐ Chemical storage ☐ Compressed gas storage ☐ Tall storage greater than 2 pallets stacked. ☐ Material & equipment laydown areas ☐ Debris removal	☒ Mechanical lifting equipment used to reduce manual material handling: (☒ Forklift/Lull ☒ Heavy Equipment ☐ Chainfall ☐ _____) ☒ Manual lifting more than 50 lbs by a single person will be avoided. ☒ Good manual lifting techniques will be reviewed prior to site work. ☐ Incompatible chemicals will be separated by 20' ☐ Secondary containment will be provided for the following chemicals: _____ ☐ Safety equipment will be located near chemical storage. ☐ Spill Kit ☐ Emergency Shower ☐ Eyewash ☐ Drench Hose ☐ Splash PPE ☐ Flammable gases and oxygen will be separated by 20'. ☐ All compressed gas cylinders will be transported vertically and secured upright. ☐ Equipment and materials will not be stored on site ☐ Debris will be moved daily and placed in designated areas. **Material Handling & Housekeeping Comments: _____**
TRAFFIC & SIDEWALK OBSTRUCTION		
☐	☐ Vehicle accidents ☐ Pedestrians struck by vehicles or heavy equipment ☐ Pedestrians falls ☐ Pedestrian struck-by falling objects	☐ DOT signal devices will be used to re-route vehicles around excavations or busy site entrances/exits that affect road traffic. ☐ Flaggers will be used and have DOT Flagger Training ☐ Pedestrian traffic will be safely routed around or over excavations. ☐ Pedestrian traffic will be safely routed around or under overhead work. **Traffic & Sidewalk Comments: _____**
HAZARDOUS WASTE SITE WORK		
☒	☒ Exposure to hazardous vapors or dust, contact with contaminated materials, fire, and explosion. Contaminants of Concern and hazardous chemicals include: ☒ Volatile organic compounds (describe: <u>BTEX</u>) ☒ Semivolatile organic cmpds (describe: <u>Coal tar and coal tar products</u>) ☒ Metal dusts (describe <u>arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc</u>) ☒ PCBs ☐ Caustic (NaOH) ☐ Acid (H_2SO_4, HCl) ☒ Other hazardous waste site hazards are covered elsewhere in the HASP)	☒ Site workers with a potential for contact with contaminated materials will have OSHA 40-hour training, current 8-hour refresher, and medical exam. ☐ No intrusive work activities or areas are anticipated with current scope of work. Intrusive work activities include: _____ The perimeter of intrusive work areas are identified by: _____ Decontamination of personnel or equipment is <u>not</u> anticipated with the current scope of work. ☐ Decontamination of personnel and small tools will be conducted as follows: _____ ☐ Decontamination of heavy equipment will be conducted as follows: _____ ☐ Heavy equipment leaving the site will be inspected by: _____ ☐ Work area monitoring is not anticipated with the current scope of work. ☒ Work Area Air Monitoring as follows for (dust, VOCs, etc.) **OR** see attached. _____ to _____ Level C: Tyvek, boot covers, nitrile gloves, half or full face respirator with _____ cartridges changed daily _____ to _____ Level B: Same as above except supplied air respirator _____ to _____ STOP work, contact EHS Department ☐ Community Air Monitoring is not anticipated with the current scope of work. ☐ Community Air Monitoring is required per the attached document. **Comments/Other: _____**

PRE-WORK THA

EMERGENCY RESPONSE (911 Service is Available ☒ Yes ☐ No)			
Emergency Medical Treatment - Hospital Name: Hospital Address:	Brooklyn Hospital Center 121 DeKalb Avenue Brooklyn, New York 11205	**Phone:**	718-250-8000
Non-Emergency Med. Treatment - Clinic Name: Occupational Clinic Address:	Interfaith Medical Center 1545 Atlantic Avenue Brooklyn, New York 11213	**Phone:**	718-613-4988
Fire Department Name	New York Fire Department	**Phone:**	911
Spill Response:	New York Fire Department	**Phone:**	911
Client Representative Name::		**Office:** **Cell:**	
[Consultant/Engineer] Project Manager Name:		**Office:** **Cell:**	
[Consultant/Engineer] Corporate H&S Name:		**Office:** **Cell:**	
Emergency Response Comments:			

Date:	
Project Name:	**Gowanus Canal Superfund Site**
THA Title:	**Reconnaissance & Mobilization/Demobilization Task Hazard Analysis**
Subcontractor Name:	
[Consultant/Engineer] Representative (reviewed by):	
Subcontractor Foreman/Supervisor Signature (authorize):	
Crew Signatures (acknowledge):	
Print Name	**Signature**

PLEASE RETURN A COPY OF THIS SIGNED PAGE TO [CONTRACTOR] PROJECT MGR., SUPERINTENDENT UPON REVIEW AND ACKOWLEDGMENT BY THE CREW MEMBERS. ALL NEW CREW MEMBERS SHALL BE ORIENTATED THE SAME AND A SUBMITTAL OF A NEW SIGN IN SHEET SHALL BE COMPLETED.

PRE-WORK THA

THA Title:	**Work Near Water Task Hazard Analysis**	**Date:**	**17 February 2014**
Project Name:	**Gowanus Canal Superfund Site**	**Client Name:**	**National Grid**
Project Number:		**Client Project Manager:**	
Project Location:	**Brooklyn, New York**	**[Consultant/Engineer] Project Manager:**	
Scope of Work Summary:	The Pre-Design Work will involve work near water (i.e., work performed near to the edges of the Gowanus Canal). (Work on boats is discussed in another THA.) Work that will be performed near water will include loading/unloading boats/barges, the assessment of bulkheads and the advancement of soil borings using drill rigs. In some locations, ladders may be used to access locations along the edge of the Canal (e.g., to permit inpection of bulkheads or to facilitate the offloading of samples from boats).		

Work Steps	**Process or Activity**	**Hazards**	**Hazard Control**
• Working near water		• Working near water	• When possible avoid working so close to the Canal edge that there is the risk of falling in • When work must be performed close to the Canal edge, all personnel must wear PFDs • When work must be performed close to the Canal edge a ring buoy should be available to assist someone who falls into the Canal
		• Slip/trip/fall (STF) hazards	• Avoid STF hazards by choosing clear paths when moving near to the edge of the Canal (or anywhere else) • Keep walkways clear of STF hazards • Mark STF hazards that cannot be removed or avoided completely • Be aware that areas close to the Canal edge may be wet or slippery (especially those areas that are submerged at high tide)
		• Ladders	• Always maintain three points of contact when climbing or descending ladders • Be aware that ladder steps may be wet/slippery • Avoid carrying items up/down ladders
•		•	•

Min. Personal Protective Equipment (PPE):	• Hardhat • Safety glasses • Gloves • Steel-toed/hard-toed boots • Hearing protection when working around loud noises • Traffic vest when working around vehicles or heavy equipment • Coast Guard-approved Personal Floatation Device (PFD) when working on or near water • Tyvek suits may be worn if desired to protect against getting contaminated water or sediment on clothing or skin

Individuals Must Sign the last page of this THA after review.

PRE-WORK THA

HAZARD		HAZARD CONTROLS (check all that apply and comment as required)
WALKING/WORKING SURFACES		
☒	☒ Uneven terrain ☒ Slippery surfaces	☒ Walkways are cleared of equipment, vegetation, excavated material, tools and debris ☒ Pits and floor openings are covered or otherwise guarded ☒ Work areas are illuminated adequately; field operations are not conducted before sunrise or after sunset unless adequate lighting is provided. ☒ Spills are cleaned up promptly ☒ Salt applied to icy areas, snow cleared from walkways
☒	LADDERS / STAIRS ☒ Extension Ladders ☐ Step Ladders ☒ Fixed Ladders ☒ Stairs	☒ Employees trained in safe ladder use at safety meeting ☒ Extension ladders are properly footed, secured at top, and setup at proper angle ☐ Stepladders are set on level ground or properly shimmed with spreaders locked. ☒ Stairs have proper rise over run and stairs >4 steps or 4' have guardrails. ☐ Never use a step ladder as a straight ladder. All straight ladders shall be extended three rungs past leading edge. Never use metal ladders while working with electricity. **Ladders/Stairs Comments: _____**
☐	MANLIFT used to reach work ☐ Scissor Lift ☐ Extensible Boom ☐ Articulated Boom ☐ Vertical Lift ("Genie")	☐ Operators are sufficiently trained, experienced and qualified. ☐ Equipment is inspected after mobilization and is in good condition. ☐ Harness & Lanyard worn whenever operating the lift (scissor lifts may be excepted) ☐ Overhead and surface obstructions are reviewed with operators prior to use. **Manlift Comments: _____**
WORKING ALONE		
☐	☐ Getting injured or incapacitated with no one else around to help ☐ Falling victim to crime	☒ Someone else knows your whereabouts, what you're doing and when you should be expected back to their office or project site location. This will be accomplished by communicating three (3) times at a minimum with the supervisor or the project manager 1 – Upon Arrival 2 – Midway through the day 3 – Upon Departure ☐ Ensure the area has wireless coverage; summon alternate communication method if wireless phones are not operable. ☐ Checked the weather forecast to avoid being caught up in bad weather conditions; ☐ Ensured that vehicle has sufficient fuel and is well maintained; ☐ Allowed self sufficient time for the trip so that you are not rushing; ☐ Drive with any bags, records and equipment hidden so that you are not seen hiding them as you park. **Working Alone Comments: _____**
EXCAVATIONS / TRENCHING/UNDERGROUND HAZARDS		
☐	☐ Max Depth ≥ 20' ☐ Max Depth ≥ 5' ☐ Max Depth <5' with potential cave-in hazard ☐ Potential permit-required confined space at depth ≥ 4' ☐ Underground utilities ☐ Structures/foundations ☐ Falls into excavations	☐ Sloping & shoring for excavations ≥20' are approved by a professional engineer ☐ Sloping & shoring for excavations ≥5' when persons are exposed to cave-in. (specify below) ☐ Sloping & shoring for shallow (<5') excavations with cave-in hazard (specify below) ☐ Excavations ≥ 4' are classified as a non-permit confined space ☐ Excavations ≥ 4' are classified as Alternate Entry or Permit-Required (see confined space) ☐ Underground utilities have been identified and marked. ☐ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☐ Hand digging within 3' of utility locations. ☐ Excavations are protected by perimeter fencing (not barricade tape): (☐ Rigid fence - chain link or wood, ☐ safety fence 6' from edge.) **Excavation Comments: _____**

PRE-WORK THA

CONFINED SPACES		
☐	☐ No <u>Serious</u> Hazards ☐ Toxic atmosphere ☐ Carbon monoxide ☐ Hydrogen sulfide ☐ _____ ☐ Flammable atmosphere ☐ Low oxygen ☐ Combustible dust ☐ Other Serious Hazard: _____	☐ Confined space is altered so that it is no longer a confined space. (describe below) ☐ Confined space is downgraded to a non-permit confined space. (identify which spaces below) ☐ Alternate Entry is used. (Identify which space qualify for confined space entry below) ☐ Full permit-required confined space entry is used due to presence of serious hazards. ☐ Rescue team has been notified (☐ Paid FD ☐ Volunteer FD ☐ Plant Rescue) Rescue team: _____ Phone number: _____ ☐ All entrants and attendants for Alternate Entry and Permit-Required Entry have confined space entry training. **Confined Space Comments:** _____
BOAT OPERATIONS/WORKING ON or NEAR WATER and ICE		
☒	☒ Drowning ☒ Hypothermia	☐ Only qualified employees are operating the boat ☒ Coast Guard-approved Personal Flotation Device (PFD), sized and adjusted to the wearer, is worn by all when involved in boat operations. ☐ A float plan is completed prior to leaving dock. ☐ Emergency equipment like ring buoy, flares and fire extinguishers are present **Boat, Water Operations Comments:** <u>A PFD should be worn whenever there is the risk of falling into the Canal. A ring buoy should be on hand to assist anyone who falls into the water.</u>
DRILLING		
☐	☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ Underground utilities, aboveground ☐ Spills	☐ Contractor inspected the drill rig ☐ High visibility vests, hard hats are being worn near the equipment ☐ Operators and helpers will maintain a safe distance to moving parts. All those working near moving or rotating parts will secure loose hair, clothing, and equipment. ☐ Drill rigs will only be moved with masts lowered. Masts will be erected with outriggers fully extended when equipped with outriggers. ☐ Max. safe slope for rig will be followed ☐ Spinning parts of the rig are guarded when possible, no loose clothing being worn near the rig ☐ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☐ IDW is being managed as per regulations ☐ Area is surveyed for overhead utilities ☐ Hearing protection is used when working near the rig ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill Kit Located: _____ **Drilling operations Comments:** _____
HEAVY EQUIPMENT [other than cranes]		
☐	☐ Max. safe slope for each vehicle will be followed ☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ Bulldozer ☐ Excavator ☐ Front Loader ☐ Mini Skid Steer (Bobcat) ☐ Mini Excavator ☐ Dump Truck ☐ Drill/Boring Rig ☐ Lull / Material Handler ☐ Forklift ☐ Manlift - specify type(s) ☐ Land Clearing loader	☐ Qualified persons operate all heavy equipment. (certificate is required for forklift and lull operators) ☐ Equipment will be inspected upon mobilization ☐ All leaks or defective safety equipment will be repaired before use. ☐ Operators will be reminded of seatbelt use by: _____ ☐ Eye contact with the operator is made prior to approaching near equipment or swing radius ☐ High visibility vests are required ☐ Max. safe slope for each vehicle will be followed ☐ Counterweight swing radius will be barricaded. ☐ Rigging directly to the forks of a lull, forklift, or front loader equipped forks is prohibited. Crane hook attachments will be used (specify): _____ ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____

PRE-WORK THA

CRANES		
☐	☐ Overhead hazards – utility lines, swing radius, falling objects, wire ropes and hoisting equipment ☐ Overbalancing – high winds, outrigger placement, overloading, safe slope ☐ Wire rope failure – condition, loading, safety lines ☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ _____ ☐ _____ ☐ _____	☐ Only qualified persons operate cranes (certificate required). ☐ A Critical Lift Plan will be developed and approved prior to mobilization. ☐ Equipment will be inspected prior to mobilization and a Crane Pre-Operational Safety Checklist will be completed and signed. ☐ A Critical Lift Checklist will be completed and signed prior to crane mobilization. ☐ Rigging, wire rope and hoisting equipment will be inspected and maintained on a weekly basis. ☐ Crane operator will remain at the controls at all times during operation. ☐ Crane operation must be performed under the direction of an appointed signal person at all times. ☐ Communication between crane operator and signal person will be maintained through standard hand signals or voice communication equipment. Radio equipment, if used, will be equipped with a discrete channel. ☐ Lifting or lowering will not exceed 100ft/minute. Lowering must be controlled i.e. no free fall. ☐ Stop work will be issued whenever hoisting equipment is exposed to winds exceeding 35mph. Hoisting equipment will be re-inspected and confirmed to be in operable condition prior to re-use. ☐ Cranes will not travel with personnel on the platform. Note that [Contractor] personnel are prohibited from entering the immediate vicinity of the crane during operation, unless prior approval has been obtained from the Corporate EHS Dept. ☐ Outriggers will be fully extended/locked with a firm footing within the maximum safe slope (<1%). ☐ Total weight of the load will not exceed 50% of the rated capacity for the crane radius and configuration. ☐ Crane hooks will be moused or provided with safety latches. ☐ Eye contact with the operator is made prior to approaching near equipment or swing radius ☐ High visibility vests are required ☐ Max. safe slope (<1%) will be followed ☐ Counterweight swing radius will be barricaded. ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____ **Crane Hazards Comments: _____** [Consultant/Engineer] personnel are prohibited from suspended personnel lifting.
ENVIRONMENTAL HAZARDS (NON CHEMICAL)		
☒	☒ Heat Stress ☒ Cold Stress ☒ Insects, spiders, ticks ☐ Wild animals ☐ Mold, fungi ☐ Poisonous plants ☐ Hazardous noise	☒ Heat/Cold stress are monitored in accordance with [Consultant/Engineer] procedures ☒ Fluids are provided to prevent worker dehydration ☒ Types and injury potential of snakes, insects, spiders are reviewed with workers ☒ Insect repellant is used, PPE is used to protect against sting/bite injuries. ☐ All potentially poisonous plants such as poison ivy, poison oak, poison sumac are identified, long sleeve shirt or Tyvek is worn or a barrier cream is used when near these plants ☐ Hearing protection is used when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period) **Environmental Hazards Comments: _____**
POWER TOOLS, HAND TOOLS, and EXTENSION CORDS		
☐	Eye injury, hand/arm cuts, electrical shock, strains, foot injuries, dust ☐ Grinders ☐ Needle Gun ☐ Chop saw ☐ Chain saw ☐ Trimmer ☐ Concrete/asphalt saw	☐ All tools and electrical cords will be inspected upon mobilization by: _____ ☐ All tools and electrical cords in-use will be inspected daily by: _____ ☐ Grinder speeds will not exceed grinding wheel ratings. ☐ Water or wet cutting performed to control dust ☐ Respirators used to prevent exposure to dust (respirator type: _____) ☐ Thorough utility survey conducted prior to any concrete cutting, coring ☐ Face shield <u>and</u> safety glasses used (required for all grinders, jackhammers, chain saws, etc.) ☐ Kevlar chaps and jacket (required for all chainsaw work) ☐ Hearing protection required for which tools or areas: _____ ☐ All extension cords are in good condition with no cuts through outer insulation, ground plugs are present, and no "vinyl tape" repairs. **Tool & Cord Comments: _____**

PRE-WORK THA

MANUAL MATERIAL HANDLING / MATERIAL STORAGE / HOUSEKEEPING		
☐	Back or shoulder strain, struck by falling objects, trips and falls, incompatible materials (fire or explosion) ☐ Hvy manual lifting (>30 lbs) ☐ Chemical storage ☐ Compressed gas storage ☐ Tall storage greater than 2 pallets stacked. ☐ Material & equipment laydown areas ☐ Debris removal	☐ Mechanical lifting equipment used to reduce manual material handling: (☐ Forklift/Lull ☐ Heavy Equipment ☐ Chainfall ☐ _____) ☐ Manual lifting more than 50 lbs by a single person will be avoided. ☐ Good manual lifting techniques will be reviewed prior to site work. ☐ Incompatible chemicals will be separated by 20' ☐ Secondary containment will be provided for the following chemicals: _____ ☐ Safety equipment will be located near chemical storage. ☐ Spill Kit ☐ Emergency Shower ☐ Eyewash ☐ Drench Hose ☐ Splash PPE ☐ Flammable gases and oxygen will be separated by 20'. ☐ All compressed gas cylinders will be transported vertically and secured upright. ☐ Equipment and materials will not be stored on site ☐ Debris will be moved daily and placed in designated areas. **Material Handling & Housekeeping Comments: _____**
TRAFFIC & SIDEWALK OBSTRUCTION		
☐	☐ Vehicle accidents ☐ Pedestrians struck by vehicles or heavy equipment ☐ Pedestrians falls ☐ Pedestrian struck-by falling objects	☐ DOT signal devices will be used to re-route vehicles around excavations or busy site entrances/exits that affect road traffic. ☐ Flaggers will be used and have DOT Flagger Training ☐ Pedestrian traffic will be safely routed around or over excavations. ☐ Pedestrian traffic will be safely routed around or under overhead work. **Traffic & Sidewalk Comments: _____**
HAZARDOUS WASTE SITE WORK		
☒	☒ Exposure to hazardous vapors or dust, contact with contaminated materials, fire, and explosion. Contaminants of Concern and hazardous chemicals include: ☒ Volatile organic compounds (describe: <u>BTEX</u>) ☐ Semivolatile organic cmpds (describe: <u>Coal tar and coal tar products</u>) ☒ Metal dusts (describe <u>arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc</u>) ☒ PCBs ☐ Caustic (NaOH) ☐ Acid (H_2SO_4, HCl) ☒ Other hazardous waste site hazards are covered elsewhere in the HASP)	☒ Site workers with a potential for contact with contaminated materials will have OSHA 40-hour training, current 8-hour refresher, and medical exam. ☐ No intrusive work activities or areas are anticipated with current scope of work. Intrusive work activities include: _____ The perimeter of intrusive work areas are identified by: _____ Decontamination of personnel or equipment is <u>not</u> anticipated with the current scope of work. ☐ Decontamination of personnel and small tools will be conducted as follows: _____ ☐ Decontamination of heavy equipment will be conducted as follows: _____ ☐ Heavy equipment leaving the site will be inspected by: _____ ☐ Work area monitoring is not anticipated with the current scope of work. ☒ Work Area Air Monitoring as follows for (dust, VOCs, etc.) **OR** see attached. _____ to _____ Level C: Tyvek, boot covers, nitrile gloves, half or full face respirator with _____ cartridges changed daily _____ to _____ Level B: Same as above except supplied air respirator _____ to _____ STOP work, contact EHS Department ☐ Community Air Monitoring is not anticipated with the current scope of work. ☐ Community Air Monitoring is required per the attached document. **Comments/Other: _____**

PRE-WORK THA

EMERGENCY RESPONSE (911 Service is Available ☒ Yes ☐ No)			
Emergency Medical Treatment - Hospital Name: Hospital Address:	Brooklyn Hospital Center 121 DeKalb Avenue Brooklyn, New York 11205	**Phone:**	718-250-8000
Non-Emergency Med. Treatment - Clinic Name: Occupational Clinic Address:	Interfaith Medical Center 1545 Atlantic Avenue Brooklyn, New York 11213	**Phone:**	718-613-4988
Fire Department Name	New York Fire Department	**Phone:**	911
Spill Response:	New York Fire Department	**Phone:**	911
Client Representative Name::		**Office:** **Cell:**	
[Consultant/Engineer] Project Manager Name:		**Office:** **Cell:**	
[Consultant/Engineer] Corporate H&S Name:		**Office:** **Cell:**	
Emergency Response Comments:			

Date:	
Project Name:	**Gowanus Canal Superfund Site**
THA Title:	**Work Near Water Task Hazard Analysis**
Subcontractor Name:	
[Consultant/Engineer] Representative (reviewed by):	
Subcontractor Foreman/Supervisor Signature (authorize):	
Crew Signatures (acknowledge):	
Print Name	**Signature**

PLEASE RETURN A COPY OF THIS SIGNED PAGE TO [CONTRACTOR] PROJECT MGR., SUPERINTENDENT UPON REVIEW AND ACKOWLEDGMENT BY THE CREW MEMBERS. ALL NEW CREW MEMBERS SHALL BE ORIENTATED THE SAME AND A SUBMITTAL OF A NEW SIGN IN SHEET SHALL BE COMPLETED.

PRE-WORK THA

THA Title:	**Work On Boats Task Hazard Analysis**	**Date:**	**18 February 2014**
Project Name:	**Gowanus Canal Superfund Site**	**Client Name:**	**National Grid**
Project Number:		**Client Project Manager:**	
Project Location:	**Brooklyn, New York**	**[Consultant/Engineer] Project Manager:**	
Scope of Work Summary:	The Pre-Design Work will involve work on boats/barges (i.e., collection of sediment core samples, delpoyment and retreival of sonar equipment, inspection of bulkheads and other Canal infrastructure, collection of surface water samples).		

Work Steps	**Process or Activity**	**Hazards**	**Hazard Control**
• Work on boats		• Work on boats	• A PFD must be worn by all personnel when working on boats • Whenever possible, vessels should have safety railings • Make yourself aware of the locations on the vessel of the rescue buoy, first aid kit, and fire extinguisher • To the maximum extent possible, stay seated while the vessel is in motion • Boat captain should communicate impending changes in direction or speed • Avoid trip hazards associated with boat anchor lines • Maintain good housekeeping practices on vessels
		• Boarding/disembarking boats	• Use three points of contact when boarding/disembarking vessels • Avoid carrying items that block your vision when boarding/dismbarking vessels (i.e., put the item down, board/disembark the vessel, then pick the item up) • Assist fellow field team members when boarding/dismbarking vessels • Avoid pinch points between vessels and bulkheads
•		•	•

Min. Personal Protective Equipment (PPE):	• Hardhat • Safety glasses • Gloves • Steel-toed/hard-toed boots • Hearing protection when working around loud noises • Traffic vest when working around vehicles or heavy equipment • Coast Guard-approved Personal Floatation Device (PFD) when working on or near water • Tyvek suits may be worn if desired to protect against getting contaminated water or sediment on clothing or skin

Individuals Must Sign the last page of this THA after review.

