ONONDAGA LAKE BOTTOM
SUBSITE OF THE ONONDAGA LAKE SUPERFUND SITE
SYRACUSE, NEW YORK

NYSDEC

PROPOSED PLAN

NOVEMBER 29, 2004

Public Involvement

Dates to Remember

Public Comment Period:
November 29, 2004 – March 1, 2005

NYSDEC will accept comments on the Proposed Plan during the public comment period.

NYSDEC will hold two availability sessions and a public meeting to present the results of the Remedial Investigation, Feasibility Study, and Proposed Plan and to solicit public comments. These will be held at the Martha Eddy Room in the Art and Home Center at the New York State Fairgrounds.

Informal Availability Sessions:

January 6, 2005	7:00-9:00 P.M.
January 12, 2005	3:00-5:00 P.M.

Public Meeting:

January 12, 2005	7:00 P.M.

COMMUNITY ROLE IN THE SELECTION PROCESS

The New York State Department of Environmental Conservation (NYSDEC) relies on public input to ensure that the concerns of the community are considered in selecting an effective remedy for each Superfund site. To this end, the Onondaga Lake Bottom Subsite Remedial Investigation and Feasibility Study (RI/FS) reports and the Proposed Plan have been made available to the community (see the text boxes entitled "Public Involvement") for a public comment period which begins on November 29, 2004 and concludes on March 1, 2005.

On January 6, 2005 from 7:00 to 9:00 P.M. and January 12, 2005 from 3:00 to 5:00 P.M., the NYSDEC will hold informal availability sessions for questions and answers regarding the proposed cleanup plan. The formal public meeting will be held on January 12, 2005 at 7:00 P.M. Both availability sessions and the public meeting will take place at the Martha Eddy Room in the Art and Home Center of the New York State Fairgrounds. These will be held to present the conclusions of the RI/FS, to elaborate further on the reasons for recommending the preferred remedy, and to receive public comments.

Comments received at the public meeting, as well as written comments, will be documented in the Responsiveness Summary section of the Record of Decision (ROD), the document which formalizes the selection of the remedy.

NYSDEC will accept comments postmarked on/or before March 1, 2005 or sent via email and received on/or before March 1, 2005.

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TEXT BOXES

Public Involvement

Submitting Written Comments

Written comments on the Proposed Plan and the RI and FS reports should be postmarked on/or before March 1, 2005 and addressed to:

Donald Hesler/Timothy Larson
Onondaga Lake Superfund Site – Public Comment
New York State Department of Environmental Conservation
625 Broadway
Albany, New York 12233-7016

or sent via email and received on/or before March 1, 2005 to the following address:

DERweb@gw.dec.state.ny.us
(Indicate "Onondaga Lake PP Comments" in the subject line of the email)

Public Involvement

Administrative Record

The administrative record file, which contains the information upon which the selection of the response action will be based, is available at the following locations:

Onondaga County Public Library
Syracuse Branch at the Galleries
447 South Salina Street
Syracuse, NY 13202

Telephone:	(315) 435-1900
Hours:	Mon., Thurs., Fri. & Sat., 9:00 A.M. – 5:00 P.M. Tues. & Wed., 9:00 A.M. - 8:30 P.M.

Atlantic States Legal Foundation
658 West Onondaga Street
Syracuse, NY 13204

Telephone:	(315) 475-1170
Hours:	Please call for hours and appointment.

NYSDEC Central Office
625 Broadway
Albany, NY 12233-7016

Telephone:	(518) 402-9767 or toll-free (800) 342-9296
Hours:	Mon. – Fri., 8:30 A.M. – 4:45 P.M. Please call for an appointment.

NYSDEC Region 7 Office
615 Erie Boulevard West
Syracuse, NY 13204-2400

Telephone:	(315) 426-7551
Hours:	Mon. – Fri., 8:30 A.M. – 4:45 P.M.

PURPOSE OF THE PROPOSED PLAN

This Proposed Plan describes the remedial alternatives considered for the Onondaga Lake Bottom subsite (hereafter referred to as the "Onondaga Lake subsite") of the Onondaga Lake Superfund Site, and identifies the preferred remedy as well as the rationale for this preference.

This Proposed Plan was developed by NYSDEC in consultation with the New York State Departments of Law (NYSDOL) and Health (NYSDOH). NYSDEC is issuing the Proposed Plan as part of the public participation requirements of Section 117(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, and Section 300.430(f)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), as well as the New York State Environmental Conservation Law (ECL) and 6 NYCRR Part 375.

This Proposed Plan is being provided as a supplement to the Onondaga Lake RI and FS reports to inform the public of

NYSDEC's preferred remedy and to solicit public comments pertaining to all of the remedial alternatives (including the preferred remedy) evaluated in this Proposed Plan, as well as the RI and FS reports. The alternatives summarized here are described in the Onondaga Lake FS report and other documents contained in the administrative record file for this site. NYSDEC encourages the public to review these documents to gain a more comprehensive understanding of the site and the Superfund-related activities that have been conducted at the site (see text box entitled "Administrative Record" for locations of the administrative record, pg. 5).

NYSDEC's preferred remedial alternative consists of the removal (dredging) of approximately 2.65 million cubic yards (cy) (2 million cubic meters [m^3]) of sediments containing toxic contaminants and non-aqueous-phase liquids (NAPLs), followed by isolation capping of about 425 acres of the littoral zone (shoreline out to water depths of 30 feet [ft] [9 m]) of Onondaga Lake (roughly 42 percent of the surface area of the littoral zone). Under this alternative, the majority of the dredged sediments (about 2 million cy [1.5 million m^3]) would be from the southern portion of the lake near the former Honeywell facilities. This alternative includes a significant removal of mass of the primary contaminants and NAPLs from the lake to ensure a remedy that is effective and permanent. This alternative also includes thin-layer capping of approximately 154 acres of contaminated sediments in the profundal (deep) zone of the lake (roughly 8 percent of the surface area of the profundal zone), along with the performance of an aeration (oxygenation) pilot study followed by full scale implementation (if supported by the pilot study) to address the water column of the deep zone of the lake, followed by monitored natural recovery (MNR).

Contaminated sediments and wastes removed from the lake would be disposed of in a sediment consolidation area (SCA) in an area that currently contains wastes from former Honeywell manufacturing operations. The sediment and waste consolidation would produce effluent water, which would be treated to remove solids and contaminants at a water treatment facility to be constructed as part of remedial activities. The treated water would be returned to the lake. Based on evaluations to be conducted during design, as well as during construction, it may be determined that a portion of the dredged materials (e.g., NAPLs) will be treated and/or disposed of at an off-site permitted facility rather than being disposed of at the SCA. The construction time for the preferred remedy is estimated to be four years. Upland source controls, including containment and treatment of contaminated groundwater and NAPLs on the Honeywell upland sites, would be necessary for the success of the remedy.

The preferred remedy would result in a long-term reduction in the toxicity, mobility, and volume of the key contaminants in Onondaga Lake, including mercury, benzene, toluene, ethylbenzene, and xylenes (BTEX), naphthalene, chlorinated benzenes, and polychlorinated biphenyls (PCBs) and would enhance the lake as a valued community resource by improving aquatic habitat throughout the lake while achieving the desired objectives and goals.

The remedy described in this Proposed Plan is the preferred remedy for the site. Changes to the preferred remedy, or a change from the preferred remedy to another remedy, may be made if public comments or additional data indicate that such a change would result in a more appropriate remedial action, pursuant to applicable environmental laws. The final decision regarding the selected remedy will be made after consideration of all public comments. NYSDEC is soliciting public comments on this Proposed Plan and the RI and FS reports because NYSDEC may select a remedy other than the preferred remedy contained within this Proposed Plan.

Following issuance of the ROD, remedial design, including additional investigations to support design, will occur prior to construction of the selected remedy.

SITE BACKGROUND

On June 23, 1989, Onondaga Lake was added to the New York State Registry of Inactive Hazardous Waste disposal sites. On December 16, 1994, Onondaga Lake and areas upland of the lake that contribute or have contributed contamination to the lake system were added to the US Environmental Protection Agency's (USEPA's) National Priorities List (NPL). This NPL listing means that the lake system is among the nation's highest priorities for remedial evaluation and response under the federal Superfund law for sites where there has been a release of hazardous substances, pollutants, or contaminants. This Proposed Plan focuses only on the Onondaga Lake subsite of the Superfund NPL site.

SITE DESCRIPTION

Onondaga Lake itself is a 4.6-square mile (sq mi) (12-square kilometer [sq km]), 3,000-acre lake, approximately 4.5 mi (7.2 km) long and 1 mi (1.6 km) wide, with an average water depth of 36 ft (11 m). The lake has two deep basins, a northern basin and a southern basin, that have maximum water depths of approximately 62 and 65 ft (19 and 20 m), respectively. The basins are separated by a saddle region at a water depth of approximately 56 ft (17 m). Most of the lake has a broad nearshore shelf in water depths of less than 12 ft (3.7 m). This nearshore shelf is bordered by a steep offshore slope in water depths of 12 to 24 ft (3.7 to 7.3 m).

During the summer months, the upper water of Onondaga Lake warms to a greater degree than the deeper water. This causes the water in the lake to stratify (separate) into two layers of water: the epilimnion, which is the warmer, less dense upper layer and is about 30 ft (9 m) thick, and the hypolimnion, which is the colder, denser, bottom layer. During the summer, the hypolimnion becomes anoxic (runs out of oxygen), which has numerous implications for the lake's chemistry and biota (e.g., fish and insect life).

For the purposes of the RI/FS and this Proposed Plan, the sediments in the lake are divided into two regions based on these two layers of water: the littoral zone, which includes sediments along the shoreline in less than 30 ft (9 m) of water and which are in contact with the epilimnion, and the profundal zone, which includes sediments in the deep basins in more than 30 ft (9 m) of water, which are in contact with the hypolimnion.

The two largest tributaries to Onondaga Lake, namely Ninemile Creek and Onondaga Creek, contribute 30.4 and 31.4 percent, respectively, of the total water flow to the lake. Other tributaries, in a clockwise direction, include Ley Creek, Harbor Brook, the East Flume, Tributary 5A, Sawmill Creek, and Bloody Brook (see attached figure entitled "Location of Onondaga Lake NPL Subsites"). In addition to the tributary streams, the treated effluent from the Onondaga County Metropolitan Wastewater Treatment Plant, or Metro, located between Onondaga Creek and Harbor Brook, provides a significant portion (approximately 19 percent) of the water entering the lake.

Various local entities have discharged wastewater directly to these tributary streams and/or have waste sites that have, or potentially have, impacted these tributaries and the lake itself.

In general, the eastern shore of Onondaga Lake is urban and residential, and the northern shore is dominated by parkland, wooded areas, and wetlands. There are approximately 320 acres of state-regulated wetlands and numerous smaller wetlands directly connected to Onondaga Lake or within its floodplains (i.e., Wetlands SYW-1, SYW-6, SYW-10, SYW-12, and SYW-19).

The northwest upland areas in Liverpool and Lakeland are mainly residential, with interspersed urban structures and several undeveloped areas. Much of the western and southern lakeshore is covered by wastebeds which received wastes generated from Honeywell's former Solvay operations and, to a lesser extent, dredge spoils from the lake, many of which have been abandoned and recolonized by vegetation. Urban centers and industrial zones in Syracuse and Solvay dominate the landscape surrounding the southern and eastern shores of Onondaga Lake from approximately the New York State Fairgrounds to Ley Creek.

The area around Onondaga Lake is the most urban in central New York State. The region experienced significant growth in the twentieth century, and in 2000, Onondaga County was the tenth most populous county in the state. The city of Syracuse is located at the southern end of Onondaga Lake, and numerous towns, villages, and major roadways surround the lake (see attached figure entitled "Location of Onondaga Lake NPL Subsites").

Historically, Onondaga Lake supported a cold-water fishery. Common species found in the lake included Atlantic salmon (*Salmo salar*), cisco (*Coregonus artedii*), American eel (*Anguilla rostrata*), and burbot (*Lota lota*). Today, Onondaga Lake supports a warm-water fish community that is dominated by the pollution-tolerant gizzard shad (*Dorosoma cepedianum*), freshwater drum (*Aplodinotus grunniens*), carp (*Cyprinus carpio*), and white perch (*Morone americana*). Sunfish are abundant in the littoral zone.

The lake supports several important sportfish, including channel catfish (*Ictalurus punctatus*), largemouth bass (*Micropterus salmonides*), smallmouth bass (*Micropterus dolomieui*), and walleye (*Stizostedion vitreum*). The shores of Onondaga Lake provide habitat for several mammal species. Woodchuck (*Marmota monax*), muskrat (*Ondatra zibethicus*), and squirrels (e.g., *Sciurus carolinensis*) are regularly observed on the shores of Onondaga Lake. These and other small-mammal species support predators such as mink (*Mustela vison*), fox (*Vulpes fulva* and *Urocyon cinereoargenteus*), and coyote (*Canis latrans*). The less-disturbed shoreline of the northwest section of the lake provides habitat for more reclusive or larger species, such as beaver (*Castor canadensis*) and deer (*Odocoileus virginianus*). Typically, large bodies of water in urban areas provide important habitat to migrating bird species which use the lakeshore as a resting area during migration. Seasonal and resident bird species around the lake include waterfowl, gulls, shorebirds, songbirds, and raptors.

SITE HISTORY

Onondaga Lake has been the recipient of over 100 years of industrial and municipal sewage discharges. Honeywell has been a major contributor, however, other industries in the area have contributed contamination as well. Other contaminant sources to the lake include the Metro facility, Ley Creek, the Crucible Materials Corporation (via Tributary 5A), and Oil City. A detailed discussion of sources to the lake can be found in the Onondaga Lake subsite Remedial Investigation Report.

This section of the Proposed Plan summarizes the industrial pollution of Onondaga Lake and key historical information regarding Honeywell International and its predecessor companies' manufacturing operations (e.g., Allied Chemical Corporation), and is based on the RI/FS reports. For clarity, and as stated in the text box entitled "What is a Potentially Responsible Party (pg. 9)," "Honeywell" is used throughout the Proposed Plan to refer to Honeywell International, Inc. and its predecessor companies. Honeywell, as a major contributor of contamination to the lake, has been named a potentially responsible party (PRP). Honeywell consented to investigate the lake pursuant

Understanding the Onondaga Lake Subsite Proposed Plan

What is a "Potentially Responsible Party?"

A PRP is an entity that is potentially responsible for the contamination, and therefore the cleanup, of a contaminated site. In the case of the Onondaga Lake subsite, Honeywell International, as a major contributor of contamination to the lake, has been named as a potentially responsible party (PRP). Honeywell agreed to investigate contamination in the lake pursuant to the terms of Consent Decree. Honeywell International, Inc., and its predecessor companies, operated manufacturing facilities in Solvay, New York, from 1881 until 1986. When Honeywell merged (December 1, 1999) with its predecessor companies (shown below), it became liable for the contamination those companies introduced into the environment. "Honeywell" is used to represent Honeywell International, as well as its predecessor companies which include:

Allied Chemical and Dye Corp. (incorporated December 17, 1920)
General Chemical
Barrett Company
National Aniline and Chemical Company
Solvay Process Company
Semet Solvay Company
\
Allied Chemical Corporation (April 28, 1958)
\
Allied Corporation (April 27, 1981)
\
AlliedSignal, Inc. (September 18, 1985)
\
Honeywell International (Present)

to the terms of a New York district court consent decree dated March 16, 1992 (89-CV-815) ("Consent Decree").

In the late 1800s and early 1900s, Onondaga Lake supported a thriving resort industry based upon the recreational utilization of the lake, including swimming and recreational fishing. The lake also had a plentiful cold-water fishery, which supported a commercial fishing industry until the late 1800s. However, from the late 1800s to the present, Onondaga Lake has been a receptacle for both industrial and municipal wastes.

Salt springs in the vicinity of Onondaga Lake supported a major salt recovery industry throughout the 1800s and were associated with the development of railroads and the Erie Canal in the region. This infrastructure supported the growth of additional industries, including former Honeywell operations (described in greater detail below), petroleum product storage (once known as "Oil City") adjacent to the southeastern shore of Onondaga Lake, fertilizer production, a steel foundry, a vehicle accessory manufacturing facility, pottery and china manufacturing, manufactured gas plants, and many other industries in the Syracuse area. These and other sites are more fully described in the RI/FS. An evolving municipal wastewater management system (initially with the development of a sewer system and later wastewater treatment facilities), now known as Metro, has been in existence since around 1896.

FORMER HONEYWELL OPERATIONS: PRODUCTION HISTORY AND RELEASES

Honeywell operated manufacturing facilities in Solvay, New York from 1881 until 1986. Manufacturing processes were based on four major product lines that resulted in releases of primarily mercury, organic and calcite-related contaminants (see the text boxes entitled "What is Mercury? [pg. 10]" and "What are Organic Contaminants in Onondaga Lake? [pg. 12]"):

- Soda ash (sodium carbonate) and related products such as baking soda (sodium bicarbonate), sodium nitrite, sodium sesquicarbonate, ammonium bicarbonate, ammonium chloride, calcium chloride, and caustic soda (sodium hydroxide) produced by a non-electrolytic cell process. The primary waste/contaminant associated with this process was Solvay waste, which is a white, chalky, calcite-related material.

Understanding the Onondaga Lake Subsite Proposed Plan

What is Mercury?

One of the main contaminants at the Onondaga Lake subsite is mercury. Honeywell used mercury in the production of chlorine and caustic soda at the mercury-cell chlor-alkali plants.

Most of the mercury in water, sediments, or plants and animals is in the form of inorganic mercury salts and organic forms of mercury (e.g., methylmercury). Methylation of mercury is a key step in the entrance of mercury into food chains. The biotransformation of inorganic mercury to methylated organic forms in water bodies can occur in the sediment and the water column.

Mercury accumulates in the food chain up to the top of the aquatic food web. Nearly all of the mercury that accumulates in fish tissue is methylmercury. Inorganic mercury, which is less efficiently absorbed and more readily eliminated from the body than methylmercury, does not tend to bioaccumulate. Accordingly, mercury exposure and accumulation is of particular concern for animals at the highest trophic levels in aquatic food webs and for animals and humans that feed on these organisms.

Mercury is a known human and ecological toxicant. Methylmercury-induced neurotoxicity is the effect of greatest concern when exposure occurs to the developing fetus. Dietary methylmercury is almost completely absorbed into the blood and distributed to all tissues including the brain; it also readily passes through the placenta to the fetus and fetal brain. Neurotoxic effects include subtle decrements in motor skills and sensory ability at comparatively low doses to tremors, inability to walk, convulsions, and death at extremely high exposures. Other adverse effects of mercury include reduced reproductive success, impaired growth and development, and behavioral abnormalities.

Mercury is known to adversely affect aquatic organisms through inhibition of reproduction, reduction in growth rate, increased frequency of tissue histopathology, impairment in ability to capture prey and olfactory receptor function, alterations in blood chemistry and enzyme activities, disruption of thyroid function, chloride secretion and other metabolic and biochemical functions. In general, the accumulation of mercury by aquatic biota is rapid and depuration is slow. It is emphasized that organomercury compounds, especially methylmercury, are significantly more effective than inorganic mercury compounds in producing adverse effects and accumulation.

- Benzene, toluene, xylene, naphthalene, and tar products from the recovery of coal distillation (coking) byproducts. The primary wastes/contaminants associated with this product line were BTEX, chlorinated benzenes, and polycyclic aromatic hydrocarbons (PAHs), especially naphthalene.

- Chlorinated benzenes and byproduct hydrochloric acid from the chlorination of benzene. The primary wastes/contaminants associated with this product line were BTEX, chlorinated benzenes, and PAHs, especially naphthalene.

- Chlor-alkali products, including chlorine, caustic potash (potassium hydroxide), caustic soda (sodium hydroxide) produced by an electrolytic cell process, and related products such as potassium carbonate, hydrogen gas, and hydrogen peroxide produced by further reacting chlor-alkali byproducts with other chemicals. The primary wastes/contaminants associated with this product line were mercury, PCBs, and polychlorinated dibenzo-*p*-dioxin/polychlorinated dibenzofurans (PCDD/PCDFs).

These four product lines were manufactured in three facilities that were collectively known as the Syracuse Works, as presented in the table below.

Product Lines and Periods of Production at the Syracuse Works

Facility	Product Line	Period of Production	Primary Contaminant Releases
Main Plant	Soda ash and related products Benzene, toluene, xylenes, naphthalene	1881 – 1986 1917 – 1970	Solvay waste, BTEX, chlorinated benzenes, PAHs (especially naphthalene), and PCBs
Willis Avenue Plant	Chlorinated benzenes, hydrochloric acid, and chlor-alkali products	1918 – 1977	Mercury, BTEX, chlorinated benzenes, PAHs (especially naphthalene), PCBs, and dioxins/furans
Bridge Street Plant	Chlor-alkali products Hydrogen peroxide	1953 – 1979[1] 1956 – 1969	Mercury, PCBs, and xylenes

Notes: [1] The Bridge Street Plant was sold to Linden Chemicals and Plastics (LCP) in 1979. LCP operated the plant until it closed in 1988.

Soda ash production at the Main Plant relied on local supplies of sodium chloride brine and limestone. Benzene, toluene, and xylene production and naphthalene production at the Main Plant were based on fractional distillation of light oil, a coke-oven byproduct that was provided by the coke ovens at the Syracuse Works until 1924, after which it was shipped to Syracuse from other locations. Benzene produced at the Main Plant served as the raw material for production of chlorinated benzenes at the Willis Avenue Plant, while xylene and other imported chemicals were used to produce hydrogen peroxide at the Bridge Street Plant.

Chlor-alkali production at both the Willis Avenue Plant and the Bridge Street Plant used mercury cells and diaphragm cells. Both types of cells are used in electrolytic processes for the production of chlorine, sodium hydroxide, and potassium hydroxide from purified sodium chloride and potassium chloride brine.

In addition to the four major product lines, Honeywell facilities produced coke and producer gas (i.e., a mixture of carbon monoxide, nitrogen, hydrogen, methane, carbon dioxide, and oxygen). Other products were produced for short periods of time as pilot plant or developmental laboratory activity or as start-up operations that were later relocated. These products included:

- Nitric and picric acids.
- Salicylic acid and methylsalicylate.
- Benzyl chloride, benzoic acid, benzaldehyde, and phthalic anhydride.
- Phenol.
- Ammonia (via nitrogen fixation at the Bridge Street Plant).

Understanding the Onondaga Lake Subsite Proposed Plan

What are Organic Contaminants in Onondaga Lake?

Honeywell released several of the major organic contaminants found at the Onondaga Lake subsite (e.g., low molecular weight PAHs [LPAHs], chlorinated benzenes, and BTEX) from at least as early as 1918, and began using PCBs and mercury as of the 1940s or possibly the late 1930s. (Mercury is an inorganic contaminant and is discussed in the text box entitled "What is Mercury?" [pg. 10])

Benzene, Toluene, Ethylbenzene, and Xylenes: BTEX compounds are used by a number of manufacturers in industrial processes including the manufacture of other chemicals, some rubbers, paints, paint thinners, lubricants, pesticides, and fuel oil, and as cleaning solvents. Benzene, toluene, and xylenes compounds were produced at the benzol facility located at the Honeywell Main Plant and used at the Honeywell Willis Avenue Plant in the production of chlorinated benzenes. Benzene, toluene, and xylenes were also part of Honeywell's waste streams, were released to the environment by Honeywell, and are each hazardous substances. In animals, benzene is not highly acutely toxic, but chronic exposure can result in central nervous system depression, immunosuppression, bone marrow depression, degenerative lesions of the gonads, fetal growth retardation, damage to genetic material, and solid tumors in several organs. Chronic exposure in humans can result in bone marrow depression, anemia, and leukemia. Breathing benzene can cause drowsiness, dizziness, and unconsciousness. Benzene is considered to be carcinogenic.

Chlorinated Benzenes: Chlorinated benzenes are a group of 12 cyclic aromatic compounds in which one to six hydrogen atoms of a benzene ring have been replaced by up to six chlorine substituents, including monochlorobenzene, dichlorobenzenes, trichlorobenzenes, tetrachlorobenzenes, pentachlorobenzene, and hexachlorobenzene. Chlorinated benzenes were produced by Honeywell's Willis Avenue Plant, which was in operation from 1918 until 1977. Chlorinated benzenes were also part of Honeywell's waste streams, were released to the environment by Honeywell, and are hazardous substances. Chlorinated benzenes are resistant to chemical and biological degradation and tend to accumulate in lipid- (fat-) containing tissues of animals and humans. Chlorinated benzenes have been shown to cause adverse reproductive effects in invertebrates and fish. Chlorinated benzenes can bioaccumulate in humans, and cause adverse health effects (e.g., hexachlorobenzene may cause liver damage).

Polycyclic Aromatic Hydrocarbons: PAHs is the general term applied to a group of compounds, including naphthalene, comprised of several hundred organic substances with two or more benzene rings. They are released to the environment mainly as a result of incomplete combustion of organic matter and are major constituents of petroleum and its derivatives. Naphthalene and other PAHs were produced by Honeywell in conjunction with the benzene, toluene, and xylenes product line and other industrial activities. PAHs, in particular naphthalene, were also part of Honeywell's waste streams, were released to the environment by Honeywell, and are hazardous substances. Exposure to PAHs may result in a wide range of effects on biological organisms. While some PAHs are known to be carcinogenic, others display little or no carcinogenic, mutagenic, or teratogenic activity. Several PAHs exhibit low levels of toxicity to terrestrial life forms, yet are highly toxic to aquatic organisms.

Polychlorinated Biphenyls: PCBs are mixtures of up to 209 different compounds (referred to as "congeners") that include a biphenyl and from one to ten chlorine atoms. They have been used commercially since 1930 as dielectric and heat-exchange fluids and in a variety of other applications. PCBs have been used at and released to the environment from the Honeywell facilities. They are persistent and accumulate in food webs. PCBs bioaccumulate in the fatty tissues of humans and other animals. PCBs are considered probable human carcinogens and are linked to other adverse health effects such as developmental effects, reduced birth weights, and reduced ability to fight infection.

Polychlorinated dibenzo-*p*-dioxins/polychlorinated dibenzofurans: PCDD/PCDFs are composed of a triple-ring structure consisting of two benzene rings connected to each other by either two (dioxins) or one (furans) oxygen atoms. Dioxins and furans are byproducts of chemical manufacturing or the result of incomplete combustion of materials containing chlorine atoms and organic compounds. Based on evidence collected by Honeywell from their sites, PCDD/PCDFs were apparently generated as the result of a fire in the chlorination building at the Willis Avenue Plant in the 1930s and as trace contaminants during the various manufacturing operations and thus were released into the environment. PCDD/PCDFs tend to be very insoluble in water; adsorb strongly onto soils, sediments, and airborne particulates; and bioaccumulate in biological tissues. These substances have been associated with a wide variety of toxic effects in animals, including acute toxicity, enzyme activation, tissue damage, developmental abnormalities, and cancer.

Although not generally considered part of the Syracuse Works, the Barrett Division of the Semet-Solvay Chemical Company (one of Honeywell's predecessor companies) operated a paving material production facility from 1919 to 1983 at a location that is now part of the Wastebed B/Harbor Brook subsite. This part of the Wastebed B/Harbor Brook subsite consists of several buildings, aboveground storage tanks, and a gravel parking lot.

FORMER HONEYWELL OPERATIONS: WASTE MANAGEMENT AND DISPOSAL

Waste was generated by most manufacturing processes at the Syracuse Works. Waste streams for disposal were discharged from the three plants to at least four different destinations: the Semet Residue Ponds (coke byproduct recovery only), Geddes Brook and Ninemile Creek (via the West Flume), the Solvay wastebeds, and directly to the lake (via the East Flume). The Solvay wastebeds are located in the towns of Camillus and Geddes, and in the city of Syracuse (see the attached figure entitled "Historical Locations of Solvay Wastebeds"). From approximately 1881 to 1986, these wastebeds were the primary means of disposal for the wastes produced by the Solvay operations. Initial Solvay waste disposal practices consisted of filling low-lying land adjacent to Onondaga Lake. Later, unlined wastebeds designed specifically for Solvay waste disposal were built using containment dikes constructed of native soils, Solvay waste, and cinders, or by using bulkheads made with timber along the lakeshore. The Syracuse Works also had a landfill in the center of Solvay Wastebed 15.

