

**FINAL REPORT
ECOLOGICAL AND HYDROLOGICAL ASSESSMENT
OF EAGLES MERE LAKE**

Prepared For:

Eagles Mere Lake and Watershed Committee

Project No. 99L478

October 30, 2001

Submitted By: Reviewed By:

Susan Runco James Richenderfer Todd I. Schively, CES

Project Ecologist Project Geologist Project Manager

BL Companies

Harrisburg, Pennsylvania

Ecological and Hydrological Assessment October 30, 2001

Eagles Mere Lake Site 99L478

CONTENTS

Part Description Page

Executive Summary..... i

I

Introduction.....1

Objective of Assessment.....1

Design of Assessment1

II Results of Internal Lake Assessment

.....2

Bathymetric Mapping of Lake2

Physicochemical Properties of Lake2

Seasonal Turnover and Stratification.....3

Water Chemistry4

Trophic Relationships: Plankton Survey and Fisheries Observations.....6

Macroinvertebrate Survey.....11

Endangered Species.....13

Exotic Invaders14

Wetland Resources.....14

III Results of External Lake Assessment

.....16

Topography.....16

Geology16

Climatology17

Hydrology.....17

Land Use20

IV Water

Supply.....22

Lake Water22

Shallow Ground Water.....23

Deep Ground Water.....24

V General Recommendations

.....25

Wetlands.....	25
Fisheries	25
Protection Against Exotic Invasions.....	26
Lilies, Algal Bloom, and Jellyfish.....	26
Withdrawl of Irrigation Water.....	27
Water Supply	27
Future Work	27

VI Literature Cited

.....	29
-------	----

Ecological and Hydrological Assessment October 30, 2001

Eagles Mere Lake Site 99L478

CONTENTS

(Continued)

Tables

Part Description

Table 1 Results of Water Chemistry Analysis – All Quarters

Table 2 Total Coliform Test Results

Table 3 Plankton Sampling Locations

Table 4 Summer Plankton Results (cells/ml sample)

Table 5 Fall Phytoplankton Results (cells/ml sample)

Table 6 Spring Phytoplankton Results (cells/ml sample)

Table 7 Total Zooplankton Collected in the Lake (cells/ml sample)

Table 8 Macroinvertebrate Species Collected from the Outlet Pond

Table 9 Bioassessment Metric Results for Outlet Stream

Table 10 Evaluation of Water Quality Using Biotic Index Values (Taken from Hilsenhoff, 1987)

Table 11 Monthly Precipitation and Lake Evaporation for Eagles Mere

Table 12 Summary of Domestic Well Inventory Eagles Mere

Table 13 Input Values for Lake Water Budget Calculations

Eagles Mere

Table 14 Output Values for Lake Water Budget Calculations Eagles Mere

Table 15 Public Drinking Water Analyses Lake Water

Figures

Part Description

Figure 1 Bathymetric Map of Eagles Mere

Figure 2 Average Seasonal Temperature Values Lake Water

Figure 3 Seasonal Dissolved Oxygen Values Lake Water

Figure 4 Average Seasonal pH Values Lake Water

Figure 5 Fall Turnover Temperature Data

Figure 6 Total Alkalinity of Lake Water

Figure 7 Wetland Location Map

Figure 8 Boundary of Surface Watershed Surrounding Lake

Figure 9 Elevation of Deep Ground Water Adjacent to Lake

Figure 10 Primary Areas of Inflow from Shallow Ground Water

System Surrounding Lake

Ecological and Hydrological Assessment October 30, 2001

Eagles Mere Lake Site 99L478

CONTENTS

(Continued)

VOLUME II (Separate Cover)

Appendices

Part Description

Appendix A GPS Waypoints

Appendix B Raw Data for Physicochemical Water Sampling

Appendix C Raw Data for Hobo Turnover Temperature Recording

Appendix D Original Laboratory Reports General Water Chemistry

Appendix E Original Laboratory Reports Lake Water Alkalinity

Appendix F Plankton Reports: Dr. Baker and Dr. Terlizzi

Appendix G Scientific Collector's Permit

Appendix H Pennsylvania Natural Diversity Inventory Letter

Appendix I Original Laboratory Report for Drinking Water Analyses

Ecological and Hydrological Assessment - i - October 30, 2001

Eagles Mere Lake Site 99L478

EXECUTIVE SUMMARY

In June 2000, the Eagles Mere Lake and Watershed Committee contracted with BL

Companies to conduct an ecological and hydrological study of the natural glacial lake

known as Eagles Mere Lake. The lake study was designed to address three primary

issues and was thus divided into three parts. The first part of the study addressed "internal lake" features, such as water chemistry, aquatic biology, physical lake characteristics, potential impact on the lake posed by adjacent land uses, and the presence of exotic plant or animal species within the lake. The second part of the study

addressed the "external lake" features including a description of the important geologic, climatic, and hydrologic characteristics of the watershed in which the lake is located.

The third part of the study addressed the potential use of the lake as a public water

supply and the possible effects such usage would have on the overall "health" or ecological balance of the lake.

The results of the internal lake study indicated that the chemical characteristics of the

lake water are remarkably positive. The lake lacks any of the common contaminants

associated with adjacent residential use (nitrates, phosphates, algal blooms, etc.) and

appears to be devoid of exotic aquatic plants and waterborne organisms that would

threaten the long-term health and recreational/aesthetic values of the lake. The lake

also has favorable pH, temperature, and dissolved oxygen profiles throughout the year.

In addition, the lake has a relatively high alkalinity level for a natural body of water

located in northcentral Pennsylvania. These positive chemical characteristics help

maintain what appears to be a very healthy and well-balanced fishery that is complemented by periodic trout stocking practices.

The results of the external lake study indicate that sandstone bedrock belonging to the

Burgoon Formation underlies both the Borough and the lake. This sandstone contains

a naturally occurring carbonate-rich material that is believed to be at least partially

responsible for the very beneficial natural alkalinity present in the lake water. It is this

natural alkalinity level of the lake which acts as a buffer to the effects of acid precipitation. In addition, the external lake study determined that a shallow ground

water system originating primarily from the northern and northeastern sides of the lake,

including the wetland areas, are critically important sources of recharge or inflow water

to the lake. Other sources of inflow water to the lake include seasonal surface water

carried by the small tributaries leading into the lake and by direct catchment of precipitation by the lake surface itself.

Ecological and Hydrological Assessment - ii - October 30, 2001

Eagles Mere Lake Site 99L478

Based upon water level measurements taken in 26 municipal and domestic wells located around the perimeter of the lake, the lake appears to be losing water to a deeper ground water system lying beneath the lake. This deeper ground water outflow

is believed to leave the lake primarily in northwestern, southern, and eastern directions.

Several wells located near Prospect Hill suggest that some very limited amount of deep

ground water may be entering the lake from the west, presumably from beneath or near

Prospect Hill. However, far too little information exists on the general characteristics of

the local deep ground water system to be certain about the magnitude of deep ground

water flows into or out of the lake.

The public water supply study was based in large part upon the combined results of the

internal and external lake studies. In general, the supply study results suggest that the biologic and hydrologic balances of the lake, and thus, its recreational and aesthetic values, could be at risk should the lake be used as a public water supply. If the lake were designated as a public supply, water would have to be drawn from the lake on a constant basis to serve the ongoing needs of the community. This constant withdrawal would have to take place during severe droughts when insufficient amounts of recharge may be received by the lake to maintain adequate recreational levels. During these drought periods, diminished recharge together with added withdrawals would also lengthen the amount of time it normally takes to exchange (freshen) the volume of water contained within the lake basin itself. The deep regional ground water system lying beneath and to the south of the Borough may provide an alternative to the lake as a future public water supply. The withdrawal of this ground water resource via municipally-owned wells would have no hydrologic or ecological impact on the lake. This opinion of no hydrologic impact is based upon the fact that the deep ground water system, including that portion located to the south of the Borough, flows away from and not toward the lake. Therefore, no deep ground water destined to flow into the lake would be intercepted by these wells. The comprehensive evaluation of the regional deep ground water system as a viable public supply was not part of the current study. It is recommended that no water supply wells be installed in either the shallow or deep ground water systems located along the northern or eastern sides of the lake. These areas are believed to play very important roles in supplying water to the lake, and any withdrawal of ground water from these areas will likely diminish or disrupt this important recharge to the lake.

PART I INTRODUCTION

Objective of Assessment

For many decades, both seasonal and year-round residents of Eagles Mere have enjoyed the aesthetic and recreational values of the natural glacial lake known as Eagles Mere Lake. In recent years, concern has been expressed by members of the

Eagles Mere Lake Association and by the Borough of Eagles Mere regarding the overall

condition or “health” of the lake and the surrounding watershed. In addition, the need to

identify a reliable long-term public water supply for the lake community has been an ongoing

concern of the Borough. In June 2000, the Eagles Mere Lake and Watershed Committee was awarded a “Growing-Greener” grant from the Commonwealth of Pennsylvania. The grant was used to contract with BL Companies to conduct an ecological and hydrological assessment of the lake and surrounding watershed.

Design of Assessment

The lake assessment was designed to address three primary issues and thus, was

divided into three parts. The first part of the assessment addressed “internal lake” features, such as water chemistry, aquatic biology, physical lake characteristics, potential impact on the lake posed by adjacent land uses, and the presence of exotic

plant or animal species within the lake. It should be noted that one portion of the original internal lake study, electric shocking of fish populations, was not conducted at

the request of the client. The second part of the assessment addressed the “external

lake” features including a description of the important geologic, climatic, and hydrologic

characteristics of the watershed in which the lake is located. The third part of the assessment addressed the potential use of the lake as a public water supply and the

possible effects such usage would have on the overall “health” or ecological balance of

the lake.

Ecological and Hydrological Assessment - 2 - October 30, 2001

Eagles Mere Lake Site 99L478

PART II

RESULTS OF INTERNAL LAKE ASSESSMENT

Bathymetric Mapping of Lake

Prior to commencement of the internal and external lake studies, bathymetric mapping

of Eagles Mere Lake was completed for the purpose of calculating volume, surface

area, and depth contours of the lake. In addition, bathymetric data were used to select locations for water chemistry analysis, physicochemical data collection, fall turnover temperature recording points and plankton collection. Bathymetric data were collected by boat, following an east-west pattern of transects across the lake, beginning at the northern end near the swimming beach. Depths were recorded using a Depthmate Model SM-5 depth sounder (Speedtech Instruments, Great Falls, VA). Depth locations were fixed, while boat was anchored using a Garmin GPS 12 Map global positioning system (GPS), and accuracy was augmented by use of a Tri-M Mighty Mouse II GPS antenna. Hundreds of GPS waypoints were recorded along each of the 19 transects. The raw data collected are presented in Appendix A. Ultimately, all GPS waypoints were downloaded to Autocad® software, where a final bathymetric map was constructed using collected data (see Figure 1). Based on calculations using these data, the surface area of the main lake is 116.5 acres, and the surface area of the outlet pond is 3.5 acres. The volume of water contained in the lake is approximately 105,300,000 cubic feet or 787,600,000 gallons. The greatest recorded depth in the lake was 50 feet.

Physiochemical Properties of Lake

Six water sampling stations were established across the lake during the bathymetric mapping activities. The locations of these six stations were fixed with GPS coordinates and could accurately be revisited throughout the assessment period. The physiochemical information collected at the six stations was believed to be representative of the entire volume of the lake water. Seasonal measurements were made at the six stations in July 2000 (summer season), October 2000 (fall season), January 2001 (winter season), and April 2001 (spring season).