PRE-WORK THA

HAZARD		HAZARD CONTROLS (check all that apply and comment as required)
WALKING/WORKING SURFACES		
☒	☒ Uneven terrain ☒ Slippery surfaces	☒ Walkways are cleared of equipment, vegetation, excavated material, tools and debris ☐ Pits and floor openings are covered or otherwise guarded ☒ Work areas are illuminated adequately; field operations are not conducted before sunrise or after sunset unless adequate lighting is provided. ☐ Spills are cleaned up promptly ☐ Salt applied to icy areas, snow cleared from walkways
☐	LADDERS / STAIRS ☐ Extension Ladders ☐ Step Ladders ☐ Fixed Ladders ☐ Stairs	☐ Employees trained in safe ladder use at safety meeting ☐ Extension ladders are properly footed, secured at top, and setup at proper angle ☐ Stepladders are set on level ground or properly shimmed with spreaders locked. ☐ Stairs have proper rise over run and stairs >4 steps or 4' have guardrails. ☐ Never use a step ladder as a straight ladder. All straight ladders shall be extended three rungs past leading edge. Never use metal ladders while working with electricity. **Ladders/Stairs Comments: _____**
☐	MANLIFT used to reach work ☐ Scissor Lift ☐ Extensible Boom ☐ Articulated Boom ☐ Vertical Lift ("Genie")	☐ Operators are sufficiently trained, experienced and qualified. ☐ Equipment is inspected after mobilization and is in good condition. ☐ Harness & Lanyard worn whenever operating the lift (scissor lifts may be excepted) ☐ Overhead and surface obstructions are reviewed with operators prior to use. **Manlift Comments: _____**
WORKING ALONE		
☐	☐ Getting injured or incapacitated with no one else around to help ☐ Falling victim to crime	☐ Someone else knows your whereabouts, what you're doing and when you should be expected back to their office or project site location. This will be accomplished by communicating three (3) times at a minimum with the supervisor or the project manager 1 – Upon Arrival 2 – Midway through the day 3 – Upon Departure ☐ Ensure the area has wireless coverage; summon alternate communication method if wireless phones are not operable. ☐ Checked the weather forecast to avoid being caught up in bad weather conditions; ☐ Ensured that vehicle has sufficient fuel and is well maintained; ☐ Allowed self sufficient time for the trip so that you are not rushing; ☐ Drive with any bags, records and equipment hidden so that you are not seen hiding them as you park. **Working Alone Comments: _____**
EXCAVATIONS / TRENCHING/UNDERGROUND HAZARDS		
☐	☐ Max Depth ≥ 20' ☐ Max Depth ≥ 5' ☐ Max Depth <5' with potential cave-in hazard ☐ Potential permit-required confined space at depth ≥ 4' ☐ Underground utilities ☐ Structures/foundations ☐ Falls into excavations	☐ Sloping & shoring for excavations ≥20' are approved by a professional engineer ☐ Sloping & shoring for excavations ≥5' when persons are exposed to cave-in. (specify below) ☐ Sloping & shoring for shallow (<5') excavations with cave-in hazard (specify below) ☐ Excavations ≥ 4' are classified as a non-permit confined space ☐ Excavations ≥ 4' are classified as Alternate Entry or Permit-Required (see confined space) ☐ Underground utilities have been identified and marked. ☐ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☐ Hand digging within 3' of utility locations. ☐ Excavations are protected by perimeter fencing (not barricade tape): (☐ Rigid fence - chain link or wood, ☐ safety fence 6' from edge.) **Excavation Comments: _____**

PRE-WORK THA

CONFINED SPACES		
☐	☐ No <u>Serious</u> Hazards ☐ Toxic atmosphere ☐ Carbon monoxide ☐ Hydrogen sulfide ☐ _____ ☐ Flammable atmosphere ☐ Low oxygen ☐ Combustible dust ☐ Other Serious Hazard: _____	☐ Confined space is altered so that it is no longer a confined space. (describe below) ☐ Confined space is downgraded to a non-permit confined space. (identify which spaces below) ☐ Alternate Entry is used. (Identify which space qualify for confined space entry below) ☐ Full permit-required confined space entry is used due to presence of serious hazards. ☐ Rescue team has been notified (☐ Paid FD ☐ Volunteer FD ☐ Plant Rescue) Rescue team: _____ Phone number: _____ ☐ All entrants and attendants for Alternate Entry and Permit-Required Entry have confined space entry training. **Confined Space Comments:** _____
BOAT OPERATIONS/WORKING ON or NEAR WATER and ICE		
☒	☒ Drowning ☒ Hypothermia	☒ Only qualified employees are operating the boat ☒ Coast Guard-approved Personal Flotation Device (PFD), sized and adjusted to the wearer, is worn by all when involved in boat operations. ☒ A float plan is completed prior to leaving dock. ☒ Emergency equipment like ring buoy, flares and fire extinguishers are present **Boat, Water Operations Comments:** <u>A PFD must be worn by all personnel when working on boats/barges. Whenever possible, vessels should have safety railings. Be careful when boarding or disembarking vessels - avoid carrying items that block your vision (i.e., put the item down, board/disembark the vessel, then pick the item up). Aid fellow field team members when boarding/disembarking vessels. Avoid trip hazards associated with boat anchor lines. Maintain good housekeeping practices on vessels.</u>
DRILLING		
☐	☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ Underground utilities, aboveground ☐ Spills	☐ Contractor inspected the drill rig ☐ High visibility vests, hard hats are being worn near the equipment ☐ Operators and helpers will maintain a safe distance to moving parts. All those working near moving or rotating parts will secure loose hair, clothing, and equipment. ☐ Drill rigs will only be moved with masts lowered. Masts will be erected with outriggers fully extended when equipped with outriggers. ☐ Max. safe slope for rig will be followed ☐ Spinning parts of the rig are guarded when possible, no loose clothing being worn near the rig ☐ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☐ IDW is being managed as per regulations ☐ Area is surveyed for overhead utilities ☐ Hearing protection is used when working near the rig ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill Kit Located: _____ **Drilling operations Comments:** _____
HEAVY EQUIPMENT [other than cranes]		
☐	☐ Max. safe slope for each vehicle will be followed ☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ Bulldozer ☐ Excavator ☐ Front Loader ☐ Mini Skid Steer (Bobcat) ☐ Mini Excavator ☐ Dump Truck ☐ Drill/Boring Rig ☐ Lull / Material Handler ☐ Forklift ☐ Manlift - specify type(s) ☐ Land Clearing loader	☐ Qualified persons operate all heavy equipment. (certificate is required for forklift and lull operators) ☐ Equipment will be inspected upon mobilization ☐ All leaks or defective safety equipment will be repaired before use. ☐ Operators will be reminded of seatbelt use by: _____ ☐ Eye contact with the operator is made prior to approaching near equipment or swing radius ☐ High visibility vests are required ☐ Max. safe slope for each vehicle will be followed ☐ Counterweight swing radius will be barricaded. ☐ Rigging directly to the forks of a lull, forklift, or front loader equipped forks is prohibited. Crane hook attachments will be used (specify): _____ ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____

PRE-WORK THA

CRANES		
☐	☐ Overhead hazards – utility lines, swing radius, falling objects, wire ropes and hoisting equipment ☐ Overbalancing – high winds, outrigger placement, overloading, safe slope ☐ Wire rope failure – condition, loading, safety lines ☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ _____ ☐ _____ ☐ _____	☐ Only qualified persons operate cranes (certificate required). ☐ A Critical Lift Plan will be developed and approved prior to mobilization. ☐ Equipment will be inspected prior to mobilization and a Crane Pre-Operational Safety Checklist will be completed and signed. ☐ A Critical Lift Checklist will be completed and signed prior to crane mobilization. ☐ Rigging, wire rope and hoisting equipment will be inspected and maintained on a weekly basis. ☐ Crane operator will remain at the controls at all times during operation. ☐ Crane operation must be performed under the direction of an appointed signal person at all times. ☐ Communication between crane operator and signal person will be maintained through standard hand signals or voice communication equipment. Radio equipment, if used, will be equipped with a discrete channel. ☐ Lifting or lowering will not exceed 100ft/minute. Lowering must be controlled i.e. no free fall. ☐ Stop work will be issued whenever hoisting equipment is exposed to winds exceeding 35mph. Hoisting equipment will be re-inspected and confirmed to be in operable condition prior to re-use. ☐ Cranes will not travel with personnel on the platform. Note that [Contractor] personnel are prohibited from entering the immediate vicinity of the crane during operation, unless prior approval has been obtained from the Corporate EHS Dept. ☐ Outriggers will be fully extended/locked with a firm footing within the maximum safe slope (<1%). ☐ Total weight of the load will not exceed 50% of the rated capacity for the crane radius and configuration. ☐ Crane hooks will be moused or provided with safety latches. ☐ Eye contact with the operator is made prior to approaching near equipment or swing radius ☐ High visibility vests are required ☐ Max. safe slope (<1%) will be followed ☐ Counterweight swing radius will be barricaded. ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____ **Crane Hazards Comments: _____** [Consultant/Engineer] personnel are prohibited from suspended personnel lifting.
ENVIRONMENTAL HAZARDS (NON CHEMICAL)		
☒	☒ Heat Stress ☒ Cold Stress ☒ Insects, spiders, ticks ☐ Wild animals ☐ Mold, fungi ☐ Poisonous plants ☐ Hazardous noise	☒ Heat/Cold stress are monitored in accordance with [Consultant/Engineer] procedures ☒ Fluids are provided to prevent worker dehydration ☒ Types and injury potential of snakes, insects, spiders are reviewed with workers ☒ Insect repellant is used, PPE is used to protect against sting/bite injuries. ☐ All potentially poisonous plants such as poison ivy, poison oak, poison sumac are identified, long sleeve shirt or Tyvek is worn or a barrier cream is used when near these plants ☐ Hearing protection is used when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period) **Environmental Hazards Comments: _____**
POWER TOOLS, HAND TOOLS, and EXTENSION CORDS		
☐	Eye injury, hand/arm cuts, electrical shock, strains, foot injuries, dust ☐ Grinders ☐ Needle Gun ☐ Chop saw ☐ Chain saw ☐ Trimmer ☐ Concrete/asphalt saw	☐ All tools and electrical cords will be inspected upon mobilization by: _____ ☐ All tools and electrical cords in-use will be inspected daily by: _____ ☐ Grinder speeds will not exceed grinding wheel ratings. ☐ Water or wet cutting performed to control dust ☐ Respirators used to prevent exposure to dust (respirator type: _____) ☐ Thorough utility survey conducted prior to any concrete cutting, coring ☐ Face shield <u>and</u> safety glasses used (required for all grinders, jackhammers, chain saws, etc.) ☐ Kevlar chaps and jacket (required for all chainsaw work) ☐ Hearing protection required for which tools or areas: _____ ☐ All extension cords are in good condition with no cuts through outer insulation, ground plugs are present, and no "vinyl tape" repairs. **Tool & Cord Comments: _____**

PRE-WORK THA

MANUAL MATERIAL HANDLING / MATERIAL STORAGE / HOUSEKEEPING		
☒	Back or shoulder strain, struck by falling objects, trips and falls, incompatible materials (fire or explosion) ☒ Hvy manual lifting (>30 lbs) ☐ Chemical storage ☐ Compressed gas storage ☐ Tall storage greater than 2 pallets stacked. ☐ Material & equipment laydown areas ☐ Debris removal	☒ Mechanical lifting equipment used to reduce manual material handling: (☐ Forklift/Lull ☐ Heavy Equipment ☐ Chainfall ☐ _____) ☒ Manual lifting more than 50 lbs by a single person will be avoided. ☒ Good manual lifting techniques will be reviewed prior to site work. ☐ Incompatible chemicals will be separated by 20' ☐ Secondary containment will be provided for the following chemicals: _____ ☐ Safety equipment will be located near chemical storage. ☐ Spill Kit ☐ Emergency Shower ☐ Eyewash ☐ Drench Hose ☐ Splash PPE ☐ Flammable gases and oxygen will be separated by 20'. ☐ All compressed gas cylinders will be transported vertically and secured upright. ☐ Equipment and materials will not be stored on site ☐ Debris will be moved daily and placed in designated areas. **Material Handling & Housekeeping Comments: _____**
TRAFFIC & SIDEWALK OBSTRUCTION		
☐	☐ Vehicle accidents ☐ Pedestrians struck by vehicles or heavy equipment ☐ Pedestrians falls ☐ Pedestrian struck-by falling objects	☐ DOT signal devices will be used to re-route vehicles around excavations or busy site entrances/exits that affect road traffic. ☐ Flaggers will be used and have DOT Flagger Training ☐ Pedestrian traffic will be safely routed around or over excavations. ☐ Pedestrian traffic will be safely routed around or under overhead work. **Traffic & Sidewalk Comments: _____**
HAZARDOUS WASTE SITE WORK		
☒	☒ Exposure to hazardous vapors or dust, contact with contaminated materials, fire, and explosion. Contaminants of Concern and hazardous chemicals include: ☒ Volatile organic compounds (describe: <u>BTEX</u>) ☒ Semivolatile organic cmpds (describe: <u>Coal tar and coal tar products</u>) ☒ Metal dusts (describe <u>arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc</u>) ☒ PCBs ☐ Caustic (NaOH) ☐ Acid (H_2SO_4, HCl) ☒ Other hazardous waste site hazards are covered elsewhere in the HASP)	☒ Site workers with a potential for contact with contaminated materials will have OSHA 40-hour training, current 8-hour refresher, and medical exam. ☐ No intrusive work activities or areas are anticipated with current scope of work. Intrusive work activities include: _____ The perimeter of intrusive work areas are identified by: _____ Decontamination of personnel or equipment is <u>not</u> anticipated with the current scope of work. ☐ Decontamination of personnel and small tools will be conducted as follows: _____ ☐ Decontamination of heavy equipment will be conducted as follows: _____ ☐ Heavy equipment leaving the site will be inspected by: _____ ☐ Work area monitoring is not anticipated with the current scope of work. ☒ Work Area Air Monitoring as follows for (dust, VOCs, etc.) **OR** see attached. _____ to _____ Level C: Tyvek, boot covers, nitrile gloves, half or full face respirator with _____ cartridges changed daily _____ to _____ Level B: Same as above except supplied air respirator _____ to _____ STOP work, contact EHS Department ☐ Community Air Monitoring is not anticipated with the current scope of work. ☐ Community Air Monitoring is required per the attached document. **Comments/Other: _____**

PRE-WORK THA

EMERGENCY RESPONSE (911 Service is Available ☒ Yes ☐ No)			
Emergency Medical Treatment - Hospital Name: Hospital Address:	Brooklyn Hospital Center 121 DeKalb Avenue Brooklyn, New York 11205	**Phone:**	718-250-8000
Non-Emergency Med. Treatment - Clinic Name: Occupational Clinic Address:	Interfaith Medical Center 1545 Atlantic Avenue Brooklyn, New York 11213	**Phone:**	718-613-4988
Fire Department Name	New York Fire Department	**Phone:**	911
Spill Response:	New York Fire Department	**Phone:**	911
Client Representative Name::		**Office:** **Cell:**	
[Consultant/Engineer] Project Manager Name:		**Office:** **Cell:**	
[Consultant/Engineer] Corporate H&S Name:		**Office:** **Cell:**	
Emergency Response Comments:			

Date:	
Project Name:	**Gowanus Canal Superfund Site**
THA Title:	**Work On Boats Task Hazard Analysis**
Subcontractor Name:	
[Consultant/Engineer] Representative (reviewed by):	
Subcontractor Foreman/Supervisor Signature (authorize):	
Crew Signatures (acknowledge):	
Print Name	**Signature**

PLEASE RETURN A COPY OF THIS SIGNED PAGE TO [CONTRACTOR] PROJECT MGR., SUPERINTENDENT UPON REVIEW AND ACKOWLEDGMENT BY THE CREW MEMBERS. ALL NEW CREW MEMBERS SHALL BE ORIENTATED THE SAME AND A SUBMITTAL OF A NEW SIGN IN SHEET SHALL BE COMPLETED.

PRE-WORK THA

THA Title:	**Sediment Core Collection & Monitoring Equipment Deployment and Retrieval Task Hazard Analysis**	**Date:**	**27 February 2014**
Project Name:	**Gowanus Canal Superfund Site**	**Client Name:**	**National Grid**
Project Number:		**Client Project Manager:**	
Project Location:	**Brooklyn, New York**	**[Consultant/Engineer] Project Manager:**	
Scope of Work Summary:	The Pre-Design Work will involve the collection of sediment core samples and the delpoyment and retreival of monitoring equipment from barges/boats on the Gowanus Canal.		

Work Steps	Process or Activity	Hazards	Hazard Control
• Sediment core collection from boats/barges		• Working around core sample collection equipment	• Avoid pinch points that occur when the mast used to deploy the core samplers is raised or lowered • Stay away from the sample collection apparatus when in use • Avoid the sample collection floor opening at all times • Avoid trip hazards associated with boat anchor lines • Wear hearing protection during Vibracore use • Use multiple persons or mechanical assistance to lift heavy loads • Wear gloves to protect against contact with contaminated sediment
		• Exposure to contaminated sediment/soil and volatile organic compound vapors	• Perform air monitoring using a PID and dust monitor (see HASP for action levels)
• Deployment/retrieval of monitoring equipment from boats/barges		• Deploying and retrieving potentially heavy/bulky equipment	• Use caution when deploying/retrieving equipment and do not put yourself in a position where you are in danger of falling overboard • Use multiple persons or mechanical assistance to lift heavy loads • Avoid trip hazard associated with boat anchor lines • Wear gloves to protect against contact with contaminated water
•		•	•

Min. Personal Protective Equipment (PPE):	• Hardhat • Safety glasses • Gloves • Steel-toed/hard-toed boots • Hearing protection when working around loud noises • Traffic vest when working around vehicles or heavy equipment • Coast Guard-approved Personal Floatation Device (PFD) when working on or near water • Tyvek suits may be worn if desired to protect against getting contaminated water or sediment on clothing or skin

Individuals Must Sign the last page of this THA after review.

PRE-WORK THA

HAZARD		HAZARD CONTROLS (check all that apply and comment as required)
WALKING/WORKING SURFACES		
☒	☒ Uneven terrain ☒ Slippery surfaces	☒ Walkways are cleared of equipment, vegetation, excavated material, tools and debris ☐ Pits and floor openings are covered or otherwise guarded ☒ Work areas are illuminated adequately; field operations are not conducted before sunrise or after sunset unless adequate lighting is provided. ☐ Spills are cleaned up promptly ☐ Salt applied to icy areas, snow cleared from walkways
☐	LADDERS / STAIRS ☐ Extension Ladders ☐ Step Ladders ☐ Fixed Ladders ☐ Stairs	☐ Employees trained in safe ladder use at safety meeting ☐ Extension ladders are properly footed, secured at top, and setup at proper angle ☐ Stepladders are set on level ground or properly shimmed with spreaders locked. ☐ Stairs have proper rise over run and stairs >4 steps or 4' have guardrails. ☐ Never use a step ladder as a straight ladder. All straight ladders shall be extended three rungs past leading edge. Never use metal ladders while working with electricity. **Ladders/Stairs Comments: _____**
☐	MANLIFT used to reach work ☐ Scissor Lift ☐ Extensible Boom ☐ Articulated Boom ☐ Vertical Lift ("Genie")	☐ Operators are sufficiently trained, experienced and qualified. ☐ Equipment is inspected after mobilization and is in good condition. ☐ Harness & Lanyard worn whenever operating the lift (scissor lifts may be excepted) ☐ Overhead and surface obstructions are reviewed with operators prior to use. **Manlift Comments: _____**
WORKING ALONE		
☐	☐ Getting injured or incapacitated with no one else around to help ☐ Falling victim to crime	☐ Someone else knows your whereabouts, what you're doing and when you should be expected back to their office or project site location. This will be accomplished by communicating three (3) times at a minimum with the supervisor or the project manager 1 – Upon Arrival 2 – Midway through the day 3 – Upon Departure ☐ Ensure the area has wireless coverage; summon alternate communication method if wireless phones are not operable. ☐ Checked the weather forecast to avoid being caught up in bad weather conditions; ☐ Ensured that vehicle has sufficient fuel and is well maintained; ☐ Allowed self sufficient time for the trip so that you are not rushing; ☐ Drive with any bags, records and equipment hidden so that you are not seen hiding them as you park. **Working Alone Comments: _____**
EXCAVATIONS / TRENCHING/UNDERGROUND HAZARDS		
☐	☐ Max Depth ≥ 20' ☐ Max Depth ≥ 5' ☐ Max Depth <5' with potential cave-in hazard ☐ Potential permit-required confined space at depth ≥ 4' ☐ Underground utilities ☐ Structures/foundations ☐ Falls into excavations	☐ Sloping & shoring for excavations ≥20' are approved by a professional engineer ☐ Sloping & shoring for excavations ≥5' when persons are exposed to cave-in. (specify below) ☐ Sloping & shoring for shallow (<5') excavations with cave-in hazard (specify below) ☐ Excavations ≥ 4' are classified as a non-permit confined space ☐ Excavations ≥ 4' are classified as Alternate Entry or Permit-Required (see confined space) ☐ Underground utilities have been identified and marked. ☐ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☐ Hand digging within 3' of utility locations. ☐ Excavations are protected by perimeter fencing (not barricade tape): (☐ Rigid fence - chain link or wood, ☐ safety fence 6' from edge.) **Excavation Comments: _____**

PRE-WORK THA

CONFINED SPACES		
☐	☐ No <u>Serious</u> Hazards ☐ Toxic atmosphere ☐ Carbon monoxide ☐ Hydrogen sulfide ☐ _____ ☐ Flammable atmosphere ☐ Low oxygen ☐ Combustible dust ☐ Other Serious Hazard: _____	☐ Confined space is altered so that it is no longer a confined space. (describe below) ☐ Confined space is downgraded to a non-permit confined space. (identify which spaces below) ☐ Alternate Entry is used. (Identify which space qualify for confined space entry below) ☐ Full permit-required confined space entry is used due to presence of serious hazards. ☐ Rescue team has been notified (☐ Paid FD ☐ Volunteer FD ☐ Plant Rescue) Rescue team: _____ Phone number: _____ ☐ All entrants and attendants for Alternate Entry and Permit-Required Entry have confined space entry training. **Confined Space Comments:** _____
BOAT OPERATIONS/WORKING ON or NEAR WATER and ICE		
☒	☒ Drowning ☒ Hypothermia	☒ Only qualified employees are operating the boat ☒ Coast Guard-approved Personal Flotation Device (PFD), sized and adjusted to the wearer, is worn by all when involved in boat operations. ☒ A float plan is completed prior to leaving dock. ☒ Emergency equipment like ring buoy, flares and fire extinguishers are present **Boat, Water Operations Comments:** <u>A PFD must be worn by all personnel when working on boats/barges. Whenever possible, vessels should have safety railings. Be careful when boarding or disembarking vessels - avoid carrying items that block your vision (i.e., put the item down, board/disembark the vessel, then pick the item up). Aid fellow field team members when boarding/disembarking vessels. Avoid pinch points between vessel and bulkheads.</u>
DRILLING		
☐	☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ Underground utilities, aboveground ☐ Spills	☐ Contractor inspected the drill rig ☐ High visibility vests, hard hats are being worn near the equipment ☐ Operators and helpers will maintain a safe distance to moving parts. All those working near moving or rotating parts will secure loose hair, clothing, and equipment. ☐ Drill rigs will only be moved with masts lowered. Masts will be erected with outriggers fully extended when equipped with outriggers. ☐ Max. safe slope for rig will be followed ☐ Spinning parts of the rig are guarded when possible, no loose clothing being worn near the rig ☐ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☐ IDW is being managed as per regulations ☐ Area is surveyed for overhead utilities ☐ Hearing protection is used when working near the rig ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill Kit Located: _____ **Drilling operations Comments:** _____
HEAVY EQUIPMENT [other than cranes]		
☐	☐ Max. safe slope for each vehicle will be followed ☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ Bulldozer ☐ Excavator ☐ Front Loader ☐ Mini Skid Steer (Bobcat) ☐ Mini Excavator ☐ Dump Truck ☐ Drill/Boring Rig ☐ Lull / Material Handler ☐ Forklift ☐ Manlift - specify type(s) ☐ Land Clearing loader	☐ Qualified persons operate all heavy equipment. (certificate is required for forklift and lull operators) ☐ Equipment will be inspected upon mobilization ☐ All leaks or defective safety equipment will be repaired before use. ☐ Operators will be reminded of seatbelt use by: _____ ☐ Eye contact with the operator is made prior to approaching near equipment or swing radius ☐ High visibility vests are required ☐ Max. safe slope for each vehicle will be followed ☐ Counterweight swing radius will be barricaded. ☐ Rigging directly to the forks of a lull, forklift, or front loader equipped forks is prohibited. Crane hook attachments will be used (specify): _____ ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____

