4. SUBWATERSHED PRIORITIZATION

Much of the information presented in this section is taken from the *Honeoye Lake Nutrient and Hydrologic Budget* prepared by Princeton Hydro, LLC for the Honeoye Lake Watershed Task Force.

4.1 Introduction

To better understand and prioritize management efforts of the Honeoye Lake Watershed, each of the subwatershed areas are described and evaluated. A subwatershed analysis helps identify specific areas of concern and potential opportunities for significant pollution reduction. The data presented in this section can be used to investigate the factors affecting water inflow, pollutant loading, the sources of nutrient loading, and the combined effects of both the hydrologic and nutrients budgets on the overall water quality of Honeoye Lake

Although there are numerous inflows to the lake, as illustrated in Figure 4-1, the majority are small, intermittent or ephemeral. In total there are ten (10) subwatersheds, but only four (4) major tributaries draining to the lake: Honeoye Inlet, Briggs Gully, Bray Gully, and Affolter Creek (Table 4-1). The various drainage areas in the Honeoye Lake Watershed can be viewed in greater detail on Map R-C: Honeoye Lake Subwatersheds in the References section of this report.

The largest contributing watershed is associated with the drainage entering the lake via the Honeoye Inlet—the mouth of which is located at the far southern end of the lake. The much smaller ditches, swales, and unnamed sloughs that convey runoff and flow into Honeoye Lake tend to be important only during the spring or immediately following periods of intense or prolonged rainfall.

The tributaries and waterways that flow into Honeoye Lake are classified by the NYSDEC as category "C" waters of the state. As per 6 NYCRR Part 701:

"Class C waters shall be suitable for fish propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes."

