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Onondaga Lake Natural Resource Damage Assessment Plan Addendum

DRAFT | November 2011

prepared for:

U.S. Department of the Interior Fish and Wildlife Service

New York State Department of Environmental Conservation

Onondaga Nation

prepared by:

Industrial Economics, Incorporated

2067 Massachusetts Avenue

Cambridge, MA 02140

INDUSTRIAL ECONOMICS, INCORPORATED

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EXECUTIVE SUMMARY

The U.S. Department of the Interior (DOI), the State of New York Department of Environmental Conservation (NYSDEC), and the Onondaga Nation are conducting a natural resource damage assessment (NRDA) of resources in and around Onondaga Lake (Lake), located near the city of Syracuse in Onondaga County, New York. The Trustees are acting pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; 42 USC § 9601 et seq.), the Oil Pollution Act (OPA; 33 USC 2701 et seq.), Executive Order 12580, the National Contingency Plan (NCP; 40 C.F.R. Part 300 - Subpart G), and the New York State Navigation Law (New York State Navigation Law § 181). Further, the Onondaga Nation is acting pursuant to the *Guswenta*, or the Two Row Wampum Treaty, and the 1794 Treaty of Canandaigua in the Nation's cooperative relationship with DOI and NYSDEC as Trustees, and with Honeywell International Inc. ("Honeywell"; a potentially responsible party for hazardous contamination in and around Onondaga Lake).

In 1996, a natural resource damage assessment plan (1996 DAP) was published by NYSDEC, which describes the State's anticipated approach for addressing natural resource damages in the Lake (Normandeau Associates 1996). Since publication of that report, the Trustees formed a Trustee Council (the Onondaga Lake Natural Resource Trustee Council (OLNRTC)); the U.S. Environmental Protection Agency (EPA), NYSDEC, and Honeywell have begun remedial planning and actions in and around the Lake; and the Trustees have entered into a cooperative agreement with Honeywell to address natural resource injuries through restoration of natural resources and resource services under CERCLA. The Trustees have produced this Natural Resource Damage Assessment Plan Addendum to update the 1996 DAP, further outlining the approach the Trustees will follow to conduct scientific studies, evaluate data and information, and plan and scale restoration projects to address past, present, and future injuries to natural resources.

Natural resources in and around the Lake include surface water and groundwater, sediments, soils, and biota. These resources constitute lake, wetland, and upland habitats that, in turn, support a variety of flora and fauna, including threatened and endangered species, migratory and resident birds, and resident fish, mammals, amphibians, and reptiles. These resources provide a variety of services, including supporting a complex web of ecological services that are integral to a properly functioning ecosystem, as well as services to humans such as boating, subsistence and recreational hunting and fishing, bird watching and wildlife appreciation, cultural services to the Onondaga Nation, and the provision of sources of water for drinking and industrial processes. These resources and the services they provide have been adversely affected by the presence of hazardous substances.

The Trustees intend to generally follow guidelines for conducting a NRDA published by the U.S. Department of the Interior (43 C.F.R. Part 11), which includes steps for determining and quantifying injury to natural resources and determining the appropriate amount of damages required, in the form of natural resource restoration, to fully compensate the public for those injuries. Working together, the Trustees and Honeywell will, to the extent possible, coordinate restoration activities with remedial actions being overseen by EPA and NYSDEC. Throughout the NRDA process, the Trustees will solicit input from the public.

Some specific studies aimed at injury determination and quantification are already underway. The Trustees and Honeywell will also continue to assemble and evaluate existing data for the Lake. Several studies are in the planning stages. As additional information is obtained, this addendum may be updated.

There are a number of damage determination approaches available to Trustees as described in the DOI NRDA regulations. Of these, the Trustees will likely apply habitat or resource equivalency analysis to quantify ecological damages. NYSDEC has already conducted a recreational impacts analysis that estimates damages to recreational fishing and boating attributable to the presence of the fish consumption advisory for the Lake, and the Trustees plan to evaluate contaminant-related changes to other recreational uses of assessment area resources. The Onondaga Nation will also assess damages to natural resource services associated with reductions in subsistence uses, cultural uses, and reductions in non-use values of those resources.

Once the magnitude of damages is determined, Trustees will evaluate a suite of restoration projects. Appropriate and relevant projects will be scaled to provide natural resource services that are commensurate with the magnitude of natural resource damages. The results of this scaling effort will be documented in a Restoration and Compensation Determination Plan, which will be completed and released for public review and comment at a future date.

CHAPTER 1 | INTRODUCTION

Over the past century and a half, Onondaga Lake (Lake) and its surroundings have been adversely affected by a range of anthropogenic activities. In addition to changes in the physical characteristics of the Lake, the Lake and its shores and tributaries have been, and continue to be, contaminated by releases of hazardous substances and oil. In the 1970s, the New York State Department of Environmental Conservation (NYSDEC) began to address contamination issues in and around the Lake. In 1994, the Lake was placed on the National Priorities List,[1] and over the last several decades NYSDEC and the U.S. Environmental Protection Agency (EPA) have been working with potentially responsible parties (PRPs) to design and implement remedial activities that address the human health and ecological risks posed by hazardous substance and oil contamination. Cleanup activities, however, do not fully address the loss of natural resources and associated resource services caused by hazardous substance and oil contamination, for which Trustees can seek compensation.

The U.S. Department of the Interior (DOI), NYSDEC, and the Onondaga Nation are conducting a natural resource damage assessment (NRDA) of resources in and around the Lake. The Trustees are acting on behalf of the public with respect to natural resources belonging to, managed by, controlled by, or appertaining to each Trustee that may have been impacted by releases of hazardous substances from the Onondaga Lake Superfund Site pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Oil Pollution Act (OPA), Executive Order 12580, the National Contingency Plan (NCP), and the New York State Navigation Law.[2] The Trustees are authorized to conduct NRDA and restoration activities and to sue for damages resulting from the destruction of, loss of, or injury to such natural resources by Section 107(a) and (f) of CERCLA, 40 C.F.R. § 300.600 et seq. The NRDA regulations, at 43 C.F.R. § 11.32(a)(2)(iii)(A), encourage the participation of potentially responsible parties (PRPs) in the assessment process, and at this time Honeywell has agreed to cooperatively assess natural resource damages with the Trustees. The Onondaga Nation is also participating pursuant to the *Guswenta*, or the Two Row Wampum Treaty, and the

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[1] Superfund is the federal government's program to clean up the nation's uncontrolled hazardous waste sites. Within the Superfund program, the *National Priorities List* (NPL) is the list of national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories. The NPL is intended primarily to guide the EPA in determining which sites warrant further investigation (USEPA 2010).

[2] 42 USC § 9601 et seq. (CERCLA); New York State Navigation Law § 181; 33 USC 2701 et seq. (OPA); 40 C.F.R. Part 300 - Subpart G.

1794 Treaty of Canandaigua in its cooperative relationship with DOI and NYSDEC as Trustees, and with Honeywell.

One of the primary components of a NRDA is the development of a Damage Assessment Plan (DAP). The purpose of a DAP is to:

> *ensure that the [damage] assessment is performed in a planned and systematic manner and that methodologies…including the Injury Determination, Quantification, and Damage Determination phases, can be conducted at a reasonable cost (43 C.F.R. § 11.30(b)).*

In 1996, a DAP for the Lake was written for NYSDEC by Normandeau Associates (hereafter referred to as the 1996 DAP), which focused primarily on hazardous wastes produced by Allied Signal, Incorporated (Normandeau Associates 1996). Since the publication of the 1996 DAP, there have been several developments that relate directly to the NRDA. Key developments are described below.

- Additional environmental investigations and research have been conducted, increasing available information regarding hazardous contamination of the Lake and its surroundings.
- Completed and ongoing remedial activities have affected the distribution, transport, and ultimate fate of contaminants in the Lake. Additional remedial activities are currently planned.
- DOI and the Onondaga Nation joined NYSDEC to form a Trustee Council. Members of the Trustee Council then signed a Memorandum of Agreement that creates a framework for the conduct of the NRDA (NYSDEC et al. 2008).
- Allied Signal, Incorporated was purchased by Honeywell, which has taken over responsibilities for remedial actions in and around the Lake.
- PRPs in addition to Honeywell have been identified.
- The Trustees and Honeywell have entered into a cooperative agreement to pursue the NRDA of the Lake (DOI et al. 2009).

As noted in the 1996 DAP, "As the results of earlier phases of the damage assessment are developed, and RI/FS response action plans are formulated, the NRDA plan can be revised as needed to provide more site-specific and cost-effective damage assessment planning" (Normandeau Associates 1996, p. 3).[3] Therefore, in light of the developments listed above, the Trustees have created this addendum to the 1996 DAP. This addendum provides context for both the key developments described above as well as the ongoing, planned, and proposed studies outlined in the following chapters. Information from the 1996 DAP that is still relevant is not repeated in this addendum; rather, readers are referred to the relevant sections of the 1996 DAP, as appropriate.

[3] RI/FS refers to Remedial Investigation / Feasibility Study.

INTENT TO PERFORM A TYPE B ASSESSMENT

Declaration of the type of assessment to be performed is a required component of a DAP (43 C.F.R. § 11.31(b)). As noted in Chapter 3 of the 1996 DAP, it is the Trustees' intent to perform a Type B assessment. The 1996 DAP notes: "These Type B procedures allow a range of alternative scientific and economic methodologies to be used for Injury Determination, Quantification and Damage Determination" (Normandeau Associates 1996, p. 19).

PUBLIC PARTICIPATION

The Trustees intend for public participation to be an important component of the DAP development process. Specifically, the Trustees propose to make the Assessment Plan available for review by any identified PRPs, other natural resource trustees, other affected Federal or State agencies or Indian tribes, and any other interested member of the public for a period of at least 30 calendar days, with reasonable extensions granted as appropriate, in accordance with 43 C.F.R. § 11.32(c)(1). Public comments on the 1996 DAP are included in Appendix E of that document. Like the 1996 DAP, this addendum is available for public comment and may be modified at any stage of the assessment as new information becomes available and as specific study plans are developed (43 C.F.R. § 11.32(e)). Significant modifications (e.g., resource-specific study plan amendments) will also be made available for review by any interested public party or individual, and will be appended to this addendum. Non-significant modifications may also be made available for review, but implementation of such modifications need not be delayed as a result of the review.

Copies of this amendment are available at:
http://www.fws.gov/northeast/nyfo/ec/onondaga.htm.

This link will be sent to subscribers of the NYSDEC Onondaga Lake News Email List, and the Trustees will present this addendum, as well as general information regarding the NRDA process, at the Onondaga Lake Watershed Forum meeting on November 29, 2011.

Comments on this addendum may be submitted in writing or via email, and are due to the Trustees by January 20, 2012. To request a copy of this addendum, to submit a comment, or for additional information, please contact:

Anne Secord
U.S. Fish and Wildlife Service
3817 Luker Road
Cortland, NY 13045
anne_secord@fws.gov

ASSESSMENT TIMELINE

The Trustees do not yet have a firm timeline for the completion of the NRDA process. However, the Trustees' general intent is to coordinate the assessment with the remedial process, ensuring any incremental changes in natural resource services resulting from implementation of the remedy be considered in the NRDA. The timeline will also accommodate public participation and environmental conditions (e.g., field studies may be subject to seasonal constraints, assessment of resources may be limited by ice cover).

OUTLINE OF THE REMAINDER OF THE DOCUMENT

The remainder of this document contains the following chapters:

- Chapter 2, Background Information, provides an overview of the Lake, including an update of the industrial and remedial activities discussed in the 1996 DAP; lists some contaminants of concern (CoCs); outlines natural resources and the services they provide; and addresses the temporal and geographic scope of the assessment.
- Chapter 3, Natural Resource Injury Determination, affirms the existence of a pathway for released hazardous substances and oil from PRP operations to trust resources and describes the injury to trust resources that has occurred as a result of these releases.
- Chapter 4, Ecological Injury Quantification Approach, discusses a framework for quantifying injury to natural resources and the services they provide (accounting for baseline), and includes a list of ongoing, planned, and potential studies.
- Chapter 5, Recreational Use Analysis and Planned Recreational Use and Non-Use Damages Quantification Approach, describes the assessment of recreational use and passive-/non-use losses associated with hazardous contamination of the Lake.
- Chapter 6, Onondaga Nation Injury Assessment Approach, describes the assessment of losses that are unique to the Onondaga Nation.
- Chapter 7, Damages Determination, discusses the approaches the Trustees anticipate using to calculate damages and scale restoration.

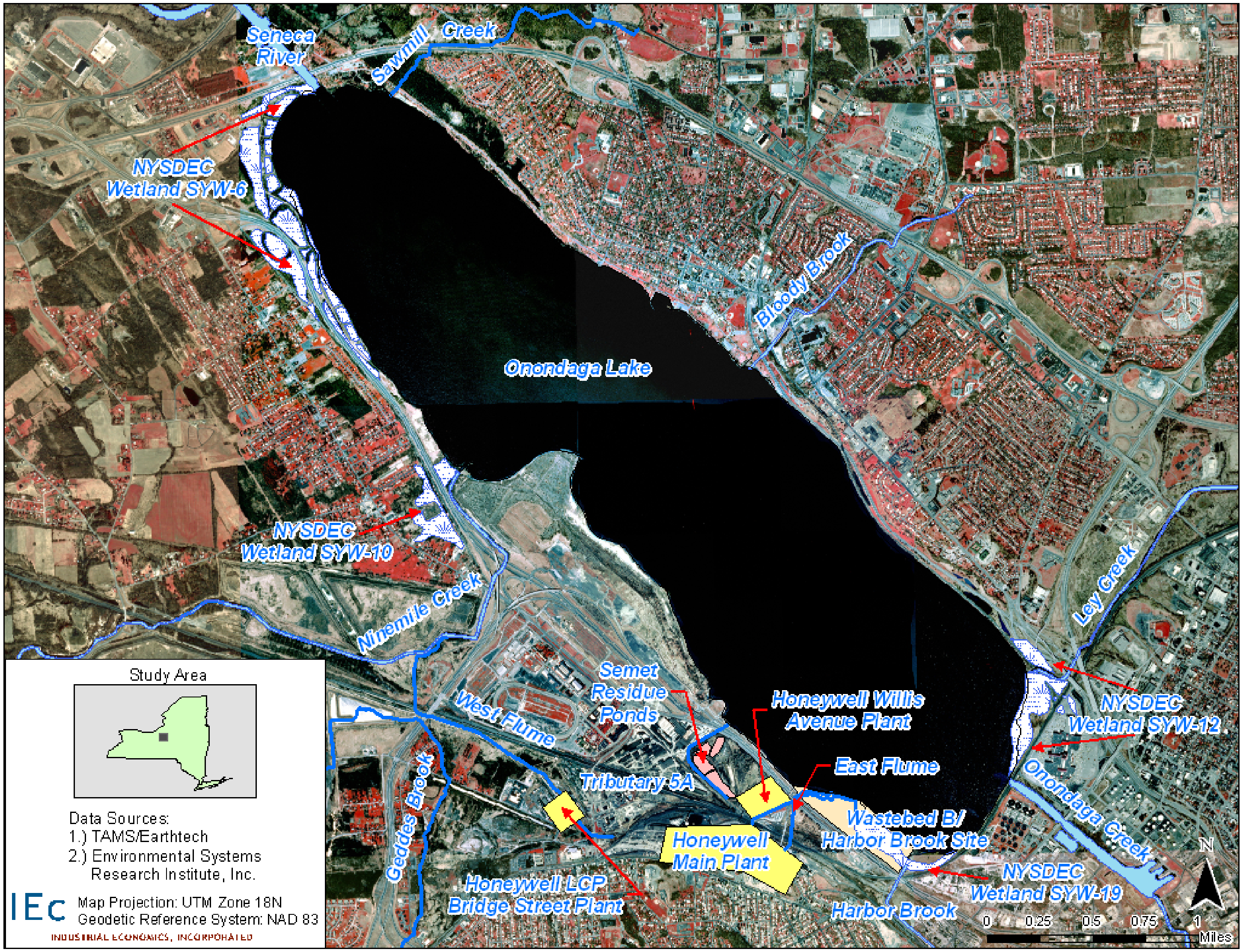
CHAPTER 2 | BACKGROUND INFORMATION

Onondaga Lake is located in Onondaga County, New York, and lies to the northwest of the city of Syracuse. It is approximately 7.6 kilometers (km) long, has a maximum width of 2 km and an average depth of 10.9 meters (m), and is divided into two large basins (northern and southern, with maximum depths of 19 m and 20 m, respectively) separated by a "saddle" approximately 17 m deep. The Lake itself covers 11.9 square km and has a shoreline that includes a shallow near-shore shelf bordered by terrestrial areas of wetlands, wooded areas, and urban and industrial development. The northern shore of the lake includes parkland; the southern and western shorelines, however, are dominated by industrial waste beds, consisting mainly of ionic wastes, many of which have been re-vegetated (NYSDEC and EPA 2005). Current land use has been the result of historic land management practices; future land use may change as a result of remedial efforts and/or changes in land use planning.

