Appendix C
Cayuga Lake Preliminary Watershed Characterization

Findings of the Cayuga Lake Preliminary Watershed Characterization

Cayuga Lake has a rich history of research activities. Physical, chemical, and biological conditions of the lake and its tributary streams have been investigated for decades. The lake and its watershed remain the focus of several long-term monitoring initiatives. However, several important data gaps remain.

Cayuga Lake's water quality is generally very good. The lake is a valued and visible resource, serving as a public water supply and focal point for recreation. The fish community is diverse and productive. Overall, the tributary streams exhibit moderate to high water quality and habitat conditions that support a balanced biological community.

Despite the general conclusion that water quality of the lake and its tributary streams is high, a number of specific areas of concern are evident. These are summarized below, along with a discussion of additional data needed to identify specific priority areas and define effective remedial strategies.

Fertilizers and pesticides have been detected in both tributary streams and the lake. Recent data provide direct evidence of chemical loss from the landscape and transport to the lake. Almost half of the land in the watershed is in active agriculture, and this land use contributes nitrate-nitrogen and pesticides (most notably, herbicides used in corn cultivation) to the lake. Using analytical methods with low detection limits, scientists from USGS and NYSDEC have documented trace concentrations of pesticides in the streams and lake. The chemicals are present at levels far below ambient water quality standards or guidelines based on toxicology and risk assessment. No exceedances of standards or guidelines developed to protect human health and the environment have been detected.

- ***Data Needs: Pesticides and Nitrates***
  Long-term effects of exposure to trace concentrations of many of these chemicals are unknown. It is important to continue to track these chemicals in all components of the ecosystem: water column, sediments, and throughout the food web.

  Additional monitoring of pesticides in streams draining mixed land uses (agricultural and residential) is needed to further our understanding of the sources, fate, and significance of these chemicals. Stream monitoring must be designed to reflect the hydrologic cycle, the agricultural cycle, and the mix of land use and geology in the subwatersheds.

  The potential for agricultural chemicals to be adsorbed to sediment particles and transported to the lake has not been fully assessed. Limited testing of lake sediments has not detected agricultural residues. However, testing has not been conducted in depositional areas of streams draining agricultural watersheds, nor in the lake at the mouths of tributaries.

  Groundwater concentrations of pesticides and nitrates are not well documented. Since much of the watershed relies on groundwater, this data gap is significant.

Sediment is a significant water quality, habitat, and use impairment issue, particularly in the southern tributaries and southern Cayuga Lake. Destruction and fill of the extensive wetland areas in southern Cayuga Lake in the early 1900s has exacerbated this problem by removing a natural filtration process that captured sediment before it flowed into the lake. In the southern tributaries, the primary source of sediment appears to be streambank erosion, not runoff from construction sites or cultivated fields. The primary sources of sediment in other tributaries are not known and may differ based on land use and geology.

- ***Data Needs: Sediment***
  Before and after monitoring is lacking on tributaries where remedial measures such as streambank stabilization or stormwater controls has been implemented. Monitoring should occur over a range of hydrologic conditions, particularly high flow events.

Heavy metals are present in at elevated concentrations in sediments of Fall Creek and nearshore areas of southern Cayuga Lake. Heavy metals may enter the aquatic system from industrial discharges, stormwater runoff, or atmospheric deposition.

- ***Data Needs: Heavy Metals and Stormwater Quality***
  The quality of urban stormwater has not been assessed in the Cayuga Lake watershed. The concentration of heavy metals, phosphorus, sediment, petroleum compounds, and pathogens in stormwater is not characterized; moreover, the significance of this source in relation to other sources is not known.

  There are no recent data characterizing chemical quality of precipitation (wetfall and dry fall) in the basin. This is important for load calculations as well as for general surveillance of acid precipitation.

  Additional sampling of tributary sediment in subwatersheds and stream reaches with different mixes of land use might help identify factors contributing to the presence and concentration of heavy metals.

Phosphorus is the limiting nutrient for algal growth in Cayuga Lake as it is for most inland lakes in the Northeast. Recent monitoring data confirm that Cayuga Lake is mesotrophic, with moderate levels of primary productivity. However, the shallow areas at the northern and southern ends of the lake exhibit higher levels of phosphorus and productivity. Both of these segments are listed by New York State as priority areas, indicating water quality concerns. Phosphorus sources include the two wastewater treatment plants discharging to the southern lake basin and runoff from residential and agricultural areas. Septic systems are considered by NYSDEC to be significant sources of phosphorus to the northern segment.