The discharge of Honeywell waste through the East Flume caused the formation of a large in-lake waste deposit (ILWD). The ILWD extends approximately 2,000 ft (610 m) into the lake, approximately 4,000 ft (1,219 m) along the lakeshore, and contains waste up to 45 ft (13.7 m) thick. The majority of the ILWD is within the boundaries of Sediment Management Unit (SMU) 1 (see the attached figure entitled "Onondaga Lake Sediment Management Units"), although some of the ILWD extends into the adjoining SMUs 2 and 7. The ILWD contains waste from all of Honeywell's product lines. The discharges of waste to Geddes Brook and Ninemile Creek through the West Flume, as well as the overflow from Solvay Wastebeds 9 to 15, also caused the formation of deposits of Honeywell wastes and resulted in the development of the deposits in the Ninemile Creek delta in the lake in SMU 4. The seeps overflow from Solvay Wastebeds 1 to 8 contributed to the formulation of Honeywell wastes in the lake itself.

Two additional sites (the Mathews Avenue Landfill and the Willis Avenue Ballfield site) were used for disposal of industrial wastes and construction and demolition debris from the Syracuse Works. A site known as the dredge spoils area located on the lakeshore northwest of the mouth of Ninemile Creek was used for disposal of dredged material from the Ninemile Creek delta and nearshore areas north of Ninemile Creek. Additional information on these Honeywell sites, including a location map, can be found in Chapter 4 of the Onondaga Lake RI.

In 1970, the Syracuse Works' Main Plant ceased production of benzene, toluene, xylenes, and naphthalene. Furthermore, releases of mercury from the Willis Avenue Plant and the Bridge Street Plant were reduced. In 1977, when the Willis Avenue Plant closed, the production of chlorinated benzenes and chlor-alkali products at the plant ceased. In 1979, the Bridge Street Plant was sold to Linden Chemicals and Plastics (LCP), which operated the plant until it closed in 1988. In 1986, the Main Plant ceased production of soda ash and related products, marking the end of manufacturing at the Syracuse Works.

In summary, Onondaga Lake has been the recipient of more than 100 years of industrial and municipal sewage discharges. Current loads of contaminants to the lake are primarily derived from

Honeywell sites in the vicinity of the lake and along its perimeter, with tributaries and groundwater delivering much of the contamination to the lake. Dense non-aqueous-phase liquid (DNAPL) plumes at the Willis Avenue and Wastebed B/Harbor Brook sites also convey contaminants to the lake. While other parties have contributed to the wastes in the lake, empirical evidence for the Honeywell contributions can be found in the water, sediment, and biota of the lake and in the sediment of selected wetlands, indicating the dominance of these sources to historical and current lake contamination.

SITE GEOLOGY/HYDROGEOLOGY

The bedrock geology beneath the lake consists of 500 to 600 ft (150 to 180 m) of sedimentary rocks of the Vernon Shale Formation, which are comprised of soft and erodible mudstones with some localized, discontinuous gypsum seams. The Syracuse Formation overlies the Vernon Formation to the south of Onondaga Lake to an elevation of 300 to 380 ft (90 to 120 m) above mean sea level. The Syracuse Formation is approximately 600 ft (180 m) thick and is comprised of shales, dolostones, and salt. In this formation, groundwater flowing upward to the north toward Onondaga Lake is the source of brines in the area that contributes to the background salinity levels in the lake.

Onondaga Lake is underlain by a thick layer of soft, unconsolidated sediments ranging from approximately 80 ft (24 m) to over 300 ft (90 m) thick beneath the mouth of Onondaga Creek at the south end of the lake.

Two primary hydrogeologic units exist at the lake: unconsolidated deposits and underlying bedrock shale. The unconsolidated deposits were formed by the combination of glacial processes, post-glacial (lacustrine) processes, and human activities. These unconsolidated deposits consist (from top to bottom) of layers of fill, marl, silt and clay, silt and fine sand, sand and gravel, and till overlying the shale bedrock.

Groundwater in the unconsolidated deposits, which overlies the silt and clay layer, comprises an unconfined groundwater zone that provides most of the discharge of groundwater to the lake. There is limited groundwater discharge from the deeper unconsolidated units to the lake. Groundwater from the bedrock discharges to the lower portion of the overlying unconsolidated deposits west of the lake. Total quantities of groundwater discharged to the lake are small compared to discharges of surface water to the lake.

A major influence on groundwater density is salinity (measured by total dissolved solids concentrations). The range in total dissolved solids concentrations in the area of the lake (400 mg/L to almost 194,000 mg/L) is caused by the presence of Honeywell's Solvay wastes and naturally occurring salt brines.

SURFACE WATER HYDROLOGY

Onondaga Lake receives surface runoff from a drainage basin of 285 sq mi (738 sq km). Surface water flows primarily from the south and southeast into the lake through six tributaries: Ninemile Creek, Onondaga Creek, Ley Creek, Harbor Brook, Bloody Brook, and Sawmill Creek. In addition, lesser amounts of surface water are contributed to the lake through two industrial conveyances: the East Flume and Tributary 5A. Ninemile Creek and Onondaga Creek are the largest sources of water flow to the lake and together accounted for approximately 62 percent of the inflow into the lake from surface sources for the period from 1971 to 1989. Discharge from the Metro Plant accounted for approximately 19 percent of the total inflow during the same period. Ley Creek and Harbor Brook accounted for an estimated 8 and 2 percent of the total inflow, respectively. Contributions from all other tributaries, including Bloody Brook, the East Flume, Tributary 5A, and Sawmill Creek were minor in comparison and together accounted for the remaining 9 percent. The highest inflows of water and suspended solids from tributaries occur during the spring due to snowmelt and springtime rain events, peaking in March and April.

Water also enters the lake through an intermittent bidirectional flow from the Seneca River at the outlet of the lake. This bidirectional flow is possible because Onondaga Lake is part of the New York State Barge Canal System, and the elevation of the lake is controlled by a dam on the Oswego River at Phoenix, New York, downstream of the site. Flow from the outlet is sensitive to the rate of tributary inflow, wind speed and direction, water surface elevations in the river and lake, seiche (variation in the lake surface) activity in the lake, and other factors. Due to the shallow depth of the outlet channel, it is likely that only epilimnetic surface water flows out of the lake into the river. The annual contribution of the Seneca River to the lake has not been quantified but is believed to be less than 10 percent of the total flow to the lake on an annual basis.

The lake elevation can influence the characteristics of the nearshore sediments, including wetlands and parts of the littoral sediments that are subject to wave and ice disturbance. The lake is generally at its highest elevation in the early spring due to increased tributary flows and at its lowest elevation during the summer months. For the 30-year period from 1971 to 2000, maximum annual variations in lake levels ranged from 1.6 ft (0.5 m) in 1988 to 7.2 ft (2.2 m) in 1993, with an overall mean of 4.1 ft (1.25 m).

Based on the United States Geological Survey (USGS) data, the following observations have been made:

1. The average lake elevation is 362.82 ft (110.59 m) above mean sea level.
2. The highest lake level was 369.18 ft (112.53 m).
3. The lowest level was 361 ft (110 m).

Onondaga Lake is stratified during summer, more weakly stratified in winter, and is vertically mixed in the spring and fall. Summer stratification is most pronounced from May through September due to temperature effects on water density. During summer stratification, the colder (and therefore denser) hypolimnion is unable to mix with the overlying warmer (and therefore less dense) epilimnion. The boundary between the epilimnion and the hypolimnion is called the thermocline and is the region in the water column where the temperature changes most rapidly with depth. In Onondaga Lake, the thermocline is located at approximately 30 ft (9 m) below the water surface. The epilimnetic waters continue to be mixed by wind and wave action, while the hypolimnion is isolated beneath the thermocline.

The hypolimnion receives organic and inorganic solids that settle by gravity from the epilimnion toward the lake bottom. As the summer progresses, biodegradation of the organic solids deplete the oxygen in the hypolimnion, creating anoxic conditions. The presence of an anoxic hypolimnion is not uncommon in stratified lakes. However, oxygen depletion in the hypolimnion of Onondaga Lake is exacerbated by loading of phosphorus to the lake from tributaries and the Metro Plant discharge. Phosphorus is the critical nutrient that promotes the growth or productivity of phytoplankton, which in turn increases the organic loading of settling solids to the hypolimnion. Increased phytoplankton productivity also leads to decreased water clarity (due to the high mass of phytoplankton in surface water). In addition to anoxia, elevated concentrations of sulfides and ammonia found in the hypolimnion are considered evidence of advanced cultural eutrophication.

Waters within Onondaga Lake are more saline than in most inland lakes. Solvay Wastebeds 1 through 15 as well as Solvay waste that was disposed of directly in the lake and at other locations along and near the lakeshore are known to contribute calcium, sodium, and chloride to Ninemile Creek and/or the lake. In addition, naturally occurring salt brine, which was collected and evaporated in the vicinity of Onondaga Lake for many years, affects both groundwater and nearby surface water quality. Natural salt springs present near the lake result in saline wetlands. The USGS recently documented a saline spring in Onondaga Creek between Kirkpatrick and Spencer Streets; however, the daily load (on the order of 10 tons [9,000 kilograms {kg}]) is a minor contribution to the salt budget of the lake. The Geddes Brook/Ninemile Creek RI report estimated that the daily total dissolved solids load from Solvay Wastebeds 9 through 15 to Ninemile Creek is on the order of 333 tons (300,000 kg).

Most solids that enter the lake from tributary inflows settle to the lake bottom and are not transported out of the lake through the outlet. Suspended solids from the tributaries initially settle in nearshore sediment, where water depth is less then 15 ft (4.5 m). With the exception of deltas formed at the mouth of some tributaries (e.g., Ninemile Creek, East Flume, and Ley Creek), nearshore sediment generally does not accumulate because it is frequently resuspended by wind and waves. Over time, sediment is carried to deeper waters by lake circulation and ultimately settles to the bottom in deeper parts of the lake.

SEDIMENT CHARACTERISTICS

Based on the depth of the thermocline during stratification, the Onondaga Lake RI report defined sediment located above the thermocline (i.e., 30 ft [9 m]) as littoral sediment and sediment located below the thermocline as profundal sediment. The intent of these designations was to distinguish between the different biological, physical, and chemical processes of the epilimnion and hypolimnion.

Littoral Sediment

Much of the sediment in water depths of less than 15 ft (4.5 m) consists generally of fine silts and clays, sand, and shell fragments.

High concentrations of calcite exist within the littoral sediments throughout most of the lake, due to disposal of Solvay waste during operation of the former Honeywell Main Plant from 1881 to 1986 and past and present input of naturally calcitic sediments from the tributaries. Available data indicate that external calcium loading to the lake decreased by 70 percent from 1983-1985 to 1987-1989, reflecting the cessation of Honeywell's activities at its Main Plant in 1986. Calcium carbonate deposition also decreased by 64 percent over the 1985 to 1989 time frame.

Oncolites are another form of calcite in littoral sediments of Onondaga Lake. Oncolites are small, oval or irregularly rounded, calcareous concretions that resemble elongated pebbles. Made up of calcium carbonate and a small fraction of organic material, they are found throughout the littoral sediments of the lake, especially along the northeast, north, and northwest shorelines. Oncolites are of relatively low mass and therefore are readily moved by waves and currents. Eventually, oncolites may become stationary if they grow to a sufficient size. In Onondaga Lake, oncolite formation is closely associated with discharges of calcium-laden wastes to the lake by Honeywell.

While much of the littoral zone is considered non-depositional due to wind and wave action, discrete areas at the mouths of the tributaries are depositional. These areas, called deltas, are created when the tributary enters the lake, the flow rate drops sharply, and suspended solids settle to the lake bottom. Sediment in these areas accumulates and reflects the composition of the suspended solids that were transported by the tributary into the lake. The delta at the mouth of Ninemile Creek was dredged in the 1960s to remove material that had accumulated over time.

Another historically depositional area within the littoral zone in the southern corner of Onondaga Lake is the area referred to as the ILWD. This area was formed primarily through the precipitation of calcite (calcium carbonate) and other Honeywell wastes from the overflow of dikes around Wastebed B and discharges via the East Flume.

Profundal Sediment

Profundal sediment (i.e., sediment in water depths greater than 30 ft [9 m]) is characterized by small particle size and relatively high moisture content and concentrations of phosphorus, nitrogen, and organic carbon. This sediment is comprised of two units. The first unit extends to approximately 35 inches (90 centimeters [cm]) below the sediment surface and is composed of black clay with distinct layers or laminations. The clay has a sulfide smell and gas bubbles, presumably methane, are present. The second unit extends from approximately 35 inches (90 cm) to at least 16 ft (500 cm) below the sediment surface and is composed of dark gray clay with occasional wood fragments and snail shells. This unit also contains laminations, though they are less distinct than in the first unit. The laminations are attributed to deposition of calcite, clays, and diatoms (silica) associated with erosion of the watershed, productivity cycles within the lake, and other annual events.

RESULTS OF THE REMEDIAL INVESTIGATION

To determine the nature and extent of contamination and assess risks to humans and the environment, an extensive RI was conducted by Honeywell from 1992 to 2000, with additional investigation by NYSDEC in 2001. More than 6,000 samples were analyzed for contaminants including metals, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs). A human health risk assessment (HHRA) and baseline ecological risk assessment (BERA) were completed as part of the RI process. These risk assessments are discussed in the Summary of Site Risks section of this Proposed Plan. The RI, HHRA, and BERA were finalized by NYSDEC in December 2002. NYSDEC conducted a public availability session in February 2003 to present the findings of these documents to the public.

As a result of the RI studies and risk assessments, numerous contaminants were identified as chemical parameters of interest (CPOIs) (see the text box entitled “What are Chemical Parameters of Interest?” [pg. 18]).

Note that the Onondaga Lake RI, HHRA, and BERA also preliminarily evaluated the sediments and soils in select wetlands around the lake and the dredge spoils area near Ninemile Creek. However, the findings for these areas are not presented in this Proposed Plan since these areas are no longer part of the Onondaga Lake subsite. Specifically, four state-regulated wetlands are located along or near the lake’s shoreline near the mouths of Harbor Brook (Wetland SYW-19), Ley Creek (Wetland SYW-12), and Ninemile Creek (Wetland SYW-10), as well as along the northwest shoreline of the lake (Wetland SYW-6), and contain portions that are directly connected to the lake.

Wetlands SYW-19 and SYW-10 were initially addressed during the Onondaga Lake RI and are being evaluated by Honeywell as part of the RI/FS for the Wastebed B/Harbor Brook and Geddes Brook/Ninemile Creek sites, respectively. Wetlands SYW-6 and SYW-12 were initially addressed during the Onondaga Lake RI. Wetland SYW-6 will be further evaluated in the site investigation for the adjacent Ninemile Creek Dredge Spoils Area, and additional sampling will be conducted for Wetland SYW-12 as part of the RI/FS for the Wastebed B/Harbor Brook site.

Understanding the Onondaga Lake Subsite Proposed Plan

What are Chemical Parameters of Interest?

The **chemical parameters of interest**, or **CPOIs**, for the Onondaga Lake RI/FS are defined as those elements or compounds that were selected as **contaminants of potential concern (COPCs)**, **chemicals of concern (COCs)**, or **stressors of concern (SOCs)**. The major classes of CPOIs include mercury and other metals, BTEX, chlorinated benzenes, PAHs, PCBs, PCDD/PCDFs, and calcite.

COPCs: COPCs are used in human health risk assessments (HHRAs) to determine contaminants that may be harmful to humans. An HHRA for the Onondaga Lake subsite was performed as part of the RI. COPCs were developed using available contaminant concentration data for lake fish (fillets only; limited to species likely to be consumed by humans), and for water and sediments in the northern and southern basins of the lake. A total of 62 COPCs were identified in the HHRA that fall into the classes identified above plus pesticides and additional VOCs and SVOCs (see attached table entitled “Contaminants of Potential Concern for the Onondaga Lake HHRA”).

COCs: COCs are used in baseline ecological risk assessments (BERAs) to determine chemicals that may be harmful to the environment. A BERA for the Onondaga Lake subsite was performed as part of the RI. COCs were developed using toxicity values to establish conservative thresholds for adverse effects to ecology (water, surface sediment, surface soil, plants, fish, and wildlife). As presented in the BERA, numerous toxic chemicals were detected at elevated concentrations in various lake media. A total of 38 COCs were identified in the BERA that fall into the classes identified above plus pesticides and additional SVOCs (see attached table entitled “Contaminants and Stressors of Concern Selected for Onondaga Lake Media in the BERA”).

SOCs: SOCs are used in BERAs to determine those chemical contaminants which may not be addressed as hazardous wastes or hazardous substances, but which may cause effects or conditions that are harmful to the environment. The SOCs identified in the BERA include calcite and oncolites in sediments and calcium, chloride, salinity, ammonia, nitrite, phosphorus, and sulfide in water, as well as depleted dissolved oxygen and reduced water transparency (see attached table entitled “Contaminants and Stressors of Concern Selected for Onondaga Lake Media in the BERA”).

The RI report presents information on site history, field and laboratory investigations, physical characteristics of the site, sources of contamination, nature and extent of contamination, and fate and transport of contaminants. The results of the RI are summarized below.

SEDIMENTS

- Mercury contamination is found throughout the lake, with the most elevated concentrations detected in sediments in the Ninemile Creek delta and in the ILWD, which extends along the southern shoreline from near Tributary 5A to beyond Harbor Brook.

- Mercury contamination is widespread in the upper 6.5 ft (2 m) of the sediments in the lake, and it is even deeper in sediment in the Ninemile Creek delta and the

ILWD. At the Ninemile Creek delta, mercury contamination extends to a depth of at least 16.4 ft (5 m) into the sediments. Mercury contamination extends to a depth of about 26.2 ft (8 m) and possibly greater into the sediment/waste in the ILWD.

- The organic contaminants (e.g., BTEX, chlorinated benzenes, LPAHs, PCBs, and PCDD/PCDFs) are primarily found in the ILWD and the shoreline area of the Honeywell sites, with concentrations of these CPOIs in the waste several orders of magnitude higher than in most of the lake. At the ILWD, elevated concentrations of these CPOIs extend to a depth of at least 26.2 ft (8 m). High molecular weight PAHs (HPAHs) are concentrated in the sediments throughout much of the southern basin of the lake, with the highest concentrations occurring off the Oil City shoreline region and the shoreline areas near the Honeywell sites.

- Elevated contaminant concentrations and visual evidence (e.g., liquids, droplets, sheens) indicate that NAPL (e.g., chlorinated benzenes, which was manufactured and released as a waste by Honeywell) exists throughout the ILWD and in an area off the Honeywell causeway. Based on data collected during the RI/FS, it was determined that the NAPLs and highly contaminated waste materials in these areas of the lake are highly mobile, at least when disturbed, have high concentrations of toxic compounds, and present a significant risk to human health and the environment should exposure occur; therefore, they are characterized as principal threat wastes (see the text box entitled "What Is a Principal Threat?" [pg. 19]). In the areas of the ILWD which are far from shore (approximately 660 to 980 ft [200 to 300 m]), it is most likely that these NAPLs were disposed of directly into the lake with the other wastes.

SURFACE WATER

- Concentrations of total mercury in lake water are highest in the nearshore areas around both Ninemile Creek and the ILWD. In the deep basins, water column total mercury concentrations increase significantly in the hypolimnion during summer stratification, with a high fraction of this hypolimnetic total mercury occurring in the dissolved phase.

- Concentrations of benzene, chlorobenzene, and dichlorobenzenes in lake water are highest near the Honeywell source areas in the vicinity of the East Flume and Harbor Brook.

Understanding the Onondaga Lake Subsite Proposed Plan

What is a Principal Threat?

The NCP establishes an expectation that USEPA will use treatment to address the principal threats posed by a site wherever practicable (NCP Section 300.430 [a][1][iii][A]). The "principal threat" concept is applied to the characterization of "source materials" at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for the migration of contamination to groundwater, surface water, or air, or acts as a source for direct exposure. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur. The decision to treat these wastes is made on a site-specific basis through a detailed analysis of alternatives, using the remedy selection criteria. This analysis provides a basis for making a statutory finding that the remedy employs treatment as a principal element.

BIOTA

- Mercury, PCBs, hexachlorobenzene, and PCDD/PCDFs have bioaccumulated in Onondaga Lake fish, and mercury has been found at elevated levels in benthic macroinvertebrates. It is likely that these contaminants have bioaccumulated in other biota (e.g., birds, mammals) as well; however, there are insufficient data to quantitatively assess the extent of bioaccumulation in these other biota. Consumption of fish drives the potential cancer risks and non-cancer hazards for humans (see the Summary of Site Risks section of this Proposed Plan).

- As reported in the HHRA, concentrations of mercury (as methylmercury) in tissue of edible size fish collected from the lake since 1992 range from less than 0.1 to 5.1 milligrams per kilograms (mg/kg) (or parts per million [ppm]), with the average concentration of 1.1 mg/kg exceeding the US Food and Drug Administration (USFDA) limit of 1 mg/kg.

IMPACTS TO FISH AND WILDLIFE RESOURCES

The contamination in the media described above has contributed to negative effects on the fish and wildlife resources around Onondaga Lake in a number of ways, including:

- Oncolite formation.
- Spring and fall turnover were not regular occurrences in the lake during the period of ionic waste discharges.
- Chloride loadings to Onondaga Lake from Solvay waste.
- Reduced species richness and standing crop of macrophytes in the nearshore zone.
- Reduced species richness of zooplankton communities.
- Increased dominance of benthic macroinvertebrate communities by pollution-tolerant taxa.
- Reduced reproduction in the lake by numerous fish species.
- Elimination of cold-water fishery.
- Mercury contamination of fish.
- Lack of amphibian reproduction in wetlands directly connected to lake water.
- Reduced species richness of amphibians and reptiles.

A detailed evaluation of the nature and extent of contamination, including contaminant distribution maps and concentration ranges of CPOIs in site media, can be found in Chapter 5 of the RI report.

FATE AND TRANSPORT OF CONTAMINANTS

Some of the key findings of the fate and transport of CPOIs analyses include:

General

- The lake is a sink for essentially all contaminants. For every CPOI examined, the estimated loads of contaminants entering the lake are at least five times greater than the loads leaving the lake.

- Several important contaminant source areas or mechanisms have been identified. These transport routes serve to deliver multiple contaminants to the lake. Among the routes and mechanisms are the following:

  – Ninemile Creek: This tributary has been and continues to be the single largest external source for total mercury. It has also been a source of PCDD/PCDFs, PCBs, lead, and chromium to the lake.

  – Harbor Brook: This tributary has been and continues to be a major source of LPAHs, particularly naphthalene, to the lake.

  – Ley and Onondaga Creeks: These tributaries appear to be ongoing sources of PCBs, and possibly PCDD/PCDFs, and are among the largest sources of lead to the lake.

  – East Flume: This tributary has been a long-term and important conduit for mercury, chlorinated benzenes, PAHs, and PCDD/PCDFs.

  – Honeywell lakeshore area groundwater: Transport of contaminants to the lake via groundwater represents the most important loading route for several CPOIs, including LPAHs such as naphthalene (from the Wastebed B/Harbor Brook site), chlorobenzene and dichlorobenzenes (from the Willis Avenue site), and all four BTEX compounds (from the Willis Avenue, Semet Residue Ponds, and Wastebed B/Harbor Brook sites). The NAPL plumes, which lie beneath the Willis Avenue and Wastebed B/Harbor Brook sites, contribute to the groundwater contamination and may also be contributing NAPL directly to the lake.

  – ILWD: Resuspension of these materials presents a significant source of mercury to the lake, perhaps representing the largest internal source to the water column. It is also a potentially important source of PCDD/PCDFs and other CPOIs such as BTEX, chlorinated benzenes, PCBs, PAHs, and other non-mercury CPOIs. Surface concentrations of several CPOIs are highly elevated in this waste area relative to the rest of the lake.

  – Profundal sediments: These sediments appear to be responsible for the increase in the hypolimnetic mercury inventory during summer stratification. This increase is believed to be a major source of mercury in the lake.

Mercury

- The lake sediments contain a huge reservoir of mercury. Both profundal and littoral sediments have high mercury inventories.

- Internal loads of mercury, generated via sediment resuspension and other mechanisms, probably yield a net load to the water column similar in magnitude to the externally derived loads, at least during the period of summer stratification.

- The primary removal mechanism for mercury in the water column of Onondaga Lake is particle settling. Deposition to the profundal sediments is the ultimate fate of most of the mercury in the lake, although data indicate that this mercury is not sequestered from the environment.

- Internal sources of total mercury include the resuspension and transfer of materials from the ILWD and the transfer of dissolved and particulate mercury from the profundal sediments. Resuspension and transfer of materials from the ILWD contributes a significant flux to the epilimnion mercury budget, while the transfer of materials from profundal sediments is an additional source of total mercury to the hypolimnion.

- Wind-driven resuspension (i.e., resuspension of lake sediments during windy conditions) is a major mechanism for the release of contaminants from the ILWD and possibly other littoral zone sediments. Groundwater advection through these materials may also transport significant quantities of mercury, as well as other CPOIs, to the lake.

- Particle resuspension and increased diffusion associated with methane gas ebullition in the anoxic sediments (i.e., disturbance of the lake bottom sediments by escaping methane bubbles) are the likely mechanisms for the release of mercury from profundal sediments to the hypolimnetic water column.

- The primary source of methylmercury to the water column is the methylation of total mercury in the hypolimnetic water column during the recurring anoxic stratified period. Diffusion of methylmercury across the thermocline during this period provides the majority of the methylmercury budget to the epilimnion.

- The methylmercury produced in the hypolimnion during stratification escapes to the oxic waters of the lake after fall turnover, resulting in a substantial increase in the epilimnetic concentrations.

CPOIs Other than Mercury

- The lake sediments represent a huge reservoir of contaminant mass for many other CPOIs. Significant contamination other than mercury exists in the littoral zone near the Honeywell lakeshore area, extending along the shore as far as Ley Creek for some compounds. This inventory of contamination cannot be considered sequestered as it is in an area subject to wind-driven waves. The ILWD is located in this region, representing a clear source of contamination to the water column of the lake.

- Low molecular weight organics, such as BTEX, chlorinated benzenes, and LPAHs, tend to be found in sediments offshore of Honeywell's former facilities. An apparent combination of rapid deposition and rapid biodegradation, as well as groundwater-based releases, has resulted in a sediment inventory that is primarily located near the source area.

- High molecular weight organics, such as HPAHs, PCDD/PCDFs, and PCBs, are present at elevated levels throughout the lake bottom sediments, reflecting their resistance to biodegradation as well as the extended period of discharge to the lake by Honeywell and possibly other sources.

- The likely sources of the current loads of BTEX, chlorinated benzenes, and LPAHs include groundwater and NAPL from the various Honeywell upland sites and the ILWD area.

- The largest sources of PCBs to the lake are likely the ILWD and Ley Creek.

- The largest sources of PCDD/PCDFs to the lake are likely Ninemile Creek (octachlorodibenzodioxin- and tetrachlorodibenzofuran-dominant), the East Flume (tetrachlorodibenzofuran-dominant), and Ley Creek (octachlorodibenzodioxin-dominant).

- Elevated levels of cadmium, chromium, copper, lead, nickel, and zinc are found in the lake sediments. The pattern of contamination suggests sources other than, or in addition to, Honeywell for many of these metals. In part because of their longevity in the environment, these metals can be found at levels above background throughout the sediments of the lake bottom.

Calcite Precipitation and Ionic Wastes

- The rate of calcite formation has diminished by at least half since the closure of Honeywell's Main Plant. This, along with remediation of the Tully Mudboils, has reduced the sedimentation rate in the lake by at least half.

- Currently, ionic concentrations remain elevated with respect to other nearby water bodies, even though overall, ionic concentrations in the lake water have been significantly reduced from conditions in the 1980s and earlier.

- Oncolites are found throughout the littoral zone along most of the northern part of the lake and may have had a significant effect on the ecological structure of the lake by creating an unstable substrate for macrophyte (aquatic plant) colonization, thus limiting macrophyte distribution.

A detailed evaluation of the fate and transport of CPOIs can be found in Chapter 6 of the RI report.

SCOPE AND ROLE OF RESPONSE ACTION AND SUBSITES

The primary objectives of this action are to remediate the sources of contamination within Onondaga Lake sediments such that any potential future health and environmental impacts are eliminated or reduced, to the extent practicable.

The NCP defines an operable unit as a discrete action that comprises an incremental step toward comprehensively addressing site problems. This discrete portion of a remedial response manages migration, or eliminates or mitigates a release, threat of a release, or pathway of exposure. The cleanup of a site can be divided into a number of operable units, depending on the complexity of the problems associated with the site. Operable units may address geographical portions of a site, specific site problems, or initial phase of an action, or may consist of any set of actions performed over time or any actions that are concurrent but located in different parts of a site.

NYSDEC and USEPA have to date organized the work for the Onondaga Lake NPL site into eight subsites. These subsites are also considered to be operable units of the NPL site by USEPA. The sites are shown in the attached figure entitled “Location of Onondaga Lake NPL Subsites.” The Onondaga Lake subsite is one of the operable units at the Onondaga Lake NPL site. The status of other subsites and Geddes Brook/Ninemile Creek is discussed below. Interim remedial measures (IRMs) are mentioned below to the extent that they address migration of contamination to the lake. The control of contamination migrating from these upland subsites to Onondaga Lake is an integral part of the overall remediation of Onondaga Lake.