Ecological and Hydrological Assessment - 3 - October 30, 2001
Eagles Mere Lake Site 99L478

The specific physiochemical parameters measured during each of the four seasons included pH, total dissolved solids (TDS), dissolved oxygen (DO), conductivity, temperature, and turbidity. Values for each of these parameters were obtained using a

Horiba U-22 water quality testing unit with a 30-foot probe containing sensors for all selected field parameters. The probe was lowered from an anchored boat at the six sampling locations distributed across the lake, and values were recorded at 2-foot intervals from the water surface to a depth of 28 feet. All raw data from the physicochemical sampling are located in Appendix B. Results of the sampling events indicate that total dissolved solids were consistently 0.04 g/l, and conductivity varied between 0.067 and 0.068 millisiemens during all four quarters. Turbidity (expressed as ntu) was normally highest at the bottom, presumably due to sediment disturbance from the probe. Turbidity values were fairly uniform during fall and spring turnover as suspended materials were equally dispersed throughout the water column. During the summer, turbidity was highest in the photic zone due to the presence of plankton populations. Temperature (C°), dissolved oxygen (mg/l), and pH data revealed seasonal differences for each of these parameters. The majority of the variations occurring during summer stratification, when warm surface waters are separated from cool, more dense waters below the photic zone, or zone of sunlight penetration. A distinct summer thermocline (point of sudden temperature drop) was detected at depths between 16 and 18 feet, below which temperature, dissolved oxygen, and pH continued to drop rapidly (see Figure 2). Bacterial decomposition of decaying plant and animal materials descending in the water column places heavy demand on dissolved oxygen levels (Cole, 1994). This resulted in the lowest recorded DO values (between 1-4 mg/l) at depths of 28 feet (see Figure 3). However, no evidence of true anoxic conditions was encountered during the study, indicating that the lake still contains DO levels supportive of an active fishery during times of peak oxygen demand. As depth increased below the photic zone during the summer, pH dropped considerably as DO levels were reduced by bacterial decay

(see Figure 4). This is likely the result of increased levels of carbonic acid at depth (Cole, 1994). It is also likely that anerobic conditions in the benthic sediments harbor reduced forms of carbon, as well as other inorganic materials (iron, sulfur, etc.).

Seasonal Turnover and Stratification

Fall turnover data were collected by suspending Hobo® remote continuous temperature data loggers into the water column at two points believed to be located at the deepest areas of the lake. Data loggers were suspended at depths of 5, 15, 19, 38, and 45 feet below the water surface. The loggers collected temperature data every four hours from mid-August to late October, when they were removed and the data were downloaded into the Onset Applications® software. Recorded temperatures were exported into Excel® software and graphed to compare changes at various depths over time (see Figure 5). All raw data for each sampling location and date are presented in Appendix C.

Ecological and Hydrological Assessment - 4 - October 30, 2001
Eagles Mere Lake Site 99L478

Eagles Mere Lake experiences complete seasonal turnover in the spring and fall of the year. Turnover occurs in fall when lake temperature (and therefore density) becomes homogeneous as seasonal changes result in cooling of surface waters that were warmed by the sun during the summer. As discussed in the prior section, during the summer months warm surface waters become distinctly separated from the cooler, denser deep waters below the photic zone. Figure 5 depicts the temperature change over time at five distinct depths in the lake as the cooling process progressed throughout the fall of 2000. During August, summer stratification of temperature is still clearly evident as depicted by the various temperature curves. The mechanics of wind action across the surface of the lake (fetch) aids in distribution of warmed waters to the remainder of the water column. When water temperature and density is equal throughout the body of the lake, it literally “turns over” in one day, resulting in suspension of debris from bottom sediments and causing increased turbidity. Data

collected by the Hobo® devices clearly depict the gradual cooling of surface waters, until waters at all depths become equal when turnover occurred in October. This is evident in Figure 5, where all temperature curves merge at the point of lake turnover.

After turnover in the spring of 2001, ambient temperatures increased and lake surface

water warmed and became considerably less dense than the water below the photic

zone. Thus began the process of summer stratification, during which time the rate of

photosynthesis increased in the photic zone, resulting in increased algal and zooplankton density. Again, the temperature, dissolved oxygen and pH values decreased below the photic zone as the lake becomes stratified and

decomposition

continued below the thermocline.

The metabolic rate for non-mammalian organisms generally doubles for each 10° C rise

in temperature therefore, the lake is most biologically active during the summer months,

and plankton populations reproduce and die at a great rate.

Water Chemistry

Methods

Water samples were collected from the six lake sampling stations on a quarterly basis.

All samples were collected with a Van Dorn sampler, a canister device that enables

water samples to be collected at specific depths within the water column. The water

samples were transported to Analytical Laboratory Services, Inc. (ALSI) located in

Middletown, Pennsylvania. ALSI is certified by the Pennsylvania Department of Environmental Protection (PADEP) to conduct drinking water analyses.

Specific chemical parameters were selected 1 to determine) the lake's potential to serve

as a future drinking water source; 2) to determine nutrient loading into the lake system

from adjacent properties; and 3) to document alkalinity at various depths within the lake.

With the exception of alkalinity testing, all water samples were collected at a depth of 8

feet.

Ecological and Hydrological Assessment - 5 - October 30, 2001

Eagles Mere Lake Site 99L478

Four metals, lead, aluminum, arsenic, and copper, were chosen for testing because of

the general risk of these metals in drinking water and the impact of these metals on the general health of the lake ecosystem, specifically the fishery.

Nitrate, nitrite, total nitrogen, phosphate, and total phosphorus were chosen because of

the enormous impact these nutrients have on the trophic characteristics of the system.

Fecal coliform (bacteria) samples were collected at four locations at depths of 8 feet,

one was collected at the swimming beach, and the last collected along the shore of the

outlet pond in shallow water. The lake depth at each sample location was recorded and

is indicated in Table 1. The two shoreline bacteria sample sites were selected because

of the potential risks presented by coliform bacteria to human health in the swim area,

and because geese (a common source of coliform contamination) were frequently

observed in the outlet pond.

Alkalinity samples were collected at depths of 5, 14, and 24 feet at the six sampling

stations for the purpose of determining whether alkalinity levels are stratified during

winter and summer. Again, the Van Dorn sampler was employed to collect water samples at the desired depths. Alkalinity is the single most important factor influencing

the ability of Eagles Mere Lake to withstand the impact of acid rains prevalent in the

northeast. The ecology of many lakes in close proximity to Eagles Mere has been heavily damaged by acid rain, and understanding the potential of Eagles Mere to buffer

future impacts from acid rain is of critical interest to the Lake Association and the Borough. Historical data indicate that seasonal differences exist in alkalinity level from

the water surface to the lake benthos (bottom).

Alkalinity samples were collected in January by augering holes in the ice; however, the

remaining parameters were not sampled during this quarter because the lake system is

essentially at biological zero, and little nutrient processing or metabolic activity occurs

under these conditions. Ice cover prevents influx of outside sources of nutrient enrichment, and there is little activity in the town of Eagles Mere during the winter.

Since no metals were detected in the lake during the busy summer season when the community was active, there appeared to be little justification for winter testing for metals.

Water Chemistry Results

No detectable levels of metals, ammonia, nitrate, or phosphorus were encountered at any point during the study (see Table 1). The data in Table 1 indicate the minimal reporting limit for each parameter and results obtained at each sample location.

Water

samples from Eagles Mere met Pennsylvania safe drinking water standards for all

parameters tested during each of the four quarters. Copies of the original analytical

reports from the laboratory are provided in Appendices D and E.

Ecological and Hydrological Assessment - 6 - October 30, 2001

Eagles Mere Lake Site 99L478

Fecal Coliform Results

Fecal coliform testing yielded one positive result during the summer of 2000 (see Table

2). The positive result originated from the swim area, most likely a result of small children in diapers introducing fecal material into the water. Coliform testing is performed routinely at the swim area, and rarely exceeds the state standard of 100 cells

per ml of sample. Ducks and geese are also attracted to the swim area and may have

contributed to the coliform count.

Alkalinity Results

Alkalinity values show evidence of stratification during the summer months, with highest

values obtained at the deepest sampling points (see Figure 6). Because of the limited

number of samples, statistical evaluation of differences in alkalinity between depths was

not a valid tool for analysis. Financial constraints on the project budget did not allow for

extensive numbers of samples; however, consistent data (as well as supportive historical data) indicate that alkalinity levels are indeed stratified in the Eagles Mere

Lake system. The lake was sampled again in the fall several days after turnover, and

alkalinity values were reversed, with highest values obtained from surface waters. It is

believed that calcium carbonate is reintroduced into the water column by disturbance of

benthic remains of calcareous exoskeletons from planktonic organisms that occurs

during turnover dynamics. In addition, precipitation of calcium carbonate (from geological and biological sources) may occur when carbon dioxide is taken up during the photosynthetic process that is most active during the summer months, causing lower alkalinity readings within the photic zone. However, the greatest source of alkalinity to Eagles Mere Lake may be attributed to the surrounding hydrogeology within the watershed. Testing on wells along the west shore of Eagles Mere revealed alkalinity levels in excess of 100 mg/l, which may play a major role in augmentation of the buffering capacity of lake waters. This topic will be discussed in more detail in the External Lake Study portion of the report.

Trophic Relationships: Plankton Survey and Fisheries Observations

Samples of phytoplankton and zooplankton were collected during three of the four quarterly water-sampling periods (July 13, 2000, October 26, 2000, and April 27, 2001). No samples were collected during the winter quarter due to ice cover on the lake. The plankton study was undertaken in an attempt to understand the dynamics of the trophic relationships in the lake, as well as to screen for exotic zooplankton and harmful algal blooms (HAB's). Descriptions of sampling locations are outlined in Table 3.

Ecological and Hydrological Assessment - 7 - October 30, 2001
Eagles Mere Lake Site 99L478

Sample locations were chosen in an attempt to discern differences in planktonic populations due to bathymetric and/or anthropogenic influences. Sample Location 1 (swim and beach area) was selected because of the potential for nutrient loading due to human use (primarily children). In addition, ducks and geese often frequent the beach area, increasing the potential for elevated coliform counts. Sample Locations 2 and 4 were selected to identify littoral plankton species, and also because the western shore (which is the site of the town of Eagles Mere) is much more heavily populated and developed. Sample Location 3 (outlet pond) is situated in a shallow-water habitat that is connected to the main body of the lake by a narrow channel. It is unlikely that much migration exists between planktonic populations located in this area with the main lake

since flow is directed out of the pond to the receiving discharge stream. Sample Locations 2 and 5 were selected in deep, open water habitat at each end of the lake equidistant from the east and west shores. Plankton samples were collected early in the morning since zooplankton are known to migrate to deeper water during daylight hours. This is believed to occur in response to predation from fish (as well as predation among zooplankton) that visually feed in the photic zone. A Lamotte® 5-inch plankton net constructed of 153-micron mesh was used to capture four horizontal and two vertical samples during each quarter. Horizontal tows were accomplished by placing the net behind the boat and towing the net at slow speed along the selected transect for each sampling location. Vertical captures originated below the photic zone as measured with a 20 cm Watermark® limnological Secchi disc, and were accomplished by lowering the net from the gunwale of the boat to the desired depth, and retrieving the net by hand. Samples 100 ml in volume were removed from the net's capture tube and placed in bottles, then preserved with Lugol's solution. Samples were placed in a cooler with ice and transported to the laboratory for identification.

Dr. Katherine H. Baker of Penn State University Department of Environmental Engineering performed the first quarter identification, and Dr. Dan Terlizzi, Water Quality Specialist for the University of Maryland, completed identification of the remaining samples. Hard copies of their reports are located in Appendix F.

Tables 4 through 7 contain a condensation of data recorded for the three sampling periods as determined by Drs. Baker and Terlizzi.

Summer Phytoplankton Results

It is evident that each sampling location generated differences in species diversity and density among algal communities in the lake. Dr. Baker noted that algal numbers were low in the summer samples, and that communities were dominated by green algae, diatoms, and desmids typically associated with good water quality. Numbers were lowest in the vertical samples since the vertical tow was limited to 5.25 m. Based on

these figures, the algal community is quite different in the outlet pond than in the main body of the lake.

Ecological and Hydrological Assessment - 8 - October 30, 2001
Eagles Mere Lake Site 99L478

Navicula and *Nitzschia* are both benthic diatoms, and exist in the outlet pond and along the swimming beach, both shallow-water areas. *Synedra*, a diatom, is common in scums on substrates, as is typical in the outlet pond. Additionally, the green alga *Oedogonium* frequents submerged aquatic vegetation, which is prevalent throughout the outlet pond.

Interestingly, *Stephanodiscus* is associated with hard or basic lakes, which is not descriptive of Eagles Mere's water chemistry. However, Eagles Mere Lake has the ability to buffer acidic conditions in a geographic region that contains many acidified lakes. Apparently *Stephanodiscus* is successful in the Eagles Mere Lake ecosystem, possibly benefiting from the same alkalinity dynamics that protect Eagles Mere from regional acidic conditions.

