Gowanus Canal
Natural Resource Damage Assessment Plan

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Gowanus Canal Natural Resource Damage Assessment Trustee Council:
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Gowanus Canal: National Oceanic and Atmospheric Administration
American Black Duck: U.S. Fish and Wildlife Service
Mummichog: U.S. Geological Survey
Double crested cormorant: National Oceanic and Atmospheric Administration

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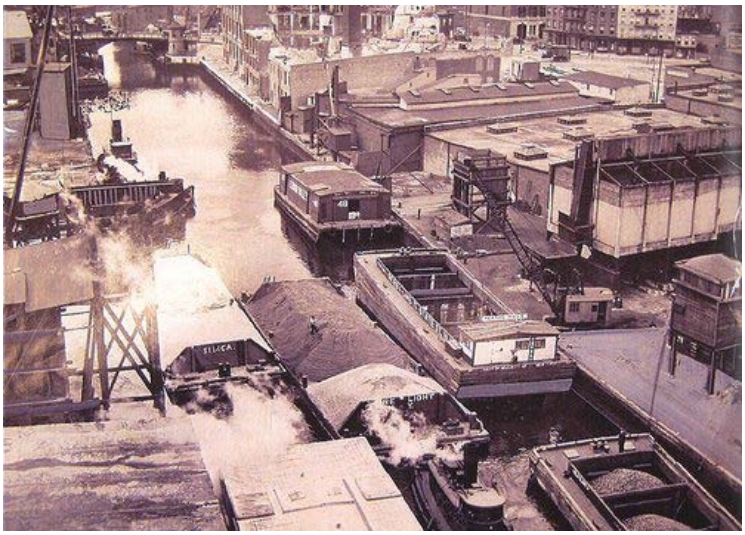
List of Acronyms

BERA	Baseline Ecological Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COCs	contaminants of concern
CSOs	combined sewer overflows
DMP	data management plan
DOI	U.S. Department of the Interior
EPA	U.S. Environmental Protection Agency
FCAs	Fish Consumption Advisories
FWS	U.S. Fish and Wildlife Service
HQ	hazard quotient
LOAEL	lowest observed adverse effect level
MGP	manufactured gas plant
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observed adverse effect level
NAPL	non-aqueous phase liquid
NRDA	Natural Resource Damage Assessment
NYSDEC	New York State Department of Environmental Conservation
OU	Operable Unit
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PEL	probable effects level
PI	principal investigator
ppb	parts per billion
ppm	parts per million

PRPs	potentially responsible parties
QA	Quality Assurance
QAP	Quality Assurance Plan
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAO	Remedial action and objective
RCDP	Restoration and Compensation Determination Plan
RI	Remedial Investigation
ROD	Record of Decision
SGV	Sediment Guidance Value
SQG	sediment quality guideline
TOC	total organic carbon
TRV	toxicity reference value

Executive Summary



The Gowanus Canal circa the 1940s. Photo courtesy of Brooklyn Public Library, Brooklyn Eagle.

Gowanus Canal is a 1.8-mile-long canal built in the mid-1800s in the Borough of Brooklyn of New York City, New York that feeds into the Upper New York Bay. Throughout the course of its complex history of industrialization, the waterway has experienced various degrees of contamination as a result of discharges from adjacent facilities, maritime activities, sewers and surface runoff from surrounding urban communities, and disturbances caused by dredging and channelization. Due to the nature and extent of the contamination, the United States Environmental Protection Agency added Gowanus Canal to the National Priorities List in 2010, making it a Superfund Site subject to investigation and remediation. While remediation of Gowanus Canal is beneficial, it does not compensate the public for past, present, or future injuries to natural resources and resource services related to releases of oil or hazardous substances.

Acting under their authority as natural resource trustees under the 1980 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the National Oceanic and Atmospheric Administration (NOAA), the New York State Department of Environmental Conservation (NYSDEC), and the United States Department of the Interior represented by the U.S. Fish and Wildlife Service (FWS), collectively the Trustees, are conducting a natural resource damage assessment (NRDA) for Gowanus Canal. The Trustees will seek damages with the goal of restoring injured natural resources and resource services resulting from releases of oil or hazardous substances and compensating the public for interim losses (i.e., losses resulting from natural resource injuries from when the injury occurred until resources have returned to their baseline condition). Damages (e.g., money) collected by the Trustees from parties potentially responsible for the contamination (referred to as potentially responsible parties or PRPs) will be used to plan, implement, and monitor restoration projects. This Gowanus Canal Natural Resource Damage Assessment Plan (Plan) describes the Trustees' proposed approach to conducting the NRDA, summarizes existing data, and outlines potential analyses and studies that may be used to evaluate contaminants and their effects on Gowanus Canal natural resources and resource services. Throughout this process, the Trustees will communicate and coordinate with relevant federal and state agencies and the public to ensure that the assessment is conducted in a systematic manner and at a reasonable cost.

This Plan focuses on ecological resources in Gowanus Canal including sediment, surface water, and biological resources such as invertebrates, fish, birds, and aquatic-dependent mammals. This

Plan also focuses on the ecological (e.g., food web) and human services (e.g., recreational opportunities, community connections) provided by these resources. To determine injury to natural resources, the Trustees will first document the pathway of contaminants from their release to natural resource exposure. The Trustees will review existing information on contaminant releases into Gowanus Canal, including direct discharges, leaks and spills, operations from adjacent industrial facilities, and wastewater from combined sewer overflows. Building on existing information, the Trustees will demonstrate that injury to natural resources has occurred or is likely to have occurred. Current lines of evidence include contaminant concentrations in exceedance of regulatory criteria or literature-based adverse effects thresholds, results of site-specific toxicity tests, and consumption advisories. Additional research and analysis of existing information, as well as primary studies, may be conducted to further determine injury to natural resources within Gowanus Canal.

Once injury to natural resources has been determined, quantification of that injury is undertaken to establish a basis for scaling restoration and quantifying damages. The Trustees will adhere to the NRDA regulations for assessing ecological and human use losses (43 CFR § 11.83).

- **Ecological**: The Trustees anticipate quantifying ecological service losses to representative biological resources. Assessed resources may include benthic organisms, fish, birds, and/or aquatic-dependent mammals that utilize intertidal or subtidal habitats in Gowanus Canal. For each species group in each habitat, ecological injury quantification would focus on toxicological effect endpoints that are considered the most biologically relevant (i.e., endpoints that most directly reflect a resource's ability to function and provide services) such as growth, reproduction, and survival. The Trustees plan to identify the area of habitat over which the injury has occurred in the past and is expected to occur in the future. The damages required to compensate for ecological injuries may be determined using equivalency analyses to scale restoration projects such that sufficient ecological benefit is provided to compensate for losses. Damages would be calculated based on the cost of implementing that restoration.

Three-spine stickleback. Photo courtesy of the Fish and Wildlife Service.

- **Human Use**: Recreational and other potential losses would be quantified based on the nature and extent of lost services. Damages may result from reduced use of the resources or a diminished recreational experience due to the presence of contaminants in Gowanus Canal. The Trustees plan to evaluate whether existing data on angler effort and relevant economic values are adequate to conduct a benefit transfer analysis of recreational fishing and crabbing damages. The Trustees plan to consider evaluating additional potential sources of recreational use losses including boating, birding, and wildlife observation, as well as other potential losses related to weakened community connections to Gowanus Canal

Juvenile tautog. Photo courtesy of NOAA.

due to the presence of contaminants. These connections may include other forms of interaction with Gowanus Canal resources by nearby residents.

To determine and quantify natural resource injuries, the Trustees plan to maximize the use of existing data, conduct analyses, identify data gaps and, if warranted, conduct primary studies. This Plan identifies potential types of studies that may be implemented. If conducted, these studies would inform injury determination and quantification, determination of damages, and identification and scaling of restoration projects. The Trustees recognize that additional or alternative study types not identified in this Plan may become necessary and therefore be conducted as the assessment proceeds and new information becomes available. Any significant modification to the Plan would be made available for public review. The mention of a study type within this Plan does not guarantee that it will be undertaken because the Trustees may determine that some of these efforts are not needed or have lower priority. Planning documents for each implemented study will contain appropriate quality assurance and quality control procedures to ensure that data are of sufficient quality to support Trustee decisions in the context of the NRDA process.

This Plan will be made available to the public at the following websites for public comment through **April 15, 2024**. The Trustees will review, respond to, and incorporate public comments into the Final Assessment Plan as applicable. Public comments and Trustee responses will be attached to the Final Assessment Plan, which also will be made publicly available.

An electronic copy of this Plan is available at:

U.S. Fish and Wildlife Service website
https://www.fws.gov/media/gowanus-canal-nrda

NOAA website
https://www.diver.orr.noaa.gov/web/guest/diver-admin-record?diverWorkspaceSiteId=6834

NYSDEC website
https://dec.ny.gov/regulatory/nrd/major-ongoing-nrd-assessments

A hard copy of the Plan is also available at the following locations:

Brooklyn Public Library
Park Slope Branch
431 6th Avenue
Brooklyn, NY 11215
Tel: (718) 832-1853

NYS Department of Environmental Conservation - Region 2
4740 21st Street
Long Island City, NY 11101
Tel: (718) 482-4900

Comments can be sent to:

NYS Department of Environmental Conservation
Natural Resource Damages Section
c/o Alicia Pasos
625 Broadway, 14th Floor
Albany, NY 12233
E-mail: nrd@dec.ny.gov

CHAPTER 1 | Introduction

Gowanus Canal is a 1.8-mile-long, human-made canal in the Borough of Brooklyn of New York City, New York that feeds into the Gowanus Bay in Upper New York Bay (Exhibit 1-1). With a complex history of industrialization dating back to Gowanus Canal's construction in the mid-1800s, the waterway has been contaminated by a suite of oil and hazardous substances (contaminants; see Section 3.1). These contaminants, including organic pollutants and metals, were released from industrial activities at facilities adjacent to Gowanus Canal as well as sewer outfalls (EPA 2013). Natural resources such as surface water, sediment, benthic invertebrates, fish, birds, and mammals have been exposed to these contaminants, resulting in adverse impacts to their health and viability. These impacts have caused a loss in both the ecological and human use services (i.e., functions) that Gowanus Canal's resources would otherwise provide. Due to the nature and extent of the contamination, the United States Environmental Protection Agency (EPA) added Gowanus Canal to the National Priorities List in 2010, making it a Superfund Site subject to remedial actions (i.e., cleanup; EPA 2023). While remediation of Gowanus Canal is beneficial, it does not compensate the public for past, present, and future contaminant-related injuries to natural resources and resource services.

Acting under their authority as natural resource trustees under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Department of Commerce, acting through the National Oceanic and Atmospheric Administration (NOAA), the New York State Department of Environmental Conservation (NYSDEC), and the United States Department of the Interior (DOI), acting through the United States Fish and Wildlife Service (FWS), collectively the Trustees, are conducting a Natural Resource Damage Assessment (NRDA) for Gowanus Canal. This document describes the Trustees' approach to conducting the NRDA, summarizes existing data, and outlines proposed analyses and studies that the Trustees may undertake to evaluate contaminants related to releases of hazardous substances and oil in Gowanus Canal and their effects on natural resources and resource services.

WHAT IS NRDA?

A Natural Resource Damage Assessment is a regulatory process to determine the appropriate amount and type of restoration and/or dollars needed to compensate the public for injuries to natural resources resulting from the release of hazardous substances or oil into the environment.

Exhibit 1-1: Map of Gowanus Canal

1.1 Purpose and Overview of the Assessment Plan

The Trustees developed this Assessment Plan (Plan) to describe their proposed approach to determining and quantifying injury to natural resources and corresponding damages pursuant to CERCLA NRDA regulations (42 USC § 9601 et seq., 43 CFR Part 11). The Plan will:

- Ensure efforts are conducted in a systematic manner and at a reasonable cost[1] as required by CERCLA and other applicable federal and state laws.
- Create a comprehensive strategy for assessing natural resource injury and determining damages.
- Facilitate coordination between the Trustees and the public, including a public comment period for this Plan.
- Assist with coordination between Trustee NRDA efforts and EPA's remedial process.

This Plan may be modified as additional information becomes available. Any significant modification to the Plan will be made available for public review for a period of 45 days (43 CFR § 11.32(e)(2)(i)).

WHAT IS INJURY?

In NRDA, injury refers to a decrease in a natural resource's ability to provide service due to contamination. Examples include, but are not limited to:

- Lower nesting success in birds,
- Contaminant concentrations in groundwater exceeding drinking water thresholds,
- Wetlands unable to support vegetation and biota, and
- Decreased quality of fishing experience due to consumption advisories

Regulatory definition at 43 CFR § 11.14(v)

WHAT ARE SERVICES?

Natural resource services are the physical and biological functions performed by the natural resources including the human uses of those functions.

Regulatory definition at 43 CRF § 11.14(nn)

WHAT ARE DAMAGES?

In NRDA, damages refer to the amount of money needed to restore resources to their baseline condition (i.e., condition without contamination) and compensate for interim losses. Trustees seek these monies from parties responsible for contamination.

Regulatory definition at 43 CRF § 11.14(l)

1.2 History of Gowanus Canal

Gowanus Canal and the adjacent area were once part of Gowanus Creek (Exhibit 1-2), a brackish tidal creek and tributaries surrounded by lowland marshes and meadows. Before the mid-1840s, the creek and its tributaries were dammed and used primarily to power tide mills (Hunter Research et al. 2014 as referenced in HDR et al. 2011). By the mid-1840s, a combination of rapid growth in Brooklyn and the residential and commercial expansion in the neighboring areas

[1] Reasonable cost means the amount that may be recovered for the cost of performing a damage assessment. Costs are reasonable when: the Injury Determination, Quantification, and Damage Determination phases have a well-defined relationship to one another and are coordinated; the anticipated increment of extra benefits in terms of the precision or accuracy of estimates obtained by using a more costly injury, quantification, or damage determination methodology are greater than the anticipated increment of extra costs of that methodology; and the anticipated cost of the assessment is expected to be less than the anticipated damage amount determined in the Injury, Quantification, and Damage Determination phases (43 CFR § 11.14 (ee)).

