6. Baseline Risk Assessment Problem Formulation (ERAGS Step 3)

Step 3 of Ecological Risk Assessment Guidance for Superfund (ERAGS) initiates the problem formulation phase of the BERA (USEPA, 1997a). The components of the screening-level problem formulation are refined, taking into account various kinds of site-specific information and the concerns of stakeholders. The major components of Step 3 are as follows:

- Refinement and finalization of the list of chemicals of concern/stressors of concern (COCs/SOCs) from the list of chemicals of potential concern/stressors of potential concern (COPCs/SOPCs) identified in earlier steps.

- Further characterization of the ecological effects of the selected COCs/SOCs.

- Review of information on COC/SOC transport and fate, complete exposure pathways, and ecosystems potentially at risk.

- Refinement of assessment and measurement endpoints.

- Refinement of the conceptual site model.

These components are discussed in the following sections.

6.1 Refinement of Chemicals of Concern

The screening-level exposure estimate and risk calculations presented in Chapter 5 identified a list of preliminary COPCs for various media in Onondaga Lake. These COPCs were refined through the use of the criteria described below to derive the final list of COCs. Chemicals covered under Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA) Section 40 CFR Part 302.4, which lists the CERCLA hazardous substances, were considered in the COC selection. The exception to this is ammonia, which is listed as a hazardous substance in the CFR, but is treated as an SOC in this BERA since it is associated with discharges from the Metropolitan Syracuse Sewage Treatment Plant (Metro), as well as various Honeywell sites, and is a nutrient.

- **Detection Frequency.** Contaminants that were not detected in all media were dropped due to the uncertainty associated with whether they were actually present at a site and, if so, at what concentration. Frequency of detection of contaminants was a factor in deciding whether to retain them as COCs. Generally, contaminants detected in less than 5 percent of the samples were not retained, as those contaminants were considered to have limited distribution around the lake.

- **Laboratory or Field Contamination.** Infrequently detected contaminants associated with laboratory contamination or decontamination of field equipment were dropped due to the tenuous association with the site.

- **Ratios.** Ratios comparing measured COC concentrations to criteria or guidelines were calculated for water, sediment, and soil. Some media had two or more ratios representing either different sampling years or locations (for soils), all of which were considered when deciding whether to retain a contaminant.

- **Hazard Quotients.** Hazard quotients (HQs) were calculated by comparing measured tissue concentrations or modeled daily doses of chemicals to toxicity reference values (TRVs). HQs equal to or greater than 1.0 were examined closely to determine whether less conservative exposure parameters (e.g., lower bioavailability of the contaminants) could bring HQs below 1.0. Some receptors had two or more HQs, representing either different sampling years or locations, all of which were considered when deciding whether to retain a contaminant.

- **Groups of Contaminants.** Similar contaminants were grouped together to streamline COC selection and evaluation. Contaminants were individually analyzed and then summed together to calculate group exposure concentrations. Generally, these contaminants share common available TRVs and physicochemical characteristics. These groupings are generally consistent with the treatment of contaminants in the Onondaga Lake Human Health Risk Assessment (HHRA) (see Appendix A of the HHRA) (TAMS, 2002a). Metals/inorganics are not listed as a group since they are evaluated individually. Contaminants grouped together as COCs are:

  - **Polycyclic Aromatic Hydrocarbons (PAHs).** This group includes both LPAHs (low molecular weight PAHs: fluorene, naphthalene, and 2-methylnaphthalene) and HPAHs (high molecular weight PAHs: 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, indeno[1,2,3-cd]pyrene, phenanthrene, and pyrene), based on the results of the principal component analysis (PCA) performed in the RI (see Appendix I of the RI report for further details [TAMS, 2002b]). Total PAHs for toxicological evaluations were calculated summing only detected values and were considered as one group due to the lack of toxicological data for most individual compounds. Distribution of PAHs in Onondaga Lake surface sediments (Chapter 8, Section 8.1.2.6) is presented for LPAHs and HPAHs.

- **DDT and Metabolites.** This group consists of 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, and other DDT metabolites.

- **Polychlorinated Biphenyls (PCBs).** This group consists of eight individual Aroclors (1016, 1221, 1232, 1242, 1248, 1254, 1260, and 1268) that were analyzed over the duration of the sampling period. The methods used for calculating total PCB concentrations are described in Chapter 8, Section 8.2.2 of this BERA.

- **Dichlorobenzenes.** This group consists of the sum of 1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene.

- **Trichlorobenzenes.** This group consists of the sum of 1,2,3-trichlorobenzene, 1,2,4-trichlorobenzene, and 1,3,5-trichlorobenzene.

- **Chlordanes.** The chlordane sum consists of alpha chlordane (same as cis-chlordane), gamma chlordane (same as trans-chlordane), oxychlordane, and nonachlor (cis- and/or trans-nonachlor).

- **Heptachlor/Heptachlor Epoxide.** These two contaminants were summed and placed in one group.

- **Endosulfans.** Alpha- and beta-endosulfan were summed and placed in one group.

- **Hexachlorocyclohexanes.** Alpha-, beta-, delta-, and gamma-hexachlorocyclohexane were summed and placed in one group.

- **Dioxins and Furans.** Dioxins and furans, also known as polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) were presented in terms of toxicity equivalent (TEQ) concentrations. The TEQ approach, developed to facilitate risk assessment, generates a single toxicity value for a mixture of compounds based on the relative risk of individual constituents. Specifically, concentrations of each PCDD/PCDF congener are multiplied by their toxicity equivalence factor (TEF), which is an estimate of a PCDD/PCDF congener's toxicity relative to the most toxic congener within that chemical group (i.e., 2,3,7,8-tetrachlorodibenzo-*p*-dioxin [2,3,7,8-TCDD]), to yield compound-specific TEQ concentrations. The individual TEQ concentrations were summed, producing a single TEQ concentration that approximates the toxicity of all PCDD/PCDFs in the mixture relative to 2,3,7,8-TCDD. The TEFs used in the BERA are World Health Organization (WHO) values taken from Van den Berg et al. (1998). Sampling for PCDDs/PCDFs was performed in 2000.

Other factors considered when selecting COCs include contaminant toxicity, bioaccumulation potential, statistical distributions of contaminant concentrations (e.g., 95 percent upper confidence limits [UCLs] versus maximum detected concentrations), and USEPA guidance. Comparisons of inorganic contaminants to background concentrations was not a factor in selecting COCs, but is discussed in the uncertainty section (Chapter 11, Section 11.4, Background and Reference Concentrations) in accordance with USEPA guidance (USEPA, 2002).