LCP BRIDGE STREET SUBSITE

In September 2000, NYSDEC issued a ROD for this subsite of the Onondaga Lake NPL site. In March 2002, Honeywell entered into an administrative consent order with NYSDEC whereby it committed to implement the remedy at the site. Remedial design has been completed and remedial construction activities have commenced. Remedial construction includes removal of impacted sediments from the West Flume, on-site ditches, and wetlands; restoration of wetlands; installation of a low-permeability cutoff wall around the site; installation of a low-permeability cap; and pumping of groundwater inside the cutoff wall. Remediation of the LCP Bridge Street subsite will control discharges of mercury and other CPOIs to the West Flume, some of which ultimately migrate to Onondaga Lake through Geddes Brook and Ninemile Creek.

GEDDES BROOK/NINEMILE CREEK

An RI/FS for Geddes Brook and Ninemile Creek is underway pursuant to the terms of the Consent Decree (referenced in the Site History section above). The RI/FS includes an evaluation of alternatives for remediating channel sediments in Ninemile Creek and floodplain soils in both streams. The remediation of both streams and associated floodplains, in conjunction with remediation of the LCP Bridge Street subsite, is expected to result in a significant reduction of loadings of mercury and other CPOIs to Onondaga Lake. In July 2002, Honeywell entered into an administrative consent order with NYSDEC whereby it committed to perform an IRM for Geddes Brook. The IRM will include removal of all sediments down to the underlying clay layer in the reach of the brook from the West Flume to the confluence with Ninemile Creek. Impacted soils and sediments within the floodplain along lower Geddes Brook will also be remediated. IRM design is underway.

WILLIS AVENUE SUBSITE/SEMET RESIDUE PONDS SUBSITE

RI/FSs are underway for the Willis Avenue subsite and the Semet Residue Ponds subsite. In March 2002, Honeywell entered into an administrative consent order with NYSDEC whereby it committed to implement an IRM for the lakeshore area downgradient of the Willis Avenue and Semet Residue Ponds subsites. The IRM consists of the design, construction, and operation of a hydraulic containment system. This IRM is planned to eliminate, to the extent practicable, the discharge of groundwater containing contaminants such as chlorinated benzenes, BTEX, naphthalene and other PAHs, mercury, and NAPLs to Onondaga Lake.

Actions will be taken by Honeywell to address principal threat wastes to be collected by the hydraulic containment systems for the Willis Avenue and Semet Residue Ponds subsites, pursuant to CERCLA. Contaminated groundwater, once collected, will be treated at a wastewater treatment plant that is proposed to be constructed on Honeywell's Willis Avenue subsite. The system will also be designed to collect NAPLs, which will be treated and/or disposed of at an off-site permitted facility. Since these NAPL materials are highly mobile, have high concentrations of toxic compounds, and present a significant risk to human health and the environment should exposure occur, they are characterized as principal threat wastes (see the text box entitled "What is a Principal Threat?" [pg. 19]). Since this IRM will involve treatment of source materials constituting principal threat wastes, the IRM is expected to address the statutory preference for treatment as a principal element.

The Willis/Semet IRM is also intended to eliminate, to the extent practicable, direct point-source discharges to the lake through stormwater conveyances (stormwater piping and outfalls associated with I-690), and to eliminate, to the extent practicable, potential impacts to fish and wildlife resources associated with ongoing discharges from the Willis Avenue and Semet Residue Ponds subsites. Design of the IRM is underway. Construction is scheduled to begin in 2005. Remedial efforts for Tributary 5A are being evaluated by Honeywell as part of the RI/FS for the Willis Avenue subsite.

In March 2002, NYSDEC and USEPA issued a ROD for the Semet Residue Ponds subsite. However, NYSDEC and Honeywell agreed in a December 2003 administrative consent order to further evaluate remedies for addressing the site's tar residues. Following this evaluation, NYSDEC and USEPA will propose for public review and comment a remedy for addressing the tar residues. Honeywell has agreed to implement the remedy that results from this further evaluation. A remedial design to collect and treat contaminated groundwater migrating to Tributary 5A is underway.

An amendment to the Willis Avenue RI/FS administrative consent order was signed in 1996 for the performance of an IRM to address the discharge of site-related contaminants from the I-690 storm drain system. As part of the IRM, the system was cleaned and surveyed using video equipment. This work indicated that contaminated groundwater was entering the system through open pipe joints. Remedial work, including the testing and sealing of the open pipe joints, began in 1998 and was completed in 1999. A program for monitoring the effectiveness of the IRM indicated that residual contaminant concentrations were reduced but not eliminated. Due to this residual contamination, a pilot study was initiated in 2002 pursuant to an administrative consent order with NYSDEC to study the isolation of the underdrain (groundwater) flow from the stormwater (from I-690) within the eastern portion of the system. This pilot study is ongoing.

WASTEBED B/HARBOR BROOK SUBSITE

Honeywell is conducting an RI/FS for the Wastebed B/Harbor Brook subsite, which includes the East Flume. In November 2003, Honeywell entered into an administrative consent order with the NYSDEC whereby it committed to implement an IRM for the Wastebed B/Harbor Brook subsite. The IRM consists of the design, construction, and operation of a hydraulic containment system at the Wastebed B/Harbor Brook subsite along the shoreline from the Willis Avenue site to Harbor Brook and along the lower portion of Harbor Brook. The IRM is intended to isolate and collect contaminants including mercury, chlorinated benzenes, BTEX, naphthalene and other PAHs, and NAPLs from groundwater before they enter Onondaga Lake and Harbor Brook. Contaminated groundwater, once collected, will be treated at a wastewater treatment plant that is proposed for construction on Honeywell's Willis Avenue subsite.

The Wastebed B/Harbor Brook subsite IRM design will address collection of NAPLs, which will be treated and/or disposed of at an off-site permitted facility. This IRM will be designed so that it can be integrated with the Willis/Semet IRM (discussed above), resulting in a continuous hydraulic containment system along the entire lakeshore of SMUs 1 and 2 from Tributary 5A to Harbor Brook as well as upstream along the west bank of lower Harbor Brook. Since this IRM involves treatment of source materials constituting principal threat wastes, this IRM also addresses the statutory preference for treatment as a principal element. Pre-design sampling associated with the IRM is underway.

In March 2002, Honeywell entered into an administrative consent order with NYSDEC whereby it committed to implement an IRM for the East Flume. As documented in the Onondaga Lake RI, the East Flume was historically one of the major discharge locations for mercury and other waste materials to the lake. The IRM for the East Flume includes the excavation of approximately 19,000 cy (14,500 m^3) of sediment from within the upper and lower East Flume, the abandonment of an existing 72-inch (183-cm) concrete pipe that discharges to the upper East Flume, and the extension of an existing 60-inch (152-cm) concrete pipe into Onondaga Lake.

GENERAL MOTORS FORMER INLAND FISHER GUIDE SUBSITE

An RI/FS is underway at the General Motors (GM) former Inland Fisher Guide (IFG) facility subsite. Confirmed hazardous wastes at the subsite include PCBs, solvents, copper, nickel, and chromium. Wastes from the plant were formerly discharged to Ley Creek.

At the GM – IFG subsite, three significant IRMs have been performed to prevent the migration of PCBs off of the site and into Ley Creek, a tributary to Onondaga Lake. An on-site industrial landfill which contained chromium- and PCB-contaminated material has been capped. The purpose of this IRM was to prevent these contaminants from leaching into the groundwater. A second IRM involved the removal of highly contaminated soil from a former discharge swale. This swale was used, in the 1950s and 1960s, as a conduit for the discharge of liquid process waste to Ley Creek. The swale was subsequently filled in but the contaminated soil remained until the performance of this IRM. Over 26,000 tons of soil containing hazardous waste levels of PCBs have been removed from the site. The third significant IRM was the construction of a treatment pond and associated water treatment system. This pond collects all water that accumulates on-site in any of the storm sewers or abandoned process sewers. The pond water is then sent through the treatment plant in order to meet permitted discharge limits, prior to discharge to Ley Creek. The purpose of this IRM was to stop the intermittent discharge of PCBs and other contaminants that had occurred during storm events.

General Motors Ley Creek Dredgings Subsite

GM's Ley Creek Dredgings subsite includes areas along the banks of Ley Creek where PCB-contaminated dredge spoils removed from the creek were placed. An RI/FS was completed by GM for the site and a ROD was issued by NYSDEC in March 1997. A 4,000-ft (1,219-m) stretch of the stream bank containing the dredge spoils has been remediated. Remedial activities included the excavation and off-site disposal of PCB-contaminated sediments exceeding 50 ppm and site capping.

Town of Salina Landfill Subsite

The Town of Salina Landfill subsite, which borders Ley Creek, received domestic, commercial, and industrial wastes from the 1950s to 1970s. An RI/FS was completed by the Town of Salina and a Proposed Plan was issued by NYSDEC in January 2003. It is anticipated that a ROD will be issued in 2005.The proposed remedy includes, among other items, construction of a 6 NYCRR Part 360 multilayer cap over the landfill areas north and south of the creek and construction of a groundwater and leachate collection trench north and south of the creek.

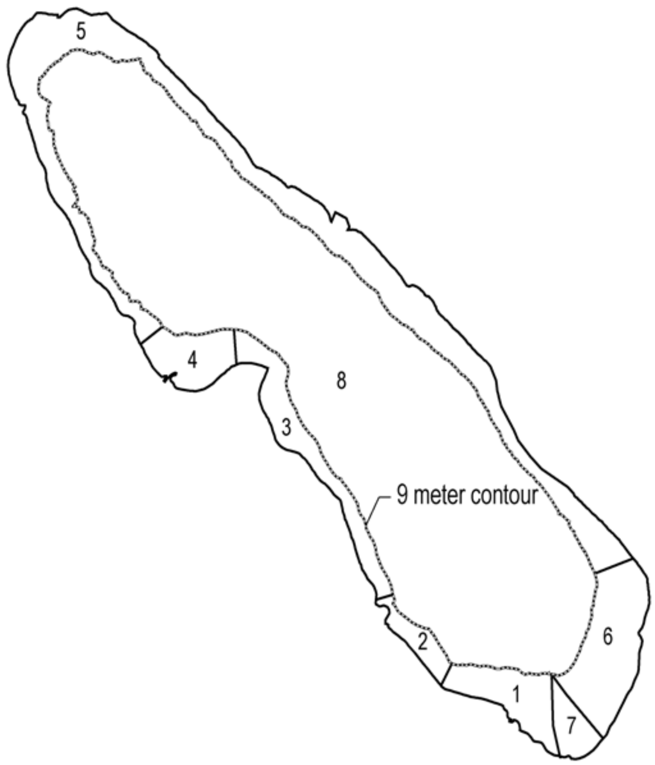
Additional sites in the vicinity of Onondaga Lake that are being addressed by various parties are in various stages of investigation or remediation but are not discussed here. Information regarding these sites is provided in the Onondaga Lake RI report.

Sediment Management Unit Descriptions

For the purposes of the FS and this Proposed Plan, the Onondaga Lake subsite ("site") was divided into eight SMUs based on water depth, sources of water entering the lake, and physical, ecological, and chemical characteristics (see the attached figure entitled "Onondaga Lake Sediment Management Units"). The division of the Onondaga Lake subsite into SMUs allows the development and evaluation of remedial alternatives appropriate to each area. The remedial alternatives evaluated for each SMU are then used in combination to develop comprehensive, lakewide remedial alternatives which would reduce site risks to humans and the environment. SMUs 1 through 7 are located in the littoral zone of the lake (i.e., water depths of 0 to 30 ft [0 to 9 m]), and SMU 8 covers the profundal zone (i.e., water depths of greater than 30 ft [9 m]).

SMU 1

SMU 1 is located at the southern end of Onondaga Lake and encompasses the majority of the ILWD. The ILWD was formed primarily through the deposition of calcium carbonate and other wastes from the overflow of dikes around Wastebed B and through discharges via the East Flume. These discharges into the lake are believed to have included a combination of cooling water, sanitary waste, Solvay waste, mercury wastes, and organic chemical wastes, which settled out and formed a large delta that is at a higher elevation than surrounding areas of the lake bottom. This waste material is typically described as very soft to soft, although there are some harder crusts. This softness, along with geophysical evidence of historical failures (i.e., underwater slumping or



Onondaga Lake Sediment Management Units (SMUs)

"landslides" associated with the ILWD), causes concern as to whether the wastes in their current configuration are sufficiently stable to prevent a portion of the ILWD from slumping in the future.

SMU 1 is located directly offshore of Wastebed B, and the East Flume and Harbor Brook enters Onondaga Lake here. SMU 1 extends approximately 3,850 ft (1,170 m) west from the mouth of Harbor Brook, encompassing a surface area of approximately 84 acres. At its widest point, SMU 1 extends approximately 2,200 ft (671 m) into the lake. Lake bathymetry indicates that the nearshore shelf (at water depths less than 13 ft [4 m]) is relatively broad and is bordered by a steeper offshore slope at water depths from 13 to 30 ft (4 to 9 m).

A portion of the SMU 1 shoreline is contiguous with the state-regulated wetland SYW-19, which is dominated by *Phragmites* while the rest of the shoreline is partially forested. Nearshore sediments are dominated by Solvay waste (e.g., calcium carbonate deposits). Macrophyte beds are lacking, fish reproduction appears low, and there is a severely impaired benthic community.

Multiple external sources for most of the CPOIs present in the lake have been identified in the vicinity of SMU 1, including the Wastebed B/Harbor Brook and the Willis Avenue subsites.

NAPL is present within layers of the ILWD and is typically found in small brown nodules. The NAPL does not appear to be present in continuous layers. Sheens were also noted on the lake surface at every location in this area during intrusive activities. There is evidence of mobility of the NAPL residual in the lake during intrusive activities such as well placement, sediment coring and sample collection, and likely during sediment resuspension caused by wind-driven waves. Since these NAPLs and other highly contaminated materials in the lake in this area are highly mobile, have high concentrations of toxic compounds, and present a significant risk to human health and the environment should exposure occur, they are characterized as principal threat wastes.

Risk concerns and associated CPOIs and stressors in SMU 1 include sediment toxicity to benthic macroinvertebrates (mercury, ethylbenzene, xylenes, chlorobenzene, dichlorobenzenes, trichlorobenzenes, PAHs, total PCBs); exposure of humans to sediments by wading (arsenic, PAHs, PCDD/PCDFs, hexachlorobenzene); exposure of fish to mercury and other CPOIs and subsequent human and wildlife consumption of fish; benthic macroinvertebrate/insect consumption by wildlife (PAHs, barium, chromium, mercury, methylmercury, selenium); a moderately to severely impaired benthic community (sediment toxicity); and impaired habitat conditions (limited macrophyte cover).

SMU 2

SMU 2 is located in the southern portion of the lake offshore from the causeway formerly used by Honeywell for loading and unloading materials. The SMU extends approximately 3,000 ft (914 m) along the southern shore of the lake, from the border with SMU 1 toward Tributary 5A. At its widest point, SMU 2 extends approximately 550 ft (170 m) into the lake. Lake bathymetry indicates that the nearshore shelf is relatively broad, except near the mouth of Tributary 5A, where it becomes steeper (i.e., greater than 15 percent slope). Storm drains associated with I-690 discharge into this SMU.

Natural shoreline features, including vegetation, are lacking in SMU 2. The littoral zone sediments are dominated by calcium carbonate deposits. Macrophyte beds are lacking, there is a moderately impaired to severely impaired benthic community, and evidence of fish reproduction in the area is low to none.

Multiple external sources for most of the CPOIs present in the lake were identified in the vicinity of SMU 2, including the Semet Residue Ponds and the Willis Avenue subsites.

Stained fill material was observed at one location within SMU 2. The 0 to 10.5 ft (0 to 3.2 m) depth interval at this location contained black impacted fill material that was granular in nature (slag, brick, wood, etc.) and was, according to Honeywell, likely placed during the construction of the causeway in the 1970s. The staining of the fill material may be a result of NAPL in this area. The source of the contamination at this location is likely related to the NAPL (chlorinated benzenes) plume from the Willis Avenue site or from the I-690 storm drains in the area, which intercept a portion of the contaminated groundwater from the Honeywell site. The NAPLs and other highly contaminated materials in the lake in this area are also characterized as principal threat wastes.

Risk concerns and associated CPOIs and stressors in SMU 2 include sediment toxicity to benthic macroinvertebrates (mercury, ethylbenzene, xylenes, chlorobenzene, dichlorobenzenes, trichlorobenzenes, PAHs, total PCBs); exposure of humans to sediments by wading (arsenic, PAHs, PCDD/PCDFs, hexachlorobenzene); exposure of fish to mercury and other CPOIs and subsequent human and wildlife consumption of fish; benthic macroinvertebrate/insect consumption by wildlife (PAHs, barium, chromium, mercury, methylmercury, selenium); a moderately to severely impaired benthic community (sediment toxicity); and impaired habitat conditions (limited macrophyte cover and oncolites).

SMU 3

SMU 3 is located offshore of Honeywell's inactive Solvay Wastebeds 1 through 8, which were used to dispose of wastes from the manufacturing of soda ash via the Solvay process. SMU 3 extends approximately 8,000 ft (2,440 m) west from SMU 2. At its widest point, it extends approximately 825 ft (250 m) into the lake. Lake bathymetry indicates that the shelf is relatively steep in the southern part of SMU 3, becoming broader to the north.

The sediments are dominated by calcium wastes including oncolites. Macrophyte beds are generally sparse, but increase at the border with SMU 4. The immediate shoreline is erosional, but vegetation on the Solvay wastebeds supports terrestrial wildlife. Evidence suggests that fish reproduction is low. The benthic community impacts vary widely from slightly to severely impacted.

Risk concerns and associated CPOIs and stressors in SMU 3 include sediment toxicity to benthic macroinvertebrates in some areas (mercury, ethylbenzene, xylenes, dichlorobenzenes, total PCBs); impaired habitat conditions (calcitic sediments, unstable shoreline, limited macrophyte cover [except at the border of SMUs 3 and 4]); a slightly to moderately impaired benthic community (sediment toxicity in some areas); and impaired habitat conditions (limited macrophyte cover and oncolites).

SMU 4

SMU 4 is located along the shore of Onondaga Lake west of SMU 3 and includes the delta where Ninemile Creek discharges into the lake. SMU 4 extends approximately 3,300 ft (1,006 m) along the shore of the lake. At its widest point, it extends approximately 1,375 ft (420 m) into the lake. Lake bathymetry indicates that the shelf is relatively steep in the northern part of SMU 4, becoming broader to the south. The sediment load at the mouth of Ninemile Creek drives the depositional processes along the central portion of this SMU by discharging fine- and coarse-grained material to the lake. The sediment load from the creek influences the bathymetry and water depth in the central portion of this SMU.

SMU 4 is contiguous with state-regulated wetland SYW-10, which is a floodplain forest. Macrophyte beds are prevalent in the depositional areas of Ninemile Creek. During low water events in late summer, exposed sediments attract shorebirds. Evidence suggests significant fish reproduction in the area. Some sediments of the SMU include eroded Solvay wastebed materials and oncolites. The benthic community is moderately impacted.

Multiple external sources were identified in the vicinity of SMU 4, including the LCP Bridge Street site, West Flume, Geddes Brook and Ninemile Creek, and Honeywell's Solvay Wastebeds 1 through 15. The LCP Bridge Street site is located along the West Flume and consists of 20 acres of land used by Honeywell for chlor-alkali production. The West Flume discharges into Geddes Brook, which discharges into Ninemile Creek.

Risk concerns and associated CPOIs and stressors in SMU 4 include moderately impaired benthic community; habitat conditions (limited macrophyte cover in some areas); and exposure of fish to mercury and other CPOIs and subsequent human and wildlife consumption of fish.

SMU 5

SMU 5 includes the littoral zone along the northern and western shores of the lake. Sawmill Creek and Bloody Brook discharge into SMU 5. The Seneca River, the main discharge point for Onondaga Lake, is also located within SMU 5 at the northwestern end of the lake. SMU 5 extends approximately 30,000 ft (9,144 m) from the Ninemile Creek delta to the Ley Creek delta. At its widest point, it extends approximately 1,375 ft (420 m) into the lake. Lake bathymetry indicates that the nearshore shelf (at water depths less than 13 ft [4 m]) is relatively broad and is bordered by a steep offshore slope at water depths from 13 to 30 ft (4 to 9 m).

Habitat conditions vary significantly across SMU 5. The northwest section is contiguous with state-regulated wetland SYW-6, which includes floodplain forest and emergent wetlands. There are large macrophyte beds and overhanging vegetation that encourage fish reproduction. The remainder of the shoreline is dominated by human uses, including the Onondaga Lake Park and roadways. Some shoreline vegetation is present. The sediments throughout the SMU are dominated by calcium carbonate and oncolites. Macrophytes and fish reproduction decrease along the northeast section of the SMU. The benthic community is slightly to moderately impacted.

External sources for some CPOIs present in the lake were identified within the vicinity of SMU 5 in the Bloody Brook area. Bloody Brook runs through an industrial complex, some suburbs, and some major transportation rights of way, discharging into the middle of the northern side of the lake.

Risk concerns and associated CPOIs and stressors in SMU 5 include slightly impaired habitat conditions in some areas (oncolites and limited macrophyte cover in some areas) and slightly to moderately impaired benthic communities and limited macrophyte cover in some areas.

SMU 6

SMU 6 extends approximately 5,000 ft (1,500 m) along the eastern end of Onondaga Lake from the mouth of Ley Creek to 700 ft (213 m) south of the mouth of Onondaga Creek, and includes the deltas where Ley Creek and Onondaga Creek discharge into Onondaga Lake. At its widest point, it extends approximately 1,925 ft (590 m) north into the lake. Lake bathymetry indicates that the nearshore shelf is relatively broad.

The SMU 6 shoreline is contiguous with state-regulated wetland SYW-12, which includes floodplain forest and emergent wetlands. Sediments are less dominated by calcium carbonate deposits than some other SMUs and oncolites are not abundant. Macrophyte beds are present, especially at the mouth of Onondaga Creek. Fish reproduction appears low. The benthic community is moderately to severely impacted.

Multiple external sources and potential sources for some of the CPOIs present in the lake were identified in the vicinity of SMU 6, including Ley Creek, Onondaga Creek, and the Oil City area. The Ley Creek area contains the GM – IFG site, the GM Ley Creek Dredgings site, the Town of Salina Landfill, and the GM Old Ley Creek Channel site. The Onondaga Creek area includes the Niagara Mohawk – Erie Boulevard Manufactured Gas Plant site, the Niagara Mohawk – Hiawatha Boulevard Manufactured Gas Plant site, the Roth Steel site, and the American Bag and Metal site. The Oil City area was used as a bulk storage and transfer facility for numerous industries. These sites are discussed further in the Onondaga Lake RI report. Although the Honeywell sites and former facilities (and related discharge points) are not located adjacent to the shoreline of SMU 6, the effects of Honeywell's facilities and discharges are evident in the sediments of this SMU based on the presence of Honeywell CPOIs.

Risk concerns and associated CPOIs and stressors in SMU 6 include sediment toxicity to benthic macroinvertebrates (mercury, ethylbenzene, xylenes, dichlorobenzenes, PAHs, total PCBs); sediment exposure to humans by wading (arsenic, PAHs, PCDD/PCDFs, hexachlorobenzene); exposure of fish to mercury and other CPOIs and subsequent human and wildlife consumption of contaminated fish; benthic macroinvertebrate/insect consumption by wildlife (PAHs, barium, chromium, mercury, methylmercury, selenium); and impaired habitat conditions (limited macrophyte cover).

SMU 7

SMU 7 is located at the southern corner of Onondaga Lake and includes the littoral zone located between SMU 1 and SMU 6. SMU 7 is located between Harbor Brook to the west and the

Onondaga Creek delta to the east and extends approximately 1,375 ft (420 m) along the shore of the lake. At its widest point, it extends approximately 2,200 ft (670 m) into the lake. Lake bathymetry indicates that the shelf is relatively broad near the shore, becoming slightly steeper at a water depth greater than 13 ft (4 m).

A portion of SMU 7 is contiguous with part of state-regulated wetland SYW-19, which is dominated by *Phragmites*. The remainder of the shoreline is in close proximity to the railway. Macrophyte beds are present. Calcium carbonate deposits and associated oncolites are less dominant than in other SMUs. Fish reproduction appears low and the benthic community is severely impacted.

Multiple external sources for most of the CPOIs present in the lake were identified in the vicinity of SMU 7, including Harbor Brook, which flows adjacent to the Lakeshore Area and the Penn-Can property (both part of the Wastebed B/Harbor Brook subsite). NAPL was observed in one boring in SMU 7. In addition, sheen was consistently noted at the water surface during installation of borings, consistent with the observations at the ILWD. NAPL was also noted in a number of sediment samples collected from Harbor Brook, as well as in samples of the marl deposit collected from beneath the sediments of Harbor Brook. Based on historic photos and sampling, it can be seen that the ILWD extends into a portion of SMU 7.

Risk concerns and associated CPOIs and stressors in SMU 7 include sediment toxicity to benthic macroinvertebrates (mercury, ethylbenzene, xylenes, chlorobenzene, dichlorobenzenes, trichlorobenzenes, PAHs, total PCBs); sediment exposure to humans by wading (arsenic, PAHs, PCDD/PCDFs, hexachlorobenzene); exposure of fish to mercury and other CPOIs and subsequent human and wildlife consumption of contaminated fish; benthic macroinvertebrate/insect consumption by wildlife (PAHs, barium, chromium, mercury, methylmercury, selenium); and impaired habitat conditions (limited macrophyte cover).

SMU 8

SMU 8 includes the entire profundal zone of Onondaga Lake, where the water depth is greater than 30 ft (9 m). It is approximately 22,000 ft (6,710 m) long and approximately 5,225 ft (1,590 m) wide at its widest part. SMU 8 has two basins, northern and southern, which are separated by a slight ridge, or saddle, that is approximately 56 ft (17 m) deep. The maximum depths of the northern and southern basins are 62 ft (19 m) and 65 ft (20 m), respectively. Lake bathymetry indicates that the profundal nearshore shelf is relatively steep, becoming broader towards the center of the lake.

SMU 8 is dominated by anoxic conditions during the summer months that limit the use of the sediments by the benthic community. Anoxic conditions also prevent fish from using the deepwater habitat during the summer. The extent to which fish use the hypolimnion under oxic conditions is unknown.

The ultimate fate of most of the sediment entering Onondaga Lake is burial in the profundal sediment. Therefore, the sources contributing to the contamination within SMUs 1 through 7, as discussed above, are also sources of contamination to the profundal sediments in SMU 8.

Risk concerns and associated CPOIs and stressors in SMU 8 include habitat impairment, with exclusion of the benthic community during periods of anoxia and exposure of fish to mercury and other CPOIs (e.g., PCBs) in the epilimnion and in the hypolimnion during those times that oxygen is available and subsequent human and wildlife consumption of contaminated fish.

SUMMARY OF SITE RISKS

As part of the RI process, baseline risk assessments were conducted for the site to estimate the risks to human health and the environment (see text box entitled “What Is Risk and How Is it Calculated?”[pg. 34]). The baseline risk assessments, consisting of an HHRA, which evaluated risks to people, and a BERA, which evaluated risks to the environment, analyzed the potential for adverse effects both under current conditions and if no actions are taken to control or reduce exposure to hazardous substances at the Onondaga Lake subsite. As indicated below, based upon the results of the RI and the risk assessments, NYSDEC has determined that active remediation is necessary to protect public health or welfare and the environment from actual and threatened releases of hazardous substances into the environment.

HUMAN HEALTH RISK ASSESSMENT

A site-specific HHRA was performed to quantitatively evaluate both cancer risks and non-cancer health hazards associated with potential current and/or future exposures to chemicals present in Onondaga Lake surface water, sediments, and fish in the absence of any action to control or mitigate those chemicals. The HHRA was prepared to evaluate potential risks associated with exposure to elevated concentrations of mercury, benzene, chlorobenzene, and other COPCs in surface water; mercury, benzene, xylenes, chlorinated benzenes, PAHs, PCBs, PCDD/PCDFs, and other COPCs in sediments; and mercury, hexachlorobenzene, PCBs, PCDD/PCDFs, and other COPCs in fish.

Hazard Identification

In addition to mercury (including methylmercury), approximately 60 other chemicals were identified as COPCs in one or more site media using a screening process comparing measured concentrations to risk-based concentrations. Risks were calculated for these COPCs in the HHRA.