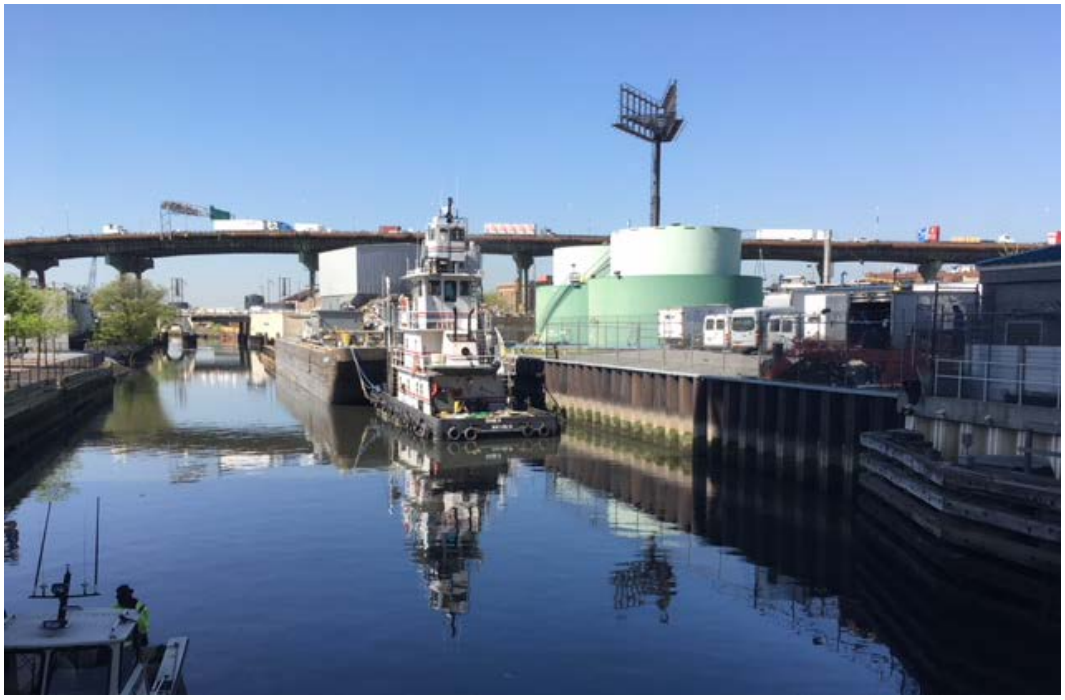
called for the establishment of navigational and docking facilities. In 1848, the State of New York authorized the construction of Gowanus Canal and filling of the adjacent lowlands, which was completed around 1868, to open an area to barge traffic and receive flushed away sewage and stormwater (HDR et al. 2011). What followed was rapid industrial development with maritime and commercial activity bolstering the construction of factories and formation of residential communities. Gowanus Canal quickly became one of the nation's busiest industrial waterways that provided services to many industries such as manufactured gas plants (MGPs), coal yards, cement manufacturers, tanneries, paint and ink factories, machine shops, chemical plants, and oil refineries. These industrial facilities and the expansion of the surrounding residential communities produced large quantities of waste and sewage ultimately discharged into Gowanus Canal along with stormwater runoff (EPA 2013).

Exhibit 1-2: Historical Map of Area that Was Previously Gowanus Creek and is Currently Gowanus Canal (1766-1767)

Courtesy of New York Public Library.

In 1911, the City of New York constructed and operated the Gowanus Flushing Tunnel system[2] to address serious water quality issues in Gowanus Canal by improving circulation, flushing aerated water from Upper New York Bay into the canal (NYCLPC 2019). The goal was to create conditions necessary to sustain marine life, improving parameters such as dissolved oxygen. Today, the tunnel system pumps more than 250 million gallons of water from Buttermilk Channel into Gowanus Canal each day (Exhibit 1-1; NYCLPC 2019).

Due to high levels of contamination, Gowanus Canal was placed on the EPA's National Priorities List of hazardous waste sites in 2010, becoming a Superfund site subject to remedial investigation and clean up. The EPA, in coordination with the City of New York and National Grid (two of the parties potentially responsible for the contamination (potentially responsible parties, or PRPs), led the Remedial Investigation (RI) to evaluate the nature and extent of the contamination as well as identify and select appropriate cleanup actions through a Feasibility Study. In 2013, EPA released a Record of Decision (ROD) that outlines EPA's cleanup plan and illustrates the basis for EPA's selection of remedy for contaminated sediments and source controls at Gowanus Canal. Cleanup activities, including dredging approximately 300,000 cubic yards of contaminated sediment, capping and in-situ stabilization of native sediments, and controlling combined sewer overflows (CSOs), began in 2020 and are anticipated to continue past 2025 (Exhibit 1-3; EPA 2023). In addition, Gowanus Canal and some of the adjacent upland properties are being investigated as part of the New York State Superfund program. A timeline of major contamination and associated remedial actions is presented in Exhibit 1-3.



The Gowanus Expressway/Hamilton Avenue Bridge crossing over the Gowanus Canal. Photo courtesy of R. DelVecchio.

[2] The system also includes the Pumping Station and the Gate House located on the west side of Gowanus Canal at Douglas Street.

Exhibit 1-3: Timeline of Example Major Contamination & Remediation Events at Gowanus Canal

Year	Event
1868	Construction of Gowanus Canal completed.
Early 1870s	Completion of 4th Street turning basin and 5th Street turning basin.
Late 1870s	Municipal sewage and industrial effluent from MGPs and other facilities, which contained hazardous substances, were discharged into Gowanus Canal.
1911	First operation of Gowanus Canal Flushing Tunnel system.
1953	Filling of 5th Street turning basin.
1976	Oil spill, more than 2.5 million gallons, resulting from an explosion at Patchogue Oil Terminal.
1998	Bayside Fuel Company oil spill, approximately 200 gallons.
2010	Gowanus Canal listed on the EPA's National Priorities List making it a Superfund site.
2011	Remedial Investigation and Feasibility Study as part of the Superfund program began.
2014	EPA released Record of Decision outlining cleanup plan and remedy selection.
2020	Initial phase of dredging in the main channel began to remove over 35,000 cubic yards of contaminated sediments. Work was completed in spring of 2021.
2021	Remediation including in-situ stabilization, dredging, and capping of sediment, began in the upper portion of Gowanus Canal. In-situ stabilization was completed in 2022. The remaining work is anticipated to continue past 2025.

1.3 Trusteeship and Authority

Under federal and state regulations, designated federal and state agencies and tribal governments are authorized to act on behalf of the public as trustees of natural resources. For Gowanus Canal, the Trustees are:

- National Oceanic and Atmospheric Administration,
- New York State Department of Environmental Conservation, and
- U.S. Department of the Interior, U.S. Fish and Wildlife Service.

The legal framework for the Trustees' actions is provided by CERCLA, 42 USC § 9601 et seq.; the Oil Pollution Act of 1990, 33 USC § 2701, et seq.; the Clean Water Act, 33 USC § 1321; the National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300, Subpart G; and Executive Orders 12580 (as amended by Executive Order 13016) and 12777. Under the authority of CERCLA and the Clean Water Act, DOI issued regulations (43 CFR Part 11) to guide Trustees in the assessment of natural resource injuries and damages to restore resources following the release

of hazardous substances or oil[3]. The purpose of these regulations "is to provide standardized and cost-effective procedures for assessing natural resource damages" (43 CFR § 11.11).

Under these legal authorities, natural resource trustees seek damages with the goal of ensuring that the natural resources, as well as the services that would have been provided by injured resources (see Section 2.3) but for the release of hazardous substances and oil into Gowanus Canal, are restored and that the public and environment are made whole for interim losses (i.e., losses resulting from natural resource exposure to contaminants from when the injury occurred until resources have returned to their baseline condition, see Section 1.4). Damages collected by the Trustees from PRPs are used to plan and implement restoration projects. For example, restoration projects may be designed to improve habitat for native biota, create recreational opportunities for the public, and/or create key services that address losses to compensate for injuries attributable to contamination.

1.4 Overview of Natural Resource Damage Assessment

The purpose of a NRDA and the goal of the Trustees is to restore natural resources that have been injured by contaminants to their baseline condition (defined as the condition of the resource that would have existed if the hazardous substances or oil were not released [43 CFR §11.14(e)]) and obtain compensation for public losses pending restoration to that baseline condition. The Trustees are conducting a NRDA consistent with the CERCLA NRDA regulations (43 CFR Part 11).

1.4.1 Determination to Pursue Type B Assessment

Sections 11.34 through 11.36 of 43 CFR set forth two assessment methods: Type A and Type B. Type A assessments rely on a computer model where input parameters related to the site are required, such as mass or volume of the substance released, the duration of the release, the location of the release, air temperature, and wind conditions. Type A assessments are limited to evaluation of relatively minor, short duration discharges or releases. Type B assessments include more comprehensive studies and analyses, such as the collection of additional data to fill information gaps. Type B assessments are typically selected when a contaminant release occurs over a long timeframe, consists of multiple contaminants, or occurs in a complex system that cannot be simplified sufficiently to be modeled by a computer program. Type B assessments allow for a wider range of scientific and economic methodologies to fill data gaps than Type A assessments. The Trustees determined that a Type B assessment is appropriate for assessing injury and damages at Gowanus Canal.

This Plan describes types of information the Trustees expect to gather and the approaches the Trustees plan to apply to conduct the assessment (identified in 43 CFR §§ 11.61, 11.70, and 11.80). Type B assessment steps are described in Section 1.4.2 of this Plan under Assessment Phase. Specific requirements for Type B procedures listed in 43 CFR § 11.31(c) and applied to Gowanus Canal are:

[3] Under the authority of the Oil Pollution Act, NOAA issued regulations (15 CFR Part 990) for the assessment of damages resulting from a discharge or substantial threat of a discharge of oil into or upon the navigable waters of the United States, adjoining shorelines, or the Exclusive Economic Zone. In this case, where both hazardous substances and oil have been released, application of the CERCLA NRDA regulations is appropriate, though the OPA NRDA regulations may also provide useful guidance (15 CFR 990.20(c)).

(1) Confirmation of natural resource exposure to Gowanus Canal-related hazardous substances and oil, described in Sections 3.2 and 3.4.

(2) A Quality Assurance Plan that satisfies the requirements listed in the National Contingency Plan and applicable EPA and FWS guidance for quality control and quality assurance plans, provided in Appendix A; and

(3) The objectives of any testing and sampling for injury or pathway determination, described in Exhibit 5-1.

A Restoration and Compensation Determination Plan (RCDP; see Section 1.4.2) may be developed following the Injury Determination and Quantification phases and would be made available for public review and comment at that time (43 CFR § 11.31 (c)(4)).

1.4.2 Steps in the Natural Resource Damage Assessment Process

The NRDA process includes three distinct phases: Preassessment, Assessment, and Post-assessment. These phases are described generally below.

Preassessment Phase

During the Preassessment Phase, trustees review readily available information and data related to the release of hazardous substances and oil and the potential impacts of those substances on natural resources. The review leads to a determination of whether there is evidence to support claims for natural resource damages against the parties responsible for releasing these substances to the environment. This step also documents the trustees' determination of whether further investigation and assessments are warranted (i.e., that a NRDA could and should be performed). This phase is a prerequisite to conducting a formal assessment. The Trustees determined that a NRDA is warranted in their Preassessment Screen for Gowanus Canal (DOI et al. 2014).

Assessment Phase

Development of an Assessment Plan is often the first step in the Assessment Phase. The second step is implementation of the plan. The various stages of drafting this Plan and conducting the NRDA include:

Assessment Planning. The assessment planning step is encompassed in this Plan but may be amended in the future by the Trustees. This Plan sets forth the methods for determination and quantification of natural resource injury and damages.

Injury Determination. Determination of injury to natural resources under CERCLA NRDA regulations consists of documentation that there is: (1) a pathway for the released hazardous substance or oil from the point of release to a point at which natural resources are exposed to the released substance, and (2) that injury to a natural resource for which a trustee is responsible (e.g., air, surface water, sediment, soil, groundwater, biota) has occurred, as defined in 43 CFR § 11.62. Generally, injury is defined as a measurable adverse change in the chemical or physical quality or viability of a natural resource resulting either directly or indirectly from exposure to a discharge of oil or release of a hazardous substance (43 CFR § 11.14(v)).

Injury Quantification. Once the trustees have determined that a resource(s) has been injured, the scope and scale of the injury is quantified for each resource for which damages will be sought. Quantification can use a wide range of metrics, depending on the injured resource and corresponding lost service (discussed further in Chapter 4). Baseline conditions must be determined and accounted for in this phase of the injury assessment.

Damage Determination. This phase involves determining damages resulting from the release of contaminants based on the information obtained in the injury quantification phase. Damages are defined as the amount of money sought by the natural resource trustee as compensation for injury, destruction, or loss of natural resources (43 CFR § 11.14(l)). Damages can be quantified based on the cost of restoration that is expected to provide the same services as those that were lost, accounting for the interim loss of services (past and future); and/or the monetary value of lost resources and/or services. Damage determination often includes the development of a RCDP, which describes options for achieving the scale of restoration or replacement/acquisition of equivalent resources such that sufficient compensation for injuries is achieved. The RCDP may build upon previous restoration evaluation and implementation efforts.

Early Restoration of Injured Resources. Trustees may identify and potentially implement early restoration opportunities, that is, chances to implement a restoration project before the previous assessment phases have been completed. These opportunities may be time sensitive, or there may be a benefit to early implementation (e.g., restoration of natural resources earlier than may otherwise be achieved). Using available information, trustees may estimate restoration credits for such projects and identify offsets against future tallies of natural resources damages. Such early restoration projects, by definition, take place before completion of the assessment process. Early restoration projects for the Gowanus Canal NRDA could be selected if consistent with the Trustees' restoration preferences (e.g., project type, location) and CERCLA restoration criteria (43 CFR § 11.82(d)).

Post-Assessment Phase

The Post-assessment Phase may include a Report of Assessment if the assessment proceeds to that stage and requires a project-specific Restoration Plan(s). The Report of Assessment describes the results of the Assessment Phase and includes all the documentation supporting the determinations that were made in the Assessment Phase (e.g., the Preassessment Screen Determination; the Assessment Plan and documentation used in the Injury Determination, Quantification, and Damage Determination phases; and the RCDP).

Following recovery of damages, the Trustees may develop a Restoration Plan based on the RCDP (if completed) or previously completed restoration planning documents to more fully develop the restoration alternatives to compensate for natural resource injuries and service losses. Trustees would conduct environmental analyses under the National Environmental Policy Act and other authorities to carry out restoration activities and fulfill the trustees' compliance obligations.