6.1.1 Surface Water Chemical of Concern/Stressor of Concern Selection

A total of 32 COPCs exceeded screening values in Onondaga Lake surface water (Chapter 5, Table 5-3). Eleven contaminants, consisting of barium, copper, cyanide, lead, manganese, mercury/methylmercury, zinc, chlorobenzene, dichlorobenzenes, trichlorobenzenes, and bis(2-ethylhexyl)phthalate, were retained as surface water COCs (Table 6-1).

Eighteen of these COPCs were not detected in surface water and were dropped from further consideration, as the presence of these contaminants at the lake was questionable in the absence of detected values. The undetected contaminants were: xylenes, all semivolatile organic compounds (SVOCs) except bis(2-ethylhexyl)phthalate (i.e., hexachlorobenzene, fluorene, benzo[a]pyrene, pentachlorophenol, hexachlorobutadiene, hexachlorocyclopentadiene, and 4-bromophenyl-phenyl ether), and all pesticides (i.e., alpha-chlordane, gamma-chlordane, alpha-endosulfan, beta endosulfan, endrin, heptachlor, heptachlor epoxide, methoxychlor, 4,4'-DDT, and toxaphene).

The only metals analyzed in the fall 1999 nearshore water sampling (performed mainly for HHRA purposes) were chromium, lead, manganese, mercury, and nickel. Thus, most metals were selected based on the 1992 data. Aluminum was dropped because it is biologically inactive in circumneutral to alkaline (pH 5.5 to 8.0) conditions (USEPA, 2001), and the mean pH of Onondaga Lake in 1992 was 7.7 (Appendix D, Table D-1). Iron was eliminated because it functions as a nutrient and, considering bioavailability, the ratios of 1.2 in 1992 and 2.0 in 1999 were not considered excessive. Cadmium was dropped because of its low detection frequency of 2 percent (it was detected in only 3 of 144 samples in 1992, and was not analyzed in 1999).

In addition, all SOPCs were retained for qualitative evaluation in the BERA. The SOCs consist of: ammonia, calcite, chloride, depleted dissolved oxygen (DO), nitrite, phosphorous, salinity, sulfide, and reduced water transparency. These stressors address the input of ionic waste and nutrients into the lake.

6.1.2 Sediment Chemical of Concern/Stressor of Concern Selection

The 95 contaminants that exceeded screening values in surface sediments are listed in Chapter 5, Table 5-5. A total of 30 contaminant/contaminant groups were retained as COCs based upon frequency of detection, magnitude of exceedances, and concentrations in aquatic organisms (Table 6-1). These COCs consist of:

- Thirteen inorganic contaminants: antimony, arsenic, cadmium, chromium, copper, lead, manganese, mercury/methylmercury, nickel, selenium, silver, vanadium, and zinc.
- Seven volatile organic compounds (VOCs): benzene, chlorobenzene, dichlorobenzenes (total), ethylbenzene, trichlorobenzenes (total), toluene, and xylenes.
- Four SVOCs: hexachlorobenzene, total PAHs, phenol, and dibenzofuran.
- Four pesticide groups and PCBs: chlordanes, dieldrin, heptachlor/heptachlor epoxide, DDT and metabolites, and total PCBs.
- Dioxins and furans: Total dioxins and furans.

Undetected contaminants that are not part of contaminant groups (28 of 32 COPCs) were dropped from further consideration. These were: 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethene (isomers), 2-hexanone, 4-methyl-2-pentanone, carbon tetrachloride, chloroform, cis-1,3-dichloropropene, trans-1,3-dichloropropene, trichloroethene, tetrachloroethene, 4-bromophenyl-phenyl ether, 4-chloro-3-methylphenol, butylbenzyl phthalate, diethylphthalate, di-n-butyl-phthalate, hexachlorobutadiene, hexachlorocyclopentadiene, hexachloroethane, pentachlorophenol, aldrin, endrin, methoxychlor, and toxaphene.

The remaining four undetected contaminants (i.e., beta-endosulfan, beta- and gamma-hexachlorocyclohexane, heptachlor epoxide) belong to one of the groups of contaminants listed above and were examined with these groups, as discussed later in this section.

2-Methylphenol was dropped as a COC because of its low detection frequency (2 of 85 samples) in 2000 and no detections in 1992. The group endosulfans (alpha- and beta-endosulfan) was dropped from screening because beta-endosulfan was not detected in 2000 and alpha-endosulfan in 2000 had a detection rate of less than 5 percent (4 of 84 samples), and neither compound was detected in 1992 (0 of 19).

The frequency of detection (Appendix D, Tables D-5A and D-47) of the following groups were sufficient to retain them as COCs:

- PAHs (acenaphthylene, acenaphthene, anthracene, benz[a]anthracene, benzo[b]-fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, benzo[a]pyrene, chrysene, dibenz[a,h]anthracene, fluoranthene, fluorene, indeno[1,2,3-cd]pyrene, 1-methylnaphthalene, 2-methylnaphthalene, naphthalene, phenanthrene, and pyrene).

- DDT and metabolites (i.e., 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT).

- PCBs (i.e., Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, and 1268).

- Dichlorobenzenes (i.e., 1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene).

- Trichlorobenzenes (i.e., 1,2,3-trichlorobenzene, 1,2,4-trichlorobenzene, and 1,3,5-trichlorobenzene).

- Chlordanes (i.e., alpha chlordane, gamma chlordane, oxychlordane, and nonachlor).

- Dioxins and furans (i.e., the sum of dioxins and furans).

The group hexachlorocyclohexanes (alpha-, beta-, delta-, and gamma-hexachlorocyclohexane) was eliminated from further consideration because individual compounds only exceeded the screening ratio for undetected values in 1992 and no individual compound had a screening ratio greater than 1.0 in 2000.

Aluminum was not retained as a sediment COC, based on draft USEPA guidance (USEPA, 2000) stating that aluminum should not be a COC at sites where the soil pH is >5.5, which applies to Onondaga Lake. Iron was eliminated as a COC because it functions as an nutrient and, assuming a bioavailability of less than 100 percent, the ratios of 1.7 in 1992 and 2.5 in 2000 were not considered excessive.

Although selenium and vanadium did not have sediment screening values (Chapter 4, Table 4-5), they were retained as COCs for fish (see Section 6.1.5) and were, therefore, also retained as COCs for sediment, as it is an exposure pathway for fish.

Acetone, methylene chloride, 2-butanone, and carbon disulfide were dropped as COCs in sediments because they may be associated with laboratory contamination or decontamination of field equipment and have no historic association with the site.

