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Newtown Creek Remedial Investigation/Feasibility Study

ANCHOR QEA

Quantitative Bounding Evaluation of the Importance of Nonaqueous Phase Liquid Seeps in the East Branch Early Action Area of Newtown Creek

Prepared for the Newtown Creek Group

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Prepared for
The Newtown Creek Group

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ABBREVIATIONS

μg/L	microgram per liter
μm	micrometer
μS/cm	microsiemen per centimeter
AOC	Administrative Order on Consent
C19-C36	C19-C36 aliphatics
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFT	chemical fate and transport
CM	creek mile
COC	contaminant of concern
CSM	conceptual site model
CSO	combined sewer overflow
CSTAG	Contaminated Sediments Technical Advisory Group
D/F	dioxin/furan
DRO	diesel-range organics
EPH	extractable petroleum hydrocarbons
FS	Feasibility Study
FS Gas Ebullition DER	*Feasibility Study Gas Ebullition Data Evaluation Report*
kg/L	kilogram per liter
kg/yr	kilogram per year
LTE	long-term equilibrium
LTE Report	*Interim Estimates of Post-Remedy Surface Sediment Concentrations*
mg/kg	milligram per kilogram
mg/L	milligram per liter
MS4	municipal separate storm sewer systems
NAPL	nonaqueous phase liquid
NAVD88	North American Vertical Datum of 1988
NCG	Newtown Creek Group
NYCDEP	New York City Department of Environmental Protection
NYCDEP NAPL Seep DSR	*2017 Upland NAPL Seep Sampling Data Summary Report*
NYSDEC	New York State Department of Environmental Conservation
OPA	oil-particle aggregate
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl

PRG	preliminary remediation goal
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RI Report	*Remedial Investigation Report*
TPAH (34)	total polycyclic aromatic hydrocarbon (34)
TPCB	total polychlorinated biphenyl
TPH	total petroleum hydrocarbons
TSS	total suspended solids
USEPA	U.S. Environmental Protection Agency

Executive Summary

Understanding the significance of ongoing sources to Newtown Creek is important to inform remedial decision-making to provide a perspective on expectations during long-term monitoring following remedy implementation. Nonaqueous phase liquid (NAPL) seeps emanating from bulkheads and shoreline areas along Newtown Creek are one of several expected ongoing sources of contaminants of concern (COCs) that the Remedial Investigation/Feasibility Study (RI/FS) has attempted to quantify to help inform that decision-making. Some stakeholders have hypothesized that contaminant loadings from seeps are important relative to other ongoing external sources of contamination and introduce contaminants into the creek that have the potential to adversely affect sediment quality.

Various surveys have been conducted by several stakeholders, including the Newtown Creek Group (NCG), to map the location of seeps and document their presence using still photography and video, as well as sample for chemical analysis either the seep fluid directly or the surface water adjacent to the seep. Although these surveys have generated some useful information regarding the presence and chemical concentrations of these seeps, the information is insufficient to calculate mass loadings of contaminants from these seeps over time because no seep volumetric discharge rate measurements have been concurrently performed. Therefore, it remains an open question whether these seeps represent an important source of contaminants to the sediments of the creek and whether they could negatively impact any sediment-based remedy implemented in the creek.

Although the available information is insufficient to calculate mass loading from seeps to the creek, this report uses the information that has been gathered to date, whether collected formally as part of the RI/FS process or not, to evaluate whether seeps are important relative to other contaminant sources and relative to the potential for recontamination of remediated sediment. This report focuses on East Branch, because the proposed Early Action in East Branch will represent the first active remedial action in the creek arising from the Superfund process.

The NCG developed this report to present a quantitative approach to bound the mass loading of NAPL seeps in remedial design planning for the East Branch Early Action using existing data and the project's long-term equilibrium (LTE) model. This report presents the following:

- A conceptual site model of the fate and transport of NAPL seeps that enter Newtown Creek
- A brief summary of available seep-related sampling efforts performed by various entities
- A discussion of the comparability of the available seep-related surveys and data, including initial interpretation of the sampling results
- A quantitative bounding analysis to evaluate the potential importance of NAPL seeps in East Branch using available data and the LTE model developed for the project

NAPL Seep Conceptual Site Model

Shoreline seeps (fluid emerging from the shoreline) and bulkhead seeps (fluid observed flowing out from bulkheads around joints, bolts, cracks, or holes) may be due to a localized area of discharge of shallow groundwater, bank storage (creek water that inundates fill materials, natural soils, gaps, or voids behind bulkheads during high tide and then drains back to the creek via gravity when the tide recedes), or NAPL, or a combination of these fluids. These seeps may introduce contaminants to the surface water and ultimately the sediment bed.

When NAPL reaches the water surface via a seep, it disperses, and depending on the physical properties of the NAPL and the quantity present, the NAPL either breaks into small droplets or transitions to a thin sheen on the water surface. Surface water NAPL and sheen can subsequently break down by photodegradation, biodegradation, volatilization, and dissolution of sheen constituents into the surface water. NAPL dispersed in or on the surface water as discrete droplets or residual sheen may aggregate with solid particles (oil-particle aggregates) suspended in or on surface water, causing some portion of the NAPL to settle through the water column and deposit on the sediment bed.

In addition to seeps emanating from shorelines or bulkheads, it is important to recognize that there are multiple other pathways for NAPL or observed sheen to be introduced to the surface water. These include gas ebullition; point sources (e.g., combined sewer overflows and municipal/industrial stormwater discharges) and overland flows that discharge to the surface water; overwater activities, such as releases from vessels; and spills and illegal dumping.

Existing Seep-Related Data

Multiple seep surveys and sampling events have been conducted within the Study Area by different entities. Seep observations and sampling have been conducted for both NAPL seeps and seeps that do not appear to contain NAPL (i.e., aqueous seeps). The various seep studies include differences in the media sampled and sampling methods; some are affected by sampling artifacts and data quality issues that preclude direct comparisons of the data. The available contaminant concentration data were compared, accounting for the differences in sampling media and methods and data quality limitations, to interpret the results. These comparisons were made for the following analytes and had the following findings (provided in bold font):

- Total polycyclic aromatic hydrocarbon (34) (TPAH [34]) was evaluated because this COC has been well studied during the RI/FS, it has a preliminary remediation goal, and polycyclic aromatic hydrocarbons (PAHs) make up a fraction of the hydrocarbons that compose NAPL at the site. **Approximately two-thirds of the seep or nearshore surface water samples collected have a TPAH (34) concentration within the range of RI/FS dry weather surface**

water TPAH (34) concentrations, indicating that overall potential seep loadings of PAHs are not significant.

- Chloride and conductivity were evaluated for aqueous seep samples because elevated chloride and conductivity are indicative of bank storage of brackish or saline surface water draining out of shoreline areas at low tide, whereas freshwater seeps are indicative of fresh groundwater seeping into the Study Area. **This evaluation indicates that many of the sampled seeps likely reflect bank storage, with the remainder likely reflecting a mixture of fresh groundwater and bank storage.**

Quantitative Evaluation of the Significance of NAPL Seeps

Quantifying mass loadings of contaminants associated with seeps is necessary to assess the relative importance of seep-related COCs and determine if seep loading should be considered in remedial decision-making. None of the seep surveys performed to date have included measurement of seep volumetric discharge rates; therefore, the NAPL and COC mass entering the Study Area from seeps cannot be quantified. To evaluate whether seep-related loadings are important from a remedial decision-making perspective, a quantitative bounding evaluation was performed using available data and the LTE model (Anchor QEA 2023). The quantitative bounding evaluation was performed to estimate the COC load associated with NAPL seeps that would be needed in East Branch to meaningfully increase the TPAH (34) LTE concentration such that NAPL seeps would have to be addressed prior to the East Branch Early Action remedy implementation.

The seep TPAH (34) load to East Branch was incrementally increased in the LTE model until the upper-bound LTE concentration predicted in East Branch exceeded the preliminary remediation goal of 100 milligrams per kilogram. The resulting hypothetical additional TPAH (34) load in East Branch from this bounding simulation was found to be 36 kilograms per year (kg/yr). This hypothetical additional NAPL seep load was compared to existing data to contextualize the load relative to other TPAH (34) or NAPL sources to East Branch as follows (with findings provided in bold font):

- First, the hypothetical additional NAPL seep load of 36 kg/yr TPAH (34) was compared with the annual TPAH (34) loads associated with fate and transport processes and other external sources quantified as part of the RI/FS. **This comparison shows that the hypothetical additional TPAH (34) NAPL seep load would need to be larger than all other TPAH (34) loads to East Branch surface water, combined, which is implausible**.
- Second, the potential volume of NAPL that would need to enter East Branch surface water from seeps each year to produce the hypothetical TPAH (34) load of 36 kg/yr was calculated to be 530 gallons per year. The estimated NAPL flow rate to East Branch from gas ebullition is 8 to 38 gallons per year; the estimated NAPL flow rate to the entire Study Area from gas ebullition is 44 to 380 gallons per year. **Thus, to be considered a significant recontamination source in East Branch, the annual volume of NAPL from seeps in**

East Branch would need to be greater than that which has been measured for gas ebullition within the entire Study Area, a scenario that is also implausible.

- Third, the surface area of sheen resulting from the hypothetical NAPL discharge of 530 gallons per year would create approximately 1.1 to 6.8 acres of sheen in East Branch during every low tide cycle. **Such an extensive and frequent sheen has never been observed in Each Branch, again indicating that this NAPL loading rate is implausible**.
- Finally, this hypothetical additional TPAH (34) load can be contextualized for the case of aqueous seeps (with no observable NAPL) by estimating the theoretical discharge volume of water necessary to produce a TPAH (34) load of 36 kg/yr. This evaluation shows that the continuous seep flow rate would need to be approximately 23 gallons per minute (of water containing dissolved phase COCs) for each of the 10 observed seeps in East Branch. **Although volumetric seep flow rates have not been measured, none of the field observations, photographs, or videos of observed seeps indicate seep discharge rates even close to this magnitude occurring anywhere in East Branch.**

Conclusions

Based on the qualitative information available and bounding calculations that were performed, the NCG concludes that claims cannot be made that NAPL seeps are a potential significant source to East Branch. Multiple lines of evidence, including comparative data analysis and bounding model calculations, support the NCG's interpretation that NAPL seeps are a relatively minor source that do not represent a potential for significant sediment recontamination that could affect remedial decision-making.