Exposure Assessment

Recreational visitors to Onondaga Lake are the receptors or individuals with the greatest potential for exposure to COPCs. Cancer risks and non-cancer health hazards were evaluated for young children (less than 6 years old), older children (6 to less than 18 years old), and adults (18 and over). In addition, it was assumed that people eat fish caught in Onondaga Lake, even though NYSDOH currently advises that women of childbearing age, infants, and children under the age of 15 should not eat any fish from Onondaga Lake and all others should eat no more than one meal per month of any species, with no walleye to be eaten at all. Recreational visitors were assumed to include anglers who eat fish from Onondaga Lake; people who swim, wade, or boat in the lake; and people who play or walk along the shoreline of the lake.

Understanding the Onondaga Lake Subsite Proposed Plan

What Is Risk and How Is it Calculated?

A Superfund baseline risk assessment is an analysis of the potential adverse effects caused by hazardous substances at a site in the absence of any actions to control or mitigate these effects under current and future conditions. Both human health risk assessments (HHRAs) and baseline ecological risk assessments (BERAs) have four main components used for assessing site-related human health or environmental risks:

Hazard Identification (used in an HHRA) or Problem Formulation (used in a BERA): In the *Hazard Identification* step of the Onondaga Lake HHRA, the COPCs in various media (i.e., sediment, surface water, and fish) are identified based on such factors as toxicity, frequency of occurrence, fate and transport of the contaminants in the environment, concentrations of the contaminants in specific media, mobility, persistence, and bioaccumulation. In the *Problem Formulation* component of the BERA, COCs are identified, ecological effects and exposure pathways are reviewed, assessment endpoints are selected, and a conceptual model is developed.

Exposure Assessment: In this component, the different exposure pathways through which receptors (people and animals) might be exposed to the contaminants identified in the previous step are evaluated. Examples of exposure pathways include incidental ingestion of and dermal contact with contaminated sediment. Factors relating to the exposure assessment include, but are not limited to, the concentrations that people or wildlife might be exposed to and the potential frequency and duration of exposure.

Toxicity or Effects Assessment: In this component, the types of adverse health effects associated with chemical exposures and the relationship between the magnitude of exposure and severity of adverse effects are determined. Potential health effects are chemical-specific and may include the risk of developing cancer over a lifetime or other non-cancer health effects, such as changes in the normal functions of organs within the body (e.g., changes in the effectiveness of the immune system) or reproductive effects. Some chemicals are capable of causing both cancer and non-cancer health effects.

Risk Characterization: This step summarizes and combines outputs of the exposure and toxicity assessments to provide a quantitative assessment of site risks. In an HHRA, exposures are evaluated based on the potential risk of developing cancer and the potential for non-cancer health hazards. The likelihood of an individual developing cancer is expressed as a probability. For example, a 10^{-4} cancer risk means a "one-in-ten-thousand excess cancer risk," or one additional cancer may be seen in a population of 10,000 people as a result of exposure to site contaminants under the conditions explained in the Exposure Assessment. Current federal Superfund guidelines for acceptable exposures are "generally concentration levels that represent an excess upper bound cancer to an individual of between 10^{-4} to 10^{-6}" (40 CFR § 300.430[e][2][A][2]) (corresponding to a one-in-ten-thousand to a one-in-a-million excess cancer risk). The 10^{-6} risk is used as the point of departure for determining remediation goals. For non-cancer health effects, a "hazard quotient" (HQ) is calculated for each contaminant. An HQ represents the ratio of the estimated exposure to the corresponding reference doses (RfDs). The sum of the HQs is termed the "hazard index" (HI). The key concept for a non-cancer HI is that a "threshold level" (measured as an HQ or HI of 1) exists, below which non-cancer health effects are not expected to occur. In a BERA, risks to the environment are evaluated using individual contaminant HIs calculated for representative species.

In addition to consumers of fish, the HHRA also evaluated exposure to those who may contact contaminated sediments and water; specifically, current and future recreational users of Onondaga Lake and future construction workers. A summary of the results of the risk estimates is provided below in the "Risk Characterization" section.

Because risk assessments are designed to be conservative so that risk management strategies can be protective of human health, as well as consistent with USEPA requirements, two types of exposure scenarios were analyzed in the HHRA to assess a range of potential risk: the reasonable maximum exposure (RME), which portrays the highest level of human exposure that could reasonably be expected to occur, and the central tendency (CT, or "typical") scenarios. Cancer risks and non-cancer health hazards were assessed for recreational visitors to Onondaga Lake and future construction workers under both these scenarios.

Toxicity Assessment

Risk estimates for all COPCs were based on use of toxicity values, using carcinogenic slope factors (CSFs) to assess potential carcinogenic effects and reference doses (RfDs) to assess potential non-cancer effects. These measures were primarily derived and published by USEPA. The three COPCs (or COPC groups) responsible for a majority of estimated site risks are methylmercury, PCBs, and PCDD/PCDFs.

- Methylmercury is a toxic chemical with which a number of adverse health effects have been associated in both human and animal studies (see the text box entitled "What is Mercury?" [pg. 10]). The largest amount of data exists on neurotoxicity, particularly in developing organisms.

- PCBs cause cancer in animals and probably cause cancer in humans (see the text box entitled "What are Organic Contaminants in Onondaga Lake?" [pg. 12]). In addition, serious non-cancer health effects have been observed in animals exposed to PCBs. Studies of Rhesus monkeys exposed to PCBs indicate a reduced ability to fight infection and reduced birth weight in offspring exposed in utero.

- PCDD/PCDFs are probable human carcinogens, based on evidence in laboratory animals (see the text box entitled "What are Organic Contaminants in Onondaga Lake?" [pg. 12]). They have also been associated with a wide variety of toxic effects in animals, including acute toxicity, enzyme activation, tissue damage, and developmental abnormalities.

Risk Characterization

The HHRA shows that cancer risks and non-cancer health hazards associated with ingestion of chemicals in sport fish (e.g., largemouth bass) from Onondaga Lake are above levels of concern. Fish ingestion is the primary pathway for exposure to COPCs and for potential adverse health effects. Cancer risks and non-cancer health hazards calculated for the consumption of Onondaga Lake fish exceeded the target risk level range, as follows:

- **Cancer risks:** The calculated RME cancer risks (ranging from 2.4×10^{-4} to 7.8×10^{-4}) exceeded the high end of the target risk range (10^{-4}), and exceeded the low end of the target cancer risk (10^{-6}) by more than two orders of magnitude. The CT fish ingestion cancer risk (about 4.5×10^{-5} for all recreational receptors) was below the high end of the target range but above the low end of the range.

- **Non-cancer health hazards:** The RME non-cancer hazard indices (ranging from about 18 to 28) exceeded the target hazard index (1) by more than an order of magnitude. The calculated CT non-cancer hazard index (ranging from about 4.5 to 7) also exceeded the target.

RME cancer risks for most recreational exposure pathways (e.g., swimming, wading, boating) other than fish ingestion equaled or exceeded the low end of the target risk range of 1×10^{-6}, with the highest of these being about 3.5×10^{-5} for older child exposure to nearshore sediments from the southern basin of the lake. For the CT cancer risk calculations, the low end of the target range was equaled and slightly exceeded in one pathway other than fish ingestion, with a maximum CT risk of about 2×10^{-6} for young child exposure to nearshore sediments from the southern basin. RME cancer risks (3.7×10^{-6}) for exposure to south basin sediments for future construction workers exceeded the low end of the target risk range of 1×10^{-6}. All other RME and CT risks for future construction workers were less than the target range. None of the calculated non-cancer hazards (for both RME and CT scenarios) associated with pathways other than fish ingestion exceeded the target threshold of 1, indicating that exposure to lake COPCs from all pathways except fish consumption are not predicted to result in adverse non-cancer effects. (Note that risks due to the sediments and soils in the wetlands around the lake and the dredge spoils area near Ninemile Creek were calculated in the Onondaga Lake risk assessments but are not presented in this Proposed Plan. These areas are now being addressed as part of investigations taking place at other upland sites; i.e., the Ninemile Creek Dredge Spoils Area for state-regulated wetland SYW-6, Geddes Brook/Ninemile Creek for state-regulated wetland SYW-10, and the Wastebed B/Harbor Brook site for state-regulated wetlands SYW-12 and SYW-19.)

Baseline Ecological Risk Assessment

The BERA evaluated the likelihood that adverse ecological effects are occurring or may occur as a result of exposure to one or more chemicals or stressors. The BERA was prepared to evaluate potential risks associated with exposure to elevated concentrations of mercury, chlorinated benzenes, and other COCs and stressors in surface water; mercury, BTEX, chlorinated benzenes, PAHs, PCBs, PCDD/PCDFs, and other COCs and stressors in sediments; and mercury, chlorinated benzenes, PAHs, PCBs, PCDD/PCDFs, and other COCs in fish and other wildlife. The framework used for assessing site-related ecological risks is similar to that used for HHRAs and consists of problem formulation, ecological exposure assessment, ecological effects assessment, and risk characterization.

Problem Formulation

Problem formulation identifies the major factors to be considered in a BERA, including COC and SOC (e.g., ionic waste) characteristics, ecosystems and/or species potentially at risk, and ecological effects to be evaluated. It establishes the goals, breadth, and focus of the assessment, develops a conceptual model, and selects assessment endpoints, which are explicit expressions of the environmental value that is to be protected. In an HHRA, only one species (humans) is evaluated and the cancer and non-cancer effects are the usual assessment endpoints. In contrast, a BERA involves multiple species that are likely to be exposed to differing degrees and respond differently to the same contaminant. Assessment endpoints focus the risk assessment on particular components of the ecosystem that could be adversely affected by contaminants from the site.

Assessment endpoints selected for Onondaga Lake are based on the sustainability of plant and animal communities and populations. “Sustainability” relates to survival, growth, and reproduction. The assessment endpoints include:

- Sustainability of an aquatic macrophyte community to provide food and shelter for aquatic organisms and wildlife.
- Sustainability of phytoplankton and zooplankton communities as a food source for aquatic organisms and wildlife.

- Sustainability of a terrestrial plant community to provide food and shelter to invertebrates and wildlife.

- Sustainability of a benthic invertebrate community to serve as a food source for local fish and wildlife.

- Sustainability of fish populations.

- Sustainability of amphibian and reptile populations.

- Sustainability of insectivorous, benthivorous, piscivorous (fish-eating), and carnivorous bird populations.

- Sustainability of insectivorous and piscivorous mammal populations.

Detailed quantitative assessment of sustainability of selected populations of fish and wildlife were conducted by selecting individual species representative of various feeding preferences, predatory levels, and habitats. Receptors selected to represent the Onondaga Lake ecological community for the BERA included eight species of fish, six species of birds, and four species of mammals. The remaining receptors (i.e., both aquatic and terrestrial plants, phytoplankton and zooplankton, amphibians, reptiles) were evaluated qualitatively.

Ecological Exposure Assessment

The assumptions and models used to predict the potential exposure of plants and animals to COCs associated with Onondaga Lake are addressed in this component. Exposure parameters (e.g., body weight, prey ingestion rate, home range) of wildlife species selected as representative receptors and site-specific fish, sediment, and water COC concentrations were used to calculate the exposure concentrations or dietary doses using food-web models.

Ecological Effects Assessment

Mercury and numerous other potentially toxic chemicals, including metals, PCBs, PAHs, BTEX, chlorinated benzenes, and PCDD/PCDFs, were detected at concentrations above ecological screening levels in various lake media.

Measures of toxicological effects were selected based on lowest-observed-adverse-effect levels (LOAELs) and no-observed-adverse-effect levels (NOAELs) from studies reported in the scientific literature. Reproductive effects (e.g., egg maturation, egg hatchability, and survival of juveniles) were generally the most sensitive endpoints.

Risk Characterization

Multiple lines of evidence, based on various measurement endpoints (measures of effect), were used to evaluate major components of the Onondaga Lake ecosystem to determine if contamination has adversely affected plants and animals in and around the lake. Almost all lines of evidence indicate that input of chemicals and ionic waste in Onondaga Lake has produced adverse ecological effects at all trophic levels (levels of the food chain) examined.

As discussed in the BERA, mercury and possibly other chemicals have bioaccumulated in most organisms serving as a food source for biota in the lake, resulting in risks to fish and wildlife above acceptable levels. Comparisons of measured tissue concentrations and modeled doses of chemicals to measures of toxicological effects show exceedances of hazard quotients for chemicals in the lake. Many of the chemicals in the lake are persistent (i.e., would remain in the same chemical state without breaking down); therefore, the risks associated with these chemicals are unlikely to decrease significantly unless remediation is performed.

Exceedances of site-specific sediment effects concentrations based on macroinvertebrate toxicity tests (see text box entitled "Development of Sediment Effect Concentrations/Probable Effect Concentrations" [pg. 39] in the Remedial Action Objectives and Preliminary Remediation Goals section of this Proposed Plan) suggest that adverse effects to benthic invertebrates due to contact with surface sediments will frequently occur in most areas of the lake. The greatest number of contaminants with exceedances and the greatest magnitude of those exceedances were found in areas in the southern portion of the lake (i.e., SMUs 1, 2, 6, and 7) and near Ninemile Creek (i.e., SMU 4).

This is confirmed by benthic community analysis, which indicates that these areas are moderately to severely impacted. As defined in the BERA, "moderately impacted" indicates that the macroinvertebrate community is altered to a large degree from the pristine state and "severely impacted" indicates that the macroinvertebrate community is limited to a few tolerant species, usually midges or worms, and often only one or two species are abundant. In addition, the aquatic macrophytes in the lake have been adversely affected by lake conditions, and the resulting loss of macrophyte habitat that formerly provided valuable feeding, spawning, and nursery areas has likely adversely affected the aquatic invertebrates and vertebrates living in Onondaga Lake.

SUMMARY OF HUMAN HEALTH AND ECOLOGICAL RISKS

Key results of the HHRA include the finding that contamination in Onondaga Lake presents risks to human health that are above USEPA guidelines. In addition, the primary sources of these cancer risks and non-cancer health hazards are due to mercury, PCBs, and PCDD/PCDFs as a result of the consumption of Onondaga Lake fish.

Key results of the BERA indicate that comparisons of measured tissue concentrations and modeled doses of chemicals to toxicity reference values show exceedances of hazard quotients for site-related chemicals throughout the range of the point estimates of risk. Site-specific sediment toxicity data indicate that sediments are toxic to benthic macroinvertebrates on both an acute (short-term) and chronic (long-term) basis. Many of the contaminants in the lake are persistent and, therefore, the risks associated with these contaminants are unlikely to decrease significantly in the absence of remediation. On the basis of these comparisons, it has been determined through the BERA that all receptors of concern are at risk. Contaminants and stressors in the lake have either impacted or potentially impacted every trophic level examined in the BERA.

Based upon the results of the RI and the risk assessments, NYSDEC has determined that active remediation is necessary to protect public health or welfare and the environment from actual and threatened releases of hazardous substances into the environment.

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Development of Sediment Effect Concentrations/Probable Effect Concentrations

To evaluate sediment quality in Onondaga Lake, toxicity of the sediment to sediment-dwelling (benthic) invertebrates was tested. Laboratory tests involved exposing the midge *Chironomus tentans* and the amphipod *Hyalella azteca* to Onondaga Lake sediments and observing their growth and survival. These acute toxicity data were then used to develop the following five site-specific SECs:

Effects Range-Low (ER-L) – The concentration that represents the lowest 10^{th} percentile of the concentrations at which toxic effects were observed. At concentrations below the ER-L, toxic effects are rarely expected.

Threshold Effect Level (TEL) – The geometric mean of the concentration that represents the lowest 15^{th} percentile of the concentrations at which toxic effects were observed and the 50^{th} percentile (median) of the concentrations at which no toxic effects were observed. At concentrations below the TEL, toxic effects are rarely expected.

Effects Range-Median (ER-M) – The concentration that represents the 50^{th} percentile (median) at which toxic effects were observed. At concentrations above the ER-M, toxic effects are likely to occur.

Probable Effect Level (PEL) – The geometric mean of the ER-M and the 85^{th} percentile of the concentration distribution for the no-effects data. At concentrations above the PEL, toxic effects are likely to occur.

Apparent Effect Threshold (AET) – The concentration of a chemical in sediment above which a particular toxic effect (e.g., increased mortality or decreased biomass) is always significant compared to reference concentrations. At concentrations above the AET, toxic effects are predicted to always occur.

The geometric mean of these five Onondaga Lake SECs was calculated to provide a single consensus-based probable effect concentration (PEC) for each contaminant. At concentrations above the PEC, adverse effects in sediments are expected to frequently occur. The derivation of these site-specific values is presented in the Onondaga Lake BERA. SECs and PECs were calculated for each of the CPOIs in the BERA. For mercury, the following SEC values were calculated: 0.51 mg/kg for ER-L, 0.99 mg/kg for TEL, 2.8 mg/kg for ER-M, 2.84 mg/kg for PEL, and 13 mg/kg for AET. Based on these five SECs, the PEC for mercury is 2.2 mg/kg. As discussed in the BERA, the SECs and PECs do not consider the potential effects that could occur throughout the food web as a result of bioaccumulation. However, bioaccumulation is considered in the development of PRGs for fish tissue and for a sediment quality value for mercury. See text boxes below.

REMEDIAL ACTION OBJECTIVES AND PRELIMINARY REMEDIATION GOALS

Remedial action objectives (RAOs) are specific goals to protect human health and the environment. These objectives are based on available information and standards, such as applicable or relevant and appropriate requirements (ARARs), to-be-considered guidance, and site-specific risk-based levels. There are no federal or New York State sediment cleanup standards for mercury or the other

CPOIs found in Onondaga Lake sediments. Although the sediments are the primary focus of the remediation, the degree of attainment of New York State's surface water standards and guidance values and site-specific fish target concentrations was also evaluated in the FS.

The RAOs for Onondaga Lake were based on site-specific information including the nature and extent of CPOIs, the transport and fate of mercury and other CPOIs, and the baseline human health and ecological risk assessments. The RAOs were developed in the RI as goals for controlling CPOIs within the lake and protecting human health and the environment. The RAOs for Onondaga Lake are:

- RAO 1: To eliminate or reduce, to the extent practicable, methylation of mercury in the hypolimnion.
- RAO 2: To eliminate or reduce, to the extent practicable, releases of contaminants from the ILWD and other littoral areas around the lake.
- RAO 3: To eliminate or reduce, to the extent practicable, releases of mercury from profundal sediments.
- RAO 4: To eliminate or reduce, to the extent practicable, existing and potential future adverse ecological effects on fish and wildlife resources, and potential risks to humans.
- RAO 5: To achieve surface water quality standards, to the extent practicable, associated with CPOIs.

In order to achieve these RAOs, preliminary remediation goals (PRGs) were established to provide additional information/goals with which remedial alternatives can be developed and selected. Onondaga Lake contains three primary media that have been impacted by CPOIs: sediments, biological tissue, and surface water. The following three PRGs have been developed, each addressing one of the affected media:

- PRG 1: Achieve applicable and appropriate sediment effect concentrations (SECs) for CPOIs and the bioaccumulation-based sediment quality value (BSQV) for mercury, to the extent practicable, by reducing, containing, or controlling CPOIs in profundal and littoral sediments.
- PRG 2: Achieve CPOI concentrations, to the extent practicable, in fish tissue that are protective of humans and wildlife that consume fish.
- PRG 3: Achieve surface water quality standards, to the extent practicable, associated with CPOIs.

PRG 1– SEDIMENTS

Toxicity

The sediment PRG (PRG 1) is based on five site-specific SECs and one consensus-based probable effect concentration (PEC) for the CPOIs evaluated in the RI and risk assessments (see the text box called "Development of Sediment Effect Concentrations/Probable Effect Concentrations" [pg. 39]). The SECs and PECs were calculated using data from acute sediment toxicity testing using benthic macroinvertebrates. Benthic macroinvertebrates live in and around the sediments for most of their lives, and therefore experience the highest direct exposure to contamination in the lake.

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Development and Use of the Mean PEC Quotient

The Onondaga Lake SECs and PECs were used to identify sediments in the lake to be considered for remediation, due to the sediment's direct, acute toxicity to the benthic community. Because of the large number of CPOIs and the differences in sources, transport, and fate, a further refinement of the SEC/PEC approach was used to develop a single number, the mean PECQ, which takes into account the presence and the concentrations of multiple chemicals in the sediments. Similar approaches have been used in many different regions of the US and Canada by federal and state agencies, monitoring programs, and ecological risk assessors to focus remediation on areas that are likely to have the greatest overall toxicity.

Mean PECQs for sediment samples were calculated in the following four-step process:

- The CPOIs were divided into five groups based on chemical class (i.e., metals, aromatics, chlorinated benzenes, PAHs, and PCBs).
- Each detected chemical concentration in a sample was divided by its PEC, resulting in a quotient of the concentration of that chemical in the sample to its respective PEC (e.g., a mercury concentration of 4.4 mg/kg was divided by the mercury PEC of 2.2 mg/kg for a mercury PECQ of 2).
- For each chemical group, all the resulting PECQs for a particular sample were summed, and the sum of the individual PECQs is divided by the total number of CPOIs for the group in that sample.
- The mean PECQs for each chemical group were summed, and the sum was divided by the total number of groups in the sum.

A simplified hypothetical example of the calculation of the mean PECQ for a sediment sample would be where only five CPOIs are present in the sample, and PECQs of 1, 2, 3, 4, and 5 were calculated for the five CPOIs. The mean PECQ for the sample would be the sum of the five individual PECQs (1 + 2 + 3 + 4 + 5 = 15) divided by the total number of PECQs calculated in the sample (i.e., 5), resulting in a mean PECQ of 3 (15/5) for the sample.

One component of the evaluation was to determine which CPOIs appeared to exhibit the strongest influence on observed acute toxicity on a lakewide basis. This analysis resulted in 23 of the 46 CPOIs for which SECs and PECs were calculated being included in the calculation of the final mean PECQ (see table below). In the case of Onondaga Lake, the mean PECQ for a sample was calculated based on the PECQs for each of the five chemical groups, which were then averaged to produce the overall mean PECQ for that sample.

As part of the FS, the PEC values were incorporated into a mean PEC quotient (PECQ) approach to provide a consistent method of comparing the overall acute toxicity risk from the mixture of contaminants at various locations of the lake (see the text box called "Development and Use of the Mean PEC Quotient" [pg. 41]) and to select a level of remediation that would address the risk of direct acute toxicity to the benthic macroinvertebrate community from the contamination in the lake sediments. Although chronic toxicity tests were conducted as part of the RI, insufficient data were available to develop SECs based on results of chronic toxicity testing.

The mean PECQ can be used as a basis for delineating areas of the lake to be remediated. The areas of the lake in which CPOI concentrations in the littoral sediment exceed a mean PECQ of 1

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Application of the Mean PEC Quotient for Determining Remedial Areas/Volumes

For Onondaga Lake, the mean PECQ for each sample is an indication of the relative risk of acute sediment toxicity posed by the suite of CPOIs at that location. Mean PECQs can be useful for ranking various stations with respect to relative risk and for prioritizing stations for remedial action. For example, if the mean PECQs at two stations are 20 and 1, the station with the higher quotient could be considered a higher priority for remediation.

The relationship of the mean PECQ to toxicity was evaluated by comparing the mean PECQ for each sediment station to the 1992 chironomid mortality data for that same station. There was a general trend showing that as the mean PECQs increased, mortality also increased. An analysis of this relationship suggested that there is an inflection point in the toxicity data around a mean PECQ value of 1 to 2, but the correlation coefficient for these data is rather small, and the data about this inflection point show a high degree of uncertainty. However, a mean PECQ value of 1 can be supported by the concept that if the concentration of a CPOI is equal to or greater than a corresponding acute toxicity threshold (i.e., the PEC for that CPOI), then toxicity would be anticipated to occur. The mean PECQ is simply the “average” quotient for the number of CPOIs detected in the sediments. A mean PECQ value of 1 suggests that on average, the concentrations of CPOIs do not exceed their corresponding PECs.

After evaluating the relationship of the mean PECQ to chironomid acute toxicity, along with the results for the 1992 amphipod acute mortality data, 2000 chironomid and amphipod chronic mortality data, and 2000 chironomid chronic non-emergence data, NYSDEC concluded that remediation of sediments in areas exceeding a mean PECQ of 1 would remediate those sediments where acute toxicity had been observed.

The use of the mean PECQ value of 1 (plus the PEC for mercury; see text) provides a measure of the areal limits of remediation of Onondaga Lake sediments that would protect the benthic community from acute toxicity resulting from direct exposure to CPOIs in the sediments. The mean PECQ methodology itself does not explicitly address chronic toxicity. However, the alternatives discussed in this Proposed Plan, other than the No Action Alternative, would result in a reduction of chronic toxicity to the benthic community in those areas of the lake where existing contaminated littoral sediments would be capped (assuming the cap is effective in keeping levels below the PECs) or where existing contaminated littoral sediments would be removed to the ER-L.

(see the text box called “Application of the Mean PEC Quotient for Determining Remedial Areas/Volumes” [pg. 42]) generally coincide well with those areas where acute toxicity to benthic macroinvertebrates was observed in the sediment toxicity tests. Therefore, the mean PECQ of 1 was determined to be protective and selected as a remediation goal to address direct acute toxicity to benthic invertebrates. In addition, since mercury in the lake is a primary concern and elimination or reduction of mercury is part of all five RAOs, the mercury PEC of 2.2 mg/kg was also selected as a remediation goal.

For all but one of the lakewide alternatives evaluated in this Proposed Plan, the primary criteria for remediation of sediment toxicity are the mean PECQ of 1 and the mercury PEC. To assess the feasibility of a cleanup based on an SEC to address chronic toxicity, one alternative was developed using the effects range-low (ER-L) as the sediment toxicity remediation goal rather than the mean PECQ of 1 and mercury PEC criteria. The ER-L is the concentration at which acute toxic effects are rarely expected, and is more likely to also protect the macroinvertebrate community from chronic effects.

Bioaccumulation

The mercury in fish is derived from a combination of food sources such as benthic macroinvertebrates, uptake from the water column through skin or gills, and incidental intake of suspended particles in the water column. Together, these exposure pathways result in the bioaccumulation of mercury in fish. To address the risk to wildlife and humans from consumption of contaminated fish, a BSQV was developed for this contaminant in addition to the benthic toxicity-based PEC of 2.2 mg/kg (see discussion under PRG 2 and associated text box). As calculated, the BSQV of 0.8 mg/kg represents a concentration in sediments that if not exceeded is predicted to result in mercury concentrations in fish below levels of concern for human and wildlife consumption.

Concentrations of PCBs, hexachlorobenzene, and PCDD/PCDFs in fish tissue were also determined to be risk drivers for human health and wildlife. PCBs, hexachlorobenzene, and PCDD/PCDFs are not widespread in sediments in the lake and are found primarily in a few specific areas of the lake (e.g., SMUs 1, 2, 6, and 7). The NYSDEC sediment screening criteria for protection of wildlife and humans from bioaccumulation were used as the comparison values for these three CPOIs. The areas where these CPOIs are elevated are generally co-located with areas that exceed the cleanup criteria of the mean PECQ of 1 plus the mercury PEC and would be addressed under the remedial alternatives evaluated in this Proposed Plan.

Contaminants Used in Mean PEC Quotient in Onondaga Lake

Group	Contaminant
Metals	Mercury
Aromatics	Ethylbenzene
	Xylenes
Chlorinated Benzenes	Chlorobenzene
	Dichlorobenzenes
	Trichlorobenzenes
Polycyclic Aromatic Hydrocarbons	Acenaphthene
	Acenaphthylene
	Anthracene
	Benz[a]anthracene
	Benzo[a]pyrene
	Benzo[b]fluoranthene
	Benzo[g,h,i]perylene
	Benzo[k]fluoranthene
	Chrysene
	Dibenz[a,h]anthracene
	Fluoranthene
	Fluorene
	Indeno[1,2,3-cd]pyrene
	Naphthalene
	Phenanthrene
	Pyrene
Polychlorinated Biphenyls (PCBs)	Total PCBs

Applicability to RAOs

PRG 1 addresses RAOs 1 through 4 to various degrees, as follows.

- RAO 1: Methylation of mercury in the hypolimnion is influenced by two primary factors: anoxic conditions (meaning there is no oxygen) and the availability of mercury for methylation. By reducing mercury concentrations in the surface sediments to achieve a specific SEC value, PRG 1 reduces the amount of mercury that may be released into the hypolimnion. The reduction in the amount of mercury released from littoral and profundal sediments into the water column would, in turn, reduce methylation of mercury in the hypolimnion, thus addressing RAO 1.

- RAO 2: Reducing the concentration of CPOIs in the ILWD and other contaminated littoral sediments would limit the amount of CPOIs available for release, thus addressing RAO 2.

- RAO 3: Reducing, containing, or controlling mercury concentrations in profundal sediments would limit the amount of mercury available for release into the lake through methane gas ebullition or diffusion, thus addressing RAO 3.