- ***Data Needs: Phosphorus***
  Annual monitoring of a limited suite of limnological parameters will provide a basis for long-term trend analysis. These parameters include total phosphorus, soluble

reactive phosphorus, total soluble phosphorus, dissolved oxygen profiles, chlorophyll a, Secchi disk transparency, and turbidity.

Biological parameters can provide information regarding trends as well. Species composition and abundance of the macroinvertebrate community (aquatic insects and worms found in the stream bed) of the tributary streams can be used to indicate water quality conditions and assess site-specific impacts of point and nonpoint discharges. Sampling tributaries in various geologic and land use settings can identify areas where the biological community is stressed.

A mathematical model would provide a tool for linking the inputs from the tributaries to the lake's water quality response.

Exotic species. Because of its connections to the Great Lakes through the Seneca River, Cayuga Lake is vulnerable to invasion by nonindigenous species of plants and animals. There have been a number of exotic species invading Cayuga Lake over the years. Three recent invaders are a focus of special concern due to their potential to alter the food web. These organisms are the zebra and quagga mussel (Dreissena polymorpha and Dreissena bugensis) and a predatory cladoceran zooplankton (Cercopagis pengoi). The macrophyte Eurasian water milfoil (Myriophyllum spicatum) is another introduced species that has, until recently, been a nuisance in Cayuga Lake.

- ***Data Needs: Exotic Organisms***
  The impacts of exotic organisms on the food web and ecology of Cayuga Lake will be an important area of research. The macrophyte data illustrate the need for long-term monitoring to differentiate trends from year-to-year variability.

Pathogens and indicators. The presence of pathogenic microorganisms in the lake and its tributary streams is a potential area of concern. Pathogens originate from untreated or inadequately treated human sewage and wild and domestic animal waste. Human exposure to pathogens can occur from direct contact with or ingestion of contaminated waters. The potential presence and abundance of pathogenic microorganisms is assayed using indicator organisms such as coliform bacteria.

- ***Data Needs: Pathogens and Indicators***
  Measurements of pathogens and indicator organisms in Cayuga Lake are very limited. Storm event monitoring in the lake and streams could help define the importance of urban runoff as a source of pathogens. The importance of waterfowl as a source of microorganisms is not known.

  Based on generalized geology and soils maps, there are large areas of the watershed with severe constraints to on-site wastewater disposal systems (septic systems). There has been no watershed-wide effort to characterize the performance of these individual systems and how leachate from septic systems contributes to nitrate, phosphorus, and pathogen levels. The experience of Cayuga County, which has a comprehensive inspection program, could serve as a guide.

Impacts of non-permitted, pre-permitted or unenforced uses

- ***Data Needs: Sources***
  Additional field work could provide useful information on pre-permit and unpermitted underground storage tank sites, waste sites, junk yards and dumps, mines and wells. There is a need for better and more accurate recreational data including the impact of boating and fishing on water quality.

Floodplain delineation, management and mitigation. Water level management and flooding are important issues. The loss of wetlands and increase in impervious areas have altered the natural hydrology.

Impacts of Cornell Lake Source Cooling. The return of noncontact cooling water to southern Cayuga Lake by Cornell University's Lake Source Cooling (LSC) facility has been an issue of concern to the community. The LSC system will not add chemicals to Cayuga Lake. However, during the period of thermal stratification, the transfer of slightly warmed water from deep in the lake to the shallow southern basin will also transfer dissolved and suspended substances. The potential ecological significance of this load depends on concentration gradients between the upper and lower waters; the mass of material transferred, and impacts of these substances on lake ecology and suitability for human use. The most significant potential environmental impact of LSC on the Cayuga Lake ecosystem hinges on the amounts and chemical forms of phosphorus transferred to the upper waters.

The environmental impact assessment and permitting of the LSC project included an extensive program of monitoring and analysis of the magnitude and implications of the phosphorus transfer. Data collected since the project came on line in July 2000 support the finding of no significant impact. Monitoring will continue. Because of the uncertainties associated with this innovative project and the current water quality conditions of southern Cayuga Lake, the LSC permit has detailed requirements for monitoring and assessment. There are "reopener" clauses in the 5-year permit requiring Cornell to take action if the LSC return flow causes water quality degradation.