REMEDIAL INVESTIGATION REPORT

REMEDIAL INVESTIGATION/FEASIBILITY STUDY, NEWTOWN CREEK

Prepared by

Anchor QEA, LLC

123 Tice Boulevard, Suite 205

Woodcliff Lake, New Jersey 07677

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The Remedial Investigation Report Executive Summary is provided following this page. The full report can be found on the EPA Newtown Creek Superfund Site website, at the following location:

https://semspub.epa.gov/work/02/652508.pdf

EXECUTIVE SUMMARY

Introduction

The Newtown Creek Superfund Site was added to the National Priorities List and published in the Federal Register on September 29, 2010. This *Remedial Investigation Report* (RI Report) presents the results of a comprehensive investigation conducted between 2011 and 2018, designed to characterize the Study Area and to assess potential risks to human health and the environment. This RI Report presents the results of the investigation and, together with the *Baseline Human Health Risk Assessment* (BHHRA; Appendix H) and the *Baseline Ecological Risk Assessment* (BERA; Appendix I), provides the foundation for evaluating remedial alternatives during the Feasibility Study (FS).

The Newtown Creek Remedial Investigation (RI) data collection program was conducted in two phases, which are referred to as Phase 1 and Phase 2 throughout the document, followed by Part 1 of the FS field program. All studies have followed methods and procedures described in U.S. Environmental Protection Agency (USEPA)-approved work plans and conducted directly under USEPA oversight. Specifically, these studies focused on the following objectives:

- Phase 1 sampling: Intended to broadly characterize chemical and physical features of the Study Area.
- Phase 2 sampling: Conducted to fill data gaps and collect additional data needed to support the risk assessments and modeling, as well as the point sources, nonaqueous phase liquid (NAPL), and groundwater evaluations.
- Part 1 of the FS field program: Conducted to collect additional data to support the development and evaluation of remedial alternatives; these data are presented in this RI Report.

Additional FS field program studies (i.e., Part 2 of the FS Field Program) are presented in the *Feasibility Study Field Sampling Program Data Summary Report Part 2* (Anchor QEA 2020a).

In addition to the field sampling and surveys, the Remedial Investigation/Feasibility Study (RI/FS) includes a modeling effort consisting of five components: hydrodynamics, sediment transport, groundwater, chemical fate and transport (CFT), and bioaccumulation.[1] These models are in various phases of development and will be used to evaluate remedial alternatives in the FS.

Site Setting and Physical Characteristics

Newtown Creek forms part of the border between the boroughs of Brooklyn and Queens, New York City, New York. It is a tidal inlet to the East River with no natural tributary inflows. It is approximately 3.8 miles long and comprises a main channel and five tributaries (Dutch Kills, Maspeth Creek, Whale Creek, East Branch, and English Kills). A navigation channel extends through the main stem and into portions of Whale Creek and English Kills. The average width of the main stem is approximately 100 meters, and the average depth ranges from approximately 5 to 6 meters, depending on location. All five tributaries tend to be narrower and shallower than the main channel; average widths range from approximately 50 to 70 meters, and average depths range from less than 1 meter to 5 meters. The

[1] On September 28, 2021, USEPA sent an email to the Newtown Creek Group (NCG) stating that the development of the bioaccumulation model should be discontinued. Based on USEPA's internal review; discussions with the NCG, New York City Department of Environmental Protection (NYCDEP), and the stakeholder group; and consultation with USEPA's Contaminated Sediments Technical Assistance Group, the USEPA concluded that finalizing the bioaccumulation model would not have a sufficiently beneficial outcome for the project to warrant the significant time and effort that would be required to complete it. USEPA concluded that a plan for communication of remedial expectations could be based around the monitoring program and the empirical sediment and porewater concentrations, empirical biota tissue concentrations, and predictions from the CFT model. The bioaccumulation model was discontinued because USEPA concluded: 1) the model was unlikely to advance the development of preliminary remediation goals; 2) the model was not necessary for evaluating alternatives as part of the FS process because the CFT model would be used to evaluate the relative magnitude of differences between remedial alternatives, and empirical monitoring of biota tissue concentrations will assess how the site responds to tissue-based risk thresholds; and 3) the model would be subject to particularly high levels of uncertainty at the Newtown Creek site due to the combination of migratory exposure of key organisms and uncertainty regarding off-site exposures. Because the off-site exposure zone is not a part of the hydrodynamic, sediment transport, and CFT models, it was unlikely that the bioaccumulation model would have provided accurate forecast results.

Administrative Order on Consent (AOC) defines the Study Area as Newtown Creek and the five tributaries extending up to the ordinary high water mark.[2,3]

The land use around Newtown Creek from the 1800s through the present has been predominately industrial. This industrial development occurred in parallel with municipal use of Newtown Creek as a receiving waterbody of both stormwater and wastewater discharges. Newtown Creek continues to be a major receiving waterbody of industrial and municipal separate storm sewer system (MS4) discharges and combined sewer overflow (CSO) discharges (containing combined flows of stormwater, sanitary wastewater, and industrial wastewater), as well as treated effluent from the Newtown Creek wastewater treatment plant (WWTP) overflow during rainfall events. It is also a designated Significant Maritime and Industrial Area (SMIA), which will continue to give preference to commercial use of the creek and industrial uses in upland areas. Modifications to Newtown Creek, such as fill placement and bulkheading along shorelines that have occurred over time, have resulted in a system that is largely adapted for industrial, municipal, and navigational purposes. Consequently, the land use history and urban landscape in which Newtown Creek exists shapes the conceptual site model and informs the nature and extent of contaminants of potential concern (COPCs) and potentially significant sources, as well as key fate and transport characteristics, pathways, and exposure scenarios.

[2] The Newtown Creek Superfund Site Study Area is described in the AOC as encompassing the body of water known as Newtown Creek, situated at the border of the boroughs of Brooklyn (Kings County) and Queens (Queens County) in the City of New York and the State of New York, roughly centered at the geographic coordinates of 40° 42' 54.69" north latitude (40.715192°) and 73° 55' 50.74" west longitude (-73.930762°), having an approximate 3.8-mile reach, including Newtown Creek proper and its five branches (or tributaries) known respectively as Dutch Kills, Maspeth Creek, Whale Creek, East Branch, and English Kills, as well as the sediments below the water and the water column above the sediments, up to and including the landward edge of the shoreline, and including also any bulkheads or riprap containing the waterbody, except where no bulkhead or riprap exists, then the Study Area shall extend to the ordinary high water mark, as defined in 33 Code of Federal Regulations § 328(e) and the areal extent of the contamination from such area, but not including upland areas beyond the landward edge of the shoreline (notwithstanding that such upland areas may subsequently be identified as sources of contamination to the waterbody and its sediments or that such upland areas may be included within the scope of the Newtown Creek Superfund Site as listed pursuant to Section 105(a)(8) of Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA]).

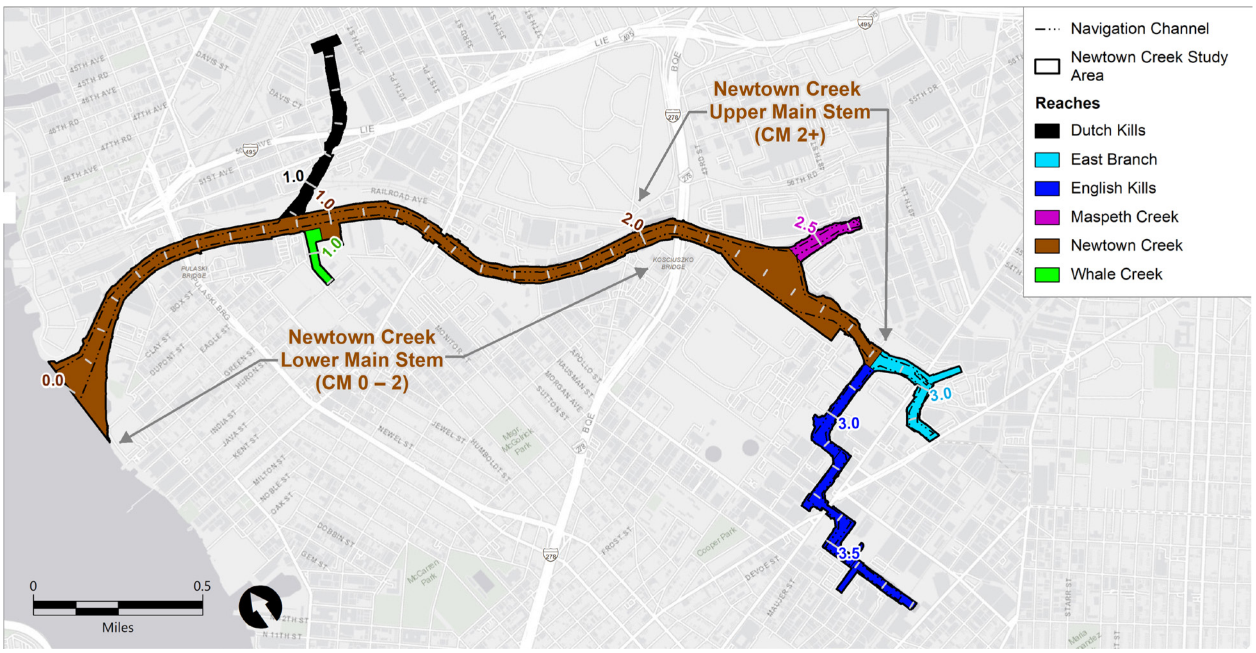
[3] The term "creek" is used interchangeably with "Study Area" throughout this RI Report.