- RAO 4: Remediating littoral and profundal sediment concentrations to achieve a specific SEC value would directly reduce adverse ecological effects to the benthic community. In addition, reductions of CPOI concentrations in sediment would reduce adverse effects associated with direct exposure of humans, fish, and wildlife to sediment, as well as adverse effects associated with bioaccumulation of CPOIs from sediment. Reductions of mercury concentrations in sediment would also reduce the amount of mercury released to the water column, thereby reducing mercury methylation in the hypolimnion. This, in turn, would make mercury less available for uptake by lake biota and would ultimately reduce potential risks to fish, wildlife, and humans, thus addressing RAO 4.

PRG 2 – FISH TISSUE

The fish tissue PRG (PRG 2) primarily addresses RAO 4, which is to eliminate or reduce, to the extent practicable, existing and potential future adverse ecological effects on fish and wildlife resources and potential risks to humans. Quantitative target concentration ranges for bioaccumulative CPOIs in fish tissue have been developed that are protective of wildlife and humans consuming fish from Onondaga Lake (see text box on “Preliminary Remediation Goals in Fish Tissue” [pg. 45]). In addition, BSQVs were developed as estimates of the concentrations of mercury in the surface sediments in the lake needed to reach human and wildlife fish tissue target concentrations (see text box on “Bioaccumulation-Based Sediment Quality Values” [pg. 45]). The selected BSQV for mercury of 0.8 mg/kg would be used to assess whether the reduction in surface-weighted average concentrations of mercury remaining in the sediments (or a cap) after the completion of the remedy would be sufficient to achieve the fish tissue target concentrations.

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Preliminary Remediation Goals in Fish Tissue

Methylmercury is a bioaccumulative contaminant that was calculated to pose potential risks (i.e., hazard quotients above 1) to piscivorous birds, mammals, and humans consuming fish from Onondaga Lake. PRGs for mercury (as methylmercury) concentrations in fish tissue were developed for Onondaga Lake using risk-based methods. There are no federal or New York State cleanup standards for mercury in fish.

The concentrations of methylmercury for the PRGs for fish were calculated based on a hazard quotient of 1 for ecological receptors and non-cancer risk for humans (see the section of this Proposed Plan on Summary of Site Risks). The hazard quotients for ecological receptors were based on both the no-observed-adverse-effect level (NOAEL), representing the highest CPOI concentration at which no adverse effects are seen, and the lowest-observed-adverse-effect level (LOAEL), representing the lowest CPOI concentration shown to produce adverse effects. The human health hazard quotient of 1 for individual CPOIs indicates the "threshold level" below which non-cancer effects are not expected to occur. The PRGs were calculated using the same exposure assumptions and toxicity values as the HHRA and BERA.

Mercury fish and wildlife PRGs range from 0.01 to 0.3 mg/kg wet weight (ww) (i.e., 0.01 to 0.3 parts per million [ppm]), depending on species and whether the NOAEL or LOAEL is used to set the target hazard quotient. Avian mercury target levels range from 0.01 to 0.3 mg/kg ww in fish tissue and mammalian target levels range from 0.01 to 0.2 mg/kg ww in fish tissue.

Human health mercury target PRG fish tissue concentrations are 0.2 mg/kg ww for the reasonable maximum exposure scenario and 0.6 mg/kg ww in fish tissue for the central tendency scenario. The 0.2 mg/kg ww target is roughly equal to the mean fish tissue background concentration of mercury in US lakes.

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Bioaccumulation-Based Sediment Quality Values

Since a variety of dynamic factors affect mercury levels in fish, mercury bioaccumulation-based sediment quality values (BSQVs) were also developed for Onondaga Lake to estimate the sediment mercury concentrations associated with the fish tissue PRGs. These BSQVs were derived to be protective of human health and the environment by reducing the potential for mercury bioaccumulation from the sediments into fish. The first step entailed calculating site-specific biota-sediment accumulation factors (BSAFs) for fish fillets consumed by people and for whole fish consumed by wildlife using lakewide fish and surface sediment data. BSAFs were calculated by dividing the average mercury concentration in fish tissue by the lakewide average mercury concentration in sediment. Lakewide averages were used because fish were assumed to move over large areas of the lake.

The mercury PRGs for fish based on human and wildlife fish consumption were divided by the BSAF to calculate the target concentration of mercury in sediments. The most sensitive ecological receptor, the river otter, was used to calculate a LOAEL-based target of 0.8 mg/kg. As the ecological-based target level was less than the human health concentration (i.e., also protective of human health), it was selected as the target BSQV against which surface-weighted average sediment concentrations will be compared.

PRG 3 – SURFACE WATER

The surface water PRG (PRG 3) directly addresses RAO 5, which is to achieve surface water quality standards, to the extent practicable, associated with CPOIs. With the exception of mercury, surface water concentrations of most of the CPOIs do not currently consistently exceed applicable standards and guidance values. New York State surface water quality standards (6 NYCRR Part 703) for mercury (i.e., the standard for protection of wildlife of 2.6 nanograms per liter [ng/L] dissolved mercury and the standard for protection of human health [via fish consumption] of 0.7 ng/L dissolved mercury) are currently consistently exceeded in Onondaga Lake. These two standards are considered to be protective of wildlife and humans exposed to mercury via fish consumption. They therefore take into account bioaccumulation of mercury from water into fish tissue.

Higher concentrations of dissolved mercury in surface waters are found primarily in the hypolimnion in summer and early fall, where the anoxic conditions cause mercury to change into more soluble forms. Exceedances of the standards for protection of wildlife and human health are found almost exclusively in the anoxic hypolimnion, with a maximum dissolved mercury concentration of 24 ng/L at the north deep basin station in 1999 at a depth of 59 ft (18 m). Reductions in the releases of mercury into the hypolimnion and eliminating anoxic conditions would help to achieve this PRG.

It is also noted that the highest total mercury concentration found in the lake in surface waters was 595 ng/L from the water column immediately above the sediment surface in SMU 1 in 2000, while the highest total mercury concentration closer to the surface of the water column was 103 ng/L at the border of SMUs 1 and 7 in 1999. Concentrations of dissolved mercury in 1999 and 2000 from the epilimnion (including nearshore areas) ranged from 1 to 7.8 ng/L, with some samples exceeding the standard of 2.6 ng/L and all samples exceeding the lowest standard of 0.7 ng/L.

There have also been exceedances of applicable surface water standards for other CPOIs related to Honeywell, such as chlorobenzene and dichlorobenzenes. The highest concentration of chlorobenzene recorded in the RI was 12 µg/L in SMU 1 near the border with SMU 2 in 1999. This concentration exceeds the NYSDEC (6 NYCRR Part 703) standard for the protection of aquatic life (chronic) of 5 µg/L. The highest concentration of dichlorobenzenes recorded in the RI was 6.6 µg/L in this same sample. This concentration exceeds the NYSDEC (6 NYCRR Part 703) surface water standard for total dichlorobenzenes for the protection of aquatic life (chronic) of 5 µg/L. Remediation of the external sources and contaminated sediments and NAPLs in this area would be needed to achieve this PRG for these CPOIs.

The narrative water quality standards for several of the physical parameters listed in 6 NYCRR Part 703.2 (i.e., turbidity, suspended and settleable solids, oil and floating substances) are consistently exceeded in the lake due to NAPLs and ionic wastes. Remediation of sediments and NAPLs will aid in achieving these standards. The proposed habitat enhancements for some SMUs will also be needed to reduce the movement of oncolites and resuspension of ionic wastes contributing to the exceedances.

Summary

Attainment or exceedance of individual PRGs will not be sufficient to establish the success or failure of the remedial program for the lake, in part because a variety of dynamic factors affect levels of mercury and other CPOIs in each medium. Rather, as per the NCP, the success or failure of the Onondaga Lake remedial program, as assessed every five years, will be based on attainment of all PRGs.

The goals of this Proposed Plan are: 1) to provide the most appropriate lakewide remedy pursuant to CERCLA (e.g., the quantitative goals associated with the three PRGs above); and 2) to consider more qualitative goals, such as habitat protection and improving conditions for recreational use of the lake. For example, some of the physical and chemical effects of ecological stressors (e.g., oncolites and calcitic sediments) are addressed by the remedial alternatives in this Proposed Plan through the proposed removal and/or containment or stabilization of contaminated sediments.

Because of the importance of Onondaga Lake as a natural resource, the protection of habitat through remediation and restoration has been an important consideration in the development of the various capping and dredging alternatives. Throughout the analysis of the various alternatives, the goal of re-establishing productive aquatic habitat in the lake has been considered along with the need to provide an effective and permanent remedy to the adverse impacts of contamination on the fish and wildlife resources of the lake. Of particular concern is the protection of shoreline habitat and the ecological integrity of the littoral zone. A lakewide habitat restoration plan will be required as part of remedial design.

DESCRIPTION OF ALTERNATIVES

GENERAL

CERCLA §121(b)(1), 42 USC §9621(b)(1), mandates that remedial actions must be protective of human health and the environment, cost-effective, comply with ARARs, and utilize permanent solutions, alternative treatment technologies, and resource recovery alternatives to the maximum extent practicable. Section 121(b)(1) also establishes a preference for remedial actions which employ, as a principal element, treatment to permanently and significantly reduce the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants at a site. CERCLA §121(d), 42 USC §9621(d), further specifies that a remedial action must attain a level or standard of control of the hazardous substances, pollutants, and contaminants, which at least attains ARARs under federal and state laws, unless a waiver can be justified pursuant to CERCLA §121(d)(4), 42 USC §9621(d)(4) (see the table entitled "Nine Evaluation Criteria for Superfund Remedial Alternatives" in the Evaluation of Alternatives section of this Proposed Plan). The various elements of the alternatives (and preferred remedy) presented below do not represent an offer of settlement by the State of the State's pending litigation claims concerning the lake or lake system.

A Phase 1 Cultural Resource Assessment for various areas including Onondaga Lake is underway. Following completion of this Cultural Resource Assessment a Phase 1B Cultural Resource Assessment (to locate culturally sensitive areas) may need to be performed during the remedial design.

This Proposed Plan discusses seven of the alternatives developed for Onondaga Lake by Honeywell and NYSDEC. These alternatives, presented in the attached table entitled "Onondaga Lake Subsite Proposed Plan – Lakewide Alternatives," are grouped by the criteria for remediation (i.e., no action, a mean PECQ of 1 plus the mercury PEC, and the ER-L) and subdivided by SMU. With the exception of the No Action Alternative, all of these alternatives involve some combination of the following remedial technologies which are described on the following pages:

- Dredging (removal).
- Disposal and treatment at an SCA.
- Isolation capping.
- Thin-layer capping.
- Aeration (oxygenation) of the hypolimnion.
- MNR.

Each of the alternatives (except the No Action Alternative) also includes habitat improvement and/or restoration elements (e.g., habitat re-establishment, habitat enhancement, habitat optimization). *Habitat re-establishment* is the restoration of habitat in areas where remediation substantially alters existing conditions. Re-establishment can be either restoring the same type of habitat that existed prior to remediation, or establishing a different type of habitat that has been deemed appropriate for the ecological conditions of the area. *Habitat enhancement* is improvement of habitat conditions in areas where CPOIs do not occur at levels that warrant active remediation, but where habitat impairment due to stressors has been identified as a concern. *Habitat optimization* means re-establishing habitat with desired characteristics to meet a particular natural resource goal for a particular area of the lake in combination with designing the dredging/capping aspect of remediation. The design and construction of habitat improvement and restoration elements must be consistent with the substantive requirements for permits associated with disturbance to state and federal regulated wetlands (e.g., 6 NYCRR Part 663, Freshwater Wetlands Permit Requirements) and navigable waters (e.g., 6 NYCRR Part 608, Use and Protection of Waters). The details will be developed during the remedial design, based upon a comprehensive lakewide habitat restoration plan.

TECHNOLOGIES

Dredging

Dredging would involve permanent removal of sediments and wastes from Onondaga Lake to a specific design depth. Sediments can be dredged hydraulically, mechanically, or by a combination of the two. Hydraulic dredging was selected as the representative process for detailed evaluation in the FS; however, the actual dredging method(s) would be determined during design. In developing alternatives that incorporate removal of contaminated sediments, the following six potential removal options were considered. These potential removal options are not mutually exclusive. In other words, combinations of these options could be employed as part of a remedial alternative for addressing lake contamination. For all dredging options, the littoral zone in the vicinity of the dredging would be restored to re-establish appropriate habitat and function following removal of contaminated sediments.

- Targeted dredging in areas with high CPOI concentrations and high groundwater upwelling velocities. Targeted dredging would increase the effectiveness of the isolation cap.
- Dredging (prior to capping) to ensure that the placement of the isolation cap would result in no loss of lake surface area (NLSA).
- Dredging to optimize habitat and erosion protection (H&E).
- Dredging to remove NAPL.
- Dredging to remove a significant mass of CPOIs (or hot spots) and reduce concentrations prior to capping.
- Dredging or full removal to an SEC.

Targeted dredging would be performed to increase long-term cap effectiveness through removal of contaminated sediments in nearshore areas where groundwater upwelling velocities are high. Groundwater modeling indicates that predicted upwelling velocities are at their greatest near shore, which may prevent the cap from providing complete chemical isolation.

Dredging (prior to capping) would be performed to ensure that the placement of the isolation cap would not result in the loss of lake surface area. Under this option, sufficient sediment would be removed so that there would be no loss of lake surface area (NLSA) following isolation cap placement.

Dredging to optimize habitat and erosion protection (H&E) would consist of removal to an optimal depth for reducing the erosive forces on the cap and re-establishing littoral zone habitat. The re-established habitat may differ from the pre-remediation habitat primarily due to a change in bathymetry or water depth (in addition to the elimination of contamination through the placement of clean material). As part of the remedial design, the final water depth would be designed to meet a particular natural resource goal for each particular SMU while also maintaining littoral zone function.

The isolation cap would be armored (as needed) to prevent erosion caused by wind-driven waves, ice scour, currents from tributaries, and scour from propeller wash. The influence from these effects tends to decrease with increasing water depths. Therefore, with regard to minimizing erosive forces, the goal under this option is to remove nearshore sediments to a depth where erosion is not significant, which allows minimal armoring.

Dredging to remove NAPL would target NAPL in sediments and waste, which constitute an ongoing source (and potential source) of contamination to other media in the lake. As such, they are "principal threat wastes," as defined by USEPA (see the text box on "What is a Principal Threat?" [pg. 19] in the Results of the Remedial Investigation section of this Proposed Plan). Remedies that involve treatment of source materials constituting principal threat wastes will satisfy the statutory preference for treatment as a principal element.

This option includes a dredging/backfilling combination that removes material known, or anticipated, to contain NAPL, such as the southeast portion of SMU 2 (which is immediately adjacent to where NAPLs have accumulated in the shoreline area in the vicinity of the Honeywell causeway and where an onshore NAPL recovery IRM is underway). While NAPLs have been observed in the sediments (up to 13 ft [4 m]) in this area, the full extent is unknown. Based on the vertical extent of NAPLs in the NAPL recovery IRM area, the possibility exists that the NAPLs are as deep as 30 ft (9 m) below the top of the sediments. Accordingly, some of the alternatives assume a removal depth of 30 ft (9 m) in the area near the causeway, rather than the 13 ft (4 m) assumed for the other alternatives. As the depth estimates above are based on limited information, the actual areal and vertical extent of NAPL, as well as the volume of NAPL would be refined in the remedial design.

Dredging to remove a significant mass of CPOIs (hot spots) and reduce concentrations in the ILWD. The southern area of the lake near the Honeywell sites represents the largest repository of CPOIs within the lake, based on volume and CPOI concentrations. The removal of portions of the ILWD prior to isolation capping has the potential to greatly reduce the mass of CPOIs in SMU 1 and portions of SMUs 2 and 7, leaving behind significantly lower volumes and masses of wastes (and residual NAPLs) and significantly lower concentrations of CPOIs beneath the cap. The occurrence of "slumps," or slope failures, within the ILWD, as noted during side-scan sonar imaging of the lake bottom, as well as the generally soft nature of the wastes/sediments (resulting in very low shear strengths in certain areas), represents a major concern in the consideration of capping in this area. Thus, dredging to improve slope stability of the ILWD as well as dredging to improve overall geotechnical conditions for cap placement are also important considerations for SMU 1 and portions of SMUs 2 and 7.

While the ILWD in SMU 1 has been defined based on historical photographs, the extent of elevated concentrations of CPOIs and the extent of Solvay waste, based on visual observations has not been fully determined. Based on the existing data, the ILWD may be as deep as 45 ft (14 m) below the top of the sediments and extends into nearby SMUs 2 and 7. As the depth and volume estimates are based on limited information, the full areal and vertical extent of the ILWD, the distribution of highly elevated CPOI concentrations, and the geotechnical characteristics of the wastes would need to be refined in the remedial design.

Dredging to an SEC relies primarily on full removal of contaminated sediments down to the SEC selected as the cleanup criterion. Some backfill would be required to establish reasonable bottom contours (bathymetry) and to reduce the impact of any residual CPOIs.

Disposal in the Sediment Consolidation Area and Water Treatment

Disposal

Large sediment-dredging projects require large areas for dredged materials management (which includes dewatering, treatment, and final disposal) of the dredged sediment. Typically, the dredged sediment from a remediation project is either consolidated in an on-site location such as an SCA, if sufficient land area is available, or is solidified and transported to an off-site permitted landfill.

The assessment of various management disposal options in the FS included hydraulic dredging with disposal in an SCA and mechanical dredging with off-site disposal (at one or more permitted landfills). On-site consolidation of the sediment in an SCA is the preferred sediment management option. On-site management in an SCA, designed, constructed, and monitored in accordance with federal and state guidance, is a proven and reliable technology for sediment and waste management that is protective of human health and the environment.

Management of the dredged sediments in an SCA would also be more cost-effective than off-site disposal, especially at sediment volumes exceeding 100,000 cy (76,500 m^3). Therefore, all of the action alternatives in the Proposed Plan assume that the dredged sediments would be disposed in an SCA. More specifically, the FS and the alternatives discussed in this Proposed Plan assume that such an SCA would be constructed on one of the Solvay wastebeds (e.g., Wastebed 13). Wastebed 13 could accommodate a large sediment volume (potentially 2,400,000 cy [1,800,000 m^3] or more, depending on final elevation), and its relatively remote location would minimize disruption to and impacts on the community during construction and operation of an SCA. However, the actual Solvay wastebed location(s) on which the SCA(s) would be constructed would be based on geotechnical testing and screening that would be performed during remedial design. Remedial design of the SCA would be undertaken in accordance with state and federal requirements and guidance and would include the installation of an impermeable liner.

The Proposed Plan assumes that preloading and stabilization of the wastebed materials would be required prior to construction of the SCA, but the extent to which preloading and stabilization would be required, if any, would be determined during remedial design.

Water Treatment

Hydraulic dredging in Onondaga Lake would be performed SMU by SMU. Silt barriers would be used to contain resuspended sediment within each SMU dredging work zone. Sediment slurry, containing approximately 10 percent solids by weight, would be transported via pipeline to the SCA for consolidation and treatment of the entrained water to remove CPOIs (including NAPL).

Four different treatment options (primary treatment, enhanced primary treatment, enhanced primary treatment with multimedia filtration, and advanced treatment), providing incrementally higher degrees of treatment, were considered for the supernatant. The specific treatment process used will be developed during the remedial design after additional sampling and treatability testing. In order to be sure that the cost of treatment was not underestimated, this Proposed Plan assumes that "advanced treatment" would be used.

The treatment train for "advanced treatment" consists of enhanced primary treatment, multimedia filtration, air stripping, and granular activated carbon treatment for additional VOC removal. This option includes pH adjustment to promote chemical precipitation of metals, including mercury.

During remedial design, NYSDEC would issue discharge limits that would need to be met by the treated water at the point of discharge (end of pipe) to the lake. As discussed above, the FS and this Proposed Plan assume that supernatant water will require advanced treatment before discharge. However, the actual level of treatment needed to ensure compliance with discharge limits would be determined during remedial design and might vary depending on the levels and types of contaminants present in lake sediments in various areas (or SMUs) of Onondaga Lake.

Understanding the Onondaga Lake Subsite Proposed Plan

Groundwater Flow Model

A groundwater flow model was developed using the software programs Groundwater Vistas and SEAWAT-2000 to simulate groundwater flow beneath and in the vicinity of the southern part of Onondaga Lake.

The groundwater flow model domain encompasses an area of approximately 13 sq mi (34 sq km) surrounding the southern shoreline of Onondaga Lake and centered on the Honeywell sites. The nine-layer model represents seven hydrogeologic units, which were identified through 216 soil borings. Estimates of hydraulic conductivity of the hydrogeologic units were derived from in situ conductivity tests, laboratory permeability tests, specific capacity tests, and pumping tests.

The density of groundwater influences groundwater flow, and therefore a rigorous representation of the groundwater density distribution was incorporated into the model. A major influence on groundwater density is salinity (measured by groundwater total dissolved solids concentrations). The range in total dissolved solids concentrations in the area of the lake (400 mg/L to almost 194,000 mg/L) is caused by the presence of both leachate from Honeywell's inactive Solvay wastebeds and naturally occurring salt brines.

The results of the groundwater flow model included an estimate of the amount and velocity of the groundwater that flows upward through the lake sediments in the various SMUs, both with and without the proposed barrier wall and collection system along the lakeshore in the southern corner. These results were used in the isolation capping model.

Isolation Capping

Isolation capping involves placement of an engineered cap on top of the contaminated sediment. This material helps to prevent or retard the movement of contaminated porewater into the water column and minimize exposure of benthic organisms to the contaminated sediments. Most of the alternatives involve capping portions of the lake bottom to meet the following objectives:

- Provide physical isolation of the impacted sediments from benthic organisms and other animals, and human contact.

- Physically stabilize the sediment to prevent resuspension, contaminant mobilization, and sediment transport.

- Provide chemical isolation of impacted sediments from advective or diffusive flux or resuspension into the overlying surface waters.

Understanding the Onondaga Lake Subsite Proposed Plan

Isolation Capping Model

A model was developed to assess the effectiveness of in-situ isolation capping of the littoral sediments of Onondaga Lake. In-situ capping involves placement of an engineered cap over contaminated sediment to prevent or limit the movement of contaminated porewater from the sediment into the water column and minimize exposure of benthic organisms to the contaminated sediments. An isolation cap would consist of three layers:

1. An isolation layer, designed to prevent or limit vertical chemical migration.
2. An armor layer, designed to protect the isolation layer from erosional processes such as waves, ice scour, and propeller wash.
3. A habitat/bioturbation layer, designed to provide habitat for benthic macroinvertebrates and allow for bioturbation processes without exposure to contaminated sediment or disruption of the isolation layer material.

There are varying degrees of contamination in the sediments of each SMU; thus, each cap would need to be of a SMU-specific thickness to ensure that contaminants are contained. Therefore, the model was developed for each littoral zone SMU. The model was used to predict chemical concentrations in the habitat/bioturbation layer at steady state, with the primary means of contaminant transport within the isolation layer being through the processes of porewater advection and diffusion. This model assumes that the cap is armored, so that erosion of the cap is minimal and does not provide the primary means of contaminant migration. In addition, the bioturbation or biologically active zone is assumed to be confined to an approximately 6 inch (15 cm) layer above the chemical isolation layer, so that few contaminants are transported to the surface of the cap by organisms mixing the sediments.

The predicted concentrations of contaminants in sediments at the top of the cap were compared to the chemicals' PECs for the 23 CPOIs and NYSDEC sediment screening criteria* for benzene, toluene, and phenol to ensure that these concentrations would not be exceeded in the habitat/bioturbation layer in the future. The cap model was then used to determine the appropriate cap thickness in each littoral zone SMU and whether sediment removal is necessary in areas of high upwelling rates. The cap model will be re-run as part of the remedial design, incorporating any new remedial design data, and the cap design may be modified as appropriate.

* NYSDEC Technical Guidance for Screening Contaminated Sediments, January 1999.

Specific factors that would be evaluated as part of the design of the engineered cap include erosion, bioturbation, chemical isolation, habitat protection, settlement, static and seismic stability, and placement techniques. Modeling performed for chemical isolation was used to produce preliminary cap designs (see the text boxes entitled "Groundwater Flow Model" [pg. 51] and "Isolation Capping Model" [pg. 52]), to ensure that there would be no predicted exceedances of the PEC of any of the CPOIs that have been shown to exhibit acute toxicity on a lakewide basis or NYSDEC sediment screening criteria for benzene, toluene, and phenol.

The results of a preliminary capping evaluation were used to produce the cap designs presented in the alternatives. Since the cap would be designed such that none of the PECs for the individual CPOIs (or the sediment criteria for benzene, toluene, and phenol) would be exceeded in the bioturbation layer, the model-predicted mean PECQ of the surficial materials following cap placement would be less than 1. The modeling indicates that the chemical isolation component of these caps should be between 1 to 2.5 ft (0.3 to 0.76 m) thick, depending on the area of the lake.

To ensure protection of human health and the environment, the caps would be designed to be an additional 50 percent thicker as a safety factor, plus an additional 6 inches (15.2 centimeters) to address possible mixing with underlying sediment and uneven application, which results in a total thickness of 2 to 4.25 ft (0.6 to 1.3 m) for the various SMUs. Settlement analysis was incorporated into the preliminary cap design to estimate the final elevation of the cap following settlement due to the weight of the cap.

Evaluations of wind-generated waves, flood flows at the mouths of tributaries, propeller wash from vessels, and ice scour predict that a cap armor layer consisting of gravel or sand (depending on location and water depth) and armor stone along the shoreline would provide physical stability for the cap. A 6-inch “habitat/bioturbation” layer was assumed for cap modeling purposes in order to incorporate assumed mixing of contaminants in the top layer of the isolation cap by benthic invertebrates. Actual habitat restoration requirements were not considered in the

For the isolation cap to be effective in certain areas of the lake, hydraulic control systems would need to be in place to minimize upwelling velocities in these areas. Due to the elevated concentrations of CPOIs and unstable areas within the littoral zone, as well as concerns for fish and wildlife exposures, isolation capping (rather than thin-layer capping) is evaluated in the alternatives for all littoral-zone SMUs (0 to 30 ft [0 to 9 m] water depths).

Thin-Layer Capping

Thin-layer capping is included in all of the action alternatives for portions of the profundal sediments of Onondaga Lake. Its objective is to provide an immediate decrease in surface sediment concentrations by introducing clean substrate into the upper layer of sediment, rather than to isolate surface sediments. It is anticipated that construction of the thin-layer cap and subsequent natural processes, such as bioturbation and sedimentation, would mix the new substrate with the underlying material or cover contaminated sediments, thereby reducing the surface concentration of the profundal sediments and the potential for adverse effects associated with CPOIs. During remedial design the appropriate thickness and type of substrate would be identified. For the profundal zone, a thin-layer cap thickness of 4 inches (10 cm) was used for cost estimating purposes.

Aeration (Oxygenation)

Aeration (oxygenation) involves the introduction of oxygen into the hypolimnion to prevent the development of anoxic (no oxygen) conditions, which currently exist in summer and early fall (June through September). Maintaining oxygenated conditions in the hypolimnion would reduce mercury methylation in the hypolimnion and reduce the concentrations of dissolved mercury. These effects, in turn, would be expected to result in decreased concentrations of mercury in fish tissue and decreased risk to fish consumers. Maintaining oxygenated conditions would also be expected to reduce the flux of methylmercury from profundal sediments.

A specific aeration (oxygenation) system technology would be determined as appropriate, during remedial design. The specific technology assumed for the purposes of the FS involves a downflow contact oxygenation system that mixes pure oxygen bubbles with oxygen-depleted water inside a contact chamber so that no bubbles are released to the surrounding water column. This system uses a submersible pump, which draws water from the hypolimnion into the conical unit. Oxygen supplied from an onshore facility is injected at the top of the cone. The oxygenated water is then discharged back to the lake through a horizontal diffuser pipe at the same depth from which it was withdrawn. Aeration (oxygenation) has been performed in other lakes and reservoirs, but rarely to specifically control methylmercury production. Furthermore, potential effects of oxygenation on productivity, the food web, and the geochemistry of the lake sediments would need to be evaluated. Consequently, pilot studies would need to be performed to aid in further evaluation of the potential effectiveness of the alternative at reducing formation of methylmercury in the water column, fish tissue methylmercury concentrations, and methane gas ebullition as well as to understand any other impacts. Pilot testing may be coordinated, if feasible, with the Onondaga Lake Partnership, which is planning a similar pilot aeration study on the lake.

Understanding the Onondaga Lake Subsite Proposed Plan

Monitored Natural Recovery Model

Natural recovery can occur through a variety of physical, chemical, and biological processes that act singly or in combination to reduce contaminant concentrations, exposure, or mobility. This process can occur in various media at a site (e.g., water and sediments. Because sediments are usually an important sink for contaminants and a potential exposure pathway to organisms, the focus of monitored natural recovery (MNR) is often on contaminated sediments and the mechanisms that affect them.