PRE-WORK THA

CRANES		
☒	☒ Overhead hazards – utility lines, swing radius, falling objects, wire ropes and hoisting equipment ☒ Overbalancing – high winds, outrigger placement, overloading, safe slope ☒ Wire rope failure – condition, loading, safety lines ☒ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ _____ ☐ _____ ☐ _____	☒ Only qualified persons operate cranes (certificate required). ☐ A Critical Lift Plan will be developed and approved prior to mobilization. ☐ Equipment will be inspected prior to mobilization and a Crane Pre-Operational Safety Checklist will be completed and signed. ☐ A Critical Lift Checklist will be completed and signed prior to crane mobilization. ☒ Rigging, wire rope and hoisting equipment will be inspected and maintained on a weekly basis. ☒ Crane operator will remain at the controls at all times during operation. ☒ Crane operation must be performed under the direction of an appointed signal person at all times. ☒ Communication between crane operator and signal person will be maintained through standard hand signals or voice communication equipment. Radio equipment, if used, will be equipped with a discrete channel. ☐ Lifting or lowering will not exceed 100ft/minute. Lowering must be controlled i.e. no free fall. ☒ Stop work will be issued whenever hoisting equipment is exposed to winds exceeding 35mph. Hoisting equipment will be re-inspected and confirmed to be in operable condition prior to re-use. ☒ Cranes will not travel with personnel on the platform. Note that [Contractor] personnel are prohibited from entering the immediate vicinity of the crane during operation, unless prior approval has been obtained from the Corporate EHS Dept. ☐ Outriggers will be fully extended/locked with a firm footing within the maximum safe slope (<1%). ☒ Total weight of the load will not exceed 50% of the rated capacity for the crane radius and configuration. ☐ Crane hooks will be moused or provided with safety latches. ☒ Eye contact with the operator is made prior to approaching near equipment or swing radius ☐ High visibility vests are required ☐ Max. safe slope (<1%) will be followed ☐ Counterweight swing radius will be barricaded. ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____ **Crane Hazards Comments:** <u>A winch mounted on a derrick on a barge will be used to raise and lower sediment samples, and may possibly be used to deploy and retrieve monitoring equipment. The hazards presented by the derrick and winch setup are similar to those presented by a crane.</u> [Consultant/Engineer] personnel are prohibited from suspended personnel lifting.
ENVIRONMENTAL HAZARDS (NON CHEMICAL)		
☒	☒ Heat Stress ☒ Cold Stress ☒ Insects, spiders, ticks ☐ Wild animals ☐ Mold, fungi ☐ Poisonous plants ☐ Hazardous noise	☒ Heat/Cold stress are monitored in accordance with [Consultant/Engineer] procedures ☒ Fluids are provided to prevent worker dehydration ☒ Types and injury potential of snakes, insects, spiders are reviewed with workers ☒ Insect repellant is used, PPE is used to protect against sting/bite injuries. ☐ All potentially poisonous plants such as poison ivy, poison oak, poison sumac are identified, long sleeve shirt or Tyvek is worn or a barrier cream is used when near these plants ☐ Hearing protection is used when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period) **Environmental Hazards Comments: _____**
POWER TOOLS, HAND TOOLS, and EXTENSION CORDS		
☐	Eye injury, hand/arm cuts, electrical shock, strains, foot injuries, dust ☐ Grinders ☐ Needle Gun ☐ Chop saw ☐ Chain saw ☐ Trimmer ☐ Concrete/asphalt saw	☐ All tools and electrical cords will be inspected upon mobilization by: _____ ☐ All tools and electrical cords in-use will be inspected daily by: _____ ☐ Grinder speeds will not exceed grinding wheel ratings. ☐ Water or wet cutting performed to control dust ☐ Respirators used to prevent exposure to dust (respirator type: _____) ☐ Thorough utility survey conducted prior to any concrete cutting, coring ☐ Face shield <u>and</u> safety glasses used (required for all grinders, jackhammers, chain saws, etc.) ☐ Kevlar chaps and jacket (required for all chainsaw work) ☐ Hearing protection required for which tools or areas: _____ ☐ All extension cords are in good condition with no cuts through outer insulation, ground plugs are present, and no "vinyl tape" repairs. **Tool & Cord Comments: _____**

PRE-WORK THA

MANUAL MATERIAL HANDLING / MATERIAL STORAGE / HOUSEKEEPING		
☒	Back or shoulder strain, struck by falling objects, trips and falls, incompatible materials (fire or explosion) ☒ Hvy manual lifting (>30 lbs) ☐ Chemical storage ☐ Compressed gas storage ☐ Tall storage greater than 2 pallets stacked. ☐ Material & equipment laydown areas ☐ Debris removal	☒ Mechanical lifting equipment used to reduce manual material handling: (☐ Forklift/Lull ☐ Heavy Equipment ☐ Chainfall ☐ _____) ☒ Manual lifting more than 50 lbs by a single person will be avoided. ☒ Good manual lifting techniques will be reviewed prior to site work. ☐ Incompatible chemicals will be separated by 20' ☐ Secondary containment will be provided for the following chemicals: _____ ☐ Safety equipment will be located near chemical storage. ☐ Spill Kit ☐ Emergency Shower ☐ Eyewash ☐ Drench Hose ☐ Splash PPE ☐ Flammable gases and oxygen will be separated by 20'. ☐ All compressed gas cylinders will be transported vertically and secured upright. ☐ Equipment and materials will not be stored on site ☐ Debris will be moved daily and placed in designated areas. **Material Handling & Housekeeping Comments: _____**
TRAFFIC & SIDEWALK OBSTRUCTION		
☐	☐ Vehicle accidents ☐ Pedestrians struck by vehicles or heavy equipment ☐ Pedestrians falls ☐ Pedestrian struck-by falling objects	☐ DOT signal devices will be used to re-route vehicles around excavations or busy site entrances/exits that affect road traffic. ☐ Flaggers will be used and have DOT Flagger Training ☐ Pedestrian traffic will be safely routed around or over excavations. ☐ Pedestrian traffic will be safely routed around or under overhead work. **Traffic & Sidewalk Comments: _____**
HAZARDOUS WASTE SITE WORK		
☒	☒ Exposure to hazardous vapors or dust, contact with contaminated materials, fire, and explosion. Contaminants of Concern and hazardous chemicals include: ☒ Volatile organic compounds (describe: <u>BTEX</u>) ☒ Semivolatile organic cmpds (describe: <u>Coal tar and coal tar products</u>) ☒ Metal dusts (describe <u>arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc</u>) ☒ PCBs ☐ Caustic (NaOH) ☐ Acid (H_2SO_4, HCl) ☒ Other hazardous waste site hazards are covered elsewhere in the HASP)	☒ Site workers with a potential for contact with contaminated materials will have OSHA 40-hour training, current 8-hour refresher, and medical exam. ☐ No intrusive work activities or areas are anticipated with current scope of work. Intrusive work activities include: _____ The perimeter of intrusive work areas are identified by: _____ Decontamination of personnel or equipment is <u>not</u> anticipated with the current scope of work. ☐ Decontamination of personnel and small tools will be conducted as follows: _____ ☐ Decontamination of heavy equipment will be conducted as follows: _____ ☐ Heavy equipment leaving the site will be inspected by: _____ ☐ Work area monitoring is not anticipated with the current scope of work. ☒ Work Area Air Monitoring as follows for (dust, VOCs, etc.) **OR** see attached. _____ to _____ Level C: Tyvek, boot covers, nitrile gloves, half or full face respirator with _____ cartridges changed daily _____ to _____ Level B: Same as above except supplied air respirator _____ to _____ STOP work, contact EHS Department ☐ Community Air Monitoring is not anticipated with the current scope of work. ☐ Community Air Monitoring is required per the attached document. **Comments/Other: _____**

PRE-WORK THA

EMERGENCY RESPONSE (911 Service is Available ☒ Yes ☐ No)			
Emergency Medical Treatment - Hospital Name: Hospital Address:	Brooklyn Hospital Center 121 DeKalb Avenue Brooklyn, New York 11205	**Phone:**	718-250-8000
Non-Emergency Med. Treatment - Clinic Name: Occupational Clinic Address:	Interfaith Medical Center 1545 Atlantic Avenue Brooklyn, New York 11213	**Phone:**	718-613-4988
Fire Department Name	New York Fire Department	**Phone:**	911
Spill Response:	New York Fire Department	**Phone:**	911
Client Representative Name::		**Office:** **Cell:**	
[Consultant/Engineer] Project Manager Name:		**Office:** **Cell:**	
[Consultant/Engineer] Corporate H&S Name:		**Office:** **Cell:**	
Emergency Response Comments:			

Date:	
Project Name:	**Gowanus Canal Superfund Site**
THA Title:	**Sediment Core Collection & Monitoring Equipment Deployment and Retrieval Task Hazard Analysis**
Subcontractor Name:	
[Consultant/Engineer] Representative (reviewed by):	
Subcontractor Foreman/Supervisor Signature (authorize):	
Crew Signatures (acknowledge):	
Print Name	**Signature**

PLEASE RETURN A COPY OF THIS SIGNED PAGE TO [CONTRACTOR] PROJECT MGR., SUPERINTENDENT UPON REVIEW AND ACKOWLEDGMENT BY THE CREW MEMBERS. ALL NEW CREW MEMBERS SHALL BE ORIENTATED THE SAME AND A SUBMITTAL OF A NEW SIGN IN SHEET SHALL BE COMPLETED.

PRE-WORK THA

THA Title:	**Work Around Heavy Equipment Task Hazard Analysis**	**Date:**	**27 February 2014**
Project Name:	**Gowanus Canal Superfund Site**	**Client Name:**	**National Grid**
Project Number:		**Client Project Manager:**	
Project Location:	**Brooklyn, New York**	**[Consultant/Engineer] Project Manager:**	
Scope of Work Summary:	As part of the Pre-Design Work, drill rigs will be employed at landside locations to collected soil cores.		

Work Steps	**Process or Activity**	**Hazards**	**Hazard Control**
• Collection of soil cores using a drill rig		• Work around heavy equipment	• Only qualfied personnel will operate drill rigs • The rule of only ever having one person's hands on the drill at a time (operator or helper) will be observed • All personnel working around drill rigs should make themselves aware of the locations of the emergency stop buttons • Hearing protection will be worn when the drill rig is in operation • High visibility vests and hardhats will be worn by all personnel when working around drill rigs
		• Overhead hazards	• Overhead hazards will be noted and avoided • Drill rigs will only be moved with masts lowered
		• Underground hazards	• Efforts will be made to determine the locations of subsurface utilities and other obstacles (e.g., DigSafe, geophysical survey) before drilling operations commence in any one area
•		•	•

Min. Personal Protective Equipment (PPE):	• Hardhat • Safety glasses • Gloves • Steel-toed/hard-toed boots • Hearing protection when working around loud noises • Traffic vest when working around vehicles or heavy equipment • Coast Guard-approved Personal Floatation Device (PFD) when working on or near water • Tyvek suits may be worn if desired to protect against getting contaminated water or sediment on clothing or skin

Individuals Must Sign the last page of this THA after review.

PRE-WORK THA

HAZARD		HAZARD CONTROLS (check all that apply and comment as required)
WALKING/WORKING SURFACES		
☒	☒ Uneven terrain ☒ Slippery surfaces	☒ Walkways are cleared of equipment, vegetation, excavated material, tools and debris ☒ Pits and floor openings are covered or otherwise guarded ☒ Work areas are illuminated adequately; field operations are not conducted before sunrise or after sunset unless adequate lighting is provided. ☒ Spills are cleaned up promptly ☒ Salt applied to icy areas, snow cleared from walkways
☐	LADDERS / STAIRS ☐ Extension Ladders ☐ Step Ladders ☐ Fixed Ladders ☐ Stairs	☐ Employees trained in safe ladder use at safety meeting ☐ Extension ladders are properly footed, secured at top, and setup at proper angle ☐ Stepladders are set on level ground or properly shimmed with spreaders locked. ☐ Stairs have proper rise over run and stairs >4 steps or 4' have guardrails. ☐ Never use a step ladder as a straight ladder. All straight ladders shall be extended three rungs past leading edge. Never use metal ladders while working with electricity. **Ladders/Stairs Comments: _____**
☐	MANLIFT used to reach work ☐ Scissor Lift ☐ Extensible Boom ☐ Articulated Boom ☐ Vertical Lift ("Genie")	☐ Operators are sufficiently trained, experienced and qualified. ☐ Equipment is inspected after mobilization and is in good condition. ☐ Harness & Lanyard worn whenever operating the lift (scissor lifts may be excepted) ☐ Overhead and surface obstructions are reviewed with operators prior to use. **Manlift Comments: _____**
WORKING ALONE		
☐	☐ Getting injured or incapacitated with no one else around to help ☐ Falling victim to crime	☐ Someone else knows your whereabouts, what you're doing and when you should be expected back to their office or project site location. This will be accomplished by communicating three (3) times at a minimum with the supervisor or the project manager 1 – Upon Arrival 2 – Midway through the day 3 – Upon Departure ☐ Ensure the area has wireless coverage; summon alternate communication method if wireless phones are not operable. ☐ Checked the weather forecast to avoid being caught up in bad weather conditions; ☐ Ensured that vehicle has sufficient fuel and is well maintained; ☐ Allowed self sufficient time for the trip so that you are not rushing; ☐ Drive with any bags, records and equipment hidden so that you are not seen hiding them as you park. **Working Alone Comments: _____**
EXCAVATIONS / TRENCHING/UNDERGROUND HAZARDS		
☐	☐ Max Depth ≥ 20' ☐ Max Depth ≥ 5' ☐ Max Depth <5' with potential cave-in hazard ☐ Potential permit-required confined space at depth ≥ 4' ☐ Underground utilities ☐ Structures/foundations ☐ Falls into excavations	☐ Sloping & shoring for excavations ≥20' are approved by a professional engineer ☐ Sloping & shoring for excavations ≥5' when persons are exposed to cave-in. (specify below) ☐ Sloping & shoring for shallow (<5') excavations with cave-in hazard (specify below) ☐ Excavations ≥ 4' are classified as a non-permit confined space ☐ Excavations ≥ 4' are classified as Alternate Entry or Permit-Required (see confined space) ☐ Underground utilities have been identified and marked. ☐ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☐ Hand digging within 3' of utility locations. ☐ Excavations are protected by perimeter fencing (not barricade tape): (☐ Rigid fence - chain link or wood, ☐ safety fence 6' from edge.) **Excavation Comments: _____**

PRE-WORK THA

CONFINED SPACES		
☐	☐ No Serious Hazards ☐ Toxic atmosphere ☐ Carbon monoxide ☐ Hydrogen sulfide ☐ _____ ☐ Flammable atmosphere ☐ Low oxygen ☐ Combustible dust ☐ Other Serious Hazard: _____	☐ Confined space is altered so that it is no longer a confined space. (describe below) ☐ Confined space is downgraded to a non-permit confined space. (identify which spaces below) ☐ Alternate Entry is used. (Identify which space qualify for confined space entry below) ☐ Full permit-required confined space entry is used due to presence of serious hazards. ☐ Rescue team has been notified (☐ Paid FD ☐ Volunteer FD ☐ Plant Rescue) Rescue team: _____ Phone number: _____ ☐ All entrants and attendants for Alternate Entry and Permit-Required Entry have confined space entry training. **Confined Space Comments: _____**
BOAT OPERATIONS/WORKING ON or NEAR WATER and ICE		
☐	☐ Drowning ☐ Hypothermia	☐ Only qualified employees are operating the boat ☐ Coast Guard-approved Personal Flotation Device (PFD), sized and adjusted to the wearer, is worn by all when involved in boat operations. ☐ A float plan is completed prior to leaving dock. ☐ Emergency equipment like ring buoy, flares and fire extinguishers are present **Boat, Water Operations Comments: _____**
DRILLING		
☒	☒ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☒ Underground utilities, aboveground ☒ Spills	☒ Contractor inspected the drill rig ☒ High visibility vests, hard hats are being worn near the equipment ☒ Operators and helpers will maintain a safe distance to moving parts. All those working near moving or rotating parts will secure loose hair, clothing, and equipment. ☒ Drill rigs will only be moved with masts lowered. Masts will be erected with outriggers fully extended when equipped with outriggers. ☒ Max. safe slope for rig will be followed ☒ Spinning parts of the rig are guarded when possible, no loose clothing being worn near the rig ☒ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☒ IDW is being managed as per regulations ☒ Area is surveyed for overhead utilities ☒ Hearing protection is used when working near the rig ☒ Spill equipment is available for fuel and hydraulic fluid leaks. Spill Kit Located: _____ **Drilling Operations Comments: _____**
HEAVY EQUIPMENT [other than cranes]		
☒	☐ Max. safe slope for each vehicle will be followed ☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ Bulldozer ☐ Excavator ☐ Front Loader ☐ Mini Skid Steer (Bobcat) ☐ Mini Excavator ☐ Dump Truck ☒ Drill/Boring Rig ☐ Lull / Material Handler ☐ Forklift ☐ Manlift - specify type(s) ☐ Land Clearing loader	☒ Qualified persons operate all heavy equipment. (certificate is required for forklift and lull operators) ☒ Equipment will be inspected upon mobilization ☒ All leaks or defective safety equipment will be repaired before use. ☐ Operators will be reminded of seatbelt use by: _____ ☒ Eye contact with the operator is made prior to approaching near equipment or swing radius ☒ High visibility vests are required ☒ Max. safe slope for each vehicle will be followed ☐ Counterweight swing radius will be barricaded. ☐ Rigging directly to the forks of a lull, forklift, or front loader equipped forks is prohibited. Crane hook attachments will be used (specify): _____ ☒ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____

PRE-WORK THA

CRANES		
☐	☐ Overhead hazards – utility lines, swing radius, falling objects, wire ropes and hoisting equipment ☐ Overbalancing – high winds, outrigger placement, overloading, safe slope ☐ Wire rope failure – condition, loading, safety lines ☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ _____ ☐ _____ ☐ _____	☐ Only qualified persons operate cranes (certificate required). ☐ A Critical Lift Plan will be developed and approved prior to mobilization. ☐ Equipment will be inspected prior to mobilization and a Crane Pre-Operational Safety Checklist will be completed and signed. ☐ A Critical Lift Checklist will be completed and signed prior to crane mobilization. ☐ Rigging, wire rope and hoisting equipment will be inspected and maintained on a weekly basis. ☐ Crane operator will remain at the controls at all times during operation. ☐ Crane operation must be performed under the direction of an appointed signal person at all times. ☐ Communication between crane operator and signal person will be maintained through standard hand signals or voice communication equipment. Radio equipment, if used, will be equipped with a discrete channel. ☐ Lifting or lowering will not exceed 100ft/minute. Lowering must be controlled i.e. no free fall. ☐ Stop work will be issued whenever hoisting equipment is exposed to winds exceeding 35mph. Hoisting equipment will be re-inspected and confirmed to be in operable condition prior to re-use. ☐ Cranes will not travel with personnel on the platform. Note that [Contractor] personnel are prohibited from entering the immediate vicinity of the crane during operation, unless prior approval has been obtained from the Corporate EHS Dept. ☐ Outriggers will be fully extended/locked with a firm footing within the maximum safe slope (<1%). ☐ Total weight of the load will not exceed 50% of the rated capacity for the crane radius and configuration. ☐ Crane hooks will be moused or provided with safety latches. ☐ Eye contact with the operator is made prior to approaching near equipment or swing radius ☐ High visibility vests are required ☐ Max. safe slope (<1%) will be followed ☐ Counterweight swing radius will be barricaded. ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____ **Crane Hazards Comments: _____** [Consultant/Engineer] personnel are prohibited from suspended personnel lifting.
ENVIRONMENTAL HAZARDS (NON CHEMICAL)		
☐	☐ Heat Stress ☐ Cold Stress ☐ Insects, spiders, ticks ☐ Wild animals ☐ Mold, fungi ☐ Poisonous plants ☐ Hazardous noise	☐ Heat/Cold stress are monitored in accordance with [Consultant/Engineer] procedures ☐ Fluids are provided to prevent worker dehydration ☐ Types and injury potential of snakes, insects, spiders are reviewed with workers ☐ Insect repellant is used, PPE is used to protect against sting/bite injuries. ☐ All potentially poisonous plants such as poison ivy, poison oak, poison sumac are identified, long sleeve shirt or Tyvek is worn or a barrier cream is used when near these plants ☐ Hearing protection is used when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period) **Environmental Hazards Comments: _____**
POWER TOOLS, HAND TOOLS, and EXTENSION CORDS		
☐	Eye injury, hand/arm cuts, electrical shock, strains, foot injuries, dust ☐ Grinders ☐ Needle Gun ☐ Chop saw ☐ Chain saw ☐ Trimmer ☐ Concrete/asphalt saw	☐ All tools and electrical cords will be inspected upon mobilization by: _____ ☐ All tools and electrical cords in-use will be inspected daily by: _____ ☐ Grinder speeds will not exceed grinding wheel ratings. ☐ Water or wet cutting performed to control dust ☐ Respirators used to prevent exposure to dust (respirator type: _____) ☐ Thorough utility survey conducted prior to any concrete cutting, coring ☐ Face shield <u>and</u> safety glasses used (required for all grinders, jackhammers, chain saws, etc.) ☐ Kevlar chaps and jacket (required for all chainsaw work) ☐ Hearing protection required for which tools or areas: _____ ☐ All extension cords are in good condition with no cuts through outer insulation, ground plugs are present, and no "vinyl tape" repairs. **Tool & Cord Comments: _____**

PRE-WORK THA

MANUAL MATERIAL HANDLING / MATERIAL STORAGE / HOUSEKEEPING		
☒	Back or shoulder strain, struck by falling objects, trips and falls, incompatible materials (fire or explosion) ☒ Hvy manual lifting (>30 lbs) ☐ Chemical storage ☐ Compressed gas storage ☐ Tall storage greater than 2 pallets stacked. ☒ Material & equipment laydown areas ☒ Debris removal	☒ Mechanical lifting equipment used to reduce manual material handling: (☐ Forklift/Lull ☐ Heavy Equipment ☐ Chainfall ☐ _____) ☒ Manual lifting more than 50 lbs by a single person will be avoided. ☒ Good manual lifting techniques will be reviewed prior to site work. ☐ Incompatible chemicals will be separated by 20' ☐ Secondary containment will be provided for the following chemicals: _____ ☐ Safety equipment will be located near chemical storage. ☐ Spill Kit ☐ Emergency Shower ☐ Eyewash ☐ Drench Hose ☐ Splash PPE ☐ Flammable gases and oxygen will be separated by 20'. ☐ All compressed gas cylinders will be transported vertically and secured upright. ☐ Equipment and materials will not be stored on site ☐ Debris will be moved daily and placed in designated areas. **Material Handling & Housekeeping Comments: _____**
TRAFFIC & SIDEWALK OBSTRUCTION		
☐	☐ Vehicle accidents ☐ Pedestrians struck by vehicles or heavy equipment ☐ Pedestrians falls ☐ Pedestrian struck-by falling objects	☐ DOT signal devices will be used to re-route vehicles around excavations or busy site entrances/exits that affect road traffic. ☐ Flaggers will be used and have DOT Flagger Training ☐ Pedestrian traffic will be safely routed around or over excavations. ☐ Pedestrian traffic will be safely routed around or under overhead work. **Traffic & Sidewalk Comments: _____**
HAZARDOUS WASTE SITE WORK		
☒	☒ Exposure to hazardous vapors or dust, contact with contaminated materials, fire, and explosion. Contaminants of Concern and hazardous chemicals include: ☒ Volatile organic compounds (describe: <u>BTEX</u>) ☒ Semivolatile organic cmpds (describe: <u>Coal tar and coal tar products</u>) ☒ Metal dusts (describe <u>arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc</u>) ☒ PCBs ☐ Caustic (NaOH) ☐ Acid (H_2SO_4, HCl) ☒ Other hazardous waste site hazards are covered elsewhere in the HASP)	☒ Site workers with a potential for contact with contaminated materials will have OSHA 40-hour training, current 8-hour refresher, and medical exam. ☐ No intrusive work activities or areas are anticipated with current scope of work. Intrusive work activities include: _____ The perimeter of intrusive work areas are identified by: _____ Decontamination of personnel or equipment is <u>not</u> anticipated with the current scope of work. ☐ Decontamination of personnel and small tools will be conducted as follows: _____ ☐ Decontamination of heavy equipment will be conducted as follows: _____ ☐ Heavy equipment leaving the site will be inspected by: _____ ☐ Work area monitoring is not anticipated with the current scope of work. ☒ Work Area Air Monitoring as follows for (dust, VOCs, etc.) **OR** see attached. _____ to _____ Level C: Tyvek, boot covers, nitrile gloves, half or full face respirator with _____ cartridges changed daily _____ to _____ Level B: Same as above except supplied air respirator _____ to _____ STOP work, contact EHS Department ☐ Community Air Monitoring is not anticipated with the current scope of work. ☐ Community Air Monitoring is required per the attached document. **Comments/Other: _____**

PRE-WORK THA

EMERGENCY RESPONSE (911 Service is Available ☒ Yes ☐ No)			
Emergency Medical Treatment - Hospital Name: Hospital Address:	Brooklyn Hospital Center 121 DeKalb Avenue Brooklyn, New York 11205	**Phone:**	718-250-8000
Non-Emergency Med. Treatment - Clinic Name: Occupational Clinic Address:	Interfaith Medical Center 1545 Atlantic Avenue Brooklyn, New York 11213	**Phone:**	718-613-4988
Fire Department Name	New York Fire Department	**Phone:**	911
Spill Response:	New York Fire Department	**Phone:**	911
Client Representative Name::		**Office:** **Cell:**	
[Consultant/Engineer] Project Manager Name:		**Office:** **Cell:**	
[Consultant/Engineer] Corporate H&S Name:		**Office:** **Cell:**	
Emergency Response Comments:			

Date:	
Project Name:	**Gowanus Canal Superfund Site**
THA Title:	**Work Around Heavy Equipment Task Hazard Analysis**
Subcontractor Name:	
[Consultant/Engineer] Representative (reviewed by):	
Subcontractor Foreman/Supervisor Signature (authorize):	
Crew Signatures (acknowledge):	
Print Name	**Signature**

PLEASE RETURN A COPY OF THIS SIGNED PAGE TO [CONTRACTOR] PROJECT MGR., SUPERINTENDENT UPON REVIEW AND ACKOWLEDGMENT BY THE CREW MEMBERS. ALL NEW CREW MEMBERS SHALL BE ORIENTATED THE SAME AND A SUBMITTAL OF A NEW SIGN IN SHEET SHALL BE COMPLETED.