Cosmarium, a desmid, and *Ceratium*, a dinoflagellate, are extremely common in fresh waters of the United States, and are dispersed among both open water and littoral zone habitats within the lake. It is also considered an indicator organism for eutrophic (food rich) systems. Eagles Mere Lake is primarily an oligotrophic (food scarce) system, but most lakes exhibit characteristics of both oligotrophy and eutrophy. Considering the low algal numbers, presence of this organism is not likely indicative of a developing eutrophic condition.

Fall Phytoplankton Results

Dr. Terlizzi noted that phytoplankton abundance was low relative to the zooplankton population present at the time of sampling. His assessment of this condition is that a fall phytoplankton bloom had recently occurred, and intensive grazing of the bloom by zooplankton was in progress during the sampling event. Algal diversity was much lower than that observed during the summer. *Dinobryon*, a dinoflagellate, is common in Canadian lakes, and according to Dr. Terlizzi's report, is not easily consumed by predaceous zooplankton because it is motile and forms large colonies. In addition, it is

well suited to an oligotrophic system because it can consume bacteria to supplement energy production.

Spring Phytoplankton Results

During the fall sampling period, it was noted that phytoplankton populations were scarce compared with zooplankton numbers. The reverse was evident during the spring sampling quarter, where Dr. Terlizzi speculated that spring turnover and/or grazing-related nutrient release may have resulted in phytoplankton blooms. Eagles Mere Lake is a very low in nutrient input, and the balance between phytoplankton and zooplankton populations, as well as other trophic relationships throughout the food web, is closely linked to nutrient availability. He further suggests that the zooplankton population may have been lower than expected because much of the available phytoplankton were large diatoms that are believed to be more resistant to grazing.

Ecological and Hydrological Assessment - 9 - October 30, 2001

Eagles Mere Lake Site 99L478

Dinobryon was much more abundant during spring sampling, and is well suited to an oligotrophic system since it is capable of ingesting bacteria as an additional energy source.

Results of the three sampling quarters indicate that the lake contains phytoplankton populations typical of an oligotrophic system, and there was no evidence that harmful algae blooms or exotic zooplankton species exist in the lake or are a cause for concern.

The phytoplankton-zooplankton balance is a dynamic system, and will fluctuate seasonally as well as on a daily basis depending on incident sunlight, nutrient availability, and predation pressure. Plankton sampling simply provides a snapshot of the community balance at a given point in time, and provides opportunities to screen for exotic species and potentially harmful blue-green algae populations.

Zooplankton Results-All Quarters

The dominant zooplankton species present during all three sampling quarters were the

Cladocerans *Bosmina* and *Diaptomus* (see Table 7). The Copepod species *Cyclops*

was also present, although most observed in the spring quarter were juveniles. Zooplankton density was highest in the fall sampling quarter, and much lower in the

spring quarter. This may simply be the result of population succession, responses to nutrient availability, or migration patterns at the time the samples were collected.

Exotic

zooplankton were not present in any of the samples, and are not believed to have been

introduced to Eagles Mere at this writing.

Dr. Terlizzi's fall assessment of the zooplankton population noted that some females

containing eggs were noted, particularly among the *Bosmina* and *Diaptomus* species.

The spring quarter sampling generated even larger numbers of eggs, suggesting that

zooplankton population dynamics were on the verge of change.

Discussion of Trophic Structure

Eagles Mere is primarily an oligotrophic (food scarce) lake with a few eutrophic (food

rich) characteristics. Although phytoplankton and zooplankton density is low, the lake

maintains a thriving fishery. The analysis of phytoplankton populations indicate that

common green and brown algae typical of clean, oligotrophic systems are dominant.

Zooplankton populations are not particularly dense or diverse, and are dominated by

Daphnia and *Cyclops*. There is no evidence of exotic invaders among the plankton

community.

Ecological and Hydrological Assessment - 10 - October 30, 2001

Eagles Mere Lake Site 99L478

Most oligotrophic lakes are deeper than Eagles Mere (Cole, 1994), and review of the

bathymetry indicates that the photic zone (epilimnion) comprises a significant portion of

the lake volume. Light penetrates to 5.25 m in the summer, or almost 20 feet.

The

deepest point measured in the lake was 50 feet, and the majority of the lake is considerably shallower. For this reason, the volume of water exposed to incident light is

quite large compared to the hypolimnion (deep water below the photic zone).

Although

most of Eagles Mere Lake's characteristics fall under the oligotrophic category, the ratio

of epilimnion to hypolimnion is more typical of eutrophic, highly productive systems.

All synthesis of organic compounds occurs in the epilimnion, and dying material falls

downward into the hypolimnion, where decay of organic compounds takes place. Carbon from diatoms (and other organisms encased in calcareous exoskeletons) is mineralized in the hypolimnion as bacterial populations break down organic materials.

Although plankton density is low, the epilimnion volume is significant. This results in

concentration of dead calcareous material as it falls through the water column, accumulating in the lake benthos. The lake appears somewhat funnel-like in cross

section, forcing calcareous material to travel from the epilimnion to the much more

confined hypolimnion. These calcareous materials, along with other minerals and nutrients, are suspended into the water column during spring and fall turnover, and may

aid in the buffering capacity of the lake.

There is little autochthonous (self-generated) nutrient input into Eagles Mere Lake, as

supported by water chemistry analysis that generated non-detect levels of nitrogen and

phosphorus during all four quarters of sampling. Autochthonous input is believed to be

limited to leaf fall and woody debris that enters the lake system. The system is primarily

driven by photosynthetic algae and bacteria, which are preyed upon by predaceous

plankton species.

Bacterial populations were not analyzed during the course of this study because lakes

are dynamic systems, and an accurate accounting of yearly production requires intensive field effort and analysis that was beyond the scope of this assessment.

However, the contribution of bacteria (both photosynthetic bacteria and those that get

energy from inorganic bonds of sulfur, nitrogen, and iron) to total primary producer

biomass is significant in lake ecosystems, and is considered widely underestimated by

most limnologists.

The *Daphnia* species detected in the lake is known for its ability to consume large

numbers of algae and bacteria, especially blue-greens. Stocking of game fish assists

Daphnia in this process, because game fish prey upon planktivorous fish that might

otherwise suppress *Daphnia* biomass. Stocking practices are most likely enhancing

water quality conditions in Eagles Mere Lake. The bathymetry and resulting ratio of epilimnion to hypolimnion supports a successful fishery, even though there is little outside nutrient input to enhance plankton density.

Ecological and Hydrological Assessment - 11 - October 30, 2001

Eagles Mere Lake Site 99L478

The biology of the outlet pond is quite distinct from that of the main body of the lake. It

is a heavily vegetated shallow-water habitat, and performs functions much like those

ordinarily associated with wetlands. In addition to providing an alternative resource to

stream inhabitants during dry periods, it provides spawning grounds for bass and other

fish species, as well as protective cover that allows juvenile fish to escape predation.

Many invertebrate species inhabit the outlet pond and provide forage for blue gills and

other small fish that are important members of the food web. The contributions of the

outlet pond to the trophic structure of the lake are significant. Reduction of the water

level in the outlet pond may result in exposure and death of shoreline vegetation, and

possible depletion of dissolved oxygen as decomposing bacterial populations increase

in response to increased amounts of dead organic materials.

Macroinvertebrate Survey

A small stream exits the outlet pond at the south end of the lake, and flows southward

down a steep slope. Stream macroinvertebrates were collected in April 2001 at three

locations to determine the quality and diversity of the benthic community, which is a

biological indicator of water quality. A collector's permit is required for stream sampling,

and was obtained from the Pennsylvania Fish and Boat Commission prior to the study

(see Appendix G). The three sites were inspected for habitat similarity using the United

States Environmental Protection Agency (USEPA) Rapid Bioassessment Protocol III

(Plafkin *et al.*, 1989) guidelines for habitat assessment.

Organisms were collected with an aquatic D-net after disturbance of the streambed

substrate, a commonly accepted method of collection. Organisms were preserved with isopropyl alcohol in the field, and transported to the laboratory for identification.

Each organism was inspected under a dissecting microscope, and identified using various macroinvertebrate identification keys (Adler and Kim, 1996; Merritt and Cummins, 1984; Pennak, 1989).

Three orders of stream macroinvertebrates are noted for their stringent requirement of clean, highly-oxygenated water. These include the Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). In general, these are very primitive insects that respire by means of gills located on the thorax or abdomen.

They depend on flowing waters with adequate dissolved oxygen concentration because they are unequipped to enhance their intake of oxygen by other physical means. The percentage of a macroinvertebrate sample that is comprised of these three orders

(Ephemeroptera, Plecoptera, and Trichoptera, or "EPT") is known as the EPT Index.

Therefore, the EPT Index was of special interest in this study.

Another metric used by aquatic ecologists to measure stream health is Species Diversity, or the number of distinct species found in a particular sample. In addition, the

percentage by which the numbers of a single species dominates the sample is called

the Percent Contribution of Dominant Taxon metric. These two metrics were also used

to characterize the macroinvertebrate community at each of the three sampling locations.

Ecological and Hydrological Assessment - 12 - October 30, 2001

Eagles Mere Lake Site 99L478

The Hilsenhoff Biotic Index (Hilsenhoff, 1977), or "HBI," is a numeric scale (0 - 10) that

categorizes aquatic invertebrates by their known tolerance to organic pollution (Hilsenhoff, 1982). The lower the HBI rating, the less tolerant the organism is to environmental stresses. The EPT taxa possess the lowest HBI ratings, and there are

other organisms that are far more tolerant of poor water quality. There are some species that are considered indicators of poor water quality, such as red-pigmented

Chironomidae (midge-fly larvae) or Oligochaetae (aquatic earthworm) populations.

An HBI value can be determined for an entire macroinvertebrate sample by multiplying

the total individuals of a distinct taxon by the correct HBI value. This is done for each taxon encountered in the sample, and then all values are summed and divided by the total number of organisms in the sample. The final value provides an indication of water quality based upon community balance and distribution of pollution intolerant taxa.

The formula for Hilsenhoff's Biotic Index is:

$$HBI = \sum x_i t_i / n$$

Where:

x_i = number of individuals within a species

t_i = tolerance value of a species

n = total number of organisms in the sample

Ordinarily, metrics such as these are used to compare impaired sites to known healthy

sites, or to assess the impact of a stress agent on a stream by comparing upstream

communities to those located downstream from the suspected problem area. In these

cases many metrics are used, and statistical analysis of data is employed to make

assumptions about the biological health of the study area. However, there are no known sources of impact to the outlet stream from Eagles Mere, so communities were

assessed for EPT Index, Species Diversity, Hilsenhoff's Biotic Index, and the percentage of the community dominated by a single species.

Results of identification of macroinvertebrate samples collected in the outlet stream are

displayed in Table 8. Results of calculated bioassessment metrics for the three stream

sample locations are found in Table 9. The EPT Indices for the three sites ranged from

0.64 to 0.67, and were highly indicative of clean, highly oxygenated flowing water.

Species diversity was 10.0 at Site 1, and 19.0 at Sites 2 and 3. Site 1 was slightly impacted by benthic sediments, probably as a result of construction of a road crossing

upstream. Sites 2 and 3 contained less sediment, and provided a better cobble and

rubble substrate than Site 1.

The percent contribution of dominant taxon metric ranged from a low of 0.20 at Site 2 to

a high of 0.32 at Site 1. None of these values suggested that any of the communities

were heavily dominated by a single taxon, and the community balance is adequate for a small, headwater stream.

Ecological and Hydrological Assessment - 13 - October 30, 2001
Eagles Mere Lake Site 99L478

The HBI values ranged from 2.64 to 3.32 on the Hilsenhoff scale. The HBI Index indicated that all sample locations exhibited excellent water quality as compared to a table (see Table 10) developed by Hilsenhoff (1987). Hilsenhoff's study involved the

extensive collection of stream macroinvertebrates, which were then compared to chemical testing of the waters from which they originated. From these data, Hilsenhoff was able to assign tolerance values that correlated with known water quality conditions.

A review of all metric results generated during the current assessment indicate that the

outflow stream is in excellent health, and supports a small, balanced community dominated by the sensitive EPT taxa. Most of the organisms identified within the stream have fairly short life cycles (< one year), which is expected in a small headwater

stream that receives little or no flow from the outlet in late summer and early fall. Some

species were typical of those found in both streams and lakes, and may well use the

outlet pond as a resource when the stream flow is diminished in late summer.