Calcite/oncolites were retained as an SOC for qualitative evaluation.

6.1.3 Wetland Surface Soils/Sediment and Dredge Spoils Area Surface Soil Chemical of Concern Selection

Wetland soils/sediments were screened against both soil and sediment guidelines and criteria (Chapter 5, Table 5-6), as many of the wetland areas are partially inundated during the year. Wetland surface soil/sediment samples were taken from 0 to 0.3 meters (m) and divided into 0 to 15 cm and 15 to 30 cm core slices. Dredge spoils surface soil samples were taken up to 107 cm in depth. Much of the dredge spoils area has been covered with fill that is believed to be from an off-site source. This fill covers the mercury-contaminated sediments dredged from the Ninemile Creek delta in the lake in the late 1960s.

Forty-one contaminants exceeded screening ratios in Onondaga Lake wetland and dredge spoils area soils/sediments (Chapter 5, Table 5-6). A total of 30 contaminants/contaminant groups were selected as soil/sediment COCs (Table 6-1). These were: antimony, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury/methylmercury, nickel, selenium, silver, thallium, vanadium, zinc, cyanide, benzene, chlorobenzene, dichlorobenzenes, trichlorobenzenes, hexachlorobenzene, phenol, total PAHs, aldrin, dieldrin, chlordanes, hexachlorocyclohexanes, DDT and metabolites, and total PCBs.

Pentachlorophenol, 2-chlorophenol, and 4-nitrophenol had ratios greater than 1.0 but were not detected in soils and were, therefore, eliminated from consideration (Chapter 5, Table 5-6).

Aluminum was not retained as a soil COC, based on draft USEPA guidance (USEPA, 2000) stating that aluminum should not be a COC at sites where the soil pH is >5.5, which applies to Onondaga Lake. Beryllium was dropped from further consideration based on an HQ of 1.1, in combination with the assumption that it was not 100 percent bioavailable from the soil.

6.1.4 Plant Chemical of Concern Selection

Only inorganic contaminant screening values (Efroymson et al., 1997a) were available for plants. A total of 14 inorganic contaminants equaled or exceeded a screening ratio of 1.0 for plants (Chapter 5, Table 5-7). Aluminum was dropped based on the draft USEPA soil guidance mentioned previously. Manganese was dropped because it has a maximum ratio of 1.0, which, in combination with lower bioavailability, results in risk below levels of concern. The remaining 12 inorganics (i.e., arsenic, cadmium, chromium, copper, lead, mercury/methylmercury, nickel, selenium, silver, thallium, vanadium, and zinc) were the COCs selected for plant exposure (Table 6-1).

6.1.5 Fish Chemical of Concern Selection

A total of 21 contaminants exceeded screening criteria for fish (Chapter 5, Table 5-8). Eleven contaminants, consisting of antimony, arsenic, chromium, mercury/methylmercury, selenium, vanadium, zinc, endrin, total PCBs, DDT and metabolites, and dioxins/furans were selected as COCs (Table 6-1).

Photomirex, mirex, and oxychlordane were dropped because they were not detected. Thallium was dropped from consideration because it was not detected from 1992 through 1998 and had a screening ratio of less than 1.0 in 2000. Bis(2-ethylhexyl)phthalate (BEHP) was dropped because it had a ratio of 1.1 in 1992, which, in combination with lower bioavailability, results in risk below levels of concern. BEHP was not analyzed in 2000. Gamma-hexachlorocyclohexane had a ratio of 2.3 in 1992, based on one detection in 13 fish samples. In 2000, the screening ratio was 4.3×10^{-4} (Appendix D, Table D-73). Based on the initial low frequency of detection and subsequent decrease in concentration, gamma-hexachlorocyclohexane was dropped as a COC. Aluminum was dropped based on draft USEPA draft guidance (USEPA, 2000). Aroclors were grouped together in the total PCBs group.

6.1.6 Wildlife Receptor Chemical of Concern Selection

COCs for wildlife receptors were selected on a species-by-species basis using the HQ results of the screening risk assessment food-chain models (Chapter 5, Table 5-9) for the following species:

- Tree swallow (*Tachycineta bicolor*).
- Mallard (*Anas platyrhynchos*).
- Belted kingfisher (*Ceryle alcyon*).
- Great blue heron (*Ardea herodias*).
- Osprey (*Pandion haliaetus*).
- Red-tailed hawk (*Buteo jamaicensis*).
- Little brown bat (*Myotis lucifugus*).
- Short-tailed shrew (*Blarina brevida*).
- Mink (*Mustela vison*).
- River otter (*Lutra canadensis*).

Specific body weights; food, water, and sediment ingestion rates; and dietary composition were used for each receptor so that a unique group of COCs was selected for each species, despite similarities amongst some.

6.1.6.1 Tree Swallow

Twenty-one of 58 contaminants/contaminant groups with HQs equal to or greater than 1.0 were retained as COCs for a final list comprised of: arsenic, barium, cadmium, chromium, cobalt, copper, lead, mercury/methylmercury, nickel, selenium, thallium, vanadium, zinc, dichlorobenzenes, trichlorobenzenes, xylenes, bis(2-ethylhexyl)phthalate, total PAHs, DDT and metabolites, total PCBs, and dioxins/furans (Table 6-2).

Vinyl chloride, pentachlorophenol, di-n-butyl phthalate, hexachloroethane, and hexachlorobutadiene were dropped as COCs because they were undetected in sediment, which was used to model aquatic invertebrate concentrations, or water. Aluminum was dropped based on draft USEPA guidance (USEPA, 2000). The remaining contaminants were evaluated separately or in groups as COCs.

6.1.6.2 Mallard

Fifteen of 45 contaminants/contaminant groups with HQs equal to or greater than 1.0 were retained as COCs for a final list comprised of: barium, cadmium, chromium, cobalt, copper, mercury/methylmercury, nickel, vanadium, zinc, dichlorobenzenes, trichlorobenzenes, xylenes, total PAHs, total PCBs, and dioxins/furans (Table 6-2). Thallium and 4,4'-DDT were dropped because they had ratios of 1.1, and with alternative assumptions (e.g., mean weight, ingestion rate, bioavailability) HQs would fall below 1.0.

Vinyl chloride, pentachlorophenol, di-n-butyl phthalate, hexachloroethane, and hexachlorobutadiene were dropped as COCs for the mallard because they were undetected in sediment and water. Aluminum was dropped based on draft USEPA guidance (USEPA, 2000). The remaining contaminants were evaluated separately or in groups as COCs.