1 Introduction

On July 12, 2023, the U.S. Environmental Protection Agency (USEPA) met with its Contaminated Sediments Technical Advisory Group (CSTAG) in New York City to discuss the East Branch Early Action for the Newtown Creek Study Area.[1] During this meeting, there were discussions and questions by stakeholders regarding prior and current observations of nonaqueous phase liquid (NAPL) seeps emanating from bulkheads or shoreline areas and the potential significance of such seeps as an ongoing loading of contaminants to the sediments. Multiple stakeholders presented their observations and information on seeps in the Study Area (many of which were not located in East Branch) and claimed that NAPL seeps could negatively impact the East Branch Early Action sediment remedy.

The Newtown Creek Group (NCG) does not agree that such claims regarding NAPL seeps as a potential significant source to East Branch (or Newtown Creek as a whole) can be supported based on the information available and presented to-date. The information presented during the CSTAG meeting is largely based on qualitative visual observations (i.e., still photographs and videos) and lacks quantitative evaluations of the potential mass loadings of contaminants associated with these seeps. In an attempt to address that issue, the NCG has conducted a quantitative bounding evaluation to help facilitate understanding and discussion as to whether NAPL seeps emanating from bulkheads or shoreline areas could negatively impact a sediment remedy.

There have been surveys of seeps in Newtown Creek conducted by multiple entities, including the NCG (as part of the ongoing Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] action, under USEPA supervision), the New York City Department of Environmental Protection (NYCDEP), the New York State Department of Environmental Conservation (NYSDEC), and USEPA. These surveys have all had differing objectives, addressed differing sampling media, and used differing sampling methods in many cases. There has been no effort, until now, to attempt to coalesce these surveys and resulting data into a single unified quantitative interpretive evaluation of the potential significance of NAPL seeps as a source of contaminant loading.

This report presents an approach to quantitatively bound the mass loading of NAPL seeps in remedial design planning for the East Branch Early Action using existing data and the project's

[1] The Remedial Investigation (RI) and the subsequent Feasibility Study (FS) for the Newtown Creek Study Area are being performed under an Administrative Order on Consent (AOC) entered into with USEPA. 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.

long-term equilibrium (LTE) model. The framework of this approach could also be applied to other reaches of Newtown Creek. This report presents the following:

- A conceptual site model (CSM) of the fate and transport of NAPL seeps that enter Newtown Creek
- A brief summary of available seep-related sampling efforts performed by various parties
- A discussion of the comparability of the available seep-related surveys and data, including initial interpretation of the sampling results
- A quantitative bounding analysis to evaluate the potential importance of NAPL seeps in East Branch using available data and the LTE model documented in the *Interim Estimates of Post-Remedy Surface Sediment Concentrations* (LTE Report; Anchor QEA 2023a)

Evaluations of ongoing external sources to the Study Area have shown that the East River and point sources would be the largest contributors of contaminants of concern (COCs) to post-remedy sediments in East Branch. The evaluations presented herein demonstrate that NAPL seeps, although observed within the Study Area, represent a comparatively minor source of COC loadings to surface sediment in East Branch and the rest of the Newtown Creek Study Area. Multiple lines of evidence, including comparative data analysis and bounding model calculations, support the conclusion that NAPL seeps do not represent a significant sediment recontamination source that could affect remedial decision-making. This is not to say that seeps should not be addressed by the parties responsible for the seeps, but simply that seeps are a relatively small source of contaminants that should not negatively impact a sediment remedy.

2 NAPL Seep Conceptual Site Model

The following discussion focuses on aspects of the Newtown Creek CSM that relate to NAPL seeps.

A variety of physical and chemical processes that influence the fate and transport of contaminants, including NAPL, in Newtown Creek, have been investigated during the Remedial Investigation/Feasibility Study (RI/FS), as discussed in detail in Section 6 of the *Remedial Investigation Report* (RI Report; Anchor QEA 2023b), the *Feasibility Study Gas Ebullition Data Evaluation Report* (FS Gas Ebullition DER; Anchor QEA 2022a), and the *Feasibility Study Nonaqueous Phase Liquid Mobility Data Evaluation Report* (Anchor QEA 2022b).

East Branch, like the rest of Newtown Creek, is a highly engineered waterbody that was almost entirely bulkheaded by the early 1900s. Approximately 80% of the shoreline within East Branch is currently bulkheaded, with nearly all the remaining shorelines containing riprap or other armoring. Shoreline seeps (fluid emerging from the shoreline) and bulkhead seeps (fluid observed flowing out from bulkheads around joints, bolts, cracks, or holes) may be due to a localized area of discharge of shallow groundwater, bank storage, or NAPL, or a combination of these fluids. Seeps due to bank storage occur when creek water that inundates fill materials, natural soils, gaps, or voids behind bulkheads during high tide drains back to the creek via gravity when the tide recedes. Seeps are potential ongoing sources of contaminants to the Study Area, particularly if an observed seep includes NAPL being transported from upland sites that may represent an ongoing source to surface water and/or sediments. The focus of this report is to better understand the potential significance of such NAPL seeps.

When NAPL reaches the water surface via a seep, it disperses, and depending on the physical properties of the NAPL and the quantity present, the NAPL either breaks into small droplets or transitions to a thin sheen on the water surface. Surface water NAPL and sheen can subsequently break down by photodegradation, biodegradation, volatilization, and dissolution of sheen constituents into the surface water. As the NAPL or sheen breaks down, the NAPL or sheen may be transported by wind and surface water flow and may eventually be deposited on the sediment bed, as discussed later in this section. The migration process is influenced by surface water currents (summarized in Section 6.2 of the RI Report), wind speed and direction, vessel traffic, and the presence of structures (e.g., shoreline bulkheads or containment booms).

Additionally, the NAPL dissolution process is complex, and often rate-limited, due to the chemical composition of the NAPL, chemical diffusion rates within the NAPL and the surrounding water, conditions that affect dissolution of NAPL constituents at the NAPL-water interface, and other factors (including temperature and salinity). Once present as a dissolved phase, chemical constituents derived from NAPL migrate with surface water flow and are subject to the fate and transport processes that are discussed in Sections 6.4.2 through 6.4.6 of the RI Report and represented in the Newtown Creek chemical fate and transport (CFT) model that is documented in the draft *Chemical Fate and Transport Model Development and Calibration Report* (Anchor QEA 2022c).

NAPL dispersed in (or on) the surface water as discrete droplets or residual sheen may aggregate with solids particles suspended in (or on) surface water, forming oil-particle aggregates (OPAs; USGS 2015). When the particles adhere to the oil droplet, the resulting OPAs become denser than water, causing them to sink within the water column and deposit onto the sediment bed. Following deposition of the OPAs, chemical constituents of the OPAs can be dissolved into the sediment porewater through the NAPL dissolution process and are subject to the various fate and transport processes affecting surface sediment that are discussed in Section 6.4 of the RI Report.

In addition to seeps emanating from shorelines or bulkheads, it is important to recognize that there are multiple other pathways for NAPL or observed sheen to be introduced to the surface water. These include the following (discussed in more detail later in this paragraph): gas ebullition, point sources (e.g., combined sewer overflows [CSOs] and municipal/industrial storm water discharges) and overland flows that discharge to the surface water, and overwater activities such as releases from vessels, as well as illegal spills and dumping.

Gas ebullition, including associated contaminant and NAPL flux, has been studied and quantitatively characterized in Newtown Creek through multiple field surveys and subsequent analysis (see Appendix D of the RI Report and the FS Gas Ebullition DER [Anchor QEA 2022a]).

Sheens have been observed discharging from outfalls during rain events (see Section 6.4.7.5 and Appendix D of the RI Report). In addition, the NCG performed a pipe sheen investigation in 2017 during which sheens were observed emanating from CSOs and municipal separate storm sewer systems (MS4s) during storm events. The sheens entering the creek from CSOs and MS4s contained contaminants, such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and metals. Concentrations of PAHs were measured in every sheen sample collected from the CSOs (Bridgers 2017). Illegal dumping of oil into stormwater drains has been reported (see RI Report Section 3.2.11). In addition, direct discharge into Newtown Creek may occur during overwater operations and discharges from vessels (e.g., gray, bilge, and ballast water), fuel releases, and spills during loading or unloading of cargo operations. Anecdotal reports of sheens on surface water associated with idling vessels passing through the Study Area have been reported.

Finally, although the focus of this report is to better understand the potential significance of NAPL seeps, seeps without observations of NAPL (referred to hereafter as aqueous seeps) are discussed as well, because they have been identified in surveys conducted to-date and can also be a source of COCs to the surface water. It must be recognized that an aqueous seep may merely be a localized area where lateral groundwater discharge is readily observable or flowing at a relatively higher rate due to heterogeneity in the geological properties of the bank or shoreline materials. Aqueous seeps observed at low tide conditions may result from bank storage or lateral groundwater discharge or a combination of both.

3 Existing NAPL Seep Information

3.1 Summary of Existing Seep Surveys and Samples

Multiple seep surveys and sampling events have been conducted within the Study Area by different entities; these are summarized in the following subsections. Seep observations and samples include both NAPL seeps (where NAPL or sheen are observed) and aqueous seeps (where NAPL or sheen was not observed).

3.1.1 Remedial Investigation/Feasibility Study Field Investigations (NCG)

No NAPL seeps were documented during the Phase 1 and 2 Remedial Investigation (RI) field activities. Bulkhead seeps with no visual indication of contamination (i.e., aqueous seeps) were observed during the Phase 1 dry weather surveys and other RI field work. The aqueous seeps were typically observed within the intertidal zone and may have been associated with bank storage. During the 2016 gas ebullition survey, a sheen was observed emanating from a bulkhead in the main stem of Newtown Creek. However, in 2019, a new sheet pile wall was installed adjacent to that sheen observation, eliminating the potential for seeps in this area.