Very

small stoneflies and caddisflies (visible only by dissecting microscope) were observed

during the process of identifying outlet pond vegetation. Seeps were noted along the

length of the stream channel and are believed to contribute to flows throughout the year,

even when the late summer lake levels do not hydraulically support the stream.

Endangered Species

A review of the Pennsylvania Natural Diversity Inventory (PNDI) for the Eagles Mere

Lake watershed indicates the presence of two plant species of concern within the internal and external lake environment (see Appendix H). *Myriophyllum tenellum* (Slender Watermilfoil) is listed as a threatened plant in Pennsylvania, and was last

observed in Eagles Mere in 1993.

Goodyera tessellata (Checkered Rattlesnake Plantain) is currently proposed for threatened status in Pennsylvania, and was last seen on East Laurel Path near Eagles

Mere in 1952. It was not encountered during the course of the lake study, but possibly

resides in isolated areas where it is not easily detected. Watermilfoil species were abundant in the outlet pond but not observed in other portions of the lake. It is likely that the Slender Watermilfoil would inhabit the outlet portion of the lake rather than the main body of the lake. Samples of milfoils observed during the assessment are believed to be Northern Watermilfoil (*Myriophyllum exalbescens*) and Eastern Watermilfoil (*Myriophyllum pinnatum*), but the possibility exists that the threatened Slender Watermilfoil may also reside within the outlet pond. The largest threat to Slender Watermilfoil is the exotic invader Eurasian Watermilfoil (*Myriophyllum spicatum*), which has been observed in the tidal Potomac and the upper Chesapeake Bay. Thus far, this species has not been detected in Eagles Mere. However, accidental introduction of this species could prove catastrophic to the native watermilfoils currently residing in the lake.

Ecological and Hydrological Assessment - 14 - October 30, 2001
Eagles Mere Lake Site 99L478

Exotic Invaders

There is the potential for invasion of several exotic species that have been identified in nearby lakes. The spread of exotic Great Lakes zooplankton into inland lakes in the last several years is of serious concern to aquatic biologists throughout the northcentral and northeastern portions of the United States. The Great Lakes has a long history of exotic invasions, including Zebra Mussels, Sea Lamprey (*Petromyzon marinus*), Rainbow Smelt (*Osmerus mordax*), Alewife (*Alosa pseudoharengus*), and many others. The recent (1984) invasion of the Cladoceran zooplankton *Bythotrephes cederstroemi* from Great Britain and Northern Europe has resulted in documented midsummer collapse of *Daphnia* populations in some lakes as the invader out-competed and preyed upon *Daphnia* species (Evans, 1988). In addition, the invader is equipped with a large spine that has been observed to cause internal injuries to fish that preyed upon it (Marquenski, 1991). The introduction of this exotic to Eagles Mere Lake could prove to be catastrophic to the trophic structure of the system, as the dominant Cladocerans, *Daphnia* and *Bosmina*, would likely experience large reductions in numbers. Injury and

death to planktivorous fishes could well result in disturbance to fisheries populations within the lake. In addition, *Daphnia* plays a vital role in the Eagles Mere Lake system by preying upon undesirable blue-green algae and bacteria. In addition, Eurasian Watermilfoil continues to spread to waterways in the United States. This exotic out-competes native species, and produces a thick growth that snags fishing lines and motors.

Wetland Resources

Approximately 25 acres of wetland resources were identified within the Eagles Mere Lake watershed. Wetlands were assessed using techniques outlined in the U.S. Army Corps of Engineers Wetland Delineation Manual (1987), and wetland functions were identified as outlined in Mitsch and Gosselink (1993). The National Wetlands Inventory Map for Eagles Mere, Pennsylvania depicts forested wetlands located north of the swimming beach. The Sullivan County soil survey indicates that wetland soils are prevalent in a large area north of the lake, and in areas that fringe the shoreline. These soils are associated with “perched” (or shallow) ground water systems. The wetlands adjacent to the lake are of a geomorphic type described by Brinson (1993) as a glacial variation of a ground water slope wetland. Because these wetland ground water systems are glacial, they are often complex compared with the relatively straightforward hydro-period identified in other wetlands. This type of wetland is characterized by till deposits arranged such that more permeable layers are overlying less permeable ones, creating a shallow, perched aquifer. The majority of the wetland acreage lies to the north of the lake, with smaller pockets associated with seeps around the shoreline and outlet pond.

Ecological and Hydrological Assessment - 15 - October 30, 2001
Eagles Mere Lake Site 99L478

Wetland perimeters were located using the GPS system, and collected data was downloaded to Autocad® software for the purpose of creating a wetland map (see Figure 7). Wetlands were primarily hemlock and beech forest with a sphagnum moss and club moss ground cover, and were saturated or inundated throughout the system.

There were areas of palustrine-emergent wetlands west of Wetland Plot 1 that were isolated from the main system due to roads that have interrupted the natural hydrology. Wetlands provide a number of functions that are essential to good water quality (Mitsch and Gosselink, 1993). The functions most likely provided by the wetlands within the Eagles Mere Lake watershed include providing a sink for nutrients, sediment retention, toxicant transformation and retention, ground water recharge (and to some extent, discharge), habitat for aquatic and semi-aquatic organisms, food and cover for wildlife, and flood flow retention. An additional function provided by sphagnum bogs is the ability to buffer the pH of acid precipitation. Forested wetlands are particularly valuable because they are nearly irreplaceable. Efforts to construct forested wetlands that retain the true functions of original forested systems have not been satisfactory.

Ecological and Hydrological Assessment - 16 - October 30, 2001
Eagles Mere Lake Site 99L478

PART III

RESULTS OF EXTERNAL LAKE ASSESSMENT

Topography

Eagles Mere is nestled within the mountainous region of Sullivan County and occupies a north-south trending shallow bowl-like topographic feature carved by glaciers ten's of thousands of years ago. The topography immediately surrounding the lake ranges in elevation from a high of 2,140 feet above mean sea level (AMSL) at the top of Crestmont Hill to a low of approximately 2000 feet, AMSL at the outlet pond area. The mean (average) elevation of the lake water surface is reported by the United States Geologic Survey (USGS) to be 1994 feet AMSL. The lake is surrounded by a relatively small watershed area approximately 240 acres in size. This watershed contributes surface runoff directly to the lake. The approximate boundary of this surface watershed is outlined on Figure 8. Beyond the perimeter of this small watershed, the land surface drops off in all directions, emphasizing the relatively high topographic position of the isolated bowl-like glacial feature occupied by

the lake.

Geology

According to the Pennsylvania Bureau of Topographic and Geologic Survey (Berg, 1981), the entire lake and much of the Borough are underlain by a single geologic formation, the Burgoon Formation. The Burgoon Formation is described by David Brezinski (ed. Shultz, 1999) as a cross-bedded, medium- to coarse-grained sandstone.

Because of the preponderance of cross-bedding, lack of recognizable overbank deposits, and the coarse grain size, the Burgoon sandstone is believed to have been

deposited by a high-gradient, braided stream.

According to Ussler (1973), calcite is present as a cementing agent in the Burgoon sandstone. This calcite is likely to be at least partially responsible for the very favorable

alkalinity levels present within the lake water as previously described in the Alkalinity

Testing Results Section of this report.

The Burgoon sandstone is underlain by the Huntley Mountain Formation.

Brezinski (ed.

Shultz, 1999) describes the Huntley Mountain Formation as an interbedded greenishgray

to tan, flaggy sandstone, sandy siltstone, and reddish-brown silty shale. Berg and Edmunds (1979) postulated that the flaggy sandstones represent channel-phase sands,

and the reddish-brown shales represent overbank deposits of alluvial-plain origin.

Ecological and Hydrological Assessment - 17 - October 30, 2001

Eagles Mere Lake Site 99L478

Climatology

The long-term monthly and annual rates of natural precipitation occurring in the Eagles

Mere area were obtained from published information collected by the National Oceanic

and Atmospheric Administration (NOAA) at the Lycoming County Airport located near

Williamsport Pennsylvania during the period 1948 through 1996. Estimates of the longterm

evaporation rates for Eagles Mere Lake were calculated from data published by the Office of the Pennsylvania State Climatologist for the F. E. Walter Dam located near

Wilkes-Barre and from information contained in Rahn (1973). Specifically, the total rate

of lake evaporation of 28 inches per year for the Eagles Mere region taken directly from

Rahn (1973) were pro-rated over a twelve month period using the monthly distribution of annual lake evaporation measured at the F. E. Walter facility. The results of these lake evaporation calculations and the long-term monthly distribution of annual precipitation as measured at Lycoming County Airport are presented in Table 11.

Hydrology

During the hydrologic phase of the assessment, static water levels of the deep ground water system were recorded in 22 domestic wells and 4 municipal wells surrounding the lake. The results of these measurements are presented in Table 12. Without exception, all of the static water levels in these 26 wells were lower, in some instances more than 160 feet lower, than the water level in the lake. The largest differences between lake water level and deep ground water levels were in the wells located along the northwestern and southern boundaries of the lake.

Ground water, like surface water, responds to the influences of gravity. It flows from higher elevations to lower elevations. Therefore, since the deep ground water levels drop off or "slope away" from the lake, the lake is believed to be losing water to the underlying deep ground water system. The slope of the ground water surface away from the lake is most severe in the northwesterly and southerly directions. Figure 9 demonstrates the slope of the deep ground water table in the vicinity of the lake. There exists the possibility that some unknown amount of deep ground water may be entering the lake from the vicinity of Prospect Hill. A domestic well (Soars residence) located in this area had a water level only several feet lower than the lake level. Since the water levels were measured in October, when ground water is at its annual lowest point, these levels exist the possibility that flow toward the lake from the Prospect Hill area may occur in the spring of the year when ground water is at its annual high point.

Ecological and Hydrological Assessment - 18 - October 30, 2001
Eagles Mere Lake Site 99L478

A small sampling of four domestic wells (each located on a different side of the lake),

and two springs (located north and south of the lake) was completed on August 1, 2001 in an attempt to better understand both the source of the alkalinity found in the lake water and the lake-related role of the deep ground water system. The four domestic wells were owned by Wetzel, located on the eastern side of the lake on Crestmont Hill; by Kazio, located on the southern side of the lake along Eagles Mere Avenue; by Todd, located on Pennsylvania Avenue along the western side of the lake near Prospect Hill; and the Beach House well located on the northern side of the lake. The two springs were Mineral Springs, located within the wetland area north of the lake, and an unnamed spring located south of the lake on the northern side of Route 42 across from the real estate office. The water samples were chemically analyzed for total alkalinity. The alkalinity result for Mineral Springs was less than the detection limit of 5 mg/l. The alkalinity level in the unnamed Route 42 spring was 6 mg/l. The four well sample results were Wetzel (20 mg/l), Kazio (34 mg/l), Todd (101 mg/l), and Beach House (77 mg/l). The very low values for the two springs may reflect the relatively low alkalinity level of the local shallow ground water system. The four wells, presumably reflecting the local deep ground water system, suggest that at least some of the lake water alkalinity may be coming from the deep ground water system. It is interesting to note that the highest alkalinity value of 101 mg/l was measured in the Todd well located within the same Prospect Hill area as the Soars residence in which the highest deep ground water level was measured. The Todd alkalinity value and the Soars water level value may both support the possibility of a deep ground water flow component entering the lake from the Prospect Hill area. Based upon the topographic position, areal extent, and hydrologic features of the wetlands located north and east of the lake, it is believed that a significant amount of shallow ground water enters the lake in the form of diffuse flow through the porous bottom and sides of the lake basin (see Figure 10). This opinion regarding the

existence of a localized shallow ground water system is consistent with observations made by local contractors conducting digging and trenching activities in the Eagles Mere area. These contractors have frequently encountered this shallow ground water system, sometimes only several feet below ground surface, especially in areas north and east of the lake near Forest Park. The area contributing shallow ground water to the lake was estimated from the Eagles Mere USGS topographic map and from budget calculations to be approximately 600 acres in size. The absence of any significant deep ground water contribution or "input" to the lake and the very limited watershed area contributing overland flow or surface water to the lake underscore the important hydrologic role played by the shallow ground water system in supporting the water balance of the lake.