1.4.3 Comparison of Remedy and NRDA

NRDA is a process that occurs *in addition* to the remedial process (cleanup) conducted by regulatory agencies like EPA and New York State. Remedy and NRDA have different goals (Exhibit

1-5). An important step in the remedial process is developing remedial action objectives (RAOs) to guide the cleanup. RAOs are risk-based in that they are developed to protect human health and the environment from unacceptable risk of further harm. Remedies (cleanup actions) are selected based on evaluation criteria that are used to compare remedial alternatives and their expected success in achieving the RAOs. Even after a remedy is complete, some contamination may remain in the environment (even the best efforts and technologies may not be able to remove all of the contamination).

In contrast, the goal of NRDA is to restore injured natural resources to their baseline condition and compensate the public for resource-related losses (Exhibit 1-5). NRDA focuses on ecological functions and human uses of natural resources (not human health). Losses resulting from natural resource exposure to contaminants are calculated over time (i.e., interim losses), including both past losses and, if post-remedy contaminant concentrations remain at levels sufficient to cause injury to natural resources, future losses.

However, there are components of NRDA and remedy that overlap. For example, NRDA-related restoration must account for remedial responses that are completed, underway, or planned. That is, the extent to which remediation returns natural resources and the services they provide to their baseline condition should be considered in the NRDA process. For example, work to remedy a site may partially restore injured natural resources, with NRDA accounting for the remaining injuries persisting into the future even after remedial activities are complete. In addition, remedial actions may cause collateral injury to habitat (e.g., physical disturbance or destruction of habitat). Assessment and restoration of remedy-induced injury is also evaluated within NRDA.

Exhibit 1-5: Overview of Remedy (Cleanup) and NRDA

EPA/New York State – Cleanup/Remedy

- Reduce or eliminate present and future harm to human health and/or the environment from release of a hazardous substance(s)
  - Often directed at the substance itself (e.g., removal via dredging) and the risk of exposure
- May not eliminate current or future natural resource injuries caused by exposure to that substance(s)
- Does not address losses to resources and/or resource uses over time (i.e., past and future)

NRDA Trustees – Restoration

- Restore natural resources injured by releases of hazardous substances or oil to baseline
- Obtain compensation for the public for both lost natural resource functions and the public's lost uses of the resources over time (past, present, and future)
- Account for injuries to natural resources related to remedial activities

1.4.4 Summary of NRDA Activities at the Site

NRDA activities at Gowanus Canal have been going on for several years.

- NYSDEC, NOAA, and FWS signed a Memorandum of Agreement in 2015 to establish a Gowanus Canal Natural Resource Trustee Council. This Memorandum of Agreement presents a framework for the Trustee Council to efficiently plan and implement NRDA and

restoration actions and coordinate Trustee activities with the remedial process (NYSDEC et al. 2015).

- The Trustees conducted a Preassessment Screen in 2014 and determined that: 1) hazardous substances were released into Gowanus Canal and potentially caused injury to natural resources, and 2) existing data and information sufficient to pursue an assessment are readily available or likely to be obtained at a reasonable cost.
- Since 2010, EPA has identified multiple parties who are potentially liable for the contamination of Gowanus Canal. The Trustees have interacted with and will continue to collaborate with willing PRPs to carry out assessment activities and expedite early restoration whenever possible.
- The Trustees are working with EPA to coordinate NRDA-related activities with the remedial process.
- The Trustees drafted this Assessment Plan.

1.5 Use of Existing Information

Consistent with the CERCLA NRDA regulations, which require that the assessment be conducted in a planned, systematic manner and at a reasonable cost (43 CFR § 11.13(c)), the Trustees are prioritizing cost effectiveness in planning and implementing studies. As such, the Trustees plan to review and gather existing data and other information prior to undertaking any new data collection, including data collected as part of remedial and restoration efforts. The existing information and data of sufficient quality would be used and incorporated into the assessment to the extent feasible and would help inform data gaps. Where existing data do not allow for the determination of the nature or extent of injuries, the Trustees may implement studies focused on filling those data gaps. Such studies will be designed and implemented in phases to allow for subsequent adjustments based on initial findings.

1.6 Coordination with Potentially Responsible Parties

Under CERCLA, the parties potentially responsible for contaminant releases may be invited to participate cooperatively in the NRDA and, when appropriate, restoration planning (43 CFR §11.32(a)(2)). The Trustees welcome PRPs' participation and are interested in facilitating cooperative discussions. Cooperative assessments can reduce duplication of effort, expedite the assessment, and accomplish resource restoration earlier than might otherwise be the case. However, the final authority regarding determinations of injury and restoration rests with the Trustees.

1.7 Coordination with the Public

Public participation and review are integral to the assessment planning process and are specifically mentioned in the CERCLA NRDA regulations (e.g., 43 CFR § 11.81(d)(2)). To facilitate public involvement in the planning process for potential assessment activities, the Trustees encourage the public to review and comment on this draft Assessment Plan. The review period is for 45 days (in accordance with 43 CFR § 11.32(c)(1)), from March 1 to April 15, 2024. The Trustees will review, respond to, and incorporate public comments into the Final Assessment Plan as applicable. Public comments and Trustee responses will be attached to the Final Assessment Plan, which also will be made publicly available.

A copy of this document is available for review online at:

U.S. Fish and Wildlife Service website
https://www.fws.gov/media/gowanus-canal-nrda

NOAA website
https://www.diver.orr.noaa.gov/web/guest/diver-admin-record?diverWorkspaceSiteId=6834

NYSDEC website
https://dec.ny.gov/regulatory/nrd/major-ongoing-nrd-assessments

A hard copy of the Plan is also available at the following locations:

Brooklyn Public Library
Park Slope Branch
431 6th Avenue
Brooklyn, NY 11215
Tel: (718) 832-1853

NYS Department of Environmental Conservation - Region 2
4740 21st Street
Long Island City, NY 11101
Tel: (718) 482-4900

Interested parties can obtain a hard copy of this Plan by submitting a written request to:

NYS Department of Environmental Conservation
Natural Resource Damages Section
c/o Alicia Pasos
625 Broadway, 14th Floor
Albany, NY 12233
E-mail: nrd@dec.ny.gov

As the Trustees move forward with this NRDA, there will be additional opportunities for public participation. These opportunities include a review of documents such as significant revisions to this Plan, future study plans, restoration plans, and proposed settlement agreements filed in court, as well as input regarding human uses of and connections to Gowanus Canal – specifically, how those uses and connections have been impacted by contamination and what actions would restore them. The Trustees intend to facilitate communication with the public and provide sufficient notification in advance of these opportunities in an efficient, effective, and inclusive manner.

Pursuant to 43 CFR § 11.91(c), the Trustees are compiling information to plan and conduct the assessment, including this draft Plan, in a publicly available Administrative Record. The Administrative Record will be available online through NOAA's Data Integration, Visualization, Exploration, and Reporting (DIVER) platform at: https://www.diver.orr.noaa.gov/web/guest/diver-admin-record?diverWorkspaceSiteId=6834

1.8 Plan Organization

This remaining chapters in this plan are organized as follows:

- **Chapter 2** – **Natural Resources and Resource Services in the Assessment Area**: This chapter provides an overview of the natural resources in Gowanus Canal, including the geographic scope of the assessment and a summary of Gowanus Canal's natural resources and the services they provide.
- **Chapter 3** – **Injury Determination Approach**: This chapter outlines the potential pathways of contaminants released from operations on or adjacent to Gowanus Canal's natural resources, describes information demonstrating injury to natural resources, and provides an overview of the Trustees' proposed approach to determining injury as a result of these releases.
- **Chapter 4** – **Injury Quantification and Damage Determination Approach**: This chapter discusses the framework for quantifying injury to natural resources and the services they provide (accounting for baseline) and the Trustees' proposed methods for determining damages.
- **Chapter 5** – **NRDA Studies and Analyses**: This chapter discusses the categories and objectives of ongoing data review and analysis efforts in addition to types of potential primary studies.

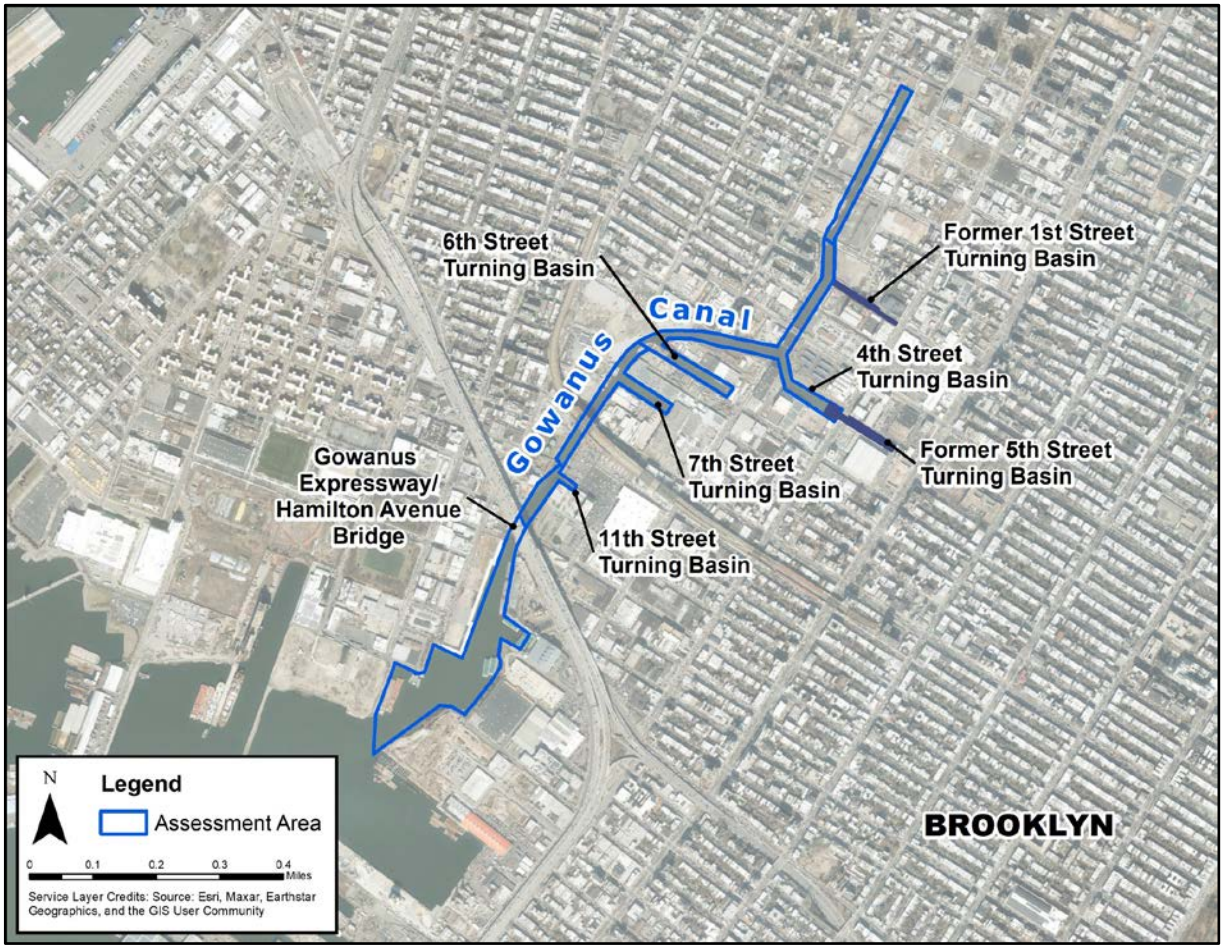
CHAPTER 2 | Natural Resources and Resource Services

The focus of a NRDA is to evaluate and restore the natural resources and resource services that are exposed to and injured by hazardous chemical contaminants and oil. This chapter provides information on the geographic scope within which exposure has likely occurred, the physical and biological characteristics of the area, and the natural resources and types of services those natural resources provide (43 CFR §11.31(a)(2)).

2.1 Geographic Scope

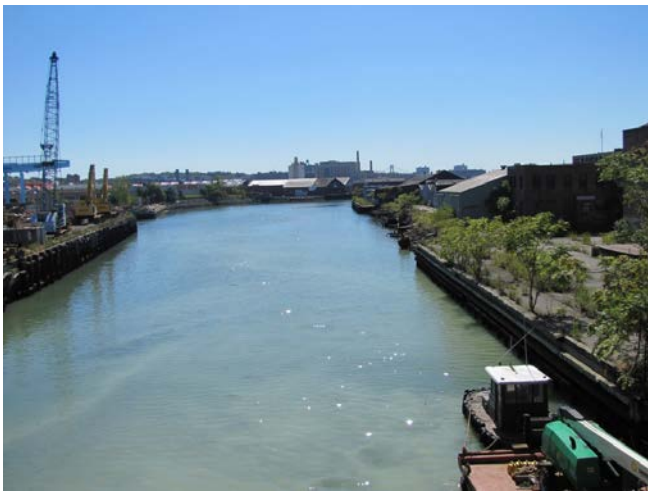
The geographic scope of the Assessment Area is defined as the area within which natural resources have been directly or indirectly affected by industrial and municipal-related oil and hazardous substances in Gowanus Canal (43 CFR § 11.14 (c)). Based on the CERCLA NRDA regulations, the industrial history of Gowanus Canal, the ongoing and proposed remedial actions, and a review of available data, the Trustees have identified the Assessment Area as the aquatic habitat within the entire Gowanus Canal, a total of approximately 32 acres. The size and extent of the Assessment Area are presented in Exhibit 2-1. The Trustees may expand or revise the geographic scope as the assessment progress.

Exhibit 2-1: Assessment Area



2.2 Description of the Assessment Area

Gowanus Canal is a human-made canal constructed in the mid-1800s by dredging an existing tidal creek, filling surrounding wetlands, and reinforcing the new canal banks by bulkheading.[4] It has a width of approximately 100 feet and the main channel has a maximum water depth of 15 feet. South of the Gowanus Expressway/Hamilton Avenue Bridge, Gowanus Canal widens to a maximum width of 2,200 feet and a maximum depth of 35 feet before joining with Gowanus Bay in the Upper New York Bay, just south of the East River. Four short turning basins branch to the east of the main channel and five bridges cross Gowanus Canal running east-west. A navigational channel maintained by the U.S. Army Corps of Engineers and the City of New York extends from Gowanus Bay to the head of Gowanus Canal and encompasses the entire width of Gowanus Canal upstream of the Hamilton Avenue Bridge (Exhibit 2-1; EPA 2013, NYCDEP 2015).



