SOURCE WATER ASSESSMENT

LAKE KOON & LAKE GORDON

For the City of Cumberland, Maryland

Lake Koon, looking south-west towards dam

Prepared by
Maryland Department of the Environment
Water Management Administration
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EXECUTIVE SUMMARY

The 1996 Safe Drinking Water Act Amendments require states to develop and implement source water assessment programs to evaluate the safety of all public drinking water systems. A Source Water Assessment (SWA) is a process for evaluating the vulnerability to contamination of the *source* of a public drinking water supply. The assessment does not address the treatment processes, or the storage and distribution aspects of the water system, which are covered under separate provisions of the Safe Drinking Water Act. The Maryland Department of the Environment (MDE) is the lead state agency in this source water assessment effort.

There are three main steps in the assessment process: (1) *delineating* the watershed drainage area that is likely to contribute to the drinking water supply, (2) *identifying* potential contaminants within that area and (3) *assessing* the vulnerability of the system to those contaminants. This document reflects all of the information gathered and analyzed required by those three steps. MDE looked at many factors to determine the vulnerability of this water supply to contamination, including the size and type of water system, available water quality data, the characteristics of the potential contaminants, and the capacity of the natural environment to attenuate any risk.

Lake Koon and Lake Gordon are located in the Cumberland Valley of southeastern Pennsylvania. The linked reservoirs have a combined capacity of approximately 3.2 billion gallons and are the source of the City of Cumberland, Evitts Creek Water Treatment Plant which provides drinking water to approximately 50,000 customers in Maryland, Pennsylvania and West Virginia. The entire watershed above the intake encompasses approximately 50.8 square miles (33,200 acres), located in Bedford County, Pennsylvania. The watershed consists of mixed land use. The majority of the watershed consists of forested land. Data on agricultural land use varies between 18-35%, with most of this in the valley along Route 220. Potential sources of contamination to Lake Koon and Lake Gordon are agricultural land including crops and pasture, discharges from three small wastewater treatment plants, spills and runoff from roads, especially Route 220 which runs through the watershed, timber harvest operation in the forested land, and existing and future development in the watershed. Review of water quality data available indicates that nutrient enrichment, sedimentation and contamination by pathogenic organisms are the major concerns.

The City of Cumberland's surface sources are vulnerable to various activities occurring within the watershed. Continuous monitoring of contaminants is important to understand changes in raw water quality to assure delivery of safe drinking water to the City's customers. Following the existing watershed management plan that was adopted by City of Cumberland and its partners in Pennsylvania will improve the safety and reliability of its water supply. The goals and recommendations of the watershed plan should be regularly evaluated to improve its ongoing effectiveness in protecting this critical resource for the citizens of Cumberland and surrounding communities.

A. Background

The 1996 Safe Drinking Water Act Amendments require states to develop and implement source water assessment programs to evaluate the safety of all public drinking water systems. A Source Water Assessment (SWA) is a process for evaluating the vulnerability to contamination of the *source* of a public drinking water supply. The assessment does not address the treatment processes, or the storage and distribution aspects of the water system, which are covered under separate provisions of the Safe Drinking Water Act. The Maryland Department of the Environment (MDE) is the lead state agency in this source water assessment effort.

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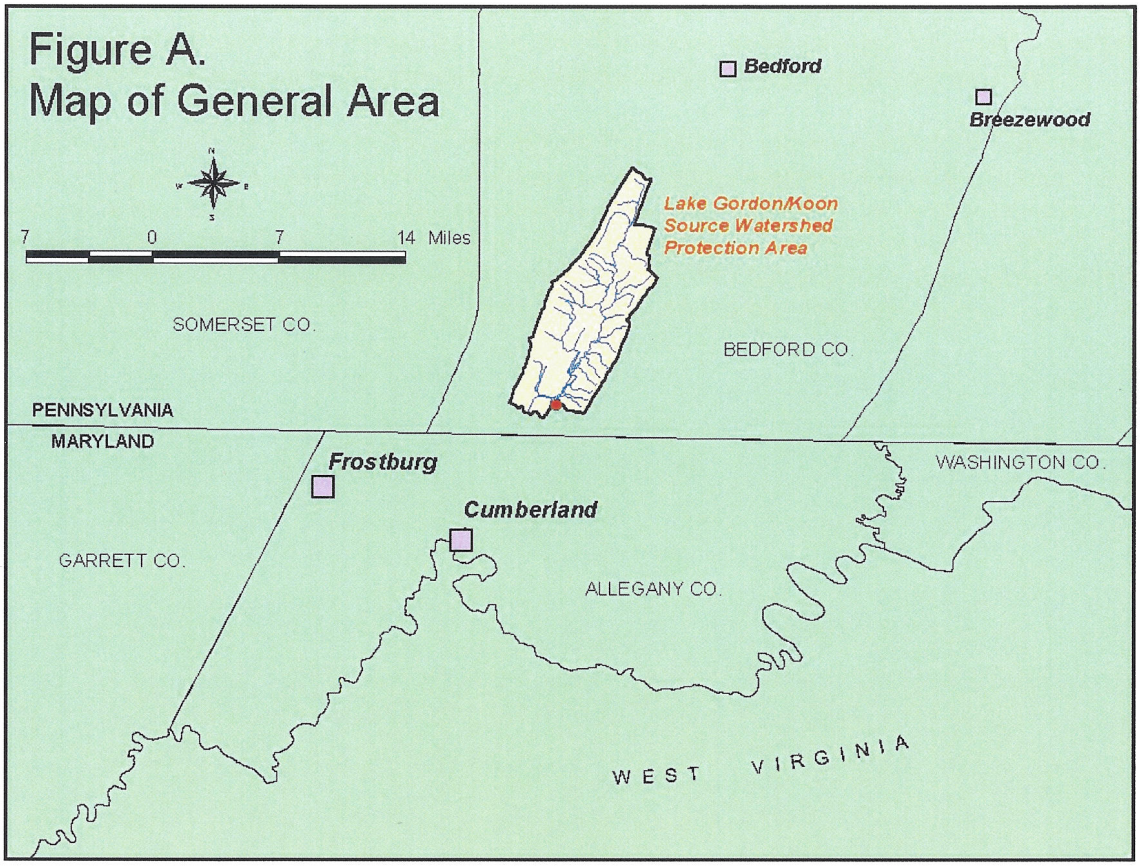
Maryland has more than 3,800 public drinking water systems. Approximately 50 of Maryland's public drinking water systems obtain their water from surface supplies, either from a reservoir or directly from a river. The remaining systems use ground water sources. Maryland's Source Water Assessment Plan was submitted to the Environmental Protection Agency in February 1999, and received final acceptance by the EPA in November 1999. A copy of the plan can be obtained at MDE's website, www.mde.state.md.us, or by calling the Water Supply Program at (410) 537-3714.