The natural hydrodynamics of the Study Area are dominated by twice-daily tidal exchange with the East River and by rainfall-related flows from point sources and overland flow. Tidal mixing with East River water is most pronounced in creek mile (CM) 0 – 2 of the main stem, but continues to a significant degree beyond CM 2. Suspended solids are introduced into the Study Area water column primarily by the twice-daily tidal inflows from the East River and from the following: periodic discharges from CSO, MS4, and other point source stormwater discharges; overland stormwater flow; and the Whale Creek WWTP treated effluent overflow. These solids are transported and mixed within the surface water, and a portion of them eventually settle, continuously adding to, covering, and mixing with the existing sediment bed. The sediment bed throughout Newtown Creek is a cohesive (muddy) bed that is primarily net depositional, due to the low near-bed current velocities. Hydrodynamic processes (i.e., tidal currents and density-driven circulation) generate relatively low, near-bed current velocities throughout large portions of the Study Area, which result in minimal or near-zero erosion of the sediment bed, except in areas where vessel traffic may cause periodic scouring of the bed, or in shallow areas (i.e., sediment mounds) near large CSO outfalls where high current velocities can occur as a result of point source discharges during wet weather events (e.g., see Section 5.3.2.2 of Appendix G).

Based on some of the unique, site-specific Study Area characteristics noted previously, Newtown Creek is evaluated in this RI in the following three primary reaches (Graphic ES-1):

- **The lower main stem, from the mouth to approximately CM 2 (CM 0 – 2)**
  - CM 0 – 2 is characterized by extensive tidal exchange with the East River. Depositing solids originate primarily from the East River.
- **The upper main stem, including the Turning Basin (CM 2+)**
  - CM 2+ is a more complex portion of the Study Area. Depositing solids originate both from downstream (the East River) and upstream (primarily CSO and stormwater outfalls). Depositional characteristics within CM 2+ vary relative to position of the navigational channel, influences of vessel traffic, and shoreline features.

- **The tributaries**
  - The tributaries exhibit low surface water current velocities under typical conditions. CSO and storm-related point source inflows provide nearly all the solids that deposit on the sediment bed in the upper tributaries (i.e., Maspeth Creek, East Branch, and English Kills). Each tributary differs in circulation, deposition characteristics, and solids sources.



Graphic ES-1. Study Area Reaches

Nature and Extent of Contamination and Fate and Transport Characteristics

A primary focus of the RI field program was to delineate the nature and extent of contamination in the Study Area. Based on the results from the BERA and BHHRA, contaminants that were found to contribute to human health or ecological risk were used to characterize the nature and extent of contamination in the RI Report. These contaminants are as follows: total polycyclic aromatic hydrocarbon (17) (TPAH [17]),[4] total polycyclic

[4] This includes the 16 USEPA priority pollutant polycyclic aromatic hydrocarbons (PAHs), as well as 2-methylnaphthalene.

aromatic hydrocarbon (34) (TPAH [34]),[5] C19-C36 aliphatic hydrocarbons (C19-C36),[6] total polychlorinated biphenyl (TPCB),[7] 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD),[8] copper (Cu), lead (Pb), and dieldrin.

While these eight contaminants (or groups of contaminants) were used to characterize nature and extent of contamination, the degree to which they contribute to human health and ecological risks varies.[9] Hydrocarbons, TPCB, and Cu contribute to risk in the human health and/or ecological risk assessments and represent three broad classes of contaminants. Hydrocarbons include TPAH (17), TPAH (34), and C19-C36 (as well as other compounds), and each of these sums was found to contribute to ecological risk (to varying degrees). 2,3,7,8-TCDD and Pb also contribute to risk in the human health and/or ecological risk assessments, albeit to a lesser degree than TPCB and Cu, respectively. Dieldrin was also

[5] This includes both the 17 compounds in TPAH (17), as well as 17 other C1- to C4-alkylated homologs of 2- to 6-ring PAHs.

[6] This is representative of hydrocarbons having between 19 and 36 carbon atoms and is also a component of C9-C40 total petroleum hydrocarbons (TPH, which also includes the C10-C28 diesel range organics [DRO]).

[7] This includes 209 individual chlorinated compounds or congeners consisting of a biphenyl molecule and one to ten chlorine atoms.

[8] This compound is a major contributor to the total dioxin/furan toxic equivalence quotient (TEQ).

[9] TPAH (17), TPAH (34), and C19-C36 are primary risk drivers in the BERA (see Appendix I), TPCB is a primary risk driver in the BHHRA and BERA (see Appendices H and I, respectively), and Cu was selected as a representative metal because of some potential ecological risk, and bulk sediment concentrations are elevated relative to screening benchmarks in sediment in CM 2+. 2,3,7,8-TCDD was identified as a risk driver in the BHHRA and as a contaminant of potential ecological concern (COPEC) in the BERA, and Pb was identified as a COPEC in the BERA. Although dieldrin was not identified as a COPC or COPEC, it was included in the nature and extent evaluation of surface sediment and tissue because of elevated concentrations in polychaete tissue in one reach of the Study Area (English Kills). These eight contaminants (or groups of contaminants) were used to characterize nature and extent of contamination; however, not all of these contaminants were included for evaluations of sources and fate and transport, because: 1) the distributions in environmental media (including surface sediment) are broadly similar to those within the same class (i.e., hydrocarbons, bioaccumulative organics, and metals); 2) in some of the locations or some of the media, some of these contaminants (e.g., C19-C36, 2,3,7,8-TCDD, and Pb) were either not analyzed or were infrequently detected (in the case of surface water, porewater, and groundwater—these contaminants were detected at generally high frequencies in sediment); and 3) their fate and transport characteristics (i.e., partitioning behavior) are similar, especially to others within the same class. As such, TPAH (17), TPCB, and Cu were used for the evaluations of sources, fate and transport, and the quantitative aspects of the conceptual site model in the RI Report. However, going forward into the FS, additional contaminants will continue to be considered; for example, due to differences in hydrocarbon distributions, TPAH (17) cannot be considered a surrogate for other hydrocarbons, so the FS will consider the other hydrocarbon groups (i.e., TPAH [34] and C19-C36) individually.

evaluated for nature and extent in some media because elevated concentrations were observed in benthic invertebrate tissue in one portion of the Study Area (i.e., English Kills).

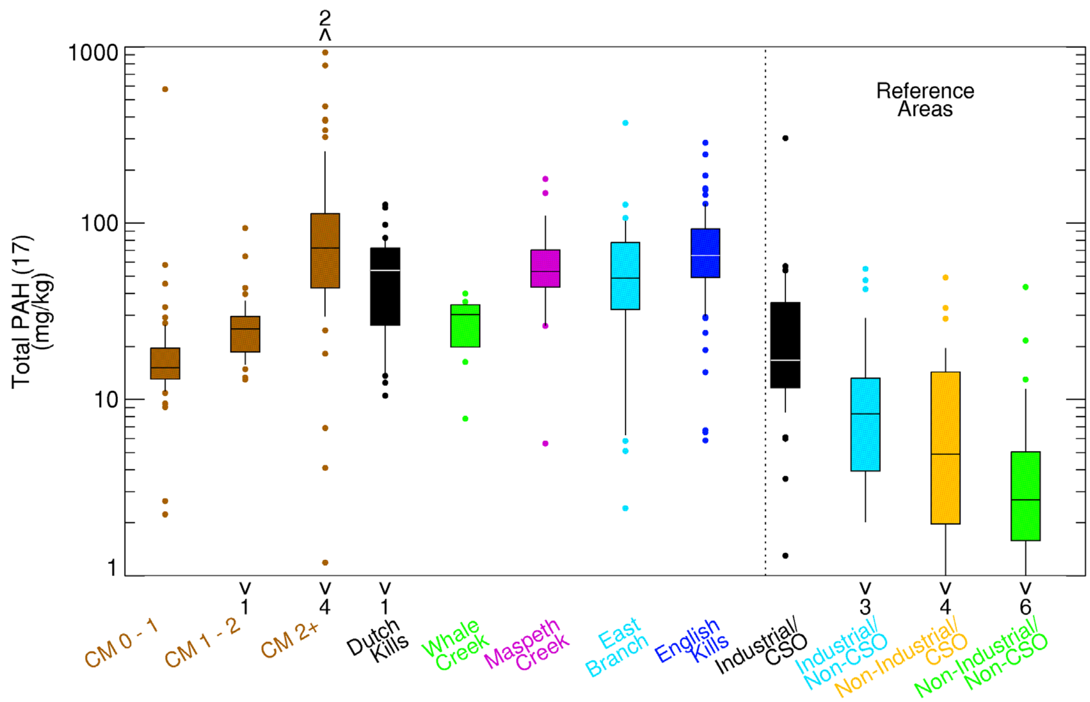
The distribution of these contaminants in the surface sediment (defined operationally as a depth of 0 to 15 centimeters [cm; 0 to 6 inches]), subsurface sediment (from 15 cm [6 inches] depth to the interface with the underlying native material), native material, surface water, and NAPL in the Study Area are summarized in the following sections.[10]