Gowanus Canal as it enters Gowanus Bay. Photo courtesy of NOAA.

As a dead-end waterway, Gowanus Canal receives limited saltwater inputs via twice-daily tidal exchanges with Gowanus Bay and freshwater inflows from the Flushing Tunnel, stormwater discharge, and other outfalls, including approximately 377 million gallons per year from combined sewer overflow (CSO) outfalls (NYCDEP 2008, EPA 2013). Gowanus Canal is underlain by four geologic units – topmost are fill materials associated with Gowanus Canal construction and subsequent industrialization, then alluvial/marsh[5] deposits associated with the native wetland sediment, glacial deposits, and bedrock (EPA 2013). The entire Gowanus Canal is considered a littoral zone, or a "shallow-water habitat that does not include coastal fresh marsh, intertidal[6] marsh or other types of wetland designation" (HDR et al. 2011). Gowanus Canal habitat hosts a variety of benthic invertebrates, small floating plants and animals (plankton), and fish, though it does not support rooted aquatic vegetation (NYCDEP 2008, HDR et al. 2011). The shoreline is composed entirely of bulkheads, riprap,[7] and piers with no remaining natural shoreline or wetlands, thereby limiting the upland habitat adjacent to Gowanus Canal (Exhibit 2-1). Gowanus Canal is also inhabited by a few species of birds and an occasional marine mammal (HDR et al. 2011, Santora 2013).

The sediment within and beneath Gowanus Canal consists of two distinct layers. The upper layer, "soft" sediment, ranges from approximately one foot to greater than 20 feet in thickness and

[4] Bulkheads are human-made barriers between shoreline and water to prevent liquid movement.

[5] Alluvial refers to clay, silt, sand, gravel, or similar detrital material deposited by running water.

[6] The area where the water of Gowanus Canal meets the land between high and low tides.

[7] Riprap is loose stone used to stabilize the shoreline.

generally consists of a dark gray to black mixture of sand, silt, and clay. The soft sediments are underlain by alluvial and marsh deposits of the Gowanus Creek complex that were originally present. These deposits are referred to as "native" sediments in the RI report and include sands, silts, silty sand, sandy clay, clay, and peat (HDR et al. 2011). The structure and characteristics of the sediment can influence the dynamics of contaminant fate and transport. For example, the particle size and organic matter content can affect the ability of the contaminants to adsorb (stick) to the sediment, increasing the contaminant concentrations in the sediment that may lead to higher exposure to certain marine biota.

Photo courtesy of NOAA.

Gowanus Canal is located in a mixed residential-commercial-industrial area, with waterfront properties being primarily commercial and industrial (EPA 2013). The waterway is used by numerous businesses for maritime commerce and by several residents with houseboats (EPA 2013). Upstream of Hamilton Avenue Bridge, NYSDEC designated Gowanus Canal Class SD, that is, appropriate for fishing (NYSDEC 2022). Downstream of Hamilton Avenue Bridge, Gowanus Canal is designated Class I, meaning appropriate for secondary contact recreation (e.g., canoeing and kayaking) and fishing as well as suitable for fish propagation and survival (NYCDEP 2015). Current recreational uses of Gowanus Canal include boating, canoeing, kayaking, swimming, scuba diving, fishing, and crabbing (NYSDOH 2017). However, the NYS Department of Health has issued advisories for fish and crab consumption for the Upper New York Bay, including Gowanus Canal since at least 1981; current advisories range from "Up to 4 meals/month" to "DON'T EAT" depending on the species and demographic group (NYSDOH 2023).

2.3 Natural Resources

Under the CERCLA NRDA regulations, natural resources include land, fish, wildlife, biota, air, water, groundwater, drinking water supplies, and other resources that belong to, are managed by, or held in trust by, appertaining to, or otherwise controlled by the United States, State or local governments, foreign governments, or Indian tribes (43 CFR § 11.14(z)). These resources are organized into five categories: surface water (including sediments), groundwater, air, geological (including soil), and biological resources.

This Plan focuses on the sediment, surface water, and biological resources in the Assessment Area, including both the ecological and human services

Cormorant in Gowanus Canal. Photo courtesy of NOAA.

provided by these resources. Groundwater and air have been exposed to Canal-related contaminants, and the Trustees reserve the right to quantify distinct injuries to these resources at a future time. However, for the purposes of this Plan, the Trustees currently consider air and groundwater as primary pathways of hazardous substances to sediment, surface water, and biological resources.

Three-spine stickleback. Photo courtesy of the Fish and Wildlife Service.

Properly functioning sediment and surface water are essential for a healthy ecosystem and directly and/or indirectly support numerous biological resources. The CERCLA NRDA regulations define biological resources as those natural resources referred to in section 101(16) of CERCLA as fish, wildlife, and other biota including marine and freshwater species, aquatic and terrestrial species, game, nongame, and commercial species, threatened and sensitive species (designated by federal or state law), and other living organisms that are otherwise not listed in the definitions (43 CFR § 11.14(f)). Biological resources exposed or potentially exposed to contaminants released into Gowanus Canal include, but are not limited to, the invertebrates, fish, birds, and mammals that utilize the aquatic habitat in the Assessment Area.

Mummichog. Photo courtesy of NOAA.

The **invertebrate** community in Gowanus Canal is dominated by annelid worms (polychaetes and oligochaetes), as well as amphipods and small mollusks (HDR et al. 2011).

A heron spotted in Gowanus Canal. Photo courtesy of NOAA.

Fish reported in Gowanus Canal include smaller species such as Atlantic tomcod, mummichog, three-spined stickleback, and rock gunnel, as well as larger fish species such as American eel, striped bass, tautog, white perch, and winter flounder (HDR et al. 2011). A broader survey that encompassed both Gowanus Canal and Gowanus Bay also documented Atlantic menhaden, blueback herring, bay anchovy, bluefish, striped bass, winter flounder, weakfish, scup, blennies, killifish, and silver perch (NYCDEP 2008, as cited in HDR et al. 2011). While many of these fish species are migratory or seasonally transient (e.g., striped bass), others are resident and spend their entire lives in Gowanus Canal (e.g., mummichog, tautog; USACE 2005, NYCDEP 2008, HDR et al. 2011).

Muskrat swimming in Gowanus Canal. Photo courtesy of NOAA.

A few species of swimming **birds** such as double crested cormorant and black duck, as well as the occasional wading bird were observed making use of Gowanus Canal's limited shoreline habitat during Phase 3 remedial sampling (HDR et al. 2011).

The few **marine mammals** that have been observed in Gowanus Canal, including a minke whale in 2007 and dolphin in 2013, died soon after arrival (Laforge 2007, Santora 2013, Reidenberg 2014).

Examples of biota that are found within Gowanus Canal are presented in Exhibit 2-2.

Exhibit 2-2: Example Biota Found in Gowanus Canal

Species Type	Common Name	Scientific Name
Invertebrates	Eastern mud snail	*Nassarius obsoletus*
	Flatworm	*Platyhelminthes*
	Gribble	*Limnoria lignorum*
	Roundworm	*Nematoda*
	Blue crab	*Callinectes sapidus*
Fish	American eel	*Anguilla rostrata*
	Atlantic silverside	*Menidia menidia*
	Mackerel	*Scomberomorus sp.*
	Northern puffer	*Sphoeroides maculatus*
	Striped bass	*Morone saxatilis*
	White perch	*Morone americana*
	Winter flounder	*Pseudopleuronectes americanus*
Birds	Black duck	*Anas rubripes*
	Black crowned night heron	*Nycticorax nycticorax*
	Double-crested cormorant	*Phalacrocorax auratus*
	Great blue heron	*Ardea Herodias*
Mammals	Raccoon	*Procyon lotor*
	Eastern red bat	*Lasiurus borealis*

Sources: GEI Consultants, Inc. (2009), HDR, et al. (2011), GCC (2019)

2.4 Natural Resource Services

Natural resource services are the physical and biological functions performed by natural resources, including the human uses of those functions, and reflect the quality of the resource (43 CFR § 11.14 (nn)).

2.4.1 Ecological Services

Each of the natural resources mentioned above provides a variety of ecological services. For example, Gowanus Canal contains sediment that provides nutrients and minerals to the aquatic system and substrate for benthic invertebrates. These invertebrates cycle nutrients, aerate sediment, and feed larger animals. Fish help control prey populations (e.g., algae, insects), comprise parts of the aquatic food web, and contribute to nutrient and energy cycling. Aquatic birds and mammals prey on invertebrates and fish, contribute to nutrient and energy cycles, connect aquatic and terrestrial ecosystems, and serve as pollinators, scavengers, and seed dispersers. These resources have been exposed or are potentially exposed to contaminants in the Assessment Area mainly through contact with contaminated sediment and water and ingestion of contaminated prey.

2.4.2 Human Use Services

In addition to ecological services, Gowanus Canal provides a suite of other services directly and indirectly to the public. These include recreational use as well as non-recreational community activities and connections.

Juvenile tautog in the Gowanus Canal. Photo courtesy of NOAA.

Recreational Use

Gowanus Canal serves as a local recreational resource and can support a variety of recreational activities such as fishing, crabbing, boating, canoeing, kayaking, swimming, and scuba diving. Gowanus Canal also provides public benefits and values to surrounding communities (NYSDOH 2017). Contamination of Gowanus Canal has likely impaired all of these activities to varying degrees. This Plan addresses recreational fishing and crabbing losses; however, the Trustees may consider additional recreational losses as the assessment proceeds.

Non-recreational Community Loss

Even within a highly developed area, Gowanus Canal is a place where people can enjoy being near and feeling connected to a natural environment. For local human communities, Gowanus Canal is not only an industrial waterway important for jobs and the local economy, it is also an essential part of the culture of local neighborhoods where more than a million people live and work (U.S. Census Bureau 2022). For example, some local community groups have used parts of Gowanus Canal for activities associated with educational programs, volunteering events, and community focused initiatives that involved public participation in ecological observations (GCC 2021, 2023). Because of its past and current contaminated state, community enjoyment of and connections to Gowanus Canal may have been diminished and in some cases eliminated altogether.

CHAPTER 3 | Injury Determination Approach

The CERCLA NRDA regulations define natural resource injuries as generally falling into two categories (43 CFR § 11.62). The first establishes injury based on physical, chemical, or biological changes to the resources as a result of contaminant exposure. Examples include changes in an organism's physical development, reproductive success, or survival. The second category establishes injury based on exceedance of regulatory criteria, including state health advisories recommending limits on consumption of contaminated biota. The Trustees plan to evaluate both types of injuries within the Assessment Area.

To determine injury in a planned, systematic manner and at a reasonable cost (43 CFR § 11.30(b)), the Trustees identified parameters on which to focus assessment efforts. The Trustees' proposed approach also emphasizes the use of existing information and identification of data gaps and may include evaluation of potential methods for addressing those data gaps. If studies are determined to be necessary, they may be designed and implemented in phases to allow for subsequent adjustments based on initial findings. The Trustees will consider the relationship between injury and restoration to ensure that the metrics used to assess each type of natural resources are comparable and that restoration will provide resources and resource services of a type and quality that are consistent with what was lost.

This Chapter identifies the hazardous substances that the Trustees plan to focus on in this assessment, confirms exposure, discusses pathways for contaminants to reach natural resources, describes proposed approaches for injury determination for natural resources and their human uses, and summarizes how the Trustees may evaluate the impacts of remediation.

3.1 Hazardous Substances

This Assessment will focus on injuries resulting from exposure to hazardous substances released from past and current industrial activities, as well as discharges from CSOs.[8] There are multiple hazardous substances to which natural resources have been exposed as a result of discharges or releases into Gowanus Canal. These contaminants include, but are not limited to, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), hazardous pesticides, and metals such as lead, mercury, and copper (EPA 2013). Currently, the Trustees plan to focus on total PAHs as the primary contaminant of concern (COC) for assessing ecological injury to natural resources in Gowanus Canal (as an individual contaminant and as part of the contaminant mixture found in Gowanus Canal). This is consistent with EPA's focus on total PAHs when setting preliminary remedial goals in the ROD (EPA 2013). The Trustees may assess injury resulting from natural resource exposure to additional COCs as the NRDA progresses and new information becomes available.

PAHs are compounds that consist of clusters of benzene rings with a variety of substituted groups and are typically of petrogenic (petroleum products) or pyrogenic (incomplete burning of organic matter) origin (Kuzia and Black 1985). Once they enter aquatic environments, PAHs are not very mobile and are typically adsorbed (stuck) to particles that settle into the sediments (Eisler 2000).

[8] Not all sewage discharges from CSOs are considered CERCLA hazardous substances.

They can bioconcentrate[9] in an individual organism as well as biomagnify[10] through food webs, depending on the specific PAH and an organism's ability to absorb, metabolize[11], and excrete PAHs. These compounds can cause a variety of developmental anomalies and tumors in fish and aquatic mammals, as well as other toxicological responses in organisms such as inhibited survival, growth, and reproduction (Eisler 2000).

The following sections indicate that these contaminants are pervasive and persistent in the aquatic environment of Gowanus Canal, and that sufficient information related to Gowanus Canal exists to describe both the extent of the contamination in the Assessment Area and the associated toxicity to natural resources.

3.2 Confirmation of Exposure

A natural resource has been exposed to a hazardous substance or oil if the resource is, or has been, in physical contact with a hazardous substance or oil or with media containing a hazardous substance or oil (43 CFR § 11.14(q), 15 CFR § 990.30). Consistent with 43 CFR § 11.31(c)(1) and § 11.37, this Plan documents that natural resources have been exposed to hazardous substances and/or oil, supporting the Trustees' decision to implement a formal assessment. For example, sediment and surface water samples from Gowanus Canal had detected concentrations of multiple hazardous substances including PAHs. Detection of PAHs in sediment and biological tissues confirms exposure of natural resources in Gowanus Canal to this contaminant and indicates the potential for injury.

3.3 Pathway

An important step in determining injury to natural resources is to establish a pathway from a known release or source of a hazardous substance or oil to exposure of natural resources. Pathway is defined as the route or medium through which a hazardous substance is or was transported from the source of the release to the injured resource (43 CFR §11.14(dd)). The main pathways of contaminants to Gowanus Canal include direct discharge to surface water and migration through soil and groundwater from point sources (e.g., CSOs, contaminated sites) and non-point sources (e.g., surface water runoff). In Gowanus Canal, contaminants initially collect in the sediments and organisms are exposed through biological uptake directly from sediments or surface water, or by consuming contaminated organisms that were exposed to contaminated sediment or surface water. A conceptual site model of major pathways is presented in Exhibit 3-1.