During the Feasibility Study (FS) Part 1 shoreline sediment sampling program, 10 seeps with no visual indication of NAPL or other contamination (i.e., aqueous seeps) were identified along four shoreline properties located in creek mile (CM) 2+ or English Kills. These aqueous seeps were located between elevation 0.8 and -1.4 feet North American Vertical Datum of 1988 (NAVD88) and were often only visible within 1 or 2 hours of low tide. Opportunistic samples of the seep fluid (i.e., aqueous samples) were collected at these locations and submitted for chemical analysis that included PAHs, PCBs, pesticides, dioxins/furans (D/F), and total petroleum hydrocarbons (TPH; C9-C40).

No aqueous or NAPL seeps were observed in East Branch during the RI or FS Part 1 field activities. Additional details regarding RI/FS field investigations of seeps are provided in Section 5.7 of the RI Report. These data collected as part of the RI/FS process were used in the development of the Newtown Creek CSM and are being used in FS evaluations such as LTE modeling.

3.1.2 NYCDEP NAPL Seep Surveys

From September to December 2016, NYCDEP conducted a series of surveys during spring low tides (when there is the greatest difference between high- and low-tide elevations)[2] to identify sites where NAPL seeps were occurring. During these surveys, observers documented, photographed, and video-recorded NAPL seeps throughout the Operable Unit (OU) 1 Study Area. A sampling program was then conducted during five sampling events in fall 2017 to collect data on chemical

[2] The greatest difference between high- and low-tide elevations during spring low tides only occurs for several hours a day for a few days out of each month (twice each lunar month).

concentrations of NAPL collected. NYCDEP summarized the field activities and presented the findings of these surveys and sampling events in the *2017 Upland NAPL Seep Sampling Data Summary Report* (NYCDEP NAPL Seep DSR; NYCDEP 2020).

A total of 44 NAPL samples and field quality control samples were collected using a glass jar or a sheen net from NAPL seeps at 11 upland sites and from in-creek structures located in the main stem of Newtown Creek, East Branch, and English Kills. Samples were collected only from those properties and structures where NAPL seeps were documented during the sampling period, and the NAPL samples were analyzed for PAHs, PCBs, pesticides, D/F, total organic carbon, black carbon, extractable petroleum hydrocarbons (EPH; EPH ranges as C9-C18 aliphatics, C19-C36 aliphatics [C19-C36], and adjusted and unadjusted C11-C22 aromatics), and TPH-diesel range organics (DRO) as three fractions: C10-C28 DRO, C28-C36 Extended DRO, and C36-C44 Heavy DRO. The sample results were reported on a mass of analyte per unit mass of NAPL basis and therefore represent a compositional analysis of the NAPL. In addition, three baseline sheen net samples were collected from nearby surface water where NAPL was not visible (approximately 20 to 60 feet from the observed NAPL seep location) to assess the potential presence of NAPL in areas close to the NAPL seep sampling location.

In East Branch, NAPL seeps were sampled at four upland properties (Feldman Metropolitan, Amboy Bus Co., Western Beef, and the East Branch Bridge).[3] Figure 1a presents a map excerpt from the NYCDEP NAPL Seep DSR (NYCDEP 2020), focused on East Branch, which shows the NYCDEP NAPL seep sampling locations. Additional details and the results of the 2017 NYCDEP seep survey and sampling are provided in the NYCDEP NAPL Seep DSR (NYCDEP 2020). These data were not collected under a USEPA-approved work plan, so they are not part of the RI/FS dataset.

3.1.3 NYSDEC Upland Seep Surveys

As part of an evaluation of upland properties in Newtown Creek, NYSDEC conducted visual seep surveys and sampling during multiple events between August and September 2021 and September and October 2022, with an additional event planned for August 2023. Each visual survey was conducted during a spring low tide. Seeps that appeared to be emanating from the shoreline or from behind a shoreline structure (e.g., bulkhead) were documented and photographed. NAPL observations associated with a seep location were also documented. Text from the *Upland Site Characterization Report* (HRP 2023) indicates that aqueous seeps (with no visual observation of NAPL) were observed on multiple occasions at 42 locations within the OU1 Study Area, and NAPL seeps were observed on multiple occasions at 8 locations in 2021 and 2 locations in 2022. A total of

[3] Based on locations labeled as "Potential NAPL Seep" on Figure 2-1 of the NYCDEP NAPL Seep DSR, NAPL seeps may have been observed but not sampled at two other properties (Department of Small Business – 47th Street and Maspeth Concrete Loading). However, the text does not explicitly state whether NAPL seeps were actually observed at these "Potential NAPL Seep" locations.

48 to 56 (the exact number is unclear in the report) aqueous samples of seeps (with or without visual observations of NAPL) were collected from locations where seeps were observed a second time, and samples were analyzed for PAHs, PCBs, pesticides, D/F, DRO, copper, lead, EPH and TPH, and total suspended solids (TSS).[4] These aqueous samples (for seep locations with or without visual observations of NAPL) were collected either from the seep fluid itself or from surface water near the seep, using a series of methods that were changed and refined with each sampling iteration. In addition to aqueous samples, sheen nets were used to collect samples at each seep location (with or without visual observations of NAPL), and results were reported on a chemical mass per sheen net basis. Finally, several surface water samples (referred to as background) were collected away from the shorelines and seep locations (e.g., mid-channel) to quantify existing surface water concentrations.

Figure 1b presents a map from the *Upland Site Characterization Report* (HRP 2023), focused on East Branch, which shows NYSDEC's observed aqueous and NAPL seep and sampling locations.[5] In East Branch, a seep with no observation of NAPL was observed twice in 2021 adjacent to the MTA-New York City Transit site, and surface water near the seep was sampled (sample EB-03 on Figure 1b). A seep with no observation of NAPL was observed twice in 2022 adjacent to Mione Transit Mix, and the seep water was sampled (samples 22-EB-03 and 22-EB-03-R in Figure 1b).

Additional information and the results of the NYSDEC surveys are provided in the *Seep Investigation Data Summary Report* (HRP 2022) and *Upland Site Characterization Report* (HRP 2023). These data were not collected as part of the RI/FS process under the oversight of USEPA; the focus of the seep surveys was on screening upland sites rather than understanding the potential influence of seeps on Newtown Creek surface water and sediments. NYSDEC is conducting an additional survey during late August 2023.

3.1.4 USEPA Survey

USEPA is currently implementing a field program with the objective of improving the understanding of, and better quantifying, shallow lateral groundwater discharge to the Study Area (CDM Smith 2022). USEPA (Schmidt 2023) provided a preliminary summary of the shoreline reconnaissance and opportunistic seep samples that were collected in May 2023 as part of this field

[4] The *Upland Site Characterization Report* (HRP 2023) does not present a clear summary of which of the observed seeps were sampled or the total number of samples. Therefore, the number of seep samples is presented as a range based on evaluating the text, tables, and figures presented in the *Upland Site Characterization Report* (HRP 2023). The maps in that report present sample locations and NAPL observations, but the total number of samples with NAPL observations does not appear to be consistent with the 10 observed NAPL seeps discussed in the report text. In addition, it is not clear which sample media were collected for chemical analysis in the case of the observed NAPL seeps (e.g., was only aqueous seep water targeted for collection, or was the observed NAPL targeted to be collected in the sample container?).

[5] Figure 4E of the *Upland Site Characterization Report* (HRP 2023) shows some locations where NAPL was observed but do not indicate that a seep was observed as well (e.g., location EB-05). The text states, "If during this review a potential NAPL observation could not be associated with a potential seep location, the NAPL observation was not sampled." Therefore, from this text it is interpreted that the three locations identified as NAPL without seep observations in East Branch in Figure 4E of the *Upland Site Characterization Report* (HRP 2023) are not associated with seeps.

program. A total of nine aqueous seep samples were collected in Newtown Creek during these efforts. Samples were analyzed for semivolatile organic compounds, PAHs, PCBs, D/F, metals, EPH, volatile petroleum hydrocarbons, TSS, total dissolved solids, chloride, total organic carbon, and dissolved organic carbon. NAPL was not observed at any of the seep locations. One aqueous seep was observed and sampled in East Branch (see Figure 1c).

The samples for this USEPA survey are being collected as part of the RI/FS process and will be incorporated into future evaluations, as appropriate, once the data are available. USEPA has indicated a more extensive summary will be provided in a forthcoming data summary report.

3.2 Comparability and Interpretation of Seep Sampling Data

3.2.1 Data Comparability

Differences exist in the media sampled and sampling methods used among the surveys described in the preceding section. The different types of sampling media are as follows:

- Direct samples of seep fluid were collected, including samples of both NAPL seeps and aqueous seeps with no observable NAPL. These included the following:
  - The RI/FS opportunistic seep samples, which were all aqueous seeps
    - Sample analytic data were reported as aqueous concentrations (mass per volume of water).
  - The NYCDEP NAPL seep samples, which sampled NAPL itself and reported concentrations on a mass of chemical per mass of NAPL basis
  - A subset of the NYSDEC samples, which included seeps with and without observations of NAPL
    - Sample analytic data were reported as aqueous concentrations (mass per volume of water).
  - The USEPA samples, which were all aqueous seeps (data forthcoming)
    - Sample analytic data are expected to be reported as aqueous concentrations (mass per volume of water).
- Surface water samples were collected near the observed discharge point of a seep. These samples were collected by NYSDEC for a subset of the locations and sampling events. Although these were collected to characterize the seep, they represent a localized condition of the seep fluid mixed with nearshore surface water within the creek.
- Background surface water samples were collected by NYSDEC away from the shoreline and seeps to characterize existing surface water conditions. These were collected generally mid-channel, like the surface water sampling conducted for the RI.
- Sheen net samples (of both NAPL from seeps and surface water in areas where NAPL was not observed) were collected by both NYCDEP and NYSDEC. These report mass of chemical per net.