PRE-WORK THA

THA Title:	**Sediment & Soil Core Logging and Sampling Task Hazard Analysis**	**Date:**	**17 February 2014**
Project Name:	**Gowanus Canal Superfund Site**	**Client Name:**	**National Grid**
Project Number:		**Client Project Manager:**	
Project Location:	**Brooklyn, New York**	**[Consultant/Engineer] Project Manager:**	
Scope of Work Summary:	As part of the Pre-Design Work, sediment cores will be obtained from locations within the Gowanus Canal using barge mounted sampling equipment, and soil cores will be obtained from landside locations along the Canal using drill rigs. Following their collection, these sediment and soil cores will be transported to landside core processing locations for logging and sampling. The hazards associated with working on barges, with sediment core collection on barges, and with working around drill rigs and soil core collection are covered in other THAs. In this THA, only the hazards associated with sediment/soil core processing (i.e., logging and sampling) are discussed.		

Work Steps / **Process or Activity**	**Hazards**	**Hazard Control**
• Transportation of sediment/soil cores from the point of collection to the processing location	• Cores (especially water-logged sediment cores) may be very heavy	• When handling heavy cores, use proper lifting techniques, request help with heavy/bulky loads, and use mechanical assistance when available
• Cutting open of plastic core liners using blades or electric shears	• Use of blades	• Leather or kevlar gloves must be worn when using a blade to cut core liners • Retractible safety blades should be used. Open blades cannot be used • When using blades, pull them away from your body • Do not pull blades towards your body and keep body parts out of the "line of fire"
	• Electric shears	• Inspect electric shears before use • Only properly trained individuals can use the electric shears • Keep power cord neat and out of walkways (tripping hazard) • Keep power cord away from water (puddles) • Leather gloves must be worn when operating the electric shears
	• Exposure to contaminated sediment/soill	• A face shield and apron or Tyvek suit must be worn when cutting open plastic core liners
• Logging/sampling of cores	• Exposure to contaminated sediment/soil and volatile organic compound vapors	• Nitrile golves must be worn when handling sediment/soil (two layers of gloves is best) • Eating, drinking, and smoking will not be allowed in the core processing locations • Remove gloves and clean hands after processing cores • Cores should be processed in a well ventilated area - open doors/windows and/or use fans to create air flow if necessary • Perform air monitoring using a PID and dust monitor (see HASP for action levels)
	• Sharp edges on cut core liners and sharp objects in sediment/soil	• Gloves (leather or nitrile) must be worn when handling cut core liners • Kevlar gloves must be worn under nitrile gloves when handling core liners and soils • Keep hands away from cut liner edges • A wide enough strip of liner should be cut off each core to permit access to the sediment/soils without the need to place ones hand too close to the cut liner edges
•	•	•

Min. Personal Protective Equipment (PPE):	• Hardhat • Safety glasses • Gloves • Steel-toed/hard-toed boots • Hearing protection when working around loud noises • Traffic vest when working around vehicles or heavy equipment • Coast Guard-approved Personal Floatation Device (PFD) when working on or near water • Tyvek suits may be worn if desired to protect against getting contaminated water or sediment on clothing or skin

Individuals Must Sign the last page of this THA after review.

PRE-WORK THA

HAZARD		HAZARD CONTROLS (check all that apply and comment as required)
WALKING/WORKING SURFACES		
☒	☒ Uneven terrain ☒ Slippery surfaces	☒ Walkways are cleared of equipment, vegetation, excavated material, tools and debris ☒ Pits and floor openings are covered or otherwise guarded ☒ Work areas are illuminated adequately; field operations are not conducted before sunrise or after sunset unless adequate lighting is provided. ☒ Spills are cleaned up promptly ☒ Salt applied to icy areas, snow cleared from walkways
☐	LADDERS / STAIRS ☐ Extension Ladders ☐ Step Ladders ☐ Fixed Ladders ☐ Stairs	☐ Employees trained in safe ladder use at safety meeting ☐ Extension ladders are properly footed, secured at top, and setup at proper angle ☐ Stepladders are set on level ground or properly shimmed with spreaders locked. ☐ Stairs have proper rise over run and stairs >4 steps or 4' have guardrails. ☐ Never use a step ladder as a straight ladder. All straight ladders shall be extended three rungs past leading edge. Never use metal ladders while working with electricity. **Ladders/Stairs Comments: _____**
☐	MANLIFT used to reach work ☐ Scissor Lift ☐ Extensible Boom ☐ Articulated Boom ☐ Vertical Lift ("Genie")	☐ Operators are sufficiently trained, experienced and qualified. ☐ Equipment is inspected after mobilization and is in good condition. ☐ Harness & Lanyard worn whenever operating the lift (scissor lifts may be excepted) ☐ Overhead and surface obstructions are reviewed with operators prior to use. **Manlift Comments: _____**
WORKING ALONE		
☐	☐ Getting injured or incapacitated with no one else around to help ☐ Falling victim to crime	☐ Someone else knows your whereabouts, what you're doing and when you should be expected back to their office or project site location. This will be accomplished by communicating three (3) times at a minimum with the supervisor or the project manager 1 – Upon Arrival 2 – Midway through the day 3 – Upon Departure ☐ Ensure the area has wireless coverage; summon alternate communication method if wireless phones are not operable. ☐ Checked the weather forecast to avoid being caught up in bad weather conditions; ☐ Ensured that vehicle has sufficient fuel and is well maintained; ☐ Allowed self sufficient time for the trip so that you are not rushing; ☐ Drive with any bags, records and equipment hidden so that you are not seen hiding them as you park. **Working Alone Comments: _____**
EXCAVATIONS / TRENCHING/UNDERGROUND HAZARDS		
☐	☐ Max Depth ≥ 20' ☐ Max Depth ≥ 5' ☐ Max Depth <5' with potential cave-in hazard ☐ Potential permit-required confined space at depth ≥ 4' ☐ Underground utilities ☐ Structures/foundations ☐ Falls into excavations	☐ Sloping & shoring for excavations ≥20' are approved by a professional engineer ☐ Sloping & shoring for excavations ≥5' when persons are exposed to cave-in. (specify below) ☐ Sloping & shoring for shallow (<5') excavations with cave-in hazard (specify below) ☐ Excavations ≥ 4' are classified as a non-permit confined space ☐ Excavations ≥ 4' are classified as Alternate Entry or Permit-Required (see confined space) ☐ Underground utilities have been identified and marked. ☐ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☐ Hand digging within 3' of utility locations. ☐ Excavations are protected by perimeter fencing (not barricade tape): (☐ Rigid fence - chain link or wood, ☐ safety fence 6' from edge.) **Excavation Comments: _____**

PRE-WORK THA

CONFINED SPACES		
☐	☐ No <u>Serious</u> Hazards ☐ Toxic atmosphere ☐ Carbon monoxide ☐ Hydrogen sulfide ☐ _____ ☐ Flammable atmosphere ☐ Low oxygen ☐ Combustible dust ☐ Other Serious Hazard: _____	☐ Confined space is altered so that it is no longer a confined space. (describe below) ☐ Confined space is downgraded to a non-permit confined space. (identify which spaces below) ☐ Alternate Entry is used. (Identify which space qualify for confined space entry below) ☐ Full permit-required confined space entry is used due to presence of serious hazards. ☐ Rescue team has been notified (☐ Paid FD ☐ Volunteer FD ☐ Plant Rescue) Rescue team: _____ Phone number: _____ ☐ All entrants and attendants for Alternate Entry and Permit-Required Entry have confined space entry training. **Confined Space Comments: _____**
BOAT OPERATIONS/WORKING ON or NEAR WATER and ICE		
☐	☐ Drowning ☐ Hypothermia	☐ Only qualified employees are operating the boat ☐ Coast Guard-approved Personal Flotation Device (PFD), sized and adjusted to the wearer, is worn by all when involved in boat operations. ☐ A float plan is completed prior to leaving dock. ☐ Emergency equipment like ring buoy, flares and fire extinguishers are present **Boat, Water Operations Comments: _____**
DRILLING		
☐	☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ Underground utilities, aboveground ☐ Spills	☐ Contractor inspected the drill rig ☐ High visibility vests, hard hats are being worn near the equipment ☐ Operators and helpers will maintain a safe distance to moving parts. All those working near moving or rotating parts will secure loose hair, clothing, and equipment. ☐ Drill rigs will only be moved with masts lowered. Masts will be erected with outriggers fully extended when equipped with outriggers. ☐ Max. safe slope for rig will be followed ☐ Spinning parts of the rig are guarded when possible, no loose clothing being worn near the rig ☐ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☐ IDW is being managed as per regulations ☐ Area is surveyed for overhead utilities ☐ Hearing protection is used when working near the rig ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill Kit Located: _____ **Drilling Operations Comments: _____**
HEAVY EQUIPMENT [other than cranes]		
☐	☐ Max. safe slope for each vehicle will be followed ☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ Bulldozer ☐ Excavator ☐ Front Loader ☐ Mini Skid Steer (Bobcat) ☐ Mini Excavator ☐ Dump Truck ☐ Drill/Boring Rig ☐ Lull / Material Handler ☐ Forklift ☐ Manlift - specify type(s) ☐ Land Clearing loader	☐ Qualified persons operate all heavy equipment. (certificate is required for forklift and lull operators) ☐ Equipment will be inspected upon mobilization ☐ All leaks or defective safety equipment will be repaired before use. ☐ Operators will be reminded of seatbelt use by: _____ ☐ Eye contact with the operator is made prior to approaching near equipment or swing radius ☐ High visibility vests are required ☐ Max. safe slope for each vehicle will be followed ☐ Counterweight swing radius will be barricaded. ☐ Rigging directly to the forks of a lull, forklift, or front loader equipped forks is prohibited. Crane hook attachments will be used (specify): _____ ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____

PRE-WORK THA

CRANES		
☐	☐ Overhead hazards – utility lines, swing radius, falling objects, wire ropes and hoisting equipment ☐ Overbalancing – high winds, outrigger placement, overloading, safe slope ☐ Wire rope failure – condition, loading, safety lines ☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ _____ ☐ _____ ☐ _____	☐ Only qualified persons operate cranes (certificate required). ☐ A Critical Lift Plan will be developed and approved prior to mobilization. ☐ Equipment will be inspected prior to mobilization and a Crane Pre-Operational Safety Checklist will be completed and signed. ☐ A Critical Lift Checklist will be completed and signed prior to crane mobilization. ☐ Rigging, wire rope and hoisting equipment will be inspected and maintained on a weekly basis. ☐ Crane operator will remain at the controls at all times during operation. ☐ Crane operation must be performed under the direction of an appointed signal person at all times. ☐ Communication between crane operator and signal person will be maintained through standard hand signals or voice communication equipment. Radio equipment, if used, will be equipped with a discrete channel. ☐ Lifting or lowering will not exceed 100ft/minute. Lowering must be controlled i.e. no free fall. ☐ Stop work will be issued whenever hoisting equipment is exposed to winds exceeding 35mph. Hoisting equipment will be re-inspected and confirmed to be in operable condition prior to re-use. ☐ Cranes will not travel with personnel on the platform. Note that [Contractor] personnel are prohibited from entering the immediate vicinity of the crane during operation, unless prior approval has been obtained from the Corporate EHS Dept. ☐ Outriggers will be fully extended/locked with a firm footing within the maximum safe slope (<1%). ☐ Total weight of the load will not exceed 50% of the rated capacity for the crane radius and configuration. ☐ Crane hooks will be moused or provided with safety latches. ☐ Eye contact with the operator is made prior to approaching near equipment or swing radius ☐ High visibility vests are required ☐ Max. safe slope (<1%) will be followed ☐ Counterweight swing radius will be barricaded. ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____ **Crane Hazards Comments:** _____ [Consultant/Engineer] personnel are prohibited from suspended personnel lifting.
ENVIRONMENTAL HAZARDS (NON CHEMICAL)		
☒	☒ Heat Stress ☒ Cold Stress ☒ Insects, spiders, ticks ☐ Wild animals ☐ Mold, fungi ☐ Poisonous plants ☐ Hazardous noise	☒ Heat/Cold stress are monitored in accordance with [Consultant/Engineer] procedures ☒ Fluids are provided to prevent worker dehydration ☒ Types and injury potential of snakes, insects, spiders are reviewed with workers ☒ Insect repellant is used, PPE is used to protect against sting/bite injuries. ☐ All potentially poisonous plants such as poison ivy, poison oak, poison sumac are identified, long sleeve shirt or Tyvek is worn or a barrier cream is used when near these plants ☐ Hearing protection is used when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period) **Environmental Hazards Comments:** _____
POWER TOOLS, HAND TOOLS, and EXTENSION CORDS		
☒	Eye injury, hand/arm cuts, electrical shock, strains, foot injuries, dust ☐ Grinders ☐ Needle Gun ☐ Chop saw ☐ Chain saw ☐ Trimmer ☐ Concrete/asphalt saw	☒ All tools and electrical cords will be inspected upon mobilization by: _____ ☒ All tools and electrical cords in-use will be inspected daily by: _____ ☐ Grinder speeds will not exceed grinding wheel ratings. ☐ Water or wet cutting performed to control dust ☐ Respirators used to prevent exposure to dust (respirator type: _____) ☐ Thorough utility survey conducted prior to any concrete cutting, coring ☐ Face shield <u>and</u> safety glasses used (required for all grinders, jackhammers, chain saws, etc.) ☐ Kevlar chaps and jacket (required for all chainsaw work) ☐ Hearing protection required for which tools or areas: _____ ☒ All extension cords are in good condition with no cuts through outer insulation, ground plugs are present, and no "vinyl tape" repairs. **Tool & Cord Comments:** <u>Electric shears must only be operated by properly trained individuals. Leather gloves should be worn when operating electric shears.</u>

PRE-WORK THA

MANUAL MATERIAL HANDLING / MATERIAL STORAGE / HOUSEKEEPING		
☒	Back or shoulder strain, struck by falling objects, trips and falls, incompatible materials (fire or explosion) ☒ Hvy manual lifting (>30 lbs) ☐ Chemical storage ☐ Compressed gas storage ☐ Tall storage greater than 2 pallets stacked. ☐ Material & equipment laydown areas ☐ Debris removal	☒ Mechanical lifting equipment used to reduce manual material handling: (☐ Forklift/Lull ☐ Heavy Equipment ☐ Chainfall ☒ <u>Vehicles</u>) ☒ Manual lifting more than 50 lbs by a single person will be avoided. ☒ Good manual lifting techniques will be reviewed prior to site work. ☐ Incompatible chemicals will be separated by 20' ☐ Secondary containment will be provided for the following chemicals: _____ ☐ Safety equipment will be located near chemical storage. ☐ Spill Kit ☐ Emergency Shower ☐ Eyewash ☐ Drench Hose ☐ Splash PPE ☐ Flammable gases and oxygen will be separated by 20'. ☐ All compressed gas cylinders will be transported vertically and secured upright. ☐ Equipment and materials will not be stored on site ☐ Debris will be moved daily and placed in designated areas. **Material Handling & Housekeeping Comments: _____**
TRAFFIC & SIDEWALK OBSTRUCTION		
☐	☐ Vehicle accidents ☐ Pedestrians struck by vehicles or heavy equipment ☐ Pedestrians falls ☐ Pedestrian struck-by falling objects	☐ DOT signal devices will be used to re-route vehicles around excavations or busy site entrances/exits that affect road traffic. ☐ Flaggers will be used and have DOT Flagger Training ☐ Pedestrian traffic will be safely routed around or over excavations. ☐ Pedestrian traffic will be safely routed around or under overhead work. **Traffic & Sidewalk Comments: _____**
HAZARDOUS WASTE SITE WORK		
☒	☒ Exposure to hazardous vapors or dust, contact with contaminated materials, fire, and explosion. Contaminants of Concern and hazardous chemicals include: ☒ Volatile organic compounds (describe: <u>BTEX</u>) ☒ Semivolatile organic cmpds (describe: <u>Coal tar and coal tar products</u>) ☒ Metal dusts (describe <u>arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc</u>) ☒ PCBs ☐ Caustic (NaOH) ☐ Acid (H_2SO_4, HCl) ☒ Other hazardous waste site hazards are covered elsewhere in the HASP)	☒ Site workers with a potential for contact with contaminated materials will have OSHA 40-hour training, current 8-hour refresher, and medical exam. ☐ No intrusive work activities or areas are anticipated with current scope of work. Intrusive work activities include: _____ The perimeter of intrusive work areas are identified by: _____ Decontamination of personnel or equipment is <u>not</u> anticipated with the current scope of work. ☐ Decontamination of personnel and small tools will be conducted as follows: _____ ☐ Decontamination of heavy equipment will be conducted as follows: _____ ☐ Heavy equipment leaving the site will be inspected by: _____ ☐ Work area monitoring is not anticipated with the current scope of work. ☒ Work Area Air Monitoring as follows for (dust, VOCs, etc.) **OR** see attached. _____ to _____ Level C: Tyvek, boot covers, nitrile gloves, half or full face respirator with _____ cartridges changed daily _____ to _____ Level B: Same as above except supplied air respirator _____ to _____ STOP work, contact EHS Department ☐ Community Air Monitoring is not anticipated with the current scope of work. ☐ Community Air Monitoring is required per the attached document. **Comments/Other: _____**

PRE-WORK THA

EMERGENCY RESPONSE (911 Service is Available ☒ Yes ☐ No)			
Emergency Medical Treatment - Hospital Name: Hospital Address:	Brooklyn Hospital Center 121 DeKalb Avenue Brooklyn, New York 11205	**Phone:**	718-250-8000
Non-Emergency Med. Treatment - Clinic Name: Occupational Clinic Address:	Interfaith Medical Center 1545 Atlantic Avenue Brooklyn, New York 11213	**Phone:**	718-613-4988
Fire Department Name	New York Fire Department	**Phone:**	911
Spill Response:	New York Fire Department	**Phone:**	911
Client Representative Name::		**Office:** **Cell:**	
[Consultant/Engineer] Project Manager Name:		**Office:** **Cell:**	
[Consultant/Engineer] Corporate H&S Name:		**Office:** **Cell:**	
Emergency Response Comments:			

Date:	
Project Name:	**Gowanus Canal Superfund Site**
THA Title:	**Sediment & Soil Logging and Sampling Task Hazard Analysis**
Subcontractor Name:	
[Consultant/Engineer] Representative (reviewed by):	
Subcontractor Foreman/Supervisor Signature (authorize):	
Crew Signatures (acknowledge):	
Print Name	**Signature**

PLEASE RETURN A COPY OF THIS SIGNED PAGE TO [CONTRACTOR] PROJECT MGR., SUPERINTENDENT UPON REVIEW AND ACKOWLEDGMENT BY THE CREW MEMBERS. ALL NEW CREW MEMBERS SHALL BE ORIENTATED THE SAME AND A SUBMITTAL OF A NEW SIGN IN SHEET SHALL BE COMPLETED.

PRE-WORK THA

THA Title:	**Waste Characterization Sampling & Drum Handling Task Hazard Analysis**	**Date:**	**18 February 2014**
Project Name:	**Gowanus Canal Superfund Site**	**Client Name:**	**National Grid**
Project Number:		**Client Project Manager:**	
Project Location:	**Brooklyn, New York**	**[Consultant/Engineer] Project Manager:**	
Scope of Work Summary:	As part of the Pre-Design Work it is expected that waste sediment/soil and water will be generated, that these wastes will be containerized in 55-gallone open top steel drums, and that samples of these waste streams will need to be collected for waste characterization analyses.		

Work Steps	**Process or Activity**	**Hazards**	**Hazard Control**
• Working with drums		• Drum handling/heavy lifting	• Stage drums on flat hard surfaces (i.e., on concrete/asphalt or plywood/wood pallets, not on soft ground) in a secure but accessible location • Do not manhandle drums - use mechanical assistance (e.g., a vehicle with a lift gate) to move drums if necessary
		• Pinch points	• Do not place hands or limbs between drums during repositioning • Wear leather gloves when working with drums - especially when working with the compression ring around the top
• Collecting waste characterization samples		• Exposure to organic vapors	• After opening drums, allow to vent before collecting samples • Use a PID to monitor the breathing zone
		• Exposure to contaminated sediment/soil and water	• Wear gloves to prevent contact with contaminated sediment/soil and water • Wear a Tyvek suit to prevent contact with contaminated sediment/soil and water if necessary
•		•	•

Min. Personal Protective Equipment (PPE):	• Hardhat • Safety glasses • Gloves • Steel-toed/hard-toed boots • Hearing protection when working around loud noises • Traffic vest when working around vehicles or heavy equipment • Coast Guard-approved Personal Floatation Device (PFD) when working on or near water • Tyvek suits may be worn if desired to protect against getting contaminated water or sediment on clothing or skin

Individuals Must Sign the last page of this THA after review.

