Appendix K
Ecological Risk Assessment

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SECTION 1

Introduction

This report presents the results of a combined Screening-Level Ecological Risk Assessment (SLERA) and Baseline Ecological Risk Assessment (BERA) for the Gowanus Canal Superfund Site, Brooklyn, New York. The assessments were conducted consistent with USEPA (1992, 1997, 1998) guidance.

The objectives of the SLERA are to

- Conduct a preliminary problem formulation that…
  - Describes the environmental setting at the site with an emphasis on ecological receptors
  - Describes the fate and transport pathways present at the site
  - Develops an ecological conceptual site model (CSM) for exposure pathways for ecological receptors
  - Identifies preliminary assessment and measurement endpoints
- Conservatively assess risks to ecological receptors from identified contaminants detected in environmental media through contaminant identification, exposure assessment, toxicity assessment, and risk characterization
- Identify contaminants of potential concern (COPCs) that exist as a result of historical operations and that may require further, more detailed evaluation

Based on the outcome of the SLERA, the problem formulation was refined and the BERA then evaluated additional data and conducted additional analyses to refine estimates of risk to ecological receptors at the site.

The combined SLERA and BERA completes Steps 1 and 7 of the eight-step Ecological Risk Assessment (ERA) process as provided by USEPA (1997) Ecological Risk Assessment Guidance for Superfund (ERAGS) and its updates.

Results of the ERA will be used to determine if chemicals present from historical site operations represent a risk to ecological receptors and to provide information that is necessary to make risk management decisions for the site, which completes Step 8 of the ERA process.

This report comprises the following sections:

- **Section 2—Preliminary Problem Formulation.** Provides an overview of the site activities, setting, and the habitats; develops a preliminary conceptual site model; identifies specific groups of organisms and endpoints for evaluation in the ERA; and summarizes the data that are used in the ERA to evaluate the potential for adverse effects to ecological receptors.

- **Section 3—Screening-Level Assessment.** Establishes chemical exposure levels (screening values) for the potential ecological receptors identified for evaluation in the SLERA**.** Identifies the analytical data available for ecologically relevant media, data groupings, and exposure models that are used to estimate the potential exposure of ecological receptors to site-related chemicals.
- **Section 4—Screening-Level Risk Outcomes.** Characterizes potential risk using conservative evaluation assumptions, consistent with the objectives of the SLERA. The outcome of this step is an initial list of COPCs for each medium-pathway-receptor combination identified for evaluation in the SLERA.
- **Section 5—Baseline Ecological Risk Assessment: Approach to Refining Risks.** Summarizes the additional data and refinements that are used to further evaluate and refine estimates of risk to ecological receptors potentially occurring at the site.
- **Section 6—Baseline Ecological Risk Assessment: Refined Risk Evaluation.** Evaluates additional site-specific data along with revised risk model calculations and additional site-specific considerations to provide a more refined and realistic estimate of risk to ecological receptors. The outcome of this step is a final list of constituents of concern (COCs) for each medium-pathway-receptor combination evaluated in the ERA.
- **Section 7—Uncertainties.** Identifies key uncertainties associated with the evaluation of ecological risk at the site and the potential impact of those uncertainties on the risk estimate.
- **Section 8—Risk Summary and Conclusions.** Provides a final summary and conclusion of risks to ecological receptors at the site.

SECTION 2

Preliminary Problem Formulation

The products of the preliminary problem formulation are (1) the preliminary CSM and (2) the assessment and measurement endpoints. The preliminary problem formulation is broken into three sections. Section 2.1 presents information pertaining to the environmental setting being assessed, including an overview of the site, surrounding land use, and onsite habitats and biota. Section 2.2 develops a preliminary CSM, discussing the potential sources of chemicals and the pathways and routes by which ecological receptors could be exposed to chemicals. Section 2.3 identifies specific groups of organisms (receptors) and the endpoints that are evaluated in this ERA. Endpoints for evaluation are then selected on the basis of the key receptors and complete exposure pathways identified in the CSM. Assessment endpoints are identified that define the ecological attributes that are the focus of the ERA while measurement endpoints characterize how they are assessed.

2.1 Environmental Setting

The following summarizes the environmental setting of the Gowanus Canal and surrounding area. A more detailed description of the site and historic investigations can be found in the remedial investigation (RI) (Sections 1.3 and 1.4, respectively).

2.1.1 Location and Background

The Gowanus Canal is located in the New York City borough of Brooklyn, Kings County, New York. The Gowanus Canal is 100 feet wide, 1.8 miles long, and is connected to the Gowanus Bay in the Upper New York Bay. The canal study area is shown in Figure 1-1 of the RI. The canal is bordered by several residential neighborhoods, including Park Slope, Cobble Hill, Carroll Gardens, and Red Hook. The adjacent waterfront is primarily commercial and industrial, and facilities bordering the canal include concrete plants, warehouses, and parking lots. An active scrap metal recycling facility is located between 9th Street and the Gowanus Expressway/Hamilton Avenue, where barges are loaded with recyclable metals and shipped out of the canal. A sand-and-gravel business also operates just below the Gowanus Expressway/Hamilton Avenue ridge. Five east–west bridges cross the canal, at Union Street, Carroll Street, Third Street, Ninth Street, and Hamilton Avenue. The Gowanus Expressway and an aboveground section of the subway system pass overhead at the Hamilton Avenue bridge crossing, near the mouth of the canal.

The Gowanus Canal was completed in the 1860s and was originally built to allow water access for industrial needs. The canal was constructed by bulkheading and dredging a tidal creek and wetland, and it quickly became one of the nation's busiest industrial waterways and a home to heavy industry. Throughout its history, the Gowanus Canal has supported the activities of numerous industries, including gas works, coal yards, cement makers, soap makers, tanneries, paint and ink factories, machine shops, chemical plants, and oil refineries. The canal has also received discharges of untreated industrial wastes, raw sewage, and surface water runoff for many decades. Although much of the industrial activity along the canal has stopped, the canal still annually receives 377 million gallons of discharge during storm events from 11 combined sewer overflow (CSO) pipes (CNYDEP, 2008).

2.1.2 Onsite Habitats and Biota

The Gowanus Canal is part of the New York–New Jersey Estuary, which the USEPA has designated as an Estuary of National Significance. Habitats in the Gowanus Canal have been significantly influenced by surrounding industries and historic development activities. No areas of natural shoreline, wetlands, or natural upland areas are located within or adjacent to the water body (CNYDEP, 2008). The entire length of the Gowanus Canal is bordered by wooden piers, bulkheads, concrete walls, and large boulders used for bank stabilization. The adjacent upland and areas bordering the canal thus provide minimal habitat for wildlife.

The City built a "flushing tunnel" in 1911 to pump fresh water from the Buttermilk Channel into the upper reaches of the Gowanus Canal. The purpose of the tunnel is to replace stagnant canal water with fresh, oxygen-rich water to improve water quality. The tunnel was in operation until the 1960s, when a mechanical failure caused it to be shut down, and the canal became stagnant once again. The New York City Department of Environmental Protection (NYCDEP) restored water flow through the tunnel in 1999. The flushing tunnel was taken offline again on July 19, 2010, and will be shut down for several years for repairs. The NYCDEP installed a system to oxygenate surface waters while the flushing tunnel is being repaired.

There are no significant colonies of rooted aquatic vegetation within the Gowanus Canal (CNYDEP, 2008). Rooted plants were not observed in the canal in 2010 during the Phase 3 sampling event. These observations are consistent with the NYSDEC tidal wetlands maps, which designate the entire water body as a littoral zone, which is a shallow-water habitat that does not include coastal fresh marsh, intertidal marsh, or other types of vegetative wetland designation and are also consistent with what is expected in this water body given the large tidal fluctuations and high degree of turbidity, which would prevent sunlight penetration.

The most abundant invertebrates in Gowanus Canal are annelid worms (polychaetes and oligochaetes), followed by amphipods and small mollusks (CNYDEP, 2008). Several other studies (Sunset Energy Fleet, 2002; USACE, 1998; Hazen and Sawyer, 2001) have similarly shown the dominance of polychaetes and oligochaetes in the Gowanus Canal and/or Upper New York Bay. A variety of epibenthic organisms (i.e., organisms attached to underwater structures and surfaces) occurs in the Gowanus Bay and has also been found in Gowanus Canal including "sea grapes" (*Molgula manhattensis*), barnacles (*Balanus sp*.), blue mussels (*Mytilus edulis*), clam worms (*Nereis succinea*), amphipods (*Leptocheirus pinguis*), blue crab (*Callinectes sapidus*), and spider crab (*Libinia emarginata*) (CNYDEP, 2008).

The reactivation of the flushing tunnel in 1999 improved the diversity and abundance of zooplankton and other planktonic organisms in the water column (CNYDEP, 2008). Prior to reactivation, over 92 percent of all organisms collected in the canal were copepods (*Acartia spp*.), whereas following reactivation, less than 45 percent of all organisms were copepods (CNYDEP, 2008). There was a greater diversity of organisms and a more even distribution of those organisms within the canal.

The most frequently caught fish species from a NYCDEP trawl survey conducted in 2001 within the Gowanus Canal and the adjacent Gowanus Bay were Atlantic menhaden, blueback herring (*Alosa aestivalis*), bay anchovy, bluefish (*Pomatomus saltatrix*), striped bass (*Morone saxatilis*), winter flounder, weakfish (*Cynoscion regalis*), and scup (*Stenotomus chrysops*) (CNYDEP, 2008). Smaller bodied species caught in ichthyoplankton tows, included blennies (*Blennidae*), rock gunnel (*Pholis gunnelus*), mackerel (*Scomberomorus sp*.), killies (*Cyprinodontidae*), and silver perch (*Bairdiella chrysoura*). Some species (blueback herring, scup, winter flounder, and windowpane flounder) use these water bodies in spring, whereas the young-of-the-year of these species and others are abundant during summer (CNYDEP, 2008).

Fish species collected from the Gowanus Canal in fall 2010 during the Phase 3 study area consist of smaller bodied fish species including Atlantic tomcod (*Microgadus tomcod*), mummichog (*Fundulus heteroclitus*), three-spined stickleback (*Gasterosteus aculeatus*), and rock gunnel (*Pholis gunnellus*), larger fish species including American eel (*Anguilla rostrata*), striped bass (*Morone saxatilis*), tautog (*Tautoga onitis*), white perch (*morone americana*), and winter flounder (*Pseudopleuronectes americanus*). Although the objective of the Phase 3 study was to collect fish tissue for chemical residue analysis and not to conduct a quantitative population survey, the collection of these species provides additional information about the fish species that were present in the canal and the immediately surrounding area in fall 2010.

Fourteen taxa of fish eggs and/or larvae were identified in Gowanus Canal and Bay during NYCDEP's Harbor-Wide Ichthyoplankton Field Sampling Analysis Program (FSAP) in 2001 (CNYDEP, 2008). The most commonly found species were winter flounder (*Pseudopleuronectes americanus*) larvae, windowpane flounder (*Scophthalmus aquosus*) eggs and larvae, wrasse (*Labridae*) family eggs and larvae, bay anchovy (*Anchoa mitchelli*), menhaden (*Brevoortia sp*.) eggs, and naked goby (*Gobiosoma bosc*) eggs and larvae. Ichthyoplankton sampling results in Gowanus Canal near Hamilton Avenue from March 2001 showed results similar to those of NYCDEP's harbor-wide study.

Among the fish species found in New York Harbor, many are migratory, seasonally transient or moving daily as part of their normal behavior in pursuit of food (CNYDEP, 2008). The Gowanus Canal has very limited physical habitat diversity and is not expected to support a diverse fish community. Many species may occur in the canal as they pass through as part of their movement patterns, but few are likely to remain in substantial numbers.

The Gowanus Canal would not support mammalian wildlife species that forage in or otherwise utilize aquatic habitats. This is due to a lack of usable bank habitat and the precipitous drop off from piers, bulkheads, docks or concrete walls along the canal, which would negate any access by mammals (CNYDEP, 2008). Consistent with this conclusion is that no mammalian wildlife was observed in fall 2010 during the Phase 3 study.

Based on the lack of shoreline habitat, the highly urbanized nature of the surrounding area, and the limited prey within this aquatic habitat, a very limited diversity and abundance of avian wildlife would make use of the canal habitat. A few swimming birds, including the double crested cormorant *(Phalacrocorax auritus)* and dabbling ducks, including the black duck (*Anas rubripes),* were observed in the canal during the Phase 3 sample event. These species are able to use the canal because they can access the water directly and do not rely on shoreline or shallow water habitat. A black crowned night heron (*Nycticorax nycticorax*) and a great blue heron (*Ardea herodias*) were also observed during the Phase 3 sampling event. The great blue heron was observed standing in a very shallow, depositional area of the canal, though the water depth throughout most of the canal is too great to support such wading species. Avian species such as shorebirds and species that are not adapted to highly urbanized habitats or to water bodies lacking shoreline/marsh habitats would not be expected to occur frequently within the Gowanus Canal.

2.1.3 Endangered Species, Threatened Species, and Species of Special Concern

Federal and state-listed species of special concern potentially occurring in the vicinity of the Gowanus Canal were identified by searching online databases and resources available through the U.S. Fish and Wildlife Service, New York State Department of Environmental Conservation (NYSDEC), and the New York Natural Heritage Program. The results of these searches are provided in Attachment A.

The results of the initial search were reviewed to identify only federal and state-listed species of special concern that occur in brackish water habitats in the New York Harbor Estuary and that could occur in aquatic habitats within the vicinity of the Gowanus Canal (Table 2-1). Among the aquatic species identified by this search, the federal and state-listed endangered shortnose sturgeon (*Acipenser brevirostrum*) is the only threatened or endangered fish species with potential to occur in the Gowanus Canal (Table 2-1). However, while this anadromous fish can be found throughout the Hudson River system, if present, it is likely to only occur for a brief period at the mouth of the Gowanus Canal while migrating to or from its preferred spawning, nursery, and overwintering areas in the Hudson River. The shortnose sturgeon is not expected to spend any significant time in the Gowanus Canal.

Five reptile species were identified as potentially occurring in brackish water habitats in and around the New York Harbor Estuary. Four species of marine turtles, all state and federally listed, are found in the waters surrounding New York City: loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), and Atlantic (Kemps) ridley (*Lepidochelys kempii*) (Table 2-1). Juvenile Atlantic ridley and adult loggerhead turtles regularly enter the New York Harbor and bays in the summer and fall. The other two turtle species may enter the higher salinity areas of the New York Harbor Estuary (USFWS, 1997). However, these four turtle species mostly inhabit Long Island Sound and Peconic and Southern Bay and do not nest in the New York Harbor Estuary, nor reside there year-round. Based on their distribution and the limited habitat available, it is highly unlikely these sea turtle species would enter the Gowanus Canal. The northern diamondback terrapin (*Malaclemys t. terrapin*), an estuarine species that feeds and nests in salt marshes and adjacent upland, has been observed in the wetlands of Jamaica Bay (USFWS, 1997). This species would not be present in the Gowanus Canal due to the lack of salt marshes and natural shorelines and the limited resources available within the canal.

Eight avian species with federal or state endangered, threatened, or species of concern status were identified as potentially occurring in the aquatic habitats near the Gowanus Canal (Table 2-1). However, these species typically either reside in areas with sandy and/or marsh shoreline habitat [common tern (*Sterna hirundo*), least bittern (*Ixobrychus exilis*), least tern

(*Sterna antillarum*), pied-billed grebe (*Podilymbus podiceps*), roseate tern (*Sterna dougallii*), and upland sandpiper (*Bartramia longicauda*)] or forage in more open water areas [bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), and peregrine falcon (*Falco peregrinus*)]. Peregrine falcons are known to occur in New York City, and could forage in areas around the Gowanus Canal, but none of these avian species would be expected to forage regularly in the habitat provided by the canal.

2.2 Conceptual Site Model

Available facility information and observations made by the Phase 3 field team during site visits in March–August 2010 were used along with historic site information for the development of the CSM. The following sections develop each component of the CSM consistent with USEPA guidance.

2.2.1 Source Areas

Chemicals have entered the Gowanus Canal from a variety of sources and pathways. Many of these pathways are associated with past industrial activities along the canal and include the following:

- Historic direct discharge of materials to surface water via industrial outfalls
- Direct release of materials to surface water from boats/barges and as a result of barge loading/offloading activities
- Leaching and runoff from surface soils and paved areas during storm events
- Leaching from contaminated subsurface soils and transport and discharge from contaminated groundwater

Industrial releases to the canal as a result of ongoing activities have been greatly reduced over the past several decades as a result of state and federal regulation, the City's Industrial Pretreatment Program, and a reduction in the level of industrial activity in the area surrounding the canal. However, there remains the potential for the continued release of chemicals to the canal as a result of historic site activities surrounding the canal and as a result of some continued industrial operations (e.g., barge/shipping activities). There remain 11 CSOs that continue to discharge untreated waste materials directly to the Canal during significant (at least 1/10 inch of rainfall) storm events. Finally, there is the potential for the continued release of chemicals into the Gowanus Canal from the adjacent Gowanus Bay as a result of tidal flux and from the Buttermilk Channel during operation of the flushing tunnel.

2.2.2 Contaminant Fate and Transport

Once released to surface water, the fate of the chemicals will be affected by a variety of environmental and physiochemical influences, including the mass of the chemical, the distance from the source, chemical fate properties (e.g., biodegradability, solubility, and hydrophobicity), sediment type, and water velocity. Most chemicals would be diluted immediately following release to surface water. Volatile chemicals (e.g., volatile organic chemicals) would largely partition into the overlying air, while many soluble chemicals would remain in surface water as a dissolved fraction. Chemicals would also adsorb/absorb to smaller particulates and remain suspended in surface water. A portion of the chemicals present in the water column may be transported from the canal and into the Upper Gowanus Bay.

Sediments represent a depositional "sink" and the highest concentrations of chemicals that have been released to the canal are likely to be present in sediment. Recalcitrant hydrophobic organic chemicals (e.g., polycyclic aromatic hydrocarbons, or PAHs), which tend to adhere/adsorb to organic materials, and metals precipitates are examples of the historically released chemicals that would be expected to be present at the highest concentrations in canal sediment. Based on the overall low energy of this aquatic environment, the Gowanus Canal is expected to be a depositional environment, where sediments will accrete and be buried over time. Following deposition, there is the potential for some chemicals in shallow sediments to partition back into surface water. There is also the potential for shallow sediments and associated chemicals to be remobilized to surface water by physical events, such as heavy storms, tidal fluctuations, and propeller wash. During this remobilization, a portion of the total chemical load may be re-exposed and/or move to upstream or downstream locations.

2.2.3 Exposure Pathways/Routes

Because of its highly urbanized location, the Gowanus Canal will provide habitat for a limited community of aquatic invertebrates, fish, and avian life. These receptors could be exposed to site-related chemicals via several exposure routes. Lower-trophic-level species, such as benthic macroinvertebrates, would have their greatest exposure through direct contact with chemicals in surficial sediment and sediment pore water. Fish and other water-column-dwelling aquatic life could be exposed to chemicals from direct exposure in surface water, from direct exposure to and ingestion of sediment, and from the ingestion of food items. Avian wildlife could be exposed to chemicals via several exposure routes, including the direct ingestion of chemicals in sediment, the ingestion of chemicals in prey, and the ingestion of surface water. The relative importance of these exposure routes depends on the specific receptor and chemical being evaluated. Dabbling ducks, for example, ingest a substantial amount of sediment while foraging, while sit-and-wait predators, such as heron, ingest only minimal amounts of sediment. For chemicals having the potential to bioaccumulate, the greatest exposure for wildlife is expected to be from the ingestion of prey. Although these receptors will intake water through incidental ingestion, water ingestion is expected to be minimal and to not represent an important exposure pathway due to the high salinity of this water body, which negates its use as a drinking water source. Figure 2-1 depicts the potentially complete exposure pathways and identifies specific receptor groups identified for evaluation in the ERA.

2.3 Receptors and Endpoints

The conclusion of the problem formulation stage includes the selection of assessment and measurement endpoints for evaluation. Endpoints define ecological attributes that are to be protected (assessment endpoints) and measurable characteristics of those attributes (measurement endpoints) that are used to gauge the degree of impact that has or could occur. Assessment endpoints relate to attributes of biological populations or communities and are intended to focus the risk assessment on particular components of the ecosystem that could be adversely affected by contaminants from the site (USEPA, 1997). Assessment endpoints contain an entity, which is often represented by a guild in the site ecosystem (e.g., avian omnivores) and ecologically relevant attributes of that entity (e.g., survival rate and/or reproduction).

Because of the complexity of natural systems, it is generally not possible to directly assess potential impacts to all ecological receptors present within an area. Therefore, receptor species (e.g., heron) or species groups (e.g., benthic macroinvertebrates) were selected as surrogates to represent the broader components of the ecological community (e.g., guilds such as avian omnivores) identified in the assessment endpoints. Species selected as surrogates typically have the following characteristics:

- Are known to occur, or are likely to occur, at the site
- Have a particular ecological, economic, or aesthetic value
- Are representative of taxonomic groups, life history traits, and/or trophic levels in the habitats present at the site for which complete exposure pathways are likely to exist
- Can be expected, because of toxicological sensitivity or potential exposure magnitude, to represent potentially sensitive populations at the site

Based on information available about the habitat and ecological species and chemicals present at the Gowanus Canal, the following assessment point/receptor combinations were selected for evaluation in the ERA:

- **Survival and reproduction of benthic macroinvertebrate communities.** Benthic macroinvertebrates serve as a forage base for many aquatic and semiaquatic species. Benthic macroinvertebrates also play an important role in the processing and breakdown of organic matter in aquatic systems. Sediment-dwelling benthic invertebrates have potential to be exposed to chemicals in sediment because they have direct contact with sediment particulates and surrounding pore water, and many species ingest a significant amount of sediment. A population of benthic macroinvertebrates that is limited by chemical concentrations at the site would support lower populations of fish, aquatic birds, and mammals that forage on these invertebrates.

  Given the broad-based nature of benthic macroinvertebrate community and the available toxicity screening values, coupled with the objective of evaluating the condition of the overall benthic community, no specific benthic macroinvertebrate species was selected for evaluation. Instead, the benthic macroinvertebrate community was identified as the surrogate for evaluation.

- **Survival and reproduction of water-column-dwelling aquatic life communities.** Water-column-dwelling aquatic life would be exposed to chemicals in surface water by direct contact, respiration, and ingestion of surface water.

  Given the broad-based nature of the toxicity screening values for water-column-dwelling aquatic life and the objective of evaluating the condition of this community, no specific water-column-dwelling aquatic species was selected for evaluation. Instead, the water-column-dwelling aquatic community as a whole was identified as the surrogate for evaluation.

- **Survival and reproduction of avian aquatic herbivores.** Although rooted aquatic vegetation was not observed in the Gowanus Canal, there is algal growth on the canal walls and in the sediments along shallower portions of the canal. Herbivorous avian species could be exposed to chemicals via the ingestion of plant materials that have accumulated these chemicals. Black duck (*Anas rubripes*) was chosen to represent the avian aquatic herbivore. Although the black duck ingests food items (e.g., insects, worms) in addition to plant materials, it was selected as the representative herbivore because a large proportion of its diet is composed of plant materials, and it has been observed foraging in the canal.

- **Survival and reproduction of avian aquatic omnivores.** These receptors could be exposed to chemicals that have bioaccumulated in both fish and aquatic invertebrate tissues. Green heron (*Butorides virescens*) was chosen to represent this endpoint because they have been observed in the canal and have potential to prey upon aquatic invertebrates (e.g., crabs), in addition to fish.

- **Survival and reproduction of avian aquatic piscivores.** These receptors are top-level consumers and could be exposed to bioaccumulative chemicals, especially those that could biomagnify through the aquatic food web. The double-crested cormorant (*Phalacrocorax auritus*) was chosen to represent this endpoint, based on the expectation that it could occur at the site and ingests primarily fish.

The following measurement endpoints were identified based on the assessment endpoints selected for evaluation:

- **Survival and reproduction of benthic macroinvertebrate communities.** Assessed by comparing medium-specific site concentrations to sediment benchmarks, evaluating site-specific chronic sediment bioassay outcomes, and comparing benthic invertebrate (crab) site tissue concentrations to applicable tissue residue benchmarks.

- **Survival and reproduction of water-column-dwelling aquatic life communities.** Assessed by comparing medium-specific site concentrations to surface water benchmarks and comparing fish site tissue concentrations to applicable tissue residue benchmarks.

- **Survival and reproduction of wildlife (avian aquatic herbivores, omnivores, and piscivores).** Assessed by comparing modeled exposure doses to dose-based ecological screening values.

Table 2-2 summarizes the receptor-specific exposure pathways, assessment endpoints, and measurement endpoints selected for evaluation in the ERA. The assessment endpoint for most receptor groups references an impact on survival and/or reproduction, as these represent ecologically relevant endpoints for these groups.

TABLE 2-1

Species of Special Concern Potentially Occurring in Aquatic Habitats Near the Gowanus Canal

Gowanus Canal Remedial Investigation

Brooklyn, New York

Common Name	Species Name	FE	FT	FS	SE	ST	SC	Notes
Fish								
Atlantic sturgeon	*Acipenser brevirostrum*	X			X			
Reptiles								
Atlantic (Kemp's) ridley sea turtle	*Lepidochelys kempii*	X			X			
Atlantic hawksbill sea turtle	*Eretmochelys imbricata*				X			
Diamondback terrapin	*Maclemys t. terrapin*			X				
Leatherback sea turtle	*Dermochelys coriacea*				X			
Loggerhead sea turtle	*Caretta caretta*		X			X		
Birds								
Bald eagle	*Haliaeetus leucocephalus*					X		
Common tern	*Sterna hirundo*					X		
Least bittern	*Ixobrychus exilis*						X	
Least tern	*Sterna antillarum*				X			
Osprey	*Pandion haliaetus*					X		
Peregrine falcon	*Falco peregrinus*	X			X			
Pied-billed grebe	*Podilymbus podiceps*					X		Recently confirmed
Roseate tern	*Sterna dougallii*	X			X			
Upland sandpiper	*Bartramia longicauda*						X	

Notes:

FE = Federal endangered
FT = Federal threatened
FS = Federal species of concern
SE = State endangered
ST = State threatened
SC = State species of concern

Sources:

USFWS. Species by County Report. Online search for Kings County on November 16, 2010.

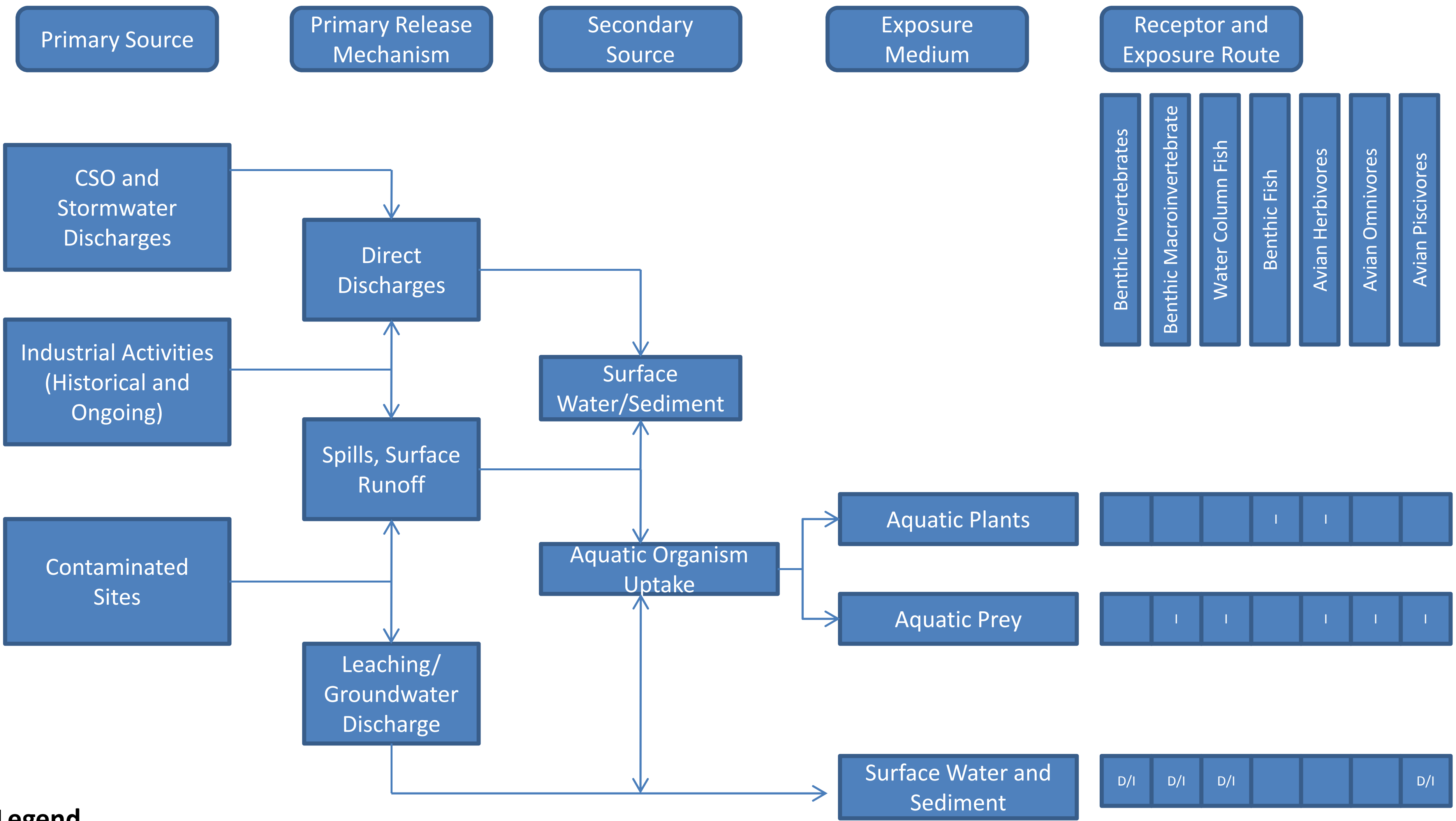
New York Heritage Program. New York Nature Explorer. Online search for Kings County on November 15, 2010.

NYDEC. List of Endangered, Threatened and Special Concern Fish & Wildlife Species of New York State (http://www.dec.ny.gov/animals/7494.html)

USFWS. 1997. Significant Habitats and Habitat Complexes of the New York Bight Watershed, Jamaica Bay and Breezy Point.

TABLE 2-2
Exposure Pathways and Receptors Selected for Evaluation
Gowanus Canal Remedial Investigation
Brooklyn, New York

Receptor	Assessment Endpoint	Surrogate Organism	Pathway/Route Selected for Evaluation	Measurement Endpoint(s)
Aquatic Receptors				
Benthic macroinvertebrates	Survival and reproduction of benthic macroinvertebrate communities	Benthic macroinvertebrates - general	Direct exposure to chemicals in sediment	1. Comparison of the ratio of medium-specific site concentrations and ecological screening values for benthic macroinvertebrates to a reference hazard quotient of 1. 2. Evaluation of chronic sediment bioassay outcomes conducted with *L . plumulosus* and *N. virens* .
Water column-dwelling aquatic life	Survival and reproduction of water column-dwelling aquatic life communities	Aquatic life - multiple species	Direct exposure to constituents in surface water	1. Comparison of the ratio of medium-specific site concentrations and ecological screening values for water column-dwelling aquatic species to a reference hazard quotient of 1. 2. Comparison of the ratio of fish and crab tissue residue concentrations and ecological screening values for fish and decapod tissue concentrations to a reference hazard quotient of 1.
Avian aquatic herbivores	Growth, survival, and reproduction of avian aquatic herbivores	Black duck	Exposure to chemicals from the ingestion of chemicals accumulated in plant/food base (from surface water and sediment) and from the direct ingestion of chemicals in sediment	Comparison of the ratio of modeled exposure doses and dose-based ecological screening values for black duck to a reference hazard quotient of 1.
Avian aquatic omnivores	Survival and reproduction of avian aquatic omnivores	Green heron	Exposure to chemicals from the ingestion of chemicals accumulated in prey (from surface water and sediment) and from the direct ingestion of chemicals in sediment	Comparison of the ratio of modeled exposure doses and dose-based ecological screening values for green heron to a reference hazard quotient of 1.
Avian aquatic piscivores	Survival and reproduction of avian aquatic piscivores	Double-crested cormorant	Exposure to chemicals from the ingestion of chemicals accumulated in prey (from surface water and sediment) and from the direct ingestion of chemicals in sediment	Comparison of the ratio of modeled exposure doses and dose-based ecological screening values for double-crested cormorant to a reference hazard quotient of 1.



Legend
I = Ingestion
D = Direct Contact
Complete exposure pathways are indicated with a D and/or I shown in the receptor boxes. All other pathways were not evaluated due to lack of significance or adequate habitat. Empty boxes indicate incomplete pathways.

FIGURE 2-1
Conceptual Site Model for Pathways to Ecological Receptors
Gowanus Canal Remedial Investigation
Brooklyn, New York

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SECTION 3

Screening-Level Assessment

The following section discusses the approach for conducting the SLERA for Gowanus Canal. The SLERA represents a first evaluation of potential risks in the eight-step ERA process, the objective of which is to determine if there is a potential risk to ecological receptors under highly conservative assumptions. As discussed in Section 2.2, the SLERA evaluated potential risks to benthic macroinvertebrates and water-column-dwelling aquatic life using sediment and surface water chemical analytical data collected during the Phase 3 investigation. If a SLERA indicates no unacceptable potential for adverse effects to those receptors, the ERA process can be terminated at the end of the SLERA for those receptors, according to USEPA (1997) ERAGs. Otherwise, the evaluation of those receptors continues in the BERA. The remaining wildlife assessment endpoints were not considered in the SLERA, but were instead carried forward and directly evaluated in the BERA.