In addition to differences in the sampling media, sampling artifacts and data quality issues were documented for the NYSDEC samples, further making a direct comparison challenging. The 2021 NYSDEC sampling included mostly surface water samples collected immediately adjacent to seeps and reported increased turbidity and elevated TSS concentrations, suggesting the sampling methodology used likely entrained solids in the samples. The 2022 NYSDEC sampling methods were modified to reduce the potential for entrainment of solids, and NYSDEC reported, "with each round of sampling, entrained solids and turbidity was reduced, resulting in generally lower concentrations of analytes in samples collected" (HRP 2023). However, elevated solids were still observed in some samples (especially those taken in the September 2022 sampling event). The sampling methods used for the October 2022 survey are planned to be used in 2023 according to NYSDEC's work plan (HRP 2023). Additionally, NYSDEC encountered significant laboratory data quality issues with all the 2022 samples, which resulted in data validators rejecting all results for alkylated PAHs, C9-C40 aliphatics, TPH, n-alkanes, and isoprenoids.

3.2.2 Preliminary Data Interpretation

The available concentration data from the various seep surveys were compared, accounting for the differences in sampling media and methods discussed in Section 3.2.1, to interpret the results. These comparisons were made for the following analytes:

- Total polycyclic aromatic hydrocarbon (34) (TPAH [34]) was evaluated because this COC has been well studied during the RI/FS, it has a preliminary remediation goal (PRG; Anchor QEA 2021; USEPA 2023), and PAHs make up a fraction of the hydrocarbons that compose NAPL at the site.
- Chloride and conductivity were evaluated for aqueous seep samples because these analytes provide a means of differentiating the source of seep water (i.e., brackish to saline tidal creek water typically associated with bank storage versus fresh groundwater).

3.2.2.1 TPAH (34)

NYCDEP measured TPAH (34) in NAPL seep samples on a per-mass of NAPL basis. As expected, the reported concentrations of TPAH (34) in NYCDEP NAPL samples are relatively high, given PAHs are a component of the hydrocarbons that compose NAPL. The TPAH (34) concentrations in East Branch NAPL samples ranged from <0.1% by weight to 30% by weight, with a median value of 2% by weight (i.e., approximately 20,000 milligrams of TPAH (34) per kilogram of NAPL).

TPAH (34) concentrations measured in aqueous seep samples are much lower. Due to the limited number of samples in East Branch, the following evaluation is based on data in Newtown Creek as a whole.[6] The aqueous seep samples from the RI data and NYSDEC surveys have TPAH (34) concentrations that range from less than 0.1 up to 98 micrograms per liter (µg/L). The NYSDEC

[6] This analysis excludes the TPAH (34) data from the NYSDEC surveys with rejected data (2022 samples) due to data quality issues.

nearshore surface water samples collected near the observed discharge point of seeps have a similar range of TPAH (34) concentrations from less than 0.1 to 240 µg/L. The samples with the highest TPAH (34) concentrations are from the NYSDEC surveys and also have elevated TSS concentrations, which indicates that these samples may contain solids disturbed and entrained into the water sample during collection, as reported by NYSDEC (HRP 2023). The solids likely include sorbed contaminants, which can bias the measured contaminant concentration above what may be truly representative of what is dissolved in the seep water. The highest TPAH (34) concentration from a location with a relatively low TSS concentration (TSS concentration of 50 milligrams per liter [mg/L] or less was judged to be a conservative value based on the evaluation of elevated solids in groundwater samples collected during the RI; see Section 3.7 of Appendix F of the RI Report) is 27 µg/L.

The background surface water TPAH (34) concentrations from the NYSDEC samples are within the range of RI dry weather surface water data concentrations, which generally range from 0.1 to 3 µg/L. For the seep samples or nearshore surface water samples discussed in the previous paragraph, approximately one-third of the samples have a TPAH (34) concentration greater than the maximum RI dry weather surface water TPAH (34) concentration of 3.1 µg/L. A subset of these samples has elevated TSS concentrations that indicate entrainment of solids in the water samples. The remaining two-thirds of the samples have TPAH (34) concentrations within the range of RI dry weather surface water data. The evaluations of chloride and conductivity in the following section can help to differentiate the source of the seep water that was sampled.

3.2.2.2 Chloride and Conductivity

In addition to COC concentrations, water quality data were reviewed to help understand the nature of seep samples. Specifically, the concentrations of chloride or conductivity in water samples can help distinguish whether aqueous seep samples consist of fresher groundwater versus brackish creek water released as bank storage.

Chloride concentrations as an indicator of saline surface water in a tidal system can be used to distinguish between freshwater discharge (i.e., seeps that represent a focused discharge of shallow groundwater flow) and bank storage. Chloride concentrations measured in the RI shoreline seep samples were compared to dry weather surface water concentrations. Freshwater typically has chloride concentrations up to several hundred mg/L (USGS 2009), whereas brackish surface water in Newtown Creek has chloride concentrations measured during the RI dry weather surface water field events generally ranging between 10,000 and 16,000 mg/L. Half of the RI shoreline seep samples (which were only collected in reaches outside of East Branch) had chloride concentrations within the range of the dry weather surface water measurements, which indicates that these shoreline seep samples were more likely the result of bank storage, rather than lateral groundwater discharge. The other half of the RI shoreline seep samples had concentrations ranging between 3,700 and

6,700 mg/L, which indicates that those shoreline seeps may represent a mixture of bank storage and shallow lateral groundwater discharge.

A similar evaluation was performed for the conductivity measurements reported for the NYSDEC seep samples. Freshwater has conductivity values generally below several thousand microsiemens per centimeter (µS/cm) (USGS 2019), whereas brackish surface water in Newtown Creek has conductivity values measured during the RI dry weather field events generally ranging between 20,000 and 40,000 µS/cm. The majority of the conductivity values measured during the NYSDEC seep sampling (excluding samples of nearshore surface water that were collected near the observed seep) were greater than 20,000 µS/cm, with the remainder ranging from 2,900 to 19,000 µS/cm. Consistent with the conclusions of the RI shoreline seep sampling, this indicates that at least half of the seeps sampled by NYSDEC likely reflect bank storage, with the remainder likely reflecting a mixture of lateral groundwater and bank storage. USEPA is planning to measure conductivity as part of the shallow lateral groundwater study (CDM Smith 2022) and, once available, these data could be used to refine this evaluation.

4 Quantitative Evaluation of the Significance of NAPL Seeps

4.1 Importance of Mass Loading Calculations and Volumetric Discharge Measurements

The mass loadings of COCs are important because they can be used to compare the relative magnitude and importance of various sources and fate and transport processes (see Section 6.5 of the RI Report). Mass loadings can also be input to calculations using quantitative mathematical models, which are tools that can be used to assess the relative importance of a COC mass loading from a particular source to the system and to estimate how the loading impacts surface sediment COC concentrations. However, in addition to the data limitations described in Section 3.2.1, none of the seep surveys to-date have attempted to measure the volumetric discharge rates for any observed seeps. The lack of such measurements complicates the assessment of the potential impacts of NAPL seeps because the NAPL and COC mass loads entering the Study Area from seeps cannot be quantified without such information.

4.2 Bounding Analysis

To assess the relative importance of NAPL seeps and whether they may represent a significant recontamination pathway that could affect remedial decision-making for the East Branch Early Action remedy,[7] a quantitative bounding evaluation was performed using available data and the LTE model (Anchor QEA 2023a). This quantitative bounding evaluation was performed because of the limitations discussed previously associated with the comparability of sampling methods and sampling media, data quality issues for the 2021 to 2022 NYSDEC surveys, and lack of volumetric discharge measurements. This bounding evaluation is described in the following subsections.

4.2.1 Bounding Analysis Approach and Setup

The LTE model (Anchor QEA 2023a) was developed to estimate ranges of COC concentrations to which surface sediments will equilibrate after a remedy is implemented because of ongoing external inputs of COCs to the Study Area. These ongoing external inputs include solids-based sources (i.e., East River surface water and point source discharges), as well as additional sources (i.e., atmospheric deposition, treated groundwater effluent, lateral groundwater/seeps, porewater advection, and bank erosion).

The COC loads associated with lateral groundwater and seep flows, combined, are included in the LTE model. The values for these loads were estimated based on the RI opportunistic seep data (see

[7] NAPL seeps are an ongoing external source that would not affect the effectiveness of the sediment remedy, but if determined to be a significant ongoing source that could recontaminate the sediment surface post-remedy, it could necessitate additional source control measures that could impact the timing of the Early Action remedy.

Section 3.1.1) and lateral groundwater discharge rates estimated in the RI groundwater investigation (see Section 5.2 and Appendix F of the RI Report). Based on the results of the LTE model, the lateral groundwater/seep COC loads represent a minor source of COCs to the Study Area, including East Branch, where the lateral groundwater/seeps only account for 1% of the predicted LTE concentration for TPAH (34) and up to 4% for other COCs.

A quantitative bounding evaluation was performed to assess what additional TPAH (34) load would be necessary for the upper-bound LTE concentration predicted in East Branch to exceed the TPAH (34) sediment PRG of 100 milligrams per kilogram (mg/kg), which would indicate NAPL seeps as a significant ongoing source that could affect remedial decision-making for the East Branch Early Action remedy. Recognizing that there is uncertainty in the LTE concentrations (quantified in the LTE model [Anchor QEA 2023a] by upper- and lower-bound ranges), the analysis was conservatively performed based on the upper-bound LTE concentration. TPAH (34) was used in this evaluation because PAHs in Newtown Creek are well characterized, and PAHs make up a fraction of the hydrocarbons that compose NAPL.[8,9]

For simplicity, the hypothetical additional NAPL seep load was added only in Each Branch. The LTE model (Anchor QEA 2023a) accounts for the fact that some fraction of COC mass will remain in the dissolved phase and will not sorb to settling solids, some fraction of COC mass entering a given reach will migrate out of the reach or the Study Area altogether, and for PAHs, some mass dissolved in the water column may degrade. This is consistent with the NAPL seep CSM discussed in Section 2, in which NAPL and sheen can break down by photodegradation, biodegradation, volatilization, and dissolution, and some NAPL or sheen may be transported out of the reach by wind and surface water flow.