3.3.1 Direct Discharge

Industrial and municipal activities have in the past and continue to directly discharge waste into Gowanus Canal. For example, in 1976, over 2.5 million gallons of oil, which contains PAHs, spilled into Gowanus Canal as a result of an explosion at the Patchogue Oil Terminal, and in 1998, the

[9] Bioconcentration is the process by which the concentration of a chemical in an organism becomes higher than its concentration in the surrounding water.

[10] Biomagnification is an increased chemical concentration in an organism resulting from ingestion of contaminated prey.

[11] Metabolism is a chemical process in the body of an organism that involves breaking down a substance into smaller units (catabolism) and synthesizing complex substances from smaller units (anabolism).

Bayside Fuel Company spilled approximately 200 gallons of oil into the canal (Exhibit 3-2; The New York Times 1976, NYCDEP 2008). Another source of ongoing PAH contamination is the ten CSOs, which annually discharge 377 million gallons into Gowanus Canal (Exhibit 3-2; NYCDEP 2008). Samples collected from wet weather CSO discharges and residual CSO sediments contained PAHs at concentrations above ecological screening values (HDR et al. 2011). Remedial documents report that contaminated CSO and stormwater solids have accumulated in the upper reach of Gowanus Canal near CSO outfall RH-034, the single largest source of CSO discharges in Gowanus Canal (EPA 2013).

3.3.2 Soil and Groundwater Migration

A major current source of PAHs to Gowanus Canal is discharge of non-aqueous-phase liquid (NAPL) contamination from former MGP sites (Exhibit 3-2). Derived from coal tar waste, NAPL has been detected at high levels in the subsurface soils at all three former MGP facilities to depths of more than 100 feet (EPA 2013). Transport of contaminants into Gowanus Canal occurs primarily by migration of NAPL "through subsurface soils and groundwater discharge of dissolved-phase contaminants" (EPA 2013). Remedial investigations have detected NAPL sheen, coating, staining, and blebs (very fine droplets) in sediment cores throughout Gowanus Canal (HDR et al. 2011). NAPL saturation has been observed in sections of the native and soft sediments at the head of Gowanus Canal and the Gowanus Expressway and in the soft sediments of Gowanus Canal near the Fulton, Metropolitan, and Carroll Gardens/Public Place former MGP sites (HDR et al. 2011). The highest PAH concentrations were detected in samples that also contained NAPL, leading EPA to conclude in the ROD that "NAPL from historic MGP operations accounts for the majority of PAH mass and the highest PAH concentrations in canal sediments" (EPA 2013).

3.3.3 Biological Uptake

Although they are detected in surface water, PAHs typically stick to sediment particles and suspended organic matter that settle to the bed of Gowanus Canal (Eisler 2000). Because of limited tidal exchange and low current velocity, contaminated sediments accumulate in Gowanus Canal with little discharge into Gowanus Bay (EPA 2013). A combination of sediment re-suspension due to vehicle traffic and upward migration of NAPL results in PAH concentrations in the bioactive zone (the top six inches of surface sediment) that are two orders of magnitude higher than concentrations in the reference area (EPA 2013).

Plants and animals are exposed to COCs in the Assessment Area through direct contact with and ingestion of contaminated surface water, sediment, porewater[12], and prey. Because PAHs can accumulate in fatty tissues, higher trophic level organisms such as fish and birds are exposed to PAHs mainly through consumption of contaminated prey (including benthic invertebrates and mollusks), though some additional exposure occurs through direct uptake and incidental ingestion of contaminated water and sediment (Exhibit 3-1).

[12] Water or fluid within the small spaces between particles (i.e., sediments)

Exhibit 3-1: Conceptual Site Model Showing Major Pathways

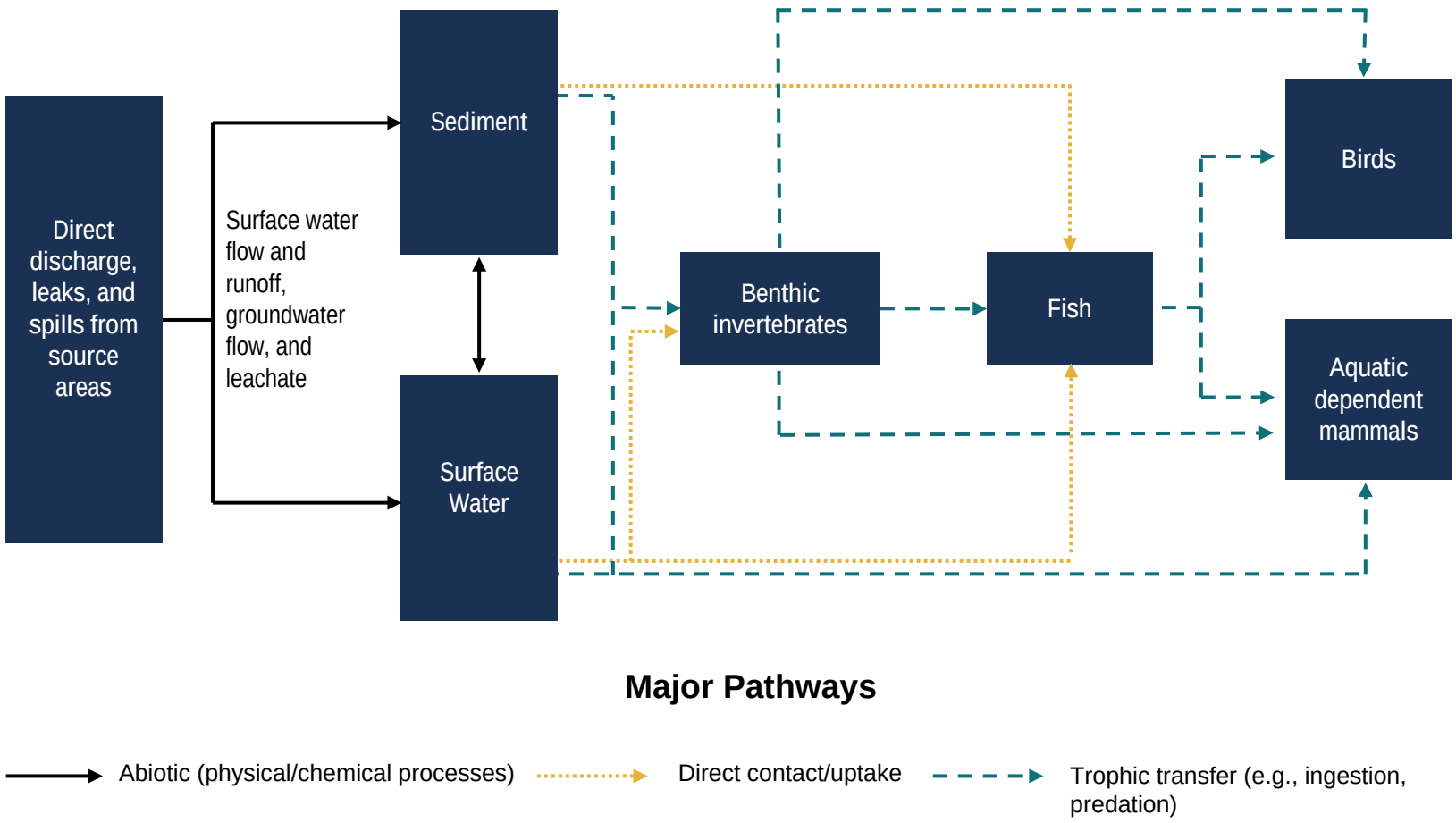
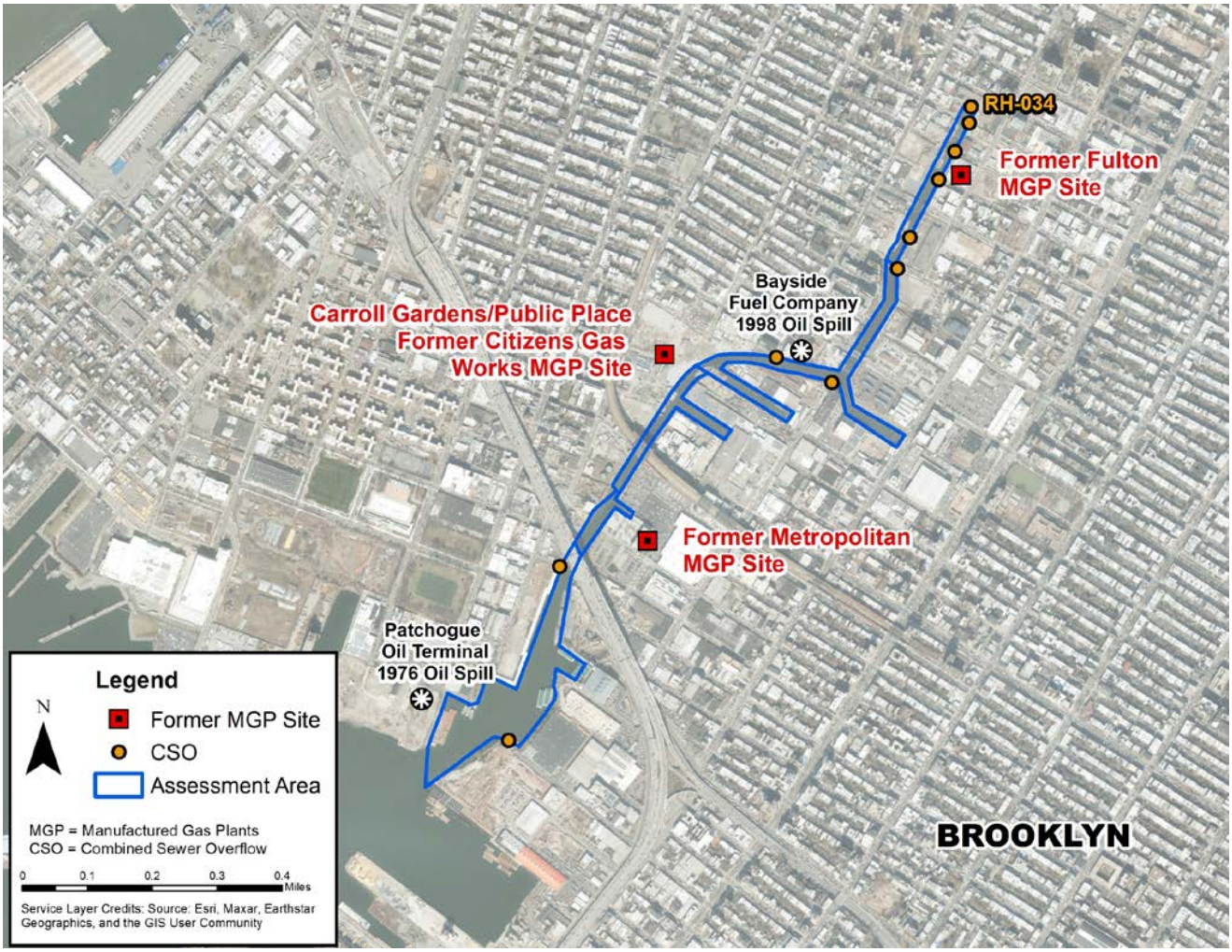


Exhibit 3-2: Former MGP Sites and CSOs at Gowanus Canal



3.4 Injury to Natural Resources

The Trustees have confirmed natural resource exposure to contaminants and identified environmental pathways and will evaluate whether injury to natural resources has occurred. This Plan focuses on assessing injury to biological resources that utilize the Assessment Area, including:

- Injury to sediment (categorized as a surface water resource (43 CFR 11.14(pp)) based on adverse impacts to biota exposed to contamination in the sediment;
- Injury to animals based on the toxic effects of contaminants; and
- Injury to surface water, sediment, and animals based on exceedances of regulatory criteria or the existence of consumption advisories.

3.4.1 Surface Water Resources (including Sediment)

An injury to surface water, including sediment, has resulted from the release of a hazardous substance or oil if, for example:

- Concentrations of hazardous substances or oil in surface water exceed applicable federal or state regulatory water quality criteria (e.g., established under section 304(a)(1) of the Clean Water Act).
- Concentrations and duration of hazardous substances measured in suspended sediments, or bed, bank, or shoreline sediments are sufficient to have caused injury to biological resources (43 CFR § 11.62(b)(1)(v)).

The Trustees intend to use existing data, as well as any additional data collected as part of the assessment, to determine: 1) whether concentrations of COCs in surface water or sediments exceed applicable water quality or sediment quality criteria or guidelines, and 2) whether COC concentrations in Assessment Area sediment are sufficient to injure biological resources, as described in Section 3.4.2. Other studies or analyses to further determine injury to sediment may be developed as necessary (see Chapter 5).

Initial review of concentration data from surface sediment samples collected by EPA as part of the Remedial Investigation (HDR et al. 2011) demonstrates that sediment contaminant concentrations are higher than relevant sediment quality guidelines (SQGs; Exhibit 3-3). For example, the average total PAHs concentration in Gowanus Canal sediments sampled during the RI was 527 parts per million (ppm), which is more than an order of magnitude greater than the total PAHs Probable Effects Level (PEL; 16.77 ppm) and NYSDEC Sediment Guidance Value (SGV) of 45 ppm (MacDonald et al. 1996, HDR et al. 2011, NYSDEC 2014). The PEL is the contaminant concentration above which adverse biological effects frequently occur (e.g., reduced growth, reproduction, and survival; MacDonald et al. 1996), and the SGVs are levels above which sediments are considered to be highly contaminated and likely to pose a risk to aquatic life (NYSDEC 2014).

Exhibit 3-3: Concentrations of PAHs and Other Contaminants in Gowanus Canal Surface Sediment

Contaminant	Concentration Range (ppm)	Average (ppm)	PEL (ppm)	SGV Class C (ppm)
Total PAHs	10.9 - 8,000	527	16.77	45
DDT	0.008 – 1.1	0.235	0.0517	5.7
Total PCBs	0.230 – 3.4	0.432	0.189	1
Copper	85.8 - 790	226	108	270
Lead	146 – 4,220	533	112	220
Mercury	0.59 - 2.30	1.27	0.7	0.71

Notes:
1. ppm = parts per million
2. PEL = Probable Effects Level (MacDonald et al. 1996)
3. SGV Class C = Sediment Guidance Value. Class C is the level above which sediments are considered to be highly contaminated and likely to pose a risk to aquatic life (NYSDEC 2014).
4. PAHs = polycyclic aromatic hydrocarbons, DDT = dichlorodiphenyltrichloroethane, PCBs = polychlorinated biphenyls

Source: HDR et al. (2011).