The Lake is eutrophic (receives high quantities of nutrients which support plant and algal growth) and dimictic (stratifies twice a year, in the summer and winter), and drains approximately 738 square km of the larger Seneca River watershed (NYSDEC and EPA 2005). The Lake has three main tributaries: Ninemile Creek to the west, Onondaga Creek to the south, and Ley Creek to the southeast. In addition, several small tributaries flow into the Lake, including Bloody Brook, Sawmill Creek, Tributary 5A, the East Flume, and Harbor Brook (Exhibit 2-1; NYSDEC and EPA 2005, NYSDEC/TAMS 2002a). While Ninemile Creek and Onondaga Creek supply the vast majority of surface water to the Lake, approximately 20 percent of the inflow comes from the Metropolitan Syracuse Wastewater Treatment Plant (Onondaga Lake Partnership 2009a, NYSDEC and EPA 2005). The Lake drains into the Seneca River through a single outlet located at the northern tip of the Lake (Effler and Hennigan 1996, NYSDEC and EPA 2005).

Over the last century and a half, the Lake and surrounding area have experienced development and industrialization, resulting in the discharge of hazardous contaminants and oil to the Lake, the presence of which has adversely affected natural resources and the services they provide. This Chapter reiterates and expands upon background information provided in the 1996 DAP. Specifically, it outlines the natural resources of the Lake and the services they provide, presents an overview of the industrialization of the Lake, lists those hazardous substances upon which the assessment will likely focus, and describes some of the remedial efforts that have been performed to-date. It also defines the geographical and temporal scope of the assessment.

EXHIBIT 2-1 MAP OF ONONDAGA LAKE AND THE SURROUNDING AREA



NATURAL RESOURCES AND THE SERVICES THEY PROVIDE

Natural resources are defined in the DOI regulations as:

> *Land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States (including the resources of the fishery conservation zone established by the Magnuson Fishery Conservation and Management Act of 1976), any State or local government, any foreign government, any Indian tribe, or, if such resources are subject to a trust restriction on alienation, any member of an Indian tribe. These natural resources have been categorized into the following five groups: surface water resources, ground water resources, air resources, geologic resources, and biological resources (43 C.F.R. § 11.14 (z)).*

The Lake, its tributaries, wetlands, and surrounding upland habitat are components of a complex ecosystem that is composed of and supports a variety of natural resources. Though the Lake and its tributaries historically included ecologically significant marl fens and inland salt marshes, the extent of wetland areas has decreased over the last century and a half (NYSDEC/TAMS 2002a). Currently, in addition to the Lake's tributaries, there are 22 state-regulated wetlands within two miles of the Lake. The Lake and its adjoining habitats currently provide a range of ecological and human use services, and likely provided additional services prior to the release of hazardous substances and oil. Ecological services are defined in the DOI regulations as "the physical and biological functions performed by the resource including the human uses of those functions. These services are the result of the physical, chemical, or biological quality of the resource" (43 C.F.R. § 11.14(nn)).

NATURAL RESOURCES

Although the Lake historically supported a cold water fishery, since at least the early 1900s the Lake has only supported a warm water fishery due to nutrient and ionic waste inputs and associated oxygen depletion at depth from eutrophication (NYSDEC and EPA 2005, Tango and Ringler 1996). In addition, the lake currently supports cool water species as well as transitory cold water species. Historical, cold water fish that are no longer resident included Atlantic salmon (*Salmo salar*), burbot (*Lota lota*), and the commercially significant Onondaga Lake whitefish (or cisco; *Coregonus artedii*). Tango and Ringler (1996) found that, as of the late 1980s, the Lake contained approximately 54 fish species, including gizzard shad (*Dorosoma cepedianum*), freshwater drum (*Aplodinotus grunniens*), carp (*Cyprinus carpio*), white perch (*Morone Americana*), catfish (*Ictalurus punctatus*) largemouth bass (*Micropterus salmonides*), smallmouth bass (*Micropterus dolomieui*), and walleye (*Stizostedion vitreum*). The researchers estimated that approximately 60 percent of these 54 species were able to successfully reproduce in the Lake. Since 2000, 45 fish species have been sampled within the Lake; in 2009, fish surveys located 29 species (EcoLogic 2010). Of these 29 fish species, surveys located larvae or young-of-year individuals for 16 species.

As of 1992, over 22 species of algae and 11 species of diatoms, as well as other phytoplankton, and over 25 different species of zooplankton had been catalogued in the Lake.[4] In addition, numerous nematodes, annelids, mollusks, and arthropods inhabit the Lake sediments (NYSDEC/TAMS 2002a).

Wetlands and shallow shore areas support macrophytes (aquatic plants), amphibians, aquatic reptiles, and birds and mammals. As of 2009, 20 species of macrophytes, the majority of which were submerged macrophytes, were found in samples taken from the Lake (EcoLogic 2010).

In the mid- to late-1990s, seven species of amphibians were found within 250 m of the Lake shoreline, including American toad (*Bufo americanus*), grey tree frog (*Hyla chrysoscelis*), spring peeper (*Pseudacris crucifer*), green frog (*Rana clamitans*), northern leopard frog (*Rana pipens*), spotted salamander (*Ambystoma maculatum*), and eastern newt (*Notophthalmus viridescens*). Surveys also identified six species of reptiles, including northern water snake (*Nerodia sipedon*), brown snake (*Storeria dekayi*), garter snake (*Thamnophis sirtalis*), snapping turtle (*Chelydra serpentina*), painted turtle (*Chrysemys picta*), and musk turtle (*Sternotherus odoratus*). This number is considerably less than the number of species found county-wide in the early- to mid-1990s (19 amphibian and 15 reptile; Ducey et al. 1998).

The Lake is within the Atlantic flyway, providing habitat for both migrating and resident birds. One-hundred and twelve bird species have been identified utilizing the Lake and its shoreline, including bald eagle (*Haliaeetus leucocephalus*), great blue heron (*Ardea herodias*), American kestrel (*Falco sparverius*), wild turkey (*Melagris gallopavo*), great horned owl (*Bubo virinianus*), red-headed woodpecker (*Melanerpes erythrocephalus*), Baltimore oreole (*Icterus galbula*), and loon (*Gavia immer*). In addition, migratory shorebirds and waterfowl breed and nest in and around the Lake (U.S. FWS 2005, NYSDEC/TAMS 2002a).

Mink (*Mustela vison*), woodchuck (*Mamota monax*), muskrat (*Ondatra zibethicus*), and squirrel (*Sciurus carolinensis*) have been observed along the shores of the Lake, which serve as prey for larger predators like fox (*Vulpes fulvia* and *Urocyon cinereoargenteus*) and coyote (*Canis latrans*). In addition, the less urbanized northwest shoreline is known to shelter beaver (*Casto Canadensis*) and deer (*Odocoileus virginianus*) (NYSDEC and EPA 2005).

Eleven state-listed and one Federally-listed rare, threatened, or endangered species have been observed in the vicinity of the Lake. These include three state-listed plant species: Sartwell's sedge (*Carex sartewelli*), little-leaf tick-trefoil (*Desmodium ciliare*), and red pigweed (*Chenopodium rubrum*); five bird species of special concern (common loon (*Gavia immer*), osprey (*Pandion haliaetus*), sharp-shinned hawk (*Accipiter striatus*), common nighthawk (*Chordeiles minor*), red-headed woodpecker (*Melanerpes erythrocephalus*), and homed lark (*Eremophila alpestris*)); two bird species classified as a

[4] Phytoplankton are microscopic aquatic plants, zooplankton are microscopic animals.

threatened species in the State of New York (the common tern (*Sterna hirundo*) and the bald eagle (*Haliaeetus leucocephalus*)); and one Federally-listed endangered bat species (Indiana bat (*Myotis sodalis*)) (U.S. FWS 2005, NYSDEC/TAMS 2002a).

ECOLOGICAL SERVICES

Each of these natural resources provides a variety of ecological services. For example, the Lake provides habitat for numerous aquatic plant and animal species. Wetland plant communities provide protective cover, spawning, and nursery habitat for aquatic biota, aid in nutrient cycling, maintain hydraulic flows, and improve water clarity by promoting sedimentation of particulate matter. Phytoplankton and zooplankton serve as prey for fish, amphibians, reptiles, birds, and small mammals and help to cycle nutrients in aquatic habitats. Fish, amphibians, and reptiles help to control insect populations and serve as prey for higher trophic level organisms, such as birds and mammals. When these resources are injured by the release of hazardous substances or oil, the services they provide may be reduced or eliminated.

HUMAN USE SERVICES

Human uses of the natural resources of the Lake began centuries ago, as the Lake was a center of the Haudenosaunee Confederacy, a group of six Native American tribes, including the Onondaga Nation.[5] Historically, the Lake and its surrounding area have provided an environment where the Onondaga Nation has engaged in building homes and communities, subsistence fishing, hunting, trapping, collecting plants and medicine, planting agricultural crops, performing ceremonies with the natural world that are dependent on the Lake, and burying ancestors. Beginning in the late 1700s, European settlers established themselves in the vicinity of the Lake, at first harvesting wildlife for fur and subsistence, and later initiating commercial salt production on the shores of the Lake. By the 1900s, the Lake became a resort destination, providing recreational services and a ready and available source of fish for consumption. Also at that time, industrial processes that capitalized on the availability of brine waters flourished (e.g., the production of soda ash by the Solvay Process Company), paving the way for an active chemicals industry on Lake shores (Onondaga Lake Partnership 2009a). Due to industrial-related contamination, fishing was banned in the Lake between 1970 and 1986. Beginning in 1986 catch-and-release fishing was permitted under a fish consumption advisory of “eat none” until the year 1999. This advisory remains in effect for walleye and small- and largemouth bass larger than 15 inches, as well as carp, channel catfish and white perch (U.S. FWS 2005, NYSDOH 2010). Swimming was banned in the Lake in 1940 due to sewage contamination. Currently, there are no recreational beaches along the shores of the Lake (Onondaga Lake Cleanup Corp. 2001).

Current human use services provided by the Lake include some limited-contact water recreation, such as fishing and boating, and use of adjacent parks and shoreline for

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[5] The Haudenosaunee Confederacy (including the Mohawk, Oneida, Onondaga, Cayuga, Tuscarora, and Seneca Nations) was initially formed at the shore of Onondaga Lake over 1,000 years ago.

activities like walking, jogging, bicycling, and potentially bird and wildlife viewing and appreciation (NYSDEC/TAMS 2002c). Limited hunting is also conducted on the Lake.[6]

The Onondaga Nation views the Lake as an important cultural resource. The Onondaga Nation sees itself as a steward of the Lake, a responsibility mandated by the *Gayanashagowa*, or the "Great Law of Peace," and views the Lake as the Nation's homeland.[7] Further, the Lake is the spiritual, cultural, and historical center of the Haudenosaunee Confederacy.

INDUSTRIAL ACTIVITIES

Industrialization of the Lake originally occurred due to the ready availability of salt from nearby salt springs, among other reasons. From 1794 until the late 1800s, salt manufacturing facilities dominated industry around the Lake. In 1881, as salt manufacturing was declining, the Solvay Process Company constructed a soda ash (Na_2CO_3) production facility on the southwestern shore of the Lake (Effler and Hennigan 1996). Over time, the original soda ash plant expanded both in size and in the types of chemicals produced. Eventually, the plant was split into three separate facilities (the Honeywell facilities): the Main Plant (1884-1986), which produced soda ash and a variety of benzene products; the Willis Avenue Plant (1918-1977), which manufactured chlor-alkali products and chlorinated benzenes; and the Bridge Street Plant (1953-1988), which produced chlor-alkali products and hydrogen peroxide (NYSDEC/TAMS 2002b). Industrial activities associated with these facilities are discussed in greater detail in the 1996 DAP. In addition to the primary Honeywell facilities, a variety of other industrial facilities have existed along the shores of the Lake and its tributaries. These include, but are not limited to:

- The General Motors (GM) Former Inland Fisher Guide Facility: this plant is located next to Ley Creek and specialized in manufacturing and finishing plastic and metal auto parts, producing wastes containing elevated levels of PCBs and metals (NYSDEC/TAMS 2002b).
- The Town of Salina Landfill: this municipal landfill, which received both domestic and commercial waste from the 1950s through the 1970s, is also located along Ley Creek (NYSDEC/TAMS 2002b). It is likely that some of the GM facility wastes were deposited at the Town of Salina Landfill, which leaches contaminants into Ley Creek (elevated levels of PCBs and metals have been found in the sediments of Ley Creek; NYSDEC/TAMS 2002b).

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[6] Though not tied to a particular location in the State, NYSDOH has issued a general statewide consumption advisory for snapping turtles (women of childbearing age, infants, and children under the age of 15 should eat none due to PCB contamination), mergansers (eat none, due to PCB, mirex, chlordane, and DDT contamination) and wild waterfowl (eat no more than two meals per month, due to PCB, mirex, chlordate, and DDT contamination) (NYSDOH 2010).

[7] In the 1794 Treaty of Canadaigua the U.S. government recognized Onondaga Lake as part of the Onondaga Nation's aboriginal territory.

- The Oil City Area: this area, located between Onondaga Creek and Interstate 81, was primarily used for the bulk storage of petroleum hydrocarbons, though some other organic chemicals, including chlorinated compounds and PCBs, were also stored there. Activities in Oil City led to the contamination of groundwater (and potentially Lake and Onondaga Creek sediment) with chlorinated and non-chlorinated hydrocarbons, including PAHs (NYSDEC/TAMS 2002a).
- Two industrial properties, the Penn-Can property (owned formerly by AlliedSignal, and used for asphalt production, storage and disposal) and the CSX Railroad area, along with Lakeshore property owned by Honeywell constitute the Wastebed B / Harbor Brook sub-site, and are a source of dense non-aqueous phase liquid (DNAPL) polycyclic aromatic hydrocarbon (PAH) contamination (and other contaminants, including mercury, BTEX (benzene, toluene, ethylbenzene, and xylene), and chlorinated benzenes) to the Lake directly and via Harbor Brook and the East Flume (NYSDEC/TAMS 2002b).
- Contaminants associated with the Crucible Materials Corporation (Crucible Doring Property and Crucible Lake Pump Station) operations and disposal areas include metals, oils, and possibly PCBs. Crucible has had 12 permitted outfalls that discharge to Tributary 5A, a tributary to the Lake (NYSDEC/TAMS 2002b).
- Additional sites, including American Bag and Metal, Niagara Mohawk (Erie Boulevard and Hiawatha Boulevard sites), Roth Steel, Solvents and Petroleum Services, and Lockheed Martin (Bloody Brook) have been identified as potential sources of hazardous contaminants and oil in the assessment area (Onondaga Lake Partnership 2009b, Arcadis 2009, Arcadis 2008, NYSDEC 2004, NYSDEC/TAMS 2002b).