Sediment

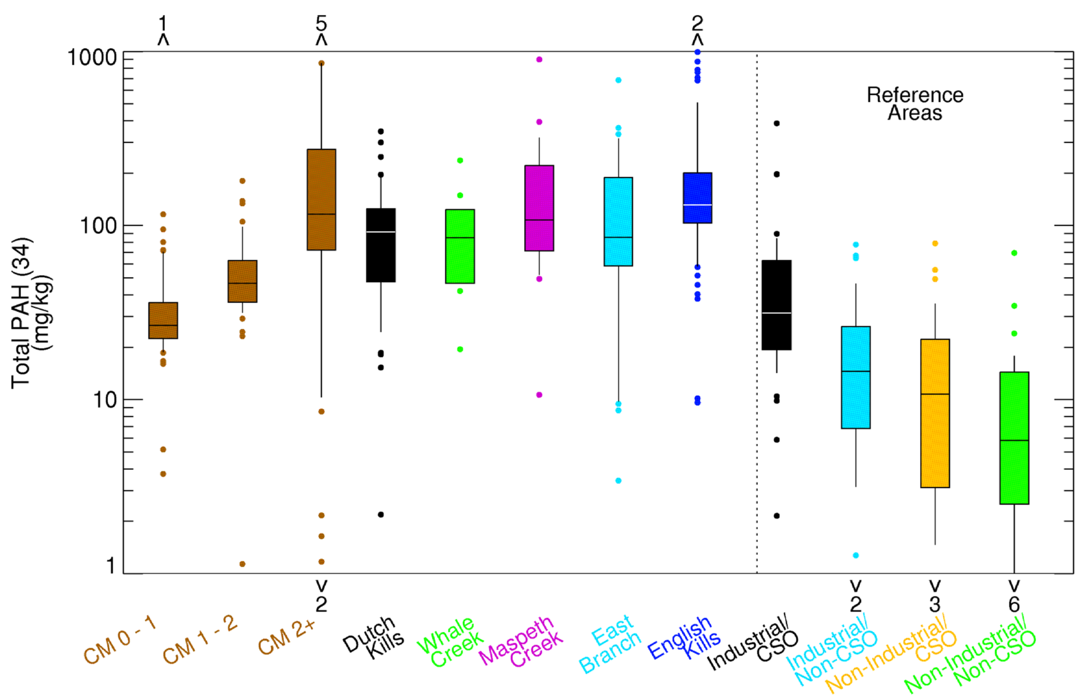
TPAH (17), TPAH (34), C19-C36, TPCB, 2,3,7,8-TCDD, Cu, and Pb concentrations in surface sediment are summarized in the following graphics (Graphics ES-2 through ES-8, respectively).[11] In these graphics, the main stem of Newtown Creek extends from the mouth of the creek at the East River upstream through the Turning Basin. The main stem is divided into three segments: CM 0 – 1, CM 1 – 2 (shown as one reach in Graphic ES-1), and CM 2+. Each tributary is represented individually. These graphics also show the surface sediment data from reference areas for comparison. These reference areas were selected by USEPA to evaluate physical, chemical, and biological conditions in waterbodies that span four categories of industrial development and influence from CSO discharges, specifically Industrial/CSO, Industrial/Non-CSO, Non-Industrial/CSO, and Non-Industrial/Non-CSO.

[10] Dieldrin was excluded from these sections because it was not identified as a COPC or COPEC in the risk assessments.

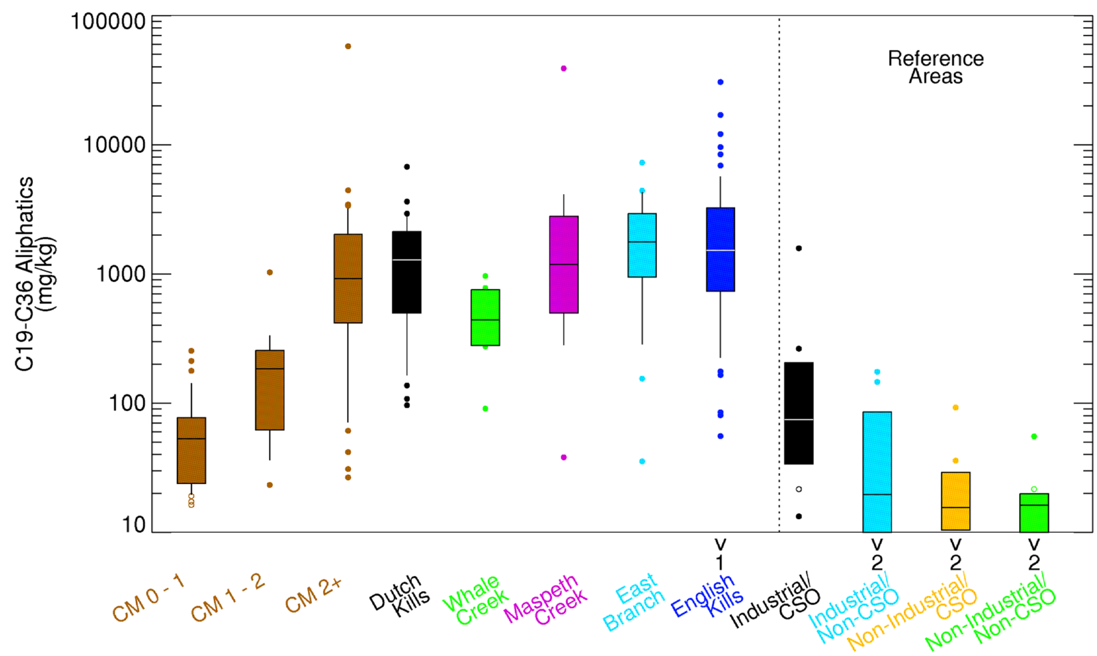
[11] In Graphics ES-2 through ES-8, the boxes represent the 25th and 75th percentiles of the data, and the vertical lines represent the 10th and 90th percentiles. The horizontal line through each box represents the median. All values lying outside the 10th and 90th percentiles are indicated individually. The caret symbols represent individual values that are above or below the panel; the number of values outside the panel is also indicated. Surface sediment includes data collected within the top 15 cm (6 inches) of the sediment bed.



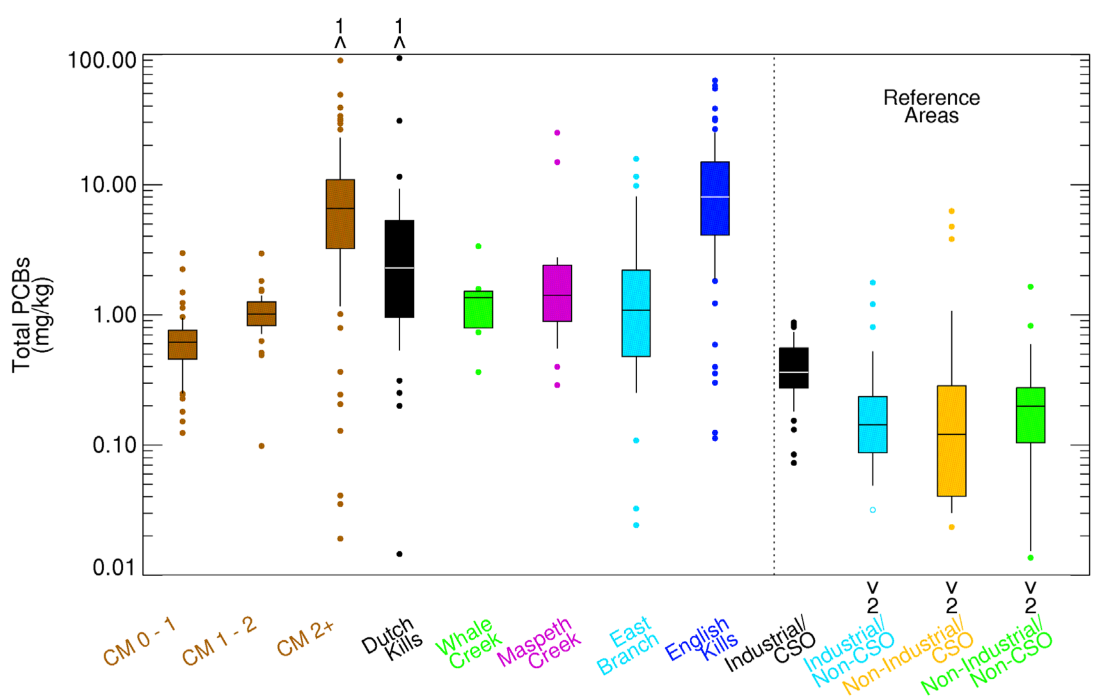
Graphic ES-2. TPAH (17) in Surface Sediment