Gowanus Flushing Tunnel Pumping Station and Gate House. Photo courtesy of R. DelVecchio.

3.4.2 Biological Resources

Injury to biological resources has resulted from the release of a hazardous substance or oil if the concentration of the substance:

- Is sufficient to cause adverse changes to the biological resource or its offspring;
- In edible portions of the organisms exceeds action or tolerance levels established under section 401 of the Food, Drug, and Cosmetic Act (21 U.S.C 342); or
- Exceeds levels set by state health agencies for consumption (43 CFR § 11.62(f)(1)).

Therefore, injury to biological resources can be assessed through documented site-specific toxicity, exceedances of toxic effects or tolerance thresholds, or the existence of a consumption advisory.

Information available for resources within the Assessment Area suggests that benthic invertebrates, fish, and birds have likely been injured due to the release of COCs. Information demonstrating injury or the potential for injury to these resources is presented below. The Trustees may also consider other resources as the assessment progresses.

The Trustees intend to use existing data and information to the fullest possible extent to establish injury metrics. Additionally, the Trustees plan to consider a phased approach for developing studies or analyses as necessary to address any data gaps. These are cost effective strategies that are expected to comply with the definition and standard of reasonable cost described in 43 CFR § 11.14(ee).

Benthic Macroinvertebrates

The potential for injury to benthic macroinvertebrates is demonstrated by several lines of evidence:

(1) Sediment toxicity tests indicated greater adverse effects, including reduced reproduction, reduced growth, and increased mortality, when benthic invertebrates were exposed to Assessment Area sediment as compared to exposure to reference[13] area sediment (Exhibit 3-4).

(2) Surface sediment concentrations of PAHs, in addition to several other contaminants, exceed SQGs, indicating that reductions in growth, survival, and/or mortality are likely to occur. Ninety-four percent of sediment samples collected during the RI exceeded the PEL for PAHs (Exhibit 3-3; HDR et al. 2011).

(3) Several benthic community studies indicate that Gowanus Canal has a low species richness and is dominated by pollution-tolerant organisms. Results from a 2003 study conducted by NYCDEP indicate that the invertebrate communities in Gowanus Canal were dominated by *Polydora* and *Capitella*, two genera of highly degradation-tolerant polychaetes (NYCDEP 2008). Several other studies conducted in Gowanus Canal and Bay found a similar dominance of polychaetes (NYCDEP 2008). A 2003 study by the U.S. Army Corps of Engineers found that Gowanus Canal was dominated by nematodes, which are also considered degradation-tolerant and "may predominate locally in an area of exceptional degradation" (NYCDEP 2008). Several studies comparing community structure in Gowanus Canal to areas in the New York Harbor system indicate that Gowanus Canal exhibits a lower species richness than reference areas (Adams et al. 1998 and Iocco et al. 2000, as cited in GEI Consultants, Inc. 2009). This change in the benthic community can reduce the quality and quantity of food for predators and affect the energy cycle within the aquatic food web.

Exhibit 3-4: Summary of Site-Specific Toxicity Tests

Receptor	Exposure Scenario	Mean Percent Survival	Mean Biomass per individual	Mean juveniles per surviving individual
Amphipod	Canal	60%	33%	15%
	Reference	103%	79%	81%
Polychaete	Canal	86%	89%	Not measured
	Reference	88%	91%	Not measured

Notes:
1. Tests were 28-day tests conducted using Canal sediment collected in 2010.
2. Values are a percentage of the laboratory control, as reported in the Baseline Ecological Risk Assessment (BERA).
3. Reference is an average of four reference areas. Consistent with the BERA, results from the fifth reference station were excluded due to low bioassay results, high frequency of NYSDEC metal criteria exceedances, and location close to the mouth of Gowanus Canal.

Source: (HDR et al. 2011)

[13] Reference areas are located outside of the Assessment Area and reflect environmental conditions similar to the Assessment Area but without contamination.

(4) Consumption advisories recommend restrictions on eating crabs from the Upper New York Bay, including Gowanus Canal, due to PCBs and other contaminants (per- and polyfluoroalkyl substances (PFAS), dioxin, and cadmium). These advisories have been issued with varying levels of severity since the early 1980s (Exhibit 3-5).

Exhibit 3-5: Fish and Crab Consumption Advisories (NYSDOH 2023)

Waterbody (County) [1]	Fish	Men Over 15 and Women Over 50	Women Under 50 and Children Under 15	Chemicals of Concern
East River to Throgs Neck Bridge (Queens, New York, Kings, Bronx) **Harlem River** (New York, Bronx) **Hudson River** (New York, Bronx) **Upper New York Bay, north of Verrazano Narrows Bridge** (Richmond, New York)	Crab or lobster tomalley [2] (hepatopancreas, mustard) and cooking liquid	DON'T EAT	DON'T EAT	PCBs, PFAS, Dioxin, Cadmium
	Channel catfish, Gizzard shad, White catfish	DON'T EAT	DON'T EAT	PCBs
	Blue crab meat [2]	Up to 4 meals/month (six crabs per meal)	DON'T EAT	PCBs, Cadmium
	Atlantic needlefish, Bluefish, Carp, Goldfish, Rainbow smelt, Striped bass, White perch	Up to 1 meal/month	DON'T EAT	PCBs
	All other fish	Up to 4 meals/month	DON'T EAT	PCBs

[1] The specific health advisories for the waters listed above also apply to tributaries (for example, Gowanus Canal and Newtown Creek) and connected waters if there are no dams, falls, or barriers to stop the fish from moving upstream or downstream. Some tributaries may also be listed based on additional information about fish or waterbodies.

[2] Don't eat the soft "green stuff" (mustard, tomalley, liver, or hepatopancreas) found in the body section of crabs and lobsters from any waters because cadmium, PCBs, and other contaminants concentrate there. As contaminants are transferred to cooking liquid, you should also discard crab or lobster cooking liquid.

Fish

The potential for injury to fish is demonstrated by two lines of evidence:

(1) Sediment PAH concentrations exceed levels reported to cause adverse effects on fish. For example, numerous studies on fish species found in Gowanus Canal (or that are closely related to Canal species) indicate that adverse effects on fish may occur when fish are exposed to sediment concentrations of total PAHs in the low parts per million. These adverse effects include biochemical changes (e.g., abnormal cell growth), changes to an organism's tissue (e.g., lesions), and reductions in growth, reproduction, and survival (Hontela et al. 1992 and Payne et al. 1988, as cited in Eisler 2000; Baumann et al. 1996; Nero et al. 2006, as cited in Collier et al. 2013). Ninety-eight percent of surface sediment samples from Gowanus Canal contained total PAH concentrations greater than 4 ppm, suggesting that fish are exposed to PAH concentrations at or above the thresholds linked to adverse effects in the literature. This indicates likely injury to fish due to PAHs.

(2) Fish consumption advisories recommend restrictions on eating fish from the Upper New York Bay, including Gowanus Canal (Exhibit 3-5). These advisories have been issued with varying levels of severity since the early 1980s and are driven by contaminants such as PCBs.

Aquatic Birds

Currently there are no site-specific COC exposure data (e.g., tissue concentrations) for Assessment Area birds. Therefore, the Trustees used modeled information provided in the Baseline Ecological Risk Assessment (BERA) to evaluate the potential for injury to this species group.

The BERA estimated current dietary intake of PAHs and other contaminants for three avian indicator species: green heron (birds that eat a varied diet; omnivore), double-crested cormorant (birds that eat fish), and black duck (birds that eat plants). Using these modeled dietary contaminant intakes, the BERA reports hazard quotients (HQs), or ratios of potential exposure to a substance and the level above which adverse effects are expected to occur (lowest observed adverse effect level; LOAEL), for each contaminant-receptor pair (Exhibit 3-6). A HQ value greater than one indicates exposure sufficient to cause adverse effects, such as reduction in survival, growth, and reproduction. The BERA reported a LOAEL HQ of 75.6 for total PAHs in the black duck for Gowanus Canal, indicating injury has likely occurred (HDR et al. 2011). For green heron and cormorants, the LOAEL HQs for total PAHs did not exceed one, which indicates that recent injury to these species is less likely to have occurred. The heightened risk to ducks as compared to herons and cormorants is reasonable based on dietary exposure pathways: dabbling ducks "ingest a substantial amount of sediment while foraging" while herons and cormorants primarily ingest fish, which typically metabolize PAHs with reduced bioaccumulation (HDR et al. 2011).

Exhibit 3-6: Hazard Quotients for Exposure to Selected Contaminants in Birds

Contaminant	LOAEL (mg/kg bw/d)	Hazard Quotients - LOAEL		
		Green Heron	Double-Crested Cormorant	Black Duck
Total PAHs	1.4	0.1		**75.6**
Arsenic	6.8	0.3	0.1	0.0
Copper	62	0.2	0.0	0.0
Lead	20	0.1	0.0	0.2
Mercury	0.05	**3.2**	0.8	0.7
Total DDT	1.8	0.0		0.0

Notes:
1. LOAEL = lowest-observed-adverse-effect level, meaning above which adverse effects are expected.
2. mg/kg bw/d = milligrams per kilogram body weight per day.
3. Shaded area means data were not available. Bolded values indicate a HQ > 1.
4. PAH = polycyclic aromatic hydrocarbons, DDT = dichlorodiphenyltrichloroethane

Source: HDR et al. (2011)

3.5 Injury Caused by Remedial Actions

Remedial actions often do not fully return natural resources and/or lost services to baseline conditions because remedial actions are designed to manage unacceptable immediate and future risks to human health and the environment (Section 1.4.3). Further, remedial actions that involve sediment removal or capping, stream reconstruction, vegetation removal, or other physical alterations of the environment may also result in unavoidable, additional injury that is compensable

under the CERCLA NRDA regulations (43 CFR § 11.15(a)(1)). The Trustees will identify and quantify the extent to which remediation affects natural resources by assessing both physical injuries and injuries resulting from residual contamination throughout the documented or expected timeframe of recovery. This evaluation will be based on consultations with EPA and a review of remedial documents that describe what remedial actions have occurred or are being planned and the timing of those actions, as well as the result, or expected result, in terms of residual contamination, habitat condition, or other relevant parameters (43 CFR §11.15(a)(1)).

As mentioned in Section 1.2, some remedial activities have already begun in several portions of Gowanus Canal; other remedial actions are planned for future implementation. The Trustees will use available information to identify remediation-related impacts in the Assessment Area, such as the NYCDEP CSO Long-Term Control Plan and the Remedial Design Report for RTA 1 (NYCDEP 2015, B&B Engineers & Geologists 2020). The Trustees will also look for opportunities to coordinate remedial actions and NRDA-related restoration efforts to increase efficiencies (i.e., cost and time) as well as benefit the natural resources within the Assessment Area. Restoration work conducted in conjunction with the remedy and any proposed compensation for natural resource injuries will be reviewed for approval by the Trustees before compensation is accepted.

3.6 Summary of Injury Determination

Currently available data demonstrate that natural resources in the Assessment Area have been exposed to and injured, or potentially injured, by contamination released into Gowanus Canal (e.g., sediment contamination concentrations in exceedance of adverse effects thresholds, presence of fish consumption advisories). The Trustees have identified specific categories of injury and corresponding resources that constitute the proposed focus of NRDA efforts, that is, the effects of PAHs on biological resources. The Trustees may consider additional research and analysis of existing information, as well as primary studies, to further determine injury to natural resources within the Assessment Area. Potential efforts are described in Chapter 5.

Head of Gowanus Canal. Photo courtesy of NOAA.

CHAPTER 4 | Injury Quantification & Damages Determination Approach

Once injury to natural resources has been determined, the Trustees intend to quantify that injury to establish a basis for scaling restoration and determine damages (43 CFR § 11.70(a)). Injuries to natural resources can be quantified in terms of the actual measured loss of specific resources and/or the services that the injured resources would have provided had the contaminant releases not occurred. In the quantification phase, the extent of the injury is measured, baseline condition and services are identified, recoverability of the injured resource is determined, and reductions in services resulting from the contaminants are calculated (43 CFR § 11.70(c)). Damages would be determined using methods described in the CERCLA NRDA regulations where applicable (43 CFR § 11.80).

To quantify losses and damages, the Trustees plan to select and scale (where feasible) restoration options. The Trustees anticipate using scaling approaches tailored to the specific services that are affected by contamination in Gowanus Canal. These include:

- Ecological losses may be quantified and scaled to restoration using equivalency analysis. Damages would be calculated as the cost of implementing the type and scale of restoration that is expected to generate future ecological services equivalent to lost ecological services.
- Human use losses, such as recreational losses, would be quantified based on the nature and extent of lost human use services (e.g., lost and diminished recreational fishing trips, lost community connections to Gowanus Canal). Damages would be determined as the corresponding value lost to the public from that change.

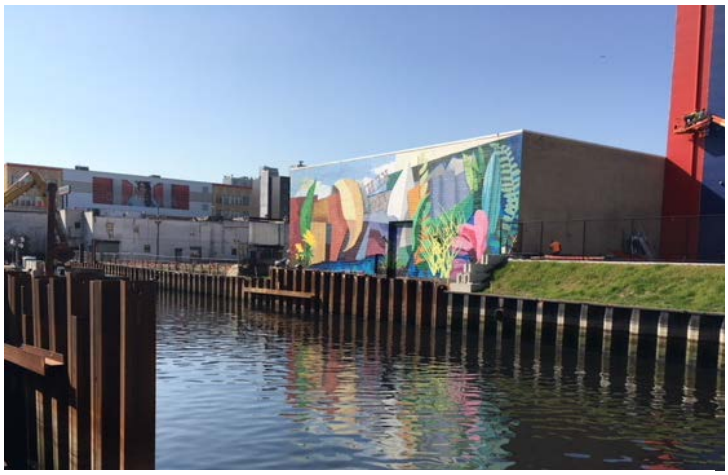
The steps and approaches to quantify injury and determine damages are discussed below, including determination of baseline conditions and the temporal scope of the assessment.