CONTAMINANTS OF CONCERN

Although a wide variety of hazardous substances and oil have been documented in the aquatic habitats of the Lake and adjacent terrestrial habitats, this assessment will focus on a sub-set of contaminants for which environmental exposure and effects data are available or may be reasonably generated. Contaminants of concern (CoCs) are listed in Table 1-1 of the 1996 DAP and include, but may not be limited to:

- Polychlorinated biphenyls (PCBs);
- Polycyclic aromatic hydrocarbons (PAHs);
- Dioxins/Furans;
- Metals (cadmium, copper, lead, mercury, nickel, and zinc);
- Dichlorodiphenyl-trichloroethane (DDT) and its breakdown products (DDE and DDD);
- Aldrin / dieldrin;
- Benzene, toluene, ethylbenzene, and xylenes (BTEX); and
- Chlorinated benzenes.

REMEDIAL ACTIVITIES

A number of remedial activities to address contamination have been undertaken in and around the Lake since the publication of the 1996 DAP. In total, there are currently 25 separate operable units (OUs) for the Onondaga Lake Superfund Site (including sub-sites) (EPA 2010).[8] While investigations and remedial planning are ongoing at most of these sites, including at the Lake itself (Lake Bottom sub-site), a number of remedial actions have taken place at several of the sub-sites within the larger Onondaga Lake Superfund site (Exhibit 2-2). In general, two types of remedial activities have been implemented: (1) interim remedial measures to address human health and environmental risks and, (2) long-term remedial actions (EPA 2008, 2005).

Examples of interim remedial measures performed since publication of the 1996 DAP include, but are not limited to (EPA 2010, 2008, 2005):

- Removal of portions of an on-site sewer system and plugging sewers remaining on-site to address residual mercury contamination at the LCP Bridge Street sub-site (conducted in 2000).
- Demolition and removal of on-site buildings and structures contaminated with mercury at the LCP Bridge Street sub-site (conducted in 2001).
- Cleaning and modification of storm drains for Interstate-690, downgradient from the Willis Avenue and Semet Tar Ponds sub-sites (conducted in 2003, 2005, and 2007; work is still underway).
- Installation of a groundwater barrier wall and groundwater collection and treatment system downgradient from the Willis Avenue and Semet Tar Ponds sub-sites (i.e., between the sub-sites and the Lake; conducted from 2006 through 2009).
- Recovery of chlorobenzene dense non-aqueous phase liquids (DNAPLs) at the Willis Avenue sub-site (ongoing).

Interim remedial measures to address contaminated soils and sediments in Geddes Brook and the East Flume are also currently planned.

In addition, the complete remediation of two sub-sites has been achieved (EPA 2010, 2008, 2005).

- Excavation, off-site treatment and disposal, and some on-site disposal and capping of PCB-contaminated soils at the Ley Creek PCB Dredgings sub-site (conducted from 1999 through 2000).
- Treatment of soil contaminated with elemental mercury and recycling of approximately eight tons of elemental mercury; consolidation of mercury

[8] The Onondaga Lake Superfund Site includes "the lake itself, its tributaries and the upland hazardous waste sites which have contributed or are contributing contamination to the lake (sub-sites)." (EPA 1994)

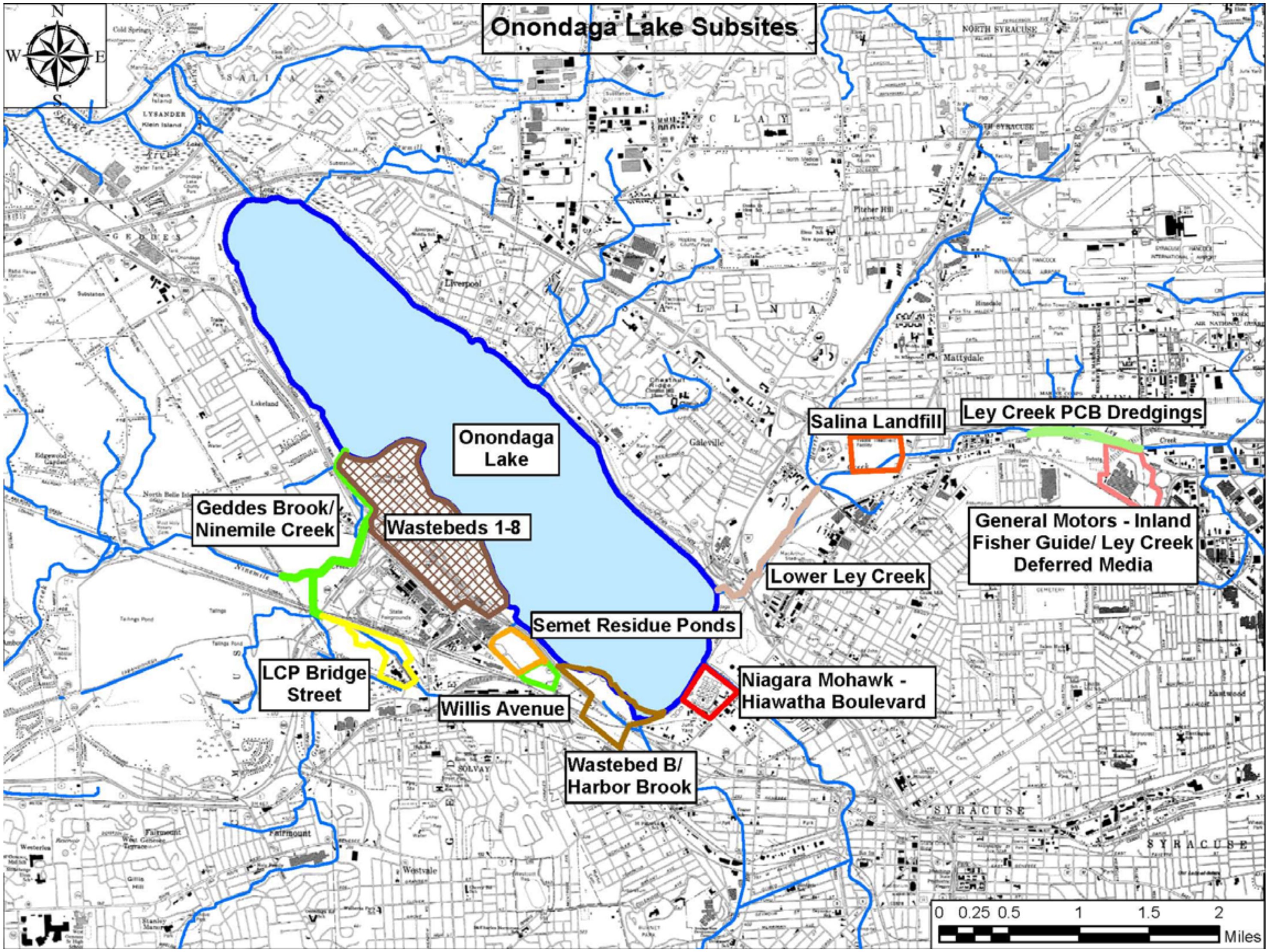
contaminated sediment and soil; construction of a slurry wall and groundwater extraction and treatment system; and construction of a temporary soil cover at the LCP Bridge Street sub-site.[9]

Remedial actions planned for the near future include activities to address contamination at the Semet Residue Ponds and the Salina Landfill.

As noted above, numerous sub-sites are still being evaluated. Remedial investigations, feasibility studies, and/or other site-specific assessments and evaluations are currently underway at additional sub-sites, including the GM Inland Fisher Guide, Niagara Mohawk (Hiawatha Boulevard), Wastebed B/Harbor Brook, Willis Avenue, Wastebeds 1 through 8, Geddes Brook/Ninemile Creek, and Lake Bottom sub-sites. Each of these sites are at different stages of the investigation and remedial process. For example, Records of Decision (RODs) have been completed for the Lake Bottom sub-site (which mandate a remedy for the Lake that includes dredging and capping of sediments), and the Geddes Brook/Ninemile Creek, Niagara Mohawk Hiawatha Boulevard, and Salina Landfill subsites (NYSDEC and EPA 2005, Hesler 2010). Additional information related to these sites, each of the 25 OUs, and the Onondaga Lake Superfund Site in general is available at http://www.dec.ny.gov/chemical/37558.html#Onondaga and http://cfpub.epa.gov/supercpad/cursites/csitinfo.cfm?id=0203382.

[9] It is anticipated that the LCP Bridge Street sub-site will be used as a staging area for remediation of the Geddes Brook/Ninemile Creek sub-site; after which, the temporary cover at the LCP Bridge Street sub-site will be replaced with a permanent cap (EPA 2008).

EXHIBIT 2-2 ONONDAGA LAKE SUPERFUND SITES AND SUB-SITES



GEOGRAPHIC SCOPE

The assessment area is based on the geographic scope within which trust resources have been directly or indirectly affected by the CoCs (43 C.F.R. § 11.14 (c)). Chapter 2 of the 1996 DAP discusses geographic scope. This area includes, but is not limited to: the aquatic habitat of the Lake (both Lake bottom and shoreline wetlands) and each of its tributaries (Ninemile Creek / Geddes Brook / West Flume, Onondaga Creek, Ley Creek, Sawmill Creek, Harbor Brook, Bloody Brook, Tributary 5A, and East Flume), seasonal wetlands associated with these water bodies, as well as all terrestrial sub-sites being evaluated as part of the Onondaga Lake Superfund Site.

TEMPORAL SCOPE

The temporal scope of the assessment is based on determination of both injury to natural resources and corresponding damages. Injury has occurred when there is:

> *A measurable adverse change, either long- or short-term, in the chemical or physical quality or the viability of a natural resource resulting either directly or indirectly from exposure to a…release of a hazardous substance (43 C.F.R. § 11.14 (v)).*

Although industrial activity around the Lake may have discharged hazardous substances and oil to the study area as early as the beginning of the 20th century, documented natural resource exposure to hazardous contaminant releases within the study area has occurred since at least 1946, when mercury discharges associated with chlor-alkali operations are known to have first occurred (Effler and Hennigan 1996, Rowell 1992). Therefore, injury to ecological resources due to contamination has likely occurred since at least that time and is expected to continue into the future.

Damages are “the amount of money sought by the natural resource trustee as compensation for injury, destruction, or loss of natural resources” (43 C.F.R. § 11.14(1)). Under CERCLA, ecological and recreational use damages are calculated beginning in 1981 (in accordance with relevant statutory language and case law) and continuing at least through the expected date of resource recovery to baseline. The rate of resource recovery will be determined based on information related to remedial and restoration activities, natural attenuation, and resource recoverability. Because they are less clearly divisible, cultural losses may be assessed beginning when Onondaga Nation members began noticing changes in their environment, and may continue indefinitely. In addition, the Nation or the State of New York may recover damages under state or common law.

Natural resources within the assessment area have been and continue to be adversely affected by both historical pollution and the continuing discharge and release of contaminants to the Lake and its tributaries and wetlands. This chapter demonstrates injury to trust resources exposed to contamination from these releases, which motivates and provides additional weight of evidence for studies proposed in this DAP Addendum.

Determination of injury to natural resources consists of documentation that there is: (1) a viable pathway for the released hazardous substance from the point of release to a point at which natural resources are exposed to the released substance, and (2) that injury of site-related resources (i.e., surface water, sediment, soil, groundwater, biota) has occurred as defined in 43 C.F.R. § 11.62.[10]

PATHWAY

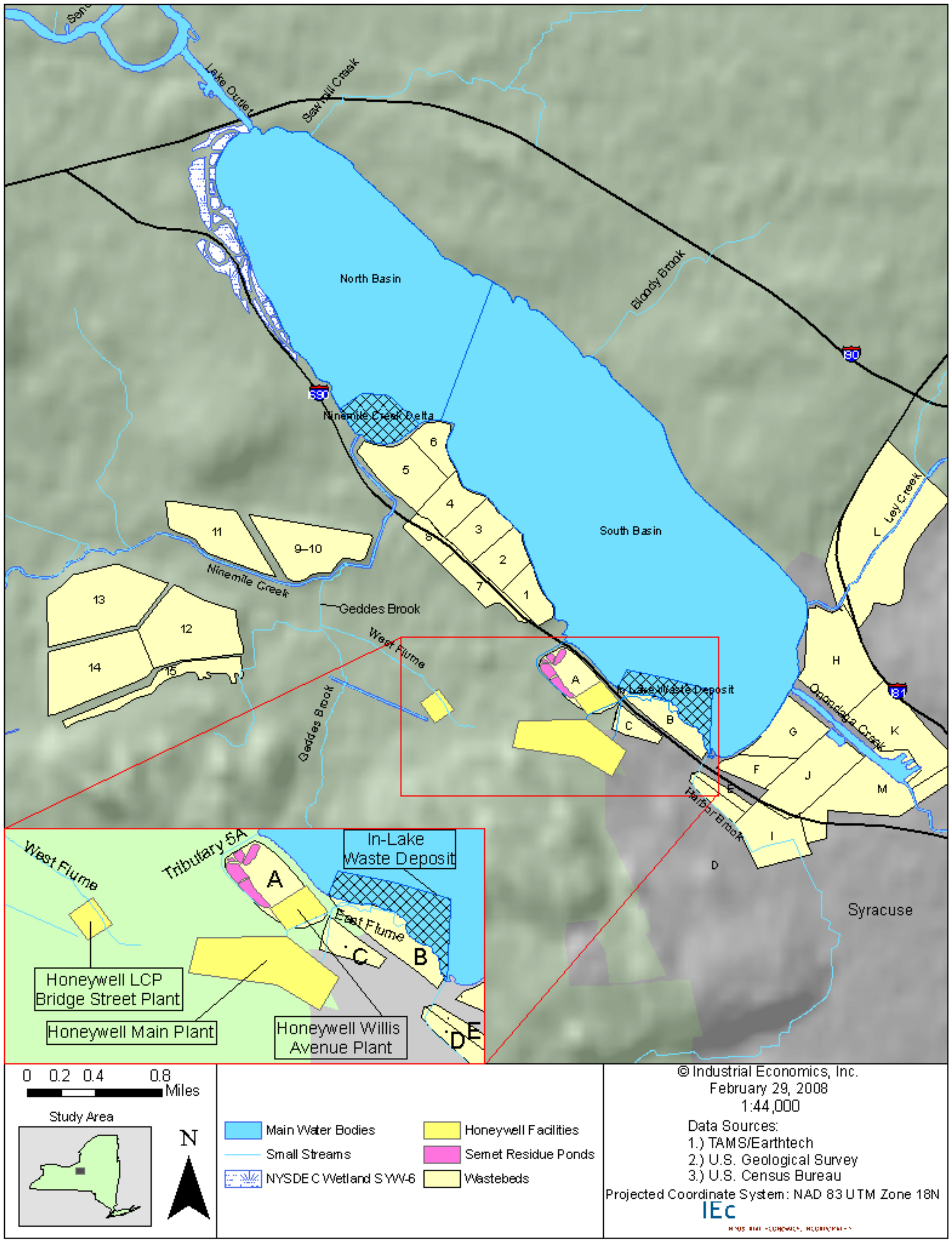
Pathway is defined as:

> *The route or medium through which…a hazardous substance is or was transported from the source of the discharge or release to the injured resource (43 C.F.R. § 11.14(dd)).*

Due to the number of industrial facilities surrounding the Lake, a variety of pathways exist for the CoCs to reach natural resources within the study area. These pathways are discussed in detail in Chapters 4 and 6 of the NYSDEC/TAMS Onondaga Lake Remedial Investigation Report (2002b). Below are descriptions of contaminant pathways tied to the direct discharge of hazardous contaminants to the Lake. Exhibit 3-1 shows some contaminant source areas adjacent to the Lake.