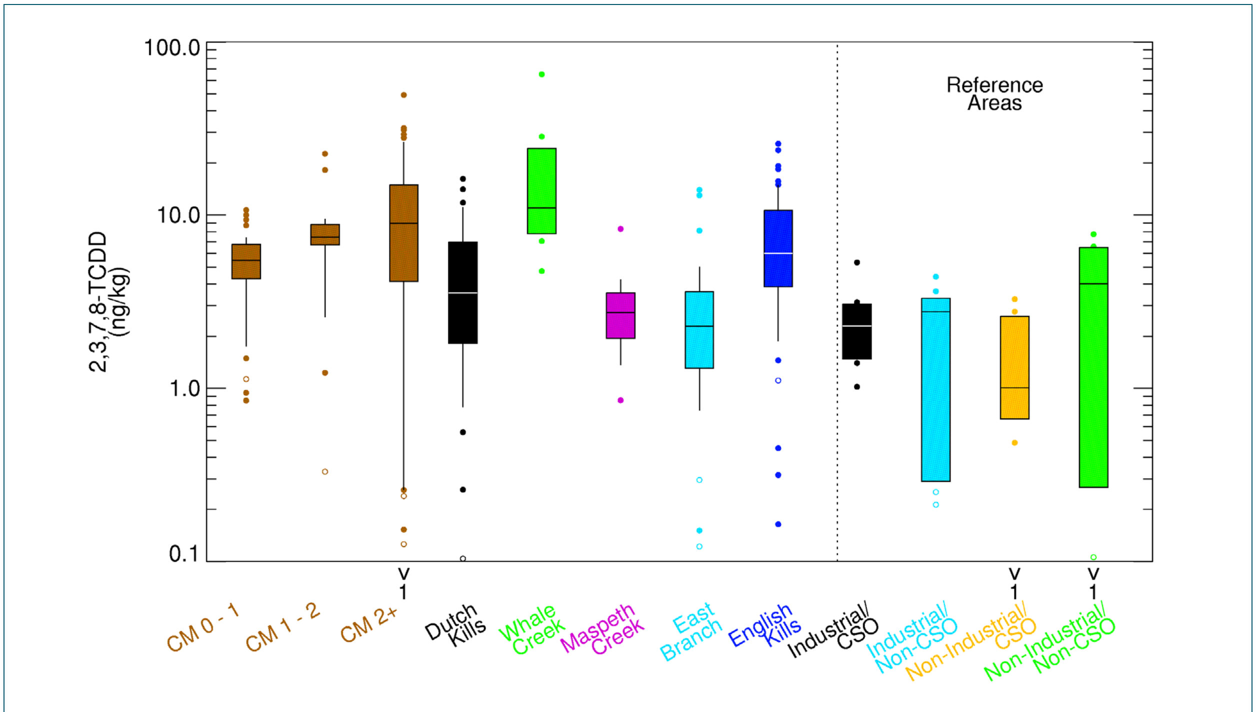
Graphic ES-3. TPAH (34) in Surface Sediment



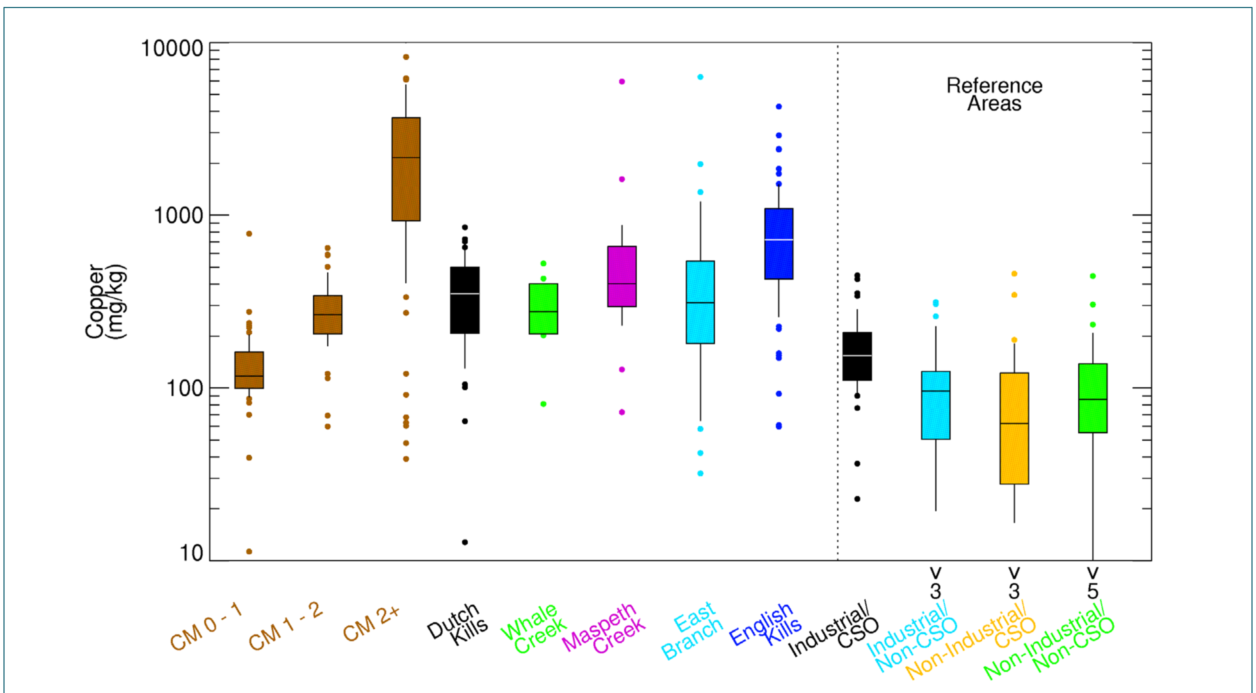
Graphic ES-4. C19-C36 in Surface Sediment



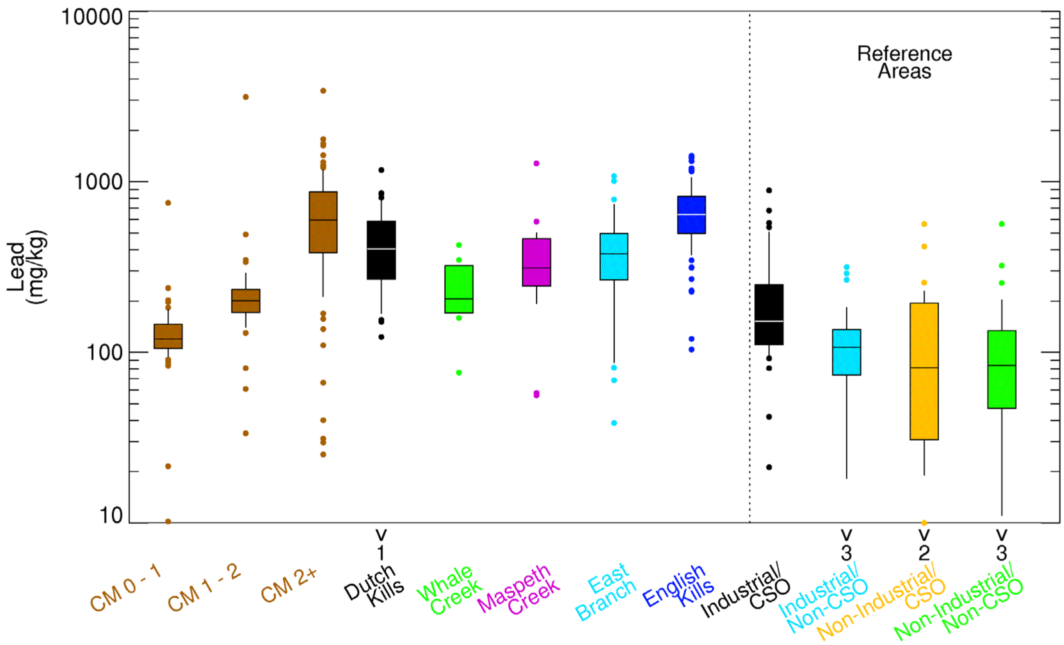
Graphic ES-5. TPCB in Surface Sediment



Graphic ES-6. 2,3,7,8-TCDD in Surface Sediment



Graphic ES-7. Copper in Surface Sediment



Graphic ES-8. Lead in Surface Sediment

Notable patterns in the surface sediment data are as follows:

- **Surface sediment, CM 0 – 2.** Surface sediment TPAH (17), TPAH (34), C19-C36, TPCB, 2,3,7,8-TCDD, Cu, and Pb concentrations in CM 0 – 1 are generally the lowest in the Study Area and are consistent with reference areas,[12] as represented by the Industrial/CSO reference area data and in the case of 2,3,7,8-TCDD all reference area categories. Concentrations in CM 1 – 2 are higher than those in CM 0 – 1, but also are generally consistent with (or approaching) reference area concentrations in the Industrial/CSO reference areas and in the case of 2,3,7,8-TCDD all reference area categories.
- **Surface sediment, CM 2+.** The highest surface sediment concentrations for TPAH (17), TPAH (34), C19-C36, TPCB, 2,3,7,8-TCDD, Cu, and Pb in the main stem are observed in CM 2+, with most values being above reference area concentrations.
- **Surface sediment, tributaries.** Concentrations in tributaries are generally higher than in CM 0 – 2 and generally exceed reference area concentrations as a result of the mixing of ongoing sources with residual historical contamination. The highest TPAH (17), TPAH

[12] Concentrations in surface sediment samples collected from reference areas are located throughout the New York Harbor and Jamaica Bay area and are considered representative of reference area sediment concentrations.

(34), Cu, and Pb tributary concentrations, as well as elevated C19-C36, TPCB, and 2,3,7,8-TCDD concentrations, are observed primarily in the lower 0.5 mile of English Kills (see Section 4.2.3). The highest C19-C36 concentrations are observed throughout English Kills (with elevated concentrations at multiple locations in the other tributaries as well). The highest TPCB and 2,3,7,8-TCDD concentrations are observed in Dutch Kills and Whale Creek, respectively. In some tributaries, specifically East Branch and English Kills, concentrations decrease moving upstream, toward the head of each tributary (see Section 4.2.3).

In subsurface sediment, TPAH (17), TPAH (34), C19-C36, TPCB, 2,3,7,8-TCDD, Cu, and Pb concentrations are higher than in surface sediment in nearly all cases throughout the Study Area. The only exceptions are C19-C36 in Dutch Kills and East Branch and 2,3,7,8-TCDD in Dutch Kills, where surface and subsurface concentrations are generally similar. Like surface sediment, subsurface sediment concentrations in CM 0 – 2 are generally the lowest near the mouth of the Study Area and increase moving upstream, with the highest subsurface sediment concentrations in the main stem being observed in CM 2+. Subsurface sediment concentrations generally increase with depth, reaching a peak several feet below the mudline or increasing until native material is reached. Elevated contaminant concentrations generally are not present in the native material.

The subsurface sediment appears relatively stable. This is supported by the following:

- Lower concentrations of COPCs in surface sediment, as compared to subsurface sediment, throughout the Study Area
- Low current velocities throughout the Study Area that result in minimal or no erosion of the sediment bed, except in localized areas owing to propeller wash disturbance and in areas near point sources that discharge during wet weather events
- Net depositional sediment bed throughout the Study Area (deposition rate varies by location), based on multiple lines of evidence (LOEs), including sediment radioisotope studies, bathymetric surveys, and historical dredging records
- Pre- and post-Hurricane Sandy bathymetric surveys, which indicate minimal erosion of the sediment bed during the anomalous current velocities generated by the storm surge

Surface Water

In general, surface water contaminant concentrations exhibit considerably less spatial gradients than surface sediment. This limited spatial pattern is primarily due to mixing and to the influence of the East River. In general, wet weather concentrations were greater than dry weather concentrations, indicating the importance of ongoing point sources and stormwater-related events occurring in the Study Area.

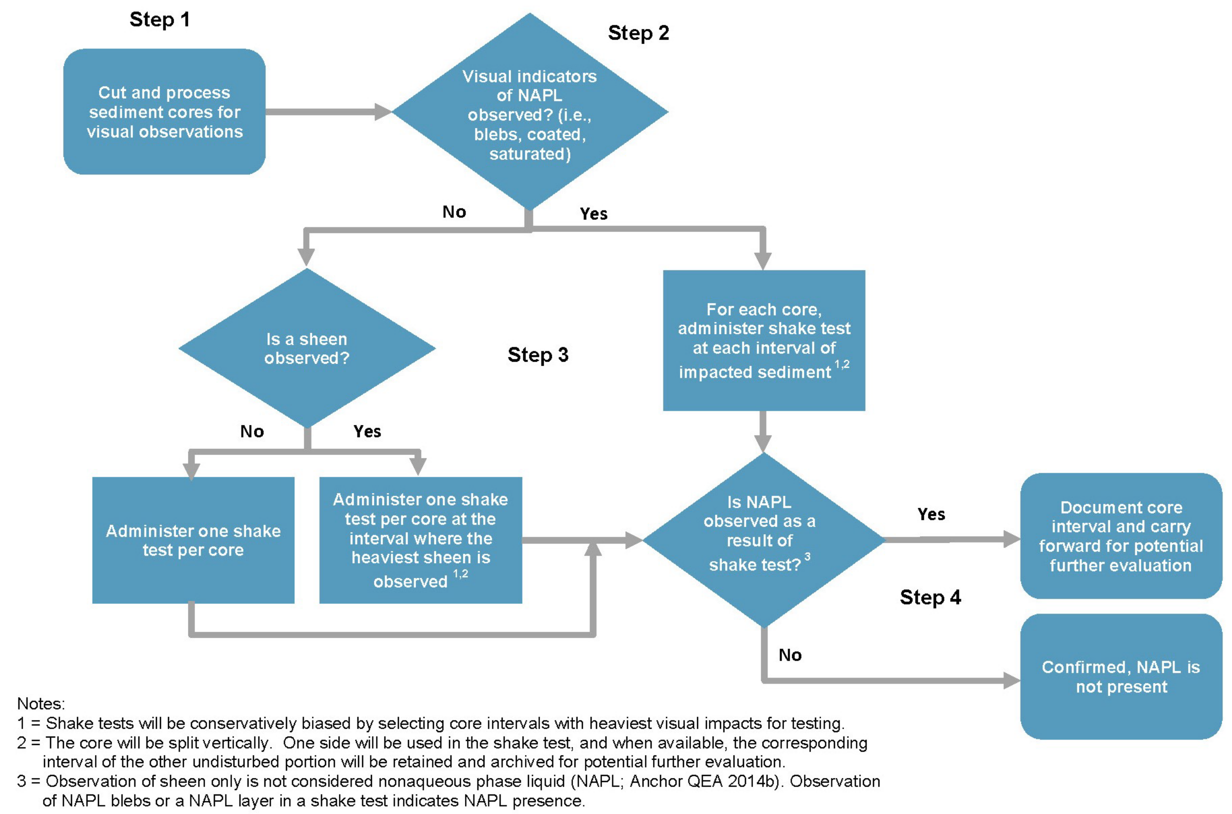
Notable patterns in the data are as follows:

- **Dry weather, CM 0 – 2 and CM 2+.** TPAH (17), TPAH (34), TPCB, Cu, and Pb concentrations generally show little overall gradient in the main stem. Concentrations throughout the main stem are generally within the range of the East River, with increases moving upstream in some cases (e.g., TPCB and TPAH [34] in CM 1 – 2 and CM 2+). 2,3,7,8-TCDD was only detected in one sample from CM 1 – 2. C19-C36 was not analyzed in surface water samples.
- **Dry weather, tributaries.** The highest dry weather TPAH (17), TPAH (34), and TPCB concentrations are observed in English Kills and to a lesser extent in East Branch. Concentrations in the other tributaries are generally similar to one another and are consistent with those observed in the main stem and in the East River. Dry weather Cu and Pb concentrations are similar across all the tributaries and are generally consistent with those observed in the main stem and in the East River. 2,3,7,8-TCDD was not detected in dry weather surface water samples from the tributaries.
- **Wet weather.** In the main stem, wet weather concentrations of TPAH (17), TPAH (34), TPCB, Cu, and Pb increase somewhat with distance upstream. These patterns suggest influence from CSOs, other point sources, and overland flow. 2,3,7,8-TCDD was only detected in one wet weather sample from CM 0 – 1 and two wet weather samples from CM 1 – 2. Wet weather TPAH (17), TPAH (34), TPCB, and Cu concentrations are higher than the corresponding dry weather concentrations in all reaches of the Study Area. Comparisons between wet and dry weather Pb concentrations are confounded by varying detection limits and low frequency of detection in dry weather samples.