4.1 Baseline

Baseline is defined as the natural resource or resource service condition(s) that would have existed if the hazardous substances or oil had not been released into the Assessment Area (43 CFR §11.14e). Therefore, baseline data should reflect expected conditions in the Assessment Area had the release of the contaminants not occurred. The baseline condition of natural resources reflects natural processes and changes that result from human activities that are not contaminant-related (e.g., structural alterations to Gowanus Canal). Because site-specific historical data applicable to establishing baseline have not been located for Gowanus Canal, the Trustees plan to use, in order of priority, data from reference areas/control groups (43 CFR § 11.72(d)) and/or relevant literature (43 CFR § 11.72(c)(2)).

4.2 Ecological Injury Quantification and Damage Determination Approach

Losses of ecological services may result from the effects of contaminants on natural resources. These losses reflect a reduction in the ability of a resource to provide the level and type of ecological functions that would have been provided under baseline conditions.



Murals along the Gowanus Canal. Photo courtesy of R. DelVecchio.

For this NRDA, the Trustees anticipate quantifying ecological service losses to representative resources for the aquatic habitat. These resources may include benthic invertebrates, fish, and birds. For each species group, ecological injury quantification will focus on effect endpoints that are considered the most biologically relevant (i.e., endpoints that most directly impact a resource's ability to function and provide services) such as growth, reproduction, and survival. The Trustees also plan to consider the exposure of these resources to PAHs over time (i.e., in the past and expected to occur in the future; 43 CFR § 11.70(e). Existing data, in combination with the potential analyses and studies described in Chapter 5, would generate data appropriate for quantifying losses for each resource and endpoint over time. The Trustees plan to consider each resource/endpoint combination as independent indicators of losses in the Assessment Area. Studies may include, but are not limited to, field-based efforts (e.g., to confirm exposure to Canal contaminants and assess the type and magnitude of injury resulting from that exposure), laboratory studies to confirm that PAHs cause the kinds of effects that have been observed in field-based studies, and studies to verify the completeness of contaminant pathways.

To determine damages required to compensate for ecological injures to resources within the Assessment Area, the Trustees intend to use appropriate equivalency analyses (e.g., habitat equivalency analysis, resource equivalency analysis, habitat-based resource equivalency method; 43 CFR § 11.83(c)(2)) to scale restoration projects such that sufficient ecological benefit is provided to compensate for losses. Equivalency analyses quantify resource losses from contamination over the spatial extent and timeframe of injury and quantify resource gains from restoration over the spatial extent and timeframe of the restoration project(s). Losses and gains would be measured in the same unit for clear comparison (e.g., number of organisms, biomass, acres of habitat). Damages would be calculated as the cost to implement that restoration.

The Trustees will ensure that there is no double-counting of losses in the quantification process (43 CFR § 11.83(c)(20)). This approach will require the evaluation of whether restoration scaled to the losses experienced by one resource will also compensate (fully or partially) for the losses associated with another injured resource.

4.3 Human Use Quantification and Damage Determination Approach

As noted in Section 2.4 of this Plan, Gowanus Canal supports a variety of recreational activities and other human uses. The presence of the crab and fish consumption advisories described previously constitute an injury under the CERCLA NRDA regulations and suggests that there has been, and will continue to be, associated compensable losses. Damages related to recreational losses would

be quantified based on the nature and extent of lost recreational services (e.g., lost and diminished recreational fishing and crabbing trips; 43 CFR § 11.83(c)(2)).

Based on an ongoing review of available information, the Trustees anticipate that existing data on angler effort and relevant economic values may be adequate to conduct a secondary (i.e., benefit transfer-based) analysis of recreational fishing and crabbing damages (43 CFR § 11.83(c)(2)(vi)). Benefit transfer analysis involves adapting research estimating economic values under one set of circumstances to an alternate situation. In this manner, estimates of recreational fishing and crabbing in the Assessment Area are combined with existing valuation research from a similar location to develop a damage estimate. Should this analysis reveal significant sources of uncertainty, or if additional information regarding the nature and extent of potential losses becomes available, the Trustees may consider designing and implementing a primary valuation study to calculate damages.

Other potential sources of recreational use losses include boating, birding, and wildlife observation. The Trustees plan to continue gathering available information on the nature, location, and levels of such activities in relation to Gowanus Canal, as well as the extent to which releases have reduced or diminished use. To augment existing information, the Trustees may consider conducting targeted qualitative research in the form of interviews or focus groups to determine whether further evaluation and potential data collection related to these other uses is warranted.

Additional losses may exist in the form of disrupted or diminished community connections to Gowanus Canal. The Trustees may consider further investigating this category of injury through background research, interviews, and/or other qualitative methods. If these additional analyses reveal a basis for pursuing related service losses and damages, the Trustees would evaluate the sufficiency of existing information to inform whether/how to conduct a secondary analysis (as described earlier in this section) and may pursue primary data collection in the form of focus groups or surveys to support quantification and damage determination.

4.4 Temporal Scope

The temporal scope of this assessment is based on the determination of injury to natural resources and corresponding damages (43 CFR § 11.14(c)). Based on the industrial history of Gowanus Canal, natural resources have likely been exposed to and injured by contaminants since at least the 1870s and are likely to continue to be injured in the future. In accordance with the promulgation of CERCLA in 1980, to the extent injuries pre- and post-CERCLA are distinguishable, the Trustees would quantify injury after the enactment of CERCLA. Where injuries are not distinguishable, injury would be quantified for all years that injury occurred in the past and is expected to occur in the future. All injury quantification calculations will include losses through the reasonable expected recovery of resource services. Rate of recovery will be based upon proposed or implemented remedial actions, potential upgradient contaminant source control, restoration activities, natural attenuation, and expected resource recovery. If a resource is not expected to fully recover, the associated injuries will be considered permanent.

CHAPTER 5 | NRDA Studies and Analysis

The previous chapters describe some of the key components of Gowanus Canal NRDA and discuss the framework and general approaches the Trustees plan to apply. The NRDA itself will be composed of a series of iterative analyses aimed at assessing the severity and magnitude of natural resource injury resulting from contaminants released into the Assessment Area. Proposed efforts focus on natural resources that are found in the Assessment Area and have likely been injured by PAHs. These resources include, but are not limited to, benthic invertebrates, fish, and birds. To advance the injury assessment process outlined in Chapters 3 and 4, the Trustees plan to undertake additional review and analysis of existing data, synthesize pertinent literature information, and/or potentially conduct primary studies. These efforts would enable the Trustees to determine and quantify the injury to natural resources and lost services resulting from contamination in Gowanus Canal and assist in identifying and scaling restoration projects that would compensate for those injuries.

Previous efforts, such as the Trustees' Preassessment Screen (DOI et al. 2014) and reports related to EPA's remedial process, documented existing information on Gowanus Canal. This enabled the Trustees to identify preliminary data gaps regarding the exposure of natural resources to PAHs (and other contaminants) and corresponding effects on ecological and human use services. This Chapter describes efforts the Trustees are presently undertaking or considering to fill these data gaps and generate sufficient information to conduct the full assessment – injury determination, injury quantification, and damage determination. These efforts include: (1) review and analysis of existing information targeted to specific injury evaluations and resources of focus, and (2) primary studies designed to address data gaps such that when combined with existing information, the Trustees' determination and quantification of injury and damages is strengthened compared to an assessment using existing information alone. The potential types of analyses and studies detailed in the following section represent the Trustees' current understanding of the information that may be needed to further refine the determination and quantification of injury to natural resources and resource services.

The scope of this Plan does not preclude additional or alternative studies not identified in this Plan that may be undertaken during the assessment. The Trustees recognize that other studies may be identified as necessary or advisable as the assessment proceeds and new information becomes available, or new data gaps are identified. Additionally, the inclusion of a study within this Plan does not guarantee that it will be undertaken. For example, the Trustees may decide that some studies are not needed if reasonable assumptions supported by expert opinion and/or existing site information can be made, considering the cost of additional research projects or sampling against the expected gain in information from a particular study. As such, this Plan provides a starting point from which the Trustees can prioritize study efforts and implement the NRDA. As assessment efforts progress and additional information is generated, the Trustees may provide amendments to this Plan for public review.

5.1 Analysis and Study Prioritization

The Trustees intend to identify and prioritize assessment activities that are expected to assist in determining and quantifying the scale of natural resource injury stemming from releases of

hazardous substances and/or oil to the Assessment Area. Considerations include, but are not limited to:

- Can an injury/loss evaluation be conducted based on existing information or does it require primary studies?
- Which resources are directly impacted by the toxicity of COCs in Gowanus Canal? Indirectly impacted?
- Which resources are most representative of those impacted by COCs in Gowanus Canal?
- Which resource services may be affected by COCs in Gowanus Canal?
- How will the result of the analysis or study assist in quantifying or qualitatively describing losses?
- Can analyses or studies be conducted in a manner that is consistent with standard methods?
- Is the analysis or study dependent on the results of other analyses or studies?
- Will efforts help to inform the determination of damages and scaling for relevant types of restoration?

Based on these and potentially other considerations, the Trustees have organized assessment activities into categories. As the assessment progresses and additional information is developed, the Trustees may add or remove studies as needed.

Category 1: Preliminary compilation and analysis of existing data on natural resources and resource services of focus. Collection and analysis of existing data on:

- Trustee resources and resource services of focus (e.g., benthic invertebrates, fish, birds (songbirds and water birds), aquatic-dependent mammals, recreation, and non-recreation community losses).
- Injury-related topics (e.g., pathway, remedial injury) essential to assess injury to natural resources of focus.
- Restoration of relevant natural resources and associated habitats and human use services.

Information collected from existing data and analyses (e.g., site-specific studies, remedial process, literature studies) would be used to determine:

- Which resources the Trustees will focus on to quantify injury,
- Which resource injuries the Trustees will describe qualitatively, and
- Whether primary field or laboratory studies or human use surveys are needed to evaluate and quantify injury to specific resources or resource services and scale restoration.

Category 2: Conduct studies to fill data gaps. Based on the results of Category 1 studies, these efforts include primary field and/or laboratory studies that may be necessary to:

- Effectively determine and quantify injury to initial natural resources and resource services of focus (e.g., fish, songbirds).
- Quantify and scale the benefits of relevant restoration projects or project types.

This may also include collection of ephemeral data to ensure that the Trustees can adequately characterize the current biological, chemical, and physical characteristics of Gowanus Canal and its resources before remedial activities are implemented and change those characteristics.

Category 3: Adapt assessment to address additional natural resource or resource services. Based on the results of Category 1 and 2 analyses and studies, these efforts may cover the following:

- Assessment of injury to any additional resources or resource services within the Assessment Area that the Trustees identify as significant as the assessment proceeds, as well as potential additional site-specific primary studies.
- Habitat restoration pilot studies to inform scaling, coordinated with EPA early remediation actions as appropriate.

5.2 Injury Assessment Analysis & Studies

The potential studies and analyses that the Trustees are considering as part of an injury assessment are presented in Exhibit 5-1. The table summarizes the objectives, description, and category of each type of study or analysis effort associated with each resource or resource service. The Trustees propose to develop the general approach to conducting specific studies and analyses following this Plan in collaboration with principal investigators and documented in study-specific plans, which would be made available to the public.

The assessment of ecological resources and resource services includes review and analysis of existing information from available sources that will be able to substantially characterize contaminant pathways, describe and quantify contaminant-related exposure and effects of ecological resources such as surface water, sediment, invertebrates, fish, aquatic birds, and aquatic-based mammals. To fill data gaps, potential additional study efforts, building on existing information, may focus on collection of additional site-specific data through means such as field sampling or laboratory tests to produce results useful for injury quantification. This may include quick-turnaround sampling for data that may otherwise be lost as remedial actions progress in Gowanus Canal (e.g., if dredging disturbs or removes sediment).

Similarly, assessment of human use service losses initially involves review and analysis of existing recreational and community use data/information to evaluate contaminant-related effects and associated damages. Where data are unavailable or there is significant uncertainty that cannot otherwise be addressed, primary studies in the form of surveys or other forms of data collection could be conducted to support quantification.

Exhibit 5-1: Potential Assessment Studies & Analyses

Resource/ Resource Service	Study/Analysis	Objective	Category
Exposure Pathway	Review existing pathway-related data	Review existing information on physical and chemical transport mechanisms within the Assessment Area to document contaminant exposure pathways. Include history of releases and data on surface water, groundwater, soil, and sediment.	1
	Analyze media to support source and pathway analyses	Collect Gowanus Canal soil, overland surface water runoff and/or groundwater. Analyze physical characteristics and COC concentrations in these media to assess connections between hazardous contaminant sources and Assessment Area natural resources.	2
Resources Potentially Impacted by Remedial Activities	Collect time sensitive field samples	Collect and analyze data from the Assessment Area to characterize current conditions prior to remedial actions that may affect those conditions (e.g., if dredging disturbs or removes sediment).	2
Surface Water	Review existing surface water data	Document whether injury to surface water has occurred through compilation of existing contaminant concentration data and comparison of those data to relevant federal and state water quality criteria.	1
Sediment	Review existing sediment data	Evaluate the extent, quality, and appropriateness of available sediment chemistry and associated toxicity data for injury assessment, information on physical parameters, and timing of relevant remedial actions.	1
	Analyze new sediment samples	Collect Gowanus Canal sediments, as needed, to complement studies of benthic invertebrate and fish exposure and toxicity and pathway. Analyze contaminant concentrations in Assessment Area sediments and corresponding physical parameters, as compared to reference site sediments.	2
Aquatic Vegetation	Review existing aquatic vegetation data	Evaluate the extent, quality, and appropriateness of available contaminant chemistry and toxicity data associated with relevant aquatic vegetation species to inform the potential severity and magnitude of injury.	1
	Assess aquatic vegetation exposure and toxicity	Design and implement field and/or laboratory studies of the site-specific effects of contaminants on aquatic vegetation. This will inform the severity and magnitude of injury.	2