[10] This DAP Addendum focuses primarily on those areas where contamination has been linked to Honeywell operations, as at this point in time only Honeywell has entered into a cooperative agreement with the Trustees to conduct a NRDA. As such, the Trustees rely primarily on data presented in the November 19, 2007 release of the Onondaga Lake Database and the associated Remedial Investigation, Baseline Ecological Risk Assessment, and Human Health Risk Assessment (NYSDEC/TAMS 2007, 2002a, 2002b, 2002c).

EXHIBIT 3-1 CONTAMINANT PATHWAYS FOR THE LAKE



EAST FLUME

One of the principal historic sources of CoCs to the Lake is the East Flume. The Honeywell Main Plant and later the Honeywell Willis Avenue Plant both piped waste material to the East Flume, which flows directly into the southwestern corner of the Lake (Figure 3-1; NYSDEC/TAMS 2002b). Waste material from the Main Plant contained Solvay Process Waste (calcium chloride, excess calcium oxide, unreacted calcium carbonate, and sodium chloride; Effler and Hennigan 1996) and byproducts of the plant's benzene production, including BTEX and PAHs (NYSDEC/TAMS 2002b). Waste material from the Willis Avenue Plant contained mercury (used in the chlor-alkali process; Effler 1996), chlorinated benzenes, and PCBs. Elevated levels of these contaminants have been documented in the Lake (NYSDEC/TAMS 2002b). In particular, the in-lake waste deposit (a large delta formed at the mouth of the East Flume in the southwestern corner of the Lake) contains some of the highest concentrations of mercury, PAHs, and PCBs in the Lake.

RESUSPENSION OF IN-LAKE WASTE DEPOSIT SEDIMENT

The in-lake waste deposit's location, near the shore of the southwestern corner of the Lake, subjects the deposit to wave disturbance caused by wind. Further, the relatively short period of time over which sediments were deposited from the East Flume makes the in-lake waste deposit unstable. Resuspension of CoCs contained in the in-lake waste deposit has been documented. For example, surface water mercury concentrations near the in-lake waste deposit are higher than surface water mercury concentrations in other areas of the Lake (NYSDEC/TAMS 2002b).

NINEMILE CREEK AREA

The Honeywell LCP Bridge Street Plant discharged waste materials into the West Flume, which flows into Geddes Brook and then into Ninemile Creek, one of the major tributaries to the Lake. Waste materials from the Bridge Street Plant contained high levels of mercury and other CoCs, and elevated levels of mercury were documented in the sediments of the West Flume, Geddes Brook, Ninemile Creek, and the Ninemile Creek delta in the Lake. Similar to the in-lake waste deposit, resuspension of sediments containing elevated levels of mercury during periods of high water flow (i.e., during the spring thaw or during storm events) have been documented in Ninemile Creek (NYSDEC/TAMS 2002b).

GROUNDWATER FLOW FROM THE SOUTHWESTERN SHORE

The Semet Residue Ponds, Wastebed B, and the Willis Avenue sites are located along the southwestern shore of the Lake. The Semet Residue Ponds were constructed within former Solvay wastebeds and were used to contain organic waste from benzene production at the Honeywell Main Plant (NYSDEC/TAMS 2002b). Several CoCs, including PAHs and mercury, exist at high concentrations within these ponds. CoCs leach from the residue ponds into the underlying groundwater, which then seeps into the Lake and Tributary 5A, a minor tributary to the Lake located northwest of the East Flume. PAHs (especially naphthalene) from Wastebed B leach via groundwater to

Harbor Brook and the Lake, and a DNAPL plume under the Willis Avenue and Wastebed B sites has been a source of chlorinated benzenes to the Lake (see Remedial Activities section above) (NYSDEC/TAMS 2002b).

LEY CREEK

The GM former Inland Fisher Guide facility and the Ley Creek Dredgings site, located adjacent to Ley Creek, along with other industrial sites in the Ley Creek watershed, have been shown to be a source of PCBs, solvents, and metals (including copper, nickel, and chromium) to Ley Creek, and subsequently the Lake. The Town of Salina landfill and the adjacent urban areas are also likely sources of contamination (including PCBs) to the Lake via Ley Creek (NYSDEC/TAMS 2002b).

ONONDAGA CREEK

Several industries along Onondaga Creek may contribute or have contributed hazardous waste contamination to the creek (directly or indirectly via groundwater) and downstream to the Lake. These include the Erie Boulevard and Hiawatha Boulevard Niagara Mohawk former manufactured gas plant sites, the Roth Steel site, and the American Bag and Metal site. Operations at these facilities resulted in the contamination of soil and groundwater with CoCs, including DNAPL PAHs, which may have migrated to Onondaga Creek and the Lake (NYSDEC/TAMS 2002b).

BIOAVAILABILITY OF CONTAMINANTS

Elevated concentrations of CoCs have been measured directly in trust resources, indicating that once CoCs are released to the Lake and surrounding areas, they are readily available for uptake into biota. For example, concentrations of mercury have been documented in zooplankton and benthic macroinvertebrates from the Lake, and PCBs, DDT and metabolites, endrin, and metals, including mercury, have been documented in fish sampled from the Lake and Ninemile Creek Area (NYSDEC/TAMS 2002a).

INJURY TO SURFACE WATER RESOURCES

Under the DOI regulations, injury to surface water from the release of a hazardous substance has occurred when concentrations and duration of substances are:

> *(i) In excess of drinking water standards established by…[the] SDWA, or by other Federal or State laws or regulations,…in surface water that was potable before…the release;*
>
> *(ii) In excess of water quality criteria established by…[the] SDWA, or by other Federal or State laws or regulations…in surface water that before…the release met the criteria and is a committed use…as a public water supply; or*
>
> *(iii) In excess of applicable water quality criteria established by…the CWA, or by other Federal or State laws or regulations…in surface water that before the…release met the criteria and is a committed use…as a habitat for aquatic life, water supply, or recreation (43 C.F.R. § 11.62 (b)(1)).*

Note that "the most stringent criterion shall apply when surface water is used for more than one of these purposes" (43 C.F.R. § 11.62 (b)(1)(iii)).

Injury to surface water is determined by comparing measured surface water concentrations in the assessment area to ambient Aquatic Life Water Quality Criteria (WQC) promulgated by EPA. These include chronic and acute criteria, which represent "not-to-exceed" concentrations for ambient waterbodies. The chronic criterion, or Criteria Continuous Concentration (CCC), represents the concentration of a given contaminant not to be exceeded over a four-day averaging period. The Criteria Maximum Concentration (CMC) is typically less stringent and represents the concentration not to be exceeded over a one-hour averaging period (EPA 2009).[11] Exhibit 3-2 presents surface water concentration ranges for the sub-set of CoCs that exceeded these criteria, indicating injury. Concentrations of cadmium and lead in the Lake exceeded corresponding WQC, whereas PCB, mercury, and nickel concentrations did not. Limited surface water samples collected in Ninemile Creek indicate that concentrations of CoCs generally have not exceeded WQC in this area.[12] No surface water data are available for wetlands in the assessment area.

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[11] New York State has promulgated water quality criteria for the protection of aquatic life based on dissolved metals concentrations. However, this assessment applies the EPA criteria because contaminant concentrations in the majority of site-specific samples are measured as whole water samples. Where dissolved site-specific concentrations are used (i.e., mercury), the NYS criterion for mercury is the same as the Federal criterion.

[12] Of 12 surface water samples collected in Ninemile Creek for cadmium, lead, mercury, and nickel in 1998, no samples exceeded the CCC or CMC (NYSDEC/TAMS 2007).

EXHIBIT 3-2 EXAMPLE SURFACE WATER CONCENTRATIONS OF COCS IN THE LAKE THAT EXCEED CORRESPONDING WATER QUALITY CRITERIA [1]

CONTAMINANT [2]	YEARS OF DATA[3]	NUMBER OF SAMPLES	CONCENTRATION RANGE (PPB) [4]	CCC [5] (PPB)	CMC [5] (PPB)
Cadmium (Total)	1992	88	BDL (1.0) – 2.9	0.3	2.9
Lead (Total)	1992, 1999	90	BDL (0.5) – 7.7	4.7	119.6

Notes:

1. Source of contaminant information: NYSDEC/TAMS Onondaga Lake Database released on September 30, 2009.
2. Total concentrations are contaminant concentrations measured in whole water samples (EPA 2009).
3. Of 12 surface water samples collected in Ninemile Creek for cadmium, lead, mercury, and nickel in 1998, no samples exceeded the CCC or CMC (NYSDEC/TAMS 2007).
4. BDL is below detection limit. One half of the detection limit is presented in parentheses.
5. CCC is the Criteria Continuous Concentration. CMC is the Criteria Maximum Concentration. These hardness-based thresholds are calculated using the minimum water hardness for the Lake of 135 mg/L based on samples collected in 1992. This hardness value is consistent with the hardness value used in the NYSDEC/TAMS Baseline Ecological Risk Assessment (EPA 2009; NYSDEC/TAMS 2002a). See footnote 11 below for additional detail on water quality criteria used in this analysis.
6. New York State has promulgated water quality criteria for the protection of aquatic life based on dissolved metals concentrations. However, this assessment applies the EPA criteria because contaminant concentrations in the majority of site-specific samples are measured as whole water samples. Where dissolved site-specific concentrations are used (i.e., mercury), the NYS criterion for mercury is the same as the Federal criterion.

INJURY TO SEDIMENT RESOURCES

Injury to sediment is defined as a component of injury to surface water resources, and has occurred when:

> *Concentrations and duration of substances [are] sufficient to have caused injury…to ground water, air, geologic, or biological resources, when exposed to surface water, suspended sediments, or bed, bank, or shoreline sediments (43 C.F.R. § 11.62(b)(1)(v)).*

Although no promulgated criteria for contaminant concentrations in sediment exist, one way to demonstrate the potential for injury to sediment in the assessment area is to compare contaminant concentrations to literature-based sediment quality guidelines (SQGs). Though the Trustees may employ other injury-determination approaches in the context of the damage assessment, as a demonstration of the likelihood of injury for purposes of this DAP Addendum, contaminant concentrations are compared to “threshold effects concentrations” (TEC; thresholds below which adverse (i.e., toxic) effects to sediment-dwelling infauna and epifauna are unlikely to occur), and “probable effects concentrations" (PEC; thresholds above which adverse effects are expected to occur), below in Exhibit 3-3 (MacDonald et al. 2000).[13]

Sediment contaminant concentration data for a sub-set of CoCs are available for the Lake for multiple years between 1986 and 2006; for Ninemile Creek for 1998; and for SYW-6 wetland sediments for 2002. Exceedences of TEC and PEC thresholds for numerous contaminants in Exhibit 3-3 above indicate that sediment resources in the Lake, Ninemile Creek, and SYW-6 Wetland have likely been injured.

[13] Infauna are biological organisms that live within sediment, epifauna are biological organisms that live on the sediment surface.

EXHIBIT 3-3 SEDIMENT CONCENTRATIONS OF COCS AND CORRESPONDING SQGS BY SITE [1]

CONTAMINANT	SITE	YEARS OF DATA	NUMBER OF SAMPLES	RANGE[2]	TEC[3]	PEC[3]
PAHS (PPB, DRY WEIGHT)[4]						
Anthracene	Onondaga Lake	1992, 2000, 2006	208	11 – 95,000	57.2	845.0
	Ninemile Creek Area	1997-1999, 2001	35	BDL(22.5) – 1,600		
	Wetlands	2002	5	100 - 750		
Benz(a)anthracene	Onondaga Lake	1992, 2000, 2006	211	BDL(14) – 100,000	108.0	1,050.0
	Ninemile Creek Area	1997-1999, 2001	35	BDL(23.5) – 3,700		
	Wetlands	NA	NA	NA		
Benzo(a)pyrene	Onondaga Lake	1992, 2000, 2006	212	BDL(12) – 65,000	150.0	1,450.0
	Ninemile Creek Area	1997-1999, 2001	35	BDL(22.5) – 2,900		
	Wetlands	2002	5	190 – 2,000		
Chrysene	Onondaga Lake	1992, 2000, 2006	211	BDL(12) – 100,000	166.0	1,290.0
	Ninemile Creek Area	1997-1999, 2001	35	56 – 3,100		
	Wetlands	2002	5	170 – 2,100		
Fluoranthene	Onondaga Lake	1992, 2000, 2006	218	23 – 250,000	423.0	2,230.0
	Ninemile Creek Area	1997-1999, 2001	35	BDL(23.5) – 7,600		
	Wetlands	2002	5	210 – 3,800		
Fluorene	Onondaga Lake	1992, 2000, 2006	206	4.4 – 140,000	77.4	536.0
	Ninemile Creek Area	1997-1999, 2001	35	BDL(22.5) - 960		
	Wetlands	2002	5	110 - 750		
Naphthalene	Onondaga Lake	1992, 2000, 2005, 2006	284	BDL(2.7) – 26,000,000	176.0	561.0
	Ninemile Creek Area	1997-1999, 2001	35	BDL(22.5) – 2,000		
	Wetlands	2002	5	BDL(210) - 950		
Phenanthrene	Onondaga Lake	1992, 2000, 2006	217	BDL(12) – 630,000	204.0	1,170.0
	Ninemile Creek Area	1997-1999, 2001	35	BDL(23.5) – 6,300		

CONTAMINANT	SITE	YEARS OF DATA	NUMBER OF SAMPLES	RANGE[2]	TEC[3]	PEC[3]
	Wetlands	2002	5	60 – 2,000		
	Onondaga Lake	1992, 2000, 2006	212	BDL(14) – 150,000		
	Ninemile Creek Area	1997-1999, 2001	35	99 – 6,500	195.0	1,520.0
Pyrene	Wetlands	2002	5	240 – 3,400		
METALS (PPM, DRY WEIGHT)						
	Onondaga Lake	1992, 2000	269	0.74 – 1,170		
	Ninemile Creek Area	1997-1999, 2001	41	3.5 - 194	35.8	128.0
Lead	Wetlands	2002	5	17.6 - 143		
	Onondaga Lake	1992, 2000, 2005, 2006	497	BDL(0.016) - 77.7		
	Ninemile Creek Area	1990, 1997-1999, 2001-2002	73	0.012 - 21.1	0.2	1.1
Mercury	Wetlands	2002	5	0.19 - 4.5		
	Onondaga Lake	1992, 2000	269	BDL(1.2) – 1,670		
	Ninemile Creek Area	1997-1999, 2001	41	6.4 - 33	22.7	48.6
Nickel	Wetlands	2002	5	5.5 - 52		
PCBS (PPM, DRY WEIGHT)						
	Onondaga Lake	1992, 2000, 2005, 2006	534	BDL(0.01) – 19.0		
	Ninemile Creek Area	1997-1999, 2001	45	BDL(0.01) – 1.0	0.06	0.68
Total PCBs	Wetlands	2002	0	N/A		

Notes:

1. Sources of contaminant information include: NYSDEC/TAMS Onondaga Lake Database released on November 19, 2007.
2. BDL is below detection limit. One half of the detection limit is presented in parentheses.
3. TEC is the Threshold Effects Concentration. PEC is the Probable Effects Concentration (MacDonald et al. 2000).
4. Total PAH data are not available.