PRE-WORK THA

HAZARD		HAZARD CONTROLS (check all that apply and comment as required)
WALKING/WORKING SURFACES		
☒	☒ Uneven terrain ☒ Slippery surfaces	☒ Walkways are cleared of equipment, vegetation, excavated material, tools and debris ☐ Pits and floor openings are covered or otherwise guarded ☒ Work areas are illuminated adequately; field operations are not conducted before sunrise or after sunset unless adequate lighting is provided. ☒ Spills are cleaned up promptly ☐ Salt applied to icy areas, snow cleared from walkways
☐	LADDERS / STAIRS ☐ Extension Ladders ☐ Step Ladders ☐ Fixed Ladders ☐ Stairs	☐ Employees trained in safe ladder use at safety meeting ☐ Extension ladders are properly footed, secured at top, and setup at proper angle ☐ Stepladders are set on level ground or properly shimmed with spreaders locked. ☐ Stairs have proper rise over run and stairs >4 steps or 4' have guardrails. ☐ Never use a step ladder as a straight ladder. All straight ladders shall be extended three rungs past leading edge. Never use metal ladders while working with electricity. **Ladders/Stairs Comments: _____**
☐	MANLIFT used to reach work ☐ Scissor Lift ☐ Extensible Boom ☐ Articulated Boom ☐ Vertical Lift ("Genie")	☐ Operators are sufficiently trained, experienced and qualified. ☐ Equipment is inspected after mobilization and is in good condition. ☐ Harness & Lanyard worn whenever operating the lift (scissor lifts may be excepted) ☐ Overhead and surface obstructions are reviewed with operators prior to use. **Manlift Comments: _____**
WORKING ALONE		
☐	☐ Getting injured or incapacitated with no one else around to help ☐ Falling victim to crime	☐ Someone else knows your whereabouts, what you're doing and when you should be expected back to their office or project site location. This will be accomplished by communicating three (3) times at a minimum with the supervisor or the project manager 1 – Upon Arrival 2 – Midway through the day 3 – Upon Departure ☐ Ensure the area has wireless coverage; summon alternate communication method if wireless phones are not operable. ☐ Checked the weather forecast to avoid being caught up in bad weather conditions; ☐ Ensured that vehicle has sufficient fuel and is well maintained; ☐ Allowed self sufficient time for the trip so that you are not rushing; ☐ Drive with any bags, records and equipment hidden so that you are not seen hiding them as you park. **Working Alone Comments: _____**
EXCAVATIONS / TRENCHING/UNDERGROUND HAZARDS		
☐	☐ Max Depth ≥ 20' ☐ Max Depth ≥ 5' ☐ Max Depth <5' with potential cave-in hazard ☐ Potential permit-required confined space at depth ≥ 4' ☐ Underground utilities ☐ Structures/foundations ☐ Falls into excavations	☐ Sloping & shoring for excavations ≥20' are approved by a professional engineer ☐ Sloping & shoring for excavations ≥5' when persons are exposed to cave-in. (specify below) ☐ Sloping & shoring for shallow (<5') excavations with cave-in hazard (specify below) ☐ Excavations ≥ 4' are classified as a non-permit confined space ☐ Excavations ≥ 4' are classified as Alternate Entry or Permit-Required (see confined space) ☐ Underground utilities have been identified and marked. ☐ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☐ Hand digging within 3' of utility locations. ☐ Excavations are protected by perimeter fencing (not barricade tape): (☐ Rigid fence - chain link or wood, ☐ safety fence 6' from edge.) **Excavation Comments: _____**

PRE-WORK THA

CONFINED SPACES		
☐	☐ No <u>Serious</u> Hazards ☐ Toxic atmosphere ☐ Carbon monoxide ☐ Hydrogen sulfide ☐ _____ ☐ Flammable atmosphere ☐ Low oxygen ☐ Combustible dust ☐ Other Serious Hazard: _____	☐ Confined space is altered so that it is no longer a confined space. (describe below) ☐ Confined space is downgraded to a non-permit confined space. (identify which spaces below) ☐ Alternate Entry is used. (Identify which space qualify for confined space entry below) ☐ Full permit-required confined space entry is used due to presence of serious hazards. ☐ Rescue team has been notified (☐ Paid FD ☐ Volunteer FD ☐ Plant Rescue) Rescue team: _____ Phone number: _____ ☐ All entrants and attendants for Alternate Entry and Permit-Required Entry have confined space entry training. **Confined Space Comments: _____**
BOAT OPERATIONS/WORKING ON or NEAR WATER and ICE		
☐	☐ Drowning ☐ Hypothermia	☐ Only qualified employees are operating the boat ☐ Coast Guard-approved Personal Flotation Device (PFD), sized and adjusted to the wearer, is worn by all when involved in boat operations. ☐ A float plan is completed prior to leaving dock. ☐ Emergency equipment like ring buoy, flares and fire extinguishers are present **Boat, Water Operations Comments: _____**
DRILLING		
☐	☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ Underground utilities, aboveground ☐ Spills	☐ Contractor inspected the drill rig ☐ High visibility vests, hard hats are being worn near the equipment ☐ Operators and helpers will maintain a safe distance to moving parts. All those working near moving or rotating parts will secure loose hair, clothing, and equipment. ☐ Drill rigs will only be moved with masts lowered. Masts will be erected with outriggers fully extended when equipped with outriggers. ☐ Max. safe slope for rig will be followed ☐ Spinning parts of the rig are guarded when possible, no loose clothing being worn near the rig ☐ Local "dig safe" organization has been notified for utility locations in public areas or rights of way. Phone number: _____ Date: _____ ☐ IDW is being managed as per regulations ☐ Area is surveyed for overhead utilities ☐ Hearing protection is used when working near the rig ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill Kit Located: _____ **Drilling Operations Comments: _____**
HEAVY EQUIPMENT [other than cranes]		
☐	☐ Max. safe slope for each vehicle will be followed ☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ Bulldozer ☐ Excavator ☐ Front Loader ☐ Mini Skid Steer (Bobcat) ☐ Mini Excavator ☐ Dump Truck ☐ Drill/Boring Rig ☐ Lull / Material Handler ☐ Forklift ☐ Manlift - specify type(s) ☐ Land Clearing loader	☐ Qualified persons operate all heavy equipment. (certificate is required for forklift and lull operators) ☐ Equipment will be inspected upon mobilization ☐ All leaks or defective safety equipment will be repaired before use. ☐ Operators will be reminded of seatbelt use by: _____ ☐ Eye contact with the operator is made prior to approaching near equipment or swing radius ☐ High visibility vests are required ☐ Max. safe slope for each vehicle will be followed ☐ Counterweight swing radius will be barricaded. ☐ Rigging directly to the forks of a lull, forklift, or front loader equipped forks is prohibited. Crane hook attachments will be used (specify): _____ ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____

PRE-WORK THA

CRANES		
☐	☐ Overhead hazards – utility lines, swing radius, falling objects, wire ropes and hoisting equipment ☐ Overbalancing – high winds, outrigger placement, overloading, safe slope ☐ Wire rope failure – condition, loading, safety lines ☐ Struck By, Run-Over, Caught In Between (pinch points), Roll Over, Fluid Leaks ☐ _____ ☐ _____ ☐ _____	☐ Only qualified persons operate cranes (certificate required). ☐ A Critical Lift Plan will be developed and approved prior to mobilization. ☐ Equipment will be inspected prior to mobilization and a Crane Pre-Operational Safety Checklist will be completed and signed. ☐ A Critical Lift Checklist will be completed and signed prior to crane mobilization. ☐ Rigging, wire rope and hoisting equipment will be inspected and maintained on a weekly basis. ☐ Crane operator will remain at the controls at all times during operation. ☐ Crane operation must be performed under the direction of an appointed signal person at all times. ☐ Communication between crane operator and signal person will be maintained through standard hand signals or voice communication equipment. Radio equipment, if used, will be equipped with a discrete channel. ☐ Lifting or lowering will not exceed 100ft/minute. Lowering must be controlled i.e. no free fall. ☐ Stop work will be issued whenever hoisting equipment is exposed to winds exceeding 35mph. Hoisting equipment will be re-inspected and confirmed to be in operable condition prior to re-use. ☐ Cranes will not travel with personnel on the platform. Note that [Contractor] personnel are prohibited from entering the immediate vicinity of the crane during operation, unless prior approval has been obtained from the Corporate EHS Dept. ☐ Outriggers will be fully extended/locked with a firm footing within the maximum safe slope (<1%). ☐ Total weight of the load will not exceed 50% of the rated capacity for the crane radius and configuration. ☐ Crane hooks will be moused or provided with safety latches. ☐ Eye contact with the operator is made prior to approaching near equipment or swing radius ☐ High visibility vests are required ☐ Max. safe slope (<1%) will be followed ☐ Counterweight swing radius will be barricaded. ☐ Spill equipment is available for fuel and hydraulic fluid leaks. Spill kit located: _____ **Crane Hazards Comments: _____** [Consultant/Engineer] personnel are prohibited from suspended personnel lifting.
ENVIRONMENTAL HAZARDS (NON CHEMICAL)		
☐	☐ Heat Stress ☐ Cold Stress ☐ Insects, spiders, ticks ☐ Wild animals ☐ Mold, fungi ☐ Poisonous plants ☐ Hazardous noise	☐ Heat/Cold stress are monitored in accordance with [Consultant/Engineer] procedures ☐ Fluids are provided to prevent worker dehydration ☐ Types and injury potential of snakes, insects, spiders are reviewed with workers ☐ Insect repellant is used, PPE is used to protect against sting/bite injuries. ☐ All potentially poisonous plants such as poison ivy, poison oak, poison sumac are identified, long sleeve shirt or Tyvek is worn or a barrier cream is used when near these plants ☐ Hearing protection is used when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period) **Environmental Hazards Comments: _____**
POWER TOOLS, HAND TOOLS, and EXTENSION CORDS		
☐	Eye injury, hand/arm cuts, electrical shock, strains, foot injuries, dust ☐ Grinders ☐ Needle Gun ☐ Chop saw ☐ Chain saw ☐ Trimmer ☐ Concrete/asphalt saw	☐ All tools and electrical cords will be inspected upon mobilization by: _____ ☐ All tools and electrical cords in-use will be inspected daily by: _____ ☐ Grinder speeds will not exceed grinding wheel ratings. ☐ Water or wet cutting performed to control dust ☐ Respirators used to prevent exposure to dust (respirator type: _____) ☐ Thorough utility survey conducted prior to any concrete cutting, coring ☐ Face shield <u>and</u> safety glasses used (required for all grinders, jackhammers, chain saws, etc.) ☐ Kevlar chaps and jacket (required for all chainsaw work) ☐ Hearing protection required for which tools or areas: _____ ☐ All extension cords are in good condition with no cuts through outer insulation, ground plugs are present, and no "vinyl tape" repairs. **Tool & Cord Comments: _____**

PRE-WORK THA

<table>
<tr><td colspan="3">MANUAL MATERIAL HANDLING / MATERIAL STORAGE / HOUSEKEEPING</td></tr>
<tr><td>☒</td><td>Back or shoulder strain, struck by falling objects, trips and falls, incompatible materials (fire or explosion)
☒ Hvy manual lifting (>30 lbs)
☐ Chemical storage
☐ Compressed gas storage
☐ Tall storage greater than 2 pallets stacked.
☐ Material & equipment laydown areas
☒ Debris removal</td><td>☒ Mechanical lifting equipment used to reduce manual material handling:
(☐ Forklift/Lull ☐ Heavy Equipment ☐ Chainfall ☒ <u>Vehicle with lift gate</u>)
☒ Manual lifting more than 50 lbs by a single person will be avoided.
☒ Good manual lifting techniques will be reviewed prior to site work.
☐ Incompatible chemicals will be separated by 20'
☐ Secondary containment will be provided for the following chemicals: _____
☐ Safety equipment will be located near chemical storage.
☐ Spill Kit ☐ Emergency Shower ☐ Eyewash ☐ Drench Hose ☐ Splash PPE
☐ Flammable gases and oxygen will be separated by 20'.
☐ All compressed gas cylinders will be transported vertically and secured upright.
☐ Equipment and materials will not be stored on site
☒ Debris will be moved daily and placed in designated areas.

Material Handling & Housekeeping Comments: _____</td></tr>
<tr><td colspan="3">TRAFFIC & SIDEWALK OBSTRUCTION</td></tr>
<tr><td>☐</td><td>☐ Vehicle accidents
☐ Pedestrians struck by vehicles or heavy equipment
☐ Pedestrians falls
☐ Pedestrian struck-by falling objects</td><td>☐ DOT signal devices will be used to re-route vehicles around excavations or busy site entrances/exits that affect road traffic.
☐ Flaggers will be used and have DOT Flagger Training
☐ Pedestrian traffic will be safely routed around or over excavations.
☐ Pedestrian traffic will be safely routed around or under overhead work.

Traffic & Sidewalk Comments: _____</td></tr>
<tr><td colspan="3">HAZARDOUS WASTE SITE WORK</td></tr>
<tr><td>☒</td><td>☒ Exposure to hazardous vapors or dust, contact with contaminated materials, fire, and explosion.

Contaminants of Concern and hazardous chemicals include:
☒ Volatile organic compounds (describe: <u>BTEX</u>)
☒ Semivolatile organic cmpds (describe: <u>Coal tar and coal tar products</u>)
☒ Metal dusts (describe <u>arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc</u>)
☒ PCBs
☐ Caustic (NaOH)
☐ Acid (H_2SO_4, HCl)
☒ Other hazardous waste site hazards are covered elsewhere in the HASP)</td><td>☒ Site workers with a potential for contact with contaminated materials will have OSHA 40-hour training, current 8-hour refresher, and medical exam.
☐ No intrusive work activities or areas are anticipated with current scope of work.
Intrusive work activities include: _____
The perimeter of intrusive work areas are identified by: _____
Decontamination of personnel or equipment is <u>not</u> anticipated with the current scope of work.
☐ Decontamination of personnel and small tools will be conducted as follows: _____
☐ Decontamination of heavy equipment will be conducted as follows: _____
☐ Heavy equipment leaving the site will be inspected by: _____
☐ Work area monitoring is not anticipated with the current scope of work.
☒ Work Area Air Monitoring as follows for (dust, VOCs, etc.) OR see attached.
_____ to _____ Level C: Tyvek, boot covers, nitrile gloves, half or full face respirator with _____ cartridges changed daily
_____ to _____ Level B: Same as above except supplied air respirator
_____ to _____ STOP work, contact EHS Department
☐ Community Air Monitoring is not anticipated with the current scope of work.
☐ Community Air Monitoring is required per the attached document.

Comments/Other: _____</td></tr>
</table>

PRE-WORK THA

EMERGENCY RESPONSE (911 Service is Available ☒ Yes ☐ No)			
Emergency Medical Treatment - Hospital Name: Hospital Address:	Brooklyn Hospital Center 121 DeKalb Avenue Brooklyn, New York 11205	**Phone:**	718-250-8000
Non-Emergency Med. Treatment - Clinic Name: Occupational Clinic Address:	Interfaith Medical Center 1545 Atlantic Avenue Brooklyn, New York 11213	**Phone:**	718-613-4988
Fire Department Name	New York Fire Department	**Phone:**	911
Spill Response:	New York Fire Department	**Phone:**	911
Client Representative Name::		**Office:**	
		Cell:	
[Consultant/Engineer] Project Manager Name:		**Office:**	
		Cell:	
[Consultant/Engineer] Corporate H&S Name:		**Office:**	
		Cell:	
Emergency Response Comments:			

Date:	
Project Name:	**Gowanus Canal Superfund Site**
THA Title:	**Waste Characterization Sampling & Drum Handling Task Hazard Analysis**
Subcontractor Name:	
[Consultant/Engineer] Representative (reviewed by):	
Subcontractor Foreman/Supervisor Signature (authorize):	
Crew Signatures (acknowledge):	
Print Name	**Signature**
PLEASE RETURN A COPY OF THIS SIGNED PAGE TO [CONTRACTOR] PROJECT MGR., SUPERINTENDENT UPON REVIEW AND ACKOWLEDGMENT BY THE CREW MEMBERS. ALL NEW CREW MEMBERS SHALL BE ORIENTATED THE SAME AND A SUBMITTAL OF A NEW SIGN IN SHEET SHALL BE COMPLETED.	

Appendix C: Summary of Chemical Hazards

Petroleum Hydrocarbons

Petroleum hydrocarbons likely at the Site include tar and/or fuel-related materials in soils and sediments. Gasoline, diesel, oil, and heavier hydrocarbons, such as grease, may be present. Volatile components of gasoline include benzene, toluene, ethylbenzene, and xylenes (BTEX).

The primary exposure routes for petroleum hydrocarbons during Site activities are inhalation, dermal contact, and ingestion of contaminated soil, sediment, dust, or water. Lighter petroleum hydrocarbons such as gasoline and benzene readily volatilize and are primarily an inhalation concern, whereas the primary route of exposure to heavier petroleum hydrocarbons such as aromatic hydrocarbons, oil, and grease is dermal contact. The target organs primarily affected by prolonged exposure to petroleum hydrocarbons are the respiratory system, central nervous system, kidneys, liver, and skin. Prolonged dermal contact with petroleum hydrocarbons can cause irritation or dermatitis. The BTEX compounds are known or suspected human carcinogens.

Petroleum hydrocarbons such as gasoline are also flammable and can be a physical hazard when present in high concentrations. Combustion of petroleum hydrocarbons can produce carbon dioxide, carbon monoxide, aldehydes, fumes, smoke (particulate matter) and other products of incomplete combustion. Neither intentional nor inadvertent combustion of petroleum hydrocarbons is expected during sampling activities; personnel will evacuate the area should a fire occur. The table below summarizes BTEX exposure limits.

Chemical Name	PEL[1]	TLV[2]
Benzene	1	0.5
Toluene	200	50
Ethylbenzene	100	100
Xylene	100	100

[1] OSHA Permissible Exposure Limit (in parts per million)

[2] ACGIH Threshold Limit Value (in parts per million)

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are produced during combustion events due to inadequate oxidation of fuel. PAHs in the pure state are yellowish crystalline solids. They are found in coal tar and in products of incomplete combustion. These chemicals have varying degrees of potency for causing cancer, with benzo(a)pyrene being among the most potent. The PAHs are evaluated collectively as coal tar pitch volatiles. Coal tar pitch volatiles may cause photo-sensitization and a rash where sunlight strikes the skin. Exposure may also cause cancer of lungs, skin, bladder or kidneys. Benzo(b)fluoranthene, benzo(j)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, and indeno(1,2,3,c,d)pyrene have been identified as carcinogenic.

While the potential for Site personnel sustaining significant inhalation exposures to volatilized PAH compounds during the Site activities of this project is minimal, there is the potential for inhalation of PAH-contaminated dust, and handling of contaminated soils presents skin exposure hazards. Use of dust suppression techniques (as appropriate) and the proper use of the PPE will adequately protect personnel. Some significant PAH compounds include:

- Anthracene
- Benzo(a)pyrene
- Benzo(a)anthracene
- Chrysene
- Benzo(b)fluoranthene
- Fluoranthene
- Benzo(k)fluoranthene
- Fluorene
- Benzo(g,h,i)perylene
- Indeno(1,2,3,c,d)pyrene
- Benzo(d,e,f)phenanthrene
- Phenanthrene
- Acenaphthene
- Acenaphthylene
- Naphthalene

OSHA PEL for coal tar pitch volatiles is 0.2 mg/m3 and NIOSH REL is 0.1 mg/m^3 , TLV 0.2 mg/m3 is for 8 hour time weighted average (TWA).

PCBs

PCBs are carcinogenic chlorinated hydrocarbons. Potential exposure routes are through inhalation, skin absorption, ingestion and skin or eye contact and may irritate eyes, cause acne, cause liver damage or have reproductive effects. Carcinogenic effects such as tumors and leukemia have been observed in animals. The OSHA permissible exposure limit (PEL) for 8-hour time-weighted average (TWA) is 1 mg/m^3 (skin). The NIOSH PEL is 0.001 mg/m^3.

Hydrogen Sulfide

Hydrogen sulfide is a naturally occurring gas often associated with organic clay and peat. Hydrogen sulfide gas is potentially toxic through inhalation, ingestion, and contact with the skin and eyes. Inhalation can result in respiratory irritation, rhinitis, and edema of the lungs. Inhalation of hydrogen sulfide gas can result in headache, dizziness, and agitation. Acute exposure at high concentrations may result in coma and death as a result of respiratory failure. Hydrogen sulfide gas has a distinct rotten egg odor, and will be noted if encountered in the field. The OSHA permissible exposure limit (PEL) for 8 hr. TWA is 20 ppm, the NIOSH REL is 10 ppm, and the ACGIH TLV is 1ppm.

RCRA Metals

These metals include arsenic, barium, cadmium, chrome, mercury, selenium, and silver. Heavy metals are known to cause neurologic effects (lead, mercury), kidney damage (cadmium), and respiratory damage (arsenic, cadmium). Oral and respiratory exposures should be minimized. The table below summarizes exposure limits for selected metals.

Chemical Name	PEL[1]	TLV[2]
Arsenic	0.01	0.01
Lead	0.05	0.05
Mercury	0.01	0.25

[1] OSHA Permissible Exposure Limit (PEL) in parts per million

[2] ACGIH Threshold Limit Value (TLV) in parts per million

Appendix D: Air Monitoring

Applies to Task:

☐ 1	☐ 2	☒ 3	☐ 4	☐ 5	☒ 6	☒ 7	☐ 8	☐ 9	☐ 10
☐ 11	☐ 12	☐ 13	☐ 14	☐ 15	☒ 16	☐ 17	☐ 18	☐ 19	☐ 20
☐ 21	☐ 22	☐ 23	☐ 24	☐ 25	☐ 26		☐ Not Applicable		

☒ ***Photoionization Detector (PID)***	☐ ***Oxygen (O_2) Meter***	☐ ***Explosimeter***
Brand/Model No.:________TBD______________eV:______ **Monitoring Frequency:____TBD________**	**Brand/Model No.:____________________** **Monitoring Frequency:________________**	**Brand/Model No.:____________________** **Monitoring Frequency:________________**
Breathing Zone Reading (ppm) — **Action** _TBD_ to _TBD_ — Level D PPE _TBD_ to _TBD_ — Level C PPE Greater than _TBD_ — Stop work. Evacuate the area. If upon return, levels still exceed the action level, stop work and implement engineering controls. **Note:** __________________________________	**Reading (%)** — **Action** Less than 19.5 — Stop work. Evacuate the area. 19.5 to 23.5 — Continue to work with caution. Greater than 23.5 — Stop work. Evacuate the area. **Note:** __________________________________	**Source (% LEL)** **Reading** — **Action** 1 to 10 — Continue with caution. Greater than 10 — Stop work. Evacuate the area. If upon return, if concentration still exceeds 10% LEL, ventilate until concentration is back to <10% LEL. **Note:** __________________________________
☐ ***Flame Ionization Detector (FID)***	☐ ***Chemical Detector Tube***	☐ ***Other***
Brand/Model No.: ____________________ **Monitoring Frequency:** ________________	**Brand/Model No.:____________________** **Monitoring Frequency:________________**	**Brand/Model No.:____________________** **Monitoring Frequency:________________**
Breathing Zone Reading (ppm) — **Action** _____ to _____ — Level D PPE _____ to _____ — Level C PPE Greater than _______ — Stop work. Evacuate the area. If upon return, levels still exceed ____, stop work and implement engineering controls. **Note:** __________________________________	**Breathing Zone Reading (ppm)** — **Action** _____ to _____ — Level D PPE _____ to _____ — Level C PPE Greater than ________ — Stop work. Evacuate the area. If upon return, levels still exceed ____, stop work and implement engineering controls. **Note:** __________________________________	**Breathing Zone Reading** — **Action** _____ to _____ — Level D PPE _____ to _____ — Level C PPE Greater than ________ — Stop work. Evacuate the area. If upon return, levels still exceed ____, stop work and implement engineering controls. **Note:** __________________________________

Appendix E: Personal Protective Equipment

Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Task 8	Task 9	Task 10
☒ D ☐ C	☐ D ☐ C	☒ D ☐ C	☒ D ☐ C	☒ D ☐ C	☒ D ☐ C	☒ D ☐ C	☐ D ☐ C	☒ D ☐ C	☐ D ☐ C
Task 11	Task 12	Task 13	Task 14	Task 15	Task 16	Task 17	Task 18	Task 19	Task 20
☒ D ☐ C	☐ D ☐ C	☐ D ☐ C	☐ D ☐ C	☐ D ☐ C	☒ D ☐ C	☐ D ☐ C	☐ D ☐ C	☐ D ☐ C	☒ D ☐ C
Task 21	Task 22	Task 23	Task 24	Task 25	Task 26				
☒ D ☐ C	☐ D ☐ C	☐ D ☐ C	☐ D ☐ C	☐ D ☐ C	☐ D ☐ C				

Modified Level D		***Level C***	
Equipment	***Material/Type***	***Equipment***	***Material/Type***
☒ Safety glasses		☐ Full-face air-purifying respirator	Cartridge Type:
☒ Hard-toed boots		☐ Half-mask air-purifying respirator	Cartridge Type:
☒ Protective clothing		☐ Safety glasses	
☒ Hard hat*		☐ Hard-toed boots	
☒ Hearing protection*		☐ Protective clothing	
☒ High-visibility vest*		☐ Hard hat	
☒ Outer boots*		☐ Hearing protection*	
☒ Outer gloves*		☐ High-visibility vest*	
☐ Other:		☐ Outer boots*	
		☐ Outer gloves*	
		☐ Inner gloves*	

* PPE items may be downgraded (only with concurrence of SHSO and PM)

Appendix F: Safety Data Sheets

Included in this HASP	Chemical
☐	Acetone
☒	Alconox
☐	Ammonia
☒	Bentonite
☐	Diesel Fuel Oil No. 2-D
☒	Gasoline
☐	Helium
☐	Hexane
☒	Hydrochloric Acid
☐	Hydrogen
☒	Isobutylene Calibration Gas
☐	Isopropyl Alcohol
☐	Methane Calibration Gas
☒	Nitric Acid
☐	Permanganate
☐	Portland Cement
☒	Sulfuric Acid
☐	Other:
☐	Other:
☐	Other:
☐	Other:

Note: SDSs are for chemicals that used to perform project work, not Site contaminants.