6.1.6.3 Belted Kingfisher

Eleven of 26 contaminants/contaminant groups with HQs equal to or greater than 1.0 were retained as COCs for a final list comprised of: chromium, lead, mercury/methylmercury, selenium, zinc, total PAHs, hexachlorocyclohexanes, DDT and metabolites, endrin, total PCBs, and dioxins/furans (Table 6-2).

Pentachlorophenol and hexachloroethane were dropped as COCs for the belted kingfisher because they were undetected in fish, sediment, or water. Bis(2-ethylhexyl)phthalate and heptachlor/heptachlor epoxide were dropped due to ratios of 1.0 and 1.1, respectively, in 1992 to 1998 and HQs below 1.0 in the 1999 to 2000 sampling, indicating that concentrations of these two contaminants have decreased below risk levels. The remaining contaminants were evaluated separately or in groups as COCs.

6.1.6.4 Great Blue Heron

Eight of 19 contaminants/contaminant groups with HQs equal to or greater than 1.0 were retained as COCs for a final list comprised of: chromium, mercury/methylmercury, selenium, zinc, total PAHs, hexachlorocyclohexanes, DDT and metabolites, and total PCBs (Table 6-2).

Pentachlorophenol and hexachloroethane were dropped as COCs for the great blue heron because they were undetected in fish, sediment, or water. The remaining contaminants were evaluated separately or in groups as COCs.

6.1.6.5 Osprey

Eight of 18 contaminants/contaminant groups with HQs above 1.0 were retained as COCs for a final list comprised of: chromium, mercury/methylmercury, selenium, zinc, hexachlorocyclohexanes, DDT and metabolites, total PCBs, and dioxins/furans (Table 6-2).

Endrin was eliminated based on a HQ of 1.0 because, with alternative assumptions (e.g., mean weight, ingestion rate, bioavailability), the HQs would fall below 1.0. The remaining contaminants were evaluated separately or in groups as COCs.

6.1.6.6 Red-Tailed Hawk

Six of 24 contaminants/contaminant groups were retained as COCs for a final list comprised of chromium, lead, mercury/methylmercury, total PAHs, DDT and metabolites, and dioxins/furans (Table 6-2).

Pentachlorophenol and hexachloroethane were dropped as COCs for the red-tailed hawk because they were undetected in soil or water. Aluminum was dropped based on draft USEPA guidance (USEPA, 2000). The remaining contaminants were evaluated separately or in groups as COCs.

6.1.6.7 Little Brown Bat

Twenty-two of 52 contaminants/contaminant groups were retained as COCs for a final list comprised of: antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, mercury/methylmercury, nickel, selenium, thallium, vanadium, zinc, trichlorobenzenes, xylenes, total PAHs, hexachlorobenzene, total PCBs, dieldrin, and dioxins/furans (Table 6-2).

Vinyl chloride, pentachlorophenol, hexachloroethane, and hexachlorobutadiene were dropped as COCs because they were not detected in sediment (used to model aquatic invertebrate concentrations) or water. Aluminum was dropped based on draft USEPA guidance (USEPA, 2000). The remaining contaminants were evaluated separately or in groups as COCs.

6.1.6.8 Short-Tailed Shrew

Eighteen of 47 contaminants/contaminant groups were retained as COCs for a final list comprised of: arsenic, barium, cadmium, chromium, lead, mercury/methylmercury, nickel, selenium, thallium, vanadium, zinc, trichlorobenzenes, total PAHs, hexachlorobenzene, chlordanes, dieldrin, total PCBs, and dioxins/furans (Table 6-2).

Pentachlorophenol, hexachloroethane, and hexachlorobutadiene were dropped as COCs for the short-tailed shrew because they were not detected in soil or water. Aluminum was dropped based on draft USEPA guidance (USEPA, 2000). Copper and nickel were dropped based on HQs of 1.1 for both these elements, which would likely go below 1.0 if mean body weights and food intake assumptions were used, or if lower bioavailability was assumed. The remaining contaminants were evaluated separately or in groups as COCs.

6.1.6.9 Mink

Eleven of 26 contaminants/contaminant groups were retained as COCs for a final list comprised of: arsenic, chromium, mercury/methylmercury, selenium, vanadium, total PAHs, DDT and metabolites, dieldrin, hexachlorobenzene, total PCBs, and dioxins/furans (Table 6-2).

Pentachlorophenol and hexachloroethane were dropped as COCs for the mink because they were undetected in fish, sediment, and water. Aluminum was dropped based on draft USEPA guidance (USEPA, 2000). Antimony was dropped because of the low overall detection rate in fish (2 of 4 samples in 1992 and 0 of 55 samples in 2000), which drives the mink food-web model. Thallium was dropped as a COC because, although the HQ was 3.1 from 1992 to 1998 and 1.1 in 1999 to 2000, it was not detected in fish in 1992 and was only detected in one of 55 fish analyzed in 2000. The remaining contaminants were evaluated separately or in groups as COCs.

6.1.6.10 River Otter

Nine of 23 contaminants/contaminant groups were retained as COCs for a final list comprised of: arsenic, chromium, mercury/methylmercury, selenium, vanadium, total PAHs, DDT and metabolites, total PCBs, and dioxins/furans (Table 6-2).

Pentachlorophenol and hexachloroethane were dropped as COCs for the river otter because they were undetected in fish, sediment, and water. Aluminum was dropped based on draft USEPA guidance (USEPA, 2000). Antimony was dropped because of the low overall detection rate in fish (2 of 4 samples in 1992 and 0 of 55 samples in 2000), which drives the river otter food-web model. Thallium was dropped as a COC because although the HQ was 2.1 in 1992, thallium was not detected in fish in 2000. Dieldrin was eliminated with a HQ of 1.1, since with alternative assumptions (e.g., mean weight, ingestion rate, bioavailability) the HQ would fall below 1.0. The remaining contaminants were evaluated separately or in groups as COCs.

6.2 Further Characterization of Ecological Effects

Screening-level effect levels were selected and addressed in Chapter 4, Section 4.2. A review of previously identified literature and new literature searches were performed to further characterize selected COCs. The Ovid search engine was used to retrieve abstracts on the toxicity of selected COCs to vertebrate receptors (i.e., fish, amphibians, reptiles, birds, and mammals) and the life-history characteristics of receptors. To assist in the selection of toxicity values (i.e., no observed adverse effect levels [NOAELs] and lowest observed adverse effect levels [LOAELs]) and receptor parameters, abstracts were reviewed and original papers selected from the searches were obtained. The TRVs selected for use in the BERA are discussed in Chapter 9, Section 9.3, and the life history characteristics of receptors are covered in Chapter 8, Section 8.2.