INJURY TO GEOLOGICAL RESOURCES

Injury to geological resources has occurred when:

> *One or more of the following changes in the physical or chemical quality of the resource is measured:*
>
> *(1) Concentrations of substances sufficient for the materials in the geologic resource to exhibit characteristics identified under or listed pursuant to section 3001 of the Solid Waste Disposal Act, 42 U.S.C. 6921;*
>
> *(2) Concentrations of substances sufficient to raise the negative logarithm of the hydrogen ion concentration of the soil (pH) to above 8.5 (above 7.5 in humid areas) or to reduce it below 4.0;*
>
> *(3) Concentrations of substances sufficient to yield a salt saturation value greater than 2 milliohms per centimeter in the soil or a sodium adsorption ratio of more than 0.176;*
>
> *(4) Concentrations of substances sufficient to decrease the water holding capacity such that plant, microbial, or invertebrate populations are affected;*
>
> *(5) Concentrations of substances sufficient to impede soil microbial respiration to an extent that plant and microbial growth have been inhibited;*
>
> *(6) Concentrations in the soil of substances sufficient to inhibit carbon mineralization resulting from a reduction in soil microbial populations;*
>
> *(7) Concentrations of substances sufficient to restrict the ability to access, develop, or use mineral resources within or beneath the geologic resource exposed to the oil or hazardous substance;*
>
> *(8) Concentrations of substances sufficient to have caused injury to ground water, as defined in paragraph (c) of this section, from physical or chemical changes in gases or water from the unsaturated zone;*
>
> *(9) Concentrations in the soil of substances sufficient to cause a toxic response to soil invertebrates;*
>
> *(10) Concentrations in the soil of substances sufficient to cause a phytotoxic response such as retardation of plant growth; or*
>
> *(11) Concentrations of substances sufficient to have caused injury as defined in paragraphs (b), (c), (d), or (f), of this section to surface water, ground water, air, or biological resources when exposed to the substances (43 C.F.R. § 11.62(e)).*

Remedial efforts specifically targeting soil clean-up and removal have been performed within the assessment area (e.g., Ley Creek PCB dredging sub-site, LCP Bridge Street sub-site). Investigations of wetland areas around the Lake and the dredge spoils area (located north of Ninemile Creek, containing materials dredged from the delta of Ninemile Creek in the 1960s) indicated that numerous soil metal concentrations (particularly chromium, lead, and mercury) exceeded toxicity thresholds for terrestrial vegetation (i.e., thresholds published by Oak Ridge National Laboratory; Efroymson et al. 1997) (NYSDEC/TAMS 2002a, 2002b). Exceedences of such thresholds indicate the potential for injury to terrestrial plants and geological resources within the assessment area (43 C.F.R. § 11.62(e)(10)). In addition, the Baseline Ecological Risk Assessment for the Lake, which modeled risks to terrestrial animals from consuming CoC-contaminated prey items in these same areas found increased risk to representative bird and mammal species, indicating the potential for injury to both biological and geological resources (NYSDEC/TAMS 2002a; 43 C.F.R. § 11.62(e)(11)).

INJURY TO GROUNDWATER RESOURCES

As indicated in the DOI regulations, an injury to groundwater resources has occurred if a release of hazardous substance or oil is sufficient to cause:

> *One or more of the following changes in the physical or chemical quality of the resource is measured:*
>
> *(i) Concentrations of substances in excess of drinking water standards, established by sections 1411–1416 of the SDWA, or by other Federal or State laws or regulations that establish such standards for drinking water, in ground water that was potable before the discharge or release;*
>
> *(ii) Concentrations of substances in excess of water quality criteria, established by section 1401(1)(d) of the SDWA [Safe Drinking Water Act], or by other Federal or State laws or regulations that establish such criteria for public water supplies, in ground water that before the discharge or release met the criteria and is a committed use, as the phrase is used in this part, as a public water supply;*
>
> *(iii) Concentrations of substances in excess of applicable water quality criteria, established by section 304(a)(1) of the CWA [Clean Water Act], or by other Federal or State laws or regulations that establish such criteria for domestic water supplies, in ground water that before the discharge or release met the criteria and is a committed use as that phrase is used in this part, as a domestic water supply; or*
>
> *(iv) Concentrations of substances sufficient to have caused injury as defined in paragraphs (b), (d), (e), or (f) of this section to surface water, air, geologic, or biological resources, when exposed to ground water (43 C.F.R. § 11.62(c)(1)).*

Within the assessment area, groundwater flows generally from south to north. Although groundwater flows only provide a modest amount of water to the Lake, they have been documented as a significant pathway of contamination (NYSDEC/TAMS 2002b). Groundwater within the assessment area is classified as Class GA, for which the best use has been designated as a source of potable water. Groundwater investigations at various upland sites have revealed CoCs at concentrations exceeding New York State groundwater standards for Class GA groundwater; maximum detected groundwater concentrations exceeding these standards are presented in Exhibit 3-4, indicating injury to groundwater resources (NYSDEC/TAMS 2002b).

EXHIBIT 3-4 COC EXCEEDANCES IN GROUNDWATER SAMPLES COLLECTED AT HONEYWELL SITES

CONTAMINANT	SITE	NUMBER OF SAMPLES	MAXIMUM DETECTION	NYSDEC CLASS GA GROUNDWATER STANDARD
METALS (PPB)				
Cadmium	Willis Avenue	69	11.6	5
	Semet Residue Ponds	25	6	
	LCP Bridge Street	17	11	
	Semet Ponds Lakeshore Area	5	8.3	
	Willis Avenue Lakeshore Area	2	7.8	
Lead	Willis Avenue	69	488	25
	LCP Bridge Street	11	538	
	Semet Ponds Lakeshore Area	5	46	
	Willis Avenue Lakeshore Area	2	40	
	Harbor Brook-Penn-Can Property	7	143	
	Harbor Brook-Lakeshore Property	15	103	
	Willis Ballfield	12	310	
Mercury	Willis Avenue	76	166	0.7
	LCP Bridge Street	62	867	
	Harbor Brook-Lakeshore Property	15	30	
	Willis Ballfield	12	31	
Nickel	Willis Avenue	69	1,730	100
	LCP Bridge Street	5	375	
	Harbor Brook-Penn-Can Property	7	394	
	Harbor Brook-Lakeshore Property	15	222	
ORGANIC CONTAMINANTS (PPB)				
Anthracene	Harbor Brook-Lakeshore Property	17	77	50
Benzo(a)anthracene	LCP Bridge Street	12	0.2	0.002
	Harbor Brook-Lakeshore Property	17	37	
Chrysene	Willis Avenue	39	4	0.002
	Semet Residue Ponds	23	2	
	LCP Bridge Street	12	0.2	
	Harbor Brook-Lakeshore Property	17	29	

CONTAMINANT	SITE	NUMBER OF SAMPLES	MAXIMUM DETECTION	NYSDEC CLASS GA GROUNDWATER STANDARD
Fluoranthene	Harbor Brook-Lakeshore Property	17	120	50
Fluorene	Harbor Brook-CSX Area	5	110	50
	Harbor Brook-Lakeshore Property	17	180	
Naphthalene	Willis Avenue	39	230	10
	Semet Residue Ponds	23	1,100	
	LCP Bridge Street	12	43	
	Semet Ponds Lakeshore Area	5	38	
	Harbor Brook-Penn-Can Property	10	18,000	
	Harbor Brook-CSX Area	5	16,000	
	Harbor Brook-Lakeshore Property	28	24,000	
PCBs	Semet Residue Ponds	22	1.5	0.1
	LCP Bridge Street	15	0.6	
	Wastebeds 9-15	18	0.2	
	Harbor Brook-Penn-Can Property	7	0.3	
Phenanthrene	Harbor Brook-CSX Area	5	60	50
	Harbor Brook-Lakeshore Property	17	340	
Pyrene	Harbor Brook-Lakeshore Property	17	90	50
Xylene (total)	Willis Avenue	84	98	5
	Semet Residue Ponds	44	210	
	Semet Ponds Lakeshore Area	5	6	
	Harbor Brook-Penn-Can Property	10	4,800	
	Harbor Brook-CSX Area	5	1,500	
	Harbor Brook-Lakeshore Property	28	3,500	

Source: NYSDEC/TAMS 2002b, Table G1-102: Exceedence Summary for Inorganics in Groundwater at Honeywell Sites and Table G1-103: Exceedence Summary for Organic Compounds in Groundwater at Honeywell Sites.

INJURY TO BIOLOGICAL RESOURCES

Injury to a biological resource has resulted from the release of a hazardous substance if the concentration of the substance is sufficient to:

> *(i) Cause the biological resource or its offspring to have undergone at least one of the following adverse changes in viability: death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformation, or*

> *(ii) Exceed action or tolerance levels established under section 402 of the Food, Drug and Cosmetic Act, 21 U.S.C. 342, in edible portions of organisms; or*
>
> *(iii) Exceed levels for which an appropriate State health agency has issued directives to limit or ban consumption of such organism (43 C.F.R. § 11.62(f)(1)).*

Information available for resources within the assessment area suggests that vegetation, benthic organisms, and fish have been injured due to the release of hazardous substances. Information further suggests that amphibians, reptiles, birds, and mammals in and around the Lake have been injured due to exposure to hazardous substances. Information demonstrating injury or the potential for injury to these resources is presented below, and studies that are ongoing or planned to assess further injury to these resources are discussed.

VEGETATION

As indicated above, soil concentrations in excess of toxicity thresholds for terrestrial vegetation (i.e., toxic effects thresholds published by Oak Ridge National Laboratory; Efroymson et al. 1997) have been measured in soils in the assessment area, indicating the potential for injury to terrestrial plants (see Injury to Geological Resources, above).

BENTHIC MACROINVERTEBRATES

The potential for injury to benthic invertebrates is demonstrated by sediment CoC concentrations in exceedence of SQGs, the results of sediment toxicity tests, and benthic community data.

Sediment chemical data presented above (Exhibit 3-3) suggests injury to benthic invertebrates in the assessment area. Exceedences of SQGs have been linked with adverse effects on growth, reproduction, and/or survival of benthic organisms exposed to assessment area CoCs. Sediment toxicity tests conducted using Lake sediment confirm this injury, as they are a direct measure of the severity and magnitude of CoC-associated adverse effects on sediment-dwelling organisms. A summary of the results of toxicity tests performed using Lake sediment is presented in Exhibit 3-5.

EXHIBIT 3-5 SUMMARY OF SITE-SPECIFIC SEDIMENT TOXICITY TEST RESULTS FOR ORGANISMS EXPOSED TO LAKE SEDIMENT

SPECIES	PERCENTAGE INCREASE IN MORTALITY	PERCENTAGE REDUCTION IN BIOMASS	PERCENTAGE REDUCTION IN REPRODUCTIVE SUCCESS
1992 RESULTS			
Amphipod	0%	20%	N/A
Chironomid	15%	49%	N/A
2000 RESULTS			
Amphipod	23%	18%	1%
Chironomid	38%	6%	7%

Notes:

1. 1992 results are for 10-day acute toxicity tests utilizing sediment from the top two centimeters of the sediment column; 2000 results are for 42-day chronic toxicity tests utilizing sediment from the top 15 centimeters of the sediment column.
2. Percentage effects are control-adjusted and presented relative to reference toxic effect values estimated for Otisco Lake (based on sediment samples collected in the same year, 1992 and 2000).
3. Source: NYSDEC/TAMS 2002a.

In addition, benthic community structure and diversity in the Lake were assessed in 1992 and 2000. Results from these analyses indicate that the majority of sites sampled throughout the Lake were "moderately impaired," with a predominance of "severely impaired" sites located in and around the in-lake waste deposit. None of the sites sampled was considered "unimpacted" (NYSDEC/TAMS 2002a).[14] Although community structure and benthic diversity could be affected by a variety of factors that may be unrelated to hazardous contamination (e.g., temperature, substrate, salinity), sediment toxicity attributable to the presence of hazardous substances may be at least partially responsible for these community-based effects.

FISH

Injury to fish is demonstrated by the following:

- The presence of a fish consumption advisory (FCA) for the Lake.

[14] Moderately impaired sites are those at which the macroinvertebrate community is altered to a large degree from the pristine state. Severely impaired sites are those at which the macroinvertebrate community is limited to a few tolerant species, usually midges and worms. Often only one or two species are very abundant at severely impaired sites. Unimpacted or non-impaired sites are those at which the macroinvertebrate community is diverse. More detailed definitions of moderately, severely, and non-impaired sites are available in NYSDEC/TAMS (2002a).

- Measured fish tissue contaminant concentrations in exceedence of toxicity thresholds from the peer-reviewed literature.
- Extirpation of fish species and reproductive failure as indicated by fish community surveys, due at least in part to hazardous waste contamination.
- Sediment concentrations of PAHs in excess of toxicological threshold values indicative of injury to fish.

Fish Consumption Advisory

From 1970 to 1985, fishing was banned on the Lake due to contamination. Beginning in 1986, fishing was permitted under a fish consumption advisory, which remains in effect through the current 2010-2011 fishing season. A catch-and-release fishery was maintained until the year 1999 and remains in effect for walleye and small- and largemouth bass larger than 15 inches, as well as carp, channel catfish and white perch (NYSDOH 2010, USFWS 2005). Currently, anglers are advised to eat no more than one fish meal per month of other species (except brown bullhead and pumpkinseed, of which anglers are advised to eat not more than four meals per month) and children under 15 and women of childbearing age are advised to eat no fish from the Lake. The FCA is based on the presence of mercury, dioxin, and PCBs in fish tissues (NYSDOH 2010). Issuance of an FCA constitutes an injury to fish resources under the DOI NRDA regulations (43 C.F.R. § 11.62(f)(1)(iii)).

Fish Tissue CoC Concentrations in Exceedence of Published Toxicity Thresholds

Measured CoC concentrations in fish tissue, when compared to toxicity thresholds from the peer-reviewed literature, demonstrate a likelihood of injury to fish in the assessment area (except for PAHs, as PAHs in fish tissue are not a good indicator of PAH exposure for fish; EPA 2000). Although a variety of contaminants have been measured in fish tissues sampled from the assessment area, concentrations of cadmium, lead, mercury, zinc, and PCBs measured in resident fish are substantially elevated above thresholds for toxic effects. Exhibit 3-6 presents ranges of concentrations of these contaminants measured in fish tissue samples from the Lake and Ninemile Creek and example adverse effects thresholds from the literature. Threshold exceedences indicate the likelihood of injury to fish from these contaminants within the assessment area. Fish tissue CoC concentration data were not available for the SYW-6 wetland.

Fish Community Surveys

As noted in Chapter 2, prior to the 20th century, the Lake supported a cold-water fish community containing Atlantic salmon and Onondaga Lake whitefish. Due in large part to the eutrophication of Onondaga Lake, which stemmed from nutrient loading associated with sewage discharges and ionic enrichment related to industrial operations along the Lake, these cold water species were eliminated from the Lake. The damming of Lake tributaries and industrialization of the areas surrounding the Lake resulted in the loss of riparian habitat, another factor that likely contributed to the decline of Lake fish species. Since the early 1900s, the fish community has shifted to a more pollution-tolerant warm-water fish community, and now supports at least 45 different fish species (Tango and Ringler 1996; EcoLogic 2010). The lake currently supports cool water species as well as transitory cold water species.

The fish community also has likely been adversely impacted by hazardous waste contamination. Specifically, EcoLogic (2010) reported that larvae or young-of-year individuals were found for only 16 of the 29 species documented in the Lake in 2009. This may indicate reduced reproductive success for some species, which could be caused by factors such as lack of suitable habitat for spawning and egg laying, limited dissolved oxygen levels, elevated salinity levels, or concentrations of CoCs.

Contamination may also adversely affect fish growth and abundance in the Lake. Gandino (1996) reported that the average size of smallmouth bass was greater in the northern basin of the Lake than the southern basin; COC concentrations in surface water and sediment are higher in the southern basin. Gandino (1996) also noted that previous studies of fish in the Lake found greater numbers of smallmouth bass in the northern basin than in the southern basin. Although this finding may result from physical and chemical factors unrelated to contamination, it may reflect the effects of increased industrial and sewage contamination in the South Basin relative to the North Basin.