ALCONOX MSDS

Section 1 : MANUFACTURER INFORMATION

Product name: Alconox

Supplier: Same as manufacturer.

Manufacturer: Alconox, Inc.
30 Glenn St.
Suite 309
White Plains, NY 10603.

Manufacturer emergency phone number: 800-255-3924.
813-248-0585 (outside of the United States).

Manufacturer: Alconox, Inc.
30 Glenn St.
Suite 309
White Plains, NY 10603.

Supplier MSDS date: 2009/04/20

D.O.T. Classification: Not regulated.

Section 2 : HAZARDOUS INGREDIENTS

C.A.S.	CONCENTRATION %	Ingredient Name	T.L.V.	LD/50	LC/50
25155-30-0	10-30	SODIUM DODECYLBENZENESULFONATE	NOT AVAILABLE	438 MG/KG RAT ORAL 1330 MG/KG MOUSE ORAL	NOT AVAILABLE
497-19-8	7-13	SODIUM CARBONATE	NOT AVAILABLE	4090 MG/KG RAT ORAL 6600 MG/KG MOUSE ORAL	2300 MG/M3/2H RAT INHALATION 1200 MG/M3/2H MOUSE INHALATION
7722-88-5	10-30	TETRASODIUM PYROPHOSPHATE	5 MG/M3	4000 MG/KG RAT ORAL 2980 MG/KG MOUSE ORAL	NOT AVAILABLE
7758-29-4	10-30	SODIUM PHOSPHATE	NOT AVAILABLE	3120 MG/KG RAT ORAL 3100 MG/KG MOUSE ORAL >4640 MG/KG RABBIT DERMAL	NOT AVAILABLE

Section 2A : ADDITIONAL INGREDIENT INFORMATION

Note: (supplier).
CAS# 497-19-8: LD50 4020 mg/kg - rat oral.
CAS# 7758-29-4: LD50 3100 mg/kg - rat oral.

Section 3 : PHYSICAL / CHEMICAL CHARACTERISTICS

Physical state:	Solid
Appearance & odor:	Almost odourless. White granular powder.
Odor threshold (ppm):	Not available.
Vapour pressure (mmHg):	Not applicable.
Vapour density (air=1):	Not applicable.
By weight:	Not available.
Evaporation rate (butyl acetate = 1):	Not applicable.
Boiling point (°C):	Not applicable.
Freezing point (°C):	Not applicable.
pH:	(1% aqueous solution). 9.5
Specific gravity @ 20 °C:	(water = 1). 0.85 - 1.10
Solubility in water (%):	100 - > 10% w/w
Coefficient of water\oil dist.:	Not available.
VOC:	None

Section 4 : FIRE AND EXPLOSION HAZARD DATA

Flammability:	Not flammable.
Conditions of flammability:	Surrounding fire.
Extinguishing media:	Carbon dioxide, dry chemical, foam. Water Water fog.
Special procedures:	Self-contained breathing apparatus required. Firefighters should wear the usual protective gear.
Auto-ignition temperature:	Not available.
Flash point (°C), method:	None
Lower flammability limit (% vol):	Not applicable.
Upper flammability limit (% vol):	Not applicable.

Not available.

Sensitivity to mechanical impact:	Not applicable.
Hazardous combustion products:	Oxides of carbon (COx). Hydrocarbons.
Rate of burning:	Not available.
Explosive power:	None

Section 5 : REACTIVITY DATA

Chemical stability:	Stable under normal conditions.
Conditions of instability:	None known.
Hazardous polymerization:	Will not occur.
Incompatible substances:	Strong acids. Strong oxidizers.
Hazardous decomposition products:	See hazardous combustion products.

Section 6 : HEALTH HAZARD DATA

Route of entry:	Skin contact, eye contact, inhalation and ingestion.
<u>Effects of Acute Exposure</u>	
Eye contact:	May cause irritation.
Skin contact:	Prolonged contact may cause irritation.
Inhalation:	Airborne particles may cause irritation.
Ingestion:	May cause vomiting and diarrhea. May cause abdominal pain. May cause gastric distress.
Effects of chronic exposure:	Contains an ingredient which may be corrosive.
LD50 of product, species & route:	> 5000 mg/kg rat oral.
LC50 of product, species & route:	Not available for mixture, see the ingredients section.
Exposure limit of material:	Not available for mixture, see the ingredients section.
Sensitization to product:	Not available.
Carcinogenic effects:	Not listed as a carcinogen.
Reproductive effects:	Not available.
Teratogenicity:	Not available.
Mutagenicity:	Not available.
Synergistic materials:	Not available.
Medical conditions aggravated by exposure:	Not available.
<u>First Aid</u>	
Skin contact:	Remove contaminated clothing. Wash thoroughly with soap and water. Seek medical attention if irritation persists.
Eye contact:	Check for and remove contact lenses. Flush eyes with clear, running water for 15 minutes while holding eyelids open: if irritation persists, consult a physician.
Inhalation:	Remove victim to fresh air. Seek medical attention if symptoms persist.
Ingestion:	Dilute with two glasses of water. Never give anything by mouth to an unconscious person. Do not induce vomiting, seek immediate medical attention.

Section 7 : PRECAUTIONS FOR SAFE HANDLING AND USE

Leak / Spill: Contain the spill.
Recover uncontaminated material for re-use.
Wear appropriate protective equipment.
Contaminated material should be swept or shoveled into appropriate waste container for disposal.

Waste disposal: In accordance with municipal, provincial and federal regulations.

Handling procedures and equipment: Protect against physical damage.
Avoid breathing dust.
Wash thoroughly after handling.
Keep out of reach of children.
Avoid contact with skin, eyes and clothing.
Launder contaminated clothing prior to reuse.

Storage requirements: Keep containers closed when not in use.
Store away from strong acids or oxidizers.
Store in a cool, dry and well ventilated area.

Section 8 : CONTROL MEASURES

Precautionary Measures

Gloves / Type:

Neoprene or rubber gloves.

Respiratory / Type:

If exposure limit is exceeded, wear a NIOSH approved respirator.

Eye / Type:

Safety glasses with side-shields.

Footwear / Type: Safety shoes per local regulations.

Clothing / Type: As required to prevent skin contact.

Other / Type: Eye wash capability should be in close proximity.

Ventilation requirements: Local exhaust at points of emission.

Material Safety Data Sheet

Version 3.0
Revision Date 12/29/2008
Print Date 06/16/2009

1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Bentonite

Product Number : 285234
Brand : Sigma-Aldrich

Company : Sigma-Aldrich Canada, Ltd
2149 Winston Park Drive
OAKVILLE ON L6H 6J8
CANADA
Telephone : +1 9058299500
Fax : +1 9058299292
Emergency Phone # : 800-424-9300

2. COMPOSITION/INFORMATION ON INGREDIENTS

Synonyms : Montmorillonite

Formula : $H_2Al_2O_6Si$
Molecular Weight : 180.1 g/mol

CAS-No.	EC-No.	Index-No.	Concentration
Bentonite a colloidal clay. consist primarily of montmorillonite			
1302-78-9	215-108-5	-	-

3. HAZARDS IDENTIFICATION

Emergency Overview

Target Organs

Lungs

WHMIS Classification

Not WHMIS controlled. Not WHMIS controlled.

HMIS Classification

Health Hazard: 0
Chronic Health Hazard: *
Flammability: 0
Physical hazards: 0

Potential Health Effects

Inhalation May be harmful if inhaled. May cause respiratory tract irritation.
Skin May be harmful if absorbed through skin. May cause skin irritation.
Eyes May cause eye irritation.
Ingestion May be harmful if swallowed.

4. FIRST AID MEASURES

If inhaled
If breathed in, move person into fresh air. If not breathing give artificial respiration

In case of skin contact
Wash off with soap and plenty of water.

In case of eye contact
Flush eyes with water as a precaution.

If swallowed
Never give anything by mouth to an unconscious person. Rinse mouth with water.

5. FIRE-FIGHTING MEASURES

Flammable properties

Flash point	not applicable
Ignition temperature	no data available

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Special protective equipment for fire-fighters
Wear self contained breathing apparatus for fire fighting if necessary.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Avoid dust formation.

Environmental precautions
Do not let product enter drains.

Methods for cleaning up
Sweep up and shovel. Keep in suitable, closed containers for disposal.

7. HANDLING AND STORAGE

Handling
Provide appropriate exhaust ventilation at places where dust is formed. Normal measures for preventive fire protection.

Storage
Keep container tightly closed in a dry and well-ventilated place.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Contains no substances with occupational exposure limit values.

Personal protective equipment

Respiratory protection
Respiratory protection is not required. Where protection from nuisance levels of dusts are desired, use type N95 (US) or type P1 (EN 143) dust masks. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
For prolonged or repeated contact use protective gloves.

Eye protection
Safety glasses

Hygiene measures
General industrial hygiene practice.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance

Form	granules
Colour	grey, beige

Safety data

pH	6.0 - 9.0
Melting point	no data available
Boiling point	no data available
Flash point	not applicable
Ignition temperature	no data available
Lower explosion limit	no data available
Upper explosion limit	no data available
Density	2.400 g/cm3
Water solubility	no data available

10. STABILITY AND REACTIVITY

Storage stability
Stable under recommended storage conditions.

Materials to avoid
Strong acids

Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Aluminum oxide, silicon oxides

11. TOXICOLOGICAL INFORMATION

Acute toxicity

LD50 Intravenous - rat - 35 mg/kg
Remarks: Lungs, Thorax, or Respiration:Acute pulmonary edema.

Irritation and corrosion

no data available

Sensitisation

no data available

Chronic exposure

Carcinogenicity - mouse - Oral
Tumorigenic:Equivocal tumorigenic agent by RTECS criteria. Liver:Tumors.

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

Signs and Symptoms of Exposure

Lung irritation, Asthma

Potential Health Effects

Inhalation	May be harmful if inhaled. May cause respiratory tract irritation.
Skin	May be harmful if absorbed through skin. May cause skin irritation.
Eyes	May cause eye irritation.
Ingestion	May be harmful if swallowed.
Target Organs	Lungs,

Additional Information
RTECS: CT9450000

12. ECOLOGICAL INFORMATION

Elimination information (persistence and degradability)

no data available

Ecotoxicity effects

Toxicity to fish	LC50 - Oncorhynchus mykiss (rainbow trout) - 19,000 mg/l - 96 h

Further information on ecology

no data available

13. DISPOSAL CONSIDERATIONS

Product
Observe all federal, state, and local environmental regulations.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
Not dangerous goods

IMDG
Not dangerous goods

IATA
Not dangerous goods

15. REGULATORY INFORMATION

DSL Status
All components of this product are on the Canadian DSL list.

WHMIS Classification
Not WHMIS controlled. Not WHMIS controlled.

16. OTHER INFORMATION

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Co., shall not be held liable for any damage resulting from handling or from contact with the above product. See reverse side of invoice or packing slip for additional terms and conditions of sale.

MATERIAL SAFETY DATA SHEET

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT

Product Name: GASOLINE, UNLEADED AUTOMOTIVE
Product Description: Hydrocarbons and Additives
Product Code: 123455-20, 9700, 977032, 977217, 977306, 977360, 977371, 977381, 977445, 977562, 977767, 977920, 979533, 97A039, 97A065, 97A078, 97A087, 97A102, 97A108, 97A146, 97A147, 97A152, 97A193, 97A200, 97A240, 97A266, 97A273, 97A290, 97A305, 97A316, 97A317, 97A328, 97A347, 97A380, 97A404, 97A424, 97A431, 97A441, 97A514, 97A556, 97A557, 97A613, 97A634, 97A653, 97A655, 97A659, 97A686, 97A696, 97A703, 97A712, 97A726, 97A736, 97A746, 97A767, 97A794, 97A798, 97A827, 97A848, 97A851, 97A876, 97A883, 97A907, 97A934, 97A948, 97A949, 97A960, 97A983, 97A989, 97AV99, 97AW00, 97AW01, 97AW38, 97AZ87, 97AZ88, 97AZ89, 97AZ90, 97AZ91, 97AZ92, 97AZ93, 97AZ94, 97AZ95, 97AZ96, 97AZ97, 97AZ98, 97AZ99, 97BA11, 97BA12, 97BA13, 97BA14, 97BA15, 97BA16, 97BA67, 97BA68, 97BA69, 97BA70, 97BE24, 97BE25, 97BE26, 97BE27, 97BE28, 97BE29, 97BE30, 97BE31, 97BE32, 97BE33, 97BE34, 97BE35, 97BE36, 97BE37, 97BE38, 97BE39, 97BN13, 97BN50, 97C070, 97C072, 97C075, 97C110, 97C112, 97C113, 97C118, 97C127, 97C140, 97C148, 97C166, 97C417, 97C558, 97C576, 97C632, 97C702, 97C731, 97C759, 97C770, 97C782, 97C794, 97C870, 97C917, 97D130, 97D228, 97E002, 97E010, 97E041, 97E065, 97E087, 97E103, 97E104, 97E11, 97E112, 97E113, 97E170, 97E171, 97E196, 97E197, 97E259, 97E260, 97E304, 97E305, 97E347, 97E42, 97E532, 97E564, 97E581, 97E595, 97E606, 97E611, 97E619, 97E649, 97E655, 97E66, 97E682, 97E749, 97E860, 97E88, 97E999, 97F005, 97F020, 97F030, 97F054, 97F312, 97F344, 97F952, 97M190, 97M191, 97M192, 97M193, 97M194, 97M195, 97M229, 97M230, 97M232, 97N832, 97N844, 97N848, 97N861, 97N873, 97N877, 97N879, 97N891, 97N895, 97N913, 97N917, 97N921, 97N941, 97N942, 97N954, 97Q303, 97Q763, 97Q781, 97Q782, 97R368, 97S760, 97U927, 97V321, 97V323, 97V325, 97V326, 97X861, EMGF20
Intended Use: Fuel, Gasoline

COMPANY IDENTIFICATION

Supplier: **EXXON MOBIL CORPORATION**
3225 GALLOWS RD.
FAIRFAX, VA. 22037 USA

24 Hour Health Emergency	609-737-4411
Transportation Emergency Phone	800-424-9300
ExxonMobil Transportation No.	281-834-3296
Product Technical Information	800-662-4525, 800-947-9147
MSDS Internet Address	http://www.exxon.com, http://www.mobil.com

SECTION 2 COMPOSITION / INFORMATION ON INGREDIENTS

Reportable Hazardous Substance(s) or Complex Substance(s)

Name	CAS#	Concentration*
ETHYL ALCOHOL	64-17-5	< 11%
Gasoline	86290-81-5	89 - 100%

Hazardous Constituent(s) Contained in Complex Substance(s)

Name	CAS#	Concentration*
BENZENE	71-43-2	0.1 - 5%
ETHYL BENZENE	100-41-4	1 - 5%

N-HEXANE	110-54-3	1 - 5%
NAPHTHALENE	91-20-3	<1%
PSEUDOCUMENE (1,2,4-TRIMETHYLBENZENE)	95-63-6	1 - 5%
Toluene	108-88-3	5 - 10%
TRIMETHYL BENZENE	25551-13-7	1 - 5%
XYLENES	1330-20-7	5 - 10%

* All concentrations are percent by weight unless material is a gas. Gas concentrations are in percent by volume.

NOTE: The concentration of the components shown above may vary substantially. In certain countries, benzene content may be limited to lower levels. Oxygenates such as tertiary-amyl-methyl ether, ethanol, di-isopropyl ether, and ethyl-tertiary-butyl ether may be present. Because of volatility considerations, gasoline vapor may have concentrations of components very different from those of liquid gasoline. The major components of gasoline vapor are: butane, isobutane, pentane, and isopentane. The reportable component percentages, shown in the composition/information on ingredients section, are based on API's evaluation of a typical gasoline mixture.

SECTION 3 HAZARDS IDENTIFICATION

This material is considered to be hazardous according to regulatory guidelines (see (M)SDS Section 15).

POTENTIAL PHYSICAL / CHEMICAL EFFECTS

Extremely flammable. Material can release vapors that readily form flammable mixtures. Vapor accumulation could flash and/or explode if ignited. Material can accumulate static charges which may cause an incendiary electrical discharge.

POTENTIAL HEALTH EFFECTS

Irritating to skin. If swallowed, may be aspirated and cause lung damage. May be irritating to the eyes, nose, throat, and lungs. May cause central nervous system depression. High-pressure injection under skin may cause serious damage. Prolonged and repeated exposure to benzene may cause serious injury to blood forming organs and is associated with anemia and to the later development of acute myelogenous leukemia (AML).

Target Organs: Lung | Skin |

ENVIRONMENTAL HAZARDS

Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

NFPA Hazard ID:	Health: 1	Flammability: 3	Reactivity: 0
HMIS Hazard ID:	Health: 1*	Flammability: 3	Reactivity: 0

NOTE: This material should not be used for any other purpose than the intended use in Section 1 without expert advice. Health studies have shown that chemical exposure may cause potential human health risks which may vary from person to person.

SECTION 4 FIRST AID MEASURES

Inhalation

Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

SKIN CONTACT

Wash contact areas with soap and water. Remove contaminated clothing. Launder contaminated clothing before reuse. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

EYE CONTACT

Flush thoroughly with water. If irritation occurs, get medical assistance.

Ingestion

Seek immediate medical attention. Do not induce vomiting.

NOTE TO PHYSICIAN

If ingested, material may be aspirated into the lungs and cause chemical pneumonitis. Treat appropriately.

PRE-EXISTING MEDICAL CONDITIONS WHICH MAY BE AGGRAVATED BY EXPOSURE

Benzene- Individuals with liver disease may be more susceptible to toxic effects.

SECTION 5 FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA

Appropriate Extinguishing Media: Use water fog, foam, dry chemical or carbon dioxide (CO_2) to extinguish flames.

Inappropriate Extinguishing Media: Straight Streams of Water

FIRE FIGHTING

Fire Fighting Instructions: Evacuate area. If a leak or spill has not ignited, use water spray to disperse the vapors and to protect personnel attempting to stop a leak. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply. Firefighters should use standard protective equipment and in enclosed spaces, self-contained breathing apparatus (SCBA). Use water spray to cool fire exposed surfaces and to protect personnel.

Unusual Fire Hazards: Extremely Flammable. Vapors are flammable and heavier than air. Vapors may travel across the ground and reach remote ignition sources causing a flashback fire danger. Hazardous material. Firefighters should consider protective equipment indicated in Section 8.

Hazardous Combustion Products: Smoke, Fume, Aldehydes, Sulfur Oxides, Incomplete combustion products, Oxides of carbon

FLAMMABILITY PROPERTIES

Flash Point [Method]: <-40C (-40F) [ASTM D-56]
Flammable Limits (Approximate volume % in air): LEL: 1.4 UEL: 7.6
Autoignition Temperature: >250°C (482°F)

SECTION 6 ACCIDENTAL RELEASE MEASURES

Notification Procedures

In the event of a spill or accidental release, notify relevant authorities in accordance with all applicable regulations. US regulations require reporting releases of this material to the environment which exceed the applicable reportable quantity or oil spills which could reach any waterway including intermittent dry creeks. The National Response Center can be reached at (800)424-8802.

PROTECTIVE MEASURES

Avoid contact with spilled material. Warn or evacuate occupants in surrounding and downwind areas if required due to toxicity or flammability of the material. See Section 5 for fire fighting information. See the Hazard Identification Section for Significant Hazards. See Section 4 for First Aid Advice. See Section 8 for Personal Protective Equipment.

SPILL MANAGEMENT

Land Spill: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Stop leak if you can do it without risk. All equipment used when handling the product must be grounded. Do not touch or walk through spilled material. Prevent entry into waterways, sewer, basements or confined areas. A vapor suppressing foam may be used to reduce vapors. Use clean non-sparking tools to collect absorbed material. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. Large Spills: Water spray may reduce vapor; but may not prevent ignition in closed spaces. Recover by pumping or with suitable absorbent.

Water Spill: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Stop leak if you can do it without risk. Do not confine in area of spill. Advise occupants and shipping in downwind areas of fire and explosion hazard and warn them to stay clear. Allow liquid to evaporate from the surface. Seek the advice of a specialist before using dispersants.

Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted. Note: Local regulations may prescribe or limit action to be taken.

ENVIRONMENTAL PRECAUTIONS

Large Spills: Dike far ahead of liquid spill for later recovery and disposal. Prevent entry into waterways, sewers, basements or confined areas.

SECTION 7 HANDLING AND STORAGE

HANDLING

Avoid breathing mists or vapors. Avoid contact with skin. Use non-sparking tools and explosion-proof equipment. Potentially toxic/irritating fumes/vapors may be evolved from heated or agitated material. Do not siphon by mouth. Use only with adequate ventilation. Use proper bonding and/or grounding procedures. Do not use as a cleaning solvent or other non-motor fuel uses. For use as a motor fuel only. It is dangerous and/or unlawful to put fuel into unapproved containers. Do not fill container while it is in or on a vehicle. Static electricity may ignite vapors and cause fire. Place container on ground when filling and keep nozzle in contact with container. Do not use electronic devices (including but not limited to cellular phones, computers, calculators, pagers or other electronic devices, etc.) in or around any fueling operation or storage area unless the devices are certified intrinsically safe by an approved national testing agency and to the safety standards required by national and/or local laws and regulations. Prevent small spills and leakage to avoid slip hazard. Material can accumulate static charges which may cause an electrical spark (ignition source).

Static Accumulator: This material is a static accumulator.

STORAGE

Ample fire water supply should be available. A fixed sprinkler/deluge system is recommended. Keep container closed. Handle containers with care. Open slowly in order to control possible pressure release. Store in a cool, well-ventilated area. Outside or detached storage preferred. Storage containers should be grounded and bonded. Drums must be grounded and bonded and equipped with self-closing valves, pressure vacuum bungs and flame arresters.