4.2.2 Bounding Analysis Results and Contextualization

The lateral groundwater/seep TPAH (34) load to East Branch was incrementally increased in the LTE model (Anchor QEA 2023a) until the upper-bound LTE concentration predicted in East Branch exceeded the PRG of 100 mg/kg (the base case LTE concentration predicted for East Branch is 43 mg/kg, with a lower bound of 33 mg/kg and an upper bound of 56 mg/kg). The resulting hypothetical additional TPAH (34) load in East Branch from this bounding simulation using the upper-bound value was found to be 36 kilograms per year (kg/yr). Figure 2 shows the base case results, including the upper- and lower-bound ranges, of the LTE model for TPAH (34) in East Branch (the empirically calculated lateral groundwater/seep load inputs range from 0.00055 to 0.33 kg/yr)

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[8] Total PCBs are another COC included in the LTE model. Compared to PAHs, concentrations of PCBs in seep media sampled were much lower. For example, the concentrations of total PCBs (TPCBs) in NYCDEP NAPL seep samples were generally two or more orders of magnitude lower than concentrations of TPAH (34). Therefore, TPCBs were not evaluated in this bounding evaluation.

[9] C19-C36 (representative of saturated and unsaturated hydrocarbons in this carbon range) is included in the LTE model (Anchor QEA 2023a) and is also a component of hydrocarbons found in NAPL. However, given the C19-C36 data limitations and associated uncertainties discussed in Section 3.1.1.2 of the LTE Report (Anchor QEA 2023a), C19-C36 was not used in this bounding evaluation.

along with two hypothetical scenarios representing increased seep loads. The first scenario demonstrates there is little impact on the LTE concentrations when the upper-bound lateral groundwater/seep load is increased by an order of magnitude to 3.3 kg/yr TPAH (34). The second scenario shows the results with the additional 36 kg/yr hypothetical NAPL seep load added into the model, which is approximately two orders of magnitude higher than the upper-bound lateral groundwater/seep load. This figure indicates that more than 50% of the TPAH (34) loading would need to be associated with NAPL seeps to be considered a significant recontamination source that could affect remedial decision-making for the East Branch Early Action remedy.

This hypothetical additional NAPL seep load was compared to existing Newtown Creek CSM information and data to contextualize the load relative to other TPAH (34) or NAPL sources into East Branch as follows:

- First, the hypothetical additional NAPL seep load of 36 kg/yr TPAH (34) was compared with the annual TPAH (34) loads associated with fate and transport processes and other external sources that are presented in Figure 3. The largest TPAH (34) source to East Branch is from point sources (17 to 23 kg/yr). Other sources of note include surface porewater diffusive exchange and porewater advection (5.0 kg/yr combined) and gas ebullition (0.0039 to 0.18 kg/yr). This comparison shows that the hypothetical additional TPAH (34) NAPL seep load would need to be larger than all other TPAH (34) loads to the East Branch surface water combined (see Figure 4). A load this significant would be expected to have impacts on the nearby surface water concentrations, and evaluations presented in Section 7 of Appendix F of the RI Report have shown this not to be the case.
- Second, to assess the potential volume of NAPL that would need to be entering East Branch surface water from seeps to result in this hypothetical additional TPAH (34) load, the contaminant concentration results from the NYCDEP surveys discussed in Section 3.1.2, expressed on a contaminant mass per NAPL basis, were used. Using the median value of 2% by weight of TPAH (34) for NAPL measured in East Branch by NYCDEP (see Section 3.2.2) and an assumed NAPL density of 0.9 kilogram per liter (kg/L),[10] 530 gallons per year of NAPL would need to be entering East Branch from NAPL seeps. The estimated NAPL load to East Branch from gas ebullition presented in the USEPA-approved FS Gas Ebullition DER (Anchor QEA 2022a) converted to a volumetric discharge (assuming the same NAPL density) is 8 to 38 gallons per year. Furthermore, the total estimated NAPL flow rate (also converted from load) to the entire Study Area from gas ebullition is 44 to 380 gallons per year, which is still

[10] Literature values for NAPL density range from 0.83 kg/L at 15°C (59°F) for automotive diesel (API 2002) to 1.43 kg/L at 20°C to 25°C (68°F to 77°F) for "aged manufactured gas plant coal tar" (ITRC 2015). Based on the observance of sheens on the water surface in some of the surveys conducted to date, a value of 0.9 kg/L was selected because it is representative of a typical hydrocarbon light NAPL. Alternative values ranging from 0.8 to 1.4 cited in literature would not change the conclusions from this bounding analysis comparison.

less than the hypothetical NAPL seep load into just East Branch from this bounding evaluation. Thus, to be considered a significant recontamination source in East Branch, the annual volume of NAPL from seeps in East Branch would need to be greater than that from gas ebullition within the entire Study Area, a scenario that is completely implausible.

- In addition, the surface area of sheen that would result from the hypothetical NAPL load that would need to be entering East Branch from NAPL seeps can be estimated. Based on a review of the available photographs of NAPL seeps in the NYCDEP survey, the observed sheens associated with NAPL seeps in East Branch generally appear to be silvery. To be conservative, given there is some uncertainty associated with visual review of photographs, thicknesses of silvery and rainbow sheens (which are thicker on average than silvery sheens) were used to estimate the sheen surface area. Based on the ASTM (2022) standard for visually estimating oil spill thickness on water, the average thickness of a silvery sheen is 0.1 micrometer (μm) and for a rainbow sheen is 0.6 μm. Assuming equal distribution of the hypothetical NAPL load of 530 gallons per year over each low tide, 0.73 gallon of NAPL would be entering East Branch during each low tide. Using this load and the literature-based sheen thicknesses for silvery and rainbow sheens, approximately 1.1 acres (rainbow sheen) to 6.8 acres (silvery sheen) of sheen would need to be present in East Branch during every low tide. Figure 5 presents the hypothetical surface area of sheen of that size that would need to be present during every low tide to support the presence of a hypothetical NAPL discharge of 530 gallons per year into East Branch. During RI/FS field investigations, sheens of this magnitude and frequency have never been observed. In addition, the observed sheens in the available photographs and videos of NAPL seeps in the NYCDEP and NYSDEC surveys appear to be much smaller than this size and are generally localized observations.
- Finally, this hypothetical additional load can also be contextualized for the case of aqueous seeps by estimating the theoretical discharge volume that would be necessary using the hypothetical load and available seep aqueous concentration data. This calculation would represent the total volumetric discharge of aqueous seeps (with no observation of NAPL) that would be necessary to produce the hypothetical additional TPAH (34) load into East Branch of 36 kg/yr. As discussed in Section 3.2, the maximum TPAH (34) seep concentration from available data that did not have data quality issues or influence from solids is 27 μg/L (see Section 3.2). Conservatively using this upper-bound TPAH (34) concentration and the hypothetical additional TPAH (34) seep load of 36 kg/yr, the seep flow rate would need to be $3.6\text{x}10^8$ gallons per year into East Branch. This is approximately 34 times greater than the estimated total annual lateral groundwater discharge into East Branch (see Section 5.2 and Appendix F of the RI Report).[11] Although volumetric seep flow rates have not been measured,

[11] Data collected during USEPA's shallow lateral groundwater discharge field program discussed in Section 3.1.4 will allow for refinement of the estimated lateral groundwater discharge rate.

none of the field observations, photographs, or videos of observed seeps indicated seep volumetric discharge rates anywhere near this magnitude occurring in East Branch.

Although the bounding analysis discussed in this section focused on East Branch, a similar evaluation could be performed for other reaches of Newtown Creek. For example, a similar bounding analysis was done by adding a hypothetical NAPL seep load to each Study Area reach in the LTE model (Anchor QEA 2023a) based on the number of observed seeps and assuming the same load per seep. The resulting TPAH (34) and loads necessary for predicted LTE concentrations to exceed the PRG in multiple reaches is significantly elevated relative to other well characterized loads, similar to the results described herein for East Branch, and likewise is simply not plausible given the multiple lines of evidence to the contrary.

4.3 Chemical Fate and Transport Model

The CFT model that is being developed for the Newtown Creek Study Area (Anchor QEA 2022c) characterizes sediment and porewater COC concentrations, incorporates chemical loads from various sources (including East River, point source discharges, and groundwater), and includes hydrodynamic, sediment transport, and CFT processes to predict temporal and spatial variation of COC concentrations in the surface water and sediment bed. This model is a refined tool that can be used to assess the relative importance of a COC mass loading to the system by linking the magnitude of the load to a quantifiable contribution to the concentration of the COC in surface water and surface sediment. The CFT model was calibrated to both surface water and surface sediment data without needing additional loads to represent NAPL seeps, further supporting the conclusion that NAPL seeps are not a significant source to the Study Area.

5 Conclusions

Bounding calculations using data collected during RI/FS field activities and from NYCDEP and NYSDEC surveys indicate that NAPL seeps, although observed within the Study Area, represent a comparatively minor source of COCs to sediment in East Branch and the rest of the Newtown Creek Although quantitative calculations of NAPL seep loads are not possible given the lack of measured volumetric discharge rates, multiple lines of evidence support the conclusion that NAPL seeps are a relatively minor source to the Study Area that do not represent a significant recontamination potential that could affect remedial decision-making, including the following:

- TPAH (34) concentrations for most sampled seeps, which are aqueous seeps that did not contain NAPL, are within the range of current surface water TPAH (34) concentrations.
- Chloride and conductivity measurements of sampled aqueous seeps indicate that approximately half of the sampled seeps likely consist of brackish creek water discharging almost entirely as bank storage, with the remainder of the sampled seeps representing a mix of bank storage and shallow lateral discharge of groundwater.
- A quantitative bounding analysis was performed to calculate the hypothetical magnitude of NAPL seeps in East Branch that would be needed to affect remedial decision-making. The resulting hypothetical TPAH (34) loads, NAPL volumetric flow rates, surface area of NAPL sheen in East Branch, and aqueous seep flow rates that would need to be present to affect remedial decision making are much higher than other existing and well characterized loads and flow rates, which is completely implausible for the reasons described throughout Section 4 of this report.