In this evaluation, potential risks were indicated in the SLERA for both benthic macroinvertebrates and water-column-dwelling aquatic life. The results of the SLERA are accordingly used to provide information about the chemicals indicating risks to those receptors. This information can be used, along with additional site-specific analyses, to further evaluate the potential for adverse effects to those receptors in the BERA.

3.1 Screening-Level Exposure Estimates

The screening-level exposure estimate summarizes the analytical data to be considered for use in the SLERA, the data groupings, and the exposure models and input parameters that are used to estimate the potential exposure of ecological receptors to chemicals at the site. As is consistent with the objectives of the SLERA, conservative assumptions were used in models estimating the potential exposure of ecological receptors to chemicals in the environment. Direct exposure of ecological receptors to chemicals in sediment and surface water is evaluated in the SLERA. The primary objective of the SLERA screening is to determine if these media represent a potential source of chemicals to the environment and the results of these screens can be used to further characterize potential chemical fate and transport pathways associated with the conceptual site model for the ERA.

3.1.1 Evaluated Analytical Data

Table 3-1 summarizes the site-specific Phase 3 sample data that were evaluated in the SLERA, along with the data groupings used for this evaluation. Given the CSM and receptors identified for evaluation, the SLERA focused on the evaluation of surface sediment (0 to 6 inches) and surface water chemistry data in the Gowanus Canal. The following subsections summarize the sediment and surface water data evaluated in the SLERA.

Sediment Chemistry

Surficial (0 to 6 inches) sediment samples collected from a total of 27 sample locations along the length of Gowanus Canal were placed into a single grouping for analysis. The locations from which these samples were taken are shown in Figures 2a, 2b, and 2c of the RI. A detailed description of this sample event is presented in Section 2.3 of the RI. Subsurface sediments were not evaluated because the exposure of ecological receptors to subsurface sediment is expected to be minimal in this water body.

Surface Water Chemistry

Surface water collected from a 27 sample locations along the length of Gowanus Canal under different water flow conditions was placed into the following two groupings for analysis:

- Dry-weather event—sampling occurred at least 2 to 3 days after the previous storm event. The objective of the dry-weather event was to collect samples when there was no direct CSO input to the Gowanus Canal.
- Wet-weather event—sampling occurred after at least 1/10 inch rain fell with low-tide conditions, with samples collected between 3 to 6 hours after the start of the rainfall. The objective of the wet-weather event was to collect samples while the CSOs are active and discharging water to the Gowanus Canal.

3.1.2 Exposure Estimation

The following guidelines were used in the SLERA to estimate the potential direct exposure of ecological receptors:

- For each data group, the maximum detected chemical concentrations were used to conservatively estimate potential direct chemical exposures.
- For samples with duplicate analyses, the higher of the two concentrations was used to estimate exposure if both values are detects. In cases where one result is a detected concentration and the other a nondetect, the detected value was used in the screening.
- Nondetected chemicals were not screened in the SLERA, but were instead considered in the uncertainty section of the ERA (Section 7).

A summary of the maximum detected chemical concentrations detected in Gowanus Canal surface sediment (0 to 6 inches) is presented in Table 3-2. Summaries of the maximum detected chemical concentrations detected in Gowanus Canal surface water under dry and wet event sample conditions are presented in Tables 3-3 and 3-4, respectively.

3.2 Screening-Level Effects Evaluation

The purpose of the screening-level effects evaluation is to establish chemical exposure levels (screening values) that represent conservative thresholds for adverse ecological effects. Screening levels in this SLERA were developed to be protective of the selected ecological receptors from direct exposure to chemicals in sediment and surface water.

Media-specific screening values are designed to identify chemical concentrations that are protective of ecological receptors from direct exposure to chemicals in that media. Two categories of media-specific screening values were used in the SLERA to evaluate potential direct exposure risks to ecological receptors:

- Sediment screening benchmarks—used to screen the potential for adverse effects to benthic invertebrates from exposure to chemicals in sediment
- Water screening benchmarks—used to screen the potential for adverse effects to water-column-dwelling aquatic life from exposure to chemicals in surface water

The following subsections summarize the process used to select benchmarks for these media.

3.2.1 Sediment Screening Benchmarks

Several sources were considered when selecting sediment screening benchmarks for the evaluation of potential impacts to benthic macroinvertebrates. NYSDEC (1999) sediment criteria were used for screening, when available. Some of the organic chemical screening benchmarks selected from this guidance for use in the ERA were based on equilibrium partitioning, which required the organic carbon content of the sediment to be estimated to derive the ecological screening benchmark. For the purposes of this evaluation, a sediment total organic carbon content of 2 percent was conservatively assumed. The measured organic carbon concentrations in the Phase 3 surface sediment samples were higher (range: 0.2 percent to 14 percent; mean: 5.4 percent), and use of the 2 percent sediment total organic carbon content therefore would result in a conservative screening value.

In the absence of applicable values from the NYSDEC, a broader range of sources was reviewed to identify additional screening values. Values from the following additional sources were used for screening:

- Effects Range—Low (ER-L) values from Long and Morgan (1991);
- Threshold Effects Level (TEL) values from MacDonald (1994); and
- Marine Sediment Quality Standards from the Washington Department of Ecology (WDOE, 1995).

The lowest available value from the above sources was generally used for screening when a value was not available from NYSDEC (1999). A summary of the sediment screening benchmarks selected for use in the SLERA is presented in Table 3-5.

3.2.2 Surface Water Screening Benchmarks

National Recommended Water Quality Criteria (USEPA, 2009) saltwater chronic values were used when available as screening benchmarks to evaluate the potential for impacts to water-column-dwelling aquatic life. In the absence of these values, marine surface water chronic values reported in Buchman (2008) were used for screening. A summary of the surface water screening benchmarks selected for use in the SLERA is presented in Table 3-5.

3.3 Screening-Level Risk Calculation

Maximum detected chemical concentrations (Section 3.1) were compared to the medium-specific screening values (Section 3.2) using a hazard quotient (HQ) approach to identify chemicals of potential concern (COPCs). HQs were calculated for each parameter by dividing the maximum detected concentration by the screening value. HQs greater than 1 were interpreted as indicating the potential for risk to ecological receptors, since the chemical exposure concentration exceeds a toxicity threshold represented by the screening value. Chemicals were identified as COPCs if they were detected at concentrations exceeding screening values. Consistent with the conservative screening approach used in the SLERA, chemicals were also identified as COPCs if they were detected but lacked screening values. These chemicals were further discussed within the uncertainty section of the ERA (Section 7).

TABLE 3-1
Summary of Sample Data Evaluated in the ERA
Gowanus Canal Remedial Investigation
Brooklyn, New York

Sample ID	Location Code	Sample Date	Sampe Type	Depth (feet)	General Chemistry	Metals, Dissolved	Metals, Total	Metals, SEM	PCB Congeners	PCBs	Pesticides	SVOCs	VOCs
Sediment (Canal)													
GC-SD301-0.0-0.5	301	06/23/10	N	0 - 0.5			x	x	x	x	x	x	x
GC-SD302-0.0-0.5	302	06/17/10	N	0 - 0.5			x	x		x	x	x	x
GC-SD303-0.0-0.5	303	06/17/10	N	0 - 0.5			x	x	x	x	x	x	x
GC-SD304-0.0-0.5	304	06/17/10	N	0 - 0.5			x	x		x	x	x	x
GC-SD305-0.0-0.5	305	06/17/10	N	0 - 0.5			x	x	x	x	x	x	x
GC-SD306-0.0-0.5	306	06/17/10	N	0 - 0.5			x	x		x	x	x	x
GC-SD307A-0.0-0.5	307A	06/17/10	N	0 - 0.5			x	x	x	x	x	x	x
GC-SD307B-0.0-0.5	307B	06/18/10	N	0 - 0.5			x	x	x	x	x	x	x
GC-SD308A-0.0-0.5	308A	06/23/10	N	0 - 0.5			x	x	x	x	x	x	x
D-062310-01	308A	06/23/10	FD	0 - 0.5			x		x	x	x	x	x
GC-SD308B-0.0-0.5	308B	06/24/10	N	0 - 0.5			x	x	x	x	x	x	x
GC-SD309-0.0-0.5	309	06/18/10	N	0 - 0.5			x	x	x	x	x	x	x
GC-SD310-0.0-0.5	310	06/24/10	N	0 - 0.5			x	x	x	x	x	x	x
GC-SD311-0.0-0.5	311	06/23/10	N	0 - 0.5			x	x		x	x	x	x
GC-SD312-0.0-0.5	312	06/23/10	N	0 - 0.5			x	x	x	x	x	x	x
GC-SD313-0.0-0.5	313	06/18/10	N	0 - 0.5			x	x	x	x	x	x	x
GC-SD314-0.0-0.5	314	06/18/10	N	0 - 0.5			x	x	x	x	x	x	x
D-06182010-01	314	06/18/10	FD	0 - 0.5			x		x	x	x	x	
D-06242010-01	314	06/18/10	FD	0 - 0.5									x
GC-SD315-0.0-0.5	315	06/18/10	N	0 - 0.5			x	x	x	x	x	x	x
D-06182010-02	315	06/18/10	FD	0 - 0.5			x		x	x	x	x	
GC-SD316-0.0-0.5	316	06/21/10	N	0 - 0.5			x	x		x	x	x	x
GC-SD317-0.0-0.5	317	06/22/10	N	0 - 0.5			x	x		x	x	x	x
GC-SD318-0.0-0.5	318	06/22/10	N	0 - 0.5			x	x	x	x	x	x	x
GC-SD319-0.0-0.5	319	06/22/10	N	0 - 0.5			x	x	x	x	x	x	x
GC-SD320-0.0-0.5	320	06/22/10	N	0 - 0.5			x	x	x	x	x	x	x
GC-SD321-0.0-0.5	321	06/21/10	N	0 - 0.5			x	x	x	x	x	x	x
GC-SD322-0.0-0.5	322	06/22/10	N	0 - 0.5			x	x		x	x	x	x
GC-SD323-0.0-0.5	323	06/22/10	N	0 - 0.5			x	x		x	x	x	x
GC-SD324-0.0-0.5	324	06/21/10	N	0 - 0.5			x	x	x	x	x	x	x
D-06212010-01	324	06/21/10	FD	0 - 0.5			x		x	x	x	x	x
GC-SD325-0.0-0.5	325	06/21/10	N	0 - 0.5			x	x	x	x	x	x	x
Surface Water, Canal (Dry Event)													
GC-SW301-0.5-DW	301	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW302-0.5-DW	302	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW303-0.5-DW	303	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW304-0.5-DW	304	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW305-0.5-DW	305	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW306-0.5-DW	306	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x

TABLE 3-1
Summary of Sample Data Evaluated in the ERA
Gowanus Canal Remedial Investigation
Brooklyn, New York

Sample ID	Location Code	Sample Date	Sampe Type	Depth (feet)	General Chemistry	Metals, Dissolved	Metals, Total	Metals, SEM	PCB Congeners	PCBs	Pesticides	SVOCs	VOCs
GC-SW307A-0.5-DW	307A	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW307B-0.5-DW	307B	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW308A-0.5-DW	308A	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW308B-0.5-DW	308B	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW309-0.5-DW	309	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW310-0.5-DW	310	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW311-0.5-DW	311	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW312-0.5-DW	312	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
D-06192010-02	312	06/19/10	FD	0.5 - 0.5		x	x			x	x	x	x
GC-SW313-0.5-DW	313	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW314-0.5-DW	314	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW315-0.5-DW	315	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW316-0.5-DW	316	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
D-06192010-03	316	06/19/10	FD	0.5 - 0.5		x	x			x	x	x	x
GC-SW317-0.5-DW	317	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW318-0.5-DW	318	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
D-06192010-04	318	06/19/10	FD	0.5 - 0.5		x	x			x	x	x	x
GC-SW319-0.5-DW	319	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW320-0.5-DW	320	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW321-0.5-DW	321	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW322-0.5-DW	322	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW323-0.5-DW	323	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW324-0.5-DW	324	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW325-0.5-DW	325	06/19/10	N	0.5 - 0.5	x	x	x			x	x	x	x
Surface Water, Canal (Wet Event)													
GC-SW301-0.5-WW	301	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW302-0.5-WW	302	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW303-0.5-WW	303	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
D-07132010-01	303	07/13/10	FD	0.5 - 0.5		x	x			x	x	x	x
GC-SW304-0.5-WW	304	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW305-0.5-WW	305	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW306-0.5-WW	306	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW307A-0.5-WW	307A	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW307B-0.5-WW	307B	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW308A-0.5-WW	308A	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW308B-0.5-WW	308B	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW309-0.5-WW	309	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW310-0.5-WW	310	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
D-07132010-02	310	07/13/10	FD	0.5 - 0.5		x	x			x	x	x	x
GC-SW311-0.5-WW	311	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW312-0.5-WW	312	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x

TABLE 3-1
Summary of Sample Data Evaluated in the ERA
Gowanus Canal Remedial Investigation
Brooklyn, New York

Sample ID	Location Code	Sample Date	Sampe Type	Depth (feet)	General Chemistry	Metals, Dissolved	Metals, Total	Metals, SEM	PCB Congeners	PCBs	Pesticides	SVOCs	VOCs
GC-SW313-0.5-WW	313	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW314-0.5-WW	314	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW315-0.5-WW	315	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW316-0.5-WW	316	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW317-0.5-WW	317	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW318-0.5-WW	318	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW319-0.5-WW	319	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
D-07132010-03	319	07/13/10	FD	0.5 - 0.5		x	x			x	x	x	x
GC-SW320-0.5-WW	320	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW321-0.5-WW	321	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW322-0.5-WW	322	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW323-0.5-WW	323	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
GC-SW324-0.5-WW	324	07/13/10	N	0.5 - 0.5	x	x	x			x	x	x	x
D-07132010-04	324	07/13/10	FD	0.5 - 0.5		x	x			x	x	x	x

Notes:
Sampe Type: N - Normal, environmental sample; FD - Field Duplicate
PCB - Polychlorinated Biphenyls
SVOC - Semivolatile Organic Compounds
VOC - Volatile Organic Compounds

TABLE 3-2
Screening Statistics - Gowanus Canal Surface Sediment (0-6") - Step 2
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Mean (1/2 RL for Non Detects)	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient	COPC?
Volatile Organic Compounds (ug/kg)									
1,2-dichloroethane	6 / 27 (22.2%)	5.00 - 23.0	3.90 - 45.0	323	9.10	NSV	0 / 27	NSV	NSV
1,4-dichlorobenzene	3 / 26 (11.5%)	5.00 - 23.0	7.60 - 240	301	16.8	240	0 / 26	1.0	No
Acetone	11 / 27 (40.7%)	9.90 - 46.0	21.0 - 90.0	314	25.0	NSV	0 / 27	NSV	NSV
Benzene	4 / 27 (14.8%)	5.00 - 23.0	6.80 - 110	304	13.7	520	0 / 27	0.21	No
Carbon disulfide	9 / 27 (33.3%)	5.00 - 23.0	4.70 - 89.0	314	10.2	NSV	0 / 27	NSV	NSV
Chlorobenzene	1 / 27 (3.7%)	5.00 - 23.0	53.0 - 53.0	301	9.44	70	0 / 27	0.76	No
Cyclohexane	3 / 27 (11.1%)	5.00 - 23.0	8.00 - 14.0	304	7.86	NSV	0 / 27	NSV	NSV
Ethylbenzene	8 / 27 (29.6%)	5.00 - 23.0	5.30 - 3600	315	233	128	4 / 27	28	YES
Isopropylbenzene (cumene)	7 / 27 (25.9%)	5.00 - 23.0	4.60 - 760	315	81.0	NSV	0 / 27	NSV	NSV
m, p xylenes	5 / 27 (18.5%)	5.00 - 23.0	5.40 - 810	315	55.7	540	1 / 27	1.5	YES
Methylcyclohexane	3 / 27 (11.1%)	5.00 - 23.0	15.0 - 170	314	14.6	NSV	0 / 27	NSV	NSV
Methylene chloride	6 / 27 (22.2%)	5.00 - 23.0	2.20 - 7.70	306	6.95	NSV	0 / 27	NSV	NSV
o-xylene (1,2-dimethylbenzene)	5 / 27 (18.5%)	5.00 - 23.0	19.0 - 1200	315	82.8	540	1 / 27	2.2	YES
Tert-butyl methyl ether	1 / 27 (3.7%)	5.00 - 23.0	34.0 - 34.0	304	8.45	NSV	0 / 27	NSV	NSV
Tetrachloroethylene(PCE)	2 / 27 (7.4%)	5.00 - 23.0	5.80 - 11.0	302	7.50	NSV	0 / 27	NSV	NSV
Toluene	4 / 27 (14.8%)	5.00 - 23.0	5.80 - 36.0	314	9.17	900	0 / 27	0.04	No
Trichloroethylene (TCE)	1 / 27 (3.7%)	5.00 - 23.0	4.20 - 4.20	301	7.64	NSV	0 / 27	NSV	NSV
Trichlorofluoromethane	3 / 27 (11.1%)	5.00 - 23.0	4.60 - 8.90	302	7.33	NSV	0 / 27	NSV	NSV
Semi-Volatile Organic Compounds (ug/kg)									
2-methylnaphthalene	16 / 27 (59.3%)	120 - 3100	190 - 870000	315	33700	70	16 / 27	12000	YES
Acenaphthene	21 / 27 (77.8%)	160 - 3100	160 - 580000	315	41200	16	21 / 27	36000	YES
Acenaphthylene	14 / 27 (51.9%)	160 - 3100	270 - 150000	314	12400	44	14 / 27	3400	YES
Anthracene	24 / 27 (88.9%)	250 - 3100	330 - 610000	315	38800	85.3	24 / 27	7200	YES
Benzo(a)anthracene	27 / 27 (100%)	---	1100 - 490000	315	36500	261	27 / 27	1900	YES
Benzo(a)pyrene	26 / 27 (96.3%)	250 - 250	1200 - 200000	314	18700	430	26 / 27	470	YES
Benzo(b)fluoranthene	26 / 27 (96.3%)	250 - 250	1000 - 210000	314	19400	4600	13 / 27	46	YES
Benzo(g,h,i)perylene	26 / 27 (96.3%)	260 - 260	610 - 74000	314	7620	620	25 / 27	120	YES
Benzo(k)fluoranthene	26 / 27 (96.3%)	250 - 250	820 - 120000	314	10600	4600	9 / 27	26	YES
Biphenyl (diphenyl)	2 / 27 (7.4%)	6200 - 230000	650 - 71000	315	19200	NSV	0 / 27	NSV	NSV
Bis(2-ethylhexyl) phthalate	21 / 27 (77.8%)	8100 - 160000	2600 - 57000	314	15600	182	21 / 27	310	YES

TABLE 3-2
Screening Statistics - Gowanus Canal Surface Sediment (0-6") - Step 2
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Mean (1/2 RL for Non Detects)	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient	COPC?
Semi-Volatile Organic Compounds (ug/kg)									
Carbazole	1 / 27 (3.7%)	6200 - 230000	1400 - 1400	308A	19100	NSV	0 / 27	NSV	NSV
Chrysene	27 / 27 (100%)	---	730 - 490000	315	35600	384	27 / 27	1300	YES
Dibenz(a,h)anthracene	23 / 27 (85.2%)	320 - 3100	200 - 14000	314	1780	63.4	23 / 27	220	YES
Dibenzofuran	1 / 27 (3.7%)	6200 - 230000	1100 - 1100	319	19500	300	1 / 27	3.7	YES
Di-n-butyl phthalate	2 / 27 (7.4%)	6200 - 230000	510 - 550	318	19200	4400	0 / 27	0.13	No
Di-n-octylphthalate	1 / 27 (3.7%)	6200 - 230000	9300 - 9300	307A	19800	1160	1 / 27	8.0	YES
Fluoranthene	27 / 27 (100%)	---	1200 - 630000	314	51200	600	27 / 27	1100	YES
Fluorene	17 / 27 (63.0%)	160 - 3100	130 - 540000	315	26400	19	17 / 27	28000	YES
Indeno(1,2,3-c,d)pyrene	27 / 27 (100%)	---	1000 - 120000	314	10600	680	27 / 27	180	YES
Naphthalene	19 / 27 (70.4%)	160 - 3100	120 - 1600000	315	61600	160	18 / 27	10000	YES
Phenanthrene	26 / 27 (96.3%)	3100 - 3100	510 - 1100000	315	64800	240	26 / 27	4600	YES
Pyrene	26 / 27 (96.3%)	230 - 230	1400 - 670000	314	60200	665	26 / 27	1000	YES
Total PAHs	27 / 27 (100%)	---	10900 - 8000000	315	527000	4022	27 / 27	2000	YES
Pesticides (ug/kg)									
Alpha-chlordane	2 / 27 (7.4%)	2.70 - 530	6.70 - 14.0	308A	79.7	0.04	2 / 27	350	YES
Beta endosulfan	1 / 27 (3.7%)	5.30 - 1000	13.0 - 13.0	308A	154	0.08	1 / 27	160	YES
Endosulfan sulfate	1 / 27 (3.7%)	5.30 - 1000	21.0 - 21.0	308A	154	NSV	0 / 27	NSV	NSV
Gamma-chlordane	3 / 27 (11.1%)	2.70 - 530	5.90 - 29.0	308A	80.6	0.04	3 / 27	730	YES
Methoxychlor	1 / 27 (3.7%)	27.0 - 5300	33.0 - 33.0	308A	792	NSV	0 / 27	NSV	NSV
P,P'-DDD	5 / 5 (100%)	---	7.90 - 1100	315	232	1.22	5 / 5	900	YES
P,P'-DDE	1 / 26 (3.8%)	5.30 - 1000	16.0 - 16.0	308A	160	2.2	1 / 26	7.3	YES
Total DDTs	5 / 5 (100%)	---	7.90 - 1100	315	235	1.58	5 / 5	700	YES
Polychlorinated Biphenyls (ug/kg)									
Aroclor 1016	4 / 27 (14.8%)	41.0 - 120	140 - 290	318	68.5	22.7	4 / 27	13	YES
Aroclor 1248	2 / 27 (7.4%)	41.0 - 120	230 - 2200	316	128	22.7	2 / 27	97	YES
Aroclor 1254	1 / 27 (3.7%)	48.0 - 120	590 - 590	308A	61.9	22.7	1 / 27	26	YES
Aroclor 1260	7 / 27 (25.9%)	41.0 - 120	150 - 3400	314	318	22.7	7 / 27	150	YES
Total PCBs	10 / 27 (37.0%)	---	230 - 3400	314	432	22.7	10 / 27	150	YES
Polychlorinated Biphenyl Congeners (ng/kg)									
Total PCB Congeners	19 / 19 (100%)	---	99500 - 15100000	314	2810000	59800	19 / 19	250	YES

TABLE 3-2
Screening Statistics - Gowanus Canal Surface Sediment (0-6”) - Step 2
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Mean (1/2 RL for Non Detects)	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient	COPC?
Metals (mg/kg)									
Aluminum	27 / 27 (100%)	---	4870 - 18900	310	13200	NSV	0 / 27	NSV	NSV
Arsenic	27 / 27 (100%)	---	3.40 - 44.7	308A	12.1	8.2	19 / 27	5.5	YES
Barium	27 / 27 (100%)	---	83.1 - 631	317	175	130.1	15 / 27	4.9	YES
Beryllium	12 / 27 (44.4%)	0.60 - 1.60	0.11 - 0.46	309	0.474	NSV	0 / 27	NSV	NSV
Cadmium	27 / 27 (100%)	---	1.50 - 20.2	308A	6.30	1.2	27 / 27	17	YES
Calcium	27 / 27 (100%)	---	4890 - 11300	313	7640	NSV	0 / 27	NSV	NSV
Chromium	27 / 27 (100%)	---	22.7 - 139	314	76.0	81	8 / 27	1.7	YES
Cobalt	14 / 27 (51.9%)	7.30 - 17.1	6.50 - 14.8	318	9.13	NSV	0 / 27	NSV	NSV
Copper	27 / 27 (100%)	---	85.8 - 790	308A	226	34	27 / 27	23	YES
Iron	27 / 27 (100%)	---	12400 - 87000	308A	29200	NSV	0 / 27	NSV	NSV
Lead	27 / 27 (100%)	---	146 - 4220	308A	533	46.7	27 / 27	90	YES
Magnesium	27 / 27 (100%)	---	4210 - 11400	318	8740	NSV	0 / 27	NSV	NSV
Manganese	27 / 27 (100%)	---	89.1 - 480	308A	276	460	1 / 27	1.0	No
Mercury	27 / 27 (100%)	---	0.59 - 2.30	313	1.27	0.15	27 / 27	15	YES
Nickel	27 / 27 (100%)	---	18.1 - 84.5	314	43.8	20.9	26 / 27	4.0	YES
Potassium	27 / 27 (100%)	---	730 - 4410	310	3200	NSV	0 / 27	NSV	NSV
Selenium	15 / 27 (55.6%)	4.20 - 12.0	0.74 - 4.90	310	3.04	NSV	0 / 27	NSV	NSV
Silver	22 / 27 (81.5%)	1.20 - 3.20	1.80 - 6.80	310	3.40	1	22 / 27	6.8	YES
Sodium	27 / 27 (100%)	---	2610 - 18700	322	11100	NSV	0 / 27	NSV	NSV
Vanadium	27 / 27 (100%)	---	19.4 - 61.2	316	42.6	NSV	0 / 27	NSV	NSV
Zinc	17 / 17 (100%)	---	240 - 1520	308A	744	150	17 / 17	10	YES
Cyanide, Total	14 / 27 (51.9%)	3.60 - 8.30	0.54 - 18.0	302	3.65	NSV	0 / 27	NSV	NSV

TABLE 3-3
Screening Statistics - Gowanus Canal Surface Water (Dry Event Sampling) - Step 2
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Mean (1/2 RL for Non Detects)	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient	COPC?
Volatile Organic Compounds (ug/l)									
1,4-dichlorobenzene	1 / 27 (3.7%)	0.50 - 0.50	0.11 - 0.11	320	0.245	129	0 / 27	0.00085	No
Acetone	26 / 27 (96.3%)	5.00 - 5.00	1.10 - 6.70	317	2.24	NSV	0 / 27	NSV	NSV
Benzene	18 / 27 (66.7%)	0.50 - 0.50	0.50 - 11.0	304	1.20	110	0 / 27	0.1	No
Ethylbenzene	16 / 27 (59.3%)	0.50 - 0.50	0.19 - 1.30	320	0.37	25	0 / 27	0.052	No
m, p xylenes	17 / 27 (63.0%)	0.50 - 0.50	0.16 - 1.30	320	0.364	NSV	0 / 27	NSV	NSV
Methylene chloride	3 / 27 (11.1%)	0.50 - 0.50	0.76 - 1.00	310	0.319	6400	0 / 27	0.00016	No
o-xylene (1,2-dimethylbenzene)	5 / 27 (18.5%)	0.50 - 0.50	0.24 - 0.53	320	0.271	NSV	0 / 27	NSV	NSV
Tert-butyl methyl ether	1 / 27 (3.7%)	0.50 - 0.50	0.18 - 0.18	304	0.247	5000	0 / 27	0.000036	No
Toluene	16 / 27 (59.3%)	0.50 - 0.50	0.17 - 0.95	308B	0.327	215	0 / 27	0.0044	No
Semi-Volatile Organic Compounds (ug/l)									
2-methylnaphthalene	1 / 27 (3.7%)	0.10 - 0.10	0.017 - 0.017	315	0.0488	NSV	0 / 27	NSV	NSV
Acenaphthene	21 / 27 (77.8%)	0.10 - 0.10	0.26 - 0.94	319	0.417	40	0 / 27	0.024	No
Anthracene	3 / 27 (11.1%)	0.10 - 0.10	1.20 - 5.20	325	0.352	NSV	0 / 27	NSV	NSV
Benzo(a)anthracene	7 / 27 (25.9%)	0.10 - 0.10	0.12 - 0.83	325	0.131	NSV	0 / 27	NSV	NSV
Benzo(a)pyrene	3 / 27 (11.1%)	0.10 - 0.10	0.19 - 0.66	319	0.0863	NSV	0 / 27	NSV	NSV
Benzo(b)fluoranthene	21 / 27 (77.8%)	0.10 - 0.10	0.11 - 0.88	319	0.216	NSV	0 / 27	NSV	NSV
Benzo(g,h,i)perylene	5 / 27 (18.5%)	0.10 - 0.10	0.099 - 0.15	302, 307A	0.0651	NSV	0 / 27	NSV	NSV
Benzo(k)fluoranthene	11 / 27 (40.7%)	0.10 - 0.10	0.10 - 0.29	319, 325	0.103	NSV	0 / 27	NSV	NSV
Bis(2-ethylhexyl) phthalate	13 / 27 (48.1%)	5.00 - 5.00	0.71 - 5.60	321	2.51	360	0 / 27	0.016	No
Caprolactam	1 / 27 (3.7%)	5.00 - 5.00	1.00 - 1.00	312	2.44	NSV	0 / 27	NSV	NSV
Carbazole	2 / 27 (7.4%)	5.00 - 5.00	1.10 - 2.10	325	2.43	NSV	0 / 27	NSV	NSV
Chrysene	15 / 27 (55.6%)	0.10 - 0.10	0.11 - 1.10	325	0.195	NSV	0 / 27	NSV	NSV
Dimethyl phthalate	8 / 27 (29.6%)	5.00 - 5.00	1.50 - 3.40	324	2.47	3.4	0 / 27	1.0	No
Di-n-butyl phthalate	3 / 27 (11.1%)	5.00 - 5.00	1.00 - 1.40	301	2.35	3.4	0 / 27	0.41	No
Fluoranthene	23 / 27 (85.2%)	0.10 - 0.10	0.095 - 2.30	325	0.443	11	0 / 27	0.21	No
Fluorene	15 / 27 (55.6%)	0.10 - 0.10	0.11 - 0.19	325	0.0926	NSV	0 / 27	NSV	NSV
Indeno(1,2,3-c,d)pyrene	10 / 27 (37.0%)	0.10 - 0.10	0.097 - 0.22	319	0.0847	NSV	0 / 27	NSV	NSV
Phenanthrene	11 / 27 (40.7%)	0.10 - 0.10	0.10 - 0.58	325	0.114	4.6	0 / 27	0.13	No
Phenol	1 / 27 (3.7%)	5.00 - 5.00	1.30 - 1.30	314	2.46	400	0 / 27	0.0033	No
Pyrene	6 / 27 (22.2%)	0.10 - 0.10	0.15 - 1.50	325	0.19	NSV	0 / 27	NSV	NSV

TABLE 3-3
Screening Statistics - Gowanus Canal Surface Water (Dry Event Sampling) - Step 2
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Mean (1/2 RL for Non Detects)	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient	COPC?
Semi-Volatile Organic Compounds (ug/l)									
Total PAHs	24 / 27 (88.9%)	---	0.11 - 13.3	325	2.12	NSV	0 / 27	NSV	NSV
Metals (ug/l)									
Aluminum Dissolved	1 / 27 (3.7%)	2000 - 3000	1480 - 1480	324	1300	NSV	0 / 27	NSV	NSV
Arsenic	25 / 25 (100%)	---	9.10 - 23.4	309	18.5	36	0 / 25	0.65	No
Arsenic Dissolved	25 / 25 (100%)	---	15.1 - 21.6	323	19.1	36	0 / 25	0.6	No
Barium	9 / 27 (33.3%)	10.0 - 100	18.4 - 23.0	312	38.4	200	0 / 27	0.12	No
Barium Dissolved	18 / 27 (66.7%)	100 - 100	18.0 - 32.5	304	30.9	200	0 / 27	0.16	No
Calcium	27 / 27 (100%)	---	259000 - 315000	312	280000	NSV	0 / 27	NSV	NSV
Calcium Dissolved	27 / 27 (100%)	---	257000 - 298000	306, 308A	274000	NSV	0 / 27	NSV	NSV
Chromium	21 / 27 (77.8%)	2.00 - 20.0	4.00 - 99.7	323	12.4	NSV	0 / 27	NSV	NSV
Chromium Dissolved	23 / 27 (85.2%)	20.0 - 20.0	3.60 - 10.5	310	5.84	NSV	0 / 27	NSV	NSV
Cobalt Dissolved	1 / 27 (3.7%)	10.0 - 10.0	2.80 - 2.80	304	4.92	1	1 / 27	2.8	YES
Copper	11 / 27 (40.7%)	25.0 - 375	123 - 232	308B	88.1	3.1	11 / 27	75	YES
Copper Dissolved	11 / 27 (40.7%)	25.0 - 375	181 - 282	303	107	3.1	11 / 27	91	YES
Lead	7 / 27 (25.9%)	10.0 - 10.0	1.90 - 7.30	304	4.68	8.1	0 / 27	0.9	No
Magnesium	27 / 27 (100%)	---	809000 - 998000	312	880000	NSV	0 / 27	NSV	NSV
Magnesium Dissolved	27 / 27 (100%)	---	803000 - 942000	306, 308A	858000	NSV	0 / 27	NSV	NSV
Manganese	27 / 27 (100%)	---	45.0 - 72.9	310	56.9	100	0 / 27	0.73	No
Manganese Dissolved	27 / 27 (100%)	---	40.0 - 71.5	323	51.1	100	0 / 27	0.72	No
Mercury	14 / 27 (51.9%)	0.20 - 0.20	0.047 - 0.06	324	0.0751	0.94	0 / 27	0.064	No
Mercury Dissolved	13 / 27 (48.1%)	0.20 - 0.20	0.047 - 0.091	323	0.0798	0.94	0 / 27	0.097	No
Nickel	22 / 27 (81.5%)	10.0 - 10.0	2.00 - 52.3	323	6.35	8.2	4 / 27	6.4	YES
Nickel Dissolved	17 / 27 (63.0%)	10.0 - 10.0	2.20 - 13.4	310	4.68	8.2	2 / 27	1.6	YES
Potassium	27 / 27 (100%)	---	277000 - 328000	312	297000	NSV	0 / 27	NSV	NSV
Potassium Dissolved	27 / 27 (100%)	---	274000 - 316000	322	289000	NSV	0 / 27	NSV	NSV
Selenium	26 / 26 (100%)	---	18.7 - 50.9	322	39.0	71	0 / 26	0.72	No
Selenium Dissolved	16 / 16 (100%)	---	38.6 - 53.5	323	45.8	71	0 / 16	0.75	No
Sodium	27 / 27 (100%)	---	5550000 - 6620000	307B	6100000	NSV	0 / 27	NSV	NSV
Sodium Dissolved	27 / 27 (100%)	---	5330000 - 6790000	322	5950000	NSV	0 / 27	NSV	NSV
Thallium	1 / 27 (3.7%)	10.0 - 10.0	2.10 - 2.10	318	4.89	17	0 / 27	0.12	No