Ecological and Hydrological Assessment - 19 - October 30, 2001
Eagles Mere Lake Site 99L478

Several components of the regional water budget published in Taylor (1984) for the Upper Susquehanna River Basin were used in calculating a water budget for Eagles Mere. The specific components of Taylor's work used in the calculations were the annual rate of overland flow from the watershed surrounding the lake (8 inches per year) and the annual rate of ground water recharge occurring within the shallow ground water system surrounding the lake (11 inches per year). Other supplemental information used to calculate the lake water budget included topographic features (drainage areas) taken from the USGS quadrangle map of the Eagles Mere area, and the climatic information described in the preceding section. The lake water budget consists of water inputs (gains) and water outputs (losses).

These inputs and outputs must be balanced if the water level within the lake is to remain constant. The water inputs or "gains" realized by the lake on an annual basis were estimated as follows:

1. Direct catchment of precipitation falling on the lake surface, 39.8 inches per year falling on 120 acres, or 130 million gallons per year.
2. Overland flow of surface water from the 240-acre watershed surrounding the

lake, 8 inches flowing from 240 acres, or 50 million gallons per year.

3. Shallow ground water inflow from adjacent wetlands and surrounding watershed,

10 inches discharging from approximately 600 acres, or 160 to 180 million gallons per year.

4. Deep ground water gain from western side of lake possible, but not quantifiable

with existing database.

5. Annual total input to lake of approximately 350 million gallons per year.

6. Length of time needed to exchange one complete lake volume estimated to be approximately 2 to 3 years.

Water outputs or "losses" from the lake on an annual basis were estimated as follows:

1. Lake evaporation, 28 inches from 120 acre lake surface, or 90 million gallons per year.

2. Losses in northern, eastern, and southern directions through the lake bottom to

the deep regional ground water system, back-calculated from mass balance procedure, 90 million gallons per year.

3. Surface water flow leaving the outlet pond, estimated from outlet flow, 160 to 170

million gallons per year.

Ecological and Hydrological Assessment - 20 - October 30, 2001

Eagles Mere Lake Site 99L478

4. Water withdrawn directly from the lake for seasonal golf course irrigation, estimated from records kept by Borough personnel, 6 to 9 million gallons per year.

5. Annual total output from lake of approximately 350 million gallons per year.

The results of the lake water budget input and output calculations are summarized in

Tables 13 and 14, respectively.

As the above-mentioned numbers indicate, the two most important sources of water

feeding the lake are the direct catchment of 130 million gallons per year, or 37 percent

of the total input, and the shallow ground water inflow of 174 million gallons per year, or

50 percent of the total input.

It is critically important for the reader to understand that some of the input and output

values presented in this report are simply approximations based upon the interpretations of available hydrologic and climatic data, and should not be viewed as

either highly accurate or verified through direct measurements. This warning especially

applies to the gains and losses of the deep ground water system. Since deep ground water gains or losses could not be measured directly, approximations of their magnitudes represented unknowns in the calculations and were thus solved for mathematically using the other hydrologic and climatic input/output data that were more readily quantified in published documents.

Land Use

A preliminary review was made of the document entitled "Zoning, Chapter 105, From the Code of the Borough of Eagles Mere," dated October 1999. The document review reported herein was conducted by earth and environmental scientists not land use planners or other zoning professionals much more qualified to comment on land use patterns and zoning regulations. The reason for the current review was simply to better understand the existing zoning ordinances currently in place within the watershed that surrounds the lake and to gage the potential impact on the lake environment posed by these permissible land uses within these zones.

The five land use zones located within the watershed surrounding the lake are Residential Districts (R-A, R-1, and R-3); Recreational-Commercial Districts (C-1); and Commercial Districts (C-2). Based upon all of the various pieces of information gathered during this assessment, it appears that the current land uses located within the watershed have had no detrimental impact on the lake environment. Therefore, no specific issues of concern were noted during the document review.

Ecological and Hydrological Assessment - 21 - October 30, 2001

Eagles Mere Lake Site 99L478

A relatively small portion of the lake watershed located near the intersection of Eagles Mere Avenue and Pennsylvania Avenue is occupied by the C-2 zoning. This zoning provides for the operation of "gasoline stations" and "automotive repair" businesses.

By their very nature, these types of businesses carry a greater long-term probability of environmental impact from solvent and petroleum product storage and leakage than do other businesses allowed within the same C-2 zones. For this reason, care should be

exercised when considering such businesses within the lake watershed in the future.

Ecological and Hydrological Assessment - 22 - October 30, 2001
Eagles Mere Lake Site 99L478

PART IV

WATER SUPPLY

Lake Water

The lake water was sampled on August 2, 2001 and chemically analyzed for constituents normally of concern for a public water supply. Copies of the original laboratory reports are presented in Appendix I. As the data summarized in Table 15

indicate, the lake water meets all of the safe drinking water parameters for which analyses were performed. From a water quality standpoint, the lake would likely be

considered a good candidate for use as a public water supply.

The public water supply study was based in large part upon the combined results of the

internal and external lake studies. In general, the supply study results suggest that

while the lake water appears to meet drinking water standards, the biologic and hydrologic balances of the lake, and thus its recreational and aesthetic values, could be

at risk should the lake be used as a public water supply. The delicacy or sensitivity of

these balances is not known, nor is it known the amount of change needed in these

ecological or hydrological systems to bring about negative shifts in the lake environment.

If the lake were designated as a public supply, water would have to be drawn from the

lake on a constant basis to serve the ongoing needs of the community. This constant

withdrawal of water would have to take place during severe droughts when insufficient

amounts of recharge may be received by the lake to maintain adequate recreational

levels. During these drought periods, diminished natural recharge from the surrounding

watershed, including the wetlands, together with added withdrawals for public supply

could create significant negative impacts to the lake's ecosystem. For example, if the

water level were lowered below the current outlet structure (excluding the 4-inch collar),

the water depth in the channel connecting the main lake and the outlet pond would be

insufficient to permit boat access to the pond. Excessive exposure of shoreline mud flats could occur. Significant reductions in dissolved oxygen levels could result due to lower water volume exchange, excessive death of plankton, and the bacterial decomposition of exposed aquatic vegetation. The water level at the bathing beach would be lowered to an undesirable level. The boat ramp along the western side of the lake would be incapable of launching boats due to shallow water conditions. In addition, the amount of time it now takes to exchange (freshen) the volume of water contained within the lake basin itself would be lengthened considerably. For all of these reasons, it is recommended that the lake not be used as a public water supply.

Ecological and Hydrological Assessment - 23 - October 30, 2001

Eagles Mere Lake Site 99L478

Water extracted from the lake for golf course irrigation poses considerably less threat to

the lake environment than would the more significant public water supply issue, unless

the amounts withdrawn were to substantially increase in the future. Since the Borough

and Lake Association limit the amounts of irrigation water that can be removed from the

lake, there exists a safeguard in place to protect the lake during drought conditions.

The most critical lake feature to focus on when deciding whether to allow the withdrawal

of irrigation water at any point in time is the depth of water existing between the main

lake and the outlet pond. Provided the water level in the outlet pond remains at or above the top of the concrete outlet structure (without the wooden collar), there should

be sufficient water flowing through the main lake and into the outlet pond to ensure

adequate circulation of fresh water within the lake and pond. In addition, maintenance

of this level should provide sufficient water depth in the connector channel to provide

boat access to the pond. If the withdrawal of irrigation water lowers the lake level below

the top of the concrete outlet, some of the same negative impacts on lake ecology and

hydrology previously discussed with regard to the public water supply issue could result.

Shallow Ground Water

The shallow ground water system surrounding the lake is believed to be a “perched” water system. This perched water system is believed to be caused by a naturally occurring layer of low-permeability material perhaps tens of feet or less beneath the ground surface. The top of this clay-rich material is visible in portions of the wetland areas north of the lake, and has been observed in trenches dug in the Forest Park area. As precipitation infiltrates the ground surface and percolates vertically downward in response to the pull of gravity, it encounters and accumulates on top of this material. In general, perched shallow water systems transmit water at a slower rate and are more susceptible to surface contaminants, and thus of lower quality, than deeper water systems. As previously discussed in this report, significant amounts of water from the local perched shallow ground water system are believed to flow into and replenish the lake, especially from the northern and eastern sides of the lake. For these reasons, it is recommended that the shallow water system surrounding the lake not be considered for use as a source for public water supply. This recommendation also applies to the three existing municipally-owned wells along the northeastern side of the lake. The withdrawal of water from these wells could diminish the amount of shallow water entering the lake from this northeastern side.

Ecological and Hydrological Assessment - 24 - October 30, 2001
Eagles Mere Lake Site 99L478

Deep Ground Water

The deep ground water system located south of Eagles Mere Avenue is believed to represent the best source for a future public water supply. This opinion is based upon the fact that deep ground water flows away from and not into the lake. Therefore, the use of this deep ground water should have no impact on lake hydrology. This area south of Eagles Mere is also beyond the bounds of the shallow ground water system feeding the lake. Therefore, any unintended hydraulic communication between the shallow and deep ground water systems possibly resulting from the installation of

multiple production wells should likewise have no impact on the lake. In addition, to the southwest and southeast of Eagles Mere Avenue there exist two drainage areas occupying topographic lows. Topographically low areas (valleys) are generally better locations for production wells than are either hillsides or hilltops. To adequately address the potential for developing a public ground water supply in the Eagles Mere area, a detailed hydrogeologic evaluation would have to be undertaken. This detailed evaluation would include: 1) geologic analyses to locate the most promising positions for test well installations; 2) the filing of required pre-drilling reports and documents to the PADEP; 3) the installation of test wells, 4) the performance of pump tests on the newly installed wells; 5) the collection of water samples from the new wells; and 6) the filing of post-drilling reports and permit applications to PADEP documenting the performance and reliability of the new wells. This type of detailed hydrogeologic evaluation of the local bedrock for a public water supply was beyond the work scope of the current assessment.

Ecological and Hydrological Assessment - 25 - October 30, 2001
Eagles Mere Lake Site 99L478

PART V

GENERAL RECOMMENDATIONS

Wetlands

Protection of the large wetland area north of the beach is vital to the future health of Eagles Mere Lake. It is believed that these wetlands play a major role in the shallow ground water system that supports the lake. In addition, the wetlands are primarily sphagnum moss bogs, which act to reduce pH of rainfall from the surrounding watershed that drains into it. Wetlands are well known for their ability to remove toxicants, nutrients, and sediments from surface runoff, all of which would be harmful to the biology of Eagles Mere, as well as threatening the excellent water quality that currently exists within the system. The wooded area that currently surrounds the lake is of great benefit to the watershed because it buffers the lake from adjacent development, protecting it from nutrients, sediments and toxicants that may be carried toward the lake

from public roads, and other activities within the Borough. It is strongly recommended that the wooded buffer around the lake remain undisturbed and undeveloped. This recommendation also pertains to the future construction of new roads (dirt or paved) in or around these wetlands. Several dirt roads currently exist within the wetlands located to the north and east of the lake. The past construction of these dirt roads may have unintentionally interrupted the natural hydrology of the surface water or shallow ground water systems operating within these wetlands. The removal of these existing dirt roads however, may cause more of a disturbance to the wetlands than if they are allowed to remain in place. Therefore, it is recommended that the existing dirt roads remain undisturbed, and that new roads within this delicate wetland area to the north and east of the lake be prohibited.

Fisheries

Although the Eagles Mere Lake Association and the Borough decided not to pursue the fisheries aspect of the original study proposal, the fishery in the lake appears to be thriving, according to reports from local fishermen. cursory observation of fish populations during the course of the study supports this assessment, as mature bass, trout, and perch were frequently encountered during routine fieldwork. Eagles Mere has been regularly stocked with trout every year, and it is recommended that this practice continue. As pointed out in the Trophic Relationships section of this report, game fish act to suppress smaller planktivorous fish populations, which in turn allow the *Daphnia* populations to flourish. This acts to reduce unwanted blue-green algae populations as well as other bacterial populations that would be deleterious to the existing favorable water quality. Based upon these observations, it is recommended that the current program of fish stocking continue. No other types of treatments or management schemes are needed to protect the fisheries of the lake.