6.3 Contaminant Transport and Fate, Ecosystems Potentially at Risk, and Complete Exposure Pathways

6.3.1 Contaminant Transport and Fate

Contaminant transport and fate are a function of the physical and chemical characteristics of the contaminant, as well as the system through which it may be transported. An important chemical characteristic for contaminants in aquatic systems is solubility in water. The Onondaga Lake COCs include both water-soluble (e.g., manganese, nickel) and relatively insoluble (e.g., PCBs, dioxin/furans) contaminants. Water-soluble contaminants are transported primarily in dissolved form in surface water and tend to remain in solution, potentially exiting the lake at the outlet. Volatilization can also affect the transport and fate of volatile COCs.

The transport and fate of relatively insoluble contaminants parallels that of particles (especially particulate organic carbon, in the case of most organic contaminants). These insoluble contaminants can be carried short distances on particles before settling to the sediment bed. Sediment is continuously deposited in depositional regions of the lake, resulting in profiles of various levels of contamination at different locations. Buried contaminants may be exposed by processes such as bioturbation and scour. Contaminant deposits may also be resuspended and transported by waves and currents to locations within the lake and connected wetlands and outside of the lake, via the lake outlet.

6.3.1.1 Mercury Methylation

One of the key contaminants present in Onondaga Lake is mercury, which is of concern because inorganic and organic forms of mercury can be converted into the highly toxic methylmercury. Parts of the following discussion of methylation and bioaccumulation of mercury were taken from the National Oceanic and Atmospheric Administration's (NOAA's) report on mercury (NOAA,1996).

Mercury Methylation in Sediments

Methylation in aquatic habitats is primarily a biological process. Mono- and dimethylmercury are formed by microorganisms in both sediment and water through the methylation of inorganic mercuric ions (Hg[II]). Dimethylmercury, which is highly volatile, is generally not persistent in aquatic environments. Methylation is influenced by environmental variables that affect both the availability of mercuric ions for methylation and the growth of the methylating microbial populations. Methylation rates are higher under anoxic conditions, in freshwater compared to saltwater, and in low-pH environments. The presence of organic matter can stimulate growth of microbial populations (and reduce oxygen levels), thereby enhancing the formation of methylmercury. Sulfide can bind mercury and limit methylation.

Methylmercury production can vary due to seasonal changes in nutrients, oxygen, temperature, and hydrodynamics. In most studies, methylation increased during the summer months when biological productivity was high, and decreased during the winter months. Measurements of total mercury concentrations in sediment do not provide information on the form of mercury present, methylation potential, or availability to organisms locally and downstream. If environmental conditions are conducive for methylation, methylmercury concentrations may be high, as compared to the supply and distribution of total mercury.

Mercury Methylation in Wetlands

Mercury methylation has been reported to occur in wetlands. As measured by the US Geological Survey (USGS), methylmercury comprises about 1 to 10 percent of total mercury in sediments of aquatic ecosystems (e.g., from streams and/or wetlands sediments in mixed agricultural/forest areas, abandoned mines, urban areas, etc.), in the US (Krabbenhoft et al., 1999). Krabbenhoft et al. (1999) found that methylmercury production was proportional to total mercury concentrations at low sediment concentrations, but at high concentrations (>1 parts per million [ppm]), little additional methylmercury was produced with increasing mercury. Sediments in mining and urban areas were found to have the lowest methylation efficiency.

Gilmour et al. (1998) studied mercury methylation in Florida Everglades wetlands. Methylation rates averaged between about 0.1 and 2 percent. The highest rates were seen in southern wetlands with lower nutrient concentrations, sulfate, and sulfide concentrations, which also had higher total mercury concentrations (up to about 0.4 ppm). The increase in methylmercury was considered to be driven by factors other than total mercury, because methylmercury concentrations increased by a factor of about 25, while total mercury increased only by a factor of 3 to 4.

In sediment samples collected by Honeywell in the West Flume, ditches, and ponded areas/wetlands at the LCP Bridge Street site in 1995 and 1996 (see Appendix G for site summary), methylmercury comprised between 0.003 and 2.2 percent of the total mercury found, with an average of 0.25 percent (Table 6-3). The average total mercury concentration was 32 mg/kg (ppm). The highest proportion of methylmercury was generally seen in samples with lower concentrations of total mercury (e.g., 3 mg/kg or less), confirming Krabbenhoft et al.'s observations (1999).

Onondaga Lake is an eutrophic system with high sulfide concentrations (sulfide inhibits methylmercury production), and is likely to have a wetland mercury methylation rate of 1 percent or less, similar to the eutrophic sites studied in the Florida Everglades. Average mercury concentrations for Wetlands SYW-6 and SYW-12 were 1.3 and 0.7 mg/kg, respectively (Appendix H, Tables H-17 and H-19). If total mercury concentrations are a main driving factor, these Onondaga Lake site wetlands are likely to have mercury methylation rates at the upper end of their expected range.

Based on the literature and LCP Bridge Street site data, a wetland mercury methylation rate of 1 percent is considered to be protective of the Onondaga Lake ecosystem for use in this BERA. No mercury methylation is assumed to occur in the dredge spoils area.

Mercury Methylation in Biota

Mercury is accumulated by fish, invertebrates, mammals, and aquatic plants, and its concentration tends to increase with increasing trophic level. Although inorganic mercury is the dominant form of mercury in the environment and is easily taken up, it is also depurated relatively quickly.

Methylmercury accumulates quickly, depurates very slowly, and, therefore, biomagnifies in higher trophic species. The percentage of methylmercury, as compared to total mercury, also increases with age in both fish and invertebrates. Uptake and depuration rates vary between tissues within an organism. Partitioning of mercury between tissues within aquatic organisms is influenced by the chemical form of mercury and route of exposure (ingestion or via the gills). Due to its preferential uptake, ability to be transferred among tissues, and slow depuration, most of the mercury (ranging between 80 to 99 percent [Huckabee et al., 1979; Chvojka, 1988; Grieb et al., 1990; Southworth et al.,1995]) in fish muscle tissue is methylmercury. NYSDEC Onondaga Lake fish samples from 1992 that were analyzed for both mercury and methylmercury indicated that mercury and methylmercury data are essentially interchangeable; that is, the methylmercury result was generally within 5 percent of the total mercury result. Based on the 1992 results, only mercury was analyzed in the 2000 fish sampling, and all of it was assumed to be methylmercury.