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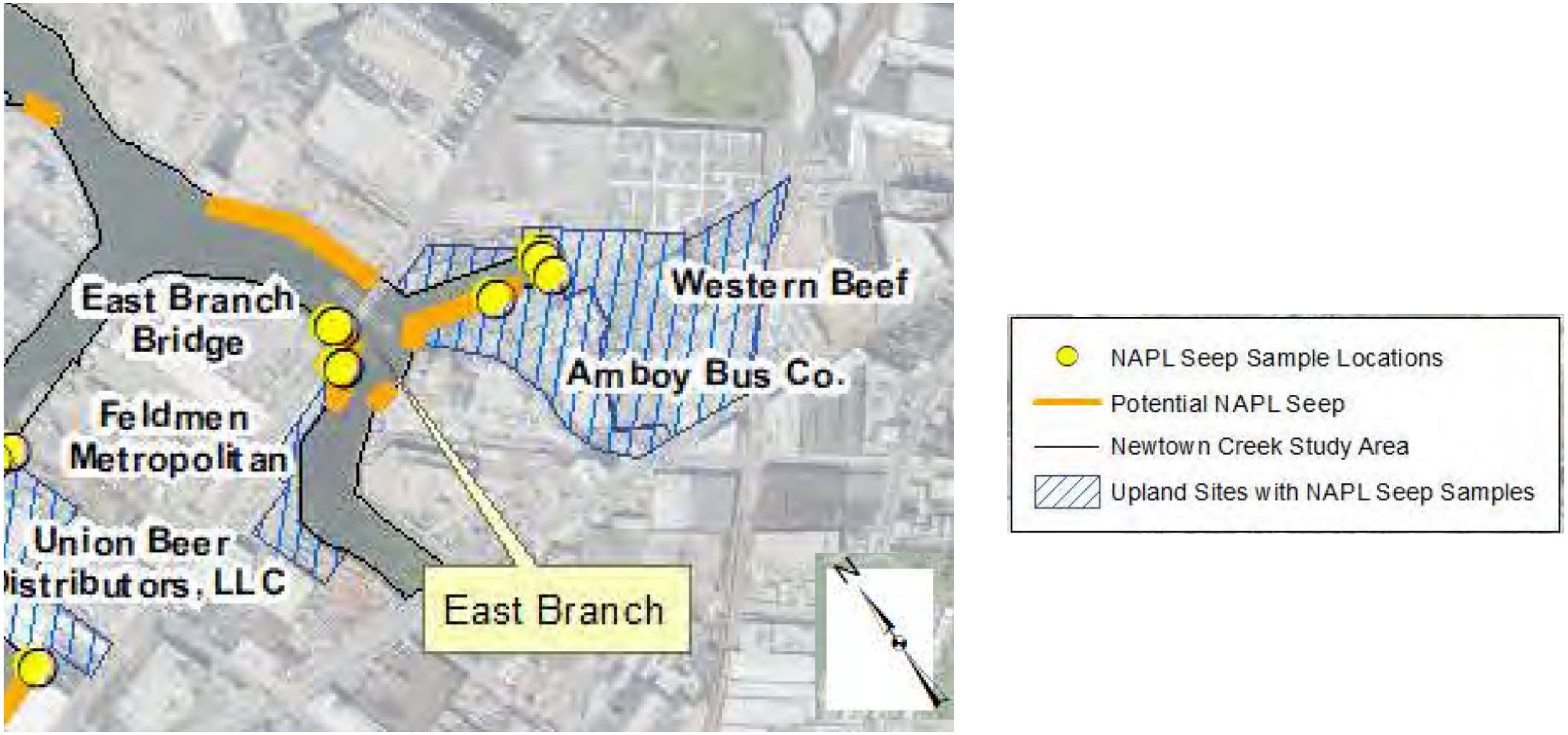
Figures



Note:
This is a copy of Figure 2-1 in NYCDEP's 2017 Upland NAPL Seep Sampling Data Summary Report (NYCDEP 2020). The original map has been cropped to focus on East Branch.

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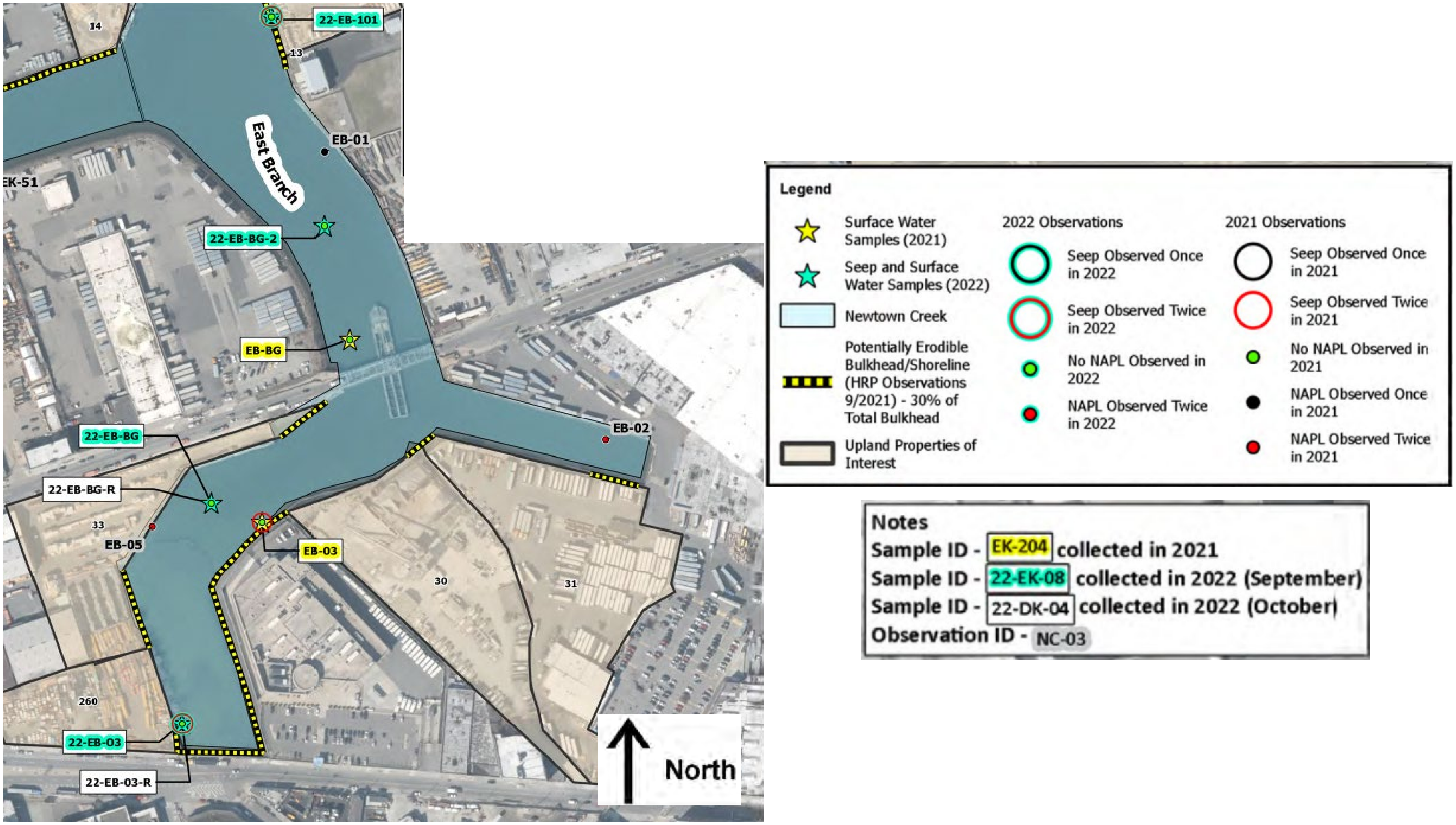
ANCHOR QEA

Figure 1a
NYCDEP Surveys: Seep Sample Locations in East Branch



Note:
This is a copy of Figure 4E in NYSDEC's Upland Site Characterization Report (HRP 2023). The original map has been cropped to focus on East Branch.

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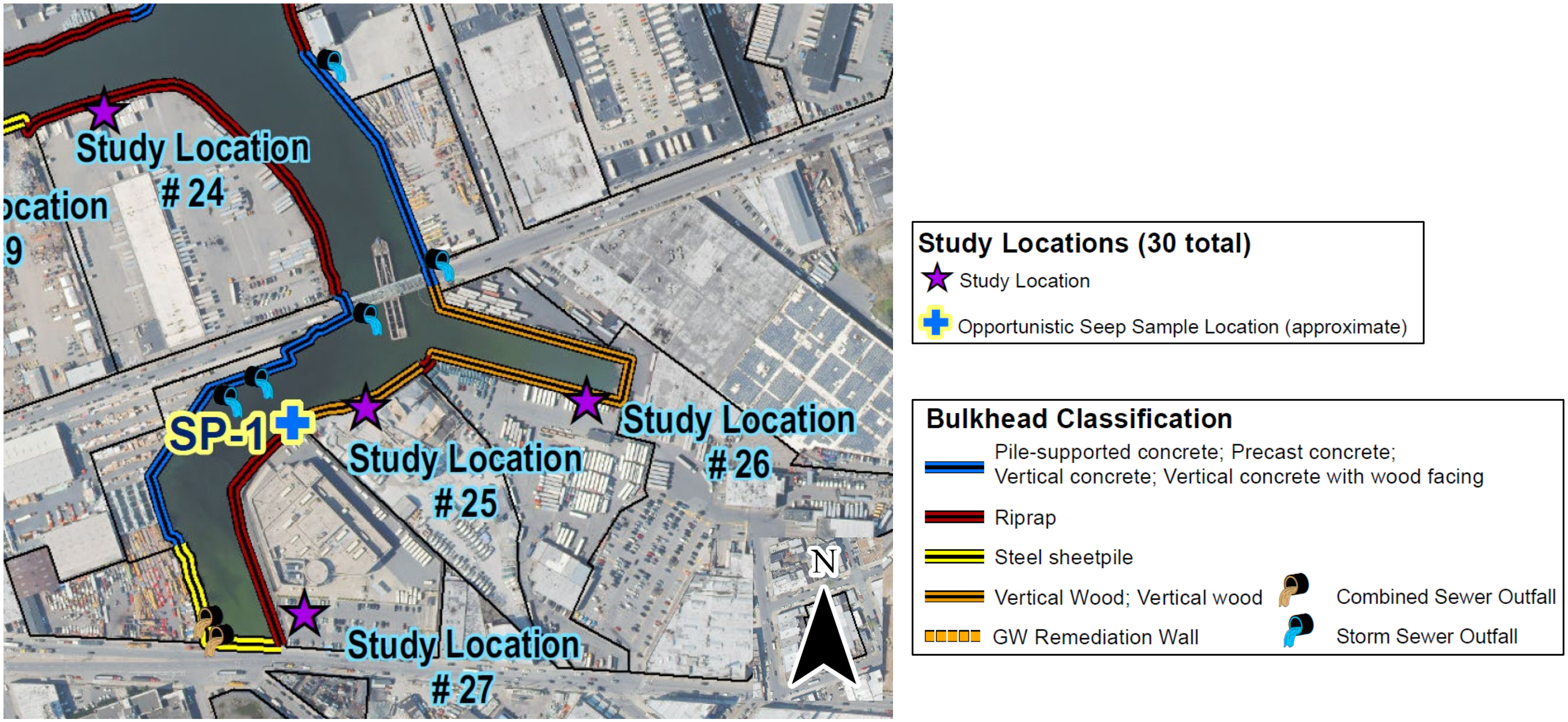
ANCHOR QEA