NAPL

The presence and extent of NAPL were extensively investigated during the RI and FS Part 1 field programs. Multiple field investigations and the collection of hundreds of surface sediment grabs and cores were used to evaluate NAPL presence and extent in Study Area sediment and native material. As shown in Graphic ES-9, NAPL presence or absence was identified using a two-part process combining direct visual observation of sediment and native material in the cores, along with the performance of shake tests and visually observing if NAPL separated from the sediment or native material.[13] The presence of NAPL blebs or a NAPL layer in a shake test indicates that NAPL is present. The lack of NAPL blebs or a NAPL layer in a shake test (i.e., no observation, or sheen only) confirms that NAPL is not present, as indicated in Note 3 of Graphic ES-9. In sediment and native material samples where shake tests were not performed (e.g., National Grid cores), direct visual observation of blebs, coated, or saturated NAPL, indicates that NAPL is potentially present.

[13] A shake test consists of placing sediment and distilled water into a clean laboratory jar, which is shaken and allowed to equilibrate, to observe whether a separate phase liquid is generated.



Graphic ES-9. Flow Diagram for Field Identification of NAPL

For much of the Study Area, where NAPL was observed, NAPL observations in sediment were intermittent (i.e., located sporadically throughout an area, not clustered at a particular location) and residual (i.e., shake test blebs, bleb visual observations).[14] A relatively greater magnitude of NAPL (i.e., shake test layer results, coated and saturated visual observations) was observed in three limited areas of the Study Area, referred to as Category 2/3 Areas. Notable patterns in the data are as follows:

- **CM 0 – 2.** NAPL was not observed in surface sediment; however, sheen in surface sediment was observed intermittently in 25% (27 of 108) of surface samples collected in CM 0 – 2. In subsurface sediment, sheen and NAPL were observed more frequently at

[14] Residual NAPL is the condition where NAPL saturation is sufficiently low that the NAPL consists of discrete blebs trapped by capillary forces, so it is immobile. This classification is specific to the ability of the NAPL to advect (i.e., flow) as a nonaqueous fluid phase. The interpretation that blebs represent residual, immobile NAPL is based on the observation that in core samples, the blebs are present as small, discrete droplets; this matches the description of residual NAPL as documented in the literature (Schwille 1988; Cohen and Mercer 1993; Pankow and Cherry 1996; API 2003; ITRC 2004; Sale et al. 2008; ITRC 2009; Kueper and Davies 2009).

various locations and depths. Where observed, NAPL was primarily in a residual state. From CM 1.6 to 1.7, shake test results for a limited number of cores indicated the presence of Category 2/3 NAPL. This area is referred to as the CM 1.7 Category 2/3 Area. With the exception of a few samples, NAPL in CM 1.7 is not present in measurably greater amounts than the surrounding areas in the CM 0 – 2 reach. NAPL mobility testing of CM 0 – 2 subsurface sediment and native material samples demonstrated that, where present, NAPL was immobile, so that NAPL will not migrate to surface sediments from underlying subsurface sediments and native material.

- **CM 2+.** NAPL was observed in surface sediment at a limited number of locations—primarily in a residual state upstream of CM 2.4. This area is referred to as the Turning Basin Category 2/3 Area. Sheen was observed in surface sediment samples at a number of surface sediment locations in this reach. In subsurface sediment, sheen and NAPL were observed more frequently than in CM 0 – 2 at various locations and depths. Quantitative NAPL mobility testing for CM 2+, including the Turning Basin Category 2/3 Area, was completed as one component of the FS Part 2 field program (data for the FS Part 2 field program are not included in the RI Report and are presented in the *Feasibility Study Nonaqueous Phase Liquid Mobility Data Evaluation Report* (FS NAPL DER; Anchor QEA 2022a).
- **Tributaries.** NAPL was not observed in surface sediment in the tributaries, except at one location, in lower English Kills. Sheen was observed in approximately half of the surface sediment samples scattered throughout the tributaries. Sheen was also observed in subsurface sediment at various depths throughout the tributaries. While NAPL was not observed in subsurface sediments in Dutch Kills and Whale Creek, it was observed in a limited number of locations in Maspeth Creek, East Branch, and the upper reach of English Kills, and more widely in the lower reach of English Kills. Category 2/3 NAPL was observed in a limited number of cores, all located in the lower portion of English Kills, between CM 2.95 and 3.2. This area is referred to as the Lower English Kills Category 2/3 Area. Quantitative NAPL mobility testing for the tributaries, including the Lower English Kills Category 2/3 Area, was performed as part of the FS Part 2 field program (data for the FS Part 2 field program are not included in the RI Report and are presented in the FS NAPL DER [Anchor QEA 2022a]).

NAPL observations in the native material were primarily limited to the areas of the Turning Basin and English Kills with footprints overlapping where NAPL was also observed in subsurface sediment. Isolated sheens in native material samples were infrequently observed in the main stem, primarily between CM 1.3 and 2.7, in lower English Kills, and at one location in Maspeth Creek.

To understand whether gas ebullition can facilitate NAPL transport from the sediment bed to surface water, qualitative studies of gas ebullition were conducted as part of the Phase 2 investigations during times of the year when gas ebullition is most active (i.e., during low tides or warmer temperatures). Observations of the location, frequency, and magnitude of bubble generation and sheen blossoms[15] at the water surface were recorded to develop an understanding of conditions where gas ebullition-facilitated NAPL transport would most likely be expected to occur. A quantitative gas ebullition pilot study was conducted in September 2017 to develop and test methodologies for the 2018 to 2019 gas ebullition field program that was conducted under Part 2 of the FS field program (data for the 2018 to 2019 field program are not included in the RI Report and are presented in the *Feasibility Study Gas Ebullition Data Evaluation Report* [FS Gas Ebullition DER; Anchor QEA 2022b]).

Sources

The current distribution of contaminants in the sediment column of the Study Area is due to historical and ongoing sources, historical dynamic fate and transport processes, and changes in contaminant loads over time. As such, the locations of impacts observed today cannot necessarily be directly linked to proximate upland sites or sources, including point sources. Historically, contaminant loads to surface sediment were much greater, as evidenced by the higher contaminant concentrations in subsurface sediment. Surface sediment concentrations have been declining over time, as a result of the deposition and mixing of these recently deposited cleaner solids with previously deposited solids. Because the constituents that describe the nature and extent of contamination are also commonly present in the urban environment of

[15] Not all sheens on the water surface originate from ebullition. Sheen blossoms are sheens that appear with a breaking gas bubble (i.e., ebullition). There can be distinct static sheens, which float on the water surface into the observation area. Potential static sheen sources might be caused by seepage from bulkheads, floatables, outfall discharge, surface scum, vessel movements, or discharges from engine/bilge/deck runoff, as well as unknown sources.

the Study Area, these contaminants can enter the system from multiple potential sources. These sources are described in the following list, and current loads to the Study Area (by reach) are summarized for several of these sources in Table ES-1 for TPAH (17), TPCB, and Cu:

- **Point sources and overland flow.** Almost one-third of the point source TPAH (17) load (30% to 32%) enters the Study Area in CM 0 – 1 from the Con Edison – 11th Street Conduit (*Data Applicability Report* No. 110) dewatering system. The majority of the point source TPAH (17) (51%), TPCB (67%), and Cu (75%) loads enter the Study Area in the tributaries—primarily Maspeth Creek, East Branch, and English Kills—predominantly from CSOs and stormwater.
- **East River.** The East River transports solids that contain contaminant concentrations consistent with the reference areas as a load to the Study Area, due to the semidiurnal tides. The East River is the primary source of the solids that deposit on the sediment bed in CM 0 – 2 and the lower tributaries (i.e., Whale Creek and Dutch Kills); these solids, along with upstream point sources, contribute to the solids that deposit in CM 2+ and, to a lesser extent, the sediment bed in the upper tributaries (i.e., Maspeth Creek, East Branch, and English Kills). Concentrations of TPAH (17), TPCB, and Cu measured in East River surface water samples collected near the mouth of Newtown Creek are generally similar to those measured in CM 0 – 2 during dry weather, reflecting the strong influence of the river on this reach of the Study Area. Estimating the contaminant loads from the East River to the Study Area requires the use of linked hydrodynamic, sediment transport, and CFT models. This work is underway and will be included in FS-related reports.
- **Groundwater.** Groundwater discharge to the Study Area occurs at the base of the Study Area and through vertical permeable shorelines to the surface water (i.e., lateral discharge; see next bullet). The base of the Study Area is defined as the interface between sediment and native material, as well as between sediment and fill. Groundwater discharge to the base of the Study Area may provide chemical loads to subsurface sediment and surface sediment, eventually discharging to surface water. This load is a small fraction of the contaminant mass present in the subsurface sediment, meaning that the subsurface sediment chemical concentrations are from other historical legacy sources. In addition, groundwater contamination, where present, is substantially attenuated in the subsurface sediment before it reaches surface sediment. For example, the total groundwater TPAH (17) load from the base of the

Study Area to subsurface sediment in CM 2+ is estimated to be between 740 and 1,400 kilograms per year (kg/year), but the load of TPAH (17) in porewater[16] flowing from subsurface to surface sediment in this reach is approximately 100 to 200 times less (7.3 kg/year). In total, groundwater contaminant loads to the surface sediments in the Study Area are minor relative to contaminant loads from point sources.