While sediment is usually the primary source of mercury in most aquatic systems, the food web is the main pathway for accumulation. High trophic level species tend to accumulate the highest concentrations of mercury, with the greatest concentrations in fish-eating predators. Methylmercury accumulates in aquatic food chains in which the top-level predators usually contain the highest concentrations. Correlations have been made between sediment and lower trophic species that typically have a high percentage of inorganic mercury, and between mercury concentrations in higher trophic species and their prey items. The best measure of bioavailability of mercury in any system is obtained by analyzing mercury concentrations in the biota at the specific site. Concentrations of methylmercury and other contaminants in fish and upper trophic level organisms can remain high after concentrations have decreased in sediment and water, due to the slow rate of depuration of methylmercury from fish tissues (e.g., Eisler, 1987a; Wiener and Spry, 1996).

6.3.1.2 Organic Compounds

Biodegradation of organic contaminants can be significant for certain contaminants under conditions favoring bacterial activity. However, most organic COCs in Onondaga Lake are relatively recalcitrant, with half-lives extending into years, especially under the anoxic conditions (Howard et al., 1991; Mackay et al., 1992) that are expected in deeper sediment. Contaminant transport and fate of COCs in Onondaga Lake is discussed in greater detail in the Onondaga Lake Remedial Investigation (RI) report (TAMS, 2002b).

6.3.2 Ecosystems Potentially at Risk

Ecosystems potentially at risk include those associated with the surface water, sediments, and bordering wetlands and terrestrial areas of Onondaga Lake. Descriptions of the aquatic environment and terrestrial habitats and the species found in them are provided in Chapter 3, Sections 3.2.4 and 3.2.5. Within these ecosystems, aquatic organisms (e.g., plankton, benthic macroinvertebrates, and fish), semiaquatic organisms (e.g., amphibians, some reptiles, some birds and mammals), terrestrial organisms (e.g., some reptiles, most birds and mammals), and plants are potentially at risk from exposure to COCs in water, sediment, soil, and prey. Animals feeding on prey from the lake can be exposed to elevated concentrations of chemicals due to the bioaccumulation potential of some of the contaminants (e.g., mercury, PCBs) present in the lake.

COCs can impact the lake ecosystem at the organism, population, and community levels. For example, ecological risk to benthic macroinvertebrates and fish can manifest itself as adverse impacts on reproduction and growth of individual organisms, abundance and distribution of populations, or community structure. For wildlife species, risk can manifest itself in diverse ways such as adverse impacts on organism growth, reproduction, behavior, and cellular/organ functions. The effects of some contaminants, particularly those affecting endocrine functions, may not show up until one or two generations after exposure.

6.3.3 Complete Exposure Pathways

Complete exposure pathways via direct contact/ingestion and bioaccumulation exist for organisms associated with surface water, sediment, and soil in and around Onondaga Lake. Direct contact with and ingestion of surface water, sediments, and prey (e.g., zooplankton, benthic invertebrates, eggs, and small fish) can expose aquatic animals, such as benthic macroinvertebrates and fish, to COCs. Exposure to contaminated lake water during sensitive development times of aquatic eggs and embryos can affect the viability of some organisms breeding in the lake. Direct contact with surface water is only discussed qualitatively in this assessment, due to limited exposure data. Reptiles and amphibians are also exposed to COCs via direct contact with and ingestion of surface water, sediments, soils, and prey.

Terrestrial species such as birds and mammals can be exposed to COCs through direct contact with and/or ingestion of surface water, sediments, soil, and prey (aquatic, semiaquatic, and terrestrial organisms). Wetland and terrestrial plants can be exposed to COCs through direct contact with surface water and uptake of contaminants from sediments and soils.

Bioaccumulation at each level of the food web can increase the contaminant exposure concentration to many times the original concentration found in water, sediments, and soil. A complete exposure pathway via bioaccumulation exists for upper trophic level species (e.g., insectivorous, piscivorous, and carnivorous fish, birds, and mammals) for COCs that bioaccumulate, such as methylmercury and PCBs.

6.4 Selection of Assessment Endpoints

USEPA guidance states, "Superfund risk assessment should use site-specific assessment endpoints that address chemical-specific potential adverse effects to local populations and communities of plants and animals" (USEPA, 1999a). Consistent with this guidance, assessment endpoints for this BERA were selected, taking into account their biological significance, their susceptibility to potential contact through indirect or direct exposure to COCs, the availability of pertinent assessment models, and toxicological information in the literature. Risks to individual fish and wildlife receptors are used to assess risks to these populations. The assessment endpoints selected during screening (Chapter 4, Section 4.1.3.1) were retained for the BERA, as follows:

- Sustainability (i.e., survival, growth, and reproduction) of an aquatic macrophyte community that can serve as a shelter and food source for local invertebrates, fish, and wildlife.

- Sustainability (i.e., survival, growth, and reproduction) of a phytoplankton community that can serve as a food source for local invertebrates, fish, and wildlife.

- Sustainability (i.e., survival, growth, and reproduction) of a zooplankton community that can serve as a food source for local invertebrates, fish, and wildlife.

- Sustainability (i.e., survival, growth, and reproduction) of a terrestrial plant community that can serve as a shelter and food source for local invertebrates and wildlife.

- Sustainability (i.e., survival, growth, and reproduction) of a benthic invertebrate community that can serve as a food source for local fish and wildlife.

- Sustainability (i.e., survival, growth, and reproduction) of local fish populations.

- Sustainability (i.e., survival, growth, and reproduction) of local amphibian and reptile populations.

- Sustainability (i.e., survival, growth, and reproduction) of local insectivorous bird populations.

- Sustainability (i.e., survival, growth, and reproduction) of local benthivorous waterfowl populations.

- Sustainability (i.e., survival, growth, and reproduction) of local piscivorous bird populations.

- Sustainability (i.e., survival, growth, and reproduction) of local carnivorous bird populations.

- Sustainability (i.e., survival, growth, and reproduction) of local insectivorous mammal populations.

- Sustainability (i.e., survival, growth, and reproduction) of local piscivorous mammal populations.

6.5 Selection of Measurement Endpoints and Associated Risk Questions

Measurement endpoints provide the actual values used to evaluate attainment of each assessment endpoint. For the Onondaga Lake BERA, the measurement endpoints (in relation to their respective assessment endpoints) are phrased as in relation to respective risk questions, as follows:

Assessment Endpoint: Sustainability (i.e., survival, growth, and reproduction) of an aquatic macrophyte community that can serve as a shelter and food source for local invertebrates, fish, and wildlife.