Ecological and Hydrological Assessment - 26 - October 30, 2001

Eagles Mere Lake Site 99L478

Protection Against Exotic Invasions

Fortunately, Eagles Mere is closed to motorized boats of the sort likely to frequent the Great Lakes. Many inland lakes however, have been invaded by Great Lakes exotic species therefore, great caution should be exercised when allowing access to boats used on other lakes in the northeast. Currently the Great Lakes Panel on Aquatic Nuisance Species is working to develop a strategy to help prevent the spread of exotic invaders through an outreach program targeting bait dealers, commercial fishermen, and other potential recreational and commercial sources that unwittingly spread invasive organisms to other lakes. Fishermen that visit the Great Lakes (as well as the Chesapeake Bay, where Eurasian Watermilfoil is common) are advised to take the following precautions to reduce the potential for exotic invasion:

- Rinse live wells, bait buckets, and fishing equipment
- Rinse bilge water from boats
- Check dock lines, anchor lines, sea anchors and outrigger equipment for attached organisms (approximately 0.5 inches in length).
- Wash boats, canoes or dinghies that may have come in contact with infested waters.
- Do not transport any sort of baitfish to Eagles Mere Lake from other bodies of water.
- Do not release live aquatic animals and plants of any sort (including aquarium plants, invertebrates, fish, reptiles, turtles or amphibians, and/or aquarium water) into the lake. Eurasian Watermilfoil and the closely related Parrotfeather are common aquarium plant species, and could prove catastrophic to the native aquatic plant community of Eagles Mere Lake.

Lilies, Algal Bloom, and Jellyfish

Although not specifically addressed in the lake study, some general recommendations pertaining to the management of the outlet pond lilies, the periodic “algal” blooms, and the freshwater “jellyfish” can be made. Control of the lilies in the outlet pond can be accomplished in several ways; by chemical application of a herbicide, by physical harvesting or cutting of the plants below water level, and by direct (hand) extraction or pulling of the entire plant including the roots. While all three will be effective, the method with the best long-term outcome is the direct hand extraction method. This method is clearly the most labor-intensive; however, it provides the best long-term

outcome with minimal plant return.

Ecological and Hydrological Assessment - 27 - October 30, 2001

Eagles Mere Lake Site 99L478

The “algal bloom” periodically observed in the main lake and accompanied by a disagreeable odor is most likely a naturally occurring bacteria, and not a true algae.

This periodic bloom should pose no threat to the health of the lake.

The freshwater “jellyfish” are most likely freshwater hydra. Their presence in the lake is

not a cause for concern and thus requires no corrective action.

Withdrawal of Irrigation Water

If the withdrawal of water from the lake for golf course irrigation is to continue, it is

recommended that a conditional use process be put in place. This conditional use

would determine if water can be withdrawn based upon water level in the channel between the outlet pond and the lake. While this conditional use may make scheduling

of irrigation activities less reliable at the golf course, it will better protect the natural

circulation of water through the lake and outlet pond during periods of drought.

Water Supply

It is recommended that neither the lake nor the shallow ground water system surrounding the lake be used for public water supply purposes. The use of either system as a water supply could result in long-term harm to the ecological and hydrological balances of the lake.

The deep ground water system located to the south of Eagles Mere Avenue represents

the best option for an Eagles Mere public water supply.

Future Work

While only one water sample collected during the assessment exceeded the Standard,

it would be prudent for the Lake Association to consider establishing and enforcing a

policy requiring babies/toddlers to wear “approved diapers,” while using the beach area.

This policy could define what constitutes an “approved diaper” and the conditions under

which they must be worn. If enforced, this policy should decrease the potential for

future fecal coliform bacteria outbreaks in the lake.

Although not specifically analyzed in the recent assessment, total coliform bacteria are

likely to be present in various portions of the lake. Total coliform are most commonly

associated with waterfowl, especially ducks and geese. Since both ducks and geese

are frequently observed on or near the floating docks, piers, and beaches in the bathing area and their droppings seen scattered about these areas, the distinct possibility exists that total coliform bacteria are also present in these areas. For these reasons, it is recommended that steps be taken to discourage waterfowl from frequenting the heavily used beach area and its associated floating docks, piers, and boat ramps.

Ecological and Hydrological Assessment - 28 - October 30, 2001
Eagles Mere Lake Site 99L478

It is recommended that the Pennsylvania Game Commission, the U.S. Fish and Wildlife Service, the National Audubon Society, and other similar resources be consulted for ways to control the waterfowl frequenting the beach areas.

It is recommended that periodic monitoring of the lake systems be performed.

The quality of the lake water should be tested every three years to confirm that the favorable alkalinity, dissolved oxygen, temperature and pH profiles documented during the current assessment remain in-place.

The ecology of the lake should be monitored on a five-year cycle. This monitoring should include the type of plankton sampling performed during the current assessment

and a search for the presence of any newly introduced exotic plant species.

It is recommended that future deicing or salting activities conducted on roadways surrounding the lake be performed using sodium-free and chloride-free material.

There are several deicing materials available to the general public that would pose minimal threat to surface water and ground water systems occupying the lake area. While the results of the current assessment found no evidence that past land use activities had any negative impact on lake water quality, it is recommended that no fertilizers, herbicides, or pesticides be used on lands where runoff to the lake can occur.

Avoidance of chemical applications in these areas will eliminate any future impacts such activities could have on the lake ecosystem.

Ecological and Hydrological Assessment - 29 - October 30, 2001
Eagles Mere Lake Site 99L478

PART VI

LITERATURE CITED

Adler, P.H. and K.C. Kim. 1986. *The Blackflies of Pennsylvania Simuliidae, Diptera*):

Bionomics, Taxonomy and Distribution. The Pennsylvania State University College of Agriculture, Agricultural Experiment Station. University Park, Pennsylvania. 88 pp.

Berg, T. M. 1981. *Atlas of Preliminary Geologic Quadrangle Maps of Pennsylvania*. Map 61. Pennsylvania Bureau of Topographic and Geologic Survey. pg 180.

Berg, T. M., and W. E. Edmunds. 1979. *The Huntley Mountain Formation: Catskill-to-Burgoon Transition in North-Central Pennsylvania*. Informational Circular 83. Pennsylvania Bureau of Topographic and Geologic Survey, 80 p.

Brinson, Mark M. 1993. A Hydrogeomorphic classification for wetlands. Technical Report WRP-DE-4. U.S. Army Corps of Engineers. Washington, D.C.

Cole, Gerald A. 1994. *Textbook of Limnology*. Waveland Press, Inc. Prospect Heights, Illinois. 412 pp.

Environmental Laboratory. 1987. *Corps of Engineers Wetland Delineation Manual.* Technical Report Y-87-1. U.S. Army Corps of Engineers Waterways Experiment Station. Vicksburg, Missouri. 100 pp.

Evans, M.S. 1988. *Bythotrephes cederstroemi*, its new appearance in Lake Michigan. *J. Great Lakes Res.* 14(2): 234-240.

Hilsenhoff, W.L. 1982. Using a biotic index to evaluate water quality in streams. Technical Bulletin Wisconsin Department of Natural Resources 132.

Hilsenhoff, W.L. 1987. An improved biotic index of organic stream pollution. *Great Lakes Entomologist.* 20: 31-39.

Marcquenski, S.V. 1991. Investigating Chinook mortalities in Lake Michigan: A multidisciplinary approach. Wisconsin Department of Natural Resources, Box 7921, Madison, Wisconsin. 53707. 5 pp.

Merritt, R.W. and K.W. Cummins, eds. 1984. *An Introduction to the Aquatic Insects of North America*. Kendall/Hunt Publishing Company. Dubuque, Iowa. 722 pp.

Mitsch, W.J. and J.G. Gosselink. 1993. *Wetlands*. 2nd edition. Van Nostrand Reinhold. New York, NY. 722 pp.

Ecological and Hydrological Assessment - 30 - October 30, 2001
Eagles Mere Lake Site 99L478

Pennak, R.W. 1989. *Fresh-Water Invertebrates of the United States: Protozoa to Mollusca*. 3rd edition. John Wiley & Sons, Inc. New York. 628 pp.

Plafkin, J.L.; M.T. Barbour; K.D. Porter; S.K. Gross and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and

fish. U.S. Environmental Protection Agency. Assessment and Watershed Protection Division. Washington, D.C. EPA 440-4-89-001.

Rahn, James J. 1973. *Pan and Lake Evaporation in Pennsylvania*. Information Report Number 69, Institute For Research on Land and Water Resources, The Pennsylvania State University.

Shultz, Charles H., editor. 1999. *The Geology of Pennsylvania*. Special Publication 1. Bureau of Topographic and Geologic Survey, Department of Conservation and Natural Resources, Commonwealth of Pennsylvania.

Taylor, Larry. 1984. *Groundwater Resources of the Upper Susquehanna River Basin, Pennsylvania*. Water Resources Report 58. Pennsylvania Bureau of Topographic and Geologic Survey.

Ussler, Bill. 1973. *The Bedrock Geology and a Paleoenvironmental Study of an Upper Mississippian (?) Calcite Cemented Sandstone in the Hillsgrove and Eagles Mere 7.5-Minute Quadrangles, Pennsylvania*, Senior Thesis, Bucknell University, 43 p.

Ecological and Hydrological Assessment October 30, 2001
Eagles Mere Lake Site 99L478

TABLES

Table 1 Results of Water Chemistry Analysis – All Quarters

Table 2 Total Coliform Test Results

Table 3 Plankton Sampling Locations

Table 4 Summer Plankton Results (cells/ml sample)

Table 5 Fall Phytoplankton Results (cells/ml sample)

Table 6 Spring Phytoplankton Results (cells/ml sample)

Table 7 Total Zooplankton Collected in the Lake (cells/ml sample)

Table 8 Macroinvertebrate Species Collected from the Outlet Pond

Table 9 Bioassessment Metric Results for Outlet Stream

Table 10 Evaluation of Water Quality Using Biotic Index Values
(Taken from Hilsenhoff, 1987)

Table 11 Monthly Precipitation and Lake Evaporation for Eagles Mere

Table 12 Summary of Domestic Well Inventory Eagles Mere

Table 13 Input Values for Lake Water Budget Calculations
Eagles Mere

Table 14 Output Values for Lake Water Budget Calculations Eagles Mere

Table 15 Public Drinking Water Analyses Lake Water

Ecological and Hydrological Assessment October 30, 2001

Eagles Mere Lake Site 99L478

TABLE 1

Results of Water Chemistry Analysis

All Quarters

Table 1. Results of Water Chemistry Analysis-All Quarters

297-8 Lead, Total <0.005 0.01 mg/l 26
297-8 Aluminum <0.30 0.30 mg/l “
297-8 Arsenic <0.005 0.01 mg/l “
297-8 Copper <0.01 0.01 mg/l “
297-8 Ammonia-Nitrogen <0.10 0.10 mg/l “
297-8 Nitrate-Nitrogen <0.50 0.50 mg/l “
297-8 Nitrite-Nitrogen <0.05 0.05 mg/l “
297-8 Total Phosphorus <0.10 0.10 mg/l “
297-8 Total Kjeldahl-N <1.0 1.00 mg/l “
297-8 Total Organic N <1.0 1.00 mg/l “
298-8 Lead, Total <0.005 0.01 mg/l 24
298-8 Aluminum <0.30 0.30 mg/l “
298-8 Arsenic <0.005 0.01 mg/l “
298-8 Copper <0.01 0.01 mg/l “
298-8 Ammonia-Nitrogen <0.10 0.10 mg/l “
298-8 Nitrate-Nitrogen <0.50 0.50 mg/l “
298-8 Nitrite-Nitrogen <0.05 0.05 mg/l “
298-8 Total Phosphorus <0.10 0.10 mg/l “
298-8 Total Kjeldahl-N <1.0 1.00 mg/l “
298-8 Total Organic N <1.0 1.00 mg/l “
299-8 Lead, Total <0.005 0.01 mg/l 17
299-8 Aluminum <0.30 0.30 mg/l “
299-8 Arsenic <0.005 0.01 mg/l “
299-8 Copper <0.01 0.01 mg/l “
299-8 Ammonia-Nitrogen <0.10 0.10 mg/l “
299-8 Nitrate-Nitrogen <0.50 0.50 mg/l “
299-8 Nitrite-Nitrogen <0.05 0.05 mg/l “
299-8 Total Phosphorus <0.10 0.10 mg/l “
299-8 Total Kjeldahl-N <1.0 1.00 mg/l “
299-8 Total Organic N <1.0 1.00 mg/l “