- **Lateral groundwater discharge.** Lateral groundwater discharge through vertical permeable shorelines also may transport contaminants to the water column. However, dry weather surface water data adjacent to the five areas with the highest estimated lateral groundwater discharge rates per linear foot of shoreline indicate no observable influence from lateral groundwater discharge on surface water chemical concentrations, although definitive conclusions cannot be drawn from such comparisons. Because shallow lateral groundwater discharge inputs to Newtown Creek have not been empirically characterized, USEPA is planning a study to further characterize shallow lateral groundwater discharge along the shoreline of Newtown Creek. The stated objective of the USEPA study is to collect empirical data to achieve sufficient characterization of shallow lateral groundwater discharge to support the FS and reduce uncertainty in the current lateral groundwater discharge estimate. Chemical loads from lateral groundwater discharge will also be further evaluated with the CFT model during the FS through sensitivity analysis.
- **Other sources.** Shoreline erosion, atmospheric deposition, overwater activities, and shoreline seeps including NAPL seeps represent additional sources of contaminants to the Study Area that are evaluated as part of the RI. Analyses of data from historical studies and data collected during FS Part 1 field activities demonstrate that shoreline erosion, atmospheric deposition, and overwater activities represent minor sources of contaminants to surface water and surface sediment in the Study Area. Quantitative estimates of mass loading could not be calculated for shoreline seeps including NAPL seeps as there are no flow data for the seeps. These sources will continue to be assessed during the FS.

[16] Shallow porewater can be impacted by tidal exchanges with surface water. Although there are no direct contaminant measures associated with such tidal exchange, multiple lines of evidence presented in the RI Report (Section 6.4.3.1.2) indicate that this process is not a primary driver of shallow porewater concentrations.

Table ES-1

Summary of Current Contaminant Loadings to Study Area

	TPAH (17)			TPCB			Cu		
	CM 0 – 2	**CM 2+**	**Tributaries**	**CM 0 – 2**	**CM 2+**	**Tributaries**	**CM 0 – 2**	**CM 2+**	**Tributaries**
Point Sources									
CSO	0.52 to 0.58	0.24 to 0.30	19 to 20	<0.01	≤0.012	0.12 to 0.27	6.0 to 6.6	3.4 to 7.6	180 to 220
Stormwater	4.5 to 5.8	2.2 to 3.2	6.6 to 8.0	0.098 to 0.17	0.033 to 0.094	0.12 to 0.24	60 to 68	28 to 37	72 to 94
Treated Groundwater	17	NA	NA	<0.01	NA	NA	2.3	NA	NA
WWTP Treated Effluent Overflow	NA	NA	0.93	NA	NA	0.050	NA	NA	33
Groundwater									
Base of Study Area	80 to 110	740 to 1,400	7.5 to 20	<0.01	<0.01	0.039 to 0.25	3.3	3.5	3.3
Other Sources	--	--	--	--	--	--	--	--	--
East River	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Notes:
Units are kilograms per year.
-- = Analysis to date suggests minor contribution to Study Area based on available information (i.e., RI data and qualitative comparisons) recognizing that not all these sources could be quantified and that additional evaluations will continue during the FS.
NA = not available – Discharge type does not occur in this reach.
TBD = to be determined – Load will be calculated based on ongoing modeling analyses.

Risk and Exposure Pathways

The results of the comprehensive site-specific BHHRA and BERA provide one set of criteria to be used during selection of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedy in the FS. Human health risks were evaluated for 12 exposure scenarios. Potential risks to human health in excess of USEPA's acceptable cancer risk range and/or non-cancer hazard threshold were identified for the following exposure scenarios:

- **Study Area**
  - Cancer risks and non-cancer hazards associated with consumption by recreational anglers/crabbers of fish and crab tissue obtained from the Study Area, primarily due to tissue concentrations of PCBs in fish, and PCBs and dioxins/furans in crab
  - Non-cancer hazard for general construction worker exposure to surface sediment along the shoreline in limited areas within the Study Area, primarily due to PCBs in surface sediments in these localized areas
- **Reference areas**
  - Cancer risks and non-cancer hazards associated with consumption by recreational anglers/crabbers of fish and crab tissue obtained from reference areas, primarily due to PCBs in fish and crabs, with some contribution from dioxins/furans to non-cancer hazards in crab. The presence of human health risks in the reference areas suggests that regional exposure for migratory fish and crab species needs to be considered when evaluating risk management options for Newtown Creek.

The BERA (see Appendix I) evaluated multiple LOEs in a quantitative and qualitative weight-of-evidence approach and identified potential risks to ecological receptors as follows:

- **Study Area**
  - Surface sediment toxicity to benthic organisms in CM 0 – 2, CM 2+ and the tributaries is greater than toxicity in sediment in the four Phase 2 reference areas based on the results of the sediment toxicity testing. Toxicity at these locations may be associated with polycyclic aromatic hydrocarbons (PAHs, in particular, alkylated PAHs) in porewater, with some contribution from porewater metals (Cu, Pb, and zinc [Zn]). Based on further evaluations completed after the BERA

  was finalized, USEPA concluded that toxicity was correlated with bulk sediment concentrations of TPAH (34) and C19-C36.
  - Hazard quotient (HQ) values greater than a threshold of 1 were exceeded in CM 2+ and the tributaries for benthic fish, due to PAHs, Cu, Pb, Zn, and TPCB in porewater.
  - HQ values greater than 1 were calculated for various avian species, primarily due to dietary exposure to TPCB in CM 2+ and the tributaries.
  - HQs ranging from less than 1 to greater than 1 were calculated for bivalves, polychaetes (*Nereis virens*), blue crab (*Callinectes sapidus*), striped bass (*Morone saxatilis*), and mummichog (*Fundulus heteroclitus*), primarily due to exposure to TPCB, with some limited contribution from dioxins/furans and Cu.

- **Reference areas**
  - For the Phase 2 reference areas, potential risks were identified for blue crab, striped bass, and mummichog, primarily due to exposure to TPCB, with some limited contribution from dioxins/furans. The presence of ecological risks in the reference areas suggests that regional exposure for migratory fish and crab species need to be considered when evaluating risk management options for Newtown Creek.

It is important to note that migratory species such as striped bass, blue crab, and Atlantic menhaden (*Brevoortia tyrannus*) are exposed to contaminants both within and outside the Study Area, including exposure within and beyond the New York Harbor region. Striped bass and blue crab are the primary species consumed by recreational anglers and crabbers, whereas Atlantic menhaden, mummichog, and benthic invertebrates represent components of their food webs. TPCB in striped bass and TPCB and dioxins/furans in blue crab are the primary CERCLA hazardous substances driving potential human health risk. Moreover, both chemicals are bioaccumulative. Because TPCB is the primary risk driver in both species, TPCB is the primary focus of the evaluation of bioaccumulation and biomagnification throughout the Study Area food web. The relative contributions of Study Area and regional sources to TPCB in fish and crabs collected in Newtown Creek are an important consideration for remedial decision-making.

Key Findings and Conclusions

A key finding of this RI is that the reaches of the Study Area (CM 0 – 2, CM 2+, and each tributary) differ materially in physical characteristics, contaminant distributions, sources of solids and contaminants, relative contributions of historical versus ongoing sources, fate and transport processes, and risk. Those differences will play an important role in identifying, developing, and assessing remedial alternatives in the FS.