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE LIMIT VALUES

Exposure limits/standards (Note: Exposure limits are not additive)

Source	Form	Limit / Standard			NOTE	Source
BENZENE		OSHA Action level	0.5 ppm		N/A	OSHA Sp.Reg.
BENZENE		STEL	5 ppm		N/A	OSHA Sp.Reg.
BENZENE		TWA	1 ppm		N/A	OSHA Sp.Reg.
BENZENE		STEL	2.5 ppm		Skin	ACGIH
BENZENE		TWA	0.5 ppm		Skin	ACGIH
ETHYL ALCOHOL		TWA	1900 mg/m3	1000 ppm	N/A	OSHA Z1
ETHYL ALCOHOL		STEL	1000 ppm		N/A	ACGIH
ETHYL BENZENE		TWA	435 mg/m3	100 ppm	N/A	OSHA Z1
ETHYL BENZENE		STEL	125 ppm		N/A	ACGIH
ETHYL BENZENE		TWA	100 ppm		N/A	ACGIH
Gasoline		STEL	200 ppm		N/A	ExxonMobil
Gasoline		TWA	100 ppm		N/A	ExxonMobil
Gasoline		STEL	500 ppm		N/A	ACGIH
Gasoline		TWA	300 ppm		N/A	ACGIH
N-HEXANE		TWA	1800 mg/m3	500 ppm	N/A	OSHA Z1
N-HEXANE		TWA	50 ppm		Skin	ACGIH
NAPHTHALENE		TWA	50 mg/m3	10 ppm	N/A	OSHA Z1
NAPHTHALENE		STEL	15 ppm		Skin	ACGIH
NAPHTHALENE		TWA	10 ppm		Skin	ACGIH
PSEUDOCUMENE (1,2,4-TRIMETHYLBENZENE)		TWA	25 ppm		N/A	ACGIH
Toluene		Ceiling	300 ppm		N/A	OSHA Z2
Toluene		Maximum concentration	500 ppm		N/A	OSHA Z2
Toluene		TWA	200 ppm		N/A	OSHA Z2
Toluene		TWA	20 ppm		N/A	ACGIH
TRIMETHYL BENZENE		TWA	25 ppm		N/A	ACGIH
XYLENES		TWA	435 mg/m3	100 ppm	N/A	OSHA Z1
XYLENES		STEL	150 ppm		N/A	ACGIH
XYLENES		TWA	100 ppm		N/A	ACGIH

NOTE: Limits/standards shown for guidance only. Follow applicable regulations.

ENGINEERING CONTROLS

The level of protection and types of controls necessary will vary depending upon potential exposure conditions. Control measures to consider:

Use explosion-proof ventilation equipment to stay below exposure limits.

Personal Protection

Personal protective equipment selections vary based on potential exposure conditions such as applications, handling practices, concentration and ventilation. Information on the selection of protective equipment for use with this material, as provided below, is based upon intended, normal usage.

Respiratory Protection: If engineering controls do not maintain airborne contaminant concentrations at a level which is adequate to protect worker health, an approved respirator may be appropriate. Respirator selection, use, and maintenance must be in accordance with regulatory requirements, if applicable. Types of respirators to be considered for this material include:

No special requirements under ordinary conditions of use and with adequate ventilation.

For high airborne concentrations, use an approved supplied-air respirator, operated in positive pressure mode. Supplied air respirators with an escape bottle may be appropriate when oxygen levels are inadequate, gas/vapor warning properties are poor, or if air purifying filter capacity/rating may be exceeded.

Hand Protection: Any specific glove information provided is based on published literature and glove manufacturer data. Glove suitability and breakthrough time will differ depending on the specific use conditions. Contact the glove manufacturer for specific advice on glove selection and breakthrough times for your use conditions. Inspect and replace worn or damaged gloves. The types of gloves to be considered for this material include:

If prolonged or repeated contact is likely, chemical resistant gloves are recommended. If contact with forearms is likely, wear gauntlet style gloves.

Eye Protection: If contact is likely, safety glasses with side shields are recommended.

Skin and Body Protection: Any specific clothing information provided is based on published literature or manufacturer data. The types of clothing to be considered for this material include:

If prolonged or repeated contact is likely, chemical, and oil resistant clothing is recommended.

Specific Hygiene Measures: Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Discard contaminated clothing and footwear that cannot be cleaned. Practice good housekeeping.

ENVIRONMENTAL CONTROLS

See Sections 6, 7, 12, 13.

SECTION 9	PHYSICAL AND CHEMICAL PROPERTIES

Typical physical and chemical properties are given below. Consult the Supplier in Section 1 for additional data.

GENERAL INFORMATION

Physical State: Liquid
Color: Clear (May Be Dyed)
Odor: Petroleum/Solvent
Odor Threshold: N/D

IMPORTANT HEALTH, SAFETY, AND ENVIRONMENTAL INFORMATION
Relative Density (at 15 C): 0.74
Flash Point [Method]: <-40C (-40F) [ASTM D-56]
Flammable Limits (Approximate volume % in air): LEL: 1.4 UEL: 7.6
Autoignition Temperature: >250°C (482°F)
Boiling Point / Range: > 20C (68F)
Vapor Density (Air = 1): 3 at 101 kPa
Vapor Pressure: > 26.6 kPa (200 mm Hg) at 20 C
Evaporation Rate (N-Butyl Acetate = 1): > 10
pH: N/A
Log Pow (n-Octanol/Water Partition Coefficient): > 3
Solubility in Water: Negligible
Viscosity: <1 cSt (1 mm²/sec) at 40 C
Oxidizing Properties: See Sections 3, 15, 16.

OTHER INFORMATION
Freezing Point: N/D
Melting Point: N/A

SECTION 10 STABILITY AND REACTIVITY

STABILITY: Material is stable under normal conditions.

CONDITIONS TO AVOID: Avoid heat, sparks, open flames and other ignition sources.

MATERIALS TO AVOID: Halogens, Strong Acids, Alkalies, Strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Material does not decompose at ambient temperatures.

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

ACUTE TOXICITY

Route of Exposure	Conclusion / Remarks
Inhalation	
Toxicity (Rat): LC50 > 5000 mg/m³	Minimally Toxic. Based on test data for structurally similar materials.
Irritation: No end point data.	Elevated temperatures or mechanical action may form vapors, mist, or fumes which may be irritating to the eyes, nose, throat, or lungs. Based on assessment of the components.
Ingestion	
Toxicity (Rat): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar materials.
Skin	
Toxicity (Rabbit): LD50 > 2000 mg/kg	Minimally Toxic. Based on test data for structurally similar

	materials.
Irritation: No end point data.	Moderately irritating to skin with prolonged exposure. Based on test data for structurally similar materials.
Eye	
Irritation: Data available.	May cause mild, short-lasting discomfort to eyes. Based on test data for structurally similar materials.

CHRONIC/OTHER EFFECTS

For the product itself:

Laboratory animal studies have shown that prolonged and repeated inhalation exposure to light hydrocarbon vapors in the same boiling range as this product can produce adverse kidney effects in male rats. However, these effects were not observed in similar studies with female rats, male and female mice, or in limited studies with other animal species. Additionally, in a number of human studies, there was no clinical evidence of such effects at normal occupational levels. In 1991, The U.S. EPA determined that the male rat kidney is not useful for assessing human risk.

Vapor concentrations above recommended exposure levels are irritating to the eyes and the respiratory tract, may cause headaches and dizziness, are anesthetic and may have other central nervous system effects.

Small amounts of liquid aspirated into the lungs during ingestion or from vomiting may cause chemical pneumonitis or pulmonary edema.

Gasoline unleaded: Caused cancer in animal tests. Chronic inhalation studies resulted in liver tumors in female mice and kidney tumors in male rats. Neither result considered significant for human health risk assessment by the United States EPA and others. Did not cause mutations In Vitro or In Vivo. Negative in inhalation developmental studies and reproductive tox studies.Inhalation of high concentrations in animals resulted in reversible central nervous system depression, but no persistent toxic effect on the nervous system. Non-sensitizing in test animals. Caused nerve damage in humans from abusive use (sniffing).

Contains:

BENZENE: Caused cancer (leukemia), damage to the blood-producing system, and serious blood disorders from prolonged, high exposure based on human epidemiology studies. Caused genetic effects and effects on the immune system in laboratory animal and some human studies. Caused toxicity to the fetus in laboratory animal studies.

ETHANOL: Prolonged or repeated exposure to high concentrations of ethanol vapor or overexposure by ingestion may produce adverse effects to brain, kidney, liver, and reproductive organs, birth defects in offspring, and developmental toxicity in offspring.

NAPHTHALENE: Exposure to high concentrations of naphthalene may cause destruction of red blood cells, anemia, and cataracts. Naphthalene caused cancer in laboratory animal studies, but the relevance of these findings to humans is uncertain.

N-HEXANE: Prolonged and/or repeated exposures to n-Hexane can cause progressive and potentially irreversible damage to the peripheral nervous system (e.g. fingers, feet, arms, legs, etc.). Simultaneous exposure to Methyl Ethyl Ketone (MEK) or Methyl Isobutyl Ketone (MIBK) and n-Hexane can potentiate the risk of adverse effects from n-Hexane on the peripheral nervous system. n-Hexane has been shown to cause testicular damage at high doses in male rats. The relevance of this effect for humans is unknown.

TOLUENE : Concentrated, prolonged or deliberate inhalation may cause brain and nervous system damage. Prolonged and repeated exposure of pregnant animals (> 1500 ppm) have been reported to cause adverse fetal developmental effects.

TRIMETHYLBENZENE: Long-term inhalation exposure of trimethylbenzene caused effects to the blood in laboratory animals.

ETHYLBENZENE: Caused cancer in laboratory animal studies. The relevance of these findings to humans is uncertain.

Additional information is available by request.

The following ingredients are cited on the lists below:

Chemical Name	CAS Number	List Citations
BENZENE	71-43-2	1, 3, 6
ETHYL BENZENE	100-41-4	5
Gasoline	86290-81-5	5
NAPHTHALENE	91-20-3	2, 5

--REGULATORY LISTS SEARCHED--

1 = NTP CARC	3 = IARC 1	5 = IARC 2B
2 = NTP SUS	4 = IARC 2A	6 = OSHA CARC

SECTION 12 ECOLOGICAL INFORMATION

The information given is based on data available for the material, the components of the material, and similar materials.

ECOTOXICITY

Material -- Expected to be toxic to aquatic organisms. May cause long-term adverse effects in the aquatic environment.

MOBILITY

More volatile component -- Highly volatile, will partition rapidly to air. Not expected to partition to sediment and wastewater solids.
Less volatile component -- Low solubility and floats and is expected to migrate from water to the land. Expected to partition to sediment and wastewater solids.

PERSISTENCE AND DEGRADABILITY

Biodegradation:

Majority of components -- Expected to be inherently biodegradable

Atmospheric Oxidation:

More volatile component -- Expected to degrade rapidly in air

BIOACCUMULATION POTENTIAL

Majority of components -- Has the potential to bioaccumulate, however metabolism or physical properties may reduce the bioconcentration or limit bioavailability.

SECTION 13 DISPOSAL CONSIDERATIONS

Disposal recommendations based on material as supplied. Disposal must be in accordance with current applicable laws and regulations, and material characteristics at time of disposal.

DISPOSAL RECOMMENDATIONS

Product is suitable for burning in an enclosed controlled burner for fuel value or disposal by supervised incineration at very high temperatures to prevent formation of undesirable combustion products.

REGULATORY DISPOSAL INFORMATION

RCRA Information: Disposal of unused product may be subject to RCRA regulations (40 CFR 261). Disposal of the used product may also be regulated due to ignitability, corrosivity, reactivity or toxicity as determined by the Toxicity Characteristic Leaching Procedure (TCLP). Potential RCRA characteristics: IGNITABILITY. TCLP (BENZENE)

Empty Container Warning Empty Container Warning (where applicable): Empty containers may contain residue and can be dangerous. Do not attempt to refill or clean containers without proper instructions. Empty drums should be completely drained and safely stored until appropriately reconditioned or disposed. Empty containers should be taken for recycling, recovery, or disposal through suitably qualified or licensed contractor and in accordance with governmental regulations. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND, OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION. THEY MAY EXPLODE AND CAUSE INJURY OR DEATH.

SECTION 14 TRANSPORT INFORMATION

LAND (DOT)

Proper Shipping Name: Gasoline
Hazard Class & Division: 3
ID Number: 1203
Packing Group: II
Marine Pollutant: MP: 100 %weight PP: 0 %weight
ERG Number: 128
Label(s): 3
Transport Document Name: UN1203, GASOLINE, 3, PG II, MARINE POLLUTANT

LAND (TDG)

Proper Shipping Name: Gasoline
Hazard Class & Division: 3
UN Number: 1203
Packing Group: II
Special Provisions: 17

SEA (IMDG)

Proper Shipping Name: MOTOR SPIRIT or GASOLINE or PETROL
Hazard Class & Division: 3
EMS Number: F-E, S-E
UN Number: 1203
Packing Group: II
Marine Pollutant: Yes
Label(s): 3
Transport Document Name: UN1203, MOTOR SPIRIT or GASOLINE or PETROL, 3, PG II, (-40°C c.c.), MARINE POLLUTANT

AIR (IATA)

Proper Shipping Name: Gasoline
Hazard Class & Division: 3
UN Number: 1203
Packing Group: II
Label(s) / Mark(s): 3
Transport Document Name: UN1203, GASOLINE, 3, PG II

SECTION 15 REGULATORY INFORMATION

OSHA HAZARD COMMUNICATION STANDARD: When used for its intended purpose, this material is classified as hazardous in accordance with OSHA 29CFR 1910.1200.

NATIONAL CHEMICAL INVENTORY LISTING: AICS, DSL, EINECS, ENCS, KECI, PICCS, TSCA

EPCRA: This material contains no extremely hazardous substances.

CERCLA: This material is not subject to any special reporting under the requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Contact local authorities to determine if other reporting requirements apply.

SARA (311/312) REPORTABLE HAZARD CATEGORIES: Fire. Immediate Health. Delayed Health.

SARA (313) TOXIC RELEASE INVENTORY:

Chemical Name	CAS Number	Typical Value
ETHYL BENZENE	100-41-4	1 - 5%
N-HEXANE	110-54-3	1 - 5%
NAPHTHALENE	91-20-3	<1%
Toluene	108-88-3	5 - 10%
XYLENES	1330-20-7	5 - 10%
PSEUDOCUMENE (1,2,4-TRIMETHYLBENZENE)	95-63-6	1 - 5%
BENZENE	71-43-2	0.1 - 5%

The following ingredients are cited on the lists below:

Chemical Name	CAS Number	List Citations
BENZENE	71-43-2	1, 2, 4, 10, 11, 13, 15, 16, 17, 18, 19
ETHYL ALCOHOL	64-17-5	1, 4, 13, 17, 18, 19
ETHYL BENZENE	100-41-4	1, 4, 10, 13, 16, 17, 18, 19
Gasoline	86290-81-5	1, 17, 18
N-HEXANE	110-54-3	1, 4, 13, 16, 17, 18, 19
NAPHTHALENE	91-20-3	1, 4, 5, 9, 10
PSEUDOCUMENE (1,2,4-TRIMETHYLBENZENE)	95-63-6	1, 13, 16, 17, 18, 19
Toluene	108-88-3	1, 4, 11, 13, 15, 16, 17, 18, 19
TRIMETHYL BENZENE	25551-13-7	1, 13, 16, 17, 18, 19
XYLENES	1330-20-7	1, 4, 5, 9, 13, 15, 17, 18, 19

--REGULATORY LISTS SEARCHED--

1 = ACGIH ALL	6 = TSCA 5a2	11 = CA P65 REPRO	16 = MN RTK
2 = ACGIH A1	7 = TSCA 5e	12 = CA RTK	17 = NJ RTK
3 = ACGIH A2	8 = TSCA 6	13 = IL RTK	18 = PA RTK
4 = OSHA Z	9 = TSCA 12b	14 = LA RTK	19 = RI RTK
5 = TSCA 4	10 = CA P65 CARC	15 = MI 293	

Code key: CARC=Carcinogen; REPRO=Reproductive

SECTION 16 OTHER INFORMATION

N/D = Not determined, N/A = Not applicable

THIS SAFETY DATA SHEET CONTAINS THE FOLLOWING REVISIONS:
Revision Changes:
Section 04: First Aid Inhalation - Header was modified.
Section 04: First Aid Ingestion - Header was modified.
Section 06: Notification Procedures - Header was modified.
Section 01: Product Code was modified.
Section 10 Stability and Reactivity - Header was modified.
Section 13: Disposal Recommendations - Note was modified.
Section 09: Evaporation Rate - Header was modified.
Section 08: Personal Protection - Header was modified.
Section 08: Personal Protection was modified.
Section 11: Inhalation Lethality Test Data was modified.
Section 05: Hazardous Combustion Products was modified.
Section 09: Relative Density - Header was modified.
Section 09: Viscosity was modified.
Section 14: Transport Document Name was modified.
Section 14: Proper Shipping Name was modified.
Section 14: Label(s) - Header was modified.
Section 14: Proper Shipping Name was modified.
Section 14: Proper Shipping Name was modified.
Section 14: Transport Document Name was modified.
Composition: Component Table was modified.
Section 15: List Citations Table was modified.
Section 11: Tox List Cited Table was modified.
Section 15: List Citation Table - Header was modified.
Section 15: SARA (313) TOXIC RELEASE INVENTORY - Table was modified.
Section 16: Materials Covered was modified.
Composition: Component Table was modified.
Section 16: Precautions - Header was modified.
Section 16: NA Contains was modified.
Section 08: Exposure Limits Table was modified.
Section 08: OEL Table - Notation Column - Header was modified.
Section 08: Exposure Limit Values - Header was modified.
Section 14: Marine Pollutant - Header was added.
Section 14: Marine Pollutant was added.
Section 14: Marine Pollutant - Header was added.
Section 14: Marine Pollutant was added.
Section 08: Exposure limits/standards was deleted.
THIS MSDS COVERS THE FOLLOWING MATERIALS: ESSO EXTRA MIDGRADE UNLEADED | ESSO MIDGRADE UNLEADED | ESSO PREMIUM UNLEADED | ESSO REGULAR UNLEADED | ESSO SUPER PREMIUM UNLEADED | EXXON MIDGRADE UNLEADED | EXXON PREMIUM UNLEADED | EXXON REGULAR UNLEADED | Gasoline | INDOLENE GASOLINE | MIDGRADE UNLEADED | MOBIL EXTRA UNLEADED | MOBIL REGULAR UNLEADED | MOBIL SPECIAL UNLEADED | MOBIL SUPER UNLEADED | PREMIUM UNLEADED | REGULAR UNLEADED | UNLEADED GASOLINE

PRECAUTIONARY LABEL TEXT:
Contains: BENZENE, Gasoline
DANGER!
HEALTH HAZARDS
Irritating to skin. If swallowed, may be aspirated and cause lung damage. Prolonged and repeated exposure to benzene may cause serious injury to blood forming organs and is associated with anemia and to the later development of acute myelogenous leukemia (AML).
Target Organs: Lung | Skin |

PHYSICAL HAZARDS
Extremely flammable. Material can accumulate static charges which may cause an incendiary electrical discharge. Material can release vapors that readily form flammable mixtures. Vapor accumulation could flash and/or explode if ignited.

Precautions
Avoid breathing mists or vapors. Avoid contact with skin. Use non-sparking tools and explosion-proof equipment. Potentially toxic/irritating fumes/vapors may be evolved from heated or agitated material. Do not siphon by mouth. Use only with adequate ventilation. Use proper bonding and/or grounding procedures.

FIRST AID
Inhalation: Remove from further exposure. For those providing assistance, avoid exposure to yourself or others. Use adequate respiratory protection. If respiratory irritation, dizziness, nausea, or unconsciousness occurs, seek immediate medical assistance. If breathing has stopped, assist ventilation with a mechanical device or use mouth-to-mouth resuscitation.

Eye: Flush thoroughly with water. If irritation occurs, get medical assistance.

Oral: Seek immediate medical attention. Do not induce vomiting.

Skin: Wash contact areas with soap and water. Remove contaminated clothing. Launder contaminated clothing before reuse. If product is injected into or under the skin, or into any part of the body, regardless of the appearance of the wound or its size, the individual should be evaluated immediately by a physician as a surgical emergency. Even though initial symptoms from high pressure injection may be minimal or absent, early surgical treatment within the first few hours may significantly reduce the ultimate extent of injury.

FIRE FIGHTING MEDIA
Use water fog, foam, dry chemical or carbon dioxide (CO2) to extinguish flames.

SPILL/LEAK
Land Spill: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Stop leak if you can do it without risk. Prevent entry into waterways, sewer, basements or confined areas. A vapor suppressing foam may be used to reduce vapors. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. Recover by pumping or with suitable absorbent.

Water Spill: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Stop leak if you can do it without risk. Do not confine in area of spill. Advise occupants and shipping in downwind areas of fire and explosion hazard and warn them to stay clear. Allow liquid to evaporate from the surface. Seek the advice of a specialist before using dispersants.

This warning is given to comply with California Health and Safety Code 25249.6 and does not constitute an admission or a waiver of rights. This product contains a chemical known to the State of California to cause cancer, birth defects, or other reproductive harm. Chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm are created by the combustion of this product.

Internal Use Only

MHC: 1A, 0, 0, 0, 3, 1 PPEC: CF

DGN: 2000316XUS (1011203)

Fisher Scientific

Material Safety Data Sheet
Hydrochloric acid

MSDS# 94460

Section 1 - Chemical Product and Company Identification

MSDS Name:	Hydrochloric acid
Catalog Numbers:	SA5-5, SA50-1, SA50-20, SA50-4, SA52-20, SA52-500, SA54-1, SA54-10, SA54-20, SA54-4, SA60-1, SA62-1
Synonyms:	Chlorohydric acid; Hydrogen chloride; Muriatic acid; Spirits of salt; Hydrochloride.

Company Identification:	Fisher Scientific One Reagent Lane Fair Lawn, NJ 07410
For information in the US, call:	201-796-7100
Emergency Number US:	201-796-7100
CHEMTREC Phone Number, US:	800-424-9300

Section 2 - Composition, Information on Ingredients

Risk Phrases: 34 37

CAS#:	7647-01-0
Chemical Name:	Hydrochloric acid
%:	<2.0
EINECS#:	231-595-7
Hazard Symbols:	C

Risk Phrases:

CAS#:	7732-18-5
Chemical Name:	Water
%:	>98
EINECS#:	231-791-2
Hazard Symbols:	

Text for R-phrases: see Section 16

Hazard Symbols:	None listed
Risk Phrases:	None listed

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Warning! May cause eye, skin, and respiratory tract irritation. Target Organs: No data found.

Potential Health Effects

Eye:	May cause eye irritation.
Skin:	May cause skin irritation.
Ingestion:	May cause irritation of the digestive tract.
Inhalation:	May cause respiratory tract irritation. Exposure to the mist and vapor may erode exposed teeth.
Chronic:	Prolonged or repeated skin contact may cause dermatitis. Repeated exposure may cause erosion of teeth. Repeated exposure to low concentrations of HCl vapor or mist may cause bleeding of nose and gums. Chronic bronchitis and gastritis have also been reported.

Section 4 - First Aid Measures

Eyes:	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical aid.
Skin:	In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid immediately. Wash clothing before reuse.
Ingestion:	If swallowed, do NOT induce vomiting. Get medical aid immediately. If victim is fully conscious, give a cupful of water. Never give anything by mouth to an unconscious person.
Inhalation:	If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician:	Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information:	As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Not flammable, but reacts with most metals to form flammable hydrogen gas. Use water spray to keep fire-exposed containers cool. Containers may explode when heated.
Extinguishing Media:	Substance is nonflammable; use agent most appropriate to extinguish surrounding fire.
Autoignition Temperature:	Not applicable.
Flash Point:	Not applicable.
Explosion Limits: Lower:	Not available
Explosion Limits: Upper:	Not available
NFPA Rating:	health: 1; flammability: 0; instability: 1;

Section 6 - Accidental Release Measures

General Information:	Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks:	Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the Protective Equipment section. Provide ventilation. Cover with dry earth, dry sand, or other non-combustible material followed with plastic sheet to minimize spreading and contact with water.

Section 7 - Handling and Storage

Handling:	Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use only in a well-ventilated area. Avoid contact with eyes, skin, and clothing. Keep container tightly closed. Avoid ingestion and inhalation. Discard contaminated shoes.
Storage:	Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances. Do not store in metal containers. Store away from alkalies.

Section 8 - Exposure Controls, Personal Protection

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Hydrochloric acid	2 ppm Ceiling	50 ppm IDLH	5 ppm Ceiling; 7 mg/m3 Ceiling
Water	none listed	none listed	none listed

OSHA Vacated PELs: Hydrochloric acid: None listed Water: None listed

Engineering Controls:

Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.

Exposure Limits

Personal Protective Equipment

Eyes:	Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin:	Wear neoprene or polyvinyl chloride gloves to prevent exposure.
Clothing:	Wear appropriate protective clothing to prevent skin exposure.
Respirators:	A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant respirator use.