EXHIBIT 3-6 FISH TISSUE CONCENTRATIONS OF COCS IN ONONDAGA LAKE AND THE NINEMILE CREEK AREA AND EXAMPLE TOXICITY THRESHOLDS

CONTAMINANT	SITE	YEARS OF DATA	NUMBER OF SAMPLES	RANGE	THRESHOLD	DESCRIPTION OF EFFECT
METALS (PPM, WHOLE BODY, WET WEIGHT)						
Cadmium	Onondaga Lake	1979, 1991, 1992, 2005	33	BDL(0.003) - 0.71	0.17	Reduced growth in bull trout fry
	Ninemile Creek Area	1998, 2002	26	BDL(0.04) - 0.16		
Lead	Onondaga Lake	1973, 1979, 1991, 1992	8	0.06 - 9.8	0.28	Reduced growth in rainbow trout fry
	Ninemile Creek Area	1998, 2002	26	0.18 - 0.49		
Mercury	Onondaga Lake	1970, 1973-1981, 1983-1992, 1994-2006	2,695	0.03 - 5.7	0.25	Testicular atrophy and impaired development and immune function in walleye
	Ninemile Creek Area	1990, 1998, 2002	31	0.01 - 1.38		
Zinc	Onondaga Lake	NA	NA	NA	20.00	Reduced plasma cortisol levels in yellow perch
	Ninemile Creek Area	1998, 2002	26	BDL(3.00) - 41.3		
ORGANIC CONTAMINANTS (PPM, WHOLE BODY, WET WEIGHT)						
Total PCB	Onondaga Lake	1972, 1975-1976, 1979-1981, 1983, 1985-1992, 1994, 2000, 2002-2003	301	0.05 – 26.3	0.34	Decreased growth and larval survival of fathead minnows
	Ninemile Creek Area	1990, 2002	7	0.25 - 0.34		

Notes:

1. Source of contaminant information: NYSDEC/TAMS Onondaga Lake Database released on November 19, 2007.
2. Sources of toxicity thresholds: Cadmium (Hansen et al. 2002, as cited in ERED database), Lead (Hansen et al. 2004 as cited in ERED Database), Mercury (Friedmann et al. 1996), Zinc (Sherwood et al. 2000 as cited in ERED database), Total PCBs (Matta et al. 2001). ERED: (U.S. ACE and U.S. EPA 2010).
3. Table includes only those CoCs for which there were exceedences of the corresponding toxicity threshold in Onondaga Lake or the Ninemile Creek area (i.e., cadmium in Ninemile Creek; and DDT, aldrin, and dieldrin in both the Lake and Ninemile Creek Area are excluded because no samples of these contaminants exceeded their respective toxicity threshold).
4. There are no fish tissue concentration data available for zinc within Onondaga Lake.
5. Concentrations of contaminants converted to whole body from fillet data using the following conversion factors: Cadmium: 1 (Lechich 1993); Lead: 2 (USGS 1998); Mercury: 0.07 (NYSDEC/TAMS 2002a); Zinc: 3 (ODEQ 2003); Total PCB: 2.5 (NYSDEC/TAMS 2002a).
6. BDL is below detection limit.

Sediment Concentrations of PAHs in Excess of Levels Indicative of Injury to Fish

PAH concentrations in fish tissue are generally inappropriate to indicate exposure to or severity of adverse effect on fish (EPA 2000). However, a number of studies evaluating PAH-induced effects indicate that adverse effects to fish occur when fish are exposed to PAH-contaminated sediment.

For example, yellow perch, northern pike, and winter flounder experienced adverse biochemical effects when exposed to total PAH concentrations in sediment in the low ppm range (Hontela et al. 1992 and Payne et al. 1988, as cited in Eisler 2000). In their work in Puget Sound, Washington, Johnson et al. (2002) developed a threshold effect concentration of 1.0 ppm, dry weight (dw) total PAHs in sediment to be protective of endangered salmon. Johnson et al. (2002, p. 531) state that reduced growth and suppressed immune function in juvenile salmonids "have been observed in fish collected from sites with sediment total PAH levels in the 5.0 – 10.0 ppm [dw] range (Arkoosh et al. 1998; Casillas et al. 1998, 1995). Similarly, Heintz et al. (1999) reported increased mortality in pink salmon embryos exposed to oiled gravel with total PAH concentrations in the 3.8 – 4.6 ppm [dw] range." Horness et al. (1998) related PAH sediment concentrations from other researchers' field survey data to biological effects in English sole, and reported the threshold for adverse effects on fish due to PAH exposure to be in the low ppm dw range.

Although total PAH concentrations for study area sediment are not available, summing the mean concentrations for the individual PAHs for which data are reported indicates that fish are exposed to sediments with PAH concentrations in the range at which adverse effects have been observed. Specifically, the sum of the geometric mean concentrations for PAHs for which data are available total 3.0 ppm dw in the Lake, 2.3 ppm dw in Ninemile Creek, and 4.5 ppm dw in the SYW-6 Wetland, indicating likely injury to fish due to PAHs. If the full suite of PAHs typically measured as part of contemporary PAH analyses had been measured in sediments in these areas, it is likely that concentrations would be even higher than these calculated values.

REPTILES AND AMPHIBIANS

No site-specific data are available on contaminant concentrations in amphibians and reptiles, or that document direct injury to these animals. However, as mentioned in Chapter 2, a four-year, multi-season, herpetological survey of species in and around the Lake conducted in the late 1990s found only seven species of amphibians and six species of reptiles, which the authors noted were "considerably less than the nineteen amphibian species and fifteen reptile species recorded for Onondaga County as a whole during 1990-1996" (NYSDEC 1997, as cited in Ducey et al. 1998, p. 119). Specifically, two common species of salamander, the red backed salamander (*Plethodon cinereus)* and the eastern newt (*Notophthalmus viridescens*), were "notably absent" and "extremely rare," respectively. If conditions at other sample sites were similar to those at Onondaga except for contamination (e.g., habitat type, level of human impact, hydrology, etc.), these results suggest that changes to amphibians and reptile populations within the study area may be due at least in part to hazardous substances contamination (Ducey et al. 1998). Therefore, although it is possible that injury to herpetofauna may have occurred due to exposure to CoCs, available data are currently insufficient to make that determination.

Additional herpetofauna survey studies are currently being planned for the summer of 2011. These additional studies may provide information on the potential exposure of herpetofauna to CoCs.

BIRDS AND MAMMALS

Comparison of contaminant concentrations in food items (e.g., fish for piscivorous birds and mammals; for which extensive data are available) to toxicity reference values (TRVs) indicates the potential for injury to upper trophic level organisms. A variety of TRVs for concentrations of contaminants in fish consumed by piscivorous birds and mammals are available in the toxicological peer-reviewed literature. Of the CoCs, mercury and PCBs are the two contaminants for which the literature provides the most robust set of toxicity information.

The average mercury concentrations in fish caught in the Lake and Ninemile Creek area and corresponding TRVs are presented in Exhibit 3-7. Fish tissue mercury concentrations in excess of diet-based TRVs suggests injury to piscivorous birds and mammals that consume fish from the Lake.

Average fish tissue PCB concentrations in the assessment area and corresponding diet-based TRVs are presented in Exhibit 3-8. PCB concentrations in fish are elevated above the PCB TRV for mink, a species representative of piscivorous mammals, and tern, a species representative of small fish-eating birds. PCB concentrations in larger fish (greater than 10 centimeters), however, are less than diet-based TRVs for osprey, a bird species representative of the large fish-eating bird guild) (Exhibit 3-8). Therefore, information suggests that PCBs in the assessment area have caused injury to piscivorous mammals and birds.

In addition to these types of prey-based approaches, recent studies conducted by the U.S. Fish and Wildlife Service have focused on bird and bat species that rely on the various habitats of the Lake. Findings from a 2008 pilot bird study indicated that insectivorous songbirds and breeding shorebirds had blood mercury concentrations greater than 0.7 μg/g (wet weight), a documented level of concern for adverse effects on songbirds (BRI 2011, Jackson et al. 2011). Twenty-seven of the 80 songbirds collected from five of six sites on the Lake had blood concentrations exceeding this level of concern. All shorebirds sampled (five total: three spotted sandpipers and two killdeer) exceeded the level of concern, with spotted sandpipers having the highest blood mercury concentrations (blood mercury in the three spotted sandpipers sampled ranged from 1.56 to 6.42 μg/g on a wet weight basis) (BRI 2010).

The 2008 bat study indicated that several Lake bat species, including the Federally-endangered Indiana bat, have elevated body burdens of mercury as compared to bats from uncontaminated reference locations.[15] Blood and fur mercury concentrations, used as indicators of mercury exposure for bats sampled in 2008, show that mercury concentrations at the Lake have the potential to adversely affect bats. A comparison of Lake sites with reference sites demonstrates a significant difference in mercury uptake by bats between the two areas. Mean bat fur mercury concentrations were more than three and a half times higher at the Lake sites compared to the reference sites; mean blood mercury concentrations at Lake sites were more than two and a half times higher than those at reference sites. Furthermore, concentrations of mercury measured in bat fur near Onondaga Lake exceeded thresholds indicative of injury to other small mammalian species (e.g., mouse, otter, and mink), indicating likely injury to bats (BRI 2009, Strom 2008, Basu 2006, Burton et al. 1977, 43 C.F.R. § 11.62(f)(1)).

Follow-up studies on the Lake further evaluating potential injury to bird and bat species and exposure of wintering waterfowl and bald eagles to mercury and other CoCs are currently being planned. Some of these studies may include sampling of biological tissues for the presence of CoCs, which can be compared to toxicological thresholds indicative of injury.

[15] Oneida Lake, in Oswego and Oneida Counties, was used as the reference area for the 2008 bat study.

EXHIBIT 3-7 TRVS FOR MERCURY IN THE DIET OF PISCIVOROUS BIRDS AND MAMMALS AND MEASURED CONCENTRATIONS OF MERCURY IN FISH FROM THE LAKE AND THE NINEMILE CREEK AREA

TROPHIC LEVEL	AVERAGE (SAMPLE SIZE) FISH TISSUE MERCURY CONCENTRATION (MG/KG WB WW)[3,4,5]		TRV (MG/KG MERCURY IN DIET)	TRV REFERENCE
	ONONDAGA LAKE	NINEMILE CREEK AREA		
Birds[1]	0.76 (2,695)	0.45 (31)	0.13	Hinck et al. 2006[6]
Mammals[2]			0.1	Basu et al. 2007

Notes:

1. Based on data for belted kingfisher, considered a representative piscivorous bird species.
2. Based mainly on data for mink, considered a representative piscivorous mammal species.
3. Source of contaminant information: NYSDEC/TAMS Onondaga Lake Database released on November 19, 2007.
4. Mercury concentrations were converted to whole body from fillet data using a conversion factor of 1 (Lechich 1993).
5. WB WW = whole body wet weight.
6. TRV based on a lowest observed adverse effect level (LOAEL) of 0.064 mg/kg/day, an average body weight of 0.15 kg, and a food ingestion rate of 0.075 kg/day for belted kingfisher provided in Hinck et al. (2006). TRV is estimated as (LOAEL)x(body weight)/(food ingestion rate).

EXHIBIT 3-8 TRVS FOR PCBS IN THE DIET OF PISCIVOROUS BIRDS AND MAMMALS AND MEASURED CONCENTRATIONS OF PCBS IN FISH FROM THE LAKE AND THE NINEMILE CREEK AREA

TROPHIC LEVEL	AVERAGE (SAMPLE SIZE) FISH TISSUE PCB CONCENTRATION (MG/KG WB WW)[3,4,5]		TRV (MG/KG PCBS IN DIET)	TRV REFERENCE
	ONONDAGA LAKE	NINEMILE CREEK AREA		
Birds[1]				
Osprey (fish >10 cm)	2.29 (300)	0.41 (1)	2.38	Extrapolated from Chapman 2003, CCME 2001, EPA 1995
Common Tern (fish <15 cm)	4.91 (2)	0.27 (6)	0.82	
Mammals[2] (all fish)	2.31 (302)	0.29 (7)	0.25	Hornshaw et al. 1983, Heaton et al. 1995, Jensen et al. 1977

Notes:

1. Based on lowest effects threshold dose of 0.5 mg PCB / kg body weight. To calculate TRV for Osprey: Average body weight = 1500 grams; average ingestion rate = 315 grams/day (based on 210 grams food/kg body weight (BW)/day). To calculate TRV for Common Tern: Average body weight = 127 grams; average ingestion rate = 77.4 grams/day (based on 609 grams food/kg BW/day) (EPA 1993).
2. Based mainly on data for mink, considered a representative piscivorous mammal species.
3. Source of contaminant information: NYSDEC/TAMS Onondaga Lake Database released on November 19, 2007.
4. PCB concentrations were converted to whole body from fillet data using a conversion factor of three (Secord 2006).
5. WB WW = whole body wet weight.

CHAPTER 4 | ECOLOGICAL INJURY QUANTIFICATION APPROACH

Once injury to natural resources has been documented, the DOI NRDA regulations stipulate that "the authorized official shall quantify for each resource determined to be injured and for which damages will be sought, the effect of the discharge or release in terms of the reduction from the baseline condition in the quantity and quality of services" (43 C.F.R. § 11.70(a)(1)). Quantified injuries form the basis for scaling restoration projects designed to compensate the public for lost or injured natural resources. The 1996 DAP includes a section that details baseline determination (Chapter 7) and a discussion of various restoration options (Chapter 8). It does not, however, include a discussion of how the Trustees expect to quantify injury. The Trustees will likely quantify ecological injury on a habitat basis and may also focus on quantifying injury to specific resources of concern (e.g., threatened or endangered species, species of special cultural importance). This chapter presents the methodologies and approaches the Trustees anticipate applying in order to determine baseline conditions and to quantify injury to natural resources and the services they provide.

BASELINE

The 1996 DAP documents a variety of approaches for determining baseline for in-Lake surface water and sediment, tributary surface water and sediment, groundwater, geological, and fish and other biological resources, respectively. Baseline is "the condition or conditions that would have existed at the assessment area had the discharge of oil or release of the hazardous substance under investigation not occurred" (43 C.F.R. § 11.14(e)). As required by the DOI regulations, the Trustees anticipate determining "the physical, chemical, and biological baseline conditions and the associated baseline services for injured resources at the assessment area" and quantifying injury based on a reduction in services (43 C.F.R. § 11.72(a)). Therefore, baseline will be considered the level of services that would have been provided in the absence of the hazardous substance contamination.

Baseline conditions may be established based on the review of historical, pre-release data and information, or on reference locations that exhibit similar physical, chemical and biological conditions as the assessment area, excluding contamination (43 C.F.R. § 11.72). The fact that releases of hazardous substances and oil have occurred within the assessment area prior to the establishment of regular or standardized approaches for the collection of physical, chemical and biological data may necessitate the use of suitable reference locations in lieu of historical data for purposes of baseline determination.

As indicated in the 1996 DAP, uncontaminated "upgradient" locations may be used for characterization of surface water and groundwater baseline conditions, and background soil concentrations could be used to establish baseline for geological resources. The 1996 DAP does not specifically refer to any particular reference area for determination of baseline conditions of other resources.

Since publication of the 1996 DAP, Otisco Lake (which forms the headwaters for Ninemile Creek) was identified as a suitable reference location for sediment, macrophyte transplant, and benthic macroinvertebrate studies conducted as part of remedial investigations (NYSDEC/TAMS 2002b). Owasco Lake, near the city of Auburn in Cayuga County, was used in a site-specific survey by NYSDEC for purposes of evaluating the effect of a hazardous contaminant-related fish consumption advisory on recreational uses of Onondaga Lake.