TABLE 3-3
Screening Statistics - Gowanus Canal Surface Water (Dry Event Sampling) - Step 2
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Mean (1/2 RL for Non Detects)	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient	COPC?
Metals (ug/l)									
Zinc	13 / 23 (56.5%)	20.0 - 20.0	11.0 - 25.7	321	13.4	81	0 / 23	0.32	No
Zinc Dissolved	12 / 24 (50.0%)	20.0 - 20.0	9.90 - 37.9	321	13.1	81	0 / 24	0.47	No
General Chemistry (mg/l)									
Total suspended solids	27 / 27 (100%)	---	52.0 - 106	309	80.1	NSV	0 / 27	NSV	NSV

TABLE 3-4
Screening Statistics - Gowanus Canal Surface Water (Wet Event Sampling) - Step 2
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Mean (1/2 RL for Non Detects)	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient	COPC?
Volatile Organic Compounds (ug/l)									
1,2,4-trichlorobenzene	1 / 26 (3.8%)	0.50 - 0.50	0.12 - 0.12	305	0.245	5.4	0 / 26	0.022	No
1,3-dichlorobenzene	2 / 26 (7.7%)	0.50 - 0.50	0.13 - 0.13	303, 305	0.241	NSV	0 / 26	NSV	NSV
1,4-dichlorobenzene	14 / 26 (53.8%)	0.50 - 0.50	0.12 - 0.87	306	0.431	129	0 / 26	0.0067	No
Acetone	1 / 26 (3.8%)	5.00 - 15.0	12.0 - 12.0	307B	4.53	NSV	0 / 26	NSV	NSV
Benzene	16 / 26 (61.5%)	0.50 - 0.50	0.36 - 2.90	316	0.563	110	0 / 26	0.026	No
Carbon disulfide	5 / 26 (19.2%)	0.50 - 0.50	0.14 - 0.17	308B, 313	0.232	NSV	0 / 26	NSV	NSV
Chlorobenzene	17 / 26 (65.4%)	0.50 - 0.50	0.12 - 0.33	306	0.253	25	0 / 26	0.013	No
Chloroform	14 / 26 (53.8%)	0.50 - 0.50	0.50 - 0.69	321	0.423	NSV	0 / 26	NSV	NSV
cis-1,2-dichloroethylene	17 / 26 (65.4%)	0.50 - 0.50	0.21 - 0.51	319	0.296	NSV	0 / 26	NSV	NSV
Ethylbenzene	21 / 26 (80.8%)	0.50 - 0.50	0.18 - 2.60	316	0.451	25	0 / 26	0.1	No
Isopropylbenzene (cumene)	4 / 26 (15.4%)	0.50 - 0.50	0.096 - 0.20	316	0.233	NSV	0 / 26	NSV	NSV
m, p xylenes	22 / 26 (84.6%)	0.50 - 0.50	0.18 - 2.60	316	0.451	NSV	0 / 26	NSV	NSV
Methyl acetate	1 / 26 (3.8%)	0.50 - 0.50	0.44 - 0.44	317	0.257	NSV	0 / 26	NSV	NSV
Methylene chloride	9 / 26 (34.6%)	0.50 - 2.90	0.99 - 3.40	321	0.961	6400	0 / 26	0.00053	No
o-xylene (1,2-dimethylbenzene)	20 / 26 (76.9%)	0.50 - 0.50	0.13 - 5.10	316	0.521	NSV	0 / 26	NSV	NSV
Tetrachloroethylene(PCE)	24 / 26 (92.3%)	0.50 - 0.50	0.70 - 40.0	319	16.5	450	0 / 26	0.089	No
Toluene	24 / 26 (92.3%)	0.50 - 0.50	0.85 - 16.0	316	5.11	215	0 / 26	0.074	No
trans-1,3-dichloropropene	1 / 26 (3.8%)	0.50 - 0.50	0.16 - 0.16	306	0.247	NSV	0 / 26	NSV	NSV
Trichloroethylene (TCE)	2 / 26 (7.7%)	0.50 - 0.50	0.10 - 0.12	320	0.239	200	0 / 26	0.0006	No
Semi-Volatile Organic Compounds (ug/l)									
2-methylnaphthalene	3 / 26 (11.5%)	0.10 - 0.10	0.17 - 3.00	316	0.174	NSV	0 / 26	NSV	NSV
Acenaphthene	20 / 26 (76.9%)	0.10 - 1.00	0.095 - 0.40	313	0.169	40	0 / 26	0.01	No
Anthracene	1 / 26 (3.8%)	0.10 - 1.00	0.095 - 0.095	302	0.069	NSV	0 / 26	NSV	NSV
Benzo(a)anthracene	4 / 26 (15.4%)	0.10 - 1.00	0.074 - 0.15	302	0.0758	NSV	0 / 26	NSV	NSV
Benzo(a)pyrene	6 / 26 (23.1%)	0.10 - 1.00	0.14 - 0.30	309	0.103	NSV	0 / 26	NSV	NSV
Benzo(b)fluoranthene	16 / 26 (61.5%)	0.10 - 1.00	0.12 - 0.33	319	0.154	NSV	0 / 26	NSV	NSV
Benzo(g,h,i)perylene	23 / 26 (88.5%)	0.10 - 1.00	0.13 - 1.50	308A	0.466	NSV	0 / 26	NSV	NSV
Benzo(k)fluoranthene	7 / 26 (26.9%)	0.10 - 1.00	0.037 - 0.12	319	0.07	NSV	0 / 26	NSV	NSV
Benzyl butyl phthalate	3 / 26 (11.5%)	5.00 - 50.0	0.73 - 1.10	307A	3.18	3.4	0 / 26	0.32	No
Caprolactam	11 / 26 (42.3%)	5.00 - 50.0	0.33 - 1.50	320	2.78	NSV	0 / 26	NSV	NSV

TABLE 3-4
Screening Statistics - Gowanus Canal Surface Water (Wet Event Sampling) - Step 2
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Mean (1/2 RL for Non Detects)	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient	COPC?
Semi-Volatile Organic Compounds (ug/l)									
Chrysene	3 / 26 (11.5%)	0.10 - 1.00	0.057 - 0.11	302	0.0709	NSV	0 / 26	NSV	NSV
Dibenz(a,h)anthracene	4 / 26 (15.4%)	0.10 - 1.00	0.071 - 0.11	303	0.0742	NSV	0 / 26	NSV	NSV
Di-n-butyl phthalate	12 / 26 (46.2%)	5.00 - 50.0	0.28 - 0.62	320	2.42	3.4	0 / 26	0.18	No
Di-n-octylphthalate	3 / 26 (11.5%)	5.00 - 50.0	0.23 - 0.28	318	3.11	3.4	0 / 26	0.082	No
Fluoranthene	22 / 26 (84.6%)	0.10 - 1.00	0.089 - 0.32	313	0.17	11	0 / 26	0.029	No
Fluorene	3 / 26 (11.5%)	0.10 - 1.00	0.079 - 0.32	313	0.0804	NSV	0 / 26	NSV	NSV
Indeno(1,2,3-c,d)pyrene	23 / 26 (88.5%)	0.10 - 0.15	0.16 - 1.10	316	0.309	NSV	0 / 26	NSV	NSV
Naphthalene	5 / 26 (19.2%)	0.10 - 0.10	0.13 - 1.40	316	0.136	1.4	0 / 26	1.0	No
Pentachlorophenol	1 / 26 (3.8%)	0.20 - 2.00	0.13 - 0.13	311	0.136	7.9	0 / 26	0.016	No
Phenanthrene	14 / 26 (53.8%)	0.10 - 0.10	0.13 - 1.40	316	0.202	4.6	0 / 26	0.3	No
Pyrene	22 / 26 (84.6%)	0.10 - 1.00	0.10 - 0.34	313	0.197	NSV	0 / 26	NSV	NSV
Total PAHs	25 / 26 (96.2%)	---	0.49 - 6.90	316	1.81	NSV	0 / 26	NSV	NSV
Metals (ug/l)									
Arsenic	26 / 26 (100%)	---	6.90 - 26.2	302	14.9	36	0 / 26	0.73	No
Arsenic Dissolved	26 / 26 (100%)	---	9.10 - 21.0	322	13.2	36	0 / 26	0.58	No
Barium	26 / 26 (100%)	---	18.4 - 42.8	307A	25.9	200	0 / 26	0.21	No
Barium Dissolved	25 / 26 (96.2%)	100 - 100	18.4 - 31.1	322	23.4	200	0 / 26	0.16	No
Calcium	24 / 24 (100%)	---	97200 - 296000	324	164000	NSV	0 / 24	NSV	NSV
Calcium Dissolved	24 / 24 (100%)	---	100000 - 304000	303	164000	NSV	0 / 24	NSV	NSV
Chromium	26 / 26 (100%)	---	3.90 - 29.3	308B	6.72	NSV	0 / 26	NSV	NSV
Chromium Dissolved	7 / 26 (26.9%)	20.0 - 20.0	3.60 - 5.80	314	8.50	NSV	0 / 26	NSV	NSV
Cobalt	1 / 26 (3.8%)	10.0 - 10.0	3.90 - 3.90	307A	4.96	1	1 / 26	3.9	YES
Cobalt Dissolved	1 / 26 (3.8%)	10.0 - 10.0	2.50 - 2.50	315	4.90	1	1 / 26	2.5	YES
Iron	3 / 26 (11.5%)	1500 - 1500	651 - 1040	317	754	50	3 / 26	21	YES
Iron Dissolved	1 / 26 (3.8%)	1500 - 7500	1020 - 1020	310	991	50	1 / 26	20	YES
Lead	26 / 26 (100%)	---	2.90 - 26.8	317	13.0	8.1	21 / 26	3.3	YES
Lead Dissolved	6 / 26 (23.1%)	10.0 - 10.0	1.90 - 17.7	314	4.93	8.1	1 / 26	2.2	YES
Magnesium	25 / 25 (100%)	---	276000 - 972000	303	505000	NSV	0 / 25	NSV	NSV
Magnesium Dissolved	25 / 25 (100%)	---	286000 - 4880000	301	805000	NSV	0 / 25	NSV	NSV
Manganese	26 / 26 (100%)	---	48.4 - 65.6	307A	54.7	100	0 / 26	0.66	No

TABLE 3-4
Screening Statistics - Gowanus Canal Surface Water (Wet Event Sampling) - Step 2
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Mean (1/2 RL for Non Detects)	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient	COPC?
Metals (ug/l)									
Manganese Dissolved	26 / 26 (100%)	---	35.6 - 63.0	322	43.9	100	0 / 26	0.63	No
Mercury	19 / 26 (73.1%)	0.20 - 0.20	0.065 - 0.089	302	0.0855	0.94	0 / 26	0.095	No
Nickel	25 / 25 (100%)	---	2.10 - 29.8	308B	5.76	8.2	5 / 25	3.6	YES
Nickel Dissolved	25 / 25 (100%)	---	2.20 - 8.00	315	3.74	8.2	0 / 25	0.98	No
Potassium	24 / 24 (100%)	---	88700 - 290000	324	155000	NSV	0 / 24	NSV	NSV
Potassium Dissolved	24 / 24 (100%)	---	92300 - 292000	303	154000	NSV	0 / 24	NSV	NSV
Selenium	26 / 26 (100%)	---	13.9 - 64.6	301	29.3	71	0 / 26	0.91	No
Selenium Dissolved	16 / 16 (100%)	---	14.7 - 41.9	303	24.5	71	0 / 16	0.59	No
Sodium	25 / 25 (100%)	---	2340000 - 7090000	301	3940000	NSV	0 / 25	NSV	NSV
Sodium Dissolved	25 / 25 (100%)	---	2480000 - 9180000	301	4050000	NSV	0 / 25	NSV	NSV
Zinc	24 / 26 (92.3%)	20.0 - 20.0	17.7 - 75.7	318	39.9	81	0 / 26	0.93	No
Zinc Dissolved	25 / 26 (96.2%)	20.0 - 20.0	11.0 - 40.2	314	22.6	81	0 / 26	0.5	No
General Chemistry (mg/l)									
Total suspended solids	26 / 26 (100%)	---	33.0 - 93.0	302	52.8	NSV	0 / 26	NSV	NSV

TABLE 3-5
Medium-Specific SLERA Screening Values—Sediment and Surface Water
Gowanus Canal Remedial Investigation
Brooklyn, New York

Chemical	Screening Value	Source
SEDIMENT		
Volatile Organic Compounds (ug/kg)		
1,2-dichloroethane	NSV	
1,4-dichlorobenzene	240	NYSDEC (1999)[1]
Acetone	NSV	
Benzene	520	NYSDEC (1999)[1]
Carbon disulfide	NSV	
Chlorobenzene	70	NYSDEC (1999)[1]
Cyclohexane	NSV	
Ethylbenzene	128	NYSDEC (1999)[1]
Isopropylbenzene (cumene)	NSV	
m, p xylenes	540	NYSDEC (1999)[1]
Methylcyclohexane	NSV	
Methylene chloride	NSV	
o-xylene (1,2-dimethylbenzene)	540	NYSDEC (1999)[1]
Tert-butyl methyl ether	NSV	
Tetrachloroethylene(PCE)	NSV	
Toluene	900	NYSDEC (1999)[1]
Trichloroethylene (TCE)	NSV	
Trichlorofluoromethane	NSV	
Semi-Volatile Organic Compounds (ug/kg)		
2-methylnaphthalene	70	NYSDEC (1999)[2]
Acenaphthene	16	NYSDEC (1999)[2]
Acenaphthylene	44	NYSDEC (1999)[2]
Anthracene	85.3	NYSDEC (1999)[2]
Benzo(a)anthracene	261	NYSDEC (1999)[2]
Benzo(a)pyrene	430	NYSDEC (1999)[2]
Benzo(b)fluoranthene	4600	WDOE (1995)[1]
Benzo(g,h,i)perylene	620	WDOE (1995)[1]
Benzo(k)fluoranthene	4600	WDOE (1995)[1]
Biphenyl (diphenyl)	NSV	
Bis(2-ethylhexyl) phthalate	182	MacDonald et al. (1996)
Carbazole	NSV	
Chrysene	384	NYSDEC (1999)[2]
Dibenz(a,h)anthracene	63.4	NYSDEC (1999)[2]
Dibenzofuran	300	WDOE (1995)[1]
Di-n-butyl phthalate	4400	WDOE (1995)[1]
Di-n-octylphthalate	1160	WDOE (1995)[1]
Fluoranthene	600	NYSDEC (1999)[2]
Fluorene	19	NYSDEC (1999)[2]
Indeno(1,2,3-c,d)pyrene	680	WDOE (1995)[1]
Naphthalene	160	NYSDEC (1999)[2]
Phenanthrene	240	NYSDEC (1999)[2]
Pyrene	665	NYSDEC (1999)[2]
Total PAHs	4022	NYSDEC (1999)[2]
Pesticides (ug/kg)		
Alpha-chlordane	0.04	NYSDEC (1999)[1]
Beta endosulfan	0.08	NYSDEC (1999)[1]
Endosulfan sulfate	NSV	
Gamma-chlordane	0.04	NYSDEC (1999)[1]
Methoxychlor	NSV	
P,P'-DDD	1.22	MacDonald et al. (1996)
P,P'-DDE	2.2	NYSDEC (1999)[2]
Total DDTs	1.58	NYSDEC (1999)[2]
Polychlorinated Biphenyls (ug/kg)		
Aroclor 1016	22.7	NYSDEC (1999)[2]
Aroclor 1248	22.7	NYSDEC (1999)[2]
Aroclor 1254	22.7	NYSDEC (1999)[2]
Aroclor 1260	22.7	NYSDEC (1999)[2]
Total PCBs	22.7	NYSDEC (1999)[2]

TABLE 3-5

Medium-Specific SLERA Screening Values—Sediment and Surface Water

Gowanus Canal Remedial Investigation

Brooklyn, New York

Chemical	Screening Value	Source
Polychlorinated Biphenyl Congeners (ng/kg)		
Total PCB Congeners	59800	MacDonald et al. (2000)
Metals (mg/kg)		
Aluminum		
Arsenic	8.2	NYSDEC (1999)[2]
Barium	130.1	MacDonald et al. (1996)
Beryllium		
Cadmium	1.2	NYSDEC (1999)[2]
Calcium	NSV	
Chromium	81	NYSDEC (1999)[2]
Cobalt	NSV	
Copper	34	NYSDEC (1999)[2]
Iron	NSV	
Lead	46.7	NYSDEC (1999)[2]
Magnesium	NSV	
Manganese	NSV	
Mercury	0.15	NYSDEC (1999)[2]
Nickel	20.9	NYSDEC (1999)[2]
Potassium	NSV	
Selenium	NSV	
Silver	1	NYSDEC (1999)[2]
Sodium	NSV	
Vanadium	NSV	
Zinc	150	NYSDEC (1999)[2]
Cyanide	NSV	
SURFACE WATER		
Volatile Organic Compounds (ug/l)		
1,2,4-trichlorobenzene	5.4	Buchman (2008)
1,3-dichlorobenzene	NSV	
1,4-dichlorobenzene	129	Buchman (2008)
Acetone	NSV	
Benzene	110	Buchman (2008)
Carbon disulfide	NSV	
Chlorobenzene	25	Buchman (2008)
Chloroform	NSV	
cis-1,2-dichloroethylene	NSV	
Ethylbenzene	25	Buchman (2008)
Isopropylbenzene (cumene)	NSV	
m, p xylenes	NSV	
Methyl acetate	NSV	
Methylene chloride	6400	Buchman (2008)
o-xylene (1,2-dimethylbenzene)	NSV	
Tert-butyl methyl ether	5000	Buchman (2008)
Tetrachloroethylene(PCE)	450	Buchman (2008)
Toluene	215	Buchman (2008)
trans-1,3-dichloropropene	NSV	
Trichloroethylene (TCE)	200	Buchman (2008)
Semi-Volatile Organic Compounds (ug/l)		
2-methylnaphthalene	NSV	
Acenaphthene	40	Buchman (2008)
Anthracene	NSV	
Benzo(a)anthracene	NSV	
Benzo(a)pyrene	NSV	
Benzo(b)fluoranthene	NSV	
Benzo(g,h,i)perylene	NSV	
Benzo(k)fluoranthene	NSV	
Benzyl butyl phthalate	3.4	Buchman (2008)
Bis(2-ethylhexyl) phthalate	360	Buchman (2008)
Caprolactam	NSV	
Carbazole	NSV	

TABLE 3-5
Medium-Specific SLERA Screening Values—Sediment and Surface Water
Gowanus Canal Remedial Investigation
Brooklyn, New York

Chemical	Screening Value	Source
Chrysene	NSV	
Dibenz(a,h)anthracene	NSV	
Dimethyl phthalate	3.4	Buchman (2008)
Di-n-butyl phthalate	3.4	Buchman (2008)
Di-n-octylphthalate	3.4	Buchman (2008)
Fluoranthene	11	Buchman (2008)
Fluorene	NSV	
Indeno(1,2,3-c,d)pyrene	NSV	
Naphthalene	1.4	USEPA (2009)
Pentachlorophenol	7.9	USEPA (2009)
Phenanthrene	4.6	Buchman (2008)
Phenol	400	Buchman (2008)
Pyrene	NSV	
Total PAHs	NSV	
Metals (ug/l)		
Arsenic	36	USEPA (2009)
Arsenic Dissolved	36	USEPA (2009)
Barium	200	Buchman (2008)
Barium Dissolved	200	Buchman (2008)
Calcium	NSV	
Calcium Dissolved	NSV	
Chromium	NSV	
Chromium Dissolved	NSV	
Cobalt	1	Buchman (2008)
Cobalt Dissolved	1	Buchman (2008)
Copper	3.1	USEPA (2009)
Copper Dissolved	3.1	USEPA (2009)
Iron	50	Buchman (2008)
Iron Dissolved	50	Buchman (2008)
Lead	8.1	USEPA (2009)
Lead Dissolved	8.1	USEPA (2009)
Magnesium	NSV	
Magnesium Dissolved	NSV	
Manganese	100	Buchman (2008)
Manganese Dissolved	100	Buchman (2008)
Mercury	0.94	USEPA (2009)
Mercury Dissolved	0.94	USEPA (2009)
Nickel	8.2	USEPA (2009)
Nickel Dissolved	8.2	USEPA (2009)
Potassium	NSV	
Potassium Dissolved	NSV	
Selenium	71	USEPA (2009)
Selenium Dissolved	71	USEPA (2009)
Sodium	NSV	
Sodium Dissolved	NSV	
Zinc	81	USEPA (2009)
Zinc Dissolved	81	USEPA (2009)

1-Value represents equilibrium-based screening value (assuming 2% total organic carbon).
2-Value represents ER-L, selected according to guidance presented in Appendix 4 of NYSDEC (1999).

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SECTION 4

Screening-Level Risk Outcomes

The screening-level risk calculation is the final step (Step 2) of the SLERA. In this step, maximum exposure concentrations in Gowanus Canal surface sediment and surface water (dry and wet) are compared to corresponding screening values to derive screening risk estimates. The outcome of this step is a list of COPCs for each medium-pathway-receptor combination evaluated or the elimination of chemicals from further consideration based on the conclusion that they are unlikely to adversely affect the ecological receptors of concern.

4.1 Selection of COPCs

In the following sections, the maximum detected chemical concentrations for sediment and surface water (dry and wet) are compared to the medium-specific screening values to identify COPCs for further evaluation in the ERA. The following sections provide the results of these comparisons. As discussed in Section 3.3, chemicals were identified as COPCs in this section if they were detected at concentrations exceeding screening values (HQs greater than 1) or were detected but lacked screening values. Chemicals that were detected, but did not have ecological screening values are further discussed within the uncertainty section of the ERA (Section 7).

4.1.1 Sediment

The sediment comparison outcomes are summarized in Table 3-2 and indicate the following:

- The maximum detected chemical concentrations of three volatile organics, 21 semivolatile organics, five pesticides, three Aroclors (PCBs), PCB congeners, and 11 metals had HQs exceeding 1 and were identified as COPCs.
- Semivolatile organics generally had the highest maximum HQs, particularly PAHs.
- The highest concentrations of PAHs were located primarily in the middle of the Gowanus Canal (Stations 314 and 315).
- Metals generally had the highest frequency of exceedance, with cadmium, copper, lead, mercury, and zinc concentrations exceeding their screening values in all samples.

4.1.2 Surface Water

Dry Event

The dry event surface water comparison outcomes are summarized in Table 3-3 and indicate the following:

- The maximum detected chemical concentrations of two total metals (copper and nickel) and one dissolved metal (copper) had maximum HQs exceeding 1 and were identified as COPCs.

- Total copper and dissolved copper had the highest HQs (74.8 and 91.0, respectively) and concentrations exceeded their screening values in 11 of the 27 samples, while nickel concentrations exceeded their screening values in four of the 27 samples.
- No volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs) or PCBs had HQs greater than 1.

Wet Event

The wet event surface water comparison outcomes are summarized in Table 3-4 and indicate the following:

- The maximum detected chemical concentrations of four total metals (cobalt, iron, lead, and nickel) and three dissolved metals (cobalt, iron, and lead) had maximum HQs exceeding 1 and were identified as COPCs.
- Total iron and dissolved iron had the highest HQs (20.8 and 20.4, respectively), while total lead had the highest frequency of exceedance, with 21 of 26 sample concentrations exceeding the screening value.
- No VOCs, SVOCs, or PCBs had HQs greater than 1.

4.2 Summary of COPCs

Chemicals identified as COPCs for benthic macroinvertebrates from direct exposure to chemicals in sediment and for water-column-dwelling aquatic life from direct exposure to chemicals in surface water (dry and wet events) are summarized in Table 4-1.

TABLE 4-1

Summary of COPCs for Surface Sediment and Surface Water (Dry and Wet) - Step 2

Gowanus Canal Remedial Investigation

Brooklyn, New York

COPCs	Surface Sediments		Surface Water (Dry)		Surface Water (Wet)	
	HQ>1	NSV	HQ>1	NSV	HQ>1	NSV
Volatile Organic Compounds (ug/kg)						
1,2,4-trichlorobenzene						
1,2-dichloroethane		**NSV**				
1,3-dichlorobenzene						**NSV**
1,4-dichlorobenzene						
Acetone		**NSV**		**NSV**		**NSV**
Benzene						
Carbon disulfide		**NSV**				**NSV**
Chlorobenzene						
Chloroform						**NSV**
cis-1,2-dichloroethylene						**NSV**
Cyclohexane		**NSV**				
Ethylbenzene	**X**					
Isopropylbenzene (cumene)		**NSV**				**NSV**
m, p xylenes	**X**			**NSV**		**NSV**
Methyl acetate						**NSV**
Methylcyclohexane		**NSV**				
Methylene chloride		**NSV**				
o-xylene (1,2-dimethylbenzene)	**X**			**NSV**		**NSV**
Tert-butyl methyl ether		**NSV**				
Tetrachloroethylene(PCE)		**NSV**				
Toluene						
trans-1,3-dichloropropene						**NSV**
Trichloroethylene (TCE)		**NSV**				
Trichlorofluoromethane		**NSV**				
Semi-Volatile Organic Compounds (ug/kg)						
2-methylnaphthalene	**X**			**NSV**		**NSV**
Acenaphthene	**X**					

TABLE 4-1

Summary of COPCs for Surface Sediment and Surface Water (Dry and Wet) - Step 2

Gowanus Canal Remedial Investigation

Brooklyn, New York

COPCs	Surface Sediments		Surface Water (Dry)		Surface Water (Wet)	
	HQ>1	NSV	HQ>1	NSV	HQ>1	NSV
Acenaphthylene	X					
Anthracene	X			NSV		NSV
Benzo(a)anthracene	X			NSV		NSV
Benzo(a)pyrene	X			NSV		NSV
Benzo(b)fluoranthene	X			NSV		NSV
Benzo(g,h,i)perylene	X			NSV		NSV
Benzo(k)fluoranthene	X			NSV		NSV
Benzyl butyl phthalate						
Biphenyl (diphenyl)		NSV				
Bis(2-ethylhexyl) phthalate	X					
Caprolactam				NSV		NSV
Carbazole		NSV		NSV		
Chrysene	X			NSV		NSV
Dibenz(a,h)anthracene	X					NSV
Dibenzofuran	X					
Dimethyl phthalate						
Di-n-butyl phthalate						
Di-n-octylphthalate	X					
Fluoranthene	X					
Fluorene	X			NSV		NSV
Indeno(1,2,3-c,d)pyrene	X			NSV		NSV
Naphthalene	X					
Pentachlorophenol						
Phenanthrene	X					
Phenol						
Pyrene	X			NSV		NSV
Total PAHs	X			NSV		NSV
Pesticides (ug/kg)						

TABLE 4-1

Summary of COPCs for Surface Sediment and Surface Water (Dry and Wet) - Step 2

Gowanus Canal Remedial Investigation

Brooklyn, New York

COPCs	Surface Sediments		Surface Water (Dry)		Surface Water (Wet)	
	HQ>1	NSV	HQ>1	NSV	HQ>1	NSV
Alpha-chlordane	X					
Beta endosulfan	X					
Endosulfan sulfate		NSV				
Gamma-chlordane	X					
Methoxychlor		NSV				
P,P'-DDD	X					
P,P'-DDE	X					
Total DDTs	X					
Polychlorinated Biphenyls (ug/kg)						
Aroclor 1016	X					
Aroclor 1248	X					
Aroclor 1254	X					
Aroclor 1260	X					
Total PCBs	X					
Metals (ug/l)						
Aluminum		NSV				
Arsenic	X					
Arsenic Dissolved						
Barium	X					
Barium Dissolved						
Beryllium		NSV				
Cadmium	X					
Calcium		NSV		NSV		NSV
Calcium Dissolved				NSV		NSV
Chromium	X			NSV		NSV
Chromium Dissolved				NSV		NSV
Cobalt		NSV			X	
Cobalt Dissolved					X	

TABLE 4-1

Summary of COPCs for Surface Sediment and Surface Water (Dry and Wet) - Step 2

Gowanus Canal Remedial Investigation

Brooklyn, New York

COPCs	Surface Sediments		Surface Water (Dry)		Surface Water (Wet)	
	HQ>1	NSV	HQ>1	NSV	HQ>1	NSV
Copper	X		X			
Copper Dissolved			X			
Cyanide, Total		NSV				
Iron		NSV			X	
Iron Dissolved					X	
Lead	X				X	
Lead Dissolved					X	
Magnesium		NSV		NSV		NSV
Magnesium Dissolved				NSV		NSV
Manganese	X	NSV				
Manganese Dissolved						
Mercury	X					
Mercury Dissolved						
Nickel	X		X		X	
Nickel Dissolved						
Potassium		NSV		NSV		NSV
Potassium Dissolved				NSV		NSV
Selenium		NSV				
Selenium Dissolved						
Silver	X					
Sodium		NSV		NSV		NSV
Sodium Dissolved				NSV		NSV
Thallium						
Vanadium		NSV				
Zinc	X					
Zinc Dissolved						

SECTION 5

Baseline Ecological Risk Assessment: Approach to Refining Risks

The following section discusses refinements to the problem formulation and analysis approaches for the BERA evaluation for the Gowanus Canal. The BERA refines the SLERA risk estimate by refining the highly conservative assumptions made in the SLERA and by incorporating the evaluation of additional site-collected data to characterize risks for all assessment endpoints identified for evaluation in the ERA. The following sections discuss the data (Section 5.1) and approach (Section 5.2) for conducting the BERA for each of the assessment endpoints selected for evaluation at this site.

5.1 Evaluated Analytical Data

5.1.1 Sediment and Surface Water Chemistry

The surficial sediment (0 to 6 inches) and surface water (dry and wet) chemical analytical data and data groupings used in the SLERA were also used for the evaluation of risks in the BERA. Surficial sediment data were used to further evaluate potential risks to benthic macroinvertebrates via direct exposure and were additionally used in the BERA to evaluate the potential for adverse effects to avian wildlife from ingestion. Surface water data were used in the BERA to further evaluate potential risks to water-column-dwelling aquatic life. A detailed description of these data and their groupings is discussed in Section 3.1.1.

5.1.2 AVS/SEM Analysis

Acid volatile sulfide/simultaneously extractable metal (AVS/SEM) analysis was performed on the 27 surficial (0 to 6 inches) sediment samples collected from the Gowanus Canal. The purpose of the AVS/SEM analysis is to assess whether divalent metals (cadmium, copper, lead, nickel, silver, and zinc) in sediment are bioavailable and have potential to be toxic. These data were used in conjunction with the sediment chemical analytical and bioassay data to evaluate the overall potential for adverse effects to benthic macroinvertebrates.

5.1.3 Crab and Fish Tissue Chemical Residue

Crab and fish tissue collected from the Gowanus Canal were used in the BERA to evaluate potential risks to multiple receptors. A detailed description of the tissue collected during the Phase 3 sample effort and used in the ERA is presented in Section 2.5 of the RI. Whole-body crab and fish tissue chemical residue concentrations were used as follows in the BERA:

- **Crab.** Whole-body crab tissue residue concentrations were used in the BERA to estimate chemical concentrations in prey, in order to evaluate potential risks to avian predators.
- **Small prey fish.** Whole-body small prey fish tissue residue concentrations were used in the BERA to estimate chemical concentrations in prey, in order to evaluate potential risks to avian predators.

The following two subsections discuss the approach used to estimate tissue residue exposure concentrations for aquatic macroinvertebrates and small prey fish.

In addition to evaluating risks to wildlife predators, whole-body crab and fish tissue residue concentrations were used in the ERA to directly screen the potential for risk to crabs, small prey fish, and larger fish species. Larger fish species are considered unlikely to represent prey for avian wildlife and were not evaluated in the avian food web models. The procedure used for directly screening risks to crab and fish (smaller prey fish and larger fish species) and the resulting risk outcomes are presented in Attachment E of the ERA, and not within the main body of the ERA document.

Aquatic Macroinvertebrates (Crab)

Whole-body tissue concentrations in aquatic invertebrates were based on tissue chemical residue concentrations that were measured in blue crab (*Callinectes sapides*) collected from the Gowanus Canal. Crab tissue samples were used as a surrogate to estimate tissue concentrations for all aquatic invertebrates. Edible and hepatopancreas tissues were mathematically "recombined" to estimate whole-body crab tissue residue concentrations for evaluation in the ERA. This recombining of the hepatopancreas with other tissues is based on the need to have whole-body tissue concentrations for the evaluation of potential impacts to avian predators, based on the assumption that most predators would indiscriminately consume all soft tissues while foraging on crabs. Chemical residue concentrations in organs other than the hepatopancreas were not measured. However, for the purposes of this evaluation, chemical concentrations in hepatopancreas tissue were assumed to be representative of all organ tissue concentrations.

Whole-body tissue residue concentrations were estimated for each composite crab sample by taking a weighted average of the chemical residue concentrations measured in the edible and hepatopancreas tissue samples. A total of 12 composite edible tissue samples were created with the crabs collected from the Gowanus Canal (Table 2-5 of the RI). However, based on the small weight of the hepatopancreas and the tissue mass required for residue analysis, only two composite hepatopancreas samples could be created (Appendix I of the RI). Therefore, the maximum of each chemical concentration measured in the two hepatopancreas samples was used to estimate the whole body tissue residue concentrations for each of the 12 composite crab tissue residue samples.