300-8 Lead, Total <0.005 0.01 mg/l 15.7
300-8 Aluminum <0.30 0.30 mg/l “
300-8 Arsenic <0.005 0.01 mg/l “

Table 1, continued

300-8 Copper <0.01 0.01 mg/l “
300-8 Ammonia-Nitrogen <0.10 0.10 mg/l “
300-8 Nitrate-Nitrogen <0.50 0.50 mg/l “
300-8 Nitrite-Nitrogen <0.05 0.05 mg/l “
300-8 Total Phosphorus <0.10 0.10 mg/l “
300-8 Total Kjeldahl-N <1.0 1.00 mg/l “
300-8 Total Organic N <1.0 1.00 mg/l “
301-8 Lead, Total <0.005 0.01 mg/l 11.7
301-8 Aluminum <0.30 0.30 mg/l “
301-8 Arsenic <0.005 0.01 mg/l “
301-8 Copper <0.01 0.01 mg/l “
301-8 Ammonia-Nitrogen <0.10 0.10 mg/l “
301-8 Nitrate-Nitrogen <0.50 0.50 mg/l “
301-8 Nitrite-Nitrogen <0.05 0.05 mg/l “
301-8 Total Phosphorus <0.10 0.10 mg/l “
301-8 Total Kjeldahl-N <1.0 1.00 mg/l “
301-8 Total Organic N <1.0 1.00 mg/l “
302-8 Lead, Total <0.005 0.01 mg/l “
302-8 Aluminum <0.30 0.30 mg/l “
302-8 Arsenic <0.005 0.01 mg/l “
302-8 Copper <0.01 0.01 mg/l “
302-8 Ammonia-Nitrogen <0.10 0.10 mg/l “
302-8 Nitrate-Nitrogen <0.50 0.50 mg/l “
302-8 Nitrite-Nitrogen <0.05 0.05 mg/l “
302-8 Total Phosphorus <0.10 0.10 mg/l “
302-8 Total Kjeldahl-N <1.0 1.00 mg/l “
302-8 Total Organic N <1.0 1.00 mg/l “

*All samples collected at depth of 8 feet. None of the samples collected met minimum reporting values for any parameter.

*Ecological and Hydrological Assessment October 30, 2001
Eagles Mere Lake Site 99L478*

TABLE 2

**Total Coliform Test Results
And**

TABLE 3

Plankton Sampling Locations

Table 3. Plankton Sampling Locations

1 Perimeter of swim area
(data points 284-289)

200 meters (approx) 0.0-3.0 m
 2 West shore (littoral zone)
 (data points 290-291)
 200 meters (approx) 1.0-3.0 m
 3 Perimeter of outlet pond
 (data point 292)
 200 meters (approx) <1.0 m
 4 Center of south end of lake
 (data point 293)
 5.25 m >12 m
 5 East shore (littoral zone)
 (data points 294-295)
 200 meters (approx) 1.0-3.0 m
 6 Center of north end of lake
 (data point 296)
 5.25 m >12 m

Table 2. FECAL COLIFORM TEST RESULTS

297-8 Fecal Coliform 0 col/100 ml West Shore
 299-8 Fecal Coliform 0 col/100 ml West Shore
 300-8 Fecal Coliform 0 col/100 ml East Shore
 302-8 Fecal Coliform 0 col/100 ml East Shore
 303-8* Fecal Coliform 160 col/100 ml Swim Area
 304-8* Fecal Coliform 1 col/100 ml Outlet Pond
 *Samples collected in shallow water at shoreline (<6”).

Ecological and Hydrological Assessment October 30, 2001
 Eagles Mere Lake Site 99L478

TABLE 4

**Summer Plankton Results
 (cells/ml sample)**

Table 4. Summer Phytoplankton Results (cells/ ml sample)

Stephanodiscus 22750 0 0 0 0 0
Amphora 1083 0 0 0 0 0

Ceratoneis 0 0 3250 0 0 0
Navicula 1080 0 1080 0 0 0
Nitzchia 0 0 2170 0 0 0
Synedra 0 0 1080 0 0 0
Oedogonium 0 0 11920 80 0 0
Scenedesmus 0 0 0 570 0 0
Ulothrix 1080 3250 0 0 0 0
Ceratium 3250 10830 0 0 6500 430
Closterium 1080 0 0 0 0 0
Cosmarium 0 3250 0 570 5420 760
Ecological and Hydrological Assessment October 30, 2001
 Eagles Mere Lake Site 99L478

TABLE 5
Fall Phytoplankton Results
(cells/ml sample)

And

TABLE 6
Spring Phytoplankton Results
(cells/ml sample)

Table 5. Fall Phytoplankton Results (cells/ ml sample)

Organism	Sample 1	Sample 2	Sample 3	Sample4	Sample 5	Sample 6
<i>Dinobryon</i>	10	20	30	30	50	0
<i>Tribonema</i>	10	10	10	10	20	0
<i>Navicula</i>	10	0	0	0	0	0

Table 6. Spring Phytoplankton Results (cells/ml sample).

Dinobryon 1221 1066 2841 2486 488 621
Tabellaria 111 0 423 22 0 44
Asterionella 37 423 0 666 111 178
Cyclotella 0 22 0 22 621 0
Melosira 0 0 1732 621 0 0
Statospore 22 44 0 0 0 88
Ecological and Hydrological Assessment October 30, 2001

TABLE 7

Total Zooplankton Collected in the Lake (cells/ml sample)

Table 7. Total Zooplankton Collected in the Lake (cells/ ml sample)

Daphnia

pulex

Summer

2000

<300 <300 <300 <300 <300 <300

Cyclops Summer

2000

<300 <300 <300 <300 <300 <300

Daphnia spp. Fall

2000

38 13 6 8 16 8

Cyclops Fall

2000

50 21 2 1 10 1

Bosmina Fall

2000

45 169 6 6 53 2

Diaptomus Fall

2000

84 186 9 7 105 8

Bosmina Spring

2001

4 0 2 0 1 4

Diaptomus Spring

2001

0 21 28 8 4 11

Eggs Fall

2000

8 18 0 0 38 4

Eggs Spring 2001 8 135 36 150 84 21

Ecological and Hydrological Assessment October 30, 2001

Eagles Mere Lake Site 99L478

TABLE 8

Macroinvertebrate Species Collected from the Outlet Pond

Table 8. Macroinvertebrate Species Collected from the Outlet Stream

Ephemeroptera Siphonuridae *Ameletus* 34 25 34

Heptageniidae *Ironodes* 11 15 2
 Ephemerellidae *Serratella* 0 0 2
Danella 0 0 2
 Plecoptera Chloroperlidae *Haploperla* 6 8 9
Alloperla 7 0 0
 Pteronarcyidae *Pteronarcys* 0 1 0
 Perlidae *Anacroneuria* 0 0 4
 Perlodidae *Clioperla* 0 0 4
 Nemouridae *Amphinemura* 0 5 11
 Peltoperlidae *Tallaperla* 0 1 0
 Tricoptera Hydropsychidae *Potamyia* 14 30 50
Macrostenum 0 2 1
 Leptoceridae *Leptocerus* 5 5 4
 Philopotamidae *Wormaldia* 4 2 3
 Diptera Tipulidae *Tipula* 3 2 0
Dicranota 0 1 0
Antocha 0 4 2
Ormosia 0 1 0
Megistocera 0 0 1
 Simuliidae *Prosimulium* 9 16 22
 Chironomidae 19 16 42
 Coleoptera Elmidae 0 0 1
 Annelida Oligochaetae 0 2 1
 Odonata
 (suborder Anisoptera Protoneuridae *Neoneura* 0 2 2
Total Organisms 106 150 197
Ecological and Hydrological Assessment October 30, 2001
 Eagles Mere Lake Site 99L478

TABLE 9

Bioassessment Metric Results for Outlet Stream And

TABLE 10

Evaluation of Water Quality Using Biotic Index Values (Taken from Hilsenhoff, 1987)

Table 9. Bioassessment Metric Results for Outlet Stream

EPT Index 0.70 0.67 0.64

% Contribution

Dominant Taxon

0.32 0.20 0.25

Species Diversity 10 19 19

Hilsenhoff's Biotic Index 2.64 3.05 3.32

Table 10. Evaluation of Water Quality Using Biotic Index Values (taken from Hilsenhoff, 1987).

0.00 – 3.50 Excellent No apparent organic pollution

3.51 - 4.50 Very Good Possible slight organic pollution

- 4.51 – 5.50 Good Some organic pollution
- 5.51 – 6.50 Fair Fairly significant organic pollution
- 6.51 – 7.50 Fairly Poor Significant organic pollution
- 7.51 – 8.50 Poor Very significant organic pollution
- 8.51 – 10.00 Very Poor Severe organic pollution

Ecological and Hydrological Assessment October 30, 2001
 Eagles Mere Lake Site 99L478

TABLE 11

Monthly Precipitation and Lake Evaporation for Eagles Mere

28

Eagles Mere

Long-Term Published 0.75 Monthly Monthly Monthly
 Average Pan Evap Lake Evap Lake Evap Lake Evap Lake Evap
 Precip. FE Walters FE Walters FE Walters Eagles Mere Eagles Mere
 Month (inches) (inches) (inches) (%) (%) (inches)

Jan	2.96	0	0	0	0	0.00
Feb	2.64	0	0	0	0	0.00
Mar	3.25	0	0	0	0	0.00
Apr	3.90	3.45	2.59	0.11	0.11	1.55
May	3.10	4.87	3.65	0.16	0.16	4.37
Jun	3.59	5.63	4.22	0.18	0.18	5.05
Jul	3.83	6.07	4.55	0.19	0.19	5.44
Aug	3.19	5.16	3.87	0.17	0.17	4.63
Sep	2.31	3.56	2.67	0.11	0.11	3.19
Oct	3.15	2.48	1.86	0.08	0.08	2.22
Nov	4.08	0	0	0	0	1.55
Dec	3.82	0	0	0	0	0.00
Annual	39.82	31.22	23.42	1.00	1.00	28.00

Notes: Monthly pan evap for Walters Dam taken from www.ems.edu/PA_Climatologist webpage.
 Total of 28 inches lake evap. for Eagles Mere taken from Fig 6 in PSU Info Report 69 (Pan & Lake Evap).
 Monthly lake evap for Eagles Mere pro-rated from Walters monthly percentages.

Monthly Precipitation and Lake Evaporation for Eagles Mere

Table 11

Ecological and Hydrological Assessment October 30, 2001
 Eagles Mere Lake Site 99L478

TABLE 12

Summary of Domestic Well Inventory Eagles Mere

Elevation Well Static

Name of Ground Casing Elevation Water Elevation Compared
 Well Owner Address or Surface Stickup TOC Level SWL to Lake General
 Or Identification Street Name (feet, AMSL) (feet) (feet, AMSL) (feet, TOC) (feet, AMSL) (- or +) Comments

Spahr Lake Drive and Clay Ave	2032	2.1	2029.9	75.4	1954.5	-39.5	
Klotz Lake Drive and Clay Ave	2048	1.0	2047.0	173.5	1873.5	-120.5	
Robson Pugad Eagles Mere Ave.	2060	1.0	2059.0	91.3	1967.8	-26.3	
Zeisloff Loch Eagle Lane	2033	1.0	2032.0	125.0	1907.0	-87.0	Water cascading @ 70 ft
Bryfogel Loch Eagle Lane	2019	0.0	2019.0	139.3	1879.8	-114.3	
Pump House Lakewood Drive	1999	1.0	1998.0	48.4	1949.6	-44.4	
Municipal Well 1 Lakewood Drive	2020	2.2	2017.8	54.9	1962.9	-31.1	
Municipal Well 2 Lakewood Drive	2038	2.3	2035.7	46.5	1989.2	-4.8	
Municipal Well 3 Lakewood Drive	2035	2.3	2032.7	52.1	1980.6	-13.4	
Beach House Lakewood Drive	1999	1.5	1997.5	93.1	1904.4	-89.6	
Moyer Park @ Linwood	2011.5	1.0	2010.5	74.0	1936.5	-57.5	
Second Nature Pennsylvania Ave	2020	1.5	2018.5	106.5	1912.0	-82.0	
Andross Pennsylvania Ave @ Lewis	2017.5	0.3	2017.2	95.7	1921.5	-72.5	
Morris Pennsylvania Ave	2020	2.0	2018.0	74.5	1943.5	-50.5	