Does the macrophyte community structure reflect the influence of COCs/SOCs?

Measurement Endpoint 1: Field observations of the abundance, distribution, and species composition of local macrophyte communities in relation to COCs/SOCs in water and sediments and habitat characteristics.

Do the contaminants/stressors present in Onondaga Lake sediment affect macrophyte growth and survival?

Measurement Endpoint 2: Greenhouse studies of macrophyte growth and survival on field-collected sediments and macrophyte transplant studies in Onondaga Lake.

Do measured concentrations of contaminants and stressors in surface water exceed standards, criteria, and guidance for the protection of aquatic organisms?

Measurement Endpoint 3: Measured average and 95 percent UCL concentrations of COCs/SOCs in water compared to state and federal water quality values and qualitative evaluation of narrative standards.

Assessment Endpoint: Sustainability (i.e., survival, growth, and reproduction) of a phytoplankton community that can serve as a food source for local invertebrates, fish, and wildlife.

Does the phytoplankton community structure reflect the influence of COCs/SOCs?

Measurement Endpoint 1: Field observations of the abundance and species composition of local phytoplankton communities in relation to COCs/SOCs in water and sediments and habitat characteristics.

Do measured concentrations of contaminants and stressors in surface water exceed standards, criteria, and guidance for the protection of aquatic organisms?

Measurement Endpoint 2: Measured average and 95 percent UCL concentrations of COCs/SOCs in water compared with state and federal water quality values and qualitative evaluation of narrative standards.

Assessment Endpoint: Sustainability (i.e., survival, growth, and reproduction) of a zooplankton community that can serve as a food source for local invertebrates, fish, and wildlife.

Does the zooplankton community structure reflect the influence of COCs/SOCs?

Measurement Endpoint 1: Field observations of the historical abundance and species composition of local zooplankton communities in relation to COCs/SOCs in water and sediments and habitat characteristics and studies of zooplankton hatching success.

Do measured concentrations of contaminants and stressors in surface water exceed standards, criteria, and guidance for the protection of aquatic organisms?

Measurement Endpoint 2: Measured average and 95 percent UCL concentrations of COCs/SOCs in water compared with state and federal water quality values and qualitative evaluation of narrative standards.

Do measured concentrations of contaminants and stressors in sediments exceed criteria and/or guidelines for the protection of aquatic organisms?

Measurement Endpoint 3: Measured average and 95 percent UCL concentrations of COCs/SOCs in sediments compared to state and federal sediment quality values.

Assessment Endpoint: Sustainability (i.e., survival, growth, and reproduction) of a terrestrial plant community that can serve as a shelter and food source for local invertebrates and wildlife.

Does the terrestrial plant community structure reflect the influence of COCs/SOCs?

Measurement Endpoint 1: Field observations of the abundance and species composition of local plant communities in relation to COCs/SOCs in soils and habitat characteristics.

Do measured concentrations of contaminants and stressors in soil exceed toxicity values for terrestrial plants?

Measurement Endpoint 2: Measured average and 95 percent UCL concentrations of COCs/SOCs in soil compared with literature plant toxicity values.

Assessment Endpoint: Sustainability (i.e., survival, growth, and reproduction) of a benthic invertebrate community that can serve as a food source for local fish and wildlife.

Does the benthic community structure reflect the influence of COCs/SOCs?

Measurement Endpoint 1: Field observations of the abundance and species composition of local benthic macroinvertebrate communities in relation to COCs/SOCs in water and sediments and habitat characteristics using benthic metrics.

Do concentrations of contaminants and stressors in sediment influence mortality, growth, or fecundity of invertebrates living in or on lake sediments?

Measurement Endpoint 2: Sediment toxicity based on laboratory tests of field-collected sediments using sensitive and representative benthic macroinvertebrate species and a variety of test endpoints.

Do measured concentrations of contaminants and stressors in surface water exceed standards, criteria, and guidance for the protection of aquatic organisms?

Measurement Endpoint 3: Measured average and 95 percent UCL concentrations of COCs/SOCs in water compared to state and federal water quality values and qualitative evaluation of narrative standards.

Do measured concentrations of contaminants and stressors in sediment exceed levels that may adversely affect benthic invertebrates and/or criteria and/or guidelines for the protection of aquatic organisms?

Measurement Endpoint 4: Measured concentrations of COCs in sediment compared to site-specific sediment effects concentrations (SECs) and consensus probable effect concentrations (PECs) and measured average and 95 percent UCL concentrations of COCs/SOCs in sediments compared to state and federal sediment quality values.

Assessment Endpoint: Sustainability (i.e., survival, growth, and reproduction) of local fish populations.

What does the fish community structure suggest about the health of local fish populations?

Measurement Endpoint 1: Field observations of the abundance, distribution, and species composition of local fish communities in relation to COCs/SOCs in water and sediments and habitat characteristics as compared to those in similar lakes in New York State.

Has the presence of contaminants and/or stressors influenced fish foraging or nesting activities?

Measurement Endpoint 2: Field observations of suitable nesting habitat and populations of juveniles in relation to COCs/SOCs and habitat characteristics.

Do fish found in Onondaga Lake show reduced growth or increased incidence of disease (e.g., tumors) as compared to fish from other lakes?

Measurement Endpoint 3: Observations of disease as compared to those in New York reference lakes.

Do measured concentrations of contaminants and stressors in surface water exceed standards, criteria, and guidance for the protection of aquatic organisms?

Measurement Endpoint 4: Measured average and 95 percent UCL concentrations of COCs/SOCs in water compared to state and federal water quality values and qualitative evaluation of narrative standards.

Do measured concentrations of contaminants and stressors in sediments exceed criteria and/or guidelines for the protection of aquatic organisms (applicable to benthic-dwelling fish)?

Measurement Endpoint 5: Measured average and 95 percent UCL concentrations of COCs/SOCs in sediments compared to state and federal sediment quality values.

Do measured concentrations of contaminants in fish exceed TRVs for adverse effects on fish mortality or reproduction?

Measurement Endpoint 6: Measured average and 95 percent UCL COC concentrations in fish compared to TRVs.

Assessment Endpoint: Sustainability (i.e., survival, growth, and reproduction) of local amphibian and reptile populations.

What do the available field-based observations suggest about the health of local amphibian and reptile communities?

Measurement Endpoint 1: Field observations of the abundance and species composition of local communities of amphibians and reptiles in relation to COCs/SOCs in water, sediments, and soils and habitat characteristics.