The wet weight, weighted average whole-body crab tissue residue concentration of each chemical was estimated for each of the 12 crab samples using the following lab-measured data:

- Measured chemical concentrations detected in each edible tissue sample;
- Measured maximum chemical concentrations detected in hepatopancreas samples (maximum concentration of each chemical detected in the two hepatopancreas samples were used in the whole-body calculation to provide a conservative concentration estimate);
- Total wet weight mass of the edible tissue sample; and

- Total wet weight mass of the hepatopancreas tissue sample (mass used in the calculation represents the maximum weight of the two hepatopancreas tissue samples measured at the time the edible tissue samples were extracted from the shell).

For each of the 12 crab samples, a wet weight, weighted average whole-body concentration was calculated for each chemical by taking the weighted average concentration of the chemical detected in the edible and hepatopancreas tissues using the following equation:

$$CWBTC_x = \frac{[[(ETC_x)(ETW)] + [(HC_x)(HW)]]}{TW}$$

Where:

$CWBTC_x$ = Weighted average crab whole body tissue concentration for constituent x (wet weight)
ETC_x = Edible tissue concentration for constituent x (wet weight)
ETW = Edible tissue weight (wet weight)
HC_x = Hepatopancreas tissue concentration for constituent x (wet weight)
HW = Hepatopancreas tissue weight (wet weight)
TW = Total weight of edible and hepatopancreas tissues (wet weight)

The chemical concentrations determined for each of the 12 crab samples were then combined to estimate the maximum and mean wet weight chemical concentrations for blue crabs within the Gowanus Canal. Table 5-1 summarizes the maximum and mean wet weight tissue residue concentrations for the combined crab tissue samples.

Wet weight tissue concentrations were converted to dry weight concentrations for use in the food web models. Dry weight concentrations were determined using the percent moisture measured in each of the samples, and this conversion was done by first calculating a weighted average whole body water content using the following additional lab-measured data:

- Percent moisture of the edible tissue sample
- Percent moisture of the hepatopancreas tissue (minimum percent water of the two hepatopancreas samples was used to conservatively estimate percent water composition)

Wet weight tissue concentrations of the edible tissue and hepatopancreas sample components were first converted to dry weight concentrations by dividing the wet weight concentration of a chemical within a sample by the fraction dry weight of that sample. The fraction dry weight component of a sample was determined by subtracting the wet weight fraction of that sample (reported in Appendix I of the RI) from one. For each of the 12 crab samples, a weighted average whole-body concentration was calculated for each chemical by taking the dry weight, weighted average concentration of the chemical detected in the edible tissue and hepatopancreas tissues. The chemical concentrations determined for each of the 12 crab samples were then combined to estimate the maximum and mean dry weight chemical concentrations for blue crab in the Gowanus Canal. Table 5-2 summarizes the maximum and mean dry weight concentrations for blue crab. These whole-body dry weight concentrations are used as described in Section 5.2.3 to model potential risks to avian wildlife predators.

Small Prey Fish

Small prey fish tissue concentration estimates were based on whole-body concentrations measured with four Atlantic tomcod and four mummichog samples (eight total small prey fish samples) collected from the Gowanus Canal (Table 2-5 of the RI). Although separate chemical analysis was conducted on the Atlantic tomcod and mummichog samples, the resulting chemical concentration data determined for the eight small prey fish samples were combined to estimate the maximum and mean wet weight chemical concentrations for small prey fish in the Gowanus Canal. Table 5-3 summarizes the maximum and mean wet weight concentrations for the combined small prey fish samples.

Wet weight tissue concentrations were converted to dry weight concentrations for use in the food web models. Wet weight tissue concentrations were converted to dry weight concentrations by dividing the wet weight concentration of a chemical within a sample by the fraction dry weight of that sample. The fraction dry weight was determined by subtracting the wet weight fraction of the sample (reported in Appendix I of the RI) from 1. The chemical concentrations determined in each of the eight small prey fish samples were then combined to estimate the maximum and mean dry weight chemical concentrations for small prey fish in the Gowanus Canal. Table 5-4 summarizes the maximum and mean dry weight concentrations for the small prey fish samples, which are composed of the combined chemical analytical data from the Atlantic tomcod and mummichog samples. These whole body dry weight concentrations are used as described in Section 5.2.3 to model potential risks to avian wildlife predators.

5.1.4 Sediment Bioassays

Sediment bioassays were used in the BERA along with chemical analytical data and crab tissue residue concentrations to evaluate the potential for adverse effects to benthic macroinvertebrates. Twenty-eight-day chronic bioassays were performed with the amphipod *Leptocheirus plumulosus* and the polychaete *Nereis virens* with splits of the surface sediment (0 to 6 inches) samples collected from Gowanus Canal for chemical and physical analysis. Splits of the following samples were used for bioassay analysis: 303, 307A, 309, 310, 313, 314, 315, 318, 319, 321, and 324. The locations of these samples are shown in Figures 2a, 2b, and 2c of the RI. The measured endpoints for the *L. plumulosus* bioassay were survival, growth, and reproduction, while the measured endpoints for the *N. virens* bioassay were survival and growth. The laboratory reports for these bioassays are presented in Attachment B.

5.2 Approach to Baseline Risk Evaluation

5.2.1 Benthic Macroinvertebrates

The BERA further evaluated sediment chemical concentrations and sediment bioassay outcomes into the BERA to refine the estimate of risk for benthic macroinvertebrates. These data were considered both individually and as part of a weight-of-evidence approach to evaluate the overall potential for adverse effects to benthic-dwelling organisms in the

Gowanus Canal. The following three sections present the approach used to summarize and evaluate the bioassay, sediment chemical analytical, and AVS/SEM data in the BERA.

Sediment Bioassays

Chronic polychaete (*N. virens*) and amphipod (*L. plumulosus*) toxicity tests were conducted with splits of each canal and reference surface sediment (0 to 6 inches) sample. Both toxicity tests were performed by EnviroSystems, Inc. (ESI), in Hampton, New Hampshire.[1] A detailed description of the bioassay tests along with all results are provided in Attachment B.

Following completion of the bioassays, each measured test endpoint was statistically analyzed to determine significant differences between field (canal or reference) and laboratory control samples. Pairwise statistical comparisons were conducted with each possible sample combination using either parametric or nonparametric Analysis of Variance (ANOVA) statistics, depending on normality of distribution and homogeneity of sample variance. The statistical significance was tested at an=0.05 level. A detailed description of the statistical approach is provided in Attachment B.

For the growth endpoints for both polychaetes and amphipods, only the biomass results were used in the risk evaluation because these measures are believed to represent overall impacts to the tested population of organisms. That is, the final biomass results reflect the difference, or remaining biomass of worm or amphipod following exposure, whereas the growth results in weight reflect only the organism's survival at the end of the test. Additionally, for amphipods, only the reproduction results in numbers of juveniles per surviving female were used for the risk evaluation, and the results per surviving adult were not considered. It is believed that the juvenile counts per female better reflect the impact of exposure since the organisms introduced at the beginning of the test are not sexed. Therefore, a lack or excess of surviving females could skew reproduction results in juvenile counts per adult, whereas the results normalized to females adjusts the results to make the sample-by-sample comparisons more consistent.

The outcomes of the pair-wise statistical comparisons between the field (canal and reference) and laboratory control samples were first evaluated to identify toxic samples. For each organism and measured endpoint, a response was considered to indicate toxicity if the measured response in the field sample was significantly reduced as compared to the laboratory control.

Once toxic responses were identified, the outcomes between the canal and reference samples were then compared to determine if toxic responses in the canal samples were different than responses in the reference area (New York Harbor). This step helped evaluate whether or not toxic responses in the canal samples were due to site-specific or ambient regional conditions. Since the land surrounding the site and the reference area is highly urbanized, with multiple contaminant influences and reduced habitat/sediment quality, reference area samples were considered reflective of the regional conditions. Therefore, a baseline of conditions in the reference area was established using a "reference envelope"

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[1] The amphipod (*L. plumulosus*) tests were run three times. The control survival was below test acceptability criteria for the first two attempts, suggesting the health of the test organisms was compromised. Therefore, those test results were invalid. The survival, and all other test acceptability criteria, was met on the third attempt, and the results discussed in this report reflect the third and final execution of the amphipod tests.

approach (Ingersoll et al., 2009) to differentiate between site- and non-site-related toxic responses. Site-specific toxicity was established by comparing the responses of polychaetes (survival and growth) and amphipods (survival, growth, and reproduction) exposed to canal sediments to corresponding endpoint results in organisms exposed to reference samples. A reference envelope represents the variance in reference endpoint response, which can be established in a number of ways depending on the number of reference samples and endpoints (e.g., maximum or 5th percentile of responses). In this case, the lowest endpoint result for the reference samples was selected as the envelope value for comparison to canal, following the elimination of any reference sample outliers.

Analysis and elimination of reference sample outliers was performed by evaluating the reference sample responses and the concentrations of constituents detected in the split sediment sample (i.e., occurrence and magnitude of detected constituents) on a sample-by-sample basis. This was done to determine if any specific observed response should be considered indicative of the reference area, given the level of contamination and responses for all other reference samples. The potential influence of detected constituents in all five reference samples was evaluated by comparing detected constituent concentrations to NYSDEC (1999) sediment criteria for marine and estuarine sediments. For each chemical, these criteria consisted of the lowest effect level (exceedance indicates moderate impacts) and severe effect level (exceedance indicates severe impact) criteria, where available. Results of these comparisons and the test endpoint responses were used to justify elimination of a reference sample before reference envelope values were established (lowest endpoint result for included reference samples). Once the reference envelope endpoint values were established, endpoint-specific responses for canal samples were compared to reference envelope values on a sample-by-sample basis to determine if the responses were below the envelope. If a measured endpoint parameter was lower than the corresponding reference envelope value, then it was concluded the response indicated a potential site-related impact. If the measured parameter was higher than the corresponding reference envelope value, then the observed response was assumed to be from a variable unrelated to the site.

Finally, the occurrence and magnitude of constituent detections in samples colocated with impacted toxicity test samples were considered after site-specific impacts were established, to identify possible causes of observed toxicity. It was assumed that the detected constituents measured in these samples were the variables most likely responsible for the observed ecotoxicological impact(s).

Sediment Chemistry

Using the surface sediment (0 to 6 inches) chemical analytical data discussed in Section 5.1.1, the following guidelines were used in the BERA to evaluate potential risks from the exposure of benthic macroinvertebrates to chemicals in sediment:

- Ninety-five percent upper confidence limit (95% UCL) chemical concentrations were calculated using Pro UCL version 4.00.05 and compared to the medium-specific screening values used in the SLERA.
- For samples with duplicate analyses, the higher of the two detected concentrations was used if both values are detects. In cases where one result is a detected concentration and the other a nondetect, the detected value was used for evaluation of the 95% UCL.

- Nondetected chemicals were not evaluated in the BERA but were instead considered in the uncertainty section of the ERA (Section 7).

A summary of the 95% UCL chemical concentrations in Gowanus Canal surface sediment (0 to 6 inches) is presented in Table 5-5.

The sediment screening benchmarks that were used in the SLERA were compared to the 95% UCL concentration to first screen the potential for adverse effects to benthic invertebrates from exposure to chemicals in sediment in the BERA. A detailed description of the sediment screening benchmarks selected for use in the BERA is presented in Section 3.2.1. HQs were calculated for each chemical by dividing the 95% UCL by the screening value. Chemicals were identified as COCs if they were detected at 95% UCL concentrations exceeding screening values.

The concentrations of chemicals that were identified as COCs with this initial screen were further evaluated in the BERA. Less conservative, but still protective, sediment criteria (NYSDEC, 1999) were used, when needed, for the further evaluation of potential risk. For the screening benchmarks that were based on equilibrium partitioning, the mean of the total organic carbon concentration that was measured in the Phase 3 surface sediment samples (5.4 percent) was used to derive the screening value, instead of the more conservative total organic carbon concentration (2 percent) that was used in the initial screening. Similarly, the less conservative Effects Range—Median (ER-M) values reported in NYSDEC (1999) were used instead of the more conservative ER-L values that were used in the initial screening.

In the absence of applicable values in NYSDEC (1999), a broader range of sources was reviewed to identify additional screening values. Values from the following additional sources were used for this evaluation:

- Probable Effects Level (PEL) values from MacDonald (1994) and
- Probable Effects Concentrations (PEC) values from MacDonald (2000).

Additional sediment benchmarks identified for use for this further evaluation in the BERA are summarized in Table 5-6.

AVS/SEM Analysis

The AVS/SEM method is based on the concept that many toxic divalent metals (specifically cadmium, copper, lead, nickel, silver, and zinc) readily precipitate as insoluble metal sulfide minerals when exposed to reactive (volatile) sulfides. Volatile sulfides are operationally defined as metastable iron sulfide minerals that, when exposed to hydrochloric acid, form H_2S, which can be subsequently collected and analyzed. When the AVS concentration in sediments exceeds that of the metals under consideration, the metals are unlikely to be toxic.

Based on equilibrium partitioning theory, AVS in sediments will bind cationic metals, primarily the SEM metals cadmium, copper, lead, nickel, silver, and zinc. An excess of AVS relative to SEM on a molar basis indicates that the bioavailability of the metals should be minimal, while SEM in excess of the AVS indicates that the metals may be biologically available. The sum of the SEM concentrations should be compared with the AVS concentration on a molar basis (using [Ag]/2 because it is monovalent).

The organic carbon content of the sediment must also be considered when evaluating SEM/AVS data because the organic carbon fraction is an important partitioning phase in sediments. The use of organic carbon-normalized excess SEM [($\sum$SEM-AVS)/f_{OC}] as a correction factor for excess SEM is based on the theoretical foundation of equilibrium partitioning and can be used to identify sediments that are likely to be toxic, are of uncertain toxicity, or are nontoxic.

Uncertainty bounds were used when estimating the toxicity of the selected metals, as the use of uncertainty bounds has been reported to improve the predictability of toxicity (USEPA, 2005a). The uncertainty bounds presented in USEPA (2005a) state that toxicity is likely when the ($\sum$SEM-AVS)/f_{OC} is >3,000 µmol/g_{OC}, uncertain when the concentration is between 130 and 3,000 µmol/g_{OC}, and not likely when the concentration is <130 µmol/g_{OC}. The carbon-normalized ($\sum$SEM-AVS)/f_{OC} values for each sample location are presented in Table 5-7.

5.2.2 Water-Column-Dwelling Aquatic Life

The BERA further evaluated surface water chemical concentrations to refine the estimate of risk for water column-dwelling aquatic life. These data outcomes were considered both individually and as part of a weight-of-evidence approach to evaluate the overall potential for adverse effects to water-column-dwelling aquatic life in the Gowanus Canal.

With the surface water chemical analytical data (wet and dry events) discussed in Section 5.1.1, the following guidelines were used in the BERA to estimate potential direct exposure of water-column-dwelling aquatic life for both the dry and wet sample events:

- For each data group, 95% UCL chemical concentrations were calculated using Pro UCL version 4.00.05 and compared to the medium-specific screening values used in the SLERA.
- For samples with duplicate analyses, the higher of the two detected concentrations was used if both values were detects. In cases where one result was a detected concentration and the other a nondetect, the detected value was used for evaluation of the 95% UCL.
- Nondetected chemicals were not evaluated in the BERA, but were instead considered in the uncertainty section of the ERA (Section 7).

A summary of the 95% UCL chemical concentrations in Gowanus Canal surface water under dry and wet event sample conditions is presented in Tables 5-8 and 5-9, respectively.

The surface water screening benchmarks that were used in the SLERA were also used in the BERA to evaluate the potential for adverse effects to water-column-dwelling aquatic life from exposure to chemicals in surface water. A detailed description of the surface water screening benchmarks selected for use in the BERA is presented in Section 3.2.

HQs were derived in the BERA to evaluate risks and were calculated for each parameter by dividing the 95% UCL by the screening value. Chemicals were identified as COCs if they were detected at 95% UCL concentrations exceeding screening values.

5.2.3 Avian Wildlife

This section presents the assessment of food web exposure risks for upper-trophic-level receptors (wildlife) potentially foraging in the canal. This assessment was conducted to be consistent with the food web evaluation approaches and assumptions employed during a BERA, per the USEPA's ERA guidance for the Superfund Program (USEPA, 1997).

Due to the urbanized setting and structure of the canal and surrounding area, only a limited number of upper-trophic-level receptors is expected to utilize this aquatic habitat. As discussed for the CSM (Section 2.1), only avian wildlife is expected to utilize this habitat. Species that represent the range of potential feeding groups using the canal include the green heron (omnivore), double-crested cormorant (piscivore), and black duck (herbivore). Therefore, these species were selected as indicator species at the focus of this food web assessment. At the BERA level of assessment, a food web scenario is considered that provides the most representative and realistic estimate of potential exposures and risks to these upper-trophic-level receptor populations (the focus of the assessment endpoints, as opposed to individuals). This is accomplished by using central tendency estimates of constituent exposure concentrations, bioaccumulation, and receptor-specific exposure parameters (e.g., body weight and food ingestion weight). This approach is appropriate; since upper-trophic-level species are highly mobile, they would be expected to effectively average their exposure over time as they forage within the area defining their home range (which will extend to offsite areas).

This section presents the components of the food web model that was used to estimate potential risks for upper trophic level receptors. Included in this section is a summary of the bioaccumulative chemicals at the focus of this portion of the assessment, the selection of ingestion screening values, identification of exposure point concentrations (EPCs), and the approach used to estimate the dietary exposure dose of selected receptor species.

Bioaccumulative Constituents Selected for Evaluation

Only constituents detected in sediment and/or wildlife prey-item tissue (fish and benthic invertebrates/crabs) at the site with the greatest potential to bioaccumulate were evaluated for exposures via the food web assessment. These consist of constituents listed in *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment* (USEPA, 2000, Table 4-2).

For the DDT family of chemicals (4,4'-DDT, 4,4'-DDE, and 4,4'-DDD), PAHs, and PCBs, a total, or cumulative, concentration was evaluated instead of individual compounds, congeners, and/or Aroclor mixtures. For these constituents, a cumulative concentration is more appropriate since the constituents in these groups occur in close association (i.e., are detected simultaneously), and the ecotoxicological basis for the toxicity reference values (TRVs) for these groups reflects a potential additive, or cumulative exposure risks.

It should be noted that for PCBs and the heron and cormorant exposure estimates, all fish and invertebrate tissue samples were analyzed only for 209 PCB congeners (not Aroclor mixtures). However, all sediment samples were analyzed for Aroclor mixtures and only a subset of samples was analyzed for PCB congeners. Since the most comprehensive data set is Aroclor-based, these data were used in the food web assessment for estimating black duck exposure via consumption of aquatic plants (bioaccumulation estimated from sediment) and incidental ingestion of sediment. However, the congener- versus Aroclor-based total PCB concentrations is evaluated in the uncertainty section as a means to evaluate the differences between these methods of analysis and potential impact on the risk assessment results.

Dioxin-like PCB congeners in tissue were also assessed using toxicity equivalents (TEQs) for the heron and cormorant exposure estimates. The method for calculating TEQs is discussed below. Due to the limited congener data available for sediment, TEQs were not calculated for sediment. Therefore TEQs could not be estimated for aquatic plants, and black duck exposure was not evaluated for this constituent. The lack of black duck/TEQ evaluation is considered in the discussion of uncertainty.

Ingestion Screening Values

Ingestion screening values, TRVs, for avian receptors were identified from the scientific literature. For the purpose of this assessment a TRV is defined as a threshold concentration of a particular chemical that represents some level of protectiveness (i.e., is the minimum concentration associated with adverse effects or the maximum concentration not associated with adverse effects) for the avian receptors selected for evaluation.

Studies that relate dietary concentrations of bioaccumulative constituents to adverse effects in birds were identified from a search of electronic databases and from a review of original studies identified in the following review sources:

- Agency for Toxic Substances and Disease Registry (ATSDR)
- ECOTOX database (EPA electronic database)
- BIOSIS electronic database
- TOXNET database (National Library of Medicine)
- Integrated Risk Information System (IRIS) database (EPA electronic database)
- U.S. Fish and Wildlife Service (USFWS) Contaminant Review series electronic database
- Oak Ridge National Laboratory database (Sample et al., 1996)

Consistent with the assessment endpoints identified for evaluation, only dietary studies with survival, growth, and reproduction as the measured endpoints were considered for use in the food web assessment. The TRVs identified for evaluation represent both concentrations below which adverse effects are not expected (i.e., no-observed-adverse-effect level [NOAEL]) and/or above which adverse effects are expected (i.e., lowest-observed-adverse-effect level [LOAEL]). NOAELs or LOAELs could be identified for only some constituents (e.g., mercury or methoxychlor). The selection of TRVs based on the available reviewed literature was prioritized using the following guidelines:

- The preferred exposure duration was subchronic or chronic, or conducted during a critical life stage such as reproduction, gestation, or development. Acute studies were considered but not preferred.

- Only studies with mortality, growth, or reproductive effect endpoints were used for birds and mammals.

- Doses received via food ingestion were preferred over administration of the dose using drinking water, gavage, oral intubation, or injection because the exposure route in nondietary studies were not preferred because the exposure route cannot be directly related to environmental exposure to the bird or mammal.

- Preferred TRVs were based on results that were evaluated statistically to identify significant differences from control values. Studies were not considered if negative control groups were not included.
- Studies using field-collected prey were reviewed and compared to the results of the laboratory studies. In general, laboratory studies were preferred as a source of TRVs because controlled test conditions provide greater certainty that the observed response can be related to the chemical dose. The presence of multiple chemicals and other environmental factors may result in adverse effects that complicate the interpretation of field study results.

The TRVs are expressed as daily dose in milligrams per kilogram body weight per day (mg/kg bw/d). Some literature sources express the TRVs as a food concentration, in which case a daily exposure dose was derived from the food concentration using the animal's body weight (kg) and ingestion rate (kg/d) as reported in the study or using values published elsewhere. The selected avian TRVs used for this assessment are presented in Table 5-10. Since the actual dose that is protective of an individual receptor falls between the NOAEL and the LOAEL, a constituent will be identified as a food web COPC if the estimated dose for at least one of the avian receptors exceeds both the NOAEL and LOAEL, when both are available. For constituents where only one endpoint has been identified, the exceedances will be evaluated on a constituent-by-constituent basis in consideration with other key information (frequency of detection, magnitude of exceedance, etc.).

Exposure Point Concentrations

An exposure point concentration (EPC) is the estimation of a constituent concentration in applicable media to which receptors might be exposed. For food web/upper-trophic-level receptors, the estimated EPCs for each ingested item (e.g., food, sediment) are used as the basis for estimating the total dietary dose for each constituent.

Medium-specific EPCs are calculated as a particular point on the distribution of concentrations from sets of site-specific data representing these media. Section 5.1 discusses the available analytical data collected at the site and the criteria used to select these sets of data (validation status, sampling date, sample depth and location, etc.). The EPCs established for this assessment varied by medium due to the number and types of samples collected at the site. The EPCs are briefly discussed by medium in the subsections below.

DDT family chemicals, PAH compounds, and PCB congeners/Aroclors were assessed on a total-concentration basis. The approach for calculating total DDT, PCBs, and PAHs is explained in Table 4-21 of the RI and in the following sections. Surface-water-based constituents were not considered for any receptors via the food web exposure assessment since the brackish conditions in the canal would not make it a suitable drinking water source for wildlife. Additionally, all EPCs used for the food web assessment are reported on a dry weight basis. Section 5.1.3 discusses how tissue how data that were reported on a wet weight basis were converted to dry weight for use here.

Sediment. The 95% UCL concentration of bioaccumulative chemicals detected within the surface sediment (0 to 6 inches) was used as the EPC for chemicals for this medium, unless the 95% UCL was greater than the maximum detected concentration. In these situations, the detected maximum concentration was used as the EPC. For conservatism, when a constituent was undetected in sediment but was detected in fish and/or crab tissue, the maximum reporting limit was used as a surrogate sediment EPC. A summary of the EPCs for sediment is presented in Table 5-5.

Fish and Benthic Invertebrate Tissue. For fish and aquatic invertebrate tissue, concentrations from crab small prey fish collected during the Phase 3 investigation were used as the basis for the EPCs. For crab EPCs, the mean concentration of whole-body crabs, as estimated by combining results of the hepatopancreas and edible tissue samples, was used (Section 5.1.3). For the fish tissue EPCs, the weighted mean concentration of whole-body small prey fish (combined grouping of tomcod and mummichog chemical analytical outcomes) was used (Section 5.1.3). Tables 5-2 and 5-4 present these EPCs for crab and fish tissues, respectively. For conservatism, when a constituent was undetected in either crab or fish tissue samples, the maximum reporting limit was used as a surrogate EPC.

The EPCs for dioxin-like PCB congeners (PCBs 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, and 189) measured in tissue samples were also evaluated using the TEQ approach. This approach was used to adjust all dioxin-like PCB congener concentrations in terms of 2,3,7,8-TCDD using a two-step process. First, a dioxin (2,3,7,8-TCDD) equivalent concentration was calculated for each of the 12 dioxin-like PCB congeners by multiplying the detected concentrations by their respective receptor-specific toxicity equivalency factor (TEF). Second, a total TEQ value was calculated for each sample by summing all congener-specific TEQs. The bird TEFs from Van den Berg et al. (1998) were used to calculate TEQs (Table 5-11). Attachment C contains the full TEQ calculation worksheets from raw data for birds.

Aquatic Plants. The concentrations in the above-sediment vegetative portion of plants were estimated for all bioaccumulative constituents, except PAHs, by multiplying sediment EPCs by chemical-specific sediment-to-plant bioconcentration factors (BCFs). These BCFs were based on central tendency estimates (e.g., median or mean) from the literature. These BCFs are listed in Table 5-12.

These BCFs were based upon root uptake from soil (and were extrapolated to sediment) and upon the ratio between dry-weight soil and dry-weight plant tissue. Literature values based upon the ratio between dry-weight soil and wet-weight plant tissue were converted to a dry-weight basis by dividing the wet-weight BCF by an estimated solids content for terrestrial plants (15 percent [0.15]; Sample et al., 1997). The aquatic plant tissue EPCs have not been summarized previously and are presented in the food web risk results table in subsequent section.

For the total PAH, aquatic plant tissue EPCs were estimated from sediment using an approach that incorporated the uptake differences between low-molecular-weight (LMW) and high-molecular-weight (HMW) PAH compounds. As with other constituents, the uptake was estimated from soil and extrapolated to sediment using the approach from the PAH-specific ecological soil screening levels (Eco-SSL) document (USEPA, 2007). Attachment D presents the detailed EPC approach and calculations used for the aquatic plant tissue.

Dietary Intakes

For receptor species used in food-web modeling, the dietary intake (i.e., dose) of each constituent (in milligrams of chemical per kilogram of body weight per day) was calculated by using species-specific life history information, where available, and the following formula (modified from USEPA, 1993):

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)]]}{BW}(AUF)$$

Where:

- DI_x = Dietary intake for constituent *x* (mg constituent/kg body weight/day)
- FIR = Food ingestion rate (kg/day, dry weight)
- FC_{xi} = Concentration of constituent *x* in food item *i* (mg/kg, dry weight)
- PDF_i = Proportion of diet composed of food item *i* (dry weight basis)
- SC_x = Concentration of constituent *x* in sediment (mg/kg, dry weight)
- PDS = Proportion of diet composed of sediment (dry-weight basis)
- BW = Body weight (kg)
- AUF = Area use factor; percent (decimal) of habitat used by receptor relative to the size of the site

Receptor-specific values used as inputs to this equation are provided in Table 5-13. It was assumed that constituents were 100 percent bioavailable to the receptor and it was also assumed that each receptor spent 100 percent of its time at the site (i.e., AUF of 1.0 was assumed). Central tendency estimates (e.g., mean, median, or midpoint) for body weight and ingestion rate were used to develop exposure estimates for upper trophic level receptors. Central tendency estimates for these exposure parameters are more relevant for a BERA because they better represent the characteristics of a greater proportion of the individuals in the population.

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TABLE 5-1
Summary Statistics – Gowanus Blue Crab Tissue – Maximum and Mean Wet Weight Tissue Residue Concentrations
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Detected Values	Location of Max Detect	Maximum Concentration Detected	Mean Concentration Detected
Semi-Volatile Organic Compounds (ug/kg)					
Acenaphthene	12 / 12 (100%)	23.8 - 73.0	GC-TI401-BC	73.0	39.5
Acenaphthylene	6 / 12 (50.0%)	6.07 - 14.3	GC-TI401-BC	14.3	9.71
Anthracene	12 / 12 (100%)	3.85 - 12.4	GC-TI401-BC	12.4	6.44
Benzo(a)anthracene	5 / 12 (41.7%)	4.75 - 15.7	GC-TI402-BC	15.7	7.64
Benzo(a)pyrene	11 / 12 (91.7%)	5.45 - 17.5	GC-TI402-BC	17.5	7.74
Benzo(b)fluoranthene	9 / 12 (75.0%)	4.82 - 9.61	GC-TI402-BC	9.61	5.87
Benzo(g,h,i)perylene	12 / 12 (100%)	13.6 - 28.2	GC-TI401-BC	28.2	18.5
Benzo(k)fluoranthene	8 / 12 (66.7%)	3.65 - 8.76	GC-TI402-BC	8.76	4.89
Chrysene	8 / 12 (66.7%)	5.03 - 13.6	GC-TI402-BC	13.6	6.66
Dibenz(a,h)anthracene	12 / 12 (100%)	2.59 - 5.13	GC-TI402-BC	5.13	3.56
Fluoranthene	12 / 12 (100%)	8.44 - 21.9	GC-TI402-BC	21.9	14.9
Fluorene	12 / 12 (100%)	6.43 - 26.8	GC-TI404-BC	26.8	14.9
Indeno(1,2,3-c,d)pyrene	12 / 12 (100%)	7.46 - 12.3	GC-TI402-BC	12.3	9.22
Phenanthrene	12 / 12 (100%)	12.2 - 44.1	GC-TI401-BC	44.1	26.6
Pyrene	12 / 12 (100%)	9.88 - 28.6	GC-TI401-BC	28.6	18.5
Total PAHs	12 / 12 (100%)	106 - 300	GC-TI401-BC	300	184
Pesticides (ug/kg)					
P,P'-DDE	12 / 12 (100%)	2.05 - 2.79	GC-TI402-BC	2.79	2.41
Total DDTs	4 / 12 (33.3%)	2.08 - 2.79	GC-TI402-BC	2.79	2.50
Polychlorinated Biphenyl Congeners (ng/kg)					
Total PCB Congeners	12 / 12 (100%)	133000 - 194000	GC-TI405-BC	194000	157000
Metals (mg/kg)					
Arsenic	12 / 12 (100%)	0.902 - 1.47	GC-TI401-BC	1.47	1.21
Calcium	12 / 12 (100%)	1050 - 1740	GC-TI406-BC	1740	1400
Copper	12 / 12 (100%)	8.19 - 11.7	GC-TI406-BC	11.7	9.65
Iron	6 / 12 (50.0%)	8.43 - 13.3	GC-TI406-BC	13.3	10.8
Magnesium	12 / 12 (100%)	318 - 395	GC-TI406-BC	395	351
Manganese	12 / 12 (100%)	2.20 - 3.24	GC-TI405-BC	3.24	2.72
Mercury	12 / 12 (100%)	0.0792 - 0.142	GC-TI402-BC	0.142	0.115
Potassium	12 / 12 (100%)	1910 - 2390	GC-TI406-BC	2390	2100

TABLE 5-1
Summary Statistics – Gowanus Blue Crab Tissue – Maximum and Mean Wet Weight Tissue Residue Concentrations
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Detected Values	Location of Max Detect	Maximum Concentration Detected	Mean Concentration Detected
Metals (mg/kg)					
Silver	2 / 12 (16.7%)	0.421 - 0.463	GC-TI401-BC	0.463	0.442
Sodium	12 / 12 (100%)	2630 - 3490	GC-TI401-BC, GC-TI402-BC	3490	3070
Zinc	12 / 12 (100%)	18.9 - 24.0	GC-TI406-BC	24.0	20.9
Cyanide, Total	10 / 12 (83.3%)	0.527 - 0.847	GC-TI401-BC	0.847	0.708

TABLE 5-2
Summary Statistics – Gowanus Blue Crab Tissue – Maximum and Mean Dry Weight Tissue Residue Concentrations
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Detected Values	Location of Max Detect	Maximum Concentration Detected	Mean Concentration Detected
Semi-Volatile Organic Compounds (ug/kg)					
Acenaphthene	12 / 12 (100%)	665 - 1370	GC-TI401-BC	1370	1160
Acenaphthylene	6 / 12 (50.0%)	210 - 247	GC-TI401-BC	247	228
Anthracene	12 / 12 (100%)	123 - 252	GC-TI401-BC	252	214
Benzo(a)anthracene	5 / 12 (41.7%)	144 - 204	GC-TI402-BC	204	159
Benzo(a)pyrene	11 / 12 (91.7%)	107 - 241	GC-TI402-BC	241	180
Benzo(b)fluoranthene	9 / 12 (75.0%)	128 - 160	GC-TI402-BC	160	139
Benzo(g,h,i)perylene	12 / 12 (100%)	282 - 491	GC-TI401-BC	491	431
Benzo(k)fluoranthene	8 / 12 (66.7%)	100 - 133	GC-TI402-BC	133	112
Chrysene	8 / 12 (66.7%)	143 - 195	GC-TI402-BC	195	157
Dibenz(a,h)anthracene	12 / 12 (100%)	74.6 - 133	GC-TI402-BC	133	120
Fluoranthene	12 / 12 (100%)	268 - 526	GC-TI402-BC	526	472
Fluorene	12 / 12 (100%)	241 - 529	GC-TI404-BC	529	443
Indeno(1,2,3-c,d)pyrene	12 / 12 (100%)	152 - 260	GC-TI402-BC	260	236
Phenanthrene	12 / 12 (100%)	451 - 934	GC-TI401-BC	934	820
Pyrene	12 / 12 (100%)	327 - 650	GC-TI401-BC	650	580
Total PAHs	12 / 12 (100%)	3000 - 6020	GC-TI401-BC	6020	5270
Pesticides (ug/kg)					
P,P'-DDE	12 / 12 (100%)	41.6 - 73.0	GC-TI405-BC	73.0	67.1
Total DDTs	4 / 12 (33.3%)	65.9 - 72.0	GC-TI402-BC	72.0	69.2
Polychlorinated Biphenyl Congeners (ng/kg)					
Total PCB Congeners	12 / 12 (100%)	2770000 - 4840000	GC-TI405-BC	4840000	4270000
Metals (mg/kg)					
Arsenic	12 / 12 (100%)	22.0 - 34.5	GC-TI404-BC	34.5	31.8
Calcium	12 / 12 (100%)	28000 - 45000	GC-TI405-BC	45000	40600
Copper	12 / 12 (100%)	167 - 258	GC-TI405-BC	258	239
Iron	6 / 12 (50.0%)	275 - 453	GC-TI405-BC	453	408
Magnesium	12 / 12 (100%)	6400 - 10300	GC-TI405-BC	10300	9510
Manganese	12 / 12 (100%)	97.6 - 182	GC-TI405-BC	182	165
Mercury	12 / 12 (100%)	1.41 - 2.23	GC-TI404-BC	2.23	2.00
Potassium	12 / 12 (100%)	31700 - 48400	GC-TI405-BC	48400	45200