Sigler Lakewood Drive 2040 1.0 2039.0 51.1 1987.9 -6.1
 Woodshed Cottage Crestmont Hill 2106 1.0 2105.0 129.6 1975.4 -18.6
 Waltz Allegheny Ave 2032 0.5 2031.5 139.7 1891.8 -102.2
 Hedley Allegheny Ave 2022 1.0 2021.0 119.0 1902.0 -92.0
 Stitzer Garage Allegheny Ave 1938.5 1.5 1937.0 31.4 1905.6 -88.4
 James Allegheny Ave @ Geyelin 1995 1.0 1994.0 51.4 1942.6 -51.4
 Eagles Mere Park Pennsylvania Ave 2043.5 3.3 2040.3 97.4 1942.9 -51.2 SWL suspect, well reported artesian
 Soars Pennsylvania Ave 2020.5 1.0 2019.5 28.1 1991.4 -2.6
 Bailey House Pennsylvania Ave @ Mifflin 2058 2.0 2056.0 222.8 1833.2 -160.8 Top of ground water divide
 Brown Mifflin @ Summit 2054 2.0 2052.0 180.8 1871.2 -122.8 Outside watershed?
 White House Mineral Springs Rd 2016 0.5 2015.5 83.0 1932.5 -61.5
 Beechwood Cottage Forest Park 2012 1.0 2011.0 165.5 1845.5 -148.5
 Note: All water level readings taken on October 24 and 25, 2000

Summary of Domestic Well Inventory

Eagles Mere

Table 12

Ecological and Hydrological Assessment October 30, 2001
 Eagles Mere Lake Site 99L478

TABLE 13

**Input Values for Lake Water Budget Calculations
 For Eagles Mere**

Month (inches) (gallons) (inches) (gallons) (inches) (gallons)

Jan 0.39 2,600,000 2.96 9,600,000 1.12 17,500,000
 Feb 0.33 2,100,000 2.64 8,600,000 1.03 16,300,000
 Mar 0.70 4,600,000 3.25 10,600,000 1.20 19,000,000
 Apr 1.13 7,400,000 3.90 12,700,000 1.18 18,700,000
 May 0.92 6,000,000 3.10 10,100,000 0.76 12,000,000
 Jun 0.92 6,000,000 3.59 11,700,000 0.79 12,500,000
 Jul 0.82 5,300,000 3.83 12,500,000 0.76 12,000,000
 Aug 0.59 3,800,000 3.19 10,300,000 0.58 9,200,000
 Sep 0.36 2,400,000 2.31 7,500,000 0.44 7,000,000
 Oct 0.53 3,400,000 3.15 10,200,000 0.77 12,200,000
 Nov 0.72 4,700,000 4.08 13,200,000 1.13 18,000,000
 Dec 0.57 3,700,000 3.82 12,500,000 1.26 20,000,000
 Totals 8.00 52,000,000 39.82 129,500,000 11.00 174,400,000

Shallow

Ground Water

Direct Catchment

(Streamflow) Precip. (Lycoming Co.)

Table 13

**Input Values for Lake Water Budget Calculations
 Eagles Mere**

Overland Flow

Ecological and Hydrological Assessment October 30, 2001
 Eagles Mere Lake Site 99L478

TABLE 14

**Output Values for Lake Water Budget Calculations
 For Eagles Mere**

Deep Outlet Golf Course

Ground Water Flows Irrigation

(Estimated) (Estimated)

Month (inches) (in/day) (gallons) (gallons) (gallons) (gallons)

Jan	0.00	0.00	0	7,500,000	4,400,000	0
Feb	0.00	0.00	0	7,500,000	8,000,000	0
Mar	0.00	0.00	0	7,500,000	33,500,000	0
Apr	1.55	0.05	5,000,000	7,500,000	43,200,000	0
May	4.37	0.14	14,200,000	7,500,000	33,500,000	1,000,000
Jun	5.05	0.17	16,400,000	7,500,000	21,600,000	1,000,000
Jul	5.44	0.18	17,700,000	7,500,000	9,000,000	1,500,000
Aug	4.63	0.15	15,000,000	7,500,000	2,000,000	1,500,000
Sep	3.19	0.11	10,400,000	7,500,000	2,000,000	1,250,000
Oct	2.22	0.07	7,200,000	7,500,000	2,200,000	0
Nov	1.55	0.05	5,000,000	7,500,000	3,200,000	0
Dec	0.00	0.00	0	7,500,000	4,400,000	0
Totals	28.00	90	90,900,000	90,000,000	167,000,000	6,250,000

Table 14

Output Values for Lake Water Budget Calculations

Eagles Mere

Lake Evaporation

Ecological and Hydrological Assessment October 30, 2001

Eagles Mere Lake Site 99L478

TABLE 15

Public Drinking Water Analyses Lake Water

Reporting Analytical

Parameter Result Units Limit Method

Metals by ICP:

Aluminum N.D. mg/l 0.100 200.7
 Arsenic N.D. mg/l 0.008 200.7
 Barium 0.021 mg/l 0.010 200.7
 Beryllium N.D. mg/l 0.004 200.7
 Cadmium N.D. mg/l 0.001 200.7
 Chromium N.D. mg/l 0.005 200.7
 Copper N.D. mg/l 0.010 200.7
 Iron N.D. mg/l 0.060 200.7
 Manganese 0.016 mg/l 0.005 200.7
 Nickel N.D. mg/l 0.020 200.7
 Silver N.D. mg/l 0.004 200.7
 Zinc N.D. mg/l 0.020 200.7

Metals by ICPMS:

Antimony N.D. ug/l 2.0 200.8
 Lead N.D. ug/l 2.0 200.8
 Selenium N.D. ug/l 2.0 200.8
 Thallium N.D. ug/l 2.0 200.8
 Mercury, Total N.D. mg/l 0.0005 245.1

Miscellaneous:

Alkalinity, Total 6 mg/l 5 2320B
 Cyanide, Free N.D. mg/l 0.005 335.4
 Color 5 C.U. 5 110.2
 Surfactants (MBAS) N.D. mg/l 0.025 5540C
 pH 7.6 150.1
 Hardness, Total 19.4 mg/l 0.66 2340B
 Total Dissolved Solids 80 mg/l 5 2540C
 Turbidity 0.90 N.T.U. 0.10 2130B

Anions:

Chloride 8.3 mg/l 5.0 300.0
 Fluoride N.D. mg/l 0.1 300.0

Nitrate-N N.D. mg/l 0.5 300.0
Nitrate/Nitrite-N N.D. mg/l 0.5 300.0
Nitrite-N N.D. mg/l 0.05 300.0
Sulfate 9.3 mg/l 5.0 300.0

Table 15

Public Drinking Water Analyses

Lake Water

Reporting Analytical

Parameter Result Units Limit Method

Trihalomethanes:

Bromodichloromethane N.D. mg/l 0.0005 502.2
Bromoform N.D. mg/l 0.0005 502.2
Chlorodibromomethane N.D. mg/l 0.0005 502.2
Chloroform N.D. mg/l 0.0005 502.2

Unregulated Contaminants:

1,2-Dibromo-3-Chloropropane N.D. ug/l 0.02 504.1
Ethylene Dibromide N.D. ug/l 0.02 504.1

Synthetic Organic Chemicals:

Alachlor N.D. ug/l 0.1 525.2
Atrazine N.D. ug/l 0.1 525.2
Benzo(a)pyrene N.D. ug/l 0.1 525.2
Bis(2-ethylhexyl)adipate N.D. ug/l 0.6 525.2
Bis(2-ethylhexyl)phthalate N.D. ug/l 0.6 525.2
Simazine N.D. ug/l 0.1 525.2
Dioxin N.D. pg/l 3.7 1613
Endothall N.D. ug/l 5 548.1
PCB's N.D. ug/l 0.1 508A
Asbestos 0 --- 0.1 TEM

Pesticides by 505:

Chlordane N.D. ug/l 1.0 505
gamma-BHC (Lindane) N.D. ug/l 0.1 505
Hexachlorocyclopentadiene N.D. ug/l 0.2 505
Methoxychlor N.D. ug/l 0.2 505

Herbicides:

2,4-D N.D. ug/l 0.5 515.3
Pentachlorophenol N.D. ug/l 0.1 515.3
Picloram N.D. ug/l 0.5 515.3

Carbamate Pesticides:

Carbofuran N.D. ug/l 2.0 531.1
Oxymyl (Vydate) N.D. ug/l 2.0 531.1

Table 15 (Continued)

Public Drinking Water Analyses

Lake Water

Ecological and Hydrological Assessment October 30, 2001
Eagles Mere Lake Site 99L478

FIGURES

- Figure 1 Bathymetric Map of Eagles Mere
- Figure 2 Average Seasonal Temperature Values Lake Water
- Figure 3 Seasonal Dissolved Oxygen Values Lake Water
- Figure 4 Average Seasonal pH Values Lake Water
- Figure 5 Fall Turnover Temperature Data

Figure 6 Total Alkalinity of Lake Water
Figure 7 Wetland Location Map
Figure 8 Boundary of Surface Watershed Surrounding Lake
Figure 9 Elevation of Deep Ground Water Adjacent to Lake
Figure 10 Primary Areas of Inflow from Shallow Ground
Water
System Surrounding Lake

Ecological and Hydrological Assessment October 30, 2001
Eagles Mere Lake Site 99L478

FIGURE 1

Bathymetric Map of Eagles Mere

Ecological and Hydrological Assessment October 30, 2001
Eagles Mere Lake Site 99L478

FIGURE 2

Average Seasonal Temperature Values Lake Water

Figure 2
**Average Seasonal Temperature Values
Lake Water**

0.00
5.00
10.00
15.00
20.00
25.00
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
Depth (ft)

Temperature (degrees C)

Ave Temp Jul
Ave Temp Oct
Ave Temp Jan
Ave Temp Apr

Ecological and Hydrological Assessment October 30, 2001
Eagles Mere Lake Site 99L478

FIGURE 3

Seasonal Dissolved Oxygen Values Lake Water

Figure 3
**Seasonal Dissolved Oxygen Values
Lake Water**

0.00
2.00
4.00
6.00
8.00
10.00
12.00

14.00
16.00
18.00
20.00
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28

Depth (ft)

Dissolved Oxygen (mg/l)

Av. DO Jul

Av. DO Oct

Av. DO Apr

Ecological and Hydrological Assessment October 30, 2001

Eagles Mere Lake Site 99L478

FIGURE 4

Average Seasonal pH Values Lake Water

Figure 4

Average Seasonal pH Values

Lake Water

5.00
5.50
6.00
6.50
7.00
7.50
8.00
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28

Depth (ft)

pH

Av. pH Jul

Av. pH Oct

Av. pH Jan

Av. pH Apr

Ecological and Hydrological Assessment October 30, 2001

Eagles Mere Lake Site 99L478

FIGURE 5

Fall Turnover Temperature Data

Figure 5

0
10
20
30
40
50
8/16/00
8/30/00
9/13/00
9/27/00
10/11/00
10/25/00
degrees C
5 feet
15 feet

19 feet
38 feet
45 feet

Fall Turnover Temperature Data

Ecological and Hydrological Assessment October 30, 2001
Eagles Mere Lake Site 99L478

FIGURE 6

Total Alkalinity of Lake Water

Figure 6

Total Alkalinity of Lake Water

8

9

10

11

12

13

14

15

16

0 10 20 30

Depth (ft)

Total Alk.(as CaCO₃, mg/l)

Jul-00

Oct-00

Jan-01

Apr-01

Ecological and Hydrological Assessment October 30, 2001
Eagles Mere Lake Site 99L478

FIGURE 7

Wetland Location Map

Figure 7. Major Wetlands Surrounding Lake

Scale

1 inch = +/- 1250 ft

Approximate Locations of Major Wetlands Surrounding Lake

Ecological and Hydrological Assessment October 30, 2001
Eagles Mere Lake Site 99L478

FIGURE 8

Boundary of Surface Watershed Surrounding Lake

Ecological and Hydrological Assessment October 30, 2001
Eagles Mere Lake Site 99L478

FIGURE 9

Elevation of Deep Ground Water Adjacent to Lake

Ecological and Hydrological Assessment October 30, 2001
Eagles Mere Lake Site 99L478

FIGURE 10

Primary Areas of Inflow from Shallow Ground Water System Surrounding Lake