Figure 1b
NYSDEC Surveys: Seep Sample Locations and Observations in East Branch
Quantitative Bounding Evaluation of the Importance of Nonaqueous Phase Liquid Seeps in the East Branch Early Action Area of Newtown Creek
Newtown Creek RI/FS



Notes:
This is a copy of Figure 1-1c provided in an email from Mark Schmidt of USEPA to Jim Quadrini of Anchor QEA on June 22, 2023. The original map has been cropped to focus on East Branch.
Each "Study Location" for the shallow lateral groundwater discharge investigation consists of 2 or 3 monitoring wells within a transect perpendicular to the shoreline.

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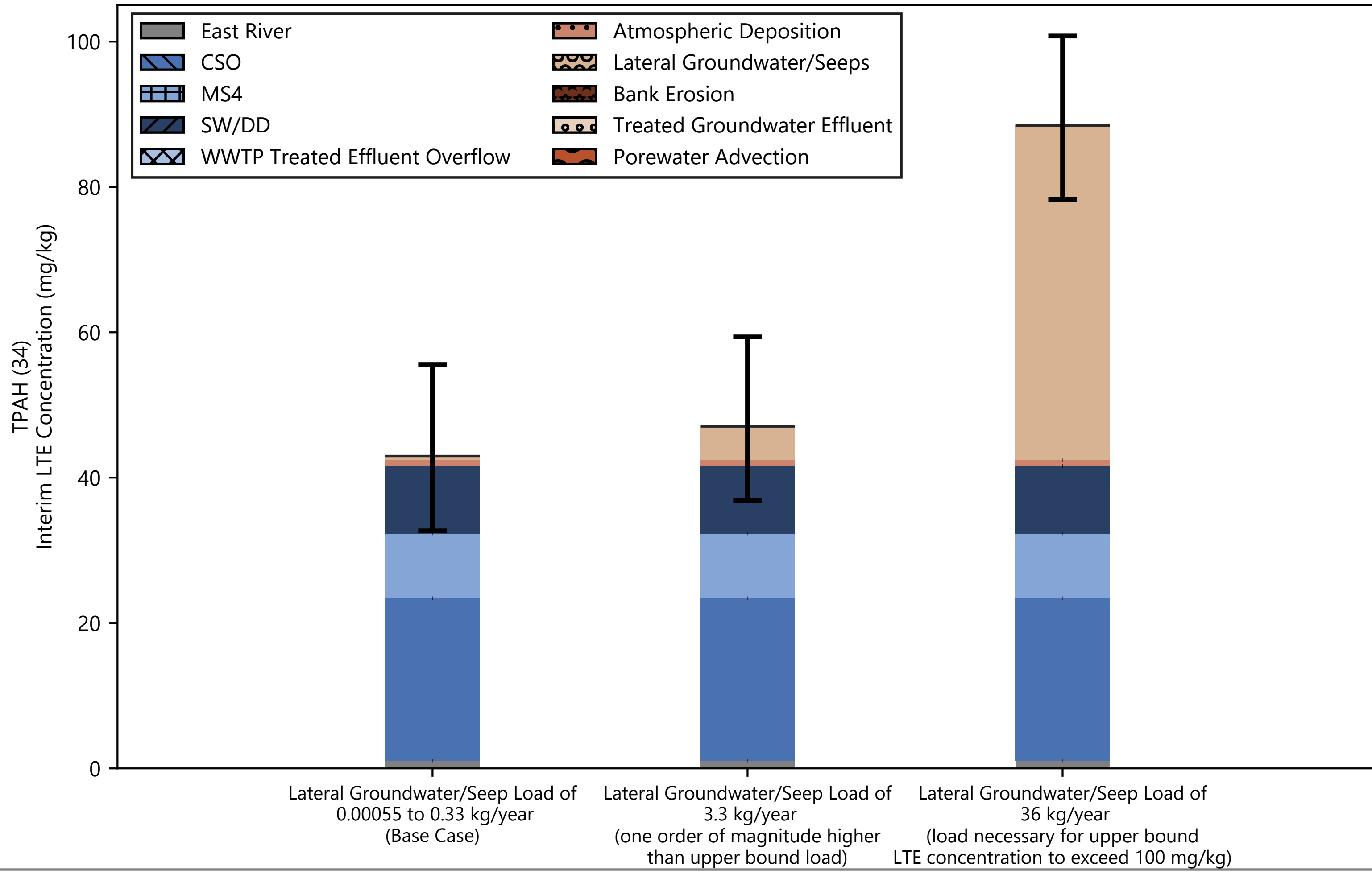
Figure 1c
USEPA Survey: Seep Sample Location in East Branch



Notes: The range on each bar indicates the calculated LTE concentrations with upper- and lower-bound ranges.
WWTP treated effluent overflow and treated groundwater effluent are sources that originate outside of East Branch. Their contribution to LTE in East Branch is a result of tidal transport.
CSO: combined sewer overflow
LTE: long-term equilibrium
MS4: municipal separate storm sewer system
SW/DD: stormwater and direct drainage
TPAH (34): total polycyclic aromatic hydrocarbon (34)

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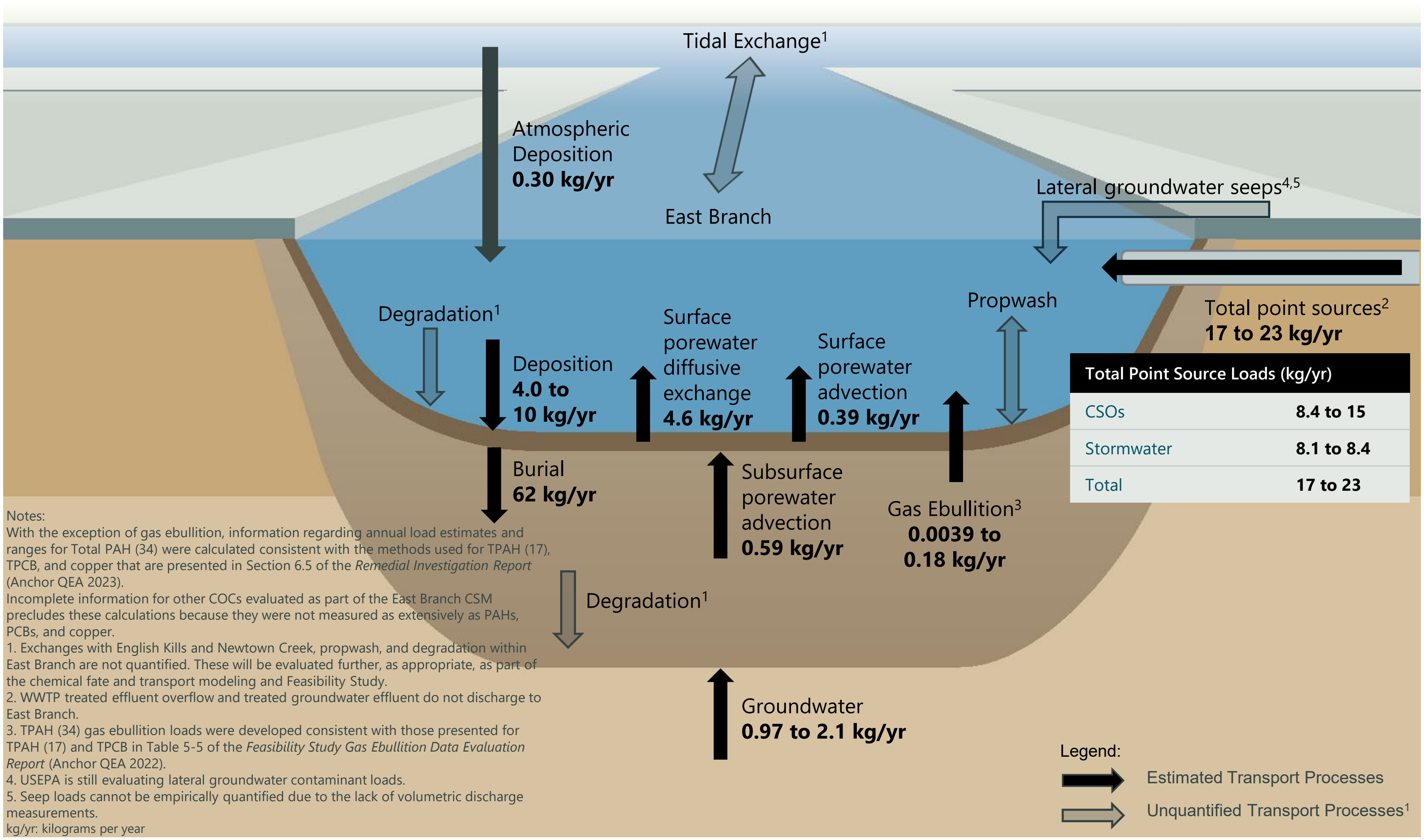
ANCHOR QEA

Figure 2

TPAH (34) Long-Term Equilibrium Concentrations in East Branch for Base Case and Bounding Evaluation Scenarios