Resource/ Resource Service	Study/Analysis	Objective	Category
Aquatic Invertebrates	Review existing invertebrate data	Evaluate the extent, quality, and appropriateness of available contaminant chemistry and toxicity data associated with relevant invertebrate species (e.g., benthic, epibenthic or pelagic insect larvae, bivalves, crustaceans) to inform the potential severity and magnitude of injury.	1
	Compile invertebrate community data and habitat extent	Compile and review existing information to determine invertebrate community characteristics (e.g., abundance of target species) and habitat extent within the Assessment Area and reference area(s). Results may inform design of subsequent primary studies.	1
	Assess invertebrate exposure and toxicity	Design and implement field and/or laboratory studies of the site-specific effects of contaminants on aquatic invertebrates (e.g., benthic, epibenthic or pelagic insect larvae, bivalves, crustaceans). This will inform the severity and magnitude of injury.	2
Fish	Review existing fish exposure and toxicity data	Review available contaminant concentrations in fish tissue, sediment, and water in Assessment Area, as well as data related to fish toxicity studies (site-specific or literature) to inform the potential severity and magnitude of injury.	1
	Review existing fish life history and habitat use	Document fish presence and abundance, especially for sensitive life stages (from Gowanus Canal surveys and/or literature studies from comparable sites), and habitat type and quality. Results may inform design of subsequent primary studies.	1
	Assess fish exposure and toxicity	Design and implement field and/or laboratory studies of the site-specific effects of contaminants on fish, with particular focus on species, life stage, and effect endpoints. This will inform the severity and magnitude of injury.	2
Birds	Review existing avian exposure, toxicity, life history, and habitat use data	Review existing data on when, where, and how many breeding songbirds, shorebirds, wading birds, and waterfowl use the Assessment Area to determine focal species and identify the time periods that they are exposed to contamination in Gowanus Canal. Use existing data on contaminant concentrations in sediment, soil, and prey items to model exposure. Compare results to existing literature on adverse effects of contaminants on relevant bird species to demonstrate potential injury. Results may inform historic contaminant exposure and effects as well as the design of subsequent primary studies.	1

Resource/ Resource Service	Study/Analysis	Objective	Category
	Assess avian exposure and toxicity	Design and implement primary field and/or laboratory studies of the effects contaminants on birds, with particular focus on species, life stage, and endpoints. This will confirm site-specific exposure and inform the severity and magnitude of injury.	2
Aquatic-Dependent Mammals	Review existing mammalian exposure, toxicity, life history, and habitat use data	Review existing data on exposure and toxicity, life history, and habitat use for aquatic-dependent mammals to determine if additional assessment is warranted.	1
Remedial Activities	Evaluate impacts of remedial activities	Compile existing information on remedial activities (completed, ongoing, and planned) and evaluate the severity of impacts to Assessment Area resources and habitat. This includes the timing, location, spatial extent, and type of remedial activities.	1
Ecological Restoration	Review existing information on wetland/marsh restoration and shoreline softening	Review existing data and information on wetland/marsh habitat restoration and shoreline softening projects to assess potential methods and benefits to inform scaling (e.g., timeframe of implementation, rate of success, rate of recovery, types of ecological improvements, metrics, recontamination potential).	1
	Assess success of marsh restoration and/or shoreline softening	Implement pilot study to assess the success of marsh restoration and/or shoreline softening in Gowanus Canal. Coordinate with EPA remedial actions.	3
Recreation	Review existing outdoor recreational use data and Canal characteristics	Review existing data and information on the types and levels of potentially affected recreational activities and values in the Assessment Area over time. Review existing public information on and awareness of contamination in the Assessment Area, including via consumption advisories and guidelines, news reports, and community information sources. Compile literature information on trip values.	1
	Complete outdoor recreational use interviews and focus groups	Organize and implement interviews and focus groups with recreationists to gain information and insights into outdoor recreational use, such as fishing, crabbing, swimming, boating, and wildlife viewing in the Assessment Area. Consider results along with previously collected information and/or information collected from reference sites to determine whether further assessment efforts are warranted.	2

Resource/ Resource Service	Study/Analysis	Objective	Category
	Primary recreation survey	Collect primary data to calculate site-specific change in recreational activities and associated monetary values resulting from contamination-related restrictions in the Assessment Area.	3
Non-Recreational Community Loss	Primary non-recreation community survey	Collect primary data to evaluate and estimate site-specific change in community connection and relationship to Assessment Area resources resulting from contamination-related degradation.	2

Notes:

Category 1: Preliminary compilation and analysis of existing data on natural resources and resource services of focus.

Category 2: Conduct studies to fill data gaps.

Category 3: Adapt assessment to address additional natural resource or resource services.

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APPENDIX A | Quality Assurance

The CERCLA NRDA regulations require that trustees develop a Quality Assurance Plan that satisfies the requirements listed in the National Contingency Plan and applicable EPA guidelines for quality control and quality assurance plans (43 CFR § 11.31(c)(2)). The collection, compilation, evaluation, and reporting of environmental data are necessary to perform the assessment. The Trustees must properly document the origin and quality of the data used to make decisions so that data limitations may be identified, and assessments of the severity, location, and extent of injury are accurate. This documentation assists the Trustees in making appropriate decisions regarding the type and scale of restoration actions necessary to compensate for natural resource injuries. Also relevant to this effort are the NOAA and FWS guidelines on data generation, use, and reporting established under the Information Quality Act of 2001. All information developed and used in this NRDA will comply with these guidelines, as described in agency publications including the FWS Data Management Handbook (FWS 2021) and the FWS Information Quality Guidelines (FWS 2012).

This Plan considers studies that evaluate existing datasets as well as studies that generate new information. With respect to the evaluation of existing data, the study's principal investigator (PI) will carefully document the source(s) of all data, available information about quality assurance (QA)/quality control (QC) procedures used by the original investigator, and any data qualifiers or other information restricting application of the data. This approach will also be applied to new data and analyses developed by federal and state agencies, academics, and information developed under other activities or programs. For new studies that are specifically undertaken to support the NRDA process, appropriate study-specific Quality Assurance Project Plans (QAPPs) or Data Management Plans (DMPs) will be developed according to the general principles described below.[14] The CERCLA NRDA regulations also state that the Assessment Plan shall contain procedures and schedules for sharing data, split samples, and results of analyses, when requested, with any identified PRPs and other natural resource trustees (43 CFR § 11.31(a)(4)). These procedures and schedules would be identified within the QAPP or DMP for individual studies, should they be undertaken, as described below.

As noted by EPA (2001), QAPPs/DMPs will vary according to the nature of the work being performed and the intended use of the data and as such, need to be tailored to match the specific data-gathering needs of a particular project (40 CFR § 300.5). The NRDA effort will entail a variety of widely different data-gathering efforts; therefore, it is not appropriate to develop a single, detailed plan to cover all these activities. Instead, the Trustees will ensure that individual study plans adequately address project-specific QA issues and provide appropriate QC for analyses and products. The discussion in this document therefore focuses on the required elements of an acceptable study plan.

[14] QAPPs are an EPA-defined product which meets a list of criteria defined in EPA 2001. DMPs are defined by FWS 2021 and may include all of the same elements as a QAPP but are focused on the Service's needs for project implementation guidance and data quality and sharing.

In general, a study specific QAPP or DMP must provide sufficient detail to demonstrate that:

- The project's technical and quality objectives are identified and agreed upon;
- The intended measurements, data generation, or data acquisition methods are appropriate for achieving project objectives;
- Assessment procedures are sufficient for confirming that data of the type and quality needed and expected are obtained; and
- Any limitations on the use of the data can be identified and documented (EPA 2001).

Accordingly, study planning documents developed for this assessment will include these elements, per FWS (2021):

- **Project Management** - documents the structure of the project team, that the project has a defined goal(s), that the participants understand the goal(s) and the approach to be used, and that the planning outputs have been documented.
- **Data Generation and Acquisition** - ensures that all aspects of project design and implementation including methods for sampling, split samples, measurement and analysis, data collection or generation, data compilation/handling, and QC activities are documented and employed.
- **Assessment and Oversight** - assesses the effectiveness of the implementation of the project and associated QA and QC activities.
- **Data Validation and Usability** - addresses the QC activities that occur after the data collection or generation phase of the project is completed.
- **Reporting and Documentation** – describes the frequency, extent, and method of data reporting. This also describes how the report and data (with associated metadata) will be disseminated to other Trustees and PRPs, including release to the public if appropriate.

A.1 Project Management

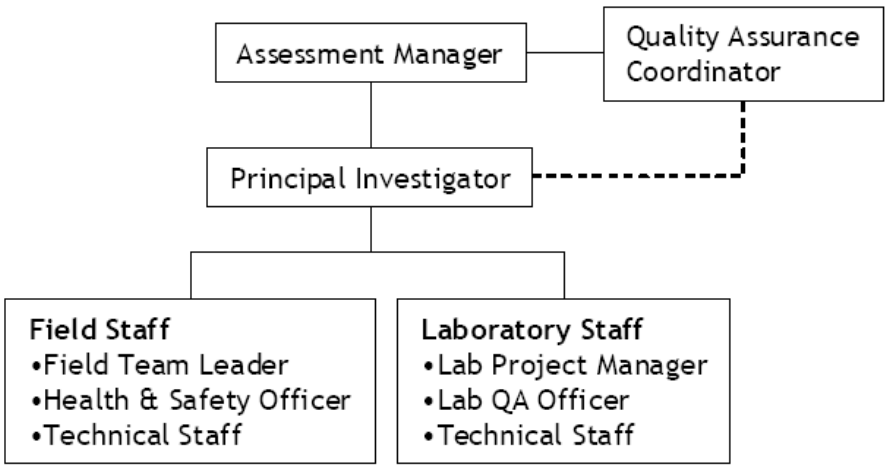
Effective implementation of project objectives requires clear project organization, which includes carefully defining the roles and responsibilities of each project participant. Unambiguous personnel structures help ensure that each individual is aware of their specific areas of responsibility, as well as clarifying internal lines of communication and authority, which is important for decision-making as projects progress. Individuals' and organizations' roles and responsibilities may vary by study or task, but each person's role and responsibility should be clearly described in the project's study plan. Exhibit A-1 below presents a generic personnel plan for a NRDA project.

The Assessment Manager is the designated Trustee representative with responsibility for the review and acceptance of the project-specific study plan. This individual is also responsible for ensuring that the project's goals and design will meet the broader requirements of the NRDA. The Assessment Manager coordinates efforts with the Quality Assurance Coordinator and oversees the PI for the study.

The QA Coordinator oversees the overall conduct of the quality system. Appointed by the Trustees, this individual's responsibilities include, but are not limited to: reviewing/assisting the PI with the development of project-specific study plans; conducting audits and ensuring

implementation of both project-specific and overall plans; archiving samples, data, and all documentation supporting the data in a secure and accessible form; and reporting to the Trustees. To ensure independence, the person serving as QA Coordinator will not serve as either the Assessment Manager or as a PI for any NRDA study.

Exhibit A-1: Personnel Plan



Study-specific PIs oversee the design and implementation of particular NRDA studies. Each PI has the responsibility to ensure that all health, safety, and relevant QA requirements are met. If deviations from the planning documents occur, the PI (or their designee) will document these deviations and report them to the Assessment Manager and the QA Coordinator.

The Field Team Leader supervises day-to-day field investigations, including sample collection, field observations, and field measurements. The Field Team Leader generally is responsible for ensuring compliance with all field quality assurance procedures defined in the study-specific QAPP/DMP. Similarly, the Laboratory Project Manager is responsible for monitoring and documenting the quality of laboratory work. The Health & Safety Officer (who may also be the Field Team Leader) is responsible for ensuring adherence to specified safety protocols in the field.

A.2 Data Generation and Acquisition

All studies under the direction of the Trustees that are specifically undertaken in support of the NRDA will have a prepared QAPP or DMP that will be completed prior to the initiation of any work. These plans will be submitted to, and approved by, the QA Coordinator or designee and will include discussion of the following data generation and acquisition topics:

- Rationale for generating or acquiring the data.
- Proposed method(s) for generating or acquiring the data, including descriptions of (or references to) standard operating procedures for all sampling or data-generating methods and analytical methods.
- Types and numbers of samples required.
- Analyses to be performed.
- Sampling locations and frequencies.
- Sample handling and storage procedures.
- Chain-of-custody procedures.
- Data quality indicators (for instance, with respect to precision, accuracy, completeness, representativeness, comparability, and sensitivity).
- Description of the procedures and acceptance criteria to be used in determining if the data meet these requirements.
- Description of the interpretation techniques to be used, including statistical analyses.
- Split sample protocols and procedures for archiving samples and management of residuals.

In addition, to the extent practicable, laboratories will be required to comply with Good Laboratory Practices. This includes descriptions and documentation of maintenance, inspections of instruments, and acceptance testing of instruments, equipment, and their components, as well as the calibration of such equipment and the maintenance of all records relating to these exercises. Documentation to be included with the final report(s) from each study will include field logs for the collection or generation of the samples, chain of custody records, and other QA/QC documentation as applicable.

A.3 Assessment and Oversight

Each QAPP or DMP will have a process for ensuring appropriate implementation of assessment and oversight procedures. To ensure that the study plan for each project is implemented effectively, the QA Coordinator will review QAPPs or DMPs for all Trustee studies that generate data. The QA Coordinator or designee will also audit all such studies. Audits will include technical system audits (e.g., evaluations of operations) as well as scrutinizing data and reports (e.g., evaluations of data quality and adequacy of documentation).

If, in the professional opinion of the QA Coordinator, the results of an audit indicate a compromise in the quality of the collection, generation, analysis, or interpretation of the data, the QA Coordinator has the authority to stop work by oral direction. Within two working days of this direction, the QA Coordinator will submit to the Trustees a written report describing the necessity for this direction. The Assessment Manager will consult with the Trustees regarding measures to be taken in response to the QA Coordinator's report.

A.4 Data Validation and Usability

The QAPP or DMP will include a process for determining data quality and usability which may address both verification and validation steps, depending on the type of information and analyses

in the study plan. In addition to the assessment and oversight activities described previously, analytical chemistry data will be considered for validation by an independent third party. Prompt validation of analytical chemistry data can assist the analyst or analytical facility in developing data that meet the requirements for precision and accuracy. If undertaken, it is expected that data validation will use the study-specific study plans and EPA Guidance on Environmental Verification and Validation (EPA 2002).

A.5 Reporting and Documentation

The DMP or QAPP will also describe the data reporting and documentation process. Data reporting consists both of processes for sharing information with other Trustees and PRPs and for sharing with the public. All datasets will include appropriate metadata, which describes the "who, what, when, where, why, and how of the dataset," using current guidelines at the time of study design, such as described in FWS (2021). The DMP or QAPP will also describe procedures for archiving and preserving data and associated documentation generated as described in sections A.3 and A.4 to meet appropriate litigation hold and administrative record requirements and Information Quality Act guidance.

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