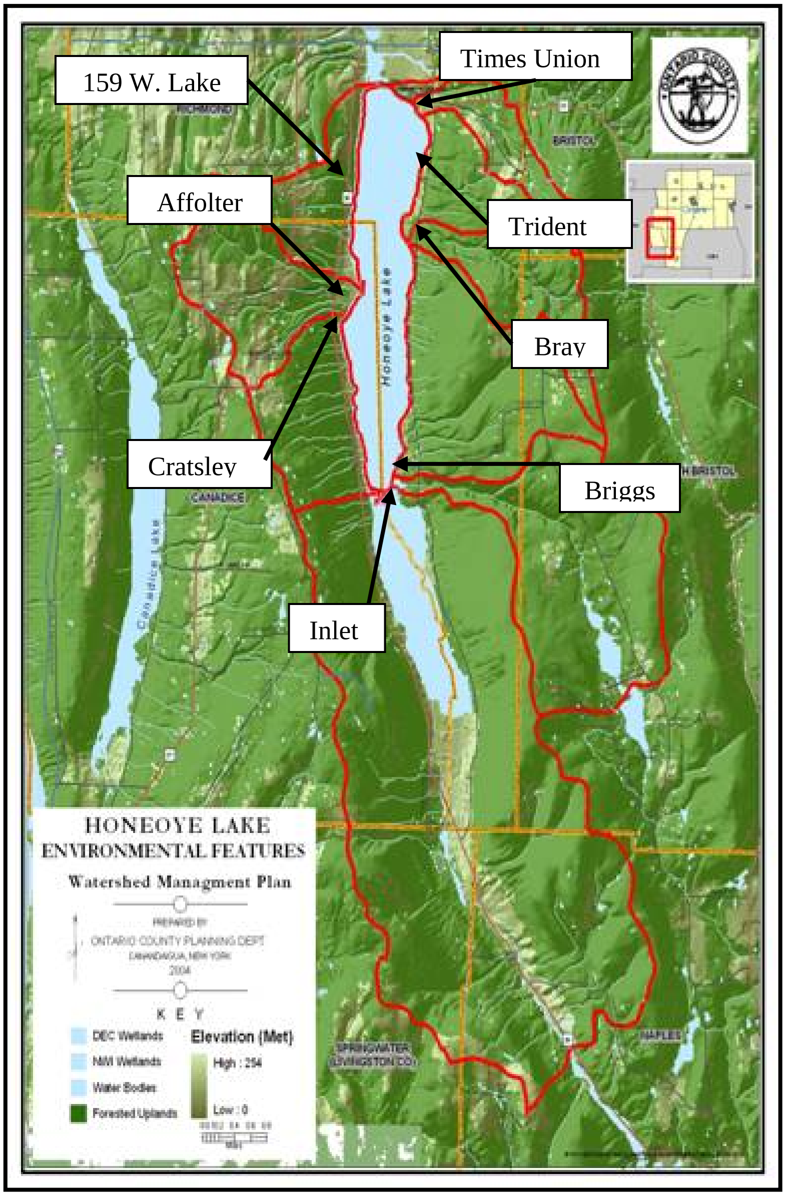

Figure 4-1: Inflows to Honeoye Lake

Drainage Area Name	**Size of Contributing**
North Shore DD*	64
Times Union Creek	651
Pinewood Hill DD	832
East Shore DD	2,387
Briggs Gully	3,140
Honeoye Inlet	676
Canadice Corners DD	1,273
Affolter Gully	1,585
West Shore DD	919
Lake Area	1,805
Total	**24,497**

Table 4-1: Honeoye Lake Subwatershed Areas

4.2 Hydrology Methodology

The hydrologic budget of Honeoye Lake is essentially its water balance. In effect, it is the cumulative volume of all water inflow to the lake (sources) and all water outflows from the lake (losses). The primary factors affecting the hydrology of Honeoye Lake are:

- Climate (precipitation, temperatures, evaporative losses);
- Watershed area;
- Watershed area land use and land cover; and,
- Lake volume.

The methodology employed makes use of empirical data in conjunction with runoff coefficients selected to best represent land use and land cover attributes broken down by sub-watersheds. Geographic Information System (GIS) software was used to delineate the watershed, further divide it into the sub-watersheds, and then label and quantify the land use and land cover (LU/LC) attributes of each polygon. A key component of modeling the lake's hydrology was to accurately map land use / land cover (LU/LC) and use that data together with GIS data layers on geology, soils, and slope. This was done both cumulatively and individually for each of Honeoye Lake's sub-watersheds. Hydrologic datasets were also valuable in developing the nutrient model.

Four sources for the lake's hydrologic budget were investigated and quantified:

1. Direct precipitation;
2. Tributary inflow;
3. Overland runoff; and,
4. Groundwater seepage.

Long-term precipitation data were obtained from the National Oceanic and Atmospheric Agency's (NOAA) 30-year historical rainfall records. An adjustment to account for the evaporative loss of water from the surface of the lake and similar adjustments were made to the precipitation falling within the watershed to account for photosynthetic related evapotranspiration.

Groundwater related interflow to the lake and its tributaries were estimated using a modification of the United States Geologic Service GSR 32 methodology. This component represents the precipitation that passes through the upper soil horizon and root zone, but then flows laterally into the lake's streams and then into the lake's littoral zone. This component of groundwater flow is what is responsible for a large percentage of each stream's "base flow."

The storm related runoff entering the lake via tributaries or as direct discharge was quantified using a modification of the USDA's Rational Method (USEPA, 1990; Maidment, 1993). This semi-deterministic model is widely used to compute the monthly or annual amounts of inflow directly resulting from rainfall and the associated stormwater runoff. The computations involved the application of runoff coefficients for each LU/LC occurring within each sub-watershed. The coefficients were selected from a standardized array developed by the USDA, then modified accordingly to more appropriately match the LU/LC, slope and soil types unique to the Honeoye Lake Watershed.

4.3 Hydrology Results

Although the summer (June-August) months are among the wettest in terms of rainfall, they actually generate the least amount of runoff and inflow due to soil infiltration and plant cover conditions and seasonal evapotranspiration rates

The total yearly inflow by subwatershed is shown in Table 4-2:

Sub-Watershed Name	Sub-Watershed Area (Acres)	Annual Runoff Volume (m^3 x 10^6) (%)
North Shore DD*	64	0.12 (0.2)
Times Union Creek	651	1.24 (2.7)
Pinewood Hill DD	832	1.58 (3.4)
Bray Gully	1,165	2.21 (4.7)
East Shore DD	2,387	4.53 (9.7)
Briggs Gully	3,140	5.96 (12.8)
Honeoye Inlet	10,676	20.30 (43.6)
Canadice Corners DD	1,273	2.42 (5.2)
Affolter Gully	1,585	3.01 (6.5)
West Shore DD	919	1.74 (3.7)
Precipitation on Lake	1,805	3.43 (7.4)
Grand Total	**24,497**	**46.54 (100.0)**

Table 4-2: Total Yearly Inflow by Subwatershed

The breakdown of the monthly inflow is shown in Table SUP-9: Estimate of Inflow Displayed by Subwatershed Monthly Inflow 10^6 m3. The fall, winter, and early spring are the periods of the year when the greatest amount of runoff is generated. Low runoff typifies the summer season.