TABLE 5-2
Summary Statistics – Gowanus Blue Crab Tissue – Maximum and Mean Dry Weight Tissue Residue Concentrations
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Detected Values	Location of Max Detect	Maximum Concentration Detected	Mean Concentration Detected
Metals (mg/kg)					
Silver	2 / 12 (16.7%)	10.0 - 16.3	GC-TI401-BC	16.3	13.2
Sodium	12 / 12 (100%)	56700 - 95500	GC-TI402-BC	95500	87100
Zinc	12 / 12 (100%)	326 - 498	GC-TI405-BC	498	467
Cyanide, Total	10 / 12 (83.3%)	22.3 - 41.7	GC-TI405-BC	41.7	37.8

TABLE 5-3
Summary Statistics – Gowanus Small Prey Fish – Maximum and Mean Wet Weight Tissue Residue Concentrations
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Detected Values	Location of Max Detect	Maximum Concentration Detected	Mean Concentration Detected
Pesticides (ug/kg)					
Alpha-chlordane	4 / 8 (50.0%)	1.80 - 4.20	GC-TI405-MCG	4.20	3.15
Endrin	1 / 8 (12.5%)	2.70 - 2.70	GC-TI401-XATC	2.70	---
Gamma-chlordane	1 / 7 (14.3%)	5.40 - 5.40	GC-TI405-MCG	5.40	---
P,P'-DDE	1 / 8 (12.5%)	3.50 - 3.50	GC-TI405-MCG	3.50	---
P,P'-DDT	1 / 8 (12.5%)	8.50 - 8.50	GC-TI401-XATC	8.50	---
Polychlorinated Biphenyl Congeners (ng/kg)					
Total PCB Congeners	8 / 8 (100%)	117000 - 650000	GC-TI404-MCG	650000	273000
Metals (mg/kg)					
Aluminum	1 / 8 (12.5%)	30.3 - 30.3	GC-TI405-XATC	30.3	---
Calcium	8 / 8 (100%)	2910 - 11600	GC-TI404-MCG	11600	7110
Chromium	2 / 8 (25.0%)	0.33 - 0.40	GC-TI405-XATC	0.40	0.365
Copper	6 / 8 (75.0%)	0.84 - 4.50	GC-TI403-MCG	4.50	2.52
Iron	8 / 8 (100%)	16.2 - 77.6	GC-TI405-XATC	77.6	31.4
Lead	1 / 8 (12.5%)	0.69 - 0.69	GC-TI405-XATC	0.69	---
Magnesium	8 / 8 (100%)	187 - 517	GC-TI404-MCG	517	361
Manganese	8 / 8 (100%)	0.92 - 4.30	GC-TI404-MCG	4.30	2.30
Mercury	8 / 8 (100%)	0.072 - 0.10	GC-TI401-XATC, GC-TI403-MCG	0.10	0.0866
Potassium	8 / 8 (100%)	1290 - 2730	GC-TI404-MCG	2730	2220
Selenium	3 / 8 (37.5%)	1.20 - 1.30	GC-TI403-MCG, GC-TI405-MCG	1.30	1.27
Sodium	8 / 8 (100%)	588 - 1910	GC-TI401-XATC	1910	1360
Zinc	8 / 8 (100%)	7.20 - 42.3	GC-TI403-MCG	42.3	21.9
Cyanide, Total	3 / 8 (37.5%)	0.24 - 0.44	GC-TI406-XATC	0.44	0.357

TABLE 5-4
Summary Statistics – Gowanus Small Prey Fish – Maximum and Mean Dry Weight Tissue Residue Concentrations
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Detected Values	Location of Max Detect	Maximum Concentration Detected	Mean Concentration Detected
Pesticides (ug/kg)					
Alpha-chlordane	4 / 8 (50.0%)	18.3 - 26.4	GC-TI401-XATC	26.4	22.1
Endrin	1 / 8 (12.5%)	18.8 - 18.8	GC-TI401-XATC	18.8	---
Gamma-chlordane	1 / 7 (14.3%)	23.5 - 23.5	GC-TI405-MCG	23.5	---
P,P'-DDE	1 / 8 (12.5%)	15.2 - 15.2	GC-TI405-MCG	15.2	---
P,P'-DDT	1 / 8 (12.5%)	59.0 - 59.0	GC-TI401-XATC	59.0	---
Polychlorinated Biphenyl Congeners (ng/kg)					
Total PCB Congeners	8 / 8 (100%)	953000 - 2890000	GC-TI404-MCG	2890000	1580000
Metals (mg/kg)					
Aluminum	1 / 8 (12.5%)	233 - 233	GC-TI405-XATC	233	---
Calcium	8 / 8 (100%)	32600 - 51600	GC-TI404-MCG	51600	41800
Chromium	2 / 8 (25.0%)	1.47 - 3.08	GC-TI405-XATC	3.08	2.28
Copper	6 / 8 (75.0%)	4.80 - 18.1	GC-TI403-MCG	18.1	13.0
Iron	8 / 8 (100%)	102 - 597	GC-TI405-XATC	597	218
Lead	1 / 8 (12.5%)	5.31 - 5.31	GC-TI405-XATC	5.31	---
Magnesium	8 / 8 (100%)	1740 - 2790	GC-TI403-XATC	2790	2250
Manganese	8 / 8 (100%)	11.1 - 19.1	GC-TI404-MCG	19.1	13.6
Mercury	8 / 8 (100%)	0.322 - 0.976	GC-TI403-XATC	0.976	0.594
Potassium	8 / 8 (100%)	10100 - 18700	GC-TI401-XATC	18700	14200
Selenium	3 / 8 (37.5%)	5.24 - 5.65	GC-TI405-MCG	5.65	5.41
Sodium	8 / 8 (100%)	5890 - 13300	GC-TI401-XATC	13300	8790
Zinc	8 / 8 (100%)	85.1 - 171	GC-TI403-MCG	171	124
Cyanide, Total	3 / 8 (37.5%)	1.67 - 4.76	GC-TI403-XATC	4.76	2.98

TABLE 5-5
Screening Statistics - Gowanus Canal Surface Sediment (0-6") - Step 3
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Screening Value	95 % UCL	UCL Type	Hazard Quotient (95% UCL)	95% UCL COC?
Volatile Organic Compounds (ug/kg)									
1,2-dichloroethane	6 / 27 (22.2%)	5.00 - 23.0	3.90 - 45.0	323	NSV	10.2	95% KM (% Bootstrap)	NSV	NSV
1,4-dichlorobenzene	3 / 26 (11.5%)	5.00 - 23.0	7.60 - 240	301	240	240	95% KM (Percentile Bootstrap)	1.0	No
Acetone	11 / 27 (40.7%)	9.90 - 46.0	21.0 - 90.0	314	NSV	34.7	95% KM (t)	NSV	NSV
Benzene	4 / 27 (14.8%)	5.00 - 23.0	6.80 - 110	304	520	53.1	95% KM (Percentile Bootstrap)	0.1	No
Carbon disulfide	9 / 27 (33.3%)	5.00 - 23.0	4.70 - 89.0	314	NSV	15	95% KM (% Bootstrap)	NSV	NSV
Chlorobenzene	1 / 27 (3.7%)	5.00 - 23.0	53.0 - 53.0	301	70	53	Max	0.76	No
Cyclohexane	3 / 27 (11.1%)	5.00 - 23.0	8.00 - 14.0	304	NSV	14	95% KM (% Bootstrap)	NSV	NSV
Ethylbenzene	8 / 27 (29.6%)	5.00 - 23.0	5.30 - 3600	315	128	484	95% KM (t)	3.8	YES
Isopropylbenzene (cumene)	7 / 27 (25.9%)	5.00 - 23.0	4.60 - 760	315	NSV	198	95% KM (Percentile Bootstrap)	NSV	NSV
m, p xylenes	5 / 27 (18.5%)	5.00 - 23.0	5.40 - 810	315	540	197	95% KM (Percentile Bootstrap)	0.36	No
Methylcyclohexane	3 / 27 (11.1%)	5.00 - 23.0	15.0 - 170	314	NSV	33	95% KM (t)	NSV	NSV
Methylene chloride	6 / 27 (22.2%)	5.00 - 23.0	2.20 - 7.70	306	NSV	4.82	95% KM (Percentile Bootstrap)	NSV	NSV
o-xylene (1,2-dimethylbenzene)	5 / 27 (18.5%)	5.00 - 23.0	19.0 - 1200	315	540	367	95% KM (Percentile Bootstrap)	0.68	No
Tert-butyl methyl ether	1 / 27 (3.7%)	5.00 - 23.0	34.0 - 34.0	304	NSV	34	Max	NSV	NSV
Tetrachloroethylene(PCE)	2 / 27 (7.4%)	5.00 - 23.0	5.80 - 11.0	302	NSV	11	95% KM (% Bootstrap)	NSV	NSV
Toluene	4 / 27 (14.8%)	5.00 - 23.0	5.80 - 36.0	314	900	25.8	95% KM (Percentile Bootstrap)	0.029	No
Trichloroethylene (TCE)	1 / 27 (3.7%)	5.00 - 23.0	4.20 - 4.20	301	NSV	4.2	Max	NSV	NSV
Trichlorofluoromethane	3 / 27 (11.1%)	5.00 - 23.0	4.60 - 8.90	302	NSV	8.9	95% KM (Percentile Bootstrap)	NSV	NSV
Semi-Volatile Organic Compounds (ug/kg)									
2-methylnaphthalene	16 / 27 (59.3%)	120 - 3100	190 - 870000	315	70	358000	99% KM (Chebyshev)	5100	YES
Acenaphthene	21 / 27 (77.8%)	160 - 3100	160 - 580000	315	16	309000	99% KM (Chebyshev)	19000	YES
Acenaphthylene	14 / 27 (51.9%)	160 - 3100	270 - 150000	314	44	84700	99% KM (Chebyshev)	1900	YES
Anthracene	24 / 27 (88.9%)	250 - 3100	330 - 610000	315	85.3	293000	99% KM (Chebyshev)	3400	YES
Benzo(a)anthracene	27 / 27 (100%)	---	1100 - 490000	315	261	128000	95% Chebyshev (Mean, Sd)	490	YES
Benzo(a)pyrene	26 / 27 (96.3%)	250 - 250	1200 - 200000	314	430	73200	97.5% KM (Chebyshev)	170	YES
Benzo(b)fluoranthene	26 / 27 (96.3%)	250 - 250	1000 - 210000	314	4600	79200	97.5% KM (Chebyshev)	17	YES
Benzo(g,h,i)perylene	26 / 27 (96.3%)	260 - 260	610 - 74000	314	620	27600	97.5% KM (Chebyshev)	45	YES
Benzo(k)fluoranthene	26 / 27 (96.3%)	250 - 250	820 - 120000	314	4600	41000	97.5% KM (Chebyshev)	8.9	YES
Biphenyl (diphenyl)	2 / 27 (7.4%)	6200 - 230000	650 - 71000	315	NSV	42300	99% KM (Chebyshev)	NSV	NSV
Bis(2-ethylhexyl) phthalate	21 / 27 (77.8%)	8100 - 160000	2600 - 57000	314	182	14600	95% KM (BCA)	80	YES

TABLE 5-5
Screening Statistics - Gowanus Canal Surface Sediment (0-6") - Step 3
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Screening Value	95 % UCL	UCL Type	Hazard Quotient (95% UCL)	95% UCL COC?
Semi-Volatile Organic Compounds (ug/kg)									
Carbazole	1 / 27 (3.7%)	6200 - 230000	1400 - 1400	308A	NSV	1400	Max	NSV	NSV
Chrysene	27 / 27 (100%)	---	730 - 490000	315	384	127000	95% Chebyshev (Mean, Sd)	330	YES
Dibenz(a,h)anthracene	23 / 27 (85.2%)	320 - 3100	200 - 14000	314	63.4	5460	97.5% KM (Chebyshev)	86	YES
Dibenzofuran	1 / 27 (3.7%)	6200 - 230000	1100 - 1100	319	300	1100	Max	3.7	YES
Di-n-butyl phthalate	2 / 27 (7.4%)	6200 - 230000	510 - 550	318	4400	550	Max	0.13	No
Di-n-octylphthalate	1 / 27 (3.7%)	6200 - 230000	9300 - 9300	307A	1160	9300	Max	8.0	YES
Fluoranthene	27 / 27 (100%)	---	1200 - 630000	314	600	180000	95% Chebyshev (Mean, Sd)	300	YES
Fluorene	17 / 27 (63.0%)	160 - 3100	130 - 540000	315	19	231000	99% KM (Chebyshev)	12000	YES
Indeno(1,2,3-c,d)pyrene	27 / 27 (100%)	---	1000 - 120000	314	680	31400	95% Chebyshev (Mean, Sd)	46	YES
Naphthalene	19 / 27 (70.4%)	160 - 3100	120 - 1600000	315	160	655000	99% KM (Chebyshev)	4100	YES
Phenanthrene	26 / 27 (96.3%)	3100 - 3100	510 - 1100000	315	240	497000	99% KM (Chebyshev)	2100	YES
Pyrene	26 / 27 (96.3%)	230 - 230	1400 - 670000	314	665	387000	99% KM (Chebyshev)	580	YES
Total PAHs	27 / 27 (100%)	---	10900 - 8000000	315	4022	1950000	95% Chebyshev (Mean, Sd)	480	YES
Pesticides (ug/kg)									
Alpha-chlordane	2 / 27 (7.4%)	2.70 - 530	6.70 - 14.0	308A	0.04	14	95% KM (% Bootstrap)	350	YES
Beta endosulfan	1 / 27 (3.7%)	5.30 - 1000	13.0 - 13.0	308A	0.08	13	Max	160	YES
Endosulfan sulfate	1 / 27 (3.7%)	5.30 - 1000	21.0 - 21.0	308A	NSV	21	Max	NSV	NSV
Gamma-chlordane	3 / 27 (11.1%)	2.70 - 530	5.90 - 29.0	308A	0.04	29	95% KM (Percentile Bootstrap)	730	YES
Methoxychlor	1 / 27 (3.7%)	27.0 - 5300	33.0 - 33.0	308A	NSV	33	Max	NSV	NSV
P,P'-DDD	5 / 5 (100%)	---	7.90 - 1100	315	1.22	1100	Max	900	YES
P,P'-DDE	1 / 26 (3.8%)	5.30 - 1000	16.0 - 16.0	308A	2.2	16	Max	7.3	YES
Total DDTs	5 / 5 (100%)	---	7.90 - 1100	315	1.58	1100	Max	700	YES
Polychlorinated Biphenyls (ug/kg)									
Aroclor 1016	4 / 27 (14.8%)	41.0 - 120	140 - 290	318	22.7	246	95% KM (Percentile Bootstrap)	11	YES
Aroclor 1248	2 / 27 (7.4%)	41.0 - 120	230 - 2200	316	22.7	935	97.5% KM (Chebyshev)	41	YES
Aroclor 1254	1 / 27 (3.7%)	48.0 - 120	590 - 590	308A	22.7	590	Max	26	YES
Aroclor 1260	7 / 27 (25.9%)	41.0 - 120	150 - 3400	314	22.7	657	95% KM (t)	29	YES
Total PCBs	10 / 27 (37.0%)	---	230 - 3400	314	22.7	846	95% KM (t)	37	YES
Polychlorinated Biphenyl Congeners (ng/kg)									
Total PCB Congeners	19 / 19 (100%)	---	99500 - 15100000	314	59800	6630000	95% Chebyshev (Mean, Sd) UCL	110	YES

TABLE 5-5
Screening Statistics - Gowanus Canal Surface Sediment (0-6") - Step 3
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Screening Value	95 % UCL	UCL Type	Hazard Quotient (95% UCL)	95% UCL COC?
Metals (mg/kg)									
Aluminum	27 / 27 (100%)	---	4870 - 18900	310	NSV	14600	95% Student's-t	NSV	NSV
Arsenic	27 / 27 (100%)	---	3.40 - 44.7	308A	8.2	14.7	95% Modified-t	1.8	YES
Barium	27 / 27 (100%)	---	83.1 - 631	317	130.1	277	95% Chebyshev (Mean, Sd)	2.1	YES
Beryllium	12 / 27 (44.4%)	0.60 - 1.60	0.11 - 0.46	309	NSV	0.371	95% KM (t)	NSV	NSV
Cadmium	27 / 27 (100%)	---	1.50 - 20.2	308A	1.2	9.99	95% Chebyshev (Mean, Sd)	8.3	YES
Calcium	27 / 27 (100%)	---	4890 - 11300	313	NSV	8230	95% Student's-t	NSV	NSV
Chromium	27 / 27 (100%)	---	22.7 - 139	314	81	84.5	95% Modified-t	1.0	No
Cobalt	14 / 27 (51.9%)	7.30 - 17.1	6.50 - 14.8	318	NSV	11	95% KM (Percentile Bootstrap)	NSV	NSV
Copper	27 / 27 (100%)	---	85.8 - 790	308A	34	274	95% Modified-t	8.1	YES
Iron	27 / 27 (100%)	---	12400 - 87000	308A	NSV	33600	95% Modified-t	NSV	NSV
Lead	27 / 27 (100%)	---	146 - 4220	308A	46.7	1200	95% Chebyshev (Mean, Sd)	26	YES
Magnesium	27 / 27 (100%)	---	4210 - 11400	318	NSV	9350	95% Student's-t	NSV	NSV
Manganese	27 / 27 (100%)	---	89.1 - 480	308A	460	306	95% Student's-t	0.67	No
Mercury	27 / 27 (100%)	---	0.59 - 2.30	313	0.15	1.39	95% Student's-t	9.3	YES
Nickel	27 / 27 (100%)	---	18.1 - 84.5	314	20.9	48.1	95% Approximate Gamma	2.3	YES
Potassium	27 / 27 (100%)	---	730 - 4410	310	NSV	3670	95% Approximate Gamma	NSV	NSV
Selenium	15 / 27 (55.6%)	4.20 - 12.0	0.74 - 4.90	310	NSV	2.13	95% KM (t)	NSV	NSV
Silver	22 / 27 (81.5%)	1.20 - 3.20	1.80 - 6.80	310	1	4.04	95% KM (Percentile Bootstrap)	4.0	YES
Sodium	27 / 27 (100%)	---	2610 - 18700	322	NSV	12400	95% Student's-t	NSV	NSV
Vanadium	27 / 27 (100%)	---	19.4 - 61.2	316	NSV	45.9	95% Student's-t	NSV	NSV
Zinc	17 / 17 (100%)	---	240 - 1520	308A	150	944	95% Approximate Gamma	6.3	YES
Cyanide, Total	14 / 27 (51.9%)	3.60 - 8.30	0.54 - 18.0	302	NSV	8.3	97.5% KM (Chebyshev)	NSV	NSV

TABLE 5-6

Medium-Specific BERA Screening Values - Sediment

Gowanus Canal Remedial Investigation

Brooklyn, New York

Chemical	Screening Value	Source
Volatile Organic Compounds (ug/kg)		
Ethylbenzene	346	NYSDEC (1999)[1]
Semi-Volatile Organic Compounds (ug/kg)		
2-methylnaphthalene	670	NYSDEC (1999)[2]
Acenaphthene	500	NYSDEC (1999)[2]
Acenaphthylene	640	NYSDEC (1999)[2]
Anthracene	1100	NYSDEC (1999)[2]
Benzo(a)anthracene	1600	NYSDEC (1999)[2]
Benzo(a)pyrene	1600	NYSDEC (1999)[2]
Benzo(b)fluoranthene	12420	WDOE (1995)[1]
Benzo(k)fluoranthene	12420	WDOE (1995)[1]
Benzo(g,h,i)perylene	1674	WDOE (1995)[1]
Bis(2-ethylhexyl) phthalate	2647	MacDonald et al. (1996)
Chrysene	2800	NYSDEC (1999)[2]
Dibenz(a,h)anthracene	260	NYSDEC (1999)[2]
Dibenzofuran	810	WDOE (1995)[1]
Di-n-octylphthalate	3132	WDOE (1995)[1]
Fluoranthene	5100	NYSDEC (1999)[2]
Fluorene	540	NYSDEC (1999)[2]
Indeno(1,2,3-cd)pyrene	1836	WDOE (1995)[1]
Naphthalene	2100	NYSDEC (1999)[2]
Phenanthrene	1500	NYSDEC (1999)[2]
Pyrene	2600	NYSDEC (1999)[2]
Total PAHs	44792	NYSDEC (1999)[2]
Pesticides (ug/kg)		
Alpha-chlordane	0.11	NYSDEC (1999)[1]
Beta endosulfan	0.22	NYSDEC (1999)[1]
Gamma-chlordane	0.11	NYSDEC (1999)[1]
P,P'-DDD	7.81	MacDonald et al. (1996)
P,P'-DDE	27	NYSDEC (1999)[2]
Total DDTs	46.1	NYSDEC (1999)[2]
Polychlorinated Biphenyls (ug/kg)		
Aroclor 1016	180	NYSDEC (1999)[2]
Aroclor 1248	180	NYSDEC (1999)[2]
Aroclor 1254	180	NYSDEC (1999)[2]
Aroclor 1260	180	NYSDEC (1999)[2]
Total PCBs	180	NYSDEC (1999)[2]
Polychlorinated Biphenyl Congeners (ng/kg)		
Total PCB Congeners	676000	MacDonald et al. (2000)
Metals (mg/kg)		
Arsenic	70	NYSDEC (1999)[2]
Barium	NA	
Cadmium	9.6	NYSDEC (1999)[2]
Copper	270	NYSDEC (1999)[2]
Lead	218	NYSDEC (1999)[2]
Mercury	0.71	NYSDEC (1999)[2]
Nickel	51.6	NYSDEC (1999)[2]
Silver	3.7	NYSDEC (1999)[2]
Zinc	410	NYSDEC (1999)[2]

1-Value represents equilibrium-based screening value (assuming 5.4% total organic carbon).

2-Value represents ER-M, selected according to guidance presented in Appendix 4 of NYSDEC (1999).

TABLE 5-7

Surface Sediment (0-6") AVS/SEM Data Outcomes

Gowanus Canal Remedial Investigation

Brooklyn, New York

Station	SEM/AVS	(Sum SEM -AVS)/foc
Gowanus Canal Sample Locations		
GC-SD301-0.0-0.5	<0.1	-2359
GC-SD302-0.0-0.5	<0.1	-2161.1
GC-SD303-0.0-0.5	<0.1	-2595.6
GC-SD304-0.0-0.5	<0.1	-2153.8
GC-SD305-0.0-0.5	<0.1	-2564.7
GC-SD306-0.0-0.5	17.1	835.8
GC-SD307A-0.0-0.5	<0.1	-2636
GC-SD307B-0.0-0.5	<0.1	-1564.6
GC-SD308A-0.0-0.5	6.6	237.9
GC-SD308B-0.0-0.5	<0.1	-654.8
GC-SD309-0.0-0.5	<0.1	-570.1
GC-SD310-0.0-0.5	9.6	371.6
GC-SD311-0.0-0.5	<0.1	-886
GC-SD312-0.0-0.5	0.1	-1056.6
GC-SD313-0.0-0.5	<0.1	-1955.8
GC-SD314-0.0-0.5	<0.1	-483.1
GC-SD315-0.0-0.5	<0.1	-1773.8
GC-SD316-0.0-0.5	0.1	-504.9
GC-SD317-0.0-0.5	<0.1	-2025.3
GC-SD318-0.0-0.5	0.1	-1274.3
GC-SD319-0.0-0.5	<0.1	-1368.2
GC-SD320-0.0-0.5	0.1	-1759.7
GC-SD321-0.0-0.5	<0.1	-3070.4
GC-SD322-0.0-0.5	<0.1	-3720
GC-SD323-0.0-0.5	<0.1	-2219.9
GC-SD324-0.0-0.5	<0.1	-2837.9
GC-SD325-0.0-0.5	<0.1	-2149.4

Notes:

Toxicity unlikely for values <130

Toxicity uncertain for values >130 and <3000

Toxicity likely for values >3000

TABLE 5-8
Screening Statistics - Gowanus Canal Surface Water (Dry Event Sampling) - Step 3
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Screening Value	95 % UCL	UCL Type	Hazard Quotient (95% UCL)	95% UCL COC?
Volatile Organic Compounds (ug/l)									
1,4-dichlorobenzene	1 / 27 (3.7%)	0.50 - 0.50	0.11 - 0.11	320	129	0.11	Max	0.00085	No
Acetone	26 / 27 (96.3%)	5.00 - 5.00	1.10 - 6.70	317	NSV	3.41	95% KM (Chebyshev)	NSV	NSV
Benzene	18 / 27 (66.7%)	0.50 - 0.50	0.50 - 11.0	304	110	2.24	95% KM (BCA)	0.02	No
Ethylbenzene	16 / 27 (59.3%)	0.50 - 0.50	0.19 - 1.30	320	25	0.455	95% KM (% Bootstrap)	0.018	No
m, p xylenes	17 / 27 (63.0%)	0.50 - 0.50	0.16 - 1.30	320	NSV	0.453	95% KM (BCA)	NSV	NSV
Methylene chloride	3 / 27 (11.1%)	0.50 - 0.50	0.76 - 1.00	310	6400	1	95% KM (Percentile Bootstrap)	0.00016	No
o-xylene (1,2-dimethylbenzene)	5 / 27 (18.5%)	0.50 - 0.50	0.24 - 0.53	320	NSV	0.359	95% KM (Percentile Bootstrap)	NSV	NSV
Tert-butyl methyl ether	1 / 27 (3.7%)	0.50 - 0.50	0.18 - 0.18	304	5000	0.18	Max	0.000036	No
Toluene	16 / 27 (59.3%)	0.50 - 0.50	0.17 - 0.95	308B	215	0.374	95% KM (t)	0.0017	No
Semi-Volatile Organic Compounds (ug/l)									
2-methylnaphthalene	1 / 27 (3.7%)	0.10 - 0.10	0.017 - 0.017	315	NSV	0.017	Max	NSV	NSV
Acenaphthene	21 / 27 (77.8%)	0.10 - 0.10	0.26 - 0.94	319	40	0.534	95% KM (Percentile Bootstrap)	0.013	No
Anthracene	3 / 27 (11.1%)	0.10 - 0.10	1.20 - 5.20	325	NSV	5.2	95% KM (Percentile Bootstrap)	NSV	NSV
Benzo(a)anthracene	7 / 27 (25.9%)	0.10 - 0.10	0.12 - 0.83	325	NSV	0.266	95% KM (Percentile Bootstrap)	NSV	NSV
Benzo(a)pyrene	3 / 27 (11.1%)	0.10 - 0.10	0.19 - 0.66	319	NSV	0.66	95% KM (Percentile Bootstrap)	NSV	NSV
Benzo(b)fluoranthene	21 / 27 (77.8%)	0.10 - 0.10	0.11 - 0.88	319	NSV	0.299	95% KM (BCA)	NSV	NSV
Benzo(g,h,i)perylene	5 / 27 (18.5%)	0.10 - 0.10	0.099 - 0.15	302, 307A	NSV	0.141	95% KM (Percentile Bootstrap)	NSV	NSV
Benzo(k)fluoranthene	11 / 27 (40.7%)	0.10 - 0.10	0.10 - 0.29	319, 325	NSV	0.156	95% KM (Percentile Bootstrap)	NSV	NSV
Bis(2-ethylhexyl) phthalate	13 / 27 (48.1%)	5.00 - 5.00	0.71 - 5.60	321	360	2.45	95% KM (t)	0.0068	No
Caprolactam	1 / 27 (3.7%)	5.00 - 5.00	1.00 - 1.00	312	NSV	1	Max	NSV	NSV
Carbazole	2 / 27 (7.4%)	5.00 - 5.00	1.10 - 2.10	325	NSV	2.1	Max	NSV	NSV
Chrysene	15 / 27 (55.6%)	0.10 - 0.10	0.11 - 1.10	325	NSV	0.297	95% KM (t)	NSV	NSV
Dimethyl phthalate	8 / 27 (29.6%)	5.00 - 5.00	1.50 - 3.40	324	3.4	2.26	95% KM (Percentile Bootstrap)	0.66	No
Di-n-butyl phthalate	3 / 27 (11.1%)	5.00 - 5.00	1.00 - 1.40	301	3.4	1.4	95% KM (Percentile Bootstrap)	0.41	No
Fluoranthene	23 / 27 (85.2%)	0.10 - 0.10	0.095 - 2.30	325	11	0.626	95% KM (BCA)	0.057	No
Fluorene	15 / 27 (55.6%)	0.10 - 0.10	0.11 - 0.19	325	NSV	0.126	95% KM (% Bootstrap)	NSV	NSV
Indeno(1,2,3-c,d)pyrene	10 / 27 (37.0%)	0.10 - 0.10	0.097 - 0.22	319	NSV	0.132	95% KM (% Bootstrap)	NSV	NSV
Phenanthrene	11 / 27 (40.7%)	0.10 - 0.10	0.10 - 0.58	325	4.6	0.183	95% KM (% Bootstrap)	0.04	No
Phenol	1 / 27 (3.7%)	5.00 - 5.00	1.30 - 1.30	314	400	1.3	Max	0.0033	No
Pyrene	6 / 27 (22.2%)	0.10 - 0.10	0.15 - 1.50	325	NSV	0.49	95% KM (Percentile Bootstrap)	NSV	NSV

TABLE 5-8
Screening Statistics - Gowanus Canal Surface Water (Dry Event Sampling) - Step 3
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Screening Value	95 % UCL	UCL Type	Hazard Quotient (95% UCL)	95% UCL COC?
Semi-Volatile Organic Compounds (ug/l)									
Total PAHs	24 / 27 (88.9%)	---	0.11 - 13.3	325	NSV	3.2	95% KM (BCA)	NSV	NSV
Metals (ug/l)									
Aluminum Dissolved	1 / 27 (3.7%)	2000 - 3000	1480 - 1480	324	NSV	1480	Max	NSV	NSV
Arsenic	25 / 25 (100%)	---	9.10 - 23.4	309	36	19.9	95% KM (Percentile Bootstrap)	0.55	No
Arsenic Dissolved	25 / 25 (100%)	---	15.1 - 21.6	323	36	19.7	95% KM (Percentile Bootstrap)	0.55	No
Barium	9 / 27 (33.3%)	10.0 - 100	18.4 - 23.0	312	200	20.9	95% KM (Percentile Bootstrap)	0.1	No
Barium Dissolved	18 / 27 (66.7%)	100 - 100	18.0 - 32.5	304	200	32.5	Max	0.16	No
Calcium	27 / 27 (100%)	---	259000 - 315000	312	NSV	285000	95% KM (Percentile Bootstrap)	NSV	NSV
Calcium Dissolved	27 / 27 (100%)	---	257000 - 298000	306, 308A	NSV	278000	95% KM (Percentile Bootstrap)	NSV	NSV
Chromium	21 / 27 (77.8%)	2.00 - 20.0	4.00 - 99.7	323	NSV	18.9	95% KM (% Bootstrap)	NSV	NSV
Chromium Dissolved	23 / 27 (85.2%)	20.0 - 20.0	3.60 - 10.5	310	NSV	10.5	Max	NSV	NSV
Cobalt Dissolved	1 / 27 (3.7%)	10.0 - 10.0	2.80 - 2.80	304	1	2.8	Max	2.8	YES
Copper	11 / 27 (40.7%)	25.0 - 375	123 - 232	308B	3.1	172	95% KM (Percentile Bootstrap)	55	YES
Copper Dissolved	11 / 27 (40.7%)	25.0 - 375	181 - 282	303	3.1	220	95% KM (Percentile Bootstrap)	71	YES
Lead	7 / 27 (25.9%)	10.0 - 10.0	1.90 - 7.30	304	8.1	4.13	95% KM (Percentile Bootstrap)	0.51	No
Magnesium	27 / 27 (100%)	---	809000 - 998000	312	NSV	897000	95% Modified-t	NSV	NSV
Magnesium Dissolved	27 / 27 (100%)	---	803000 - 942000	306, 308A	NSV	873000	95% Modified-t	NSV	NSV
Manganese	27 / 27 (100%)	---	45.0 - 72.9	310	100	59.3	95% Student's-t	0.59	No
Manganese Dissolved	27 / 27 (100%)	---	40.0 - 71.5	323	100	53.6	95% Modified-t	0.54	No
Mercury	14 / 27 (51.9%)	0.20 - 0.20	0.047 - 0.06	324	0.94	0.0534	95% KM (Percentile Bootstrap)	0.057	No
Mercury Dissolved	13 / 27 (48.1%)	0.20 - 0.20	0.047 - 0.091	323	0.94	0.0632	95% KM (t)	0.067	No
Nickel	22 / 27 (81.5%)	10.0 - 10.0	2.00 - 52.3	323	8.2	14.1	95% KM (% Bootstrap)	1.7	YES
Nickel Dissolved	17 / 27 (63.0%)	10.0 - 10.0	2.20 - 13.4	310	8.2	13.4	Max	1.6	YES
Potassium	27 / 27 (100%)	---	277000 - 328000	312	NSV	301000	95% KM (Percentile Bootstrap)	NSV	NSV
Potassium Dissolved	27 / 27 (100%)	---	274000 - 316000	322	NSV	294000	95% KM (Percentile Bootstrap)	NSV	NSV
Selenium	26 / 26 (100%)	---	18.7 - 50.9	322	71	41	95% KM (Percentile Bootstrap)	0.58	No
Selenium Dissolved	16 / 16 (100%)	---	38.6 - 53.5	323	71	53.5	Max	0.75	No
Sodium	27 / 27 (100%)	---	5550000 - 6620000	307B	NSV	6200000	95% Student's-t	NSV	NSV
Sodium Dissolved	27 / 27 (100%)	---	5330000 - 6790000	322	NSV	6090000	95% Student's-t	NSV	NSV
Thallium	1 / 27 (3.7%)	10.0 - 10.0	2.10 - 2.10	318	17	2.1	Max	0.12	No