Quantitative Bounding Evaluation of the Importance of Nonaqueous Phase Liquid Seeps in the East Branch Early Action Area of Newtown Creek

Newtown Creek RI/FS



Total Point Source Loads (kg/yr)	
CSOs	8.4 to 15
Stormwater	8.1 to 8.4
Total	17 to 23

Notes:
With the exception of gas ebullition, information regarding annual load estimates and ranges for Total PAH (34) were calculated consistent with the methods used for TPAH (17), TPCB, and copper that are presented in Section 6.5 of the *Remedial Investigation Report* (Anchor QEA 2023).
Incomplete information for other COCs evaluated as part of the East Branch CSM precludes these calculations because they were not measured as extensively as PAHs, PCBs, and copper.
1. Exchanges with English Kills and Newtown Creek, propwash, and degradation within East Branch are not quantified. These will be evaluated further, as appropriate, as part of the chemical fate and transport modeling and Feasibility Study.
2. WWTP treated effluent overflow and treated groundwater effluent do not discharge to East Branch.
3. TPAH (34) gas ebullition loads were developed consistent with those presented for TPAH (17) and TPCB in Table 5-5 of the *Feasibility Study Gas Ebullition Data Evaluation Report* (Anchor QEA 2022).
4. USEPA is still evaluating lateral groundwater contaminant loads.
5. Seep loads cannot be empirically quantified due to the lack of volumetric discharge measurements.
kg/yr: kilograms per year

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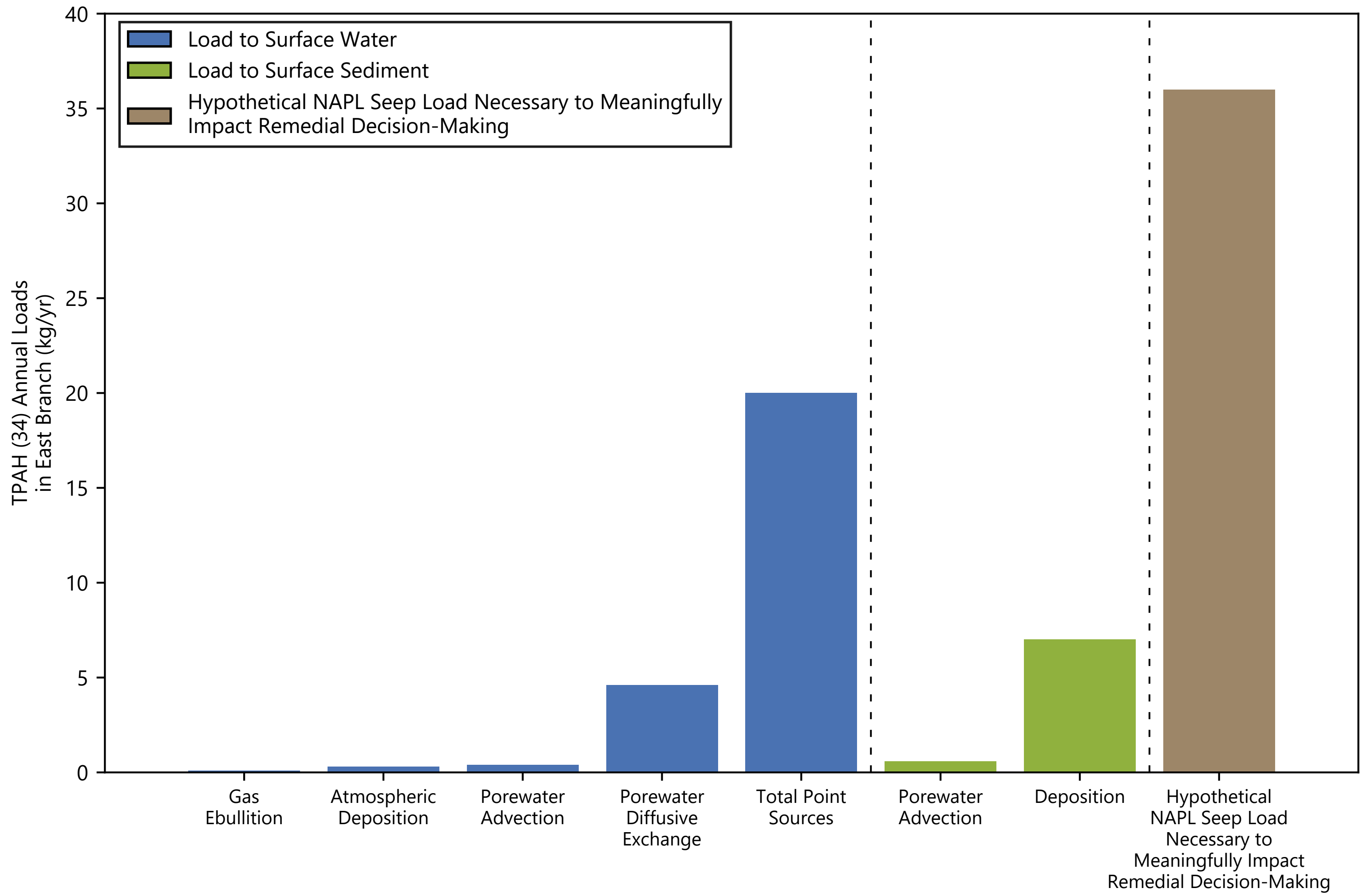

The hypothetical NAPL seep load is compared to the annual TPAH (34) loads associated with fate and transport processes and other external sources that are presented in Figure 3.
For loads presented as a range in Figure 3 (point sources, deposition, and gas ebullition), the arithmetic average value is shown.
LTE: long-term equilibrium
TPAH (34): total polycyclic aromatic hydrocarbon (34)

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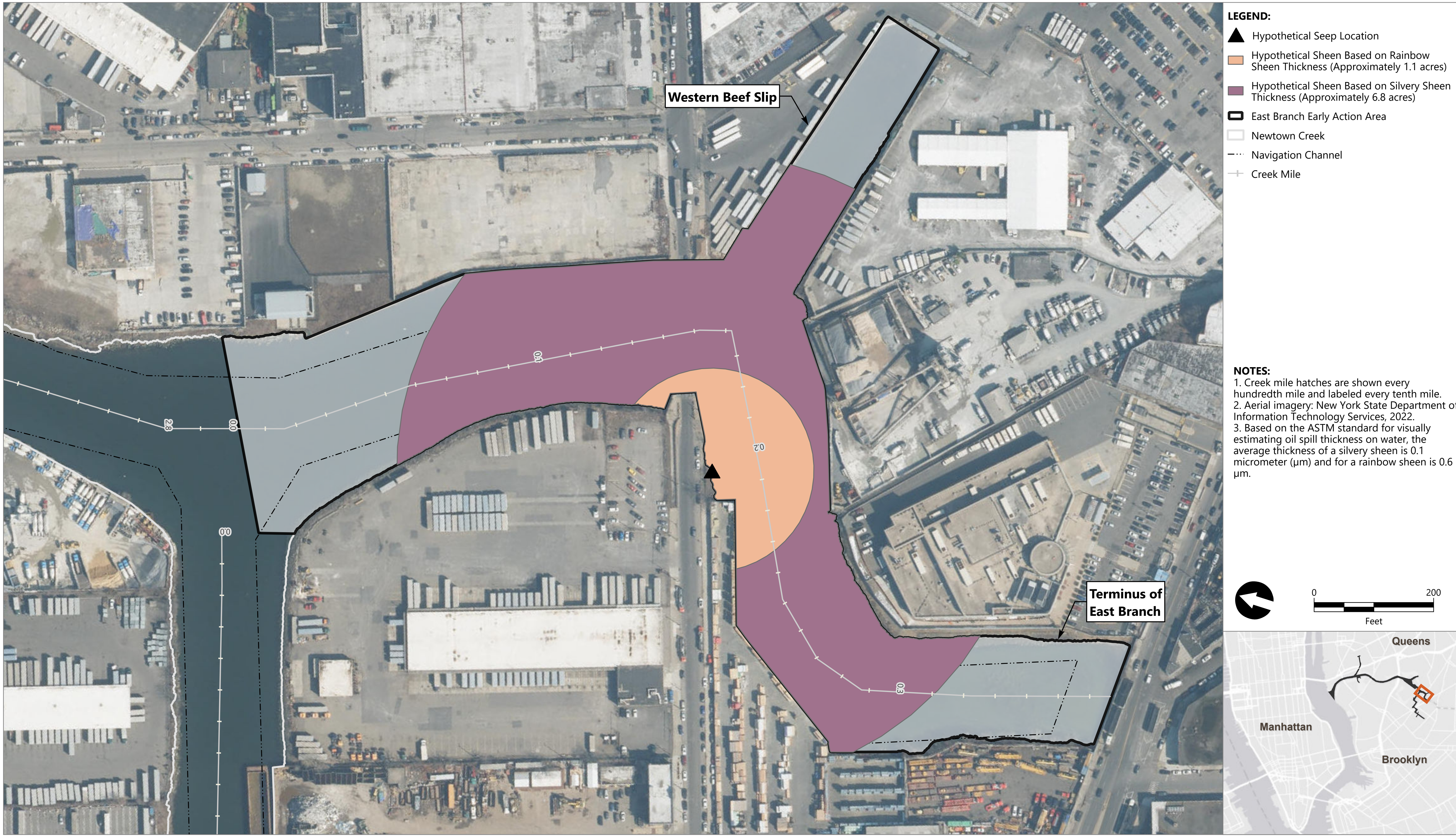
Figure 4

Comparison of Annual Loads in East Branch and the Hypothetical Bounding Evaluation NAPL Seep Load for TPAH (34)

Quantitative Bounding Evaluation of the Importance of Nonaqueous Phase Liquid Seeps in the East Branch Early Action Area of Newtown Creek

Newtown Creek RI/FS



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ANCHOR QEA

Figure 5

Hypothetical Area of Sheen from NAPL Seeps Necessary During Each Low Tide to Meaningfully Impact Remedial Decision-Making

Quantitative Bounding Evaluation of the Importance of Nonaqueous Phase Liquid Seeps in the East Branch Early Action Area of Newtown Creek

Newtown Creek RI/FS