The nature and extent of contamination within the Study Area is affected by influences that include the following: historical and ongoing discharge, transport, and deposition of contaminants and solids from point sources; surface water and solids exchange with the East River (due to the tides); mixing (due to biological activity within the surface sediment [i.e., bioturbation]); episodic storm events that primarily affect the tributaries near the large outfalls; and marine vessel traffic, which also acts as a sediment mixing process. These influences contribute to the following notable observations of the nature and extent, sources, and fate and transport of contaminants (represented by TPAH [17], TPCB, and Cu) in the Study Area:

- **CM 0 – 2**
  - Concentrations of TPAH (17), TPCB, and Cu in surface sediment in CM 0 – 2 are generally the lowest in the Study Area and are consistent with (or approaching) reference areas, based on data from reference areas similar to Newtown Creek. Surface sediments are stable due to low current velocities. Concentrations tend to increase with depth in the subsurface sediment and are low in underlying native materials. Deposition of solids in this reach is primarily from East River tidal exchange. These solids mix with the existing shallow surface sediments that have been influenced by historical and ongoing sources typically found in urban, industrialized waterbodies. NAPL was only observed in subsurface sediments and has been demonstrated to be immobile. Minimal gas ebullition and sheen blossom formation have been observed in CM 0 – 2 during field surveys. Toxicity to benthic macroinvertebrates and risks to other ecological receptors such as fish and crab in CM 0 – 2 are similar to those in the four Phase 2 reference areas, with some exceptions. Surface water concentrations overlap with East River concentrations.

- **CM 2+**
  - Concentrations of TPAH (17), TPCB, and Cu in surface sediment are higher than in CM 0 – 2 and are above reference area concentrations. Concentrations tend to increase with depth in subsurface sediment and are generally lower in the native material. Solids deposited from CSOs and MS4s, stormwater inputs and runoff, and to some extent from East River tidal exchange, become mixed within the surface sediment layer via biological and physical processes, resulting in a blend of previously deposited and currently depositing contaminants in the surface sediment. NAPL was observed in several portions of the Turning Basin in subsurface sediment and native material, and less frequently in surface sediment. Areas of gas ebullition and sheen blossom formation were observed in the Turning Basin along the Brooklyn and Queens shorelines at water depths less than 6 meters. Toxicity to benthic macroinvertebrates and risks to other ecological receptors, such as fish and crab, are greater than in the Phase 2 reference areas. Toxicity to benthic macroinvertebrates at some locations cannot be attributed solely to porewater contaminant concentrations, but may be influenced by other stressors including low dissolved oxygen (DO), elevated porewater sulfide, and bulk sediment concentrations of complex hydrocarbon mixtures.
- **Tributaries**
  - Major CSOs present at the heads of English Kills, East Branch, Maspeth Creek, and Dutch Kills are the primary source of solids to the tributaries. Large MS4 outfalls are also located in the tributaries. Surface sediment exhibits very high total organic carbon (TOC) levels, primarily due to discharges of solids from CSO and MS4 point sources, but are also affected by influences from historical sources (both municipal and industrial). Concentrations of TPAH (17), TPCB, and Cu in surface sediment are generally higher than in CM 0 – 2 and are above reference area concentrations. Concentrations tend to increase with depth in subsurface sediment, but are lower in the native material. In Maspeth Creek, East Branch, and upper English Kills, NAPL was only observed in a few cores as residual NAPL. In a localized area within lower English Kills, NAPL was observed in coarse-grained beds in subsurface sediment and native material. Areas of gas ebullition and sheen blossom formation were observed in each of the tributaries.

> More widespread gas bubbles were observed in the tributaries, where the TOC is higher and water depths are generally shallower than in the main stem. Toxicity to benthic macroinvertebrates and risks to other ecological receptors such as fish and crab are greater than in the Phase 2 reference areas. Toxicity to benthic macroinvertebrates cannot be attributed solely to porewater contaminant concentrations, but may be influenced by other stressors including low DO, elevated porewater sulfide, and bulk sediment concentrations of complex hydrocarbon mixtures.

In summary, surface sediment contamination drives the ecological and human health risks within the Study Area. Due to the continuous deposition of sediments in the Study Area that are representative of inputs from sources consistent with an urban industrialized environment, reference area levels of CERCLA hazardous substances and other contaminants will reaccumulate in surface sediments, even after remedial action is undertaken. While the CERCLA process needs to consider the protection of human health and the environment, appropriate long-term equilibrium conditions in the Study Area must be established and factored into remedial decision-making where risk-based levels are not achievable due to the influence of ongoing external inputs of contaminants to the Study Area and in-creek processes that influence the nature and extent and fate and transport characteristics of these contaminants. There are characteristics associated with Newtown Creek, such as the physical structure, surrounding land uses, and hydrodynamic and sediment transport dynamics that are important to recognize when establishing long-term equilibrium conditions in Newtown Creek.

Specifically, conditions in Newtown Creek will continue to reflect ongoing external inputs to the Study Area that include, but are not limited to, tidal flows from the East River, point source discharges, overland stormwater flow, and other sources (such as atmospheric deposition, overwater activities, shoreline erosion, lateral groundwater discharge, and shoreline seeps [including bulkhead NAPL seeps]), which may have influences on more localized scales. Developing an understanding of long-term equilibrium conditions in Newtown Creek requires, to some degree, a comparison to conditions in waterbodies that are similar to Newtown Creek, but that are not influenced by the site-specific releases of hazardous substances and other contaminants that are the focus of the RI/FS process being conducted in the Study Area. Understanding regional conditions, in addition to understanding the contribution of ongoing external inputs to the Study Area, is necessary to understand possible future conditions of Newtown Creek.

Specifically with respect to risk to human health from consumption of fish and crab, the species consumed by people in the Study Area and used to represent human exposure in this risk assessment—namely, striped bass, white perch, and (to a lesser extent) blue crab—exhibit wide-ranging movement and are exposed to contamination present in the wider New York-New Jersey urban area. Furthermore, the food web of striped bass, white perch, and blue crab species may also be wide-ranging or largely water column-based, meaning that the base of the food web (smaller fish, phytoplankton, and zooplankton) likely accumulates contaminants from outside, as well as within, the Study Area.

PCB is the primary COPC that contributed to both cancer risk and noncancer hazard estimates in the Study Area and in the Phase 2 reference areas. These Phase 2 reference area results, along with an understanding of species migration and movement, indicate that fish and crab exposure to COPCs occurs on a regional scale, and COPCs in the species consumed by people fishing and crabbing in the Study Area likely originate in a wider regional urban area beyond just the Study Area boundaries. These regional-scale cancer risks and noncancer hazards are in the upper end of the USEPA acceptable risk range or above the USEPA acceptable risk range and exceed the hazard index threshold of 1. The cancer risks and noncancer hazards calculated for the Phase 2 reference areas provide one estimate of regional risks that could be present in the absence of Study Area-related contamination. Because of this, regional fish and crab consumption advisories currently in place that include Newtown Creek may persist in the future regardless of remedial actions completed in the Study Area.

Specifically with respect to ongoing external inputs, the East River and various point sources will continue to contribute a significant load of contaminants that are common in urban environments like Newtown Creek and the surrounding greater New York Harbor area even after any future sediment remediation. In comparison, contaminant loadings from lateral groundwater discharge and other non-point sources such as shoreline seeps and eroding shorelines are currently interpreted to be lesser contributors of these constituents to surface sediment based on available information, although they have not been directly quantified and some will be evaluated further in the FS. In addition, some upland properties may potentially contribute these constituents to the Study Area. The FS will need to evaluate the potential for the ongoing contribution of contaminants and other constituents as part of the remedy evaluation process, consistent with USEPA's first listed risk management principle, which states that significant direct and indirect ongoing sources should be identified and controlled if they have the potential to cause significant recontamination at sediment sites (Horinko 2002). As noted by USEPA guidance, "Identifying and controlling contaminant sources typically is critical to the effectiveness of any Superfund sediment cleanup" (USEPA 2005a). Influences from the East River, CSO and MS4 discharges, other point sources, overland stormwater flows, and other sources will continue over the long term into the creek. Accordingly, remedial alternatives evaluated in the FS need to assess these ongoing contributions, and any potential controls, in the context of the timing of the remedy and its long-term effectiveness. Notwithstanding the extensive dataset compiled during this RI, future investigations undertaken within the boundaries of the Study Area may indicate as yet unidentified sources that will need to be considered as remedial designs move forward.

The RI Report represents a comprehensive study that complies with the AOC entered into with USEPA for this site. The voluminous dataset supports multiple LOEs to characterize the nature and extent of contamination in the Study Area. This work also establishes a solid foundation to evaluate a combination of sustainable remedial approaches to utilize in different portions of the creek to achieve practicable risk reduction and ensure long-term success. The FS for Newtown Creek will utilize the information generated in the RI to evaluate cost-effective and sustainable remedies for Newtown Creek.