With respect to reference lakes, the Trustees recognize that use of certain reference lakes may be more appropriate than others depending on the categories of injury and service losses being considered. The Trustees will be flexible and fully analyze all relevant characteristics of reference lakes used to establish baseline for each of the injury and service loss categories pursued. Therefore, the Trustees will evaluate further the potential for use of Otisco and Owasco Lakes as a reference areas for NRDA purposes.

INJURY QUANTIFICATION

The Trustees anticipate quantifying injury to natural resources based on reductions in the level of services provided by resources over time attributable to hazardous substances contamination. This approach is presented in Exhibit 4-1. Furthermore, injury quantification will consider the effect of remedial activities in the assessment area on the return of injured natural resources to their baseline condition.

INTERDEPENDENT SERVICES

The various natural resources that are present within the assessment area are important components of a complex ecosystem that comprises the Lake and its surrounding habitats. Each of these resources (surface water, sediment, groundwater, soil, and myriad biological organisms) perform unique roles and provide services that maintain the proper function of the ecosystem. Therefore, the various services that these natural resources provide are interdependent. Examples of interdependent ecological services provided by trust resources are indicated below:

- **Geological (soil) and sediment resources** provide habitat for biological organisms that live within the soil or sediment, foraging opportunities for biota that reside in the Lake or in upland habitat, growth media for plants, carbon storage, nutrient cycling, decomposition of organic matter, and groundwater filtration and storage.
- **Surface water resources** provide habitat for phytoplankton, zooplankton, fish, amphibians, reptiles, and migratory and resident waterfowl; each of which serve as food sources for biota at higher trophic levels. Surface water also serves as a source of drinking water for terrestrial biota, cycles nutrients, and aids in geochemical and atmospheric exchange processes.

- **Biological resources** serve as food (prey) sources for other biological organisms, maintain the sustainability of the food web, and assist in energy cycling. Plant species also provide shelter (from the elements and as security cover) for animals.
- **Groundwater resources** contribute to base water levels in the Lake and support base flows in Lake tributaries, and are an essential component of the local and regional water cycle.

The injuries documented in Chapter 3 likely have directly adversely affected these resource services. In addition, due to the interdependent nature of the natural resources in the assessment area, resources likely have experienced secondary service losses (e.g., a decrease in benthic invertebrate abundance can lead to a reduction in the abundance of fish that rely on benthic invertebrates as a prey source; 43 C.F.R. § 11.71(b)(4)).

As a result of this potential reduction in the overlapping services provided by natural resources in the assessment area, and consistent with the use of habitat and resource equivalency methods, the Trustees anticipate focusing ecological injury quantification on a sub-set of potentially adversely affected resources that constitute major components of the aquatic and terrestrial ecosystems within the assessment area. In addition, the Trustees may also focus specifically on quantifying ecological injury to resources of special concern (e.g., threatened or endangered species, species of special cultural importance).

HABITATS FOR WHICH INJURY MAY BE QUANTIFIED

For purposes of injury quantification, the Trustees anticipate quantifying ecological service losses to representative resources within four general habitat types in and around the Lake.

- **Open Lake Habitat:** includes the deeper open water and shallow aquatic shoreline habitats of the Lake. The Trustees may divide this habitat into shallow and deep habitat areas based on observed differences in biological community and structure associated with stratification. Potential representative resources the Trustees may use to quantify injury include, but are not limited to: fish, sediment macroinvertebrates, amphibians, reptiles, and piscivorous birds and mammals.
- **Wetland Habitat:** includes the 22 state-regulated, predominantly palustrine wetlands located primarily on the north and northwest sides of the Lake, as well as all other wetlands. Potential representative resources the Trustees may use to quantify injury include those resources listed above for use in Lake habitat injury quantification, as well as additional resources specific to wetlands, such as insectivorous birds.
- **Upland Shoreline Habitat:** includes those terrestrial habitats that are components of the Onondaga Lake Superfund site. Targeted representative resources may include terrestrial invertebrates and insectivorous and omnivorous birds and mammals.

- **Riverine Habitat:** includes the in-stream and riparian habitats of those tributaries that feed the Lake, including Onondaga Creek, Ninemile Creek, Bloody Brook, Sawmill Creek, Tributary 5A, the East Flume, and Harbor Brook. Representative resources that may be used to quantify injury include: sediment macroinvertebrates, fish, amphibians, reptiles, birds, and mammals.

ONGOING, PLANNED, AND POTENTIAL ECOLOGICAL STUDIES

The 1996 DAP outlined a number of specific studies to assess injury and corresponding ecological service losses in the assessment area. These include studies to:

- Assess injuries to wildlife from mercury exposure (Research Study 1),
- Evaluate mercury concentrations in fish from the Seneca/Oswego River (Research Study 2),
- Calculate the acreage and determine ecological functions of wetlands impacted by ionic waste loading (Research Study 3),
- Assess the extent and value of historic wetlands filled with Solvay and other process waste (Research Study 4), and
- Evaluate impacts of ionic waste discharges on aquatic macrophytes (Research Study 5) (Normandeau Associates 1996).

Although these research studies have not been formally undertaken, pilot wildlife injury assessment studies to assess exposure and/or impacts to birds, mammals, reptiles and amphibians are both ongoing and planned. The U.S. Department of the Interior Fish and Wildlife Service has conducted winter waterfowl abundance and distribution surveys and initial data are available from an ongoing study of CoCs in song birds breeding on the Lake (Research Study 1). Concentrations of CoCs have been measured in a small number of fish tissue samples collected from the Seneca River by NYSDEC (Research Study 2), and some wetlands have been evaluated as part of sub-site investigations (Research Studies 3 and 4). However, wetland acreages and functions have not been evaluated and wetlands associated with Sawmill Creek were determined to be “off-site” for purposes of Lake-bottom remedial investigations, so were not evaluated. Although the Trustees have not determined if these studies will be formally pursued in the future, additional studies are being planned or may be planned for the future (Exhibit 4-2; this list represents currently ongoing and planned studies) and the Trustees may perform targeted studies to assess and quantify potential injuries caused by CoCs to resources of special concern. Additional studies may be evaluated and implemented as the NRDA process moves forward. As studies are designed and planned, sampling and analysis plans will be developed, appended to this document, and made available for public review.

EXHIBIT 4-1 INJURY QUANTIFICATION METHODOLOGY

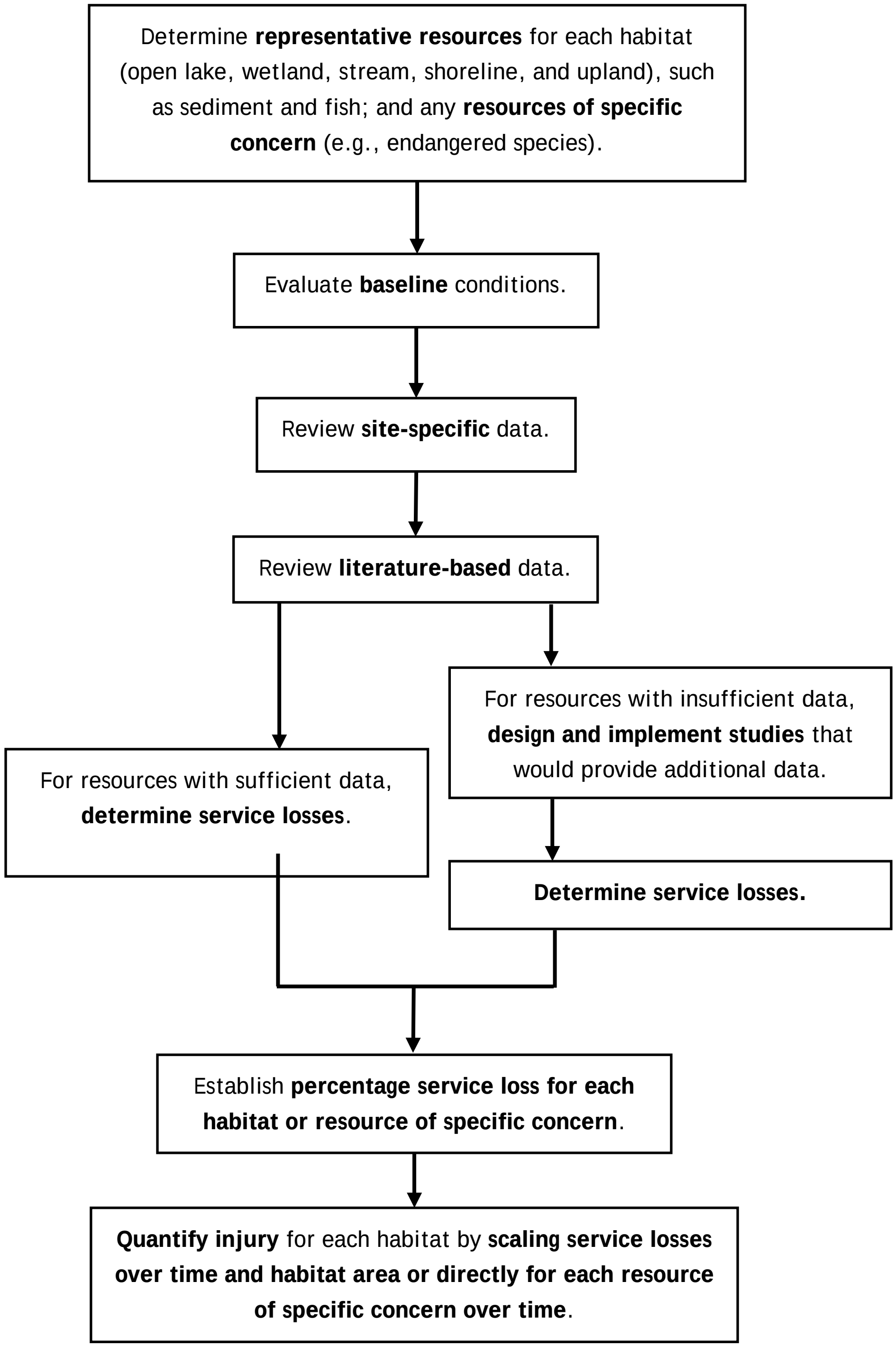

EXHIBIT 4-2 ONGOING AND PLANNED INJURY QUANTIFICATION STUDIES

HABITATS	STUDIES	OBJECTIVE	STATUS
Open Lake, Wetlands, Upland Shoreline, Riverine	Evaluation of existing data and information related to toxicological effects of CoCs on sediment, surface water, soil, and biological resources in or around the Lake	Determine if existing data and information are sufficient to quantify injury; compare data with existing thresholds and criteria as a measure of injury	Ongoing
	Data compilation and surveys of resident biological resources (e.g., birds, wintering waterfowl, bats, herpetofauna)	Compile information on resident and migratory biological resources potentially exposed to CoCs; identify data gaps	Ongoing and planned
	Biological exposure and effects studies on resources for which data are lacking (e.g., waterfowl, piscivorous and insectivorous birds, herpetofauna, bats)	Assess scale of injury to biological organisms relying on the various habitats in the assessment area	Ongoing and planned
	Biological surveys and/or exposure and effects studies on resources for which data are lacking (e.g. mink, small mammals, piscivorous and insectivorous birds for which studies are not currently ongoing or planned)	Assess scale of injury to biological organisms relying on the various habitats in the assessment area	Potential
	Sediment toxicity tests	Determine the level of injury to benthic macroinvertebrates caused by CoCs	Potential

CHAPTER 5 | RECREATIONAL USE, PAST AND PROPOSED ASSESSMENT

Consistent with the DOI NRDA regulations, NYSDEC established, quantified, and preliminarily valued the injury and associated lost recreational fishing and boating services provided by Onondaga Lake due to contaminant releases. In the future, the Trustees also plan to assess other recreational use services that have been and continue to be lost due to the presence of hazardous substance contamination in and around the Lake. The Trustees also may decide in the future to assess non-indigenous cultural or non-use damages for both indigenous and non-indigenous populations.

RECREATIONAL IMPACTS ASSESSMENT

Recreation in the Lake has been hindered by releases of hazardous and non-hazardous substances. As noted in Chapter 3 above, consumption of fish from Onondaga Lake has been limited for nearly 40 years due to high levels of mercury, dioxin, and PCBs in the flesh of fish taken from the Lake. Fishing was banned entirely between 1970 and 1985, and it was limited to catch-and-release between 1986 and 1999. Today, the Lake's walleye fishery, along with largemouth and smallmouth bass over 15 inches, remain catch-and-release, while anglers are advised to consume no more than one meal per month of other fish species (except brown bullhead and pumpkinseed, of which anglers are advised to eat not more than four meals per month) and children under 15 and women of childbearing age are advised to eat no fish from the Lake (NYSDOH 2010, USFWS 2005).

Although the choice of boating destination in part reflects the type of excursion desired, boating activity, as with any activity that involves contact with the shoreline, water and lake bottom, is also affected by the contaminated state of the Lake. For purposes of this assessment, boating activity includes those boating trips taken for purposes other than fishing (e.g., water-skiing, sailing, or cruising).

Since publication of the 1996 DAP, NYSDEC performed a recreational impacts assessment (RIA) that focused on lost and diminished fishing and boating opportunities resulting from the release of hazardous and non-hazardous substances to Onondaga Lake. In 2000 and 2001, a team of experts worked with NYSDEC on a series of analyses designed to assess economic damages associated with a contaminant-related loss in value of Onondaga Lake as a recreational resource. Substances considered were mercury (the contaminant responsible for fisheries closures and FCAs issued beginning in 1970), other hazardous substances, and ionic wastes. The RIA estimated fishing and boating losses by applying standard economic procedures, using both existing information and new data.

Specifically, two types of analyses to address recreational fishing losses were conducted. First, an application of the unit value (i.e., benefits transfer) approach was done. Second, a model of fishing participation and site choice that used existing data on New York lakes and New York angler behavior was applied. This second analysis is based on a Random Utility Model (RUM), an econometric approach to modeling recreation decisions that has widespread acceptance among economists.

For the boating analysis, a RUM was developed using existing data on New York lakes and New Yorker boating behavior; only boating trips taken for purposes other than fishing are considered. The fishing and boating data used in this analysis are from the same survey of water-based recreation in New York used in the first recreational angling analysis.

OTHER PROPOSED AND PLANNED WORK

In addition to the previously conducted RIA, other, additional recreational use assessment activities have been proposed or are currently being planned. Below the Trustees highlight potential studies to evaluate impacts to recreational activites other than recreational fishing and boating, as well as non-use and non-indigenous cultural losses attributable to hazardous waste contamination in the Lake.

OTHER RECREATIONAL IMPACTS

While research conducted under the RIA indicated that, absent contamination, the Lake could support higher levels of or higher values for swimming, wildlife viewing, and land-based recreation such as biking and walking, quantification of the damages associated with these activities has not yet been conducted.

An assessment of the losses associated with the effects of Lake contamination on these activities could be conducted in the future. One method involves using the unit value approach in a benefit transfer context. For example, Rosenberger and Loomis (2001) list mean and median values for recreational activities by U.S. Department of Agriculture Forest Service region: swimming $16.37; biking $34.11; wildlife viewing $26.06; and picnicking $47.04 (mean per person per day values for the Northeastern Region, Table 3). In order to generate a damages estimate with these data for the relevant time period, and levels of activity with and without contamination would need to be estimated or determined.

NON-USE AND NON-INDIGENOUS CULTURAL LOSSES TO THE CITY OF SYRACUSE, ONONDAGA COUNTY, AND UPSTATE NEW YORK

The RIA results showed that residents living near a lake choose different forms of water-based recreation depending on the water quality of the resource. It is natural then to expect residents would also have other cultural expressions that are affected by the quality of the resource, including non-use or passive use of the resource. The pollution of Onondaga Lake likely has many negative impacts on the culture and way of life of people living in the area (as well as former residents and people living in adjacent regions). An investigation into the negative effects of the contamination of the Lake on the culture of the area and its expressions may be warranted.