TABLE 5-8
Screening Statistics - Gowanus Canal Surface Water (Dry Event Sampling) - Step 3
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Screening Value	95 % UCL	UCL Type	Hazard Quotient (95% UCL)	95% UCL COC?
Metals (ug/l)									
Zinc	13 / 23 (56.5%)	20.0 - 20.0	11.0 - 25.7	321	81	15.7	95% KM (t)	0.19	No
Zinc Dissolved	12 / 24 (50.0%)	20.0 - 20.0	9.90 - 37.9	321	81	37.9	Max	0.47	No

TABLE 5-9

Screening Statistics - Gowanus Canal Surface Water (Wet Event Sampling) - Step 3

Gowanus Canal Remedial Investigation

Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Screening Value	95 % UCL	UCL Type	Hazard Quotient (95% UCL)	95% UCL COC?
Volatile Organic Compounds (ug/l)									
1,2,4-trichlorobenzene	1 / 26 (3.8%)	0.50 - 0.50	0.12 - 0.12	305	5.4	0.12	Max	0.022	No
1,3-dichlorobenzene	2 / 26 (7.7%)	0.50 - 0.50	0.13 - 0.13	303, 305	NSV	0.13	Max	NSV	NSV
1,4-dichlorobenzene	14 / 26 (53.8%)	0.50 - 0.50	0.12 - 0.87	306	129	0.59	95% KM (Percentile Bootstrap)	0.0046	No
Acetone	1 / 26 (3.8%)	5.00 - 15.0	12.0 - 12.0	307B	NSV	12	Max	NSV	NSV
Benzene	16 / 26 (61.5%)	0.50 - 0.50	0.36 - 2.90	316	110	0.835	95% KM (BCA)	0.0076	No
Carbon disulfide	5 / 26 (19.2%)	0.50 - 0.50	0.14 - 0.17	308B, 313	NSV	0.166	95% KM (t)	NSV	NSV
Chlorobenzene	17 / 26 (65.4%)	0.50 - 0.50	0.12 - 0.33	306	25	0.259	95% KM (t)	0.01	No
Chloroform	14 / 26 (53.8%)	0.50 - 0.50	0.50 - 0.69	321	NSV	0.559	95% KM (Percentile Bootstrap)	NSV	NSV
cis-1,2-dichloroethylene	17 / 26 (65.4%)	0.50 - 0.50	0.21 - 0.51	319	NSV	0.317	95% KM (t)	NSV	NSV
Ethylbenzene	21 / 26 (80.8%)	0.50 - 0.50	0.18 - 2.60	316	25	0.868	95% KM (Chebyshev)	0.035	No
Isopropylbenzene (cumene)	4 / 26 (15.4%)	0.50 - 0.50	0.096 - 0.20	316	NSV	0.186	95% KM (t)	NSV	NSV
m, p xylenes	22 / 26 (84.6%)	0.50 - 0.50	0.18 - 2.60	316	NSV	0.868	95% KM (Chebyshev)	NSV	NSV
Methyl acetate	1 / 26 (3.8%)	0.50 - 0.50	0.44 - 0.44	317	NSV	0.44	Max	NSV	NSV
Methylene chloride	9 / 26 (34.6%)	0.50 - 2.90	0.99 - 3.40	321	6400	1.42	95% KM (t)	0.00022	No
o-xylene (1,2-dimethylbenzene)	20 / 26 (76.9%)	0.50 - 0.50	0.13 - 5.10	316	NSV	0.873	95% KM (BCA)	NSV	NSV
Tetrachloroethylene(PCE)	24 / 26 (92.3%)	0.50 - 0.50	0.70 - 40.0	319	450	24.4	95% KM (Chebyshev)	0.054	No
Toluene	24 / 26 (92.3%)	0.50 - 0.50	0.85 - 16.0	316	215	6.35	95% KM (BCA)	0.03	No
trans-1,3-dichloropropene	1 / 26 (3.8%)	0.50 - 0.50	0.16 - 0.16	306	NSV	0.16	Max	NSV	NSV
Trichloroethylene (TCE)	2 / 26 (7.7%)	0.50 - 0.50	0.10 - 0.12	320	200	0.12	Max	0.0006	No
Semi-Volatile Organic Compounds (ug/l)									
2-methylnaphthalene	3 / 26 (11.5%)	0.10 - 0.10	0.17 - 3.00	316	NSV	1.1	97.5% KM (Chebyshev)	NSV	NSV
Acenaphthene	20 / 26 (76.9%)	0.10 - 1.00	0.095 - 0.40	313	40	0.191	95% KM (Percentile Bootstrap)	0.0048	No
Anthracene	1 / 26 (3.8%)	0.10 - 1.00	0.095 - 0.095	302	NSV	0.095	Max	NSV	NSV
Benzo(a)anthracene	4 / 26 (15.4%)	0.10 - 1.00	0.074 - 0.15	302	NSV	0.104	95% KM (Percentile Bootstrap)	NSV	NSV
Benzo(a)pyrene	6 / 26 (23.1%)	0.10 - 1.00	0.14 - 0.30	309	NSV	0.205	95% KM (Percentile Bootstrap)	NSV	NSV
Benzo(b)fluoranthene	16 / 26 (61.5%)	0.10 - 1.00	0.12 - 0.33	319	NSV	0.189	95% KM (Percentile Bootstrap)	NSV	NSV
Benzo(g,h,i)perylene	23 / 26 (88.5%)	0.10 - 1.00	0.13 - 1.50	308A	NSV	0.585	95% KM (BCA)	NSV	NSV
Benzo(k)fluoranthene	7 / 26 (26.9%)	0.10 - 1.00	0.037 - 0.12	319	NSV	0.0535	95% KM (t)	NSV	NSV
Benzyl butyl phthalate	3 / 26 (11.5%)	5.00 - 50.0	0.73 - 1.10	307A	3.4	1.06	95% KM (t)	0.31	No
Caprolactam	11 / 26 (42.3%)	5.00 - 50.0	0.33 - 1.50	320	NSV	1.28	95% KM (t)	NSV	NSV

TABLE 5-9
Screening Statistics - Gowanus Canal Surface Water (Wet Event Sampling) - Step 3
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Screening Value	95 % UCL	UCL Type	Hazard Quotient (95% UCL)	95% UCL COC?
Semi-Volatile Organic Compounds (ug/l)									
Chrysene	3 / 26 (11.5%)	0.10 - 1.00	0.057 - 0.11	302	NSV	0.11	95% KM (Percentile Bootstrap)	NSV	NSV
Dibenz(a,h)anthracene	4 / 26 (15.4%)	0.10 - 1.00	0.071 - 0.11	303	NSV	0.101	95% KM (Percentile Bootstrap)	NSV	NSV
Di-n-butyl phthalate	12 / 26 (46.2%)	5.00 - 50.0	0.28 - 0.62	320	3.4	0.5	95% KM (t)	0.15	No
Di-n-octylphthalate	3 / 26 (11.5%)	5.00 - 50.0	0.23 - 0.28	318	3.4	0.275	95% KM (t)	0.081	No
Fluoranthene	22 / 26 (84.6%)	0.10 - 1.00	0.089 - 0.32	313	11	0.185	95% KM (BCA)	0.017	No
Fluorene	3 / 26 (11.5%)	0.10 - 1.00	0.079 - 0.32	313	NSV	0.32	95% KM (Percentile Bootstrap)	NSV	NSV
Indeno(1,2,3-c,d)pyrene	23 / 26 (88.5%)	0.10 - 0.15	0.16 - 1.10	316	NSV	0.5	95% KM (Chebyshev)	NSV	NSV
Naphthalene	5 / 26 (19.2%)	0.10 - 0.10	0.13 - 1.40	316	1.4	0.364	95% KM (Percentile Bootstrap)	0.26	No
Pentachlorophenol	1 / 26 (3.8%)	0.20 - 2.00	0.13 - 0.13	311	7.9	0.13	Max	0.016	No
Phenanthrene	14 / 26 (53.8%)	0.10 - 0.10	0.13 - 1.40	316	4.6	0.336	95% KM (% Bootstrap)	0.073	No
Pyrene	22 / 26 (84.6%)	0.10 - 1.00	0.10 - 0.34	313	NSV	0.215	95% KM (Percentile Bootstrap)	NSV	NSV
Total PAHs	25 / 26 (96.2%)	---	0.49 - 6.90	316	NSV	2.31	95% KM (BCA)	NSV	NSV
Metals (ug/l)									
Arsenic	26 / 26 (100%)	---	6.90 - 26.2	302	36	16.6	95% Student's-t	0.46	No
Arsenic Dissolved	26 / 26 (100%)	---	9.10 - 21.0	322	36	14.3	95% Approximate Gamma	0.4	No
Barium	26 / 26 (100%)	---	18.4 - 42.8	307A	200	27.7	95% Approximate Gamma	0.14	No
Barium Dissolved	25 / 26 (96.2%)	100 - 100	18.4 - 31.1	322	200	23.4	95% KM (BCA)	0.12	No
Calcium	24 / 24 (100%)	---	97200 - 296000	324	NSV	183000	95% Approximate Gamma	NSV	NSV
Calcium Dissolved	24 / 24 (100%)	---	100000 - 304000	303	NSV	182000	95% Modified-t	NSV	NSV
Chromium	26 / 26 (100%)	---	3.90 - 29.3	308B	NSV	8.53	95% Modified-t	NSV	NSV
Chromium Dissolved	7 / 26 (26.9%)	20.0 - 20.0	3.60 - 5.80	314	NSV	4.92	95% KM (t)	NSV	NSV
Cobalt	1 / 26 (3.8%)	10.0 - 10.0	3.90 - 3.90	307A	1	3.9	Max	3.9	YES
Cobalt Dissolved	1 / 26 (3.8%)	10.0 - 10.0	2.50 - 2.50	315	1	2.5	Max	2.5	YES
Iron	3 / 26 (11.5%)	1500 - 1500	651 - 1040	317	50	1040	95% KM (% Bootstrap)	21	YES
Iron Dissolved	1 / 26 (3.8%)	1500 - 7500	1020 - 1020	310	50	1020	Max	20	YES
Lead	26 / 26 (100%)	---	2.90 - 26.8	317	8.1	14.9	95% Student's-t	1.8	YES
Lead Dissolved	6 / 26 (23.1%)	10.0 - 10.0	1.90 - 17.7	314	8.1	3.88	95% KM (% Bootstrap)	0.48	No
Magnesium	25 / 25 (100%)	---	276000 - 972000	303	NSV	575000	95% Modified-t	NSV	NSV
Magnesium Dissolved	25 / 25 (100%)	---	286000 - 4880000	301	NSV	1850000	95% Chebyshev (Mean, Sd)	NSV	NSV
Manganese	26 / 26 (100%)	---	48.4 - 65.6	307A	100	56.4	95% Approximate Gamma	0.56	No

TABLE 5-9
Screening Statistics - Gowanus Canal Surface Water (Wet Event Sampling) - Step 3
Gowanus Canal Remedial Investigation
Brooklyn, New York

Parameter	Frequency of Detection	Range of Non-Detect Values	Range of Detected Values	Location of Max Detect	Screening Value	95 % UCL	UCL Type	Hazard Quotient (95% UCL)	95% UCL COC?
Metals (ug/l)									
Manganese Dissolved	26 / 26 (100%)	---	35.6 - 63.0	322	100	45.9	95% Approximate Gamma	0.46	No
Mercury	19 / 26 (73.1%)	0.20 - 0.20	0.065 - 0.089	302	0.94	0.0825	95% KM (t)	0.088	No
Nickel	25 / 25 (100%)	---	2.10 - 29.8	308B	8.2	10.6	95% Chebyshev (Mean, Sd)	1.3	YES
Nickel Dissolved	25 / 25 (100%)	---	2.20 - 8.00	315	8.2	4.24	95% Modified-t	0.52	No
Potassium	24 / 24 (100%)	---	88700 - 290000	324	NSV	175000	95% Modified-t	NSV	NSV
Potassium Dissolved	24 / 24 (100%)	---	92300 - 292000	303	NSV	172000	95% Approximate Gamma	NSV	NSV
Selenium	26 / 26 (100%)	---	13.9 - 64.6	301	71	33.6	95% Approximate Gamma	0.47	No
Selenium Dissolved	16 / 16 (100%)	---	14.7 - 41.9	303	71	29	95% Approximate Gamma	0.41	No
Sodium	25 / 25 (100%)	---	2340000 - 7090000	301	NSV	4410000	95% Modified-t	NSV	NSV
Sodium Dissolved	25 / 25 (100%)	---	2480000 - 9180000	301	NSV	4580000	95% Modified-t	NSV	NSV
Zinc	24 / 26 (92.3%)	20.0 - 20.0	17.7 - 75.7	318	81	45.6	95% KM (t)	0.56	No
Zinc Dissolved	25 / 26 (96.2%)	20.0 - 20.0	11.0 - 40.2	314	81	24.9	95% KM (BCA)	0.31	No

TABLE 5-10
Ingestion Screening Values for Birds
Gowanus Canal Remedial Investigation
Brooklyn, New York

Analyte	NOAEL (mg/kg bw/d)	LOAEL (mg/kg bw/d)	Source	Endpoint	Test Species	Chemical Form	Exposure Mode	FI (kg dw or L/day)	Wet or Dry?	Food Ingestion Default?	Nagy bird guild	Body Weight (kg)	Body Weight Default ?	% Moisture	NEC wet (ppm)	NEC dry (ppm)	LEC wet (ppm)	LEC dry (ppm)	Exposure Duration	Effect Endpoint	Notes
2,3,7,8-TCDD	0.000014	0.00014286	Nosek et al. 1992b	growth, mortality, reproduction	Ring-necked pheasant	2,3,7,8-TCDD	weekly ip injection					1.1				0.0001		0.001	10 wks- 1/wk	body weight loss, adult mortality, egg production and embryo survival	
1,4-Dichlorobenzene	32.2	160.8	TERRETOX 2002	survival	Northern bobwhite		oral					0.19							14 days		
PCBs, total	0.29	0.58	Britton and Huston 1973	reproduction	White leghorn chickens	Aroclor 1242	food	0.0997	W	3		1.71	C		5		10		6 weeks + 5 weeks untreated	hatchability	significant effects on hatchability
Arsenic	2.3	6.8	USFWS 1969 as cited in Sample et al. 1996	mortality	Brown-headed cowbird	Copper acetoarsenite (As^{+3})	food	0.0090	D	1	2	0.049		10%	11.085	12.317	33.255	36.95	7 months	20% mortality @ LOAEL; 0% mortality @ NOAEL and control	Original paper could not be located; updated Nagy 2001 equation- Sample NOAEL=2.5 and LOAEL=7.4
Cadmium	7.3	29	Leach et al. 1979	reproduction	Leghorn hen	$CdSO_4$*$8H_2O$	food	1.019	W	3		1.70	C		12.22		48.22		48 wks	egg production, shell thickness	
Chromium	1.0	5.0	Haseltine et al. unpub as cited in Sample 1996	reproduction	Black duck	Cr 3+ as $CrK(SO_4)_2$	food	0.1250	W	2		1.25	B		10		50		10 months (and critical lifestage)	duckling survival	Original paper could not be located
Copper	47	62	Mehring et al. 1960	growth/ mortality	Chicks	Copper oxide	food	0.044	W	5		0.534	F		570		749		10 weeks	Growth, mortality	
Lead	2.0	20	Edens et al. 1976	reproduction	Japanese quail	Lead acetate	food	0.031	W	6		0.155	G		10		100		12 weeks	Egg hatchability	
Mercury		0.050	Heinz 1979	reproduction, behavior	Mallard	Methylmercury	food	0.1082	W	2		1.082	B				0.5		3 generations	egg and young production, eggshell thinning, duckling response to maternal call, duckling avoidance behavior	only one dose used
Nickel		107	Cain and Pafford 1981	mortality, growth	Mallard	nickel sulfate	food	0.0178	W	2		0.178		10%			1069	1187.78	90 days	mortality, bw; bill length	no stats for mortality; statistically significant growth effects at LOAEL
Nickel	77		Cain and Pafford 1981	mortality, growth	Mallard	nickel sulfate	food	0.0561	W	2		0.561		10%	774	860			90 days	mortality, bw; bill length	no stats for mortality; statistically significant growth effects at LOAEL
Selenium		0.82	Heinz et al. 1989	reproduction	Mallard	selenomethionine	food	0.1145	W	2		1.145		11%			8.15		~100 d	offspring growth/survival	statistically significant effects at LOAEL
Selenium	0.42		Heinz et al. 1989	reproduction	Mallard	selenomethionine	food	0.1158	W	2		1.158		11%	4.15				~100 d	offspring growth/survival	statistically evaluated
Silver	35.60	178	USEPA 1999	survival	Mallard		food	0.1100				1.100							14 days		
Zinc	82	124	Roberson and Schaible 1960	growth	White rock chicks	Zinc oxide, zinc sulfate, or zinc carbonate	food	0.044	W	5		0.534	F		1000		1500		5 weeks	Growth	domestic species
PAHs		1.4	Hough et al. 1993	reproduction	pigeons	benzo(a)pyrene	weekly im injection												5 mos	fertility, ovarian appearance	Weekly intramuscular injection
Chlordane	0.6		Ludke 1976	growth, mortality	Bobwhite Quail	tech chlordane	food	0.0082	D	1	3	0.1613		11%	10	11.236			10 wks	body weight, adult mortality	one test conc.; no stats for mortality- 0% mort
Chlordane		1.5	Kreitzer and Heinz 1974	behavior	Japanese quail	Chlordane	food	0.0048	D	1	3	0.09	B	10%			25	27.8	8 days treated + 6 days untreated	avoidance response (depressed response to stimuli)	statistically significant effect; only one dose used
gamma-chlordane	0.8	4.0	Wiemeyer 1996	reproduction	Mallard		food					1.0							not specified		
Total DDT	0.18		Davison and Sell 1974	reproduction	Mallard	tech DDT	food	0.1110	W			1.22			2				11 mos	eggshell weight and thickness	statistically evaluated
Total DDT		1.8	Davison and Sell 1974	reproduction	Mallard	tech DDT	food	0.1040	W			1.17333					20		11 mos	eggshell weight and thickness	statistically significant effects
Endosulfan	10		Abiola 1992	reproduction	Gray partridge	endosulfan	food	0.0183	D	1	3	0.4		10%	125	222.22			4 wks- during critical lifestage	number of eggs; egg fertility, embryo and chick mortality; eggs hatched	Sample NOAEL=10 (ww to dw conversion not made?)
Endrin		0.06	DeWitt 1956	reproduction	Quail	endrin	food	0.0048	D	1	3	0.09	B	10%			1	1.11	reprod period	chick survival - 64% vs. 83% control	no stats
Methoxychlor	831		Hill et al. 1975b; Heath et al. 1972	Mortality	Bobwhites (juvenile), Japanese quail, Ringed-necked pheasant, mallard (young)	technical methoxychlor	food	0.0150	D	1	1	0.1	A	10%	5000	5555.6			5 d	mortality	0% mortality

NC = TRV not calculated in database because more preferable studies were available for TRV selection (see notes)
FI = food ingestion rate
NEC = No effect concentration in exposure medium
LEC = Low effect concentration in exposure medium
W = wet weight basis
D = dry weight basis

Default ingestion rates:
1 - Nagy 2001
2 - Heinz et al. 1987
3 - NRC 1984
4 - NRC 1994
5 - EPA 1993
6 - Edens and Garlich 1983
7 - Kushlan 1978

Nagy bird group allometric equation
1- all birds: FI (kg/d dw) = [0.638*((bw(g))^0.685)]/1000
2- Passerines: FI = [0.630*((bw(g))^0.683)]/1000
3- Galliformes: FI = [0.088*((bw(g))^0.891)]/1000
4- Omnivorous birds: FI = [0.670*((bw(g))^0.627)]/1000
5- Carnivorous birds: FI = [0.849*((bw(g))^0.663)]/1000
6- Eurasian Kestrel: FI =(22.1/211)*bw(kg)

Default body weight:
A - NRC 1994
B - Dunning 1993
C - NRC 1984
D - Peakall et al. 1975
E - Sample et al. 1996
F - EPA 1993
G - Edens and Garlich 1983

TABLE 5-11
Toxicity Equivalents Factors for Dioxin-like PCB Congeners
Gowanus Canal Remedial Investigation
Brooklyn, New York

Congener Group	Constituent/Congener	Bird TEF[1]
Non-ortho PCBs	3,3',4,4'-TCB (77)	0.05
	3,4,4',5-TCB (81)	0.1
	3,3',4,4',5-PeCB (126)	0.1
	3,3',4,4',5,5'-HxCB (169)	0.001
Mono-ortho PCBs	2,3,3',4,4'-PeCB (105)	0.0001
	2,3,4,4',5-PeCB (114)	0.0001
	2,3',4,4',5-PeCB (118)	0.0001
	2',3,4,4',5-PeCB (123)	0.00001
	2,3,3',4,4',5-HxCB (156)	0.0001
	2,3,3',4,4',5'-HxCB (157)	0.0001
	2,3',4,4',5,5'-HxCB (167)	0.00001
	2,3,3',4,4',5,5'-HeCB (189)	0.00001

Source:

[1]Van den Berg, M; Birnbaum, L; Bosveld, ATC; Brunstrom, B; Cook, P; Feeley, M; Giesy, JP; Hanberg, A; Hasegawa, R; Kennedy, SW; Kubiak, T; Larsen, JC; van Leeuwen, FX; Liem, AK; Nolt, C; Peterson, RE; Poellinger, L; Safe, S; Schrenk, D; Tillitt, D; Tysklind, M; Younes, M; Waern, F; Zacharewski, T. (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.

TABLE 5-12

Sediment-to-Plant Bioaccumulation Factors For Chemcials Detected in Sediment

Gowanus Canal Remedial Investigation

Brooklyn, New York

Chemical	Sediment-Plant BCF (dry weight)	
	Value	**Reference**
Inorganics		
Arsenic	0.037	Bechtel Jacobs 1998a
Cadmium	0.514	Bechtel Jacobs 1998a
Chromium	0.048	Bechtel Jacobs 1998a
Copper	0.123	Bechtel Jacobs 1998a
Lead	0.038	Bechtel Jacobs 1998a
Mercury	0.344	Bechtel Jacobs 1998a
Nickel	0.034	Bechtel Jacobs 1998a
Selenium	0.567	Bechtel Jacobs 1998a
Silver	0.013	Bechtel Jacobs 1998a
Zinc	0.358	Bechtel Jacobs 1998a
Pesticides/PCBs		
DDT, total[1]	0.4234	USEPA 2005
alpha-Chlordane	0.3771	USEPA 2005
Endosulfan II	0.9741	USEPA 2005
Endrin	0.7328	USEPA 2005
gamma-Chlordane	0.3771	USEPA 2005
Methoxychlor	0.7251	USEPA 2005
Semivolatile Organics		
PAHs, total[2]	--	--
Volatile Organics		
1,4-Dichlorobenzene	1.7399	USEPA 2005
Dioxin/Furans		
2,3,7,8-TCDD	0.3375	USEPA 2005

Notes:

1 - maximum BCF of 4,4'-DDD, 4,4'-DDE and 4,4'-DDT

2 - No BCF used; PAH bioaccummulation determiend on a LMW and HMW basis using methods described in the text

TABLE 5-13
Exposure Parameters for Avian Receptors
Gowanus Canal Remedial Investigation
Brooklyn, New York

Receptor	Body Weight (kg)		Food Ingestion Rate (kg/day - dry)		Dietary Composition (decimal percent)				Sediment Ingestion (decimal percent)	
	Value	Reference	Value	Reference	Fish	Aquatic Plants	Benthic Invertebrates	Reference	Value	Reference
Double-crested cormorant	2.33	Glahn and McCoy 1995	0.0925	Bivings et al. 1989	1.0	0	0	Bivings et al. 1989	0	Assumed based on diet
Green heron	0.21	Dunning 1993	0.0250	Nagy 2001; allometric equation below	0.71	0	0.29	USEPA 1993a; Quinney and Smith 1980	0	Sample et al. 1997
Black duck	1.18	Bellrose 1980	0.0564	Nagy 2001; allometric equation below	0	0.867	0.10	Palmer 1976	0.033	Beyer et al. 1994

Allometric equations:

Equation	*Group (Receptor)*	*a*	*b*
dry matter kg/day = (**a***(body weight*1000)$^{\mathbf{b}}$)/1000	Piscivores (heron)	0.638	0.685
	Omnivore (duck)	0.67	0.627

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SECTION 6

Baseline Ecological Risk Assessment: Refined Risk Evaluation

The following sections present a final evaluation of risks to benthic macroinvertebrates (Section 6.1), water-column-dwelling aquatic life (Section 6.2), and avian wildlife (Section 6.3) using the data and approach discussed in Section 5. The outcome of this step is a final list of COCs for each medium-pathway-receptor combination identified for evaluation. Because risk to each receptor is being evaluated using multiple data inputs, conclusions about the potential for adverse effects to each receptor will be based on a weight-of-evidence analysis of the available data. The results of this evaluation should be used, along with consideration of the uncertainties (Section 7) in the ERA, to draw conclusions about the overall potential for adverse effects to ecological receptors in the Gowanus Canal.

6.1 Benthic Macroinvertebrates

6.1.1 Sediment Bioassays

Laboratory Control Comparison

The results of the comparison to laboratory control by stations for all endpoints are shown in Figure 6-1. The results by endpoint are discussed below.

Survival (Polychaete and Amphipod). Figure 6-2 summarizes the mean survival results for both test organisms. For the polychaete (*N. virens*), survival was significantly reduced for nine of 12 canal samples and all five reference samples. However, survival was most reduced for three canal samples (Stations 313, 314, and 315), where mean survival was 61.3 percent, 75.0 percent and 71.3 percent, respectively. The mean survival for all other samples (both canal and reference) was $\geq$83.7 percent.

For the amphipod, survival effects were most severe following exposure to canal sediments (Figure 6-2). Survival was significantly reduced for five of 12 canal samples, with none of the reference samples yielding a statistically significant reduction in survival. As with the polychaete, the lowest survival was observed for Stations 313, 314, and 315, with survival at or near 0 percent. The range of mean survival for all other canal samples was between 27.5 percent (Station 310) and 86.25 percent (Station 309). Mean survival in the reference samples ranged from 70.63 percent (Station 326) to 91.88 percent (Station 330).

Growth (Polychaete and Amphipod). Figure 6-3 presents the polychaete growth results in mean wet biomass (g/organism). Growth was significantly reduced for three canal sediment samples (Stations 313, 314, and 315) and one reference sample (Station 329).

Figure 6-4 presents the amphipod growth results in mean dry biomass (mg/organism). Growth was significantly reduced for all of the statistically tested samples, with the exception of one canal sample (Station 303) and two reference samples (Stations 328 and

330). Growth was not statistically tested for samples from Stations 314 and 315, because none of the amphipods survived following exposure to these samples.

Reproduction (Amphipod Only). Figure 6-5 presents the amphipod reproduction results in mean number of juveniles per surviving female. Reproduction was significantly reduced for all of the statistically tested canal samples, and for three reference samples (Stations 326, 329, and 333). As noted for the growth endpoint, growth was not statistically tested in samples from Stations 314 and 315, because none of the amphipods survived in these samples. Additionally, the results for the canal sample from Station 313 were not statistically significant, even though there was no measurable reproduction for this treatment. Regardless of this statistical outcome, the lack of reproduction is considered biologically significant and indicative of an impact.

Reference Envelope Comparison

The first step of the reference envelope approach is to evaluate all reference sample data and eliminate outlier samples before envelope values (i.e., lowest endpoint result) are established. Based on this evaluation, the reference sample from Station 326 was eliminated prior to establishing the reference envelope values. This reference samples was eliminated from consideration based on the following:

- **Bioassay results.** The sample from Station 326 yielded more severe impacts, particularly for amphipods, than other reference samples. This sample yielded the lowest amphipod survival (Figure 6-1), growth (Figure 6-3), and reproduction (Figure 6-4) observed for any reference samples.
- **Screening results.** As shown in Table 6-1, the sample from Station 326 also yielded the highest frequency of metal NYSDEC criteria exceedances and was the only reference sample for which chromium, lead, and silver also exceeded severe effect levels (SELs).
- **Location**. The sample from Station 326 is the reference sample collected closest to the canal (Figure 2-3c), and the increased constituent concentrations are more likely to have been influenced by the canal, relative to other reference sample locations.

Therefore, Station 326 results were not included when establishing the reference envelope values (i.e., lowest endpoint result for other reference samples).

Table 6-2 summarizes all toxicity test results for the canal sediment samples and includes a comparison to the reference envelope values. According to this comparison, polychaete survival was below the envelope in four of the canal samples (Stations 310, 313, 314, and 315). Polychaete growth was also below the envelope in three of these four samples (Stations 313, 314, and 315). However, each incidence of polychaete endpoint result below the envelope also corresponded to an incidence of identified impacts relative to control (Figure 6-1; also bolded results in Table 6-2).

For amphipods, survival was below the reference envelope for eight samples (Stations 307B, 310, 313, 314, 315, 318, 319, and 321). Two of these samples (Stations 307B and 321) were not identified as significantly reduced compared to control. However, all samples exhibited significantly impacted growth as compared to control, and all samples but one (Station 370B) yielded levels of reproduction below the envelope.

Following evaluation of the bioassay results, it was determined that impacts were indicated at all tested sample locations, with the only variable being the magnitude of the observed effect. Most samples fit into one of three categories across a range of severity of toxicity, or impact. These categories of impacts were defined as follows:

- **Severe.** Impacts to polychaetes and/or amphipods; all endpoints (lethal and sublethal) for amphipod or some endpoints for both organisms were reduced relative to reference envelope
- **Moderate.** Impacts to only amphipods; all lethal and sublethal or both sublethal amphipod endpoints were reduced relative to reference envelope
- **Limited.** Impacts to only amphipods; only one sublethal endpoint reduction

The following subsections discuss the outcomes for samples in these categories and concentrations of detected constituents in these samples. Figure 6-6 shows the spatial relationship of the impacted stations.

Severe Impacts. Based on all toxicity test results, the most severe impacts to polychaetes and amphipods were in canal samples from Stations 313, 314, and 315. These were the only samples that exhibited impacts for both organisms and to all endpoints relative to the control and reference envelope. While polychaete survival in these samples was 61.3 percent to 75.0 percent, amphipod survival was less than 1 percent for all three samples (Table 6-2). These samples were collected from the central portion of the canal, in close proximity to each other (Figure 2-3b). Table 6-3 summarizes the concentrations of detected constituents in all canal samples. Samples from Stations 314 and 315 yielded the highest total PAH and total PCB concentrations (greater than 4,243,600 and 2,400 µg/kg, respectively), which were greater than SELs. While PCBs were undetected in the sample from Station 313, and PAHs were much lower than observed in samples from Stations 314 and 315 (i.e., between the LEL and SEL), all three of these samples exhibited concentrations of copper, lead, mercury, nickel, and/or silver greater than SELs.

The sample from Station 310 also exhibited significant reduction in the survival of both organisms and in growth and reproduction for amphipods. Therefore, this sample was also considered severely impacted. This station is located in a branch of the canal approximately 1,500 feet upstream (northeast) of the sample from Station 313 (Figure 6-6) and yielded concentrations of total PAHs and six metals (copper, lead, mercury, nickel, silver, and zinc) that exceeded SELs (Table 6-3).

Finally, severe toxicity was also observed for organisms exposed to sediment samples from Stations 318 and 319, but mostly for amphipods. These were the only other samples that yielded statistically significant reductions for all three amphipod endpoints (survival, growth and reproduction; Table 6-3) as compared to the control *and* responses below the reference envelope. There was also significantly reduced polychaete survival at Station 318, as compared to control. These two samples are located just down gradient of the other severely impacted stations noted above (Stations 310, 313, 314, and 315; Figure 6-6). As with these other stations, detected concentrations of total PAHs, total PCBs and up to six metals (copper, lead, mercury, nickel, silver, and/or zinc) were also above SELs in these samples.