A one-dimensional, numerical model was developed using STELLA Research software in order to determine whether MNR is a feasible technology for remediating the contaminated profundal sediments in Onondaga Lake. The primary purpose of the MNR model is to understand how natural recovery might occur (or fail to occur) in the future based on what is known about the lake system. The output or results from the model are presented in terms of expected mercury concentrations in surface sediments in the profundal areas of the lake. The model looks at present-day conditions and predicts how those conditions are expected to change several years in the future.

Another purpose of the model is to provide information on how sediment surfaces might react during and after remedial actions. The model focuses on changes in the sediment surface and provides information on reactions to inputs such as isolation or thin-layer caps. Thin-layer capping is a remediation technique (along with MNR) that is evaluated for profundal sediments. The model was used to assess the long-term solid and dissolved contaminant fate and transport associated with natural recovery by simulating the diffusion, bioturbation, groundwater mediated advection, settling, burial, and degradation mechanisms likely to be present at the Onondaga Lake site. By assessing these mechanisms over time, a prediction of contaminant concentrations and fluxes in the future was obtained. Using the sediment data currently available (primarily from 1992 for the profundal sediments), the model predicts that any area that had an observed total mercury concentration of 6.7 mg/kg or less in 1992 would be expected to achieve the mercury PEC of 2.2 mg/kg by 2014. Thus, the model suggests that most of the profundal zone would be amenable to MNR as a remedial alternative. However, additional MNR modeling would need to be performed during the remedial design phase based upon additional sampling that would take place prior to remediation.

Monitored Natural Recovery

MNR is a sediment management tool that depends on a variety of physical, chemical, and biological processes that reduce chemical concentrations, exposure, and mobility. MNR requires a goal that defines the expected contaminant concentrations to be reached in a specified time period (assumed in the FS to be 10 years following the remediation of upland sources, littoral sediments, and initial thin-layer capping in the profundal zone). The MNR alternative includes the completion of investigations during remedial design to refine the application of a monitored natural recovery model (see the text box entitled "Monitored Natural Recovery Model" [pg. 54]), long-term monitoring, and institutional controls to protect the integrity of the remedy and ensure long-term protectiveness of human health and the environment. Monitoring the effectiveness of natural recovery would be described in a long-term monitoring plan to be developed during remedial design and would include evaluations of mercury and other CPOI concentrations in sediment, water, and fish over time.

LAKEWIDE ALTERNATIVES

As presented in the attached table entitled "Onondaga Lake Subsite Proposed Plan – Lakewide Alternatives," combinations of these remedial technologies have been considered relative to individual SMUs and developed into lakewide alternatives. While the FS evaluated 14 alternatives, it was determined that some of the alternatives would not be evaluated in this Proposed Plan. Reasons for exclusion include ARAR compliance issues, levels of protectiveness, and the similarity of a number of the alternatives. Estimates of cost (including capital, annual operation and maintenance [O&M], and present worth costs) and construction time are also presented in the table for each alternative. With the exception of the No Action Alternative, all alternatives for the littoral zone (SMUs 1 through 7) include varying amounts of dredging, isolation capping, NAPL removal, and habitat optimization and enhancement. With the exception of the No Action Alternative, all alternatives for the profundal zone (SMU 8) include aeration, MNR, and varying amounts of thin-layer capping. The table presents the littoral- and profundal-specific alternatives for each SMU for each alternative.

Six of the 14 lakewide alternatives (LWAs) from the FS and one new alternative have been incorporated into this Proposed Plan, as follows:

- Proposed Plan Alternative 1 – FS LWA A (No Action)
- Proposed Plan Alternative 2 – FS LWA F1 (Dredge/Cap)
- Proposed Plan Alternative 3 – FS LWA F2 (Dredge/Cap)
- Proposed Plan Alternative 4 – New Alternative (Dredge/Cap)
- Proposed Plan Alternative 5 – FS LWA H (Dredge/Cap)
- Proposed Plan Alternative 6 – FS LWA I (Dredge/Cap)
- Proposed Plan Alternative 7 – FS LWA J (Dredge/Cap)

Alternative 1 (FS LWA A – No Action)

The Superfund program requires that the No Action Alternative be considered as a baseline for comparison with the other alternatives. The no action remedial alternative for sediment does not include any physical remedial measures that address the problem of sediment contamination at the site. Because this alternative would result in contaminants remaining on-site above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the site be reviewed at least once every five years. If justified by the review, remedial actions may be implemented to remove, treat, or contain the contaminated sediments.

The No Action Alternative does not include any remedial measures to address contamination at any of the SMUs, monitoring of progress toward remedial goals, or institutional controls. The No Action Alternative and all other alternatives assume that upland source controls will be implemented through other programs designed to control external sources of CPOIs to the lake. Costs for remediating upland sources are not included in the costs for these alternatives. The No Action Alternative is retained for all SMUs as a baseline for comparison to other alternatives, consistent with CERCLA guidance and the NCP.

Dredged Volume (cy):	0
Capital Cost:	$0
Average O&M Annual Costs:	$0
Present-Worth O&M Costs:	$0
Present-Worth Cost:	$0
Construction Time:	0 years

Alternatives Based on the Mean PECQ of 1 Plus the Mercury PEC

Alternative 2 – Dredging/Capping (FS LWA F1)

Alternative 2 is based on remediating all areas of the lake where the surface sediments exceed a mean PECQ of 1 or the mercury PEC (2.2 mg/kg) (see the attached figure entitled "Mean PEC Quotient Distribution and Exceedances of the Mercury PEC"). Alternative 2 includes dredging prior to capping in SMUs 1 to 7 to prevent a loss of lake surface area, minimize erosive forces on the cap, and optimize habitat, as well as to ensure cap effectiveness and remove NAPL in select SMUs; and phased thin-layer capping, aeration (oxygenation), and MNR in SMU 8. Specifically, the components of Alternative 2 include:

- Dredging of an estimated 354,000 cy (271,000 m^3) of sediment in SMU 1, prior to capping, to minimize erosive forces on the cap, prevent a loss of lake surface area, and optimize habitat. Capping of approximately 84 acres in SMU 1.

- Dredging of an estimated 169,000 cy (129,000 m^3) of sediment in SMU 2, prior to capping, to remove NAPL to a 13-ft (4-m) depth in the vicinity of the causeway, minimize erosive forces on the cap, prevent a loss of lake surface area, and optimize habitat. Capping of approximately 16 acres in SMU 2.

- Dredging of an estimated 75,000 cy (57,000 m^3) of sediment in SMU 3, prior to capping, to maintain cap effectiveness in the absence of hydraulic containment, to minimize erosive forces on the cap, prevent a loss of lake surface area, and optimize habitat. Capping of approximately 29 acres in SMU 3.

- Dredging of an estimated 135,000 cy (103,000 m^3) of sediment in SMU 4, prior to capping, to minimize erosive forces on the cap, prevent a loss of lake surface area, and optimize habitat. Capping of approximately 75 acres in SMU 4.

- Dredging of an estimated 140,000 cy (107,000 m^3) of sediment in SMU 5, prior to capping, to minimize erosive forces on the cap, prevent a loss of lake surface area, and optimize habitat. Capping of approximately 60 acres in SMU 5.

- Dredging of an estimated 245,000 cy (187,000 m^3) of sediment in SMU 6, prior to capping, to maintain cap effectiveness in the absence of hydraulic containment, to minimize erosive forces on the cap, prevent a loss of lake surface area, and optimize habitat. Capping of approximately 123 acres in SMU 6.

- Dredging of an estimated 89,000 cy (68,000 m^3) of sediment in SMU 7, prior to capping, to minimize erosive forces on the cap, prevent a loss of lake surface area, and optimize habitat. Construction/operation of a hydraulic control system along the SMU 7 shoreline to maintain cap effectiveness. Capping of approximately 38 acres in SMU 7.

- Isolation capping over an estimated 425 acres (approximately 42 percent) of the littoral zone, as noted for each littoral SMU above.

- Thin-layer capping over an estimated 154 acres (approximately 8 percent) of the profundal area (SMU 8) based on the current extent of exceedances of mean PECQ of 1.

- Habitat enhancement along an estimated 1.5 mi (2.4 km) of shoreline (SMU 3) and over approximately 23 acres (SMU 5) to stabilize calcite deposits and oncolites and promote submerged macrophyte growth.

- Aeration of the hypolimnion (SMU 8) to reduce methylation of mercury, reduce dissolved mercury concentrations, and reduce methylmercury flux from profundal sediments, thereby reducing mercury bioaccumulation in fish tissue.

- MNR in the profundal area (SMU 8) with a contingency of additional thin-layer capping.

- Consolidation of dredged sediment in an SCA.

- Treatment of water generated by sediment dewatering, produced at the SCA through sediment consolidation, prior to discharge of the water back to Onondaga Lake.

- Continuation of existing institutional controls on fish consumption, as necessary, and implementation of other institutional controls (e.g., prohibition of unauthorized dredging in capped areas) as needed to ensure long-term effectiveness of the remedy.

The dredging and capping components of this alternative would occur over a period of approximately four years.

Because this alternative would result in contaminants remaining on-site above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the site be reviewed at least once every five years. If justified by the review, additional remedial actions may be implemented to remove, treat, or contain the contaminated sediments.

Alternative 2 is discussed in detail in order to provide a point of reference for the other alternatives, which are discussed in general below. For a detailed description of Alternatives 3, 4, 5, 6, and 7, see the attached table entitled "Onondaga Lake Subsite Proposed Plan – Lakewide Alternatives."

Alternative 3 – Dredging/Capping with up to 25 Percent Removal of the ILWD (FS LWA F2)

Alternative 3 differs from Alternative 2 in its treatment of the ILWD in SMU 1. Specifically, approximately 25 percent of the ILWD would be removed under Alternative 3 prior to capping and would result in an additional 661,000 cy (505,000 m^3) of waste/sediment being removed.

Alternatives 3, 4, and 5 (described below) would result in varying depths of removal in SMU 1, where most of the ILWD is located. These alternatives in SMU 1 would remove increasing quantities of highly contaminated material (waste, NAPLs, sediment) which would significantly reduce the mass and/or concentrations of CPOIs that would remain under the isolation cap. As noted in the Results of the Remedial Investigation section of this Proposed Plan, this area of the lake contains the highest concentrations of the more mobile contaminants such as BTEX, chlorobenzene, and dichlorobenzenes.

Alternative 2 is based on remediating surface sediments that exceed a mean PECQ of 1 and the mercury PEC, with removal for habitat optimization and erosion minimization, which is, on average, 3.3 ft (1 m) of dredging in nearshore areas of the ILWD prior to capping. The depth of removal in SMU 1 under Alternative 3 would be approximately 6.5 ft (2 m) on average to represent approximately 25 percent of the ILWD (based on the 26 ft [8 m] limit of analytical data.

All other components of this alternative are the same as Alternative 2 (e.g., 425 acres of isolation capping in the littoral zone, 154 acres of thin-layer capping in the profundal zone, aeration of the hypolimnion, and MNR).

Because this alternative would result in contaminants remaining on-site above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the site be reviewed at least once every five years. If justified by the review, additional remedial actions may be implemented to remove, treat, or contain the contaminated sediments.

Alternative 4 – Dredging/Capping with Removal of 2 m (on average) of the ILWD with Additional Removal in Hot Spots (up to an additional 1 meter in depth) in the ILWD and NAPL Removal to 9 meters in SMU 2

Alternative 4 differs from Alternative 2 in its treatment of the ILWD in SMU 1 and NAPL contaminated materials in SMU 2.

Similar to Alternative 3, dredging would be performed to a depth of 6.5 ft (2 m) on average to remove 25 percent of the ILWD. However, under Alternative 4, dredging would also be performed to remove material from hot spot area to a depth of 3.3 ft (1 m) below the dredge cut associated with the 25 percent removal. The remedy would include additional dredging, if needed, to address geotechnical concerns with the ILWD. The nature of the wastes, as well as geophysical evidence of historical failures (i.e., underwater slumping or "landslides" associated with the ILWD) might require the removal of additional wastes to ensure the long-term stability of the cap. Adequate data would be gathered during remedial design to identify the appropriate measures that might need to be taken (e.g., additional dredging) to ensure that the cap would be structurally sound and otherwise effective. Accordingly, up to 10 ft (3 m) on average of the ILWD would be removed under

Alternative 4 prior to capping and would result in an additional 1,212,000 cy (927,000 m^3) of waste/sediment being removed (relative to Alternative 2) from the ILWD in SMU1.

Alternative 4 is also different from Alternative 2 in how it addresses the NAPLs present within SMU 2. The information currently available indicates that the NAPLs present in sediments in the area of the causeway in SMU 2 extend to a depth of approximately 13 ft (4 m). Alternative 2 includes the removal of these materials. However, under Alternative 4, NAPLs would be removed to an estimated depth of 30 ft (9 m). This would include the NAPL removal described in Alternative 2, as well as the removal of the NAPL which may be present within the marl unit beneath the lake sediments. Therefore, Alternative 4 would result in an additional 234,000 cy (179,000 m^3) of additional sediments/marl being removed (relative to Alternative 2) from SMU 2.

All other components of this alternative are the same as Alternative 2 (e.g., 425 acres of isolation capping in the littoral zone, 154 acres of thin-layer capping in the profundal zone, aeration of the hypolimnion, and MNR).

Because this alternative would result in contaminants remaining on-site above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the site be reviewed at least once every five years. If justified by the review, additional remedial actions may be implemented to remove, treat, or contain the contaminated sediments.

Alternative 5 – Dredging and Capping with NAPL Removal to 9 meters in SMU 2 (FS LWA H)

Alternative 5 differs from Alternative 2 in its treatment of the ILWD in SMU 1 and NAPL contaminated sediments in SMU 2. Specifically, approximately 16.4 ft (5 m) of the ILWD would be removed under Alternative 5 prior to capping and would result in an additional 2,283,000 cy (1,745,000 m^3) of waste/sediment being removed from SMU 1. In addition, 403,000 cy (308,000 m^3)of NAPL and other contaminated sediments would be removed from SMU 2.

All other components of this alternative are the same as Alternative 2 (e.g., 425 acres of isolation capping in the littoral zone, 154 acres of thin-layer capping in the profundal zone, aeration of the hypolimnion, and MNR).

Because this alternative would result in contaminants remaining on-site above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the site be reviewed at least once every five years. If justified by the review, additional remedial actions may be implemented to remove, treat, or contain the contaminated sediments.

While the actual depths and areas of removal would be refined in the design, Alternatives 2 through 5 provide approximate volumes that can be used to evaluate cost estimates for removal of the ILWD to varying depths and NAPL-contaminated materials in SMU 2. The dredging and capping components of these alternatives would occur over a period of approximately four years. The total estimated volumes, construction times, and costs of these alternatives are:

	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Dredged Volume (cy):	1,207,000	1,868,000	2,653,000	3,724,000
Capital Cost:	$275,000,000	$333,000,000	$414,000,000	$499,000,000
Average O&M Annual Cost:	$3,000,000	$3,000,000	$3,000,000	$3,100,000
Present-Worth O&M Costs:	$37,000,000	$37,000,000	$37,000,000	$38,000,000
Present-Worth Cost:	$312,000,000	$370,000,000	$451,000,000	$537,000,000
Construction Time	4 years	4 years	4 years	4 years

Alternative 6 – Dredging for Removal and Capping (FS LWA I)

Alternative 6 differs from Alternative 2 by utilizing dredging to remove all sediments in all SMUs (except 5 and 8) that exceed the mean PECQ of 1 or the mercury PEC. This alternative includes partial dredging followed by isolation capping in SMU 5 and thin-layer capping in SMU 8 to the same criteria. Overall, this alternative would include a combination of dredging, backfilling, residual capping (if needed), habitat re-establishment, habitat enhancement, aeration (oxygenation), MNR, and phased thin-layer capping, as summarized on a SMU-specific basis in the attached table entitled “Onondaga Lake Subsite Proposed Plan – Lakewide Alternatives.”

Alternative 6 involves dredging approximately 10,977,000 cy (8,400,000 m^3) more than Alternative 2, for a total of 12,184,000 cy (9,315,300 m^3) from 385 acres of the littoral zone, and capping 60 acres in SMU 5. This amount of dredging would require placement of roughly 8,200,000 cy (6,270,000 m^3) of backfill material to maintain reasonable water depths and bathymetry. All other components of this alternative are the same as Alternative 2 (e.g., 154 acres of thin-layer capping in the profundal zone, aeration of the hypolimnion, and MNR).

Because this alternative would result in contaminants remaining on-site above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the site be reviewed at least once every five years. If justified by the review, additional remedial actions may be implemented to remove, treat, or contain the contaminated sediments.

Dredged Volume (cy):	12,184,000++
Capital Cost:	$1,292,000,000
Average O&M Annual Cost:	$2,800,000
Present Worth O&M Costs:	$35,000,000
Present-Worth Cost:	$1,327,000,000
Construction Time:	10 years

Alternative Based on ER-L Criteria

Alternative 7 – Dredging for Removal and Capping (FS LWA J)

This alternative is based on remediating areas of the lake where sediments exceed the ER-Ls (rather than using the mean PECQ of 1 and the mercury PEC). It is included to evaluate removal and capping based on a more protective site-specific SEC.

Alternative 7 differs from Alternative 2 by dredging in the littoral zone to the ER-L (except for SMU 5) of any of the CPOIs shown to exhibit a relationship with benthic toxicity on a lakewide basis (see the attached figure entitled "Exceedances of the ER-L"). This alternative would include a combination of dredging, backfilling, residual capping (if needed), habitat re-establishment, habitat enhancement, aeration (oxygenation), and thin-layer capping, as summarized on a SMU-specific basis in the attached table entitled "Onondaga Lake Subsite Proposed Plan – Lakewide Alternatives."

The remediation of the lake to the ER-L expands upon Alternative 2 by capping an additional 289 acres in SMU 5 (for a total of 349 acres of capping in the littoral zone). An additional 1,826 acres in the profundal zone (for a total of 1,980 acres) exceed the ER-L criteria (instead of the mean PECQ criteria) and would be capped. This alternative would include dredging an additional 18,914,000 cy (14,461,000 m^3) of sediment (for a total of 20,121,000 cy [15,384,000 m^3]) from the littoral zone. This would require more than 14,600,000 cy (11,163,000 m^3) of backfill material to maintain reasonable water depths and bathymetry. In addition, the entire bottom of the lake in SMU 8 would be covered with a thin-layer cap.

Because this alternative would result in contaminants remaining on-site above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the site be reviewed at least once every five years. If justified by the review, additional remedial actions may be implemented to remove, treat, or contain the contaminated sediments.

Dredged Volume (cy):	20,121,000++
Capital Cost:	$2,086,000,000
Average O&M Annual Cost:	$5,700,000
Present Worth O&M Costs:	$71,000,000
Present-Worth Cost:	$2,157,000,000
Construction Time:	17 years

EVALUATION OF ALTERNATIVES

During the detailed evaluation of remedial alternatives, each alternative is assessed against nine evaluation criteria, namely, overall protection of human health and the environment, compliance with applicable or relevant and appropriate requirements, long-term effectiveness and permanence, reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, cost, and support agency and community acceptance.

The evaluation criteria are described in the table below ("Nine Evaluation Criteria for Superfund Remedial Alternatives"). A comparative analysis of the alternatives was performed, based on these nine criteria, and is presented in this section of the Proposed Plan. A detailed analysis of alternatives is contained in the FS.

Nine Evaluation Criteria for Superfund Remedial Alternatives

Overall Protection of Human Health and the Environment addresses whether or not a remedy provides adequate protection and describes how risks posed through each exposure pathway (based on a reasonable maximum exposure scenario) are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.
Compliance with ARARs addresses whether or not a remedy would meet all of the applicable or relevant and appropriate requirements of other federal and state environmental statutes and requirements or provide grounds for invoking a waiver.
Long-term Effectiveness and Permanence refers to the ability of remedy to maintain reliable protection of human health and the environment over time, once cleanup goals have been met. It also addresses the magnitude and effectiveness of the measures that may be required to manage the risk posed by treatment residuals and/or untreated wastes.
Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment is the anticipated performance of the treatment technologies, with respect to these parameters, a remedy may employ.
Short-term Effectiveness addresses the period of time needed to, achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup goals are achieved.
Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.
Cost includes estimated capital and annual operation and maintenance costs, as well as present-worth cost. Present-worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.
Support Agency Acceptance indicates whether, based on its review of the RI/FS reports and Proposed Plan, USEPA and NYSDOH concur with, opposes, or have no comments on the preferred remedy.
Community Acceptance will be assessed in the ROD and refers to the public's general response to the alternatives described in the Proposed Plan and the RI/FS reports.

CRITERION 1: OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

This criterion addresses whether each alternative would provide adequate protection of human health and the environment and describes how risks posed through each exposure pathway would be eliminated, reduced, or controlled through treatment, engineering controls, and/or institutional controls.

Alternative 1, the No Action Alternative, would not actively address risks to human health and the environment posed by contaminated sediments, water, and biota in Onondaga Lake because it would not reduce or control risk to receptors or the release and transport of CPOIs at the site. The RAOs and PRGs would not be met under this alternative.

The remaining six alternatives, which are "active" remediation alternatives, would be protective of human health and the environment because they would, to varying degrees, meet RAOs and PRGs for littoral and profundal areas and would result in residual risks less than the No Action Alternative. With regards to eliminating or reducing releases of contaminants from the ILWD and other littoral areas around the lake (RAO 2), Alternatives 2 through 6, which dredge to depths ranging from 1 to 8 m in the ILWD, would result in progressively greater reduction in the concentrations and masses of CPOIs prior to capping.

Alternatives 2 through 6 are equally able to eliminate or reduce existing and potential future adverse ecological effects on fish and wildlife resources and potential risks to humans (RAO 4), achieve CPOI concentrations in fish tissue that are protective of humans and wildlife that consume fish (PRG 2), reduce methylation of mercury in the hypolimnion (RAO 1), reduce releases of mercury from profundal sediments (RAO 3), and achieve surface water quality standards (RAO 5 and PRG 3), to the extent that they also meet RAO 2. With regards to achieving applicable and appropriate SECs for CPOIs and the BSQV for mercury (PRG 1), Alternatives 2 through 6 are equally proficient in attaining the SECs; however, they are not predicted, in the short term, to achieve the BSQV for mercury on a lakewide basis or in SMU 8.

Since Alternative 7 includes thin-layer capping throughout all of SMU 8 as well as aeration, it would be the most effective alternative in achieving RAOs 1 and 3. In addition, Alternative 7 would meet the BSQV for mercury on a lakewide basis and in SMU 8, and it would be the most effective at meeting RAOs, 2, 4, and 5 and PRGs 1, 2, and 3, since it would address all areas exceeding the ER-L.

All of the alternatives which employ capping in a given area would be protective to the extent that the cap functions properly. If the cap fails via contaminant breakthrough and/or a catastrophic event (e.g., slope failure), the cap would need to be repaired and sediments contaminated by the release would need to be remediated (e.g., removed, capped in place). In the event of a failure, the impacts would be expected to be greatest under those alternatives that involve capping of the greatest mass/highest concentrations of contaminants. Accordingly, Alternative 4 provides more protection than Alternatives 2 and 3. While Alternative 5 would remove more material, similar concentrations would remain; therefore; Alternative 5 would not provide more protection. Alternative 4 includes cap enhancement in any residual hot spot areas which is not a component of Alternative 5. This component of Alternative 4 provides greater cap reliability over Alternative 5. Alternative 6 would provide greater protection than Alternative 5, and Alternative 7 would be the most protective alternative because it would result in the further reduction of surface concentrations.

Alternatives 3, 4, and 5 address (through dredging to various depths in the ILWD and removal of NAPL-contaminated sediments in SMU 2) the masses and concentrations of the CPOIs that would remain under the cap in SMUs 1 and 2. While the cap under Alternative 2 would be designed to be protective based on modeling studies, reducing the masses and concentrations increases the reliability of and, therefore, the protectiveness of the cap. Accordingly, in regard to SMU 1, the level of protectiveness increases progressively from Alternative 2 through Alternative 7 (with the exception of Alternative 5 discussed above).

In regard to contaminant mass removal, Alternatives 2 and 3 also address a portion of the NAPL within SMU 2. The information currently available indicates that the NAPL present in sediments in the area of the causeway in SMU 2 extends to a depth of approximately 13 ft (4 m), and the corresponding volume of sediment that would be required to remove this NAPL along with other contaminated sediments (under Alternatives 2 and 3) is about 169,000 cy (129,000 m^3). Alternatives 4 and 5 provides for greater mass removal in SMU 2 as they include the NAPL removal described above, relative to Alternatives 2 and 3, as well as removal of the NAPL which may be present within the marl unit beneath the lake sediments. Thus, Alternatives 4 and 5 expand upon Alternatives 2 and 3 by including the removal of approximately 234,000 cy (179,000 m^3) of additional sediments/marl up to a depth of approximately 30 ft (9 m). This would provide greater protectiveness by precluding the NAPL from further impacting the environment. The extent of NAPL in this area would be determined during pre-design sampling.

For Alternatives 6, and 7, which consist of full removal to the cleanup criteria for the littoral zone SMUs (with the exception of SMU 5), an additional level of long-term protectiveness would be achieved through sediment removal instead of capping.

Criterion 2: Compliance with ARARs

As there are currently no federal or state promulgated standards for contaminant levels in sediments, the ERLs, mean PECQ of 1, and mercury PEC will be used as "To-Be-Considered" criteria. New York State has promulgated surface water standards which are enforceable standards for various surface water contaminants.

In general, Alternatives 2, 3, 4, 5, 6, and 7 would be expected to comply with all of the designated chemical-specific ARARs to the extent practicable, while Alternative 1(No Action) would not, since there would be no active remediation associated with the sediments. However, it may not be feasible to meet the New York State surface water quality standards for mercury (i.e., the standard for protection of wildlife of 2.6 ng/L dissolved mercury and the standard for protection of human health [via fish consumption] of 0.7 ng/L dissolved mercury). Aeration of the hypolimnion, as proposed in all of the active alternatives, would change the lake's anoxic chemical conditions, which is a primary cause of high concentrations of dissolved mercury. While this, along with a reduction in inputs of mercury, would substantially reduce the frequency and magnitude of the exceedances of these two standards, it is possible that standards would not be met all of the time during the post-remediation period. If the post-remediation monitoring indicated that it was technically impracticable to consistently meet these standards, an ARAR waiver might be needed.

Alternatives 6 and 7 might reduce water column concentrations to a greater degree than Alternatives 2, 3, 4, and 5.

During remedy implementation, any short-term exceedances of surface water ARARs in the lake due to dredging or capping would be expected to be limited to the area in the vicinity of the work zone. Sufficient engineering controls would need to be put in place during dredging and capping to prevent or minimize exceedances of surface water ARARs outside of the work zone.

The primary location-specific ARARs applicable to the remediation are Environmental Conservation Law (ECL) Article 24 Freshwater Wetlands, ECL Article 15 Use and Protection of Waters, and Clean Water Act (CWA) Section 404. For freshwater wetlands, 6 NYCRR Part 663 regulates activities conducted in or adjacent to regulated wetlands. Article 15 is implemented by 6 NYCRR Part 608 which regulates alterations to protected waters such as dredging and filling.

CWA Section 404 includes requirements related to the discharge of dredged or fill material into navigable waters of the United States and prohibits activities which adversely affect an aquatic ecosystem, including wetlands. In addition, Superfund actions must meet USEPA's 1985 Policy on Floodplains and Wetland Assessments for CERCLA Actions, and USEPA's Protection of Wetlands Executive Order 11990. The policy memorandum discusses situations that require preparation of a floodplains or wetlands assessment, and the factors that should be considered in preparing an assessment, for response actions taken pursuant to Section 104 or 106 of CERCLA. Executive Order 11990 addresses long and short term adverse impacts associated with the destruction or modification of wetlands and seeks to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative.

Since all of the alternatives except the No Action Alternative include dredging and/or capping within the lake, the final design of the remedy must meet the substantive requirements of the regulations. Alternatives that re-establish appropriate littoral zone habitat and function, that do not result in unacceptable changes in water depth or the loss of lake surface area, and do not result in a diminishment of natural resource values throughout the lake would more readily meet the requirements. All of the alternatives except the No Action Alternative are expected to comply with all of the designated location-specific and action-specific ARARs, to varying degrees. The development of a lakewide habitat restoration plan is essential to provide a comprehensive evaluation of the selected alternative's ability to meet the requirements of Articles 15 and 24 and develop appropriate bathymetry and habitat re-establishment requirements for each SMU.

CRITERION 3: LONG-TERM EFFECTIVENESS AND PERMANENCE

Permanence of the Remedial Alternative

Since Alternative 1 would involve no active remedial measures, it would not be effective in the long term in controlling exposure.