The results of such an investigation could be used to support and inform planning for restoration projects that compensate for injuries not directly tied to other types of recreational use losses.

In addition to lost ecological and recreational services, information suggests that releases of hazardous substances in and around Onondaga Lake have resulted in a reduction in uses of and non-use values associated with the Lake and its environment by Citizens of the Onondaga Nation. For example, absent natural resource injury, the Lake and its environment would likely support a wide array of sacred and ceremonial activities as well as safe traditional and subsistence uses. Contamination has either reduced or eliminated some uses; other activities may continue but are impaired or incomplete. Further, given their spiritual, culturally distinct, and historic relationship with Onondaga Lake, the existence value or non-use value of the Lake may be differentially impaired for Nation citizens than for members of the general public. These existence or non-use values may include the option value of preserving the ability to return to the Lake, the vicarious value of knowing that a spiritually and culturally important set of resources is preserved and able to continue doing its duty in the broader world, and the intertemporal value of knowing that the resources are being preserved for future generations.

As noted in earlier sections, the Trustees anticipate determining "the physical, chemical, and biological baseline conditions and the associated baseline services for injured resources at the assessment area" and quantifying injury based on a contaminant-related reduction in services (43 C.F.R. § 11.72(a)). As part of this assessment, the Trustee Council plans to conduct an assessment of lost use value and lost cultural service connected to injured natural resources by Citizens of the Onondaga Nation that are attributable to site releases. The Trustees may also assess lost non-use value in relation to the Onondaga Nation. The goal of this portion of the assessment will be to define the nature and magnitude of the loss of services including those services which are not tied to direct resource use experienced by Citizens of the Onondaga Nation. This will allow for selection and scaling of appropriate primary restoration actions to reduce future service losses, and compensatory restoration actions to address interim reductions in services pending full restoration of injured resources to their baseline condition.

CONTEXT

Onondaga Lake and its associated watershed is the homeland of the Onondaga Nation. In the 1794 Treaty of Canandaigua, the United States government recognized Onondaga Lake as part of the aboriginal territory of the Onondaga Nation. The Onondaga people have long served as stewards of the Lake and will continue to do so forever, as mandated from the Gayanashagowa, the Great Law of Peace.

The Lake is a spiritual, cultural and historic center of the Haudenosaunee Confederacy. Onondaga Nation history teaches that over one thousand years ago, the Peacemaker brought the Mohawk, Oneida, Onondaga, Cayuga, and Seneca Nations together on the shores of Onondaga Lake. At the lakeshore, these Nations accepted the message of peace, laid down their arms, and formed the Haudenosaunee Confederacy, seen by many as the first representative democracy in the West[16]. To symbolize the Confederacy, the Peacemaker planted a white pine, the Tree of Peace, on the shores of Onondaga Lake. It is understood that the Peacemaker chose the white pine because the white pine's needles are clustered in groups of five, just as the five founding Nations of the Confederacy clustered together for strength. The Onondaga Nation sees the boughs of the white pine as representing the laws that protect all the people. An eagle was placed at the top of the tree to watch for danger from without and within. Four white roots of peace reach out in the four directions toward anyone or any Nation who wishes to come under this tree of peace.

Onondaga Lake is sacred to the Haudenosaunee. The Onondaga Nation has resided on the Lake and throughout its watershed for millennia, building homes and communities, fishing, hunting, trapping, collecting plants and medicine, planting agricultural crops, performing ceremonies, and burying their ancestors - the mothers, fathers and children of the Onondaga Nation. The Onondaga Nation views its relationship to this area as a place from which Nation members will forever come and to which they will forever return. Onondaga Lake and the living and non-living beings which comprise it are integral to the Nation’s world view, which teaches that all parts of creation have a duty to fulfill, and that the duty of the people is to give thanks to all those beings for fulfilling their role.

INJURY QUANTIFICATION

As a result of the presence of hazardous contaminants and corresponding injuries to natural resources, Citizens of the Onondaga Nation may have changed their use of and relationship to the Lake and its environment. These changes could affect subsistence use, traditional, and/or spiritual use and enjoyment of natural resources such as subsistence, medicinal, ceremonial, spiritual, and other use benefits, as well as nonuse values (i.e., values held for simply knowing that a resource exists in an uncontaminated state). Assessing both lost and diminished uses of and values held for natural resources and the services these resources provide, contaminant-related changes could be manifested in effects on the frequency, manner, and security with which Nation Citizens use or rely upon injured natural resources or on the spiritual or cultural value or duty attributed to or provided by the resource. The Trustees plan to describe potentially impacted services and associated natural resources, and the nature and magnitude of reductions in those services that have occurred as a result of the release of hazardous substances from the Site.

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[16] The Tuscarora Nation joined the confederacy in the early 1700s.

ONGOING, PLANNED, AND POTENTIAL STUDIES OF NATURAL RESOURCE SERVICES LOST TO THE ONONDAGA NATION

The Trustees propose the following approach for assessment of lost services:

Characterize traditional uses of, and values held for, natural resources by Citizens of the Onondaga Nation. That is, describe the relationship between Nation Citizens and natural resources as well as the Nation's safe use or perception of those resources that would exist absent injury due to the release of hazardous substances in the study area. This will allow the Trustees to describe the natural resource-associated services that may have been impacted as a result of the release of hazardous substances.

Determine the degree and the geographical extent to which injuries to natural resources in the assessment area have affected these services through time.

Specifically, the Trustees plan to conduct a review of available information on traditional Onondaga Nation uses of, and values for, natural resources in the assessment area. This inventory will be based on existing data, literature, oral histories and stories, the literal meaning of the traditional names and words including those used for plants, places and other resources, and other probative information in any form regarding the historical extent of resource use and other services available to Nation Citizens. Because some resources that existed historically in the assessment area may be absent or diminished for reasons other than Site releases, efforts will be made to determine the baseline condition of these resources (43 C.F.R. § 11.14 (e)). This task will include identification of gaps in the existing data and methods for potentially addressing those data gaps.

Once the review of traditional uses of, and values for, natural resources in the assessment area is developed, the Trustees will characterize lost natural resource services according to type of activity, degree of impact (e.g., completely precluded, diminished, or replaced with a substitute of lesser value), duration of impact, and geographic area of impact. As noted above, a variety of events have potentially affected the Nation's use of natural resources. These include social and cultural changes potentially not related to the effects of hazardous substance releases. Thus, the Trustees will attempt to separate changes in resource services provided to Citizens of the Nation that resulted from natural resource injuries caused by Site-related hazardous substance releases from those changes that relate to other factors (i.e., baseline factors).

The results of these efforts will be used to identify and qualitatively describe primary restoration projects that may serve to reduce adverse impacts on traditional uses of, and values for, injured natural resources, and compensatory restoration projects to make the greatest progress possible toward restoring traditional uses to compensate for past and future lost uses and connections to natural resources due to the hazardous substance releases.

Once injuries to natural resources in the assessment area are quantified, Trustees must determine the appropriate scale of damages required to fully compensate the public. The DOI NRDA regulations define damages as "the amount of money sought by the natural resource trustee as compensation for injury, destruction, or loss of natural resources" (43 C.F.R. § 11.14(l)). As the 1996 DAP notes, the DOI regulations indicate that there are generally two categories of damages: (1) the cost of restoration, replacement, or acquisition of the equivalent, and (2) the compensable value of lost services. Specifically:

> *The measure of damages is the* ***cost of (i) restoration or rehabilitation of the injured natural resources*** *to a condition where they can provide the level of services available at baseline, or (ii)* ***the replacement and/or acquisition of equivalent*** *natural resources capable of providing such services. Damages may also include, at the discretion of the authorized official, the* ***compensable value*** *of all or a portion of the services lost to the public for the time period from the discharge or release until the attainment of the restoration, rehabilitation, replacement, and/or acquisition of equivalent of baseline (43 C.F.R. § 11.80(b); emphasis added).*

The 1996 DAP includes a list of general potential restoration projects (Chapter 8), and a list of potential studies that could be performed by the Trustees to assess compensatory damages (Chapter 9). This information is updated and expanded upon below.

COST OF RESTORATION, REPLACEMENT, OR ACQUISITION OF THE EQUIVALENT

As indicated in the DOI regulations, "restoration or rehabilitation of the injured natural resources" refers to actions aimed directly at recovery of the actual injured resource. "Replacement and/or acquisition of equivalent natural resources" refers to restoration actions that are separate and distinct from the actual injured resource, and which aim to replace the services lost due to natural resource injury. There is, however, a clear preference on the part of natural resource regulators to focus on restoration of the injured natural resource. Specifically, in discussing the role of "restoration, rehabilitation, replacement, and/or acquisition of equivalent resources" in the regulations, DOI stated that it:

> *does not believe that Congress intended to allow trustee agencies to simply restore the abstract services provided by a resource, which could conceivably be done through an artificial mechanism. For example, nothing in the language or*

legislative history of CERCLA suggests that replacement of a spring with a water pipeline would constitute "restoration, rehabilitation, replacement, and/or acquisition of equivalent resources." CERCLA requires that natural resource damages be based on the cost of restoring, rehabilitating, replacing and/or acquiring the equivalent of an actual natural resource (Federal Register, Volume 58, Number 139, 22 July 1993).

There are three general steps the Trustees anticipate taking to determine natural resource damages. These are:

1. Determine the scale of natural resource injuries and service losses relative to baseline, including interim losses.
2. Determine the appropriate scale of a restoration project(s) needed to fully compensate for these losses.
3. Calculate damages as the cost, in dollars, to perform the restoration project(s).

Scaling in Step 1 will also take into consideration the extent to which planned remedial activities will return natural resources and the services they provide to their baseline condition. For example, if remedial actions do not return natural resources and resource services to baseline, loss estimates will reflect the difference between the natural resource services provided after completion of the remedy and the resource services expected under baseline (residual injuries). Similarly, if remedial actions lead to an enhancement of natural resources and resource services above and beyond baseline, damages will be adjusted accordingly (e.g., increased services provided by excess primary restoration may be credited towards interim loss damages; see Compensable Value section below).

An important component of Step 2 is the consideration of general criteria for evaluation of restoration projects indicated in the DOI regulations (43 C.F.R. § 11.82(d)), as well as any site-specific criteria or objectives for particular restoration projects. Factors for consideration explicitly listed in the DOI regulations include, but are not limited to:

- the technical feasibility of the restoration action,
- the cost-benefit and cost-effectiveness of the restoration,
- results of actual or planned response actions,
- potential for additional injury or adverse effects on human health and safety to be caused by the restoration action,
- the natural recovery period and the ability of the natural resources to recover without restoration, and
- consistency and compliance with Federal, state, and tribal policies (43 C.F.R. § 11.82(d)).

Because damages will likely be calculated prior to actual implementation of a restoration project, the Trustees will use one or more methodologies approved of in the DOI regulations to estimate costs in Step 3, which include:

- Comparison methodology,

- Unit methodology,
- Probability methodologies,
- Factor methodologies,
- Standard time data methodology, or
- Cost- and time-estimating relationships (43 C.F.R. § 11.83(b)(2)).[17]

In selecting and implementing cost estimating methodologies, the Trustees will take measures to avoid double counting. Double counting may occur when evaluating damages associated with resources that provide multiple, overlapping benefits and services.

COMPENSABLE VALUE

The compensable value of a natural resource refers to the loss experienced by the public in the interim time period between resource injury and recovery to baseline. For this reason, such damages are often referred to as "interim losses." According to the DOI regulations, compensable value:

> *can include the economic value of lost services provided by the injured resources, including both public use and nonuse values such as existence and bequest values. Economic value can be measured by changes in consumer surplus, economic rent, and any fees or other payments collectable by a Federal or State agency or an Indian tribe for a private party's use of the natural resources; and any economic rent accruing to a private party because the Federal or State agency or Indian tribe does not charge a fee or price for the use of the resources. Alternatively, compensable value can be determined utilizing a restoration cost approach, which measures the cost of implementing a project or projects that restore, replace, or acquire the equivalent of natural resource services lost pending restoration to baseline (43 C.F.R. § 11.83(c)(1)).*

The 1996 DAP explicitly proposes four approaches for estimating the compensable value of injuries in the assessment area: (1) conducting a recreational impacts assessment, (2) performing a habitat equivalency analysis, (3) performing an added and averted cost study, and (4) conducting a total value contingent valuation survey. Additional methodologies available to Trustees for damage determination include, but are not restricted to:

- Market price,
- Appraisal,
- Factor income,

[17] Unit costs for various restoration actions are provided in the 1996 DAP in 1995 dollars. Since remedial and primary restoration has not yet been determined for the assessment area and the Trustees have not finalized which cost estimation methodology will be ultimately used, the Trustees have not updated those values at this time.

- Travel cost, and
- Hedonic pricing (43 C.F.R. § 11.83(c)(2)).

When implementing any of these approaches, damages will be scaled and calculated in a manner similar to the three step process described above to ensure that damages are commensurate with injury.

ECOLOGICAL DAMAGES DETERMINATION

Since the publication of 1996 DAP, the DOI regulations have been updated to explicitly include habitat and resource equivalency analyses as acceptable approaches for damages determination (43 C.F.R. § 11.83(c)(2)(ix – x)). As indicated in Chapter 4 above, the Trustees anticipate the use of one or both of these types of analyses to determine ecological interim loss damages based on restoration costs. However, the need for evaluating added costs and / or conducting a contingent valuation survey may be considered in the future, as necessary.

HUMAN USE DAMAGES DETERMINATION

As mentioned in Chapter 5 above, NYSDEC conducted a recreational fishing and boating study. This study was conducted from 1999 through 2005, and estimated dollar damages were updated in September of 2008.[18] This study used a benefits transfer approach and a random utility maximization model to estimate the change in consumer surplus experienced by recreational anglers in Onondaga Lake due to the presence of the fish consumption advisory. Consumer surplus is the amount individuals are willing to pay for a good or service above and beyond the cost of that good or service. That is, consumer surplus measures the difference between what a person is willing to pay and the amount he/she actually is required to pay (i.e., expenditures). People realize positive net benefits when they are able to obtain goods and services for less than they are willing to pay. Consumer surplus is a measure of that net benefit.

The Trustees may use additional damage determination approaches to assess damages to other recreational use losses as well as specific cultural losses experienced by the Onondaga Nation, including, but not limited to, subsistence use losses.

DAMAGES DETERMINATION AND RESTORATION

Damages determination and resource restoration are directly related to one another. As mentioned above, the goal of NRDA is to compensate the public for natural resource injuries through restoration; damages are a measure of the loss experienced by the public in monetary terms. However, monetary damages are required to be spent on restoration, and as such, are sometimes calculated based on the cost of restoration. Ultimately, restoration projects are intended to provide the public with natural resources that were lost or injured as a result of the release of hazardous substances or oil. In some cases,

[18] No updates or changes have been made to the analytical methods component of this study, or the values transferred since its original completion.

however, restoration projects may take the form of preservation of existing natural resources that would otherwise be lost for reasons unrelated to the release of hazardous substances or oil (e.g. through development or consumptive use).

The determination of appropriate damages and restoration will be summarized in a Restoration and Compensation Determination Plan (RCDP), to be produced by the Trustees with input from the cooperating potentially responsible party(ies). The RCDP will evaluate restoration alternatives, describe the selection process followed in choosing the preferred alternatives, and identify the cost estimating and valuation methodologies that will be used to calculate damages. The Trustees will seek input from the public regarding potential restoration projects, and the RCDP will be made available to the public for review and comment.

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