4.4 Nutrient Loading Methodology

The methodology employed in preparing the lake's nutrient budget was a mass-balance approach similar to the hydrology analyses. Essentially an effort was made to account for all major nutrient sources, apply factors for conditions unique to Honeoye Lake, and consider factors that could limit the assimilation of available nutrients. This was achieved for Honeoye Lake by using a variety of mathematical models to analyze specific components of the lake's loads. The results of each model yielded a cumulative load. The models used in this project are based on empirical data collection, that is, they are based on actual field studies. Although the loading coefficients specific to each model can be considered generalized, they were rectified to the fullest extent possible to account for conditions specific for Honeoye Lake and its watershed.

Both the external (watershed generated) and internal (biota and sediment recycled) components of the nutrient budget were investigated and quantified, and include the following:

1. External Watershed Based Loading;
2. External Loading from On-site Wastewater Systems (Septic Systems);
3. External Loading due to Precipitation Falling Directly on the Lake's Surface;
4. Internal Loading from Anoxic Sediments;
5. Internal Loading from Oxic Sediments;
6. Internal Loading Due to the Decomposition of Aquatic Plants; and,
7. Internal Loading Due to the Decomposition of Zebra Mussels.

All of the above nutrient sources were quantified using loading coefficients derived from the scientific literature, but applied to, or used in concert with information and data derived specifically through the study of Honeoye Lake and its watershed.

The ArcView Globalized Watershed Loading Functions (AVGWLF) Model was used to quantify the nutrient and sediment sources entering Honeoye Lake from each of the lake's main sub-watersheds and tributaries. The AVGWLF nutrient and sediment loading modeling approach is based on the premise that different land uses and land covers contribute different quantities of nutrients and sediment largely through stormwater runoff. A number of land use and land cover data sources were used in this project: mapped delineations of the watershed completed by FLCC, United States Geological Survey (USGS) digital elevation model (DEM) data, and the National Land Cover Dataset (NCLD 1992) published by the Multi-Resolution Land Characteristics Consortium (MRLCC). With the land use and land cover data digitized, it was then possible to assign the appropriate loading coefficients and compute the watershed derived nutrient and sediment loads.

4.5 Nutrient and Sediment Loading Results

Using the methodology described above the external nutrient and sediment loading of total phosphorus (TP), total nitrogen (TN), and total suspended solids (TSS) were calculated for each subwatershed and are summarized in Table 4-3.

As would be expected, the larger sub-watersheds generate the bulk of the lake's nutrient and sediment load. However, this does not mean that these subwatersheds (e.g. Honeoye Inlet) should be prioritized for nutrient and sediment load reduction management. A more meaningful assessment of the data is to examine the loading per unit area for each sub-watershed (Table 4-4). Data shows the highest areal nutrient loading is within the North Shore Subwatershed, which is the smallest subwatershed comprising only 0.3% of the entire watershed, and is composed of high density residential. In spite of North Shore having the highest loading on a areal basis, it should not be considered a priority watershed since it contributes only 0.4% of the total watershed phosphorus loading, Since nutrient loading across all of the other subwatersheds is fairly uniform, there is no evidence to suggest any priority watershed based on nutrient loading.

Subwatershed	Area (Ac)	TP	TN	TSS
North Shore DD[1]	64	11.88	160.76	21,825.13
Times Union Creek	651	73.44	960.42	163,853.71
Pinewood Hill DD	832	96.17	1,207.94	197,623.66
Bray Gully	1,165	112.35	1,362.78	249,648.41
East Shore DD	2,387	242.81	2,926.16	520,369.44
Briggs Gully	3,140	352.56	3,784.55	759,974.66
Honeoye Inlet	10,676	1,177.61	15,279.27	2,581,387.68
Canadice Corners DD	1,273	132.26	1,639.05	288,821.93
Affolter Gully	1,585	219.07	3,334.86	537,509.41
West Shore DD	919	128.56	1,794.68	285,492.88
Atmospheric over watershed	24,497	182.6	7,304.8	298,848.47
Atmospheric on lake surface	1,805	19.97	177.57	22,091.90
Total		**2,749.28**	**39,932.84**	**5,927,447.28**
DD = Direct Drainage				

Table 4-3: Summary of Subwatershed Loading Kg/yr

The breakdown of monthly nutrient loading is shown in Table SUP-10: Total Annual Phosphorus Loading to Honeoye Lake by Contributing Subwatershed, Table SUP-11: Total Annual Nitrogen Loading to Honeoye Lake by Contributing Subwatershed, and Table SUP-12: Total Annual Suspended Solids Loading to Honeoye Lake by Contributing Subwatershed.