Section 9 - Physical and Chemical Properties

Physical State:	Clear liquid
Color:	colorless to slight yellow
Odor:	Not available
pH:	0.10 (1.0N soln)
Vapor Pressure:	Not available
Vapor Density:	Not available
Evaporation Rate:	Not available
Viscosity:	Not available
Boiling Point:	Not available
Freezing/Melting Point:	Not available
Decomposition Temperature:	Not available
Solubility in water:	Soluble
Specific Gravity/Density:	Not available.
Molecular Formula:	HCl
Molecular Weight:	36.46

Section 10 - Stability and Reactivity

Chemical Stability:	Stable under normal temperatures and pressures.
Conditions to Avoid:	Excess heat.
Incompatibilities with Other Materials	Bases.
Hazardous Decomposition Products	Hydrogen chloride.
Hazardous Polymerization	Will not occur.

Section 11 - Toxicological Information

RTECS#:	CAS# 7647-01-0: MW4025000 MW4031000 CAS# 7732-18-5: ZC0110000
LD50/LC50:	RTECS: **CAS# 7647-01-0:** Inhalation, mouse: LC50 = 1108 ppm/1H; Inhalation, mouse: LC50 = 20487 mg/m3/5M; Inhalation, mouse: LC50 = 3940 mg/m3/30M; Inhalation, mouse: LC50 = 8300 mg/m3/30M; Inhalation, rat: LC50 = 3124 ppm/1H; Inhalation, rat: LC50 = 60938 mg/m3/5M; Inhalation, rat: LC50 = 7004 mg/m3/30M; Inhalation, rat: LC50 = 45000 mg/m3/5M; Inhalation, rat: LC50 = 8300 mg/m3/30M; Oral, rabbit: LD50 = 900 mg/kg; . RTECS: **CAS# 7732-18-5:** Oral, rat: LD50 = >90 mL/kg; .
Carcinogenicity:	Hydrochloric acid - IARC: Group 3 (not classifiable) Water - Not listed as a carcinogen by ACGIH, IARC, NTP, or CA Prop 65.
Other:	Rinsed with water test: Administration into the eye (rabbit) = 5 mg/30sec (Mild).

Section 12 - Ecological Information

Ecotoxicity:	Fish: Bluegill/Sunfish: 3.6 mg/L; 48 Hr; Lethal (unspecified) Fish: Bluegill/Sunfish: LD50; 96 Hr; pH 3.0-3.5

Section 13 - Disposal Considerations

Dispose of in a manner consistent with federal, state, and local regulations.

Section 14 - Transport Information

US DOT
Shipping Name: HYDROCHLORIC ACID
Hazard Class: 8
UN Number: UN1789
Packing Group: II
Canada TDG
Shipping Name: Not regulated as a hazardous material
Hazard Class:
UN Number:
Packing Group:

USA RQ: CAS# 7647-01-0: 5000 lb final RQ; 2270 kg final RQ

Section 15 - Regulatory Information

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:Not available

Risk Phrases:

Safety Phrases:

S 24/25 Avoid contact with skin and eyes.

WGK (Water Danger/Protection)

CAS# 7647-01-0: 1

CAS# 7732-18-5: Not available

Canada

CAS# 7647-01-0 is listed on Canada's DSL List

CAS# 7732-18-5 is listed on Canada's DSL List

Canadian WHMIS Classifications: Not controlled.

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by those regulations.

CAS# 7647-01-0 is listed on Canada's Ingredient Disclosure List

CAS# 7732-18-5 is not listed on Canada's Ingredient Disclosure List.

US Federal

TSCA

CAS# 7647-01-0 is listed on the TSCA Inventory.

CAS# 7732-18-5 is listed on the TSCA Inventory.

Section 16 - Other Information

MSDS Creation Date: 12/19/2007

Revision #2 Date 7/20/2009

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantibility or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall the company be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential, or exemplary damages howsoever arising, even if the company has been advised of the possibility of such damages.

MATERIAL SAFETY DATA SHEET
29 CFR 1910.1200 OSHA Hazard
Communication Rule Format
Chem-Tel 24 Hour Emergency # 1-800-255-3924

MINE SAFETY APPLIANCES COMPANY
P.O. Box 426
Pittsburgh, PA 15230
PHONE (412) 967-3000

This product contains isobutylene, oxygen and nitrogen, substances subject to the Pennsylvania Worker and Community Right-To-Know Act.

PRODUCT IDENTITY

LABEL IDENTITY - MSA P/N 10028038 Calibration Check Gas, 100 ppm Isobutylene in Air

CHEMICAL NAME - Isobutylene, Oxygen, Nitrogen Mixture

ADDITIONAL IDENTITIES - MSA P/N 10028038 Calibration Gas

FORMULA - C_4H_8 in Air

APPLICABLE CHEMICAL CONTENTS

	ppm	TWA
Isobutylene (CAS 115-11-7)	100	None
Air	Balance	None

NOTE: Gas under pressure, 1000 PSIG at 70°F, Approx. 100 Liters gas at atmospheric pressure

PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE AND ODOR - Colorless odorless gas.

BOILING POINT - N/A

SPECIFIC GRAVITY (H_2O = 1) - N/A

VAPOR PRESSURE - N/A

PERCENT VOLATILE BY VOLUME - N/A

VAPOR DENSITY (AIR = 1) - > 1

SOLUBILITY IN WATER - Isobutylene - Insoluble
Oxygen - 3.2 cm^3/100 ml (25°C)
Nitrogen - 2.3 cm^3/100 ml (0°C)

N/A - Not Applicable

PHYSICAL HAZARD INFORMATION

PHYSICAL HAZARD - Compressed gas, 1000 PSIG at 70°F

CONDITIONS OR MATERIALS TO AVOID - None

FLASH POINT - N/A   LEL - N/A   UEL - N/A

EXTINGUISHING MEDIA - This calibration gas mixture is not flammable. Use extinguishing media appropriate to surrounding fire.

SPECIAL FIRE FIGHTING PROCEDURES - See Next Item

UNUSUAL FIRE AND EXPLOSION HAZARDS - Gas under pressure, 1000 PSIG at 70°F. Do not exceed 120°F.

HEALTH HAZARDS

HEALTH HAZARDS - None Known for 100 ppm Isobutylene in Air. Isobutylene Inhalation Rat LC50: 620 Gm/M^3/4H. Isobutylene Inhalation Mouse LC50: 415 gm/M^3/2H.

SIGNS AND SYMPTOMS OF EXPOSURE - N/A to this gas mixture.

PRIMARY ROUTES OF ENTRY - Inhalation

TARGET ORGANS - Isobutylene is an asphyxiant, which displaces oxygen in the environment..

MEDICAL CONDITIONS GENERALLY RECOGNIZED AS BEING AGGRAVATED BY EXPOSURE - No information

EXPOSURE LIMITS - None (ACGIH 2009)

CARCINOGENICITY DATA - Component gases are not listed by NIOSH RTECS, OSHA, NTP or IARC.

EMERGENCY AND FIRST AID PROCEDURES - None

SAFE HANDLING AND USE

HYGIENIC PRACTICES - Avoid breathing gas.

PROTECTIVE MEASURES DURING REPAIR AND MAINTENANCE OF CONTAMINATED EQUIPMENT - N/A

PROCEDURES FOR SPILL OR LEAK CLEANUP - Ventilate area

WASTE DISPOSAL - Do not puncture or incinerate cylinder. Before discarding cylinder, slowly release contents to a safe exhaust. Dispose of cylinder in accordance with local, state and federal regulations

STORAGE - Store in a cool, dry, well-ventilated area. Do not exceed 120°F.

CONTROL MEASURES

PERSONAL PROTECTIVE EQUIPMENT - Due to the limited amount of gas in the cylinder, and the low release rate employed in instrument calibration, respiratory protection is not indicated under conditions of intended use.

ENGINEERING CONTROLS - Mechanical ventilation is suitable.

WORK PRACTICES - Avoid breathing gas. Use in well-ventilated areas. Follow the calibration procedure detailed in the MSA instruction manual provided with the instrument under calibration.

DATE OF PREPARATION - Rev. 2, April 2009

SIGMA-ALDRICH

Material Safety Data Sheet

Version 3.0
Revision Date 05/12/2009
Print Date 06/23/2009

1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Nitric acid

Product Number : 258121
Brand : Sigma-Aldrich

Company : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA
Telephone : +1 800-325-5832
Fax : +1 800-325-5052
Emergency Phone # : (314) 776-6555

2. COMPOSITION/INFORMATION ON INGREDIENTS

Formula : HNO3

CAS-No.	EC-No.	Index-No.	Concentration
Nitric acid			
7697-37-2	231-714-2	007-004-00-1	>= 90 %
Water			
7732-18-5	231-791-2	-	<= 10 %

3. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards
Target Organ Effect, Corrosive

Target Organs

Lungs, Teeth., Cardiovascular system.

HMIS Classification
Health Hazard: 3
Chronic Health Hazard: *
Flammability: 0
Physical hazards: 0

NFPA Rating
Health Hazard: 3
Fire: 0
Reactivity Hazard: 3
Special hazard.: OX

Potential Health Effects

Inhalation	May be harmful if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.
Skin	May be harmful if absorbed through skin. Causes skin burns.
Eyes	Causes eye burns.
Ingestion	May be harmful if swallowed. Causes burns.

4. FIRST AID MEASURES

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing give artificial respiration Consult a physician.

In case of skin contact
Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Continue rinsing eyes during transport to hospital.Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIRE-FIGHTING MEASURES

Flammable properties

Flash point	no data available
Ignition temperature	no data available

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Special protective equipment for fire-fighters
Wear self contained breathing apparatus for fire fighting if necessary.

Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Use personal protective equipment. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.

Environmental precautions
Do not let product enter drains.

Methods for cleaning up
Contain spillage, and then collect with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and place in container for disposal according to local / national regulations (see section 13).

7. HANDLING AND STORAGE

Handling
Avoid inhalation of vapour or mist.
Keep away from sources of ignition - No smoking. Keep away from combustible material.

Storage
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Components	CAS-No.	Value	Control parameters	Update	Basis
Nitric acid	7697-37-2	TWA	2 ppm	2007-01-01	USA. ACGIH Threshold Limit Values (TLV)
Remarks	Eye & Upper Respiratory Tract irritation Dental erosion				
		STEL	4 ppm	2007-01-01	USA. ACGIH Threshold Limit Values (TLV)
	Eye & Upper Respiratory Tract irritation Dental erosion				
		TWA	2 ppm 5 mg/m3	1989-01-19	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		STEL	4 ppm 10 mg/m3	1989-01-19	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		TWA	2 ppm 5 mg/m3	1997-08-04	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
	The value in mg/m3 is approximate.				

Personal protective equipment

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
Handle with gloves.

Eye protection
Safety glasses

Skin and body protection
Choose body protection according to the amount and concentration of the dangerous substance at the work place.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance

Form	liquid
Colour	colourless

Safety data

pH	< 1 at 20 °C (68 °F)
Melting point	no data available
Boiling point	100 °C (212 °F) at 1,013 hPa (760 mmHg)
Flash point	no data available
Ignition temperature	no data available
Lower explosion limit	no data available
Upper explosion limit	no data available
Vapour pressure	11 hPa (8 mmHg) at 20 °C (68 °F)
Density	1.4 g/cm3
Water solubility	completely soluble

10. STABILITY AND REACTIVITY

Storage stability
Stable under recommended storage conditions. Stable under recommended storage conditions.

Conditions to avoid
May discolor on exposure to air and light.

Materials to avoid
Alkali metals, Organic materials, Acetic anhydride, Acetonitrile, Alcohols, Acrylonitrile

Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - nitrogen oxides (NOx)

11. TOXICOLOGICAL INFORMATION

Acute toxicity

no data available

Irritation and corrosion

Skin - rabbit - Extremely corrosive and destructive to tissue. - Draize Test

Sensitisation

no data available

Chronic exposure

IARC:	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
ACGIH:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
NTP:	No component of this product present at levels greater than or equal to 0.1% is identified as

	a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Developmental Toxicity - rat - Oral
Effects on Embryo or Fetus: Fetotoxicity (except death, e.g., stunted fetus).

Reproductive toxicity - rat - Oral
Effects on Newborn: Biochemical and metabolic.

Signs and Symptoms of Exposure

burning sensation, Cough, wheezing, laryngitis, Shortness of breath, spasm, inflammation and edema of the larynx, spasm, inflammation and edema of the bronchi, pneumonitis, pulmonary edema, Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin.

Potential Health Effects

Inhalation	May be harmful if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.
Skin	May be harmful if absorbed through skin. Causes skin burns.
Eyes	Causes eye burns.
Ingestion	May be harmful if swallowed. Causes burns.
Target Organs	Lungs, Teeth., Cardiovascular system.,

12. ECOLOGICAL INFORMATION

Elimination information (persistence and degradability)

no data available

Ecotoxicity effects

Toxicity to fish	LC50 - Asterias rubens - 100 - 330 mg/l - 48 h

Further information on ecology

May be harmful to aquatic organisms due to the shift of the pH.

13. DISPOSAL CONSIDERATIONS

Product
Observe all federal, state, and local environmental regulations. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN-Number: 2031 Class: 8 (5.1) Packing group: I
Proper shipping name: Nitric acid
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
UN-Number: 2031 Class: 8 (5.1) Packing group: I EMS-No: F-A, S-Q
Proper shipping name: NITRIC ACID
Marine pollutant: No

IATA
UN-Number: 2031 Class: 8 (5.1) Packing group: I
Proper shipping name: Nitric acid
IATA Passenger: Not permitted for transport

15. REGULATORY INFORMATION

OSHA Hazards
Target Organ Effect, Corrosive

DSL Status
All components of this product are on the Canadian DSL list.

SARA 302 Components

	CAS-No.	Revision Date
Nitric acid	7697-37-2	2007-07-01

SARA 313 Components

	CAS-No.	Revision Date
Nitric acid	7697-37-2	2007-07-01

SARA 311/312 Hazards
Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Nitric acid	7697-37-2	2007-07-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Water	7732-18-5	
Nitric acid	7697-37-2	2007-07-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
Water	7732-18-5	
Nitric acid	7697-37-2	2007-07-01

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth, or any other reproductive defects.

16. OTHER INFORMATION

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Co., shall not be held liable for any damage resulting from handling or from contact with the above product. See reverse side of invoice or packing slip for additional terms and conditions of sale.

SIGMA-ALDRICH

Material Safety Data Sheet

Version 3.0
Revision Date 07/02/2009
Print Date 08/06/2009

1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Sulfuric acid

Product Number : 07208
Brand : Sigma-Aldrich

Company : Sigma-Aldrich
3050 Spruce Street
SAINT LOUIS MO 63103
USA
Telephone : +1 800-325-5832
Fax : +1 800-325-5052
Emergency Phone # : (314) 776-6555

2. COMPOSITION/INFORMATION ON INGREDIENTS

Formula : H2SO4

CAS-No.	EC-No.	Index-No.	Concentration
Sulfuric acid			
7664-93-9	231-639-5	016-020-00-8	>= 95 - <= 97 %
Water			
7732-18-5	231-791-2	-	>= 3 - <= 5 %

3. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards
Target Organ Effect, Highly toxic by inhalation, Corrosive

Target Organs

Teeth., Lungs

HMIS Classification
Health Hazard: 4
Chronic Health Hazard: *
Flammability: 0
Physical hazards: 3

NFPA Rating
Health Hazard: 3
Fire: 0
Reactivity Hazard: 0
Special hazard.: W

Potential Health Effects

Inhalation	May be fatal if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.
Skin	May be harmful if absorbed through skin. Causes skin burns.
Eyes	Causes eye burns.
Ingestion	May be harmful if swallowed. Causes burns.

4. FIRST AID MEASURES

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing give artificial respiration Consult a physician.

In case of skin contact
Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Continue rinsing eyes during transport to hospital.Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIRE-FIGHTING MEASURES

Flammable properties

Flash point	not applicable
Ignition temperature	no data available

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Special protective equipment for fire-fighters
Wear self contained breathing apparatus for fire fighting if necessary.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Use personal protective equipment. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.

Environmental precautions
Do not let product enter drains.

Methods for cleaning up
Soak up with inert absorbent material and dispose of as hazardous waste. Keep in suitable, closed containers for disposal.

7. HANDLING AND STORAGE

Handling
Avoid inhalation of vapour or mist.
Normal measures for preventive fire protection.

Storage
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Components	CAS-No.	Value	Control parameters	Update	Basis
Sulfuric acid	7664-93-9	TWA	0.2 mg/m3	2004-01-01	USA. ACGIH Threshold Limit Values (TLV)
Remarks	Refers to Appendix A -- Carcinogens. ACGIH 2004 Adoption Sulfuric acid contained in strong inorganic acid mists Thoracic fraction				
		TWA	1 mg/m3	1989-03-01	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		TWA	1 mg/m3	1993-06-30	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants

Personal protective equipment

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
Handle with gloves.

Eye protection
Tightly fitting safety goggles. Faceshield (8-inch minimum).

Skin and body protection
Choose body protection according to the amount and concentration of the dangerous substance at the work place.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance

Form	clear, liquid
Colour	colourless

Safety data

pH	no data available
Melting point	no data available
Boiling point	no data available
Flash point	not applicable

Ignition temperature	no data available
Lower explosion limit	no data available
Upper explosion limit	no data available
Water solubility	no data available

10. STABILITY AND REACTIVITY

Storage stability
Stable under recommended storage conditions.

Materials to avoid
Bases, Halides, Organic materials, Carbides, fulminates, Nitrates, picrates, Cyanides, Chlorates, alkali halides, Zinc salts, permanganates, e.g. potassium permanganate, Hydrogen peroxide, Azides, Perchlorates., Nitromethane, phosphorous, Reacts violently with:, cyclopentadiene, cyclopentanone oxime, nitroaryl amines, hexalithium disilicide, phosphorous(III) oxide, Powdered metals

Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Sulphur oxides

Hazardous reactions
Reacts violently with water.

11. TOXICOLOGICAL INFORMATION

Acute toxicity

LD50 Oral - rat - 2,140 mg/kg (Sulfuric acid)

LC50 Inhalation - rat - 2 h - 510 mg/m3(Sulfuric acid)

Irritation and corrosion

Skin - rabbit - Extremely corrosive and destructive to tissue. (Sulfuric acid)

Eyes - rabbit - Severe eye irritation (Sulfuric acid)

Sensitisation

no data available (Sulfuric acid)

Chronic exposure

The International Agency for Research on Cancer (IARC) has determined that occupational exposure to strong-inorganic-acid mists containing sulfuric acid is carcinogenic to humans (group 1). (Sulfuric acid)

IARC:	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
ACGIH:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
NTP:	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Signs and Symptoms of Exposure

Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin., spasm, inflammation and edema of the larynx, spasm, inflammation and edema of the bronchi, pneumonitis, pulmonary edema, burning sensation, Cough, wheezing, laryngitis, Shortness of breath, Headache, Nausea, Vomiting, Pulmonary edema. Effects may be delayed., To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated. (Sulfuric acid)

Potential Health Effects

Inhalation	May be fatal if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.
Skin	May be harmful if absorbed through skin. Causes skin burns.
Eyes	Causes eye burns.
Ingestion	May be harmful if swallowed. Causes burns.
Target Organs	Teeth., Lungs,

Additional Information
RTECS: WS5600000

12. ECOLOGICAL INFORMATION

Elimination information (persistence and degradability)

no data available

Ecotoxicity effects

Toxicity to fish LC50 - Gambusia affinis (Mosquito fish) - 42 mg/l - 96 h (Sulfuric acid)

Further information on ecology

no data available

13. DISPOSAL CONSIDERATIONS

Product
Observe all federal, state, and local environmental regulations. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN-Number: 1830 Class: 8 Packing group: II
Proper shipping name: Sulfuric acid
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
UN-Number: 1830 Class: 8 Packing group: II EMS-No: F-A, S-B
Proper shipping name: SULPHURIC ACID
Marine pollutant: No

IATA
UN-Number: 1830 Class: 8 Packing group: II
Proper shipping name: Sulphuric acid

15. REGULATORY INFORMATION

OSHA Hazards
Target Organ Effect, Highly toxic by inhalation, Corrosive

DSL Status
All components of this product are on the Canadian DSL list.

SARA 302 Components

	CAS-No.	Revision Date
Sulfuric acid	7664-93-9	2007-03-01

SARA 313 Components

	CAS-No.	Revision Date
Sulfuric acid	7664-93-9	2007-03-01

SARA 311/312 Hazards
Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Sulfuric acid	7664-93-9	2007-03-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Water	7732-18-5	
Sulfuric acid	7664-93-9	2007-03-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
Water	7732-18-5	
Sulfuric acid	7664-93-9	2007-03-01

California Prop. 65 Components

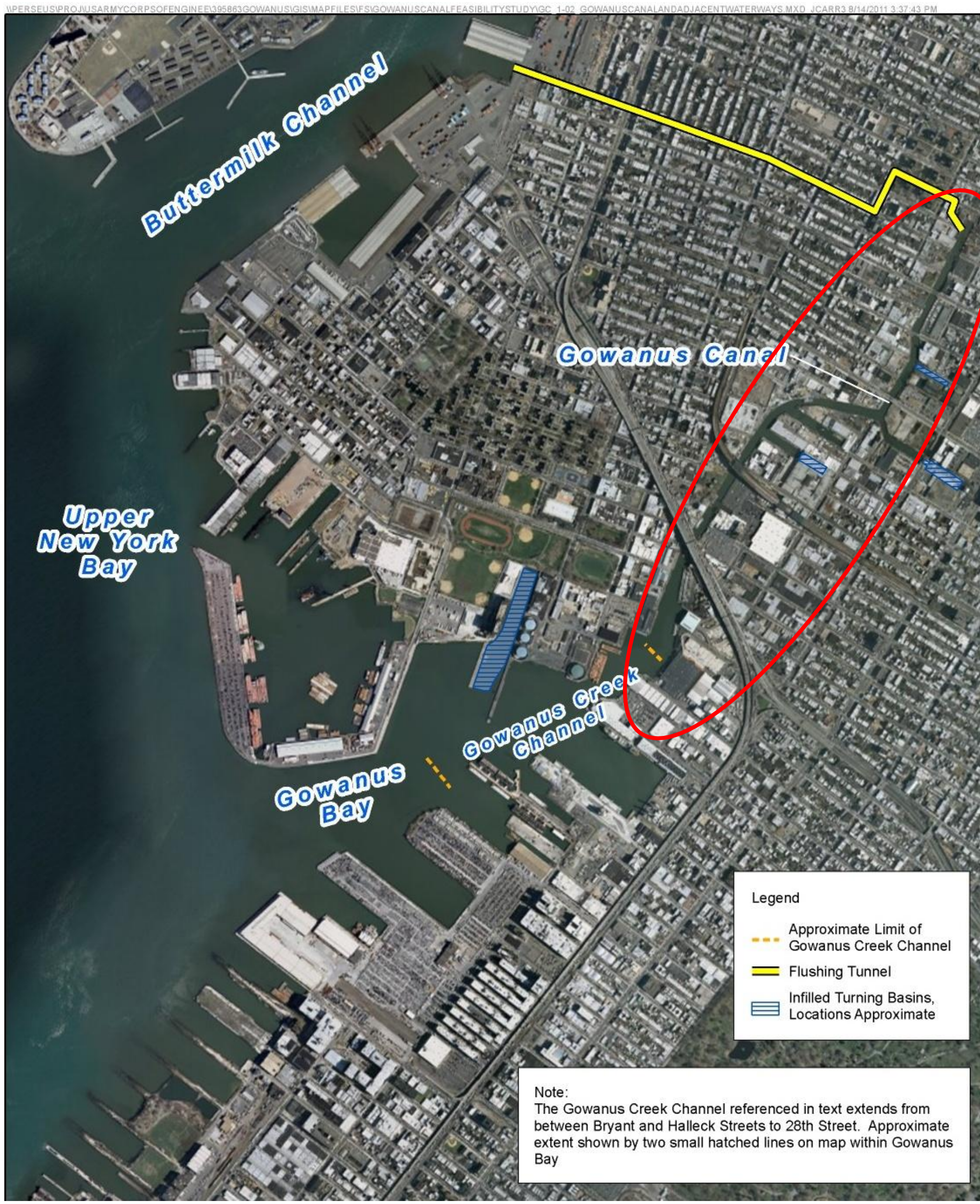
	CAS-No.	Revision Date
WARNING! This product contains a chemical known in the State of California to cause cancer. Sulfuric acid	7664-93-9	2007-09-28

16. OTHER INFORMATION

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Co., shall not be held liable for any damage resulting from handling or from contact with the above product. See reverse side of invoice or packing slip for additional terms and conditions of sale.

Site Location



Gowanus Canal
Project Area