Alternatives 6 and 7 provide the greatest long-term effectiveness and permanence by removal of all of the sediment that exceeds the cleanup criteria from SMUs 1 through 7 (with the exception of SMU 5). For SMU 8 (profundal zone), all of the action alternatives include MNR and/or thin-layer capping to remediate the contaminated sediments and aeration (oxygenation) to maintain the proper chemical conditions (and hence greatly reduce the methylation of mercury) in the hypolimnion.

Alternatives 2, 3, 4, and 5, respectively, incorporate removal of increasing volumes of contaminated sediments prior to capping. These alternatives include an isolation cap in the littoral zone, which is a key component of these alternatives' protectiveness. Consolidation and disposal in an aboveground containment area (i.e., SCA) is more proven, easily maintained, and easily monitored compared to capping of wastes and contaminated sediments in an underwater environment. This makes it more reliable. For those sediments that are removed to a more secure location (i.e., the SCA), the remedial action is more permanent than capping within the lake. Therefore, as the volume of material being removed and disposed of in the SCA increases, the permanence of the alternative increases.

For the contaminated sediments that would be left in the lake, the isolation cap would be designed to ensure long-term chemical isolation, including provisions to prevent ice scour and other types of erosion and provisions to ensure structural integrity. The integrity of the cap would be maintained through active operation and maintenance of an on-shore barrier wall and groundwater collection system in SMUs 1and 2 (which will be installed as IRMs associated with the Willis Avenue, Semet Residue Ponds, and Wastebed B/Harbor Brook upland sites), as well as SMU 7 to prevent upwelling of contaminants through the sediment cap. In addition, development and implementation of a monitoring and maintenance program to ensure that cap integrity and effectiveness is maintained would be included.

With regards to SMU 2, Alternatives 4 and 5 would remove sediments/marl contaminated with NAPL down to a depth of approximately 30 ft (9 m) and would be more effective in satisfying USEPA's preference for treatment of principal threat waste than would Alternatives 2 and 3, which would remove and treat contaminated NAPL down to a depth of approximately 13 ft (4 m).

Reduction of Residual Risk

Residual risk in Onondaga Lake can be evaluated on the basis of direct toxicity, bioaccumulation, and potential for recontamination.

Since Alternative 1 would involve no active remedial measures, it would not, therefore, be effective in reducing residual risk.

Alternatives 2, 3, 4, 5, and 6 would remediate all areas of the lake that exceed either the mean PECQ of 1 or the mercury PEC. These cleanup criteria address acute sediment toxicity to benthic macroinvertebrates. For those areas that are capped and covered with a clean substrate layer, it is expected that concentrations of CPOIs in the clean substrate overlying the isolation cap would remain low enough to reduce chronic toxicity. Alternative 7 would remediate all areas of the lake exceeding the ER-Ls and therefore would result in the lowest residual risk of acute and chronic toxicity.

A mercury concentration goal in sediments of 0.8 mg/kg (ppm) was developed for the site to address bioaccumulation concerns (see the text box entitled “Bioaccumulation-Based Sediment Quality Values” [pg. 45]). In order to evaluate alternatives with respect to the bioaccumulation goal, the estimated post-remedial surface area weighted average concentration (SWAC) in each SMU corresponding to each respective alternative was compared to the 0.8 ppm goal, since animals that bioaccumulate mercury, such as fish, are not limited to a specific area of the lake.

An analysis of the SWACs predicted to remain in the lake after the remediation indicates that all alternatives other than the No Action Alternative would be protective for the littoral zone as a whole (SMUs 1 to 7). The residual mercury concentrations in the profundal zone (SMU 8) surface sediments are predicted to drop significantly from the 1992 concentrations. However, based on MNR modeling with aeration, they would not reach the 0.8 mg/kg value throughout the profundal sediments, and may therefore require additional thin-layer capping.

Adequacy and Reliability of Controls

Since Alternative 1 would involve no active remedial measures, the migration of contaminants would continue.

Alternatives 6 and 7 provide the greatest long-term effectiveness and reliability of controls since these alternatives would remove the largest volumes of contaminated sediment and place them in a secure SCA. The technology used in containment facilities such as the proposed SCA is well established and dependable. Since the contamination would be removed from the environment, the control and maintenance of the contained material is highly reliable, and monitoring of the SCA and treatment systems would be easily accomplished.

Alternatives 2, 3, 4, and 5 include increasing removals of contaminated sediments, but do not incorporate complete removal of all sediments above the cleanup criteria and depend on an isolation cap in order to be protective. The extent to which these alternatives remove additional contaminated sediment from the lake provides additional reliability since all of the removed sediments would be permanently secured. Therefore, the greater the amount of sediment that is removed, the more permanent and reliable is the alternative. For the contaminated sediments left in the lake, reliability would be addressed through installation of a cap designed to ensure long-term chemical isolation, prevent ice scour and other types of erosion, and provide long-term stability. The integrity of this cap would be maintained through active operation and maintenance of an on-shore barrier wall and groundwater collection system in SMUs 1, 2, and 7 to prevent upwelling of contaminants through the sediment.

With the exception of the No Action Alternative (Alternative 1), all alternatives include aeration, thin-layer capping, and MNR for SMU 8. An oxygenation system would have to be actively maintained in order to aerate the hypolimnion. While the technology is proven and reliable (in general), its application (and design issues) for addressing the mercury methylation in Onondaga Lake would be assessed as part of a pilot study during the remedial design phase. For MNR, additional contingency measures would be taken in profundal areas that do not achieve acceptable goals (e.g., achieving the mercury BSQV of 0.8 mg/kg, achieving PRGs for fish) during the MNR period, possibly including additional thin-layer capping beyond that proposed in the alternative, as required.

CRITERION 4: REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Type of Containment and Treatment

The type of containment and treatment used for Alternatives 2, 3, 4, and 5 would include:

- Dredging with upland containment of dredge spoils and treatment of supernatant.
- Collection and treatment and/or off-site disposal of NAPLs, if feasible.
- Isolation capping in portions of the littoral area.
- Thin-layer capping in a portion of the profundal area.
- Stabilization of calcitic sediments and oncolites.
- MNR.
- Aeration.

Alternatives 6 and 7 would not involve isolation capping (except for SMU 5). Although the degree of containment and treatment varies among the alternatives in general, the type of containment and treatment is similar for all the active alternatives.

Degree of Expected Reduction in Toxicity, Mobility, or Volume Through Treatment

Alternative 1 (no action) would provide no reduction in toxicity, mobility, or volume through treatment or otherwise. There are three remedial actions that would be conducted under the action alternatives: dredging, capping, and aeration of the hypolimnion. The dredging of contaminated sediments and their placement in a secure, lined SCA would result in a reduced mobility for these materials, as would inlake capping. In addition, those NAPLs removed from the dredged material would be treated and/or disposed of at an off-site permitted landfill.

Aeration, which is included in Alternatives 2, 3, 4, 5, 6, and 7, is expected to reduce mercury methylation and the degree to which mercury is dissolved in the hypolimnion. As a result, the overall contaminant toxicity and bioavailability in the hypolimnion would be reduced under all active remediation alternatives relative to the No Action Alternative. Although thin-layer capping and MNR are expected to reduce the surface sediment concentrations in the profundal zone (SMU 8) under all alternatives other than the No Action Alternative, the volume of mercury and other key CPOIs in profundal sediments would not be reduced since there would be no sediment removal prior to thin-layer capping. However, a combination of all three remedial components (aeration, MNR, and thin-layer capping) would be expected to reduce the overall bioavailability and mobility of contaminants in the profundal zone and hypolimnion.

Amount of Hazardous Materials Treated or Destroyed

For the alternatives which incorporate significant removal for SMU 1 (i.e., Alternatives 3, 4, and 5), the removal volume in SMU 1 ranges from approximately 1,015,000 to 2,637,000 cy (776,000 to 2,016,000 m^3). Alternatives 2, 3, 4, and 5 include varying degrees of removal of the NAPLs and contaminated sediments that are present along the causeway in SMU 2 to either 13 ft (4 m) in depth or 30 ft (9 m) in depth. The estimated volume of NAPL and contaminated sediment removal within SMU 2 ranges from 169,000 to 403,000 cy (129,000 to 308,000 m^3). With the exception of Alternatives 6 and 7, Alternative 5, which includes the most significant removal in the ILWD, as well as NAPL removal to 9 meters from the area of the causeway in SMU 2, would include the greatest amount of hazardous materials removed from the lake.

Degree to Which Treatment Would Be Irreversible

For the NAPLs treated and/or disposed of, the treatment would be irreversible and permanent. The reduction in mobility provided by containment in the SCA would be highly reliable. Releases of CPOIs from a secure, lined, maintained, and monitored SCA would be unlikely.

Aeration of the hypolimnion would need to be actively maintained for Alternatives 2, 3, 4, 5,6, and 7 to be effective. If the aeration system was suspended during the summer months, the oxygen demand of the profundal sediments would rapidly cause the loss of oxygen in the hypolimnion, and result in the resumption of mercury methylation in the hypolimnion. Thus, the treatment afforded by aeration is reversible. As a result, the overall irreversibility of this treatment in the hypolimnion would be low, but equivalent, in Alternatives 2, 3, 4, 5, 6, and 7.

Type and Quantity of Residuals

Alternatives 6 and 7 would remove all contaminated sediments down to their respective cleanup criteria in the littoral zone, except for areas within SMU 5 which would be capped to the respective cleanup criteria. Alternatives 2, 3, 4, and 5 would isolate littoral sediments using an engineered isolation cap and would also progressively remove higher concentrations and/or masses of CPOIs in the ILWD and the NAPL in SMU 2, with Alternative 2 removing the least volume and Alternative 5 removing the greatest volume. Alternatives 2, 3, 4, 5, and 6 would address contamination in the profundal sediments through oxygenation, thin-layer capping, and MNR.

USEPA Preference for Treatment as a Principal Remedy

The treatment and/or disposal of NAPLs at an off-site facility and aeration in the hypolimnion are critical components of the alternatives that meet USEPA’s treatment preference. The larger the volume of NAPLs that are removed from the lake and treated, the more an alternative satisfies this USEPA preference for treatment.

USEPA's statutory preference for treatment of principal threat materials has been considered as part of this remedy. Given the extraordinary volume of materials being evaluated (e.g., greater than 4,000,000 cy [3,060,000 m^3] of sediments and wastes within the ILWD, some of which contain NAPLs), treatment of all principal threat wastes (which are present in various portions of the ILWD) is impracticable. However, the implementation of any of these alternatives would include the off-site treatment and/or disposal of all NAPLs that were segregated during the dredging/handling process.

CRITERION 5: SHORT-TERM EFFECTIVENESS

Alternative 1 (No Action Alternative) does not include any active remediation and, therefore, would not present any potential adverse impacts to on-site workers, the environment, or the community as a result of its implementation. However, as previously noted, unacceptable risks to human health and the environment posed by contaminated sediments, water, and fish in the lake would continue to occur.

Alternatives 2 through 7 could present some limited adverse impacts to on-site workers through dermal contact and inhalation related to dredging activities. Noise from the dredging work and from the on-site treatment processes could present some limited adverse impacts to on-site workers and nearby residents. In addition, post-dredging sampling activities would pose some risk to on-site workers. Another potential adverse impact associated with dredging would be odors associated with the dredged sediments. The risks to on-site workers and nearby residents under all of the alternatives could, however, be mitigated by following appropriate health and safety protocols, by exercising sound engineering practices, and by utilizing proper protective equipment.

Alternatives 2 through 7 would require the transport of significant volumes of capping and backfill material, which may involve use of local roadways and would cause an increase in traffic. Alternatives 6 and 7 would result in the greatest amount of traffic related to the transport of these materials. However, during remedial design, various means would be evaluated for minimizing potential adverse impacts (e.g., traffic, odors associated with dredged sediments) on the community.

Under Alternatives 2, 3, 4, 5, and 6, MNR would take several years to achieve objectives in the profundal area, while aeration (oxygenation) would be expected to produce immediate benefits in terms of methylmercury reduction. Since no activities would be performed under the No Action Alternative, no time would be required to implement this alternative. Construction activities associated with the implementation of Alternatives 2, 3, 4, and 5 would be completed within four years. Implementation of Alternatives 6 and 7 would take significantly longer because of the increased dredging volumes, requiring 10 and 17 years, respectively.

Short-term impacts to the ecological community from implementation of all of the alternatives, except the No Action Alternative, would include temporary loss of lake habitat and aquatic communities. The impact duration could be significantly greater for the implementation of Alternatives 6 and 7 because of the additional dredging and backfilling required under these alternatives, which could substantially increase the time before the area could be recolonized. However, if the construction was phased (i.e., not performed over the entire lake at once), this impact would be decreased.

The public would be excluded from the work areas of the lake during the time they are under remediation. The impact duration would be significantly greater for the implementation of Alternatives 6 and 7 because of the 10- to 17-year estimated construction durations, respectively.

CRITERION 6: IMPLEMENTABILITY

Reliability of Technology

Alternative 1 would be the easiest to implement, as there are no activities to undertake. Aquatic capping (isolation and thin-layer), dredging, containment, treatment (of segregated NAPLs), aeration, and MNR are all implementable technologies that have been used at other sites. However, aquatic capping presents challenges not typically associated with capping of upland sites (e.g., landfills). These issues would be addressed during remedial design. Furthermore, the application of aeration (to address mercury methylation within Onondaga Lake) would require pilot testing before full-scale implementation. SCA-type facilities have been successfully constructed and operated at numerous sites.

Reliability (in terms of being able to construct and operate the technology) of the remedial components to be used in all of the alternatives is high. All of the action alternatives can be constructed and operated; however, Alternatives 6 and 7 would involve dredging and containing a much larger volume of sediments than the other alternatives. Construction of the SCA for Alternatives 6 and 7 would be challenging because of its size (i.e., approximately 282 and 442 acres, respectively, with 50 ft [15 m] high dikes). The large volumes of sediment involved in these alternatives might stretch the limits of the ability to design and contain the dredge spoils on nearby Honeywell properties. For Alternatives 2, 3, 4, and 5, there would be sufficient capacity at the proposed SCA to contain the sediment generated. Alternative 5, while implementable, would be more difficult than Alternative 4 due to the removal of an additional 1,071,000 cy associated with Alternative 5.

All of the action alternatives include near-shore capping. As a result, institutional controls and restrictions on the use of the capped areas would be required.

Ability to Monitor Effectiveness of Remedy

A monitoring program would be developed during design that would be used to assess remedy effectiveness. Remedy effectiveness in achieving the PRGs and the RAOs would be measured. Monitoring to ensure that the remedial technologies are performing as specified in design (e.g., cap integrity) would also be a component of the monitoring program. Except for the No Action Alternative (Alternative 1), monitoring programs would be needed for each of the alternatives and are expected to include, at a minimum, sampling of biological tissue (e.g., fish, invertebrates), surface water, and sediments within the lake before, during, and following remediation; sampling of the aquatic cap to determine its integrity (chemically and structurally); and sampling of the SCA to determine its integrity (chemically and structurally). The specific monitoring programs required to evaluate remedy effectiveness would depend on the specific alternative. The scope of the program, including sampling and analytical details, would be determined during remedial design.

The monitoring program, although comprehensive and broad in scope, would be comprised of sampling and analytical methods that should be readily implementable. However, monitoring the conditions and effectiveness of an aquatic isolation cap is not routine relative to monitoring an upland containment cell such as the SCA. Direct visual inspections of the aquatic cap may not be possible, so alternative methods to determine cap structural integrity would be evaluated during remedial design.

Ease of Undertaking Additional Remedial Actions as Needed

The remedial technologies to be utilized as part of the alternatives generally do not preclude other remedial actions from being implemented as needed. For example, settling of the cap could potentially necessitate adding more material to maintain suitable littoral water depths. In addition, capped materials could be excavated if necessary or additional cap material could be placed. However, such additional remedial actions would need to comply with ARARs (e.g., 6 NYCRR Part 608).

Ability to Obtain Approvals from Other Agencies

It is expected that the necessary administrative approvals from other agencies can be acquired for all alternatives.

Availability of Adequate On-Site or Off-Site Treatment, Storage Capacity, and Disposal Services

There would be sufficient capacity at the SCA to contain the sediment generated under Alternatives 2, 3, 4, and 5. However, due to the large volume of sediment removal associated with Alternatives 6 and 7, it is possible that the capacity at the SCA would be inadequate and that additional containment cells would need to be constructed or that a significant volume of material would have to be disposed of at an off-site facility.

Availability of Necessary Equipment and Personnel

The technology, equipment, subcontractors, personnel, and facilities required to successfully complete all alternatives are available in the environmental marketplace.

CRITERION 7: COST

In general, the cost of each alternative increases with increases in the area of the lake bottom remediated and with the amount of sediment removed, as follows:

- There is no cost associated with Alternative 1, the No Action Alternative.

- Alternatives 2, 3, 4, and 5, which include the use of dredging and capping technologies to address sediments that exceed a mean PECQ of 1 or the mercury PEC, as well as significant removals in the ILWD and in SMU 2, range in estimated present-worth cost from $312,000,000 (for Alternative 2) to $537,000,000 (for Alternative 5).

- Alternatives 6 and 7, which primarily depend upon full removal (versus partial removal and capping) to one of the two cleanup criteria evaluated, range in estimated present-worth cost from $1,327,000,000 to $2,157,000,000, respectively.

Lakewide Alternative	Capital Costs	Average O&M Annual Cost	Present-Worth O&M Costs	Present-Worth Costs
1	$0	$0	$0	$0
2	$275,000,000	$3,000,000	$37,000,000	$312,000,000
3	$333,000,000	$3,000,000	$37,000,000	$370,000,000
4	$414,000,000	$3,000,000	$37,000,000	$451,000,000
5	$499,000,000	$3,100,000	$38,000,000	$537,000,000
6	$1,292,000,000	$2,800,000	$35,000,000	$1,327,000,000
7	$2,086,000,000	$5,700,000	$71,000,000	$2,157,000,000

The cost estimates presented in this Proposed Plan are based upon capital (construction) costs and the present-worth of the annual O&M costs calculated using a discount rate of 7 percent and a 30-year time interval. The actual costs will vary depending on the specifications contained in the detailed remedial design. Further, the actual costs will also vary because the cost estimates provided are developed conservatively and have an accuracy of +50 percent to -30 percent, in compliance with the 1988 USEPA guidance document, "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA."

CRITERION 8: SUPPORT AGENCY ACCEPTANCE

NYSDOH has reviewed this Proposed Plan and concurs with the preferred remedy.

USEPA has informed NYSDEC that it will offer a position on the preferred remedy after the Proposed Plan and other project documents have been reviewed by USEPA’s National Remedy Review Board (NRRB) and USEPA’s Office of Superfund Remediation and Technology Innovation (OSRTI) Sediment Team. The NRRB is a USEPA peer review group that reviews all proposed Superfund cleanup decisions that meet certain cost-based or other review criteria to ensure that these proposed decisions are consistent with Superfund law, regulations, and guidance. The OSRTI Sediment Team offers consultation to assist site managers in making scientifically sound and nationally consistent risk management decisions at contaminated sediment sites.

CRITERION 9: COMMUNITY ACCEPTANCE

Community acceptance of the preferred remedy will be assessed in the ROD following review of the public comments received on the Onondaga Lake RI/FS reports and this Proposed Plan.

PREFERRED REMEDY – *ALTERNATIVE 4 DREDGING/CAPPING*

The preferred remedy (Alternative 4) would remediate all areas of the lake where the surface sediments exceed a mean PECQ of 1 or the mercury PEC (2.2 mg/kg) (see the attached figure entitled “Mean PEC Quotient Distribution and Exceedances of the Mercury PEC”). Alternative 4 includes dredging prior to capping in SMUs 1 to 7 to a depth that prevents a loss of lake surface area (to ensure that any cap is submerged), minimize erosive forces on the cap, and optimize habitat, as well as to ensure cap effectiveness, remove NAPLs, and reduce CPOI mass (hot spots) in the ILWD. In SMU 8, Alternative 4 calls for phased thin-layer capping, aeration (oxygenation), and MNR.

The preferred remedy would include the dredging of as much as an estimated 2,653,000 cy (2,030,000 m^3) of sediment from the littoral zone, with most of the dredging (approximately 75%) being performed in SMUs 1 and 2. It would also include the use of isolation capping over an estimated 425 acres (approximately 42 percent) of the littoral zone (between SMUs 1 to 7). An estimated 154 acres (approximately 8 percent) of the profundal zone (SMU 8) would receive a thin-layer cap. Specifically, the components of the preferred remedy within each SMU include:

- **SMU 1** – Dredging of an estimated 1,566,000 cy (1,197,000 m^3) of sediment/waste from the ILWD, prior to capping, to minimize erosive forces on the cap, prevent a loss of lake surface area, reduce average CPOI concentrations in sediments/wastes remaining under the cap, and optimize habitat. Capping of the entire SMU (approximately 84 acres). Capping effectiveness would rely upon the proper functioning of the hydraulic control system which will be installed/operated as part of the Wastebed B/Harbor Brook Barrier IRM.

  Dredging would be performed to remove (on average) 6.5 ft (2 m) of sediment/waste prior to capping. This would provide an adequate water depth to allow for the establishment of a productive habitat after capping, reduce average CPOI concentrations in wastes remaining under the cap, and would allow for erosion protection for the cap. This is shown on the attached cross section for SMU 1 (see attached figure entitled “Preferred Remedy for SMU 1”). While the average dredge cut across SMU 1 would be 6.5 ft (2 m), the actual depth of dredging in the various portions of SMU 1 would be determined during remedial design. The determination would be based on various factors including contaminant distribution, habitat needs, and erosional concerns.

  In areas defined as hot spots, dredging would also be performed to remove an additional 3.3 ft (1 m) of wastes (below the dredge cut described above). The hot spots would be defined as those wastes/sediments that contain CPOIs above threshold concentrations. The purpose of this additional removal in hot spot areas is to improve capping effectiveness. The hot spot threshold concentrations that would trigger the additional dredging are as follows:

  - Benzene – 208 ppm.
  - Chlorobenzene – 114 ppm.

- Dichlorobenzenes – 90 ppm.
- Naphthalene – 20,573 ppm.
- Xylene – 142 ppm.
- Ethylbenzene – 1,655 ppm.
- Toluene – 2,626 ppm.
- Mercury – 2,924 ppm.

The above concentrations were developed using a cap model developed by Honeywell and represent the maximum concentrations that could be present in the wastes/sediments and not cause failure of a cap with a 2.5-ft-thick isolation layer assuming an upwelling rate of 2.4 inches/year (6 cm/year). Capping effectiveness is related to cap thickness, contaminant concentrations below the cap, and the upwelling rate (rate at which groundwater flows up through the capped sediments/wastes). With regard to the upwelling rate, Honeywell's cap model predicts that the cap would be effective based on an assumed upwelling rate of 0.8 inches/year (2 cm/year). This assumption relies upon the proper construction/operation of a hydraulic control system which would be installed (as part of the Wastebed B/Harbor Brook IRM) along the lakeshore adjacent to SMU 1. While the capping model assumes an upwelling rate of 0.8 inches/year (2 cm/year), the hot spot threshold concentrations were developed by NYSDEC by assuming a higher (2.4 inches/year [6 cm/year]) upwelling rate.

The use of a higher upwelling rate in the development of these values resulted in lower (more conservative) hot spot threshold concentrations than would be developed by assuming lower (e.g., 0.8 inches/year [2 cm/year] or 1.6 inches/year [4 cm/year]) upwelling rates. The use of these threshold concentrations for identifying hot spots within SMU 1 provides a method for increasing the effectiveness of capping at the site. As refined cap modeling would be performed during remedial design, it is possible that these concentrations may be modified. However, the hot spot concentrations would need to be based on an assumed upwelling rate of 2.4 inches/year (6 cm/year).

As indicated above, in the hot spot areas, wastes would be removed to a maximum depth of 3.3 ft (l m) below the dredge cut described above. If during remedial design or construction it became apparent that concentrations (hot spots) that exceeded these threshold values were present at depths greater than 3.3 ft (l m) below the dredge cut, NYSDEC would evaluate the need for additional remediation (e.g., increase the cap thickness to contain those CPOIs to ensure cap effectiveness) in these areas of the ILWD.

The removal (on average) of the upper 6.5 ft (2 m) of materials and deeper removal in the area of the hot spots would be expected to improve the reliability of capping of the ILWD. This removal would likely reduce the average contaminant concentrations, as well as the maximum concentrations of some of the contaminants, in the residual waste. Furthermore, the available data suggest that Alternative 4 would result in the removal of a significant portion of the contaminant mass present within the ILWD.

The remedy would include additional dredging, if needed, to address geotechnical concerns with the ILWD. The nature of the wastes, as well as geophysical evidence of historical failures (i.e., underwater slumping or “landslides” associated with the ILWD), might require the removal of additional wastes or other engineering measures to ensure the long-term stability of the cap. Adequate data would be gathered during remedial design to enable the determination of appropriate measures to ensure that the cap would be structurally sound and otherwise effective.

As the ILWD extends to some extent beyond SMU 1’s boundary into SMUs 2 and 7, the removal and capping of the ILWD sediment/wastes in the adjacent SMUs would be performed in a similar fashion to SMU 1.

- **SMU 2** – Dredging of an estimated 403,000 cy (308,000 m^3) of sediment in SMU 2, prior to capping. This includes dredging to remove NAPL to an estimated 30-ft (9-m) depth in the vicinity of the causeway, as well as dredging to shallower depths in other areas to minimize erosive forces on the cap, prevent a loss of lake surface area, and optimize habitat. Dredging would also be performed to remove sediments/wastes from the portion of the ILWD which extends into SMU 2. The removal of these ILWD materials in SMU 2 would be performed consistent with how these materials would be addressed in SMU 1.

  Capping of approximately 16 acres in SMU 2. Capping effectiveness would rely upon the proper functioning of the hydraulic control system which will be installed/operated as part of the Willis/Semet Barrier IRM (the design of which is underway).

- **SMU 3** – Dredging of an estimated 75,000 cy (57,000 m^3) of sediment in SMU 3, prior to capping, to maintain cap effectiveness in the absence of a hydraulic control system, to minimize erosive forces on the cap, prevent a loss of lake surface area, and optimize habitat. Capping of approximately 29 acres.

- **SMU 4** – Dredging of an estimated 135,000 cy (103,000 m^3) of sediment in SMU 4, prior to capping, to minimize erosive forces on the cap, prevent a loss of lake surface area, and optimize habitat. Although mercury does not exceed the PEC in the surface sediment interval at all of the sampling stations in SMU 4, concentrations of mercury exceed the PEC at sediment intervals just below the surface in the top 3.3 ft (1 m) at all stations in this SMU. Since these surface sediments are subject to erosion, it is assumed that all of SMU 4 (approximately 75 acres) would require capping.

- **SMU 5** – In SMU 5, there were a limited number of locations where CPOI concentrations in sediment exceeded either the mean PECQ of 1 or the mercury PEC. The below remedial actions are proposed to address the estimated areas represented by these sample results. During remedial design, an additional investigation of the sediments in the vicinity of these data points would be conducted to delineate the actual sediment areas and volumes exceeding the mean PECQ of 1 or the mercury PEC. This further delineation would be used to determine the scope and extent of capping and/or dredging activities needed to address these limited areas.

Based on the available data, the preferred remedy is as follows: dredging of an estimated 140,000 cy (107,000 m^3) of sediment in SMU 5, prior to capping, to minimize erosive forces on the cap, prevent a loss of lake surface area, and optimize habitat. Capping of approximately 60 acres.

- **SMU 6** – Dredging of an estimated 245,000 cy (187,000 m^3) of sediment in SMU 6, prior to capping, to maintain cap effectiveness in the absence of a hydraulic control system, to minimize erosive forces on the cap, prevent a loss of lake surface area, and optimize habitat. Capping of approximately 123 acres.

- **SMU 7** – Dredging of an estimated 89,000 cy (68,000 m^3) of sediments and wastes in SMU 7 prior to capping, to minimize erosive forces on the cap, prevent a loss of lake surface area, and optimize habitat. Dredging would also be performed to remove sediments/wastes from the portion of the ILWD which extends into SMU 7. The removal of these ILWD materials would be performed consistent with how these materials would be addressed in SMU 1. The preferred remedy also includes the construction/operation of a hydraulic control system along the SMU 7 shoreline to maintain cap effectiveness. Capping of approximately 38 acres.

- **SMU 8** – Thin-layer capping over an estimated 154 acres (approximately 8 percent) of the profundal area. The remedy also includes the performance of an aeration (oxygenation) pilot study within the profundal area. This would be followed by full-scale implementation if supported by the pilot study results. MNR would also be performed in the profundal area.