Watershed	Area (Ac)	TP	TN	TSS
North Shore DD	64	0.19	2.51	341.02
Times Union Creek	651	0.11	1.48	251.70
Pinewood Hill DD	832	0.12	1.45	237.53
Bray Gully	1,165	0.10	1.17	214.29
East Shore DD	2,387	0.10	1.23	218.00
Briggs Gully	3,140	0.11	1.21	242.03
Honeoye Inlet	10,676	0.11	1.43	241.79
Canadice Corners DD	1,273	0.10	1.29	226.88
Affolter Gully	1,585	0.14	2.10	339.12
West Shore Direct DD	919	0.14	1.95	310.66
Bold- Largest Areal Contributors				

Table 4-4: Summary Areal Subwatershed Loading Kg/ac/yr

In contrast to external loads, internal loading in waterbodies results mostly from the regeneration or liberation of nutrients bound in the sediment. One of the largest drivers of internal nutrient loading in lake systems results from the dynamic relationship between dissolved oxygen depletion (anoxia) and the liberation of phosphorus from lake sediments. Loading coefficients were selected for both oxic and anoxic conditions: the phosphorus loading rate from oxic sediments (sediments overlaid by waters having a DO concentration of > 1 mg/L) is 0.6 mg TP/m^2/d, while loading rates from anoxic sediments is 6.0 mg anoxic TP/m^2/d. These coefficients were selected for regional fitness and are considered representative for lakes located in the Mid-Atlantic and Great Lake regions.

Table 4-5 summarizes both the internal and external nutrient loading estimates for total phosphorus (TP), total nitrogen (TN) and total suspended solids (TSS) for the lake. This data was also generated on a monthly basis which shows that although the internally generated phosphorus from the anoxic sediment accounts for about 30% on an annual basis it can account for approximately 90% of the lake's late summer TP load. This is because most of the lakes internal load comes from anoxic sediments that occur in the summer. This is due to a significant portion of the lake bottom becoming stratified and dissolved oxygen is depleted in the deeper reaches of the water column. At this same time of year stream flows and associated external phosphorus loadings are minimal. As a result, during the late summer the combination of minimal inflow, low hydraulic flushing, a large influx of internally regenerated phosphorus, warm water temperatures and intensified sunlight, causes the lake's productivity to peak. These conditions consistently foster late summer algae blooms that vary in their intensity from year to year.

External Loading Sources	kg TP / year	kg TN / year	kg TSS / year
Watershed Loading	2,546.7	32,450.5	5,606,506.9
Septic Loading	168.2	6,287.9	0.0
Atmospheric Over Watershed	182.6	7,304.8	298,848.4
Atmospheric On Lake Surface	20.0	177.8	22,091.9
Canada geese	324.0	5,640.0	0.0
Total External Load	**3,241.5**	**51,861.0**	**5,927,447.2**
Internal Loading Sources	**kg TP / year**	**kg TN / year**	**kg TSS / year**
Anoxic Sediment	1,652.0	0.0	0
Oxic Sediment	340.0	0.0	0
Plant Decomposition	110.0	512.6	0
Zebra Mussel Decomposition	116.0	1,039.0	0
Load Reduction Due to Harvesting	-45.7	-292.3	0
Total Internal Load, corrected for harvesting	**2,172.3**	**1,259.3**	**0**
Total Annual Nutrient and sediment Loading	**5,414.8**	**53,120.3**	**5,927,447.2**
Calculated Nitrogen : Phosphorus Ratio	**9.8 : 1**		

Table 4-5: Summary of Internal and External Nutrient and Sediment

4.6 Hotspots

Land uses commonly associated with nutrient enrichment, such as agricultural, industrial, commercial, and high density residential, are not common in the watershed, except for the high density shoreline residences. Heavy recreational use is made of the lake but this is not commonly associated with nutrient sources. Honeoye Lake benefited immensely from the 1973 statewide ban on phosphorus in laundry detergents and the 1978 perimeter sewer. Most of the external sources of nutrients flow into the lake from streams or directly from the shoreline.