Moderate Impacts. Moderate impacts were observed for five stations (Stations 307A, 307B, 309, 321, and 324). These samples yielded some of the higher amphipod growth and reproduction responses (i.e., least degraded) relative to other canal stations (Figure 6-1 and Table 6-2). Even though these reductions in growth and reproduction were observed, only samples from Stations 307B and 321 exhibited notable reductions in amphipod survival. However, amphipod survival at Stations 307B (70 percent) and 321 (68.8 percent) was not considered severely degraded because they were below the reference envelope, but not significantly reduced when compared to control. Stations 307A, 307B, and 309 are located up gradient, and north of the severely/moderately impact samples, while samples from Stations 321 and 324 are down gradient of these samples near the mouth of the canal (Figure 6-6). The contaminant results for these samples support the toxicity findings. Total PAHs were detected in all of these samples, with each concentration exceeding the LEL but not exceeding the SEL as observed for the moderately and severely impacts samples (Table 6-3). PCBs were undetected in all five of these samples and there was a lower incidence of metal contamination than severely impacted samples. Only three metals (lead, mercury, and zinc) were detected in these samples at concentrations above the SEL.

Limited Impacts. Although still indicating impact, Station 303 was the only station resulting in a lower level of toxicity based on a minimal amphipod reproduction reduction (Table 6-2). All other endpoints were above the reference envelope. Even though polychaete survival at this station was significantly reduced compared to control, it was not below the reference envelope. Therefore, it was not indicative of canal impacts. Chemical analytical results support these observations, with relatively low contamination compared to other stations (Table 6-3), and Station 303 is located above the zone of the canal where moderately/severely impacted stations are located.

Summary. All tested sample locations indicated impacts to benthic macroinvertebrates, with primarily the magnitude of potential impact varying between the sample locations. Four samples in a central area of the canal (Stations 310, 313, 314, and 315) were identified as the most severely impacted based on *both* amphipod and polychaete bioassay responses (Table 6-2). However, responses for two other samples (Stations 318 and 319) also suggest severe impacts as well, based on amphipod responses. Based on detected constituents in all six of these samples, the occurrence of total PAHs, total PCBs and some metals (copper, lead, mercury, nickel, silver, and/or zinc) are the most likely cause of these impacts based on exceedances of the NYSDEC SELs (Table 6-3). These samples were collected from an area within the central portion of the canal that is approximately 2,200 feet long (0.4 miles; Figure 6-6). Station 303 was the only location with limited impacts, due to only sublethal amphipod toxicity, relatively low chemical contamination, and the location of this station north of moderately/severely impacted stations.

6.1.2 Sediment Chemical Concentration Analysis

The 95% UCL chemical concentration of one volatile organic, 21 semivolatile organics, five pesticides, two PCBs, PCB congeners, and nine metals had HQs exceeding 1 and were identified as COCs (Table 5-5).

PAHs had the highest overall HQs (up to 19,000). The highest concentrations of these PAHs were detected in the middle of the Gowanus Canal in samples from Stations 314 and 315 (Figure 6-7). PCB parameters (total PCBs and PCB congeners) also exceeded their screening values, indicating a potential for adverse effect. The highest total concentrations of PCBs were detected in the sample collected from Station 314.

Of the 22 metals analyzed in sediment, nine exceeded their screening values, while 12 did not have screening values. Arsenic, barium, cadmium, copper, lead, mercury, nickel, silver, and zinc concentrations exceeded their screening values, but had HQs (1.8 to 26) that were generally lower than the exceedances for PAHs and pesticides. The highest concentrations of these metals were detected in samples collected from the middle of the Gowanus Canal, from Stations 308A, 310, 313, 314, and 317 (Figure 6-8).

6.1.3 AVS/SEM Analysis

The carbon-normalized ($\sum$SEM-AVS)/f_{OC} value for each station is presented in Table 5-7. As discussed in Section 5.2.1, divalent metals (cadmium, copper, lead, nickel, silver, and zinc) are considered bioavailable, and toxicity is considered likely when the ($\sum$SEM-AVS)/f_{OC} is >3,000 µmol/g_{OC}, uncertain when the concentration is between 130 and 3,000 µmol/g_{OC}, and not likely when the concentration is <130 µmol/g_{OC}. Thirty-four of the samples had excess carbon-normalized SEM values <130 µmol/g_{OC}, indicating that toxicity from metals would not be likely in these samples. SEM values in three of the samples (GC-SD306-0.0-0.5, GC-SD308A-0.0-0.5, and GC-SD310-0.0-0.5) fall in the lower end of the uncertain toxicity range of 130 to 3,000 µmol/g_{OC}, indicating that toxicity from metals is uncertain in these samples (Figure 6-9). None of the samples had excess carbon-normalized SEM values greater than 3,000 µmol/g_{OC}, which would indicate that toxicity is likely a result of divalent metals. Therefore, SEM metals appear to represent only a potential risk in three of Gowanus Canal samples (GC-SD306-0.0-0.5, GC-SD308A-0.0-0.5, GC-SD310-0.0-0.5).

6.1.4 Evaluation of Risks to Benthic Macroinvertebrates

Results of the sediment bioassays with both the amphipod and polychaete indicate a site-related potential for adverse effects to benthic communities throughout the length of the Gowanus Canal from the presence of chemicals in sediment (Section 6.1.1). Both bioassays suggest the greatest adverse effects to the benthic community will occur in the central portion of the canal (Stations 310, 313, 314, 315, 318, and 319). Several of the samples from these locations exhibited impacts for both organisms and to all measured test endpoints relative to both the laboratory control and reference samples. The bioassay results suggest there is also the potential for less severe, but still site-related, effects to the benthic community at other locations in the Gowanus Canal.

Chemical analysis indicates the presence of organic chemicals (primarily PAHs and PCBs) and metals in sediments at concentrations that are likely to be causing the outcomes observed in the sediment bioassays. The highest concentrations of PAHs, PCBs, and metals exceeding their ecological screening benchmarks were generally detected within the central portion of the canal, which is also the location where the most severe effects were observed in the bioassay test organisms.

PAHs were consistently detected at the highest concentrations relative to their ecological screening benchmarks (Table 5-5), were generally detected at concentrations above those detected in the Gowanus Bay reference sediments (Table 5-4 of the RI), and are considered to represent the greatest site-related risk to the benthic community. Other chemicals, such as PCBs and metals (barium, cadmium, copper, lead, mercury, nickel, and silver), were also detected at concentrations above their ecological screening benchmarks and at concentrations above those detected in the Gowanus Bay reference sediments, and are also likely to represent a potential risk to the benthic community. However, AVS/SEM analysis (Section 6.1.3) suggests that many of the metals with concentrations exceeding their ecological screening values are bound to sediment, have limited bioavailability, and are likely to represent a lesser potential risk to the benthic community.

6.2 Water-Column-Dwelling Aquatic Life

6.2.1 Surface Water Concentration Analysis

Dry Event

The 95% UCL chemical concentrations of only two total metals (copper and nickel) and one dissolved metal (copper) had HQs exceeding 1 and were identified as COCs (Table 5-8). No VOCs, SVOCs, or PCBs had HQs greater than 1. No chemicals initially identified as COPCs in the SLERA (Section 4.1.2) were thus eliminated in the BERA using the 95% UCL comparison.

Total and dissolved copper had the highest HQs (55.0 and 71.0, respectively). The 95% UCL concentrations of both total and dissolved copper exceeded the copper screening value in 11 of the 27 samples. The nickel 95 percent UCL concentration exceeded the screening value in four of the 27 samples. No spatial trend was evident for these chemicals.

Wet Event

A few more metals were detected at concentrations exceeding surface water screening values during the wet sample event, when compared to the dry sample event. The 95% UCL chemical concentration of four total metals (cobalt, iron, lead, and nickel) and two dissolved metals (cobalt and iron) had HQs exceeding 1 and were identified as COCs (Table 5-9). No other chemicals had HQs greater than 1.

Total and dissolved iron had the highest HQs (21 and 20, respectively). Total lead had the highest frequency of exceedance, with 21 of 25 sample concentrations exceeding its screening value. Dissolved lead was not identified as a COC. Total iron and nickel had three and five concentrations greater than their screening values, respectively, and total cobalt and dissolved iron each had one concentration greater than its screening value. The highest detected concentrations of these metals were in the middle of the Gowanus Canal (Stations 308B, 310, 315, and 317).

6.2.2 Evaluation of Risks to Water-Column-Dwelling Aquatic Life

Results of the evaluation of chemical concentrations in surface water indicate a site-related potential for adverse effects to water-column-dwelling aquatic life from the presence of a few chemicals in surface water. Surface water samples collected both during dry and wet (storm) events do not indicate the presence of organic chemicals at concentrations that could adversely affect aquatic life. Some VOCs and PAHs were detected in surface water during both sample events (Tables 5-8 and 5-9), but the detected concentrations of those chemicals did not exceed the available ecological screening benchmarks, indicating these chemicals do not represent a risk to aquatic life.

Results of the surface water samples collected during both the dry and wet events similarly indicate the potential for a few metals to cause site-related adverse effects. In surface water samples collected during the dry event, for example, copper (total and dissolved) and nickel (total) were detected at concentrations exceeding their ecological screening benchmarks (Table 5-8). However, neither chemical was detected in canal surface water at concentrations statistically exceeding those detected in the Gowanus Bay reference samples (Table 4-11 of the RI), indicating that onsite concentrations do not exceed those detected in non-site-impacted areas.

A few additional chemicals were detected at concentrations exceeding their ecological screening values when samples were collected during the wet event. Cobalt and iron (total and dissolved) and lead and nickel (total only) exceeded ecological screening benchmarks in the wet event samples. However, only lead was detected in the canal surface water at concentrations exceeding those detected in the Gowanus Bay reference samples (Table 4-11 of the RI), indicating it is the only chemical representing a site-related risk.

6.3 Avian Wildlife

Table 6-4 summarizes the bioaccumulative constituents that were detected in sediment and/or wildlife prey-item tissue samples (fish and benthic invertebrates/crabs). Only constituents that were detected in one or more of these media were quantitatively evaluated in the food web models. There were three instances were no tissue data were available for a chemical or chemical group, and these could not be evaluated for avian wildlife risks. First, total DDT was not calculated for small prey fish tissue samples, because data for 4,4′-DDD in sample GC-TI401-XATC-WB-1 was rejected (Appendix I of the RI). Second, PAHs were not analyzed in fish tissue samples. PAHs were not analyzed in fish tissue because they are typically metabolized by fish and do not bioaccumulate. However, PAHs were present in elevated concentrations in sediment, and it is possible that some PAHs may be present in fish tissues prior to metabolism, in which case risks could have been underestimated. Finally, VOCs were not analyzed in either fish or invertebrate samples, so tissue concentrations of 1,4-dichlorobenzene could not be included even though it was detected in sediment. The implications of these data limitations on the risk estimates are further discussed as an uncertainty (Section 7) of the ERA. The following subsections present and discuss the food web results.

6.3.1 Avian Wildlife Food Web Model Outcomes

Table 6-5 summarizes the food web model outcomes for avian wildlife. The estimated dietary intake (i.e., dose) of these constituents was estimated for green heron (representative of avian aquatic omnivores), double-crested cormorant (representative of avian aquatic piscivores), and black duck (representative of avian aquatic herbivores) and compared to ingestion screening values to estimate the potential for risk.

The estimated dose of two constituents for heron (mercury and selenium) and one constituent group for duck (total PAHs) yielded LOAEL-based HQs greater than 1.0, indicating a potential for risk. For cormorant, no HQs exceeded 1.0 for any constituent, suggesting no risks are expected for avian piscivores. For heron, the LOAEL-based HQ was 3.2 for both mercury and selenium. For duck, the LOAEL-based HQ for total PAHs was 75.6.

6.3.2 Evaluation of Risks to Avian Wildlife

Results of the food web models indicate a potential risk to heron from exposure to mercury and selenium and to duck from exposure to PAHs. The heron exposure was estimated through the consumption of constituents in fish and crab. Mercury was detected in all samples of both prey items. Selenium, meanwhile, was detected only in three of eight fish samples and was not detected in crab tissue. Furthermore, mercury was detected in the canal sediments at concentrations exceeding those detected in Gowanus Bay reference sediments (Table 4-5 of the RI), while selenium was not detected at concentrations above reference in either sediment or surface water. These data suggest that only mercury represents a potential site-related risk to avian aquatic omnivores.

Risks to ducks resulted from the presence of PAHs in sediment. Because PAHs were detected in canal sediments at concentrations exceeding those detected in Gowanus Bay reference sediments (Table 4-5 of the RI), it is concluded that PAHs represent a potential site-related risk to avian aquatic omnivores.

TABLE 6-1
Comparison of Detected Constituents in Reference Sediment Samples to Criteria
Gowanus Canal Remedial Investigation
Brooklyn, New York

Constituent	Sediment Criteria[1]		326			328			329			330			333		
	Lowest Effect Level	Severe Effect Level	Values	Exceedances LEL	Exceedances SEL	Values	Exceedances LEL	Exceedances SEL	Values	Exceedances LEL	Exceedances SEL	Values	Exceedances LEL	Exceedances SEL	Values	Exceedances LEL	Exceedances SEL
SVOCs (ug/kg)																	
Total PAHs	4,022	44,792	1,890			7,840	X		3,430			4,210	X		4,410	X	
Pesticides/PCBs (ug/kg)																	
None detected																	
Volatile Organic Compounds (ug/kg)																	
Acetone	*NSV*		32 J	--	--	17 U	--	--	20 U	--	--	22 U	--	--	9.6 J	--	--
Carbon disulfide	*NSV*		16 U	--	--	3.2 J	--	--	10 U	--	--	11 U	--	--	5.9 U	--	--
Metals (mg/kg)																	
Aluminum	*NSV*		17,900 J	--	--	9,890	--	--	15,500 J	--	--	18,000 J	--	--	16,800 J	--	--
Arsenic	8.2	70.0	19 J	X		9.3	X		13.3 J	X		15.7 J	X		11.9 J	X	
Barium	*NSV*		133 J	--	--	45.8	--	--	67.2 J	--	--	69 J	--	--	76.1 J	--	--
Beryllium	*NSV*		0.4 J	--	--	0.26 J	--	--	1.3 UJ	--	--	0.44 J	--	--	0.46 J	--	--
Cadmium	1.2	9.6	5.7 J	X		0.38 J			6.3 J	X		0.4 J			0.32 J		
Chromium	81.0	370.0	181 J	X	X	41			60.1 J			58 J			55.6 J		
Cobalt	*NSV*		13.2 UJ	--	--	7.6 J	--	--	12.7 J	--	--	12.8 J	--	--	11.9 J	--	--
Copper	34.0	270.0	242 J	X		80.2	X		65.2 J	X		70.7 J	X		76.9 J	X	
Iron	2.0%	4.0%	34,400 J	X		18,200			31,600 J	X		33,300 J	X		29,900 J	X	
Lead	46.7	218.0	244 J	X	X	61.7	X		90 J	X		93.5 J	X		87.5 J	X	
Manganese	460.0	1,100.0	554 J	X		323			559 J	X		866 J	X		503 J	X	
Mercury	0.15	0.7	3.7 J	X	X	0.85	X	X	1.2 J	X	X	0.91 J	X	X	1 J	X	X
Nickel	20.9	51.6	45.2 J	X		23.8	X		34.9 J	X		34.6 J	X		34.2 J	X	
Selenium	*NSV*		9.2 UJ	--	--	6.9 U	--	--	2 J	--	--	10.8 UJ	--	--	8.3 UJ	--	--
Silver	1.0	3.7	9.5 J	X	X	2 U	--	--	2.6 UJ	--	--	3.1 U	--	--	2.4 UJ	--	--
Vanadium	*NSV*		53.6 J	--	--	25.6	--	--	42.8 J	--	--	45.6 J	--	--	38.1 J	--	--
Zinc	150.0	410.0	378 R	--	--	160	X		200 J	X		193 R	--	--	185 R	--	--
Cyanide, Total	*NSV*		6.6 UJ	--	--	4.9 U	--	--	6.4 UJ	--	--	7.7 UJ	--	--	5.9 UJ	--	--

Notes:
1 - Criteria for marine and estaurine sediment from *New York State Department of Environmental Conservation Technical Guidance for Screening Contaminated Sediments* (NYSDEC 1999)
Shaded concentrations indicate detections
An "X" indicates exceedances of noted benchmark(s)

TABLE 6-2
Comparison of Canal Sample Toxicity Test Results to the Reference Envelope
Gowanus Canal Remedial Investigation
Brooklyn, New York

Area	Sediment Sample	Polychaete		Amphipod			Reference Envelope Response Category
		Survival (%)	Growth (Wet Biomass - g/organism)	Survival (%)	Growth (Dry Biomass - mg/organism)	Reproduction (# of juveniles/ female)	
Laboratory	Control	97.5	2.837	81.3	1.058	4.86	NA
Canal	303	**87.5**	2.668	81.3	0.886	**1.58**	Limited
	307A	93.8	3.21	79.4	**0.576**	**0.87**	Moderate
	307B	**87.5**	2.58	70.0	**0.645**	**2.20**	Moderate
	309	**85.0**	2.65	86.3	**0.643**	**0.96**	Moderate
	310	**83.8**	2.67	**27.5**	**0.130**	**0.00**	Severe
	313	**61.3**	**1.88**	**0.6**	**0.003**	0.00	Severe
	314	**75.0**	**2.24**	**0.0**	*None Surviving*		Severe
	315	**71.3**	**1.79**	**0.0**			Severe
	318	**86.3**	2.53	**35.6**	**0.105**	**0.00**	Severe
	319	97.5	2.76	**53.8**	**0.175**	**0.00**	Severe
	321	92.5	2.66	68.8	**0.418**	**0.47**	Moderate
	324	**87.5**	2.82	85.6	**0.666**	**0.88**	Moderate
Reference Envelope							
Reference	Lowest Response[1]	85.0	2.25	75.0	0.673	2.12	
	Sample ID of Lowest Response	328, 329	329	328	333	329	

Notes:

Bolded values represent significantly reduced responses compared to control

Shaded values represent responses below the reference envelope

1 - values represent the lowest response result for reference samples 328, 329, 330 and 333 (Sample 326 excluded based on observed toxicity and and benchmark exceedances

TABLE 6-3
Detected Constituents in Surficial Canal Sediment Samples
Gowanus Canal Remedial Investigation
Brooklyn, New York

		SVOCs (ug/kg)						PCBs (ug/kg)			Volatile Organic Compounds (ug/kg)																		Pesticides (ug/kg)	
Sample ID	Sample Type	Biphenyl (diphenyl)	Bis(2-ethylhexyl) phthalate	Dibenzofuran	Di-n-butyl phthalate	Di-n-octylphthalate	Total PAHs	Aroclor 1016	Aroclor 1260	Total PCBs	1,2-dichloroethane	1,4-dichlorobenzene	Acetone	Benzene	Carbon disulfide	Chlorobenzene	Cyclohexane	Ethylbenzene	Isopropylbenzene (cumene)	m, p xylenes	Methylcyclohexane	Methylene chloride	o-xylene (1,2-dimethylbenzene)	Tert-butyl methyl ether	Tetrachloroethylene(PCE)	Toluene	Trichloroethylene (TCE)	Trichlorofluoromethane	P,P'-DDD	Total DDTs
303	Normal		3,400 J				39,370			--			39		4.7 J										5.8 J			5.4 J		--
307A	Normal		6,400 J			9,300 J	29,090			--			42		5.2 J							4.7 J								--
307B	Normal		4,500 J				28,690			--	8.5 J	7.6 J	21 J															4.6 J	7.9 NJ	7.9
309	Normal		2,600 J				13,750			--	5.8 J		21 J																	--
310	Normal		16,000 J				66,900			--																			13 NJ	13
313	Normal						13,070			--			29	6.8 J	6.7 J		8 J	1,100 J	200	310		3.9 J				7.8 J				--
314	Field Duplicate						2,874,500		2,800 J	2,800																				--
314	Normal		57,000 J				4,243,600		3,400 J	3,400			90	46 J	89			1,100 J	640 J	120 J	170 J		290 J			36 J				--
315	Field Duplicate	53,000 J					5,338,200		1,200 J	1,200	*Not analyzed*																		1,000 NJ	1,000
315	Normal	71,000 J					8,001,000		2,400 J	2,400				34 J	8.5 J		8 J	3,600 J	760 J	810 J	15	4.7 J	1,200 J			25			1,100 NJ	1,100
318	Normal		14,000		550 J		235,500	290	440	730																				--
319	Normal	650 J	7,700 J	1,100 J			289,300	220 J	440	660								61	65	5.4 J	27		19							--
321	Normal		4,000 J				33,890			--																				--
324	Field Duplicate						9,840			--												4.3 J								--
324	Normal						16,350			--					11 J															--

TABLE 6-3
Detected Constituents in Surficial Canal S
Gowanus Canal Remedial Investigation
Brooklyn, New York

Sample ID	Sample Type	Metals (mg/kg)																	
		Aluminum	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver	Vanadium	Zinc	Cyanide, Total
303	Normal	16,200 J	8.2 J	94.8 J	0.43 J	1.6 J	62 J		168 J	29,600 J	201 J	287 J	1.2 J	36.1 J		2.7 J	45.1 J		
307A	Normal	15,900 J	7.7 J	134 J	0.4 J	2.2 J	65.6 J		192 J	27,700 J	776 J	283 J	1.4 J	37.1 J		3.4 J	42.6 J		
307B	Normal	18,200 J	9.9 J	103 J	0.44 J	1.5 J	69.8 J	12.5 J	191 J	28,800 J	216 J	314 J	1.2 J	40.8 J		1.9 J	50.4 J		
309	Normal	17,200 J	9.1 J	98.2 J	0.46 J	2.1 J	69.1 J	12.5 J	149 J	29,500 J	184 J	305 J	1.2 J	38.9 J		3.2 J	42.2 J		
310	Normal	18,900 J	13.2 J	248 J	0.33 J	5.6 J	96.8 J	14.2 J	314 J	32,600 J	600 J	303 J	1.6 J	56.3 J	4.9 J	6.8 J	60.1 J	773 J	
313	Normal	10,200 J	8.8 J	166 J	0.2 J	5.1 J	95 J	8.6 J	246 J	24,200 J	355 J	199 J	2.3 J	55.7 J		4.5 J	42 J		1 J
314	Field Duplicate	10,300 J	12.2 J	301 J	0.24 J	7.6 J	133 J	9.6 J	323 J	25,200 J	531 J	166 J	1.6 J	79.8 J		4.5 J	47.7 J		1 J
314	Normal	10,100 J	10.8 J	304 J	0.26 J	8.1 J	139 J	10 J	349 J	26,400 J	488 J	173 J	0.95 J	84.5 J		6.1 J	47.7 J		1.2 J
315	Field Duplicate	5,560	11.4	134	0.11 J	2.4	50.9	6.5 J	181	21,700	387	145	0.77	36.5		1.8	25.2	378	1.2 J
315	Normal	5,550	13.6	232	0.11 J	2.3	48.8	5.9 J	151	21,900	1,600	140	1	32.7		1.3 J	24	1,510	1.5 J
318	Normal	15,800 J	23.2 J	308 J		13.6 J	117 J	14.8 J	349 J	33,400 J	669 J	301 J	1.8 J	60.1 J	2.3 J	4.1 J	54.5 J	1,460 J	
319	Normal	10,000 J	11.9 J	163 J		7.6 J	73.7 J		178 J	24,200 J	376 J	203 J	0.92 J	42.4 J	1.3 J	2.8 J	32.6 J	914 J	0.54 J
321	Normal	13,000 J	12.8 J	90.8 J		7 J	64.2 J	11.7 J	110 J	27,600 J	146 J	392 J	0.9 J	36 J	0.99 J		35.7 J	318 J	1.1 J
324	Field Duplicate	16,900 J	13.6 J	141 J		9.5 J	83.4 J		176 J	33,700 J	239 J	361 J	1.3 J	42.2 J	1.7 J	3.7 J	47.9 J	535 J	1.1 J
324	Normal	17,600 J	15.1 J	127 J		9.7 J	84.7 J	13.4 J	167 J	34,500 J	216 J	399 J	1.4 J	43 J	2.2 J		46.9 J	432 J	

TABLE 6-4
Detected Bioaccumulative Constituents
Gowanus Canal Remedial Investigation
Brooklyn, New York

Bioaccumulative Constituents[1]	Sediment[2]	Prey Item Tissue[3]	
		Fish	Benthic Invertebrates
Inorganics			
Arsenic	x	--	x
Cadmium	x	--	--
Chromium	x	x	--
Copper	x	x	x
Lead	x	x	--
Mercury	x	x	x
Nickel	x	--	--
Selenium	x	x	--
Silver	x	--	x
Zinc	x	x	x
Pesticides			
DDT, total	x	*see note 4*	x
Aldrin	--	--	--
alpha-BHC	--	--	--
alpha-Chlordane	x	x	--
beta-BHC	--	--	--
delta-BHC	--	--	--
Dieldrin	--	--	--
Endosulfan I	--	--	--
Endosulfan II	x	--	--
Endrin	--	x	--
gamma-BHC (Lindane)	--	--	--
gamma-Chlordane	x	x	--
Heptachlor	--	--	--
Heptachlor epoxide	--	--	--
Methoxychlor	x	--	--
Toxaphene	--	--	--
Polychlorinated Biphenyls			
PCBs, total	x	x	x
Semivolatile Organics			
4-Bromophenyl-phenylether	--	--	--
4-Chlorophenyl-phenylether	--	--	--
Hexachlorobenzene	--	--	--
Hexachlorobutadiene	--	--	--
Hexachlorocyclopentadiene	--	--	--
Hexachloroethane	--	--	--
PAHs, total	x	*NA*	x
Pentachlorophenol	--	--	--
Volatile Organics			
1,1,2,2-Tetrachloroethane	--	--	--
1,2,4-Trichlorobenzene	--	--	--
1,2-Dichlorobenzene	--	--	--
1,3-Dichlorobenzene	--	--	--
1,4-Dichlorobenzene	x	*NA*	*NA*

Notes:

A shaded "x" indicates a detection
An "--" indicates a nondetect
"NA" not analyzed in medium noted
1 - Constituents with the greatest potential to bioaccumulate (Table 4-2 of USEPA, 2000)
2 - Detected constituent concentrations in sediment are summarized in Table 5-5
3 - Detected constituent concentrations in tissue are summarized in Tables 5-2 (crab) or 5-4 (small prey fish)
4 - Total DDT not calculated because data for 4,4'-DDD in sample GC-TI401-XATC-WB-1 was rejected

TABLE 6-5
Food Web Risk Calculations
Gowanus Canal Remedial Investigation
Brooklyn, New York

Constituent	Sediment (mg/kg dw)[1]	Prey Item Tissue[2] Fish (mg/kg dw)	Prey Item Tissue[2] Benthic Invertebrates (mg/kg dw)	Aquatic Plants BCF	Aquatic Plants mg/kg dw	Avian TRVs (mg/kg/day) NOAEL	Avian TRVs (mg/kg/day) LOAEL	Green Heron Dietary Intake (mg/kg/day)	Green Heron Hazard Quotients NOAEL	Green Heron Hazard Quotients LOAEL	Double-Crested Cormorant Dietary Intake (mg/kg/day)	Double-Crested Cormorant Hazard Quotients NOAEL	Double-Crested Cormorant Hazard Quotients LOAEL	Black Duck Dietary Intake (mg/kg/day)	Black Duck Hazard Quotients NOAEL	Black Duck Hazard Quotients LOAEL
Inorganics																
Arsenic	14.70	11.8	34.5	0.037	0.545	2.30	6.78	2.170	0.9	0.3	0.468	0.2	0.1	0.211	0.1	0.0
Cadmium	9.99	5.98	8.93	0.514	5.132	7.32	28.87	0.807	0.1	0.0	0.237	0.0	0.0	0.272	0.0	0.0
Chromium	84.50	3.08	17.8	0.048	4.018	1.00	5.00	0.867	0.9	0.2	0.122	0.1	0.0	0.386	0.4	0.1
Copper	274.00	18.1	258	0.123	33.721	46.97	61.72	10.349	0.2	0.2	0.719	0.0	0.0	3.072	0.1	0.0
Lead	1200.00	5.31	17.8	0.038	45.244	2.00	20.00	1.054	0.5	0.1	0.211	0.1	0.0	3.864	**1.9**	0.2
Mercury	1.39	0.976	2.2	0.344	0.478	NTRV	0.05	0.158	--	**3.2**	0.039	--	0.8	0.033	--	0.7
Nickel	48.10	47.6	71.4	0.034	1.646	77.40	106.90	6.433	0.1	0.1	1.890	0.0	0.0	0.487	0.0	0.0
Selenium	2.13	5.650	62.3	0.567	1.208	0.42	0.82	2.606	**6.3**	**3.2**	0.224	0.5	0.3	0.352	0.8	0.4
Silver	4.04	11.8	16.3	0.013	0.051	35.6	178.0	1.547	0.0	0.0	0.468	0.0	0.0	0.087	0.0	0.0
Zinc	944.00	171	498	0.358	337.689	82.40	123.60	31.378	0.4	0.3	6.789	0.1	0.1	17.916	0.2	0.1
Pesticides																
DDT, total	1.10	*see note 3*	0.072	0.423	0.466	0.18	1.77	0.002	0.0	0.0	--	--	--	0.021	0.1	0.0
alpha-Chlordane	0.014	0.026	0.030	0.377	0.005	0.57	1.50	0.003	0.0	0.0	0.001	0.0	0.0	0.000	0.0	0.0
Endosulfan II	0.013	0.0402	0.059	0.974	0.013	10.18	NTRV	0.005	0.0	--	0.002	0.0	--	0.001	0.0	--
Endrin	1.00	0.0188	0.059	0.733	0.733	NTRV	0.06	0.004	--	0.1	0.001	--	0.0	0.032	--	0.5
gamma-Chlordane	0.029	0.0235	0.030	0.377	0.011	0.80	4.00	0.003	0.0	0.0	0.001	0.0	0.0	0.001	0.0	0.0
Methoxychlor	0.033	0.207	0.304	0.725	0.024	830.9	NTRV	0.028	0.0	--	0.008	0.0	--	0.003	0.0	--
Polychlorinated Biphenyls																
PCBs, total	0.85	2.89	4.84	0.34	0.29	0.29	0.58	0.408	**1.4**	0.7	0.115	0.4	0.2	0.037	0.1	0.1
Semivolatile Organics																
PAHs, total	1950.3	*see note 4*	6.020	*see note 5*	2,522	NTRV	1.43	0.206	--	0.1	--	--	--	107.933	--	**75.6**
Volatile Organics																
1,4-Dichlorobenzene	0.24	*see note 6*		1.740	0.418	32.16	160.80	--	--	--	--	--	--	0.018	0.0	0.0
Dioxins/Furans																
TEQ (total)[7]	*see note 8*	0.00028	0.00124	0.338	--	0.000014	0.000143	0.0000659	**4.6**	0.5	0.000	0.8	0.1	--	--	--

Dietary Intake Equation[9] Component	Heron	Cormorant	Duck	Description
DI	*Chemical-specific*			Dietary intake for chemical (see above)
FIR	0.0250	0.0925	0.0564	Food ingestion rate (kg/day dry weight)
FCx_{fish}	*Chemical-specific*			Concentration of chemical x in fish (see above)
PDF_{fish}	0.71	1.0	0	Proportion of diet composed of fish (percent)
FCx_{invert}	*Chemical-specific*			Concentration of chemical x in benthic invertebrates (see above)
PDF_{invert}	0.29	0	0.10	Proportion of diet composed of benthic invertebrates (percent)
FCx_{plant}	*Chemical-specific*			Concentration of chemical x in aquatic plants (see above)
PDF_{plant}	0	0	0.867	Proportion of diet composed aquatic plants (percent)
SCx	*Chemical-specific*			Concentration of chemical x in sediment (see above)
$PD_{sediment}$	0	0	0.033	Proportion of diet composed of sediment (percent)
BW	0.21	2.33	1.18	Body weight (kg wet weight)
AUF	1.0	1.0	1.0	Area Use Factor (Site Size/Home Range; Max. is 1.0)

Notes:

Shaded concentrations indicate detections (from tables cited below); unshaded concentrations are maximum reporting limits (RI Appendix I)

NTRV - no TRV available

Bolded Hazard Quotients are > 1.0

1 - Lower of the 95% upper confidence limits (UCL) of the mean or the maximum concentration (Table 5-5)

2 - Maximum detected concentration; fish are small prey fish (atlantic tomcod and mummichog; Table 5-4); Invertebrates are blue crab (Table 5-2)

3 - Total DDT not calculated because data for 4,4'-DDD in one sample (GC-TI401-XATC-WB-1) was rejected

4 - PAHs not analyzed in small prey fish tisse samples

5 - Aquatic plant concentration calculated based on bioaccummulation from Low Molecular Weight (LMW) and High Molecular Weight (HWM) PAHs (see text and Attachment F)

6 - VOCs not analyzed in fish or crab tissue samples

7 - Toxicity Equivalents (TEQ) for dioxin-like PCB congeners (see text and Attachment E)