- Additional studies would be conducted during the remedial design to determine the appropriate areas where the BSQV for mercury of 0.8 mg/kg would be applied and whether the SWACs of mercury that would remain in the sediments following remediation would meet the BSQV of 0.8 mg/kg. If these studies indicated that mercury in surficial sediments in the applicable areas would exceed 0.8 mg/kg, then additional remedial measures (e.g., additional thin-layer capping in SMU 8 beyond the estimated 154 acres) would be implemented, as needed, so that surficial sediment concentrations of mercury would not exceed 0.8 mg/kg on an area-wide basis.

- Habitat optimization would be performed in areas where dredging/capping would occur.

- The preferred remedy would include habitat enhancement along an estimated 1.5 mi (2.4 km) of shoreline (SMU 3) and over approximately 23 acres (SMU 5) to stabilize calcite deposits and oncolites and promote submerged macrophyte growth.

- Consolidation of dredged sediment in an SCA. The majority of the dredged sediments would be disposed in an SCA constructed on one of the Solvay wastebeds. Based on evaluations to be conducted during design, as well as during construction, it may be determined that a portion of the dredged materials (e.g., NAPLs) will be treated and/or disposed of at an off-site permitted facility rather than at the SCA. The FS assumed that the SCA would be constructed on Wastebed 13 based on its capacity, as well as other factors. However, the actual Solvay wastebed location(s) on which the SCA(s) would be constructed would be based on geotechnical testing and screening that would be performed during remedial design. Remedial design of the SCA would be undertaken in accordance with state and federal requirements and guidance and would include, at a minimum, the installation of an impermeable liner, leachate collection and treatment, and a cap. The Proposed Plan assumes that preloading and stabilization of the wastebed materials would be required prior to construction of the SCA, but the extent to which preloading and stabilization would be required, if any, would be determined during remedial design.

- Treatment of water generated by the dredging/sediment handling processes as a result of dewatering of the sediments at the SCA. During remedial design, NYSDEC would issue discharge limits (that would be protective of Onondaga Lake) that would need to be met by the treated water prior to its discharge (end of pipe) back to the lake. This Proposed Plan assumes that the water would require "advanced treatment" (which includes enhanced primary treatment, multimedia filtration, air stripping, and granular activated carbon treatment for additional VOC removal, and pH adjustment as defined in the FS) in order to meet discharge limits. However, the actual treatment technologies needed to ensure compliance with discharge limits would be determined during remedial design and might vary depending on the levels and types of contaminants present in lake sediments in various areas (or SMUs) of Onondaga Lake.

- Continuation of existing institutional controls on fish consumption, as necessary, and implementation of other institutional controls (e.g., prohibition of unauthorized dredging in capped areas) as needed to ensure long-term effectiveness of the remedy.

- Implementation of a long-term monitoring program to assess the effectiveness of the remedy in achieving the RAOs and PRGs and to ensure that the remedial technologies are performing as specified in remedial design. The monitoring would be comprehensive and the scope would be determined during remedial design. The program would be designed to monitor and evaluate the effectiveness of the various remedy components including containment at the SCA, isolation capping, thin-layer capping, aeration, MNR, and habitat optimization and enhancement. Types of monitoring which would likely be employed include sampling within the lake before, during, and following remediation, including sampling of biological tissue (e.g., fish, invertebrates), measurements of the effects on the environment (e.g., toxicity testing, community analysis), and sampling of surface water and sediments; sampling of the aquatic cap to determine its integrity (chemically and structurally), and sampling of the SCA to determine its integrity (chemically and structurally).

- Development and implementation of a long-term O&M program which would include the inspection of the various components of the remedy, and the performance of any repairs (e.g., cap repair) that might be necessary to ensure the effectiveness of the remediation. The scope of the program would be determined during remedial design.

- Remedial design would include the collection of additional site data (e.g., sediment cores) to delineate in detail the various areas in which remedial activities would be performed, dredging areas and volumes, capping areas, etc. While hydraulic dredging was assumed for the purpose of detailed evaluation in the FS and this Proposed Plan, the actual dredging method(s) would be determined during design.

- During remedial design, treatability studies (e.g., water treatment) would be performed if necessary.

- The caps to be constructed in the littoral zone would include the following components from top to bottom: habitat layer, erosion layer (where applicable and at the appropriate depth), safety factor buffer layer, chemical isolation layer, and cap foundation layer. The design of these caps would be based, in part, on further cap modeling to be performed during remedial design. The actual thicknesses of the various cap layers in different areas of the lake would likely vary depending on the specific characteristics and conditions (e.g., contaminant levels, groundwater upwelling rates) of the area being modeled. The caps would need to incorporate a chemical isolation layer with a minimum thickness of 12 inches (30 cm). The design would need to be based on the point of compliance of the PEC values as well as the sediment screening criteria (for benzene, toluene, and phenol) being at the top of the chemical isolation layer. In addition, the design will need to incorporate a 50 percent safety factor buffer layer.

- A habitat restoration layer with a minimum thickness of 12 inches (30 cm) would be placed on all areas capped within the littoral zone. The specific thickness(es) and type(s) of substrate material to be used for the habitat layer in these areas would be determined during remedial design as part of the comprehensive lakewide habitat restoration plan. The safety buffer layer would be included as part of the habitat restoration layer.

- The design and construction of the remedy, including the habitat restoration layer, would need to meet the substantive requirements for permits associated with disturbance to state and federal regulated wetlands (e.g., 6 NYCRR Part 663, Freshwater Wetlands Permit Requirements) and navigable waters (e.g., 6 NYCRR Part 608, Use and Protection of Waters). The details for habitat restoration would be developed during remedial design, based upon a comprehensive lakewide habitat restoration plan.

- As indicated earlier in the Proposed Plan, a Phase 1 Cultural Resource Assessment for various areas, including Onondaga Lake, is underway. Following completion of this Cultural Resource Assessment a Phase 1B Cultural Resource Assessment (to locate culturally sensitive areas) may need to be performed during the remedial design.

- The remediation of the Onondaga Lake subsite would need to be coordinated with upland remedial activities. The control of contamination migrating to the lake from the various upland sites (e.g., Willis Avenue, Semet Residue Ponds, Wastebed B/Harbor Brook, LCP/Bridge Street, and Geddes Brook/Ninemile Creek) is an integral part of the overall cleanup of Onondaga Lake. To prevent the recontamination of lake sediments, active sources of contamination to a given portion of the lake will need to be shut off prior to performing cleanup activities in that area of the lake. For example, the hydraulic control systems which will be installed/operated as part of the Wastebed B/Harbor Brook and Willis/Semet Barrier IRMs will address the ongoing releases of contaminants from these upland areas to SMUs 1 and 2, respectively. These systems will need to be constructed and operating prior to cleanup activities commencing in this part of the lake.

  Furthermore, the effectiveness of the capping proposed for SMUs 1 and 2 would rely upon the proper functioning of these hydraulic control systems. Likewise, the effectiveness of capping in SMU 7 would rely upon the proper functioning of the hydraulic control system which is proposed to be installed along the lakeshore as part of the remedy for this portion of the lake. Therefore, the timing of remedial activities in Onondaga Lake would need to be coordinated with the remedial work which would be performed as part of the interim and final remedies at these upland sites.

- The remedial construction (dredging and capping) components of this preferred remedy are estimated to take approximately four years. This does not include the time it would take to design the remedy which would take approximately three years.

- The cost for the preferred remedy is $451,000,000. This total cost estimate is comprised of capital costs of $414,000,000 and annual O&M costs of $3,000,000 (or $37,000,000 in O&M present-worth costs).

The cost estimates presented in this Proposed Plan are based upon capital (construction) costs and the present-worth of the annual O&M costs calculated using a discount rate of 7 percent and a 30-year time interval. The actual costs will vary depending on the specifications contained in the detailed remedial design. Further, the actual costs will also vary because the cost estimates provided are developed conservatively and have an accuracy of +50 percent to -30 percent, in compliance with the 1988 USEPA guidance document, "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA."

Because this alternative would result in contaminants remaining on-site above levels that allow for unrestricted use and unlimited exposure, CERCLA requires that the site be reviewed at least once every five years. If justified by the review, additional remedial actions may be implemented to remove, treat, or contain the contaminated sediments.

BASIS FOR THE REMEDY PREFERENCE

Alternatives 2 through 6 address the same surface area of contaminated lake bottom sediments. A major difference between Alternatives 2 through 6 is how each respective alternative would address the ILWD (SMU 1). In general, the alternatives call for successively greater depths of excavation and therefore, increasing volumes of waste to be removed. Specifically, Alternatives 2, 3, 4, 5, and 6 call for removal depths of up to 1, 2, 3, 5, and 8 meters, respectively within the ILWD. The long term effectiveness of the alternatives for the ILWD increases with increasing amounts of removal since less waste would be contained in the aquatic environment. The reliability of the aquatic cap is enhanced with removal of the more highly concentrated wastes. Therefore, Alternative 4, which includes hot spot removals up to a depth of 3 meters below grade, provides a greater degree of reliability than Alternatives 2 and 3. The highest concentrations of the majority of CPOIs, on average, are found in the upper 3 meters of the ILWD. While Alternative 5 includes approximately 2 m of additional removal within SMU 1 (relative to Alternative 4), this removal does not target hot spot areas and therefore does not increase cap reliability commensurate with the increased $86 million in estimated present worth costs over Alternative 4. In addition, Alternative 4 includes cap enhancements in any residual hot spot areas which is not a component of Alternative 5. Since the cap enhancements would be placed over the most highly contaminated sediments, this component of Alternative 4 provides greater cap reliability over Alternative 5.

Another significant difference among Alternatives 2 through 6 relates to SMU-2. Alternatives 4, 5, and 6 would remove NAPLs to a depth of 9 meters and, thus, result in a greater reduction in the concentrations and masses of CPOIs prior to capping than would Alternatives 2 and 3, thus providing greater long term effectiveness and cap reliability. Since Alternatives 4, 5, and 6 remove and treat a larger volume of NAPLs than would Alternatives 2 and 3, they would satisfy the NCP's preference for treatment of principal threat waste to a greater degree than would Alternatives 2 and 3.

Under Alternatives 6 and 7, an estimated 11 million and 18.9 million additional cy of material, respectively, would be removed from the lake compared to Alternative 2. While Alternatives 6 and 7 would provide greater long term effectiveness than Alternative 4, the greater volumes of material to be removed and disposed would likely exceed the capacity for a single SCA. Multiple containment cells might be needed or significant volumes of material would have to be disposed of at an off-site facility. The $876,000,000 and $1,706,000,000 in incremental costs over Alternative 4 associated with the additional removals called for under Alternatives 6 and 7, respectively, would not be cost effective. A properly designed and constructed aquatic cap, together with the other elements of Alternative 4, would provide a similar degree of protection offered by Alternatives 6 and 7 at significantly less cost and with greater ease of implementation.

Alternative 4 would excavate up to 3 meters of some of the most highly concentrated wastes from the ILWD. This removal would facilitate construction of a structurally stable cap and would result in the removal of the most contaminated principal threat waste. The residual waste could be effectively contained under the engineered cap. Those sediments removed from the Lake could be contained in a single SCA. Finally, continued monitoring and operation and maintenance of the cap would ensure its continued effectiveness. For all of these reasons, Alternative 4 is protective of human health and the environment, provides long-term effectiveness, is able to achieve the ARARs more quickly, or as quickly, as the other alternatives, is cost-effective, and offers the best balance of tradeoffs among the alternatives.

Therefore, the preferred remedy will provide the best balance of tradeoffs among alternatives with respect to the evaluation criteria. NYSDEC believes that the preferred remedy will treat principal threat wastes, be protective of human health and the environment, comply with ARARs, be cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. The preferred remedy also will meet the statutory preference for the use of treatment as a principal element.

ACRONYMS AND ABBREVIATIONS

Specialized acronyms and abbreviations used in this Proposed Plan are defined below.

AET	apparent effect threshold
ARAR	applicable or relevant and appropriate requirement
BERA	baseline ecological risk assessment
BSAF	biota-sediment accumulation factor
BSQV	bioaccumulation-based sediment quality value
BTEX	benzene, toluene, ethylbenzene, and xylenes
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR	Code of Federal Regulations
COC	chemical of concern
COPC	contaminant of potential concern
CPOI	chemical parameter of interest
CSF	cancer slope factor
CT	central tendency
CWA	Clean Water Act
cy	cubic yard
DNAPL	dense non-aqueous-phase liquid
ECL	Environmental Conservation Law
ER-L	effects range-low
ER-M	effects range-median
FS	feasibility study
H&E	Dredging to a depth that optimizes *habitat* and reduces *erosive* forces (as relates to a remedial alternative for Onondaga Lake).

Hg	mercury
HHRA	human health risk assessment
HI	hazard index
HPAH	high molecular weight polycyclic aromatic hydrocarbon
HQ	hazard quotient
ILWD	in-lake waste deposit
IRM	interim remedial measure
kg	kilogram
km	kilometer
LOAEL	lowest observed adverse effect level
LPAH	low molecular weight polycyclic aromatic hydrocarbon
LWA	lakewide alternative
mg	milligram
mg/L	milligrams per liter
MGP	manufactured gas plant
MNR	monitored natural recovery
NAPL	non-aqueous-phase liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAEL	no observed adverse effect level
ng/L	nanograms per liter
NLSA	no loss of lake surface area
NPL	National Priorities List
NRRB	National Remedy Review Board
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health

O&M	operation and maintenance
OSRTI	Office of Superfund Remediation and Technology Innovation
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo-*p*-dioxin
PCDF	polychlorinated dibenzofuran
PEC	probable effect concentration
PECQ	probable effect concentration quotient
PEL	probable effect level
ppm	parts per million
PRG	preliminary remediation goal
PRP	potentially responsible party
RAO	remedial action objective
RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SCA	sediment consolidation area
SEC	sediment effect concentration
SOC	stressor of concern
SMU	sediment management unit
SVOC	semi-volatile organic compound
SWAC	surface-weighted average concentration
SYW	Syracuse West (from US Geological Survey quadrant sheet; used to identify New York State wetlands)

TEL	threshold effect level
USC	US Code
USEPA	US Environmental Protection Agency
VOC	volatile organic compound
ww	wet weight

GLOSSARY

Specialized terms used in this Proposed Plan are defined below.

Acute – Occurring over a short time. The duration of the acute toxicity tests performed for the Onondaga Lake RI/FS was 10 days.

Advection – The movement of a mass of fluid and the transport of the contents (e.g., contaminants) of the fluid.

Aeration – Exposure to the action of air; introduction of air into a solution.

Anoxic – Containing no dissolved oxygen. Commonly used to indicate an environment that cannot support life, except for some types of bacteria.

Applicable or Relevant and Appropriate Requirements (ARARs) – The federal and state environmental laws that a selected remedy will meet. These requirements may vary among sites and alternatives.

Baseline – Current conditions without remediation implemented (i.e., no action).

Bathymetry – The measurement of the depth of the floor of a water body from the water surface.

Benthic – Occurring at the bottom of a body of water (e.g., a lake bottom).

Benthic Macroinvertebrates – Small but visible animals (e.g., insects, worms, clams, and snails) that live in or on the sediment at the bottom of a lake or stream.

Bioaccumulation – The general term describing a process by which chemicals are taken up by an organism either directly from exposure to a contaminated medium or by consumption of food containing the chemical.

Bioavailability – Degree of ability to be absorbed and metabolized in an organism.

Biota – Animal and plant life.

Bioturbation – The process whereby bottom dwelling and burrowing organisms mix up sediment and destroy primary layering.

Byproduct – Material, other than the principal product, generated as a consequence of an industrial process or as a breakdown product in a living system.

Calcite – A mineral composed of calcium and carbonate.

Cancer Slope Factor (CSF) – A plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The CSF is used to estimate an upper-bound probability of an individual developing cancer as a result of a lifetime of exposure to a particular concentration of a specific potential carcinogen.

Carcinogenic – The property of a substance to cause or aggravate cancer.

Chronic – Involving a stimulus that is lingering or continues for a long time; often signifies periods from several weeks to years, depending on the reproductive life cycle of the species. Chronic exposures typically induce a biological response of relatively slow progress and long duration.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) – Commonly known as Superfund, CERCLA was enacted by Congress on December 11, 1980 and subsequently amended. This law provided broad federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment.

Consent Decree – A legal document, approved by a judge, that, in the case of a CERCLA investigation, formalizes an agreement between USEPA (or, in the case of Onondaga Lake, New York State) and one or more potentially responsible parties outlining the terms by which the investigation will take place. A Consent Decree is subject to a public comment period prior to its approval by a judge and is enforceable as a final judgment by a court.

Contaminant – Any physical, chemical, biological, or radiological substance or matter that has an adverse effect on air, water, sediment, soil, or biota. In the case of Onondaga Lake, contaminants are typically chemical substances.

Coring – The use of a core barrel (hollow length of tubing) to take samples from the subsurface (underground).

Dewater – To remove water from solid material (e.g., sediments) by a solid-liquid separation technique.

Diffusion – The movement of dissolved constituents from areas of high concentration to areas of low concentration.

Discharge – Flow of surface water in a stream or the outflow of groundwater from a flowing well, ditch, or spring. Can also apply to release of liquid effluent from a facility or to chemical emissions into the air.

Dissolved Oxygen (DO) – The oxygen freely available in water, vital to fish and other aquatic life and for the prevention of odors. DO levels are considered an important indicator of a water body's ability to support desirable aquatic life.

Ebullition – The process or state of a liquid or gas bubbling up. In Onondaga Lake, methane gas ebullition occurs, which is the process whereby gas bubbles that contain methane formed by bacteria in the sediments are released from the sediment to overlying lake water. Mercury can be released from the sediments through this process.

Ecological Risk Assessment – The application of a formal framework, analytical process, or model to estimate the effects of human actions on a natural resource and to interpret the significance of those effects in light of the uncertainties identified in each component of the assessment process. Such analysis includes initial hazard identification, exposure and dose-response assessments, and risk characterization.

Ecosystem – The biotic community and abiotic (non-living) environment within a specified location and time, including the chemical, physical, and biological relationships among the biotic and abiotic components.

Epilimnion – During summer stratification, the upper portion of the water column located between the 0 and 30 foot (0 and 9 meter) water depth in Onondaga Lake. The epilimnion is warm and well-mixed by wind and waves.

Exposure – Contact by humans or wildlife with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term (acute exposure), of intermediate duration, or long-term (chronic exposure).

Exposure Pathway – The course (path) a contaminant takes from the source to the exposed individual.

Eutrophication – The change in biological, chemical, and physical conditions in a lake caused by increasing concentrations of algal nutrients (e.g., phosphorus) usually associated with human activities. Results of eutrophication include low water clarity, low dissolved oxygen, floating algae, anoxic conditions in the hypolimnion, changes in biological communities, and unpleasant odors.

Feasibility Study (FS) – A study to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well. The FS typically evaluates a series of remedial alternatives and recommends the selection of a cost-effective alternative.

Flume – A natural or manmade channel that diverts water.

Groundwater – Underground water that fills pores in soils or openings in rocks to the point of saturation.

Hazard Index (HI) – The sum of more than one hazard quotient for multiple substances and/or multiple exposure pathways.

Hazard Quotient (HQ) – The ratio of an exposure level to a substance to a toxicity value selected for the risk assessment for that substance.

Hazardous Substance – Defined in CERCLA and New York State law generally, any material that poses a threat to human health and/or the environment. Typical hazardous substances are toxic, corrosive, ignitable, explosive, or chemically reactive.

Human Health Risk – The likelihood that a given exposure or series of exposures may have damaged or will damage the health of individuals.

Hypolimnion – During summer stratification, the lower portion of the water column located between the 30 and 60 foot (9 to 18 meter) water depth in Onondaga Lake. The hypolimnion is cool and not well-mixed by wind and waves.

Ionic Waste – Solid and liquid materials contaminated with calcium, calcium carbonate, chloride, and sodium ions, that have been historically discharged to Onondaga Lake. Ionic waste was produced as a result of Honeywell's soda-ash manufacturing process and was disposed of by various means (e.g., pumped to the Honeywell wastebeds in the form of a slurry).

Littoral Sediment – Sediments located beneath epilimnetic water in water depths less than 30 feet (9 meters).

Macrophyte – Plants, usually aquatic, large enough to be seen without magnification. They may be rooted or free floating.

Marl – A mixture of clay with lime (calcium carbonate).

Media (singular: medium) – Specific environments (e.g., water, sediment, fish) that are the subject of regulatory concern and activities.

Mercury Methylation – The process of bonding an organic molecule (a methyl group) to a mercury atom (mercuric ion) to form a new chemical: methylmercury.

Mitigation – Measures taken to reduce adverse impacts on the environment.

Monitoring – Ongoing collection of information about the environment that helps gauge the effectiveness of a cleanup action.

Mudboil –The Tully Valley mudboils are volcano-like cones of fine sand and silt that range from several inches to several feet high and from several inches to more than 30 feet in diameter. Active mudboils are dynamic ebb-and-flow features that can erupt and form a large cone in several days, then cease flowing, or they may discharge continuously for several years. Mudboil formation may be associated with solution salt mining by Honeywell, which began in the late 1800s. The discharge of turbid groundwater and fine sand to the land surface from mudboils in the Tully Valley, approximately 20 miles south of Syracuse, historically has discharged to tributaries to the lake and been carried to the lake by these tributaries, primarily Onondaga Creek.

Mutagenic – The property of a substance or mixture of substances to cause genetic changes.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP) – The federal regulation governing CERCLA cleanups and the determination of the sites to be corrected under both the Superfund program and the program to prevent or control spills into surface waters or elsewhere. 40 CFR Part 300, et seq.

National Priorities List (NPL) – The NPL is USEPA's 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 USEPA in determining which sites warrant further investigation and remediation.

Non-Aqueous-Phase Liquid (NAPL) – Contaminants that remain undiluted as the original bulk liquid in the subsurface; e.g. spilled oil. Dense NAPL, or DNAPL, includes chlorinated hydrocarbon solvents or petroleum fractions with a specific gravity greater than 1.0 that can sink through the water column until they reach a confining layer.

Operable Unit (OU) – Term for each of a number of separate activities undertaken as part of a Superfund site cleanup.

Operation and Maintenance (O&M) – Activities conducted after a Superfund site action is completed to ensure that the action is effective. O&M actions can include those taken after construction to ensure that facilities constructed to treat wastewater will be properly operated and maintained to meet discharge limits.

Organic Compounds – Carbon compounds, such as solvents, oils, and pesticides. Most are not readily dissolved in water. Some organic compounds can cause cancer.

Oxic – Containing dissolved oxygen. Commonly used to indicate a chemically oxidizing environment where substances like sulfide are not stable.

Pathway – The physical course a chemical or pollutant takes from its source to the exposed organism.

Persistence – Refers, in general, to the length of time a compound remains in the environment, once introduced. A compound may persist for less than a second or indefinitely.

pH – An expression of the intensity of the basic or acidic condition of a liquid; may range from 0 to 14, where 0 is the most acidic, 7 is neutral, and 14 is the most basic. Natural waters usually have a pH between 6.5 and 8.5.

Phytoplankton – Microscopic plant life (i.e., algae) that lives in the water column of a lake and serves as food for zooplankton and some fish species.

Plankton – Minute organisms that drift with the currents in seas and lakes. Plankton includes many microscopic animals and plants.

Porewater – Porewater is the water filling the spaces between grains of sediment.

Preliminary Remediation Goal (PRG) – Established for the Onondaga Lake RI/FS to provide additional information and goals with which remedial alternatives can be developed and selected. PRGs are used to achieve remedial action objectives.

Present-Worth Analysis/Present-Worth Cost – A method of evaluation of expenditures that occur over different time periods. By discounting all costs to a common base year, the costs for different remedial action alternatives can be compared. When calculating present worth costs for Superfund sites, capital and operation and maintenance costs are included.

Probable Effect Concentrations (PECs) – Sediment quality values established as the concentrations of individual chemicals above which adverse effects in sediments are expected to frequently occur.

Profundal Sediment – Sediment located beneath hypolimnetic water in water depths greater than 30 feet (9 meters).

Proposed Plan – Part of the Superfund remedial response process. The preferred remedy for a site is presented to the public in the Proposed Plan. The Proposed Plan briefly summarizes the alternatives studied in the detailed analysis phase of the Remedial Investigation/Feasibility Study, highlighting the key factors that led to identifying the preferred remedy. The Proposed Plan, as well as the Remedial Investigation/Feasibility Study and the other information that forms the basis for the lead agency's response selection, is made available for public comment in the Administrative Record file. The opportunity for a public meeting is provided at this stage.

Receptor – Entity exposed to a stressor.

Record of Decision (ROD) – Following receipt of public comments and any final agency comments, the lead agency (in the case of Onondaga Lake, NYSDEC) selects and documents the remedy selection decision in a ROD. The ROD documents the remedial action plan for a site.

Remedial Action Objective (RAO) – RAOs were developed for the Onondaga Lake subsite to provide the overall goals of the remedial process and provide the basis for comparing the degree to which various alternatives protect human health and the environment.

Remedial Design – A phase of remedial action that follows the remedial investigation/feasibility study and Record of Decision and includes development of engineering drawings and specifications for a site cleanup.

Remedial Investigation (RI) – An in-depth study designed to gather data needed to determine the nature and extent of contamination and risks to humans and the environment at a Superfund site. The RI is usually done prior to the feasibility study (FS). Together they are usually referred to as the "RI/FS."

Remediation – Cleanup or other methods used to remove or contain a toxic spill or hazardous materials from a Superfund site.

Residuals – Contaminants that are left in place following remediation.

Responsiveness Summary – A summary of oral and/or written public comments received during a comment period on key documents, and a response to those comments. A Responsiveness Summary will be issued with the Record of Decision to address comments received on this Proposed Plan.

Resuspension – The process of lifting sediment particles from the bottom of a lake into the overlying water. Resuspension can be caused by forces such as water turbulence from waves and currents, bottom-feeding fish (e.g., carp), and methane gas ebullition. The particles may settle back to the bottom or be carried away by currents.

Salinity – A measure of the total concentration of dissolved salts in water.

Sediment – Materials that sink to the bottom of a body of water or materials that are deposited by wind, water, or glaciers. Sediment is the primary contaminated medium at the Onondaga Lake subsite.

Sediment Effects Concentrations (SECs) – Sediment quality guidelines used to predict sediment toxicity. Site-specific SECs were derived for Onondaga Lake based on the results of the acute toxicity tests.

Sediment Management Units (SMUs) – The eight areas of Onondaga Lake that were established to assist in the evaluation to better manage remediation of contaminated sediments.

SMUs 1 through 7 are located in the littoral zone of the lake and SMU 8 is the entire profundal zone of the lake.

Seiche – An oscillation of the surface of a landlocked body of water (as a lake) that varies in period from a few minutes to several hours.

Solidification and Stabilization – Removal of wastewater from a waste or water from dredged sediments, or changing it chemically to make it less permeable and susceptible to transport by water.

Soluble – Capable of being dissolved.

Stratification – Containing distinct layers. During summer stratification, from approximately mid-May to mid-October, Onondaga Lake consists of two layers of water (i.e., the hypolimnion and the epilimnion).

Stressor – A physical, chemical, or biological entity that can induce adverse effects on an ecosystem or human health.

Substrate – The surface or medium that serves as a base for something.

Superfund – The common name for the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. The Superfund Amendments and Reauthorization Act (SARA) amended CERCLA on October 17, 1986.

Supernatant – The liquid above settled solids.

Surface Water – Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs.

Sustainability – Relates to survival, growth, and reproduction. The sustainability of plant and animal communities and populations was used in the Onondaga Lake baseline ecological risk assessment as the basis for assessment endpoints.

Teratogenic – The property of a substance to interfere with the normal development of a fetus or embryo.

Thermocline – The boundary between the epilimnion and hypolimnion where the water temperature changes the fastest with changing depth.

Threshold – The dose or exposure level below which a significant adverse effect is not expected.

Treatment – Any method, technique, or process designed to remove solids and/or pollutants from solid waste, waste streams, effluents, and air emissions.

Trophic – Pertaining to a position in a food web, food chain, or food pyramid.

Upwelling – The upward movement of groundwater through sediments.

Zooplankton – Small (often microscopic) planktonic animals that live in the water column of a lake and serve as food for some fish species.

USE THIS SPACE TO WRITE YOUR COMMENTS

Your input on the Proposed Plan for the Onondaga Lake subsite of the Onondaga Lake Superfund site is important to NYSDEC. Comments provided by the public are valuable in helping us select a final cleanup remedy for the site.

You may use the space below to write your comments, then fold and mail to the address provided at the beginning of this Proposed Plan. Comments must be postmarked by March 1, 2005. Those with electronic communications capabilities may submit their comments to NYSDEC via the Internet at the following e-mail address: DERweb@gw.dec.state.ny.us. Please note “Onondaga Lake Proposed Plan” in subject box.

Name ____________________

Address ____________________

City ____________________

State ____________________

Zip ____________________