However, a number of different sites with a variety of uses have been identified within the watershed that have the potential to be significant pollution contributors. Many of these sites are no longer in use. A more detailed analysis of these hotspots will need to be made to determine if any have a potential for significant pollution.

These sites are identified on Map 16: Honeoye Lake Hotspots and include:

4.6.1 Possible Hydrocarbon Pollution

H-1 Bill Frost Garage and Storage, Pinewood Hill Road
H-2 Coye Airport and Former Tire Shop, Curtis Road
H-3 Former Skippers Store, 5361 CR 36 (gas station, status of underground tank(s) unknown)
H-4 Former Honeoye Lake Marine, 5159 CR 36 (status of underground tank(s) unknown)
H-5 Trident Marine

H-6 New York State Boat launch
H-7 Sandy Bottom Park boat launch
H-8 FLCC Muller Field Station, County Road 36
H-9 California Ranch maintenance barn
H-10 Any underground or aboveground fuel or heating oil tanks

4.6.2 Possible Chemical Pollution

C-1 3M Plant Site (remediated former leach fields and ponds)

4.6.3 Possible Nutrient Pollution

N-1 Horse Farm, East Lake Road
N-2 Country Colony Estates Apartments, Curtis Road (has SPDES permit)
N-3 Any active agricultural operations
N-4 Sites exhibiting severe flooding and erosion during heavy rains

4.6.4 Former Landfills/Mining

M-1 Former Canadice Landfill, Old West Lake Road
M-2 Wohlschelegel Gravel Pit, County Road 36
M-3 Former Gravel Pit, East Lake Rd. (presently Richmond brush pile)

4.6.5 Other Possible Hot Spots

O- 1 Hunt Hollow Ski Lodge, County Road 36
O- 2 Cell Tower, Ross Road off Gulick Road

See Map P: Hot Spots in Honeoye Watershed in the Reference section for the location of these sites.

4.7 Road Crossings

As impervious surfaces, roads and driveways have the potential for increased runoff of pollutants into the lake. Table SUP-13: Estimate of Road and Driveways in Watershed (miles) provides the length of roads broken down by subwatershed. On an areal basis, the North Shore DD has the highest number of roads per unit area and hence the potential for greatest runoff. However, this is a very small subwatershed and only contains a total 1.7% of the total roads and driveways in the watershed, and hence its potential for significant pollution is negligible.

4.8 Subwatershed Prioritization

An attempt was made to evaluate and rank subwatersheds according to impairments and/or threats to water quality and habitat. This attempt to identify priority subwatersheds for nonpoint source pollution management action included an evaluation of the following:

1. Percentage of Impervious Cover, Forest Cover, Turf Cover, and Riparian Cover: Discussion has been included in the previously cited Nutrient and Hydrologic Model.
2. “Hotspot” Density: Discussion has been included in the previous section on Hotspots.. Hotspots are dispersed throughout most of the subwatersheds.

3. Number of Road Crossings: Discussion has been included in the previous section on Road Crossings. Road crossings are dispersed throughout most of the subwatersheds.
4. Industrial Land: There is no industrial land in the watershed
5. Development Potential: Development in the Honeoye Lake Watershed is significantly less than in the larger Finger Lakes. In addition, the potential for future development is fairly uniform across the ten subwatersheds.
6. Public Ownership: There is a significant amount of public protected lands in the Inlet and Briggs Subwatersheds, which are the two largest subwatersheds comprising 47.0% and 13.8% of the watershed respectively. These lands are protected from future private development.
7. Sewer system condition: Although there are no known major problems, a more detailed survey of the sewer system should be done.
8. Violations of Water Quality Standards: There are no known violations of water quality standards in the watershed.

Based on the above analysis, there is no priority subwatershed identified for a focused nonpoint source pollution management action. This is not surprising due to fairly uniform land use characteristics across the watershed. Many of the other Finger Lakes have a high concentration of agriculture which has the potential to cause high nutrient loadings that are subwatershed dependent. Since the Honeoye Lake Watershed has very little agriculture and uniformity throughout its subwatersheds, it does not appear that nutrient pollution is highly subwatershed dependent.