Do measured concentrations of contaminants and stressors in surface water exceed standards, criteria, and guidance for the protection of aquatic organisms?

Measurement Endpoint 2: Measured average and 95 percent UCL concentrations of COCs/SOCs in water compared to state and federal water quality values and qualitative evaluation of narrative standards.

Have laboratory studies indicated the potential for adverse effects to amphibian embryos from exposure to Onondaga Lake water?

Measurement Endpoint 3: Results of amphibian embryos exposed to unfiltered lake water as compared to filtered water or controls.

Assessment Endpoint: Sustainability (i.e., survival, growth, and reproduction) of local insectivorous bird populations.

Do modeled dietary doses to insectivorous birds exceed TRVs for adverse effects on reproduction?

Measurement Endpoint 1: Modeled average and 95 percent UCL COC concentration dietary doses based on measured and modeled concentrations of COCs in lake media (i.e., surface water and invertebrates), compared with TRVs.

Do measured concentrations of contaminants and stressors in surface water exceed standards, criteria, and guidance for the protection of wildlife?

Measurement Endpoint 2: Measured average and 95 percent UCL concentrations of COCs in surface water compared to state and federal water quality criteria for protection of wildlife.

What do the available field-based observations suggest about the health of local insectivorous bird populations?

Measurement Endpoint 3: Field observations of insectivorous birds around Onondaga Lake.

Assessment Endpoint: Sustainability (i.e., survival, growth, and reproduction) of local benthivorous waterfowl populations.

Do modeled dietary doses to benthivorous waterfowl exceed TRVs for adverse effects on reproduction?

Measurement Endpoint 1: Modeled average and 95 percent UCL COC concentrations based on measured and modeled concentrations of COCs (i.e., surface water, sediment, and invertebrates) in lake media compared with TRVs.

Do measured concentrations of contaminants and stressors in surface water exceed standards, criteria, and guidance for the protection of wildlife?

Measurement Endpoint 2: Measured average and 95 percent UCL concentrations of COCs in surface water compared to state and federal water quality criteria for protection of wildlife.

What do the available field-based observations suggest about the health of local waterfowl populations?

Measurement Endpoint 3: Field observations of waterfowl around Onondaga Lake.

Assessment Endpoint: Sustainability (i.e., survival, growth, and reproduction) of local piscivorous bird populations.

Do modeled dietary doses to piscivorous birds exceed TRVs for adverse effects on reproduction?

Measurement Endpoint 1: Modeled average and 95 percent UCL COC dietary doses based on measured concentrations of COCs in lake media (i.e., surface water, sediment, and fish), compared with TRVs.

Do measured concentrations of contaminants and stressors in surface water exceed standards, criteria, and guidance for the protection of wildlife?

Measurement Endpoint 2: Measured average and 95 percent UCL concentrations of COCs in surface water compared to state and federal water quality criteria for protection of wildlife.

What do the available field-based observations suggest about the health of local piscivorous bird populations?

Measurement Endpoint 3: Field observations of piscivorous birds around Onondaga Lake.

Assessment Endpoint: Sustainability (i.e., survival, growth, and reproduction) of local carnivorous bird populations.

Do modeled dietary doses to carnivorous birds exceed TRVs for adverse effects on reproduction?

Measurement Endpoint 1: Modeled average and 95 percent UCL COC dietary doses based on measured concentrations of COCs in media (i.e., surface water, soil, and small mammals), compared with TRVs.

What do the available field-based observations suggest about the health of local carnivorous bird populations?

Measurement Endpoint 2: Field observations of carnivorous birds around Onondaga Lake.

Assessment Endpoint: Sustainability (i.e., survival, growth, and reproduction) of local insectivorous mammal populations.

Do modeled dietary doses to insectivorous mammals exceed TRVs for adverse effects on reproduction?

Measurement Endpoint 1: Modeled average and 95 percent UCL COC dietary doses based on measured and modeled concentrations of COCs in lake media (i.e., surface water, soil, and invertebrates), compared with TRVs.

Do measured concentrations of contaminants and stressors in surface water exceed standards, criteria, and guidance for the protection of wildlife?

Measurement Endpoint 2: Measured average and 95 percent UCL concentrations of COCs in surface water compared to state and federal water quality criteria for protection of wildlife.

What do the available field-based observations suggest about the health of local insectivorous mammal populations?

Measurement Endpoint 3: Field observations of insectivorous mammals around Onondaga Lake.

Assessment Endpoint: Sustainability (i.e., survival, growth, and reproduction) of local piscivorous mammal populations.

Do modeled dietary doses to piscivorous mammals exceed TRVs for adverse effects on reproduction?

Measurement Endpoint 1: Modeled average and 95 percent UCL COC dietary doses based on measured concentrations of COCs in lake media (i.e., surface water, sediment, soil, and fish), compared with TRVs.

Do measured concentrations of contaminants and stressors in surface water exceed standards, criteria, and guidance for the protection of wildlife?

Measurement Endpoint 2: Measured average and 95 percent UCL concentrations of COCs in surface water compared to state and federal water quality criteria for protection of wildlife.

What do the available field-based observations suggest about the health of local piscivorous mammal populations?

Measurement Endpoint 3: Field observations of piscivorous mammals around Onondaga Lake.

Given the limitations of the available data, some of the selected measurement endpoints do not provide direct measures of the assessment endpoints. In such cases, every effort has been made to evaluate the implications of the measurement endpoint results for the assessment endpoints, and the resulting uncertainties are acknowledged and discussed further in Chapter 11, Uncertainty Analysis.

6.6 Conceptual Model

The preliminary conceptual model for Onondaga Lake was presented in Chapter 4, Section 4.1 (Figure 4-1) and remains unchanged for this ERAGS step. The major potential sources of contaminants to the lake are point-source discharges, tributaries, and groundwater. From these potential sources, contaminants can enter lake water through inflow, can enter sediments through precipitation and deposition, and can enter biota through direct contact, respiration, and ingestion. Contaminants can also enter lake water from resuspension of the in-lake waste deposit and contaminated sediments. Therefore, potential secondary sources are the water, sediments, and biota of the lake. Potentially toxic chemicals in secondary sources can result in exposure to aquatic and semiaquatic ecological receptors through direct contact, respiration, and ingestion. These chemicals can also reach terrestrial receptors through direct contact and ingestion. Additional potential stressors include ionic waste (calcium, chloride, and sodium), nutrients (i.e., nitrite, phosphorus, sulfide), calcite deposits (including oncolites), salinity, ammonia, depleted DO, and reduced water transparency.