8 - TEQs not calculated since congener data only available for subset of samples

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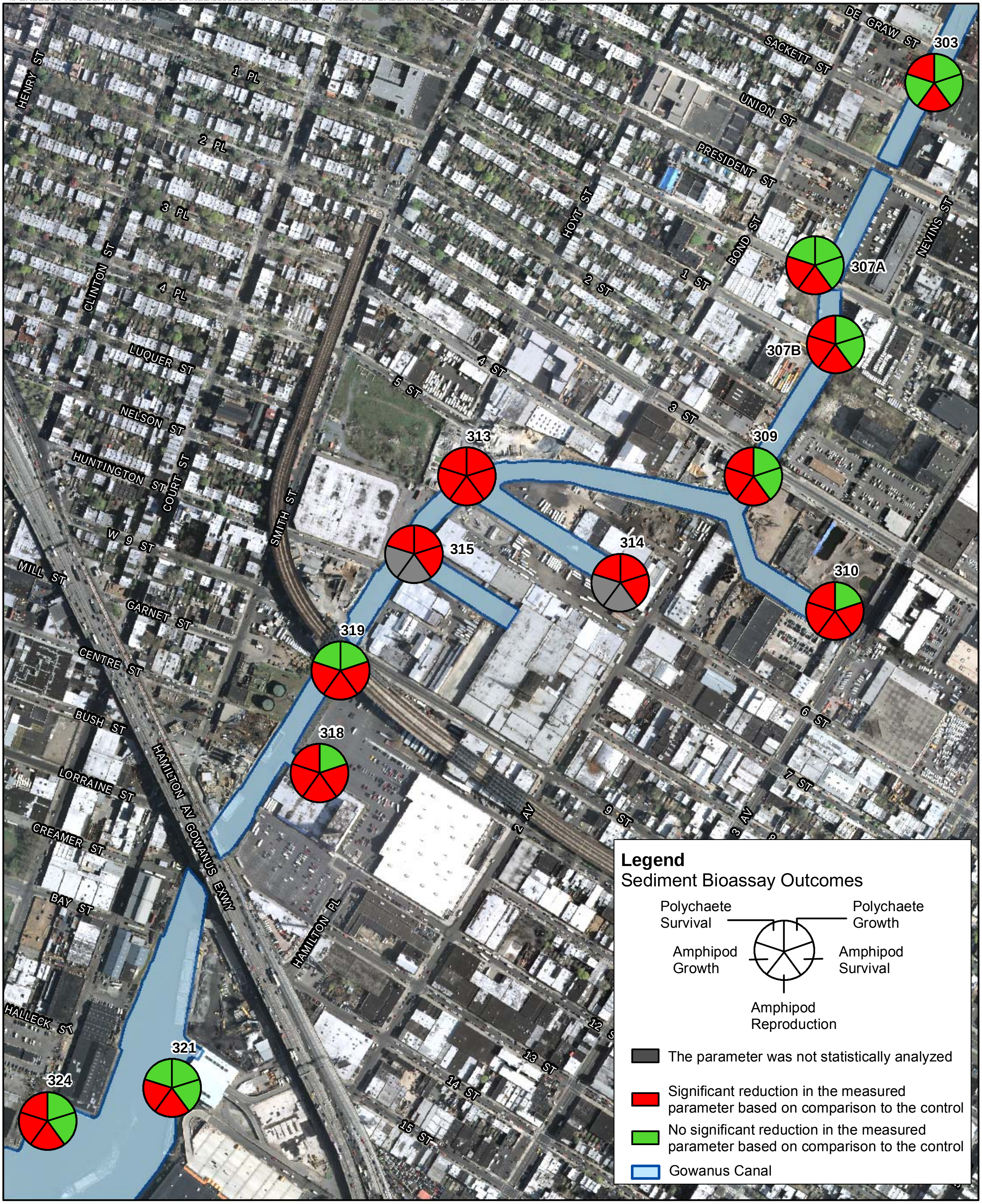

N

0 150 300

Feet

FIGURE 6-1
Summary of Sediment Bioassay Outcomes
Gowanus Canal Remedial Investigation
Brooklyn, New York

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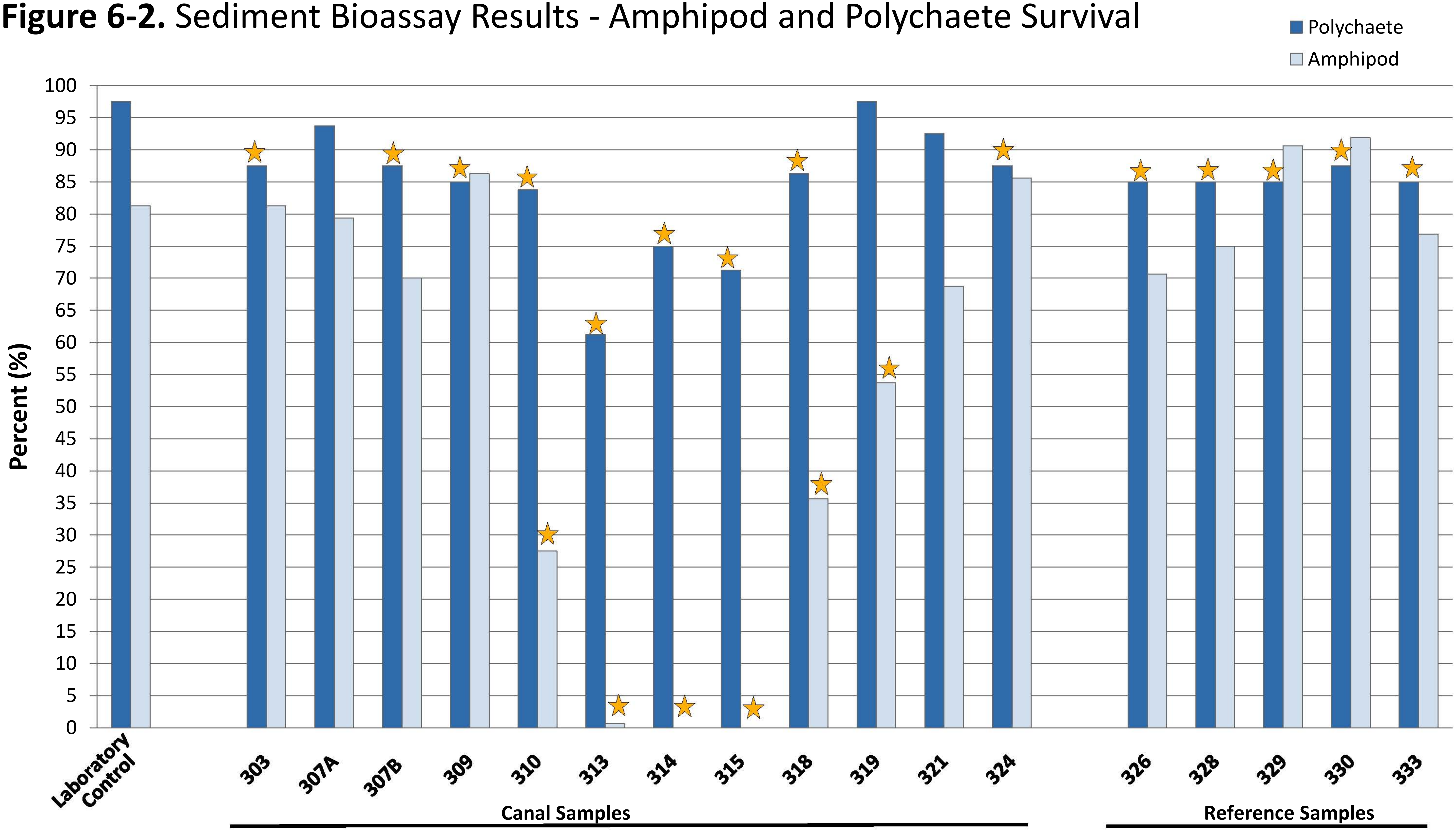
Figure 6-2. Sediment Bioassay Results - Amphipod and Polychaete Survival



★ - *indicates a negative effect based on the finding of statistically significant reduction as compared to the control*

Figure 6-3. Sediment Bioassay Results - Polycheate Growth

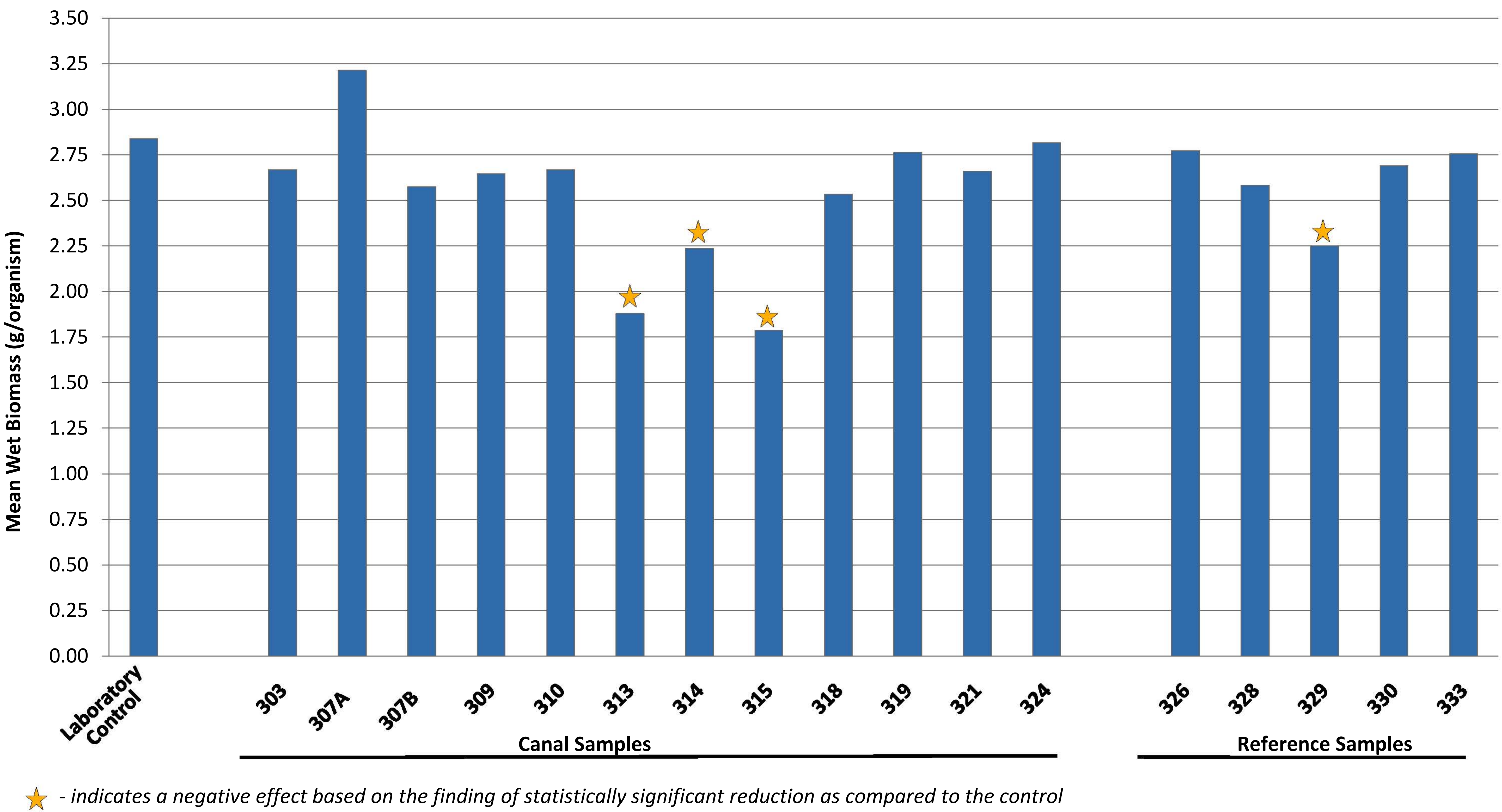
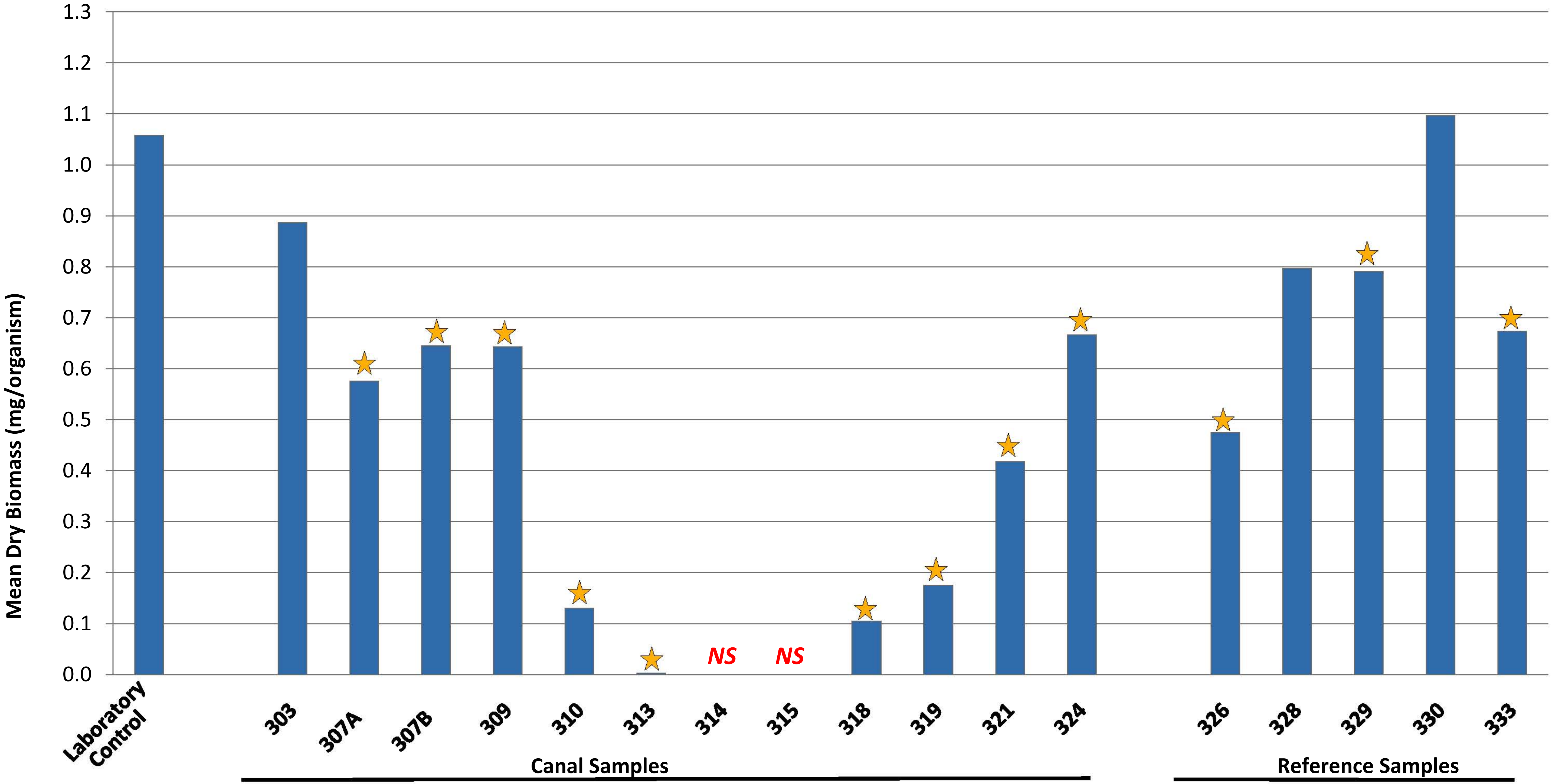


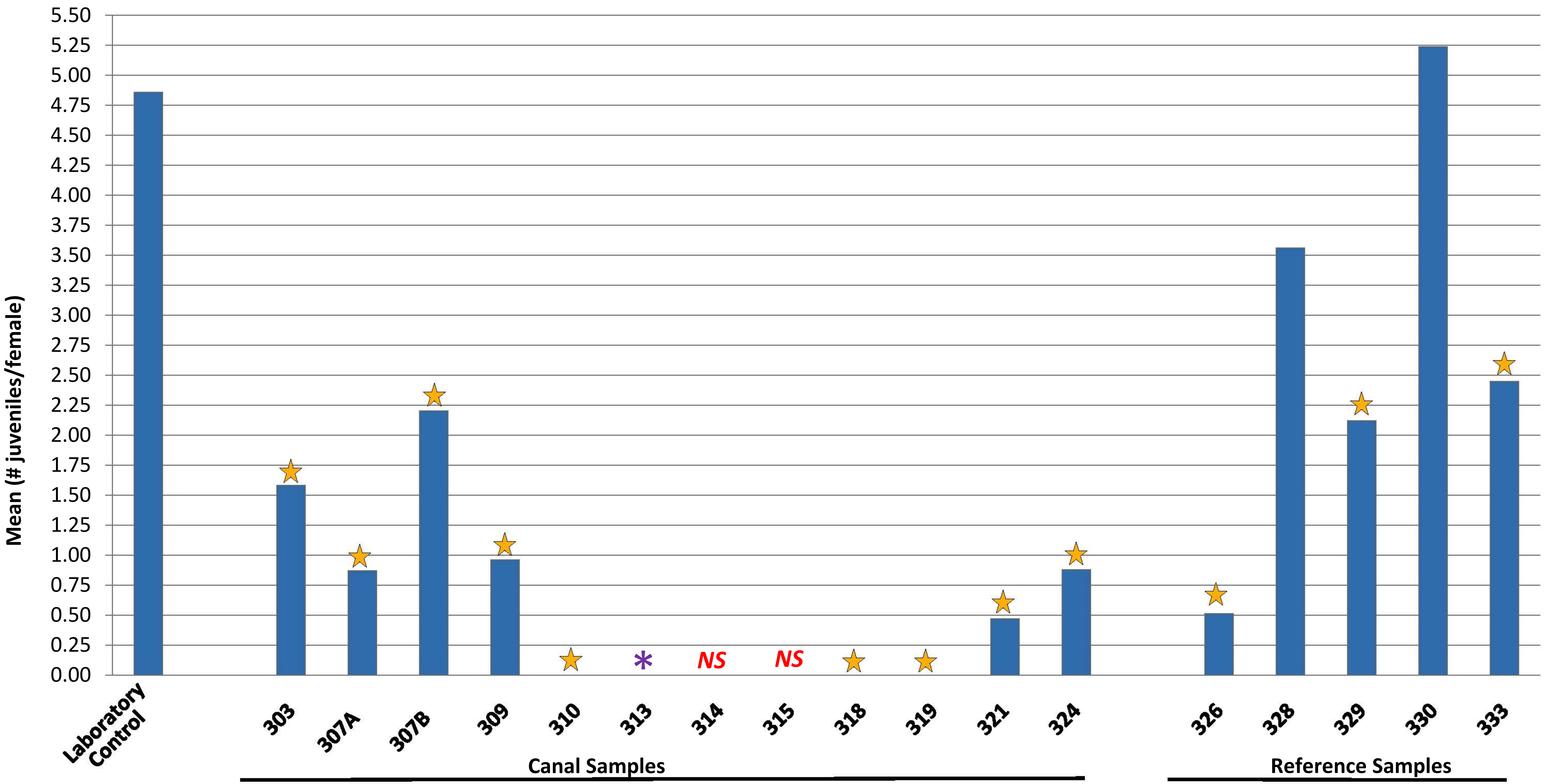
Figure 6-4. Sediment Bioassay Results - Amphipod Growth



★ - *indicates a negative effect based on the finding of statistically significant reduction as compared to the control*

NS - *none surviving; no reproduction measures possible*

Figure 6-5. Sediment Bioassay Results - Amphipod Reproduction



★ - *indicates a negative effect based on the finding of statistically significant reduction as compared to the control*

NS - *none surviving; no reproduction measures possible* ✱ - *neither endpoint yeilded statistically signficant impact, but results considered signficant biological impact*

FIGURE 6-6
Summary of Reference Envelope Evaluation Outcomes
Gowanus Canal Remedial Investigation
Brooklyn, New York

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SECTION 7

Uncertainties

Uncertainties are present in all ERAs because of the limitations in the available data and the need to make certain assumptions and extrapolations based upon incomplete information. In addition, each of various models (for example, uptake and food web exposures) carries with it some associated uncertainty as to how well the model reflects actual conditions. This ERA considered multiple lines of evidence when evaluating the potential for adverse effects to the assessment endpoints identified for evaluation. For example, risks to the benthic-dwelling community were evaluated using the results of two sediment bioassays along with chemical analytical data. Although using multiple lines of evidence does not eliminate the uncertainties inherent to the evaluation of ecological risk, the use of multiple measures helps to substantiate the general outcomes and conclusions of the ERA. General agreement in the different lines of evidence evaluated for each of the ecological receptors increases the level of confidence in the final conclusions made in this ERA.

This section presents and discusses the primary uncertainties in this ERA and the implications of those uncertainties on the risks estimated in this ERA.

7.1 Site-Specific Media Data

7.1.1 Constituent Mixtures and Cumulative Concentrations

Information on the ecotoxicological effects of constituent interactions is generally lacking, which requires (as is standard for ERAs) that the constituents be evaluated on an individual basis during the comparison to screening values. This could result in an underestimation of risk (if there are additive or synergistic effects among constituents) or an overestimation of risks (if there are antagonistic effects among constituents).

For sediment and tissue, total PCBs, DDTs, and PAHs (as well as consideration of LMW and HMW PAHs) concentrations were calculated and evaluated in lieu of addressing individual compounds from these groups. Assuming a cumulative concentration for these groups could either overestimate risk (assuming additivity) or result in the possibility of overlooking the impacts from individual compounds. However, the uncertainty associated with combining concentrations is considered low because more ecotoxicological data are available for the grouped (totaled) constituents relative to individual constituents.

7.1.2 Detection Limits

The instrument detection limit for some non-detected chemicals in analyzed media exceeded applicable screening values. This occurred most frequently for organic chemicals in sediment. It cannot be determined if these chemicals are present, and if present, if they are occurring at concentrations above their applicable screening values, in which case there is the potential for these chemicals to represent a risk to ecological receptors. The potential for risks associated with these chemicals cannot be fully evaluated and risks associated with these chemicals may be underestimated. The frequency of this occurrence and potential uncertainty associated with these elevated reporting limits is discussed in Appendix H of the RI.

7.1.3 Evaluation of Sediments

The evaluation of chemical contamination in sediments was restricted to the 0-to-6-inch depth range. Although few ecological receptors would be expected to burrow to greater depths within the Gowanus Canal habitat, there is the potential for somewhat deeper sediments to be remobilized, primarily due to physical activities such as boating activities (e.g., propeller wash), dredging, and remobilization during storm events. The Gowanus Canal is generally considered to be a low-energy environment, and the overall potential for sediment remobilization during storm events is considered to be low. There is the potential for disturbance as a result of boating and/or dredging activities. However, the potential for this disturbance would be primarily at the mouth of the canal, where most boating activity occurs. The potential for sediments to be remobilized throughout much of the remaining canal is considered to be minimal and will have very little effect on the overall estimate of risk.

7.1.4 Tissue Residue Concentrations

There is some uncertainty associated with the site relatedness of chemical concentration in fish and crab tissues. Many of the fish species sampled and blue crabs represent transient populations that are only seasonally present in the Gowanus Canal. The body burden of these species is therefore likely to reflect chemical concentrations accumulated both from the Gowanus Canal and from non-site-impacted locations. Although this uncertainty cannot be completely eliminated, reference samples were collected from surrounding areas in order to establish a non-site-impacted baseline of the chemical concentrations within non-site-impacted fish species. An evaluation of chemical concentrations in the fish collected from non-site-impacted areas was conducted in Attachment E. Furthermore, the concentrations measured in the fish and crab tissue provide a realistic estimate of the total concentrations to which a receptor would be exposed. Finally, mummichog, which are the major component of the small prey fish grouping, are resident species, have very limited mobility, and are expected to provide an accurate estimate of tissue concentrations that would be accumulated directly from the canal.

7.2 Bioassays

7.2.1 Endpoint Selection

There are some uncertainties associated with the selection of available representative growth and reproduction endpoints to use for interpretation of bioassay results and the evaluation of impacts from exposure to canal sediments. For the growth endpoints for both polychaetes and amphipods, the *biomass* results were used in the risk evaluation instead of *weights*, because biomass measures are believed to represent overall impacts to the tested population of organisms. That is, the final biomass results reflect the difference, or remaining, biomass of the worm or amphipod following exposure, whereas the growth results in weight only reflects the organisms surviving at the end of the test. Additionally, for amphipods, only the reproduction results in numbers of juveniles *per surviving female* was used for the risk evaluation, and the results *per surviving adult* were ignored. It is believed that the juvenile counts per female better reflects the impact of exposure since the organisms introduced at the beginning of the test are not sexed. Therefore, a lack or excess of surviving females could skew reproduction results in juvenile counts per adult, whereas the results normalized to females adjusts the results to make the sample-by-sample comparisons more consistent. Given this rationale, the uncertainty associated with the endpoint selection is not considered significant. The assumption of low uncertainty is also bolstered by the fact that results for multiple endpoints and test organisms were assessed, offering a higher of confidence that the selected endpoints would not result in either overlooking or underestimating impacts.

7.2.2 Reference Envelope

There is some uncertainty with establishing the reference envelope values used to for the final interpretation of site-specific impacts following exposure to canal sediments. This uncertainty is related to the elimination of reference sample data from Station 326 prior to establishing the reference envelope values. After reviewing all reference sample results, the elimination of Sample 326 was determined to be appropriate based on it exhibiting the following characteristics:

- Poor bioassay results—more severe impacts, particularly for amphipods, than other reference samples
- Screening value exceedances—highest frequency of NYSDEC metal criteria exceedances, including the only reference sample occurrence with some SEL exceedances
- Location relative to canal—closest reference sample to the canal, with highest likelihood of canal contamination influences

Based on these factors, there is most likely less uncertainty with the reference envelope values that there would be with the inclusion of Sample 326.

7.2.3 Test Failures

The amphipod (*L. plumulosus*) tests were run three times. The control survival was below test acceptability criteria for the first two attempts, suggesting the health of the test organisms might have been compromised. Therefore, data from the first two test runs were considered invalid and were not used in the ERA. Control survival and all other test acceptability criteria for the control were met with the third test run, and the results discussed in this report reflect the third and final execution of the amphipod test. Since a completely new and different test organism population was used to perform the third test run, and the control results meet the test acceptability criteria as dictated by the protocol, there is low uncertainty associated with the outcome of the final amphipod bioassay. The viability of the test outcomes is further substantiated by the outcome of the polychaete test, whose results were in general agreement with the results of the amphipod tests.

7.3 Food Web Model

7.3.1 Total PCBs

For sediment-associated PCBs, not all sediment samples were analyzed for PCB congeners, but all samples were analyzed for Aroclors. Therefore, the more comprehensive Aroclor-based data set was used in the food web assessment for estimating black duck total PCB exposures. There is some uncertainty associated with the derivation of exposure point concentrations from Aroclors and not congeners. There are 209 individual PCB congeners (compounds), but there are nine Aroclors (Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268). Aroclor names reflect the percent chlorine (by weight) of the mixture (e.g., Aroclor 1242 is 42 percent chlorine by weight), with the more chlorinated mixtures generally being the most persistent and toxic. Aroclors consist of a mixture of PCB congeners. Since not all congeners are represented in Aroclor mixtures, congener-specific data offers a more comprehensive representation of the total PCB concentrations in a medium. However, not all congeners represent a significant risk to ecological receptors. The Aroclor mixtures that were analyzed include the most persistent and toxic. Therefore, an Aroclor-based EPC estimate is considered adequate and appropriate for assessing potential exposures and risks. Therefore, this uncertainty is considered low.

7.3.2 Aquatic Plant Bioaccumulation

Constituent concentrations in aquatic food items (aquatic plants) were estimated via multiplying measured sediment concentrations by BCFs and were not directly measured in actual tissue (food). Therefore, the use of generic, literature-derived BCFs introduces some uncertainty into the resulting estimates. The values selected and methodology employed was intended to provide a reasonable estimate of potential food web exposure concentrations with a potential for over and not under estimation. Therefore, this uncertainty is considered low.

7.3.3 Receptor Selection and Assumptions

There is some uncertainty associated with the receptors selected for the food web exposure assessment. Due to the urbanized setting and structure of the canal and surrounding area, only a limited number of upper trophic level receptors are expected to utilize this aquatic habitat. Therefore, it was assumed that the species most representative of the range of potential feeding groups using the canal included the green heron (omnivore), double-crested cormorant (piscivore), and black duck (herbivore). There is some uncertainty associated with the exclusion of mammalian receptors, and it may be possible for a mammalian receptor to opportunistically forage within the canal. However, because of limitations in habitat and access to the site, the potential for mammalian receptors to be exposed to this site is considered low.

7.3.4 Area Use Factors

AUFs were assumed to equal 1. This is a conservative assumption since a significant percentage of each upper trophic level receptor species' time is expected to be spent foraging outside the canal system unimpacted areas, where constituent concentrations could be significantly lower. Therefore, assuming 100 percent of food and potential exposure is derived from the canal in the ERA, though providing a baseline estimate of risk, is likely to overestimate actual risk.

7.3.5 Black Duck and Sediment TEQs

2,3,7,8-TCDD TEQs were calculated for all dioxin-like PCB congeners in tissue samples (fish and crab) and the heron and cormorant exposure estimates. However, TEQs were not calculated for black duck because of the lack of congener data for some sediment samples and the decision to use Aroclor-based data for assessment of PCB exposures from sediment, and because additional bioaccumulation information (e.g., dioxin-like congener-specific biota-sediment accumulation factors [BSAFs]) would have been needed to estimate accumulation in tissue. The BSAFs would add another layer of uncertainty. Black duck exposure to total PCBs, which included dioxin-like congeners, is being evaluated via incidental sediment ingestion and plant consumption. Furthermore, PCB uptake into herbivorous black duck is less significant than that for heron and cormorant, which eat organisms that are mobile (exposed to more areas of contamination) and interact more with sediment (live and forage within it). Therefore, the inclusion of a TEQ and total PCB food web exposure assessment is most appropriate for heron and cormorant. Based on this information, the lack of the TEQs analysis for black duck is considered a low uncertainty.

7.3.6 Wildlife Toxicity Reference Value Selection

Data on the toxicity of some constituents to the upper-trophic-level receptor species were sparse or lacking, requiring the extrapolation of data from other wildlife species or from laboratory studies with nonwildlife species. This is a typical limitation and extrapolation for ERAs because so few wildlife species have been tested directly for most constituents. The uncertainties associated with toxicity extrapolation were minimized by selecting the most appropriate test species for which suitable toxicity data were available. The factors considered in selecting a test species to represent a receptor species included taxonomic relatedness, trophic level, foraging method, and similarity of diet.

A second uncertainty related to the derivation of TRVs applies to metals. Most of the toxicological studies on which the ingestion screening values for metals were based used forms of the metal (such as salts) that have high water solubility and high bioavailability to receptors. Because the analytical data on which site-specific exposure estimates were based were for total metals, regardless of form, and the highly bioavailable forms are expected to compose only a fraction of the total metal concentrations, this is likely to result in an overestimation of potential risks for these constituents.

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SECTION 8

Risk Summary and Conclusions

This report presents the results of a combined Screening-Level Ecological Risk Assessment (SLERA) and Baseline Ecological Risk Assessment (BERA) for the Gowanus Canal Superfund Site, Brooklyn, New York. The combined SLERA and BERA completes Steps 1 and 7 of the eight-step Ecological Risk Assessment (ERA) process as described in the USEPA (1997) ERAGS and its updates. All steps of the ERA were conducted in accordance with applicable USEPA (1997) guidance.

Based on consideration of onsite habitat and biota, site-related and non-site-related chemical sources, chemical fate and transport, and ecological receptor exposure pathways, the survival and reproduction of following receptor groups were selected for evaluation in the ERA:

- Benthic (sediment)-dwelling macroinvertebrate communities;
- Water-column-dwelling aquatic life communities; and
- Avian wildlife (aquatic herbivores, aquatic omnivores, and aquatic piscivores).

The following summarizes the key investigation methods and findings and conclusions for each receptor group.

8.1 Benthic Macroinvertebrate Communities

Risks to benthic macroinvertebrate communities were evaluated primarily through the use of laboratory-based sediment bioassays, which were conducted with two sediment-dwelling invertebrates (amphipods and polychaetes), and through the comparison of sediment chemical concentrations to literature-based screening benchmarks. The overall spatial patterns of risk are shown in Figure 6-6. The analyses indicate the following:

- Sediment bioassays indicate a site-related potential for adverse effects to benthic communities from the presence of chemicals in sediment throughout the length of the canal, with the greatest potential for adverse effects occurring in the central portion of the canal. The bioassay results also indicate the potential for less severe, but site-related, adverse effects to the benthic community at several other locations scattered throughout the canal.

- Chemical analysis indicates the presence of organic chemicals (primarily PAHs and PCBs) and metals in sediment at concentrations that are likely to be causing the adverse effects observed in the sediment bioassays. The highest concentrations of those chemicals were detected primarily in the central portion of the canal, which coincides with the locations where the most severe effects to the sediment bioassay organisms were also observed.

- PAHs were consistently detected in sediment at the highest concentrations relative to their ecological screening benchmarks and are considered to represent the greatest site-related risk to the benthic community. Other chemicals, most notably PCBs and several metals (barium, cadmium, copper, lead, mercury, nickel, and silver), were also detected at concentrations above their ecological screening benchmarks and at concentrations above those detected in offsite sediments, and are also considered to represent a potential site-related risk to the benthic community.

8.2 Water-Column-Dwelling Aquatic Life Communities

Risks to water-column-dwelling aquatic life communities were evaluated primarily through the comparison of surface water chemical concentrations, which were sampled both during dry-weather and wet-weather (while CSO outfalls were discharging) periods, to literature-based screening benchmarks. Chemical concentrations in surface water indicate very little site-related potential for adverse effects to water-column-dwelling aquatic life. The analyses indicate the following:

- In surface water collected during the dry period, no chemicals were detected at concentrations that could adversely affect aquatic life.
- In surface water collected during the wet period, only lead was detected at a concentration exceeding its ecological screening benchmark and at a concentration above that detected in offsite surface water, indicating it represents a site-related risk to aquatic life.

8.3 Wildlife (Avian Aquatic Herbivores, Omnivores, and Piscivores)

Risks to avian aquatic wildlife were evaluated by modeling the potential exposure of these receptors to chemicals ingested in prey (fish and crabs) and via the ingestion of sediment. The analyses indicate the following:

- There is a potential risk to aquatic herbivores (represented by black duck) from exposure to PAHs. PAHs were detected onsite (in sediments) at concentrations above those detected in offsite locations and represent a site-related risk to aquatic herbivores.
- There is a potential risk to avian omnivores (represented by heron) from exposure to mercury and selenium. However, mercury was the only metal that was frequently detected at elevated concentrations in fish and crab tissues, and that was also detected onsite (in sediments) at concentrations above those detected in offsite locations, and thus represents a site-related risk to avian omnivores.
- There is no potential risk indicated to avian piscivores (represented by double-crested cormorant) from the ingestion of fish in the canal.

SECTION 9

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