B. City of Cumberland's Water Supply

The City of Cumberland, located in Allegany County, Maryland, relies on a linked reservoir system to supply its drinking water needs and that of surrounding communities. Lake Gordon and Lake Koon are located approximately 10 miles northeast of Cumberland, in Cumberland Valley Township, Bedford County, Pennsylvania. Lake Gordon, the smaller of the two lakes and where the City draws its water supply, is located downstream of Lake Koon. Drinking water is treated at the Evitts Creek Water Treatment Plant, and distributed by the City of Cumberland to approximately 50,000 customers in Maryland, Pennsylvania, and West Virginia.

The City of Cumberland supply is unique for a Maryland water system, because its entire source of water is located out of state. Below is a figure depicting the general area:



In 1913, The City of Cumberland built a dam across Evitts Creek, a tributary to the North Branch of the Potomac River. The original dam created Lake Gordon, which had a surface area of 135 acres and a capacity of 1.3 billion gallons (BG). Then in 1932, and additional dam was constructed above Lake Gordon, creating Lake Koon with a surface area of 192 acres and a capacity of 2.3 BG. Cost of construction in 1932 was 1 million dollars. According to a 1970's brochure by the city, "the crystal like waters (of the lakes) have blended in so harmoniously with the natural beauty of their setting that they attract thousands of sightseers." The original water plant was one of only two plants in the U.S. at the time to use anthracite coal in the filters.

Discharge from Lake Koon is managed by the city and is used to control reservoir elevation in Lake Gordon, where the raw water intake for the treatment plan is located. From the intake structure in the dam, lake water is sent to the Evitts Creek Water Treatment plant, which is located adjacent to the lake and dam. The plant is in operation 24-hours per day and has a design capacity of 14.0 million gallons per day (MGD); however, it usually produces 9.0 MGD of drinking water. Evitts Creek Water plant employs conventional treatment techniques, including coagulation and mixing, flocculation, dissolved air flotation (DAF) clarification, filtration, and disinfection by chlorination (MDE- CPE, 2000). Dissolved air flotation was added in the late 90's to assist in the removal of high concentrations of algae.

C. Description of Surface Water Source

Lake Gordon and Lake Koon are a linked reservoir system formed by two impoundments on Evitts Creek. The reservoirs are located northeast of Cumberland in the Evitts Creek watershed, which drains the commonly referred to Cumberland Valley. Both reservoirs were created in the early 1900's to supply the City of Cumberland with public water. Lake Gordon was constructed first, in 1913; it is a concrete structure with an elevation of 948.5 ft (above sea level). In 1991 the spillway was lowered to its current elevation of 947.1 feet MSL. Lake Gordon has a surface area of approximately 135 acres and according to the latest study completed in April, 2002 by the City's consultants (Gwin Dobson and Foreman), the total volume of water stored in the lake is approximately 1.13 billion gallons. Because of the intake location, approximately 1.037 BG are available as drinking water. Safe yield from the reservoir is 16 MGD. Lake Gordon has an average depth of 15 feet, and a maximum depth of 70 feet (FX Browne, 1998). Lake Gordon had a hydraulic residence time of 0.34 years, or 124 days, during a two-year study that included a hydraulic budget (FX Browne, 1998).

Lake Koon, constructed in 1932, is approximately 1.3 miles upstream of the Gordon Dam, and is the larger of the two lakes. Koon's surface area is 268 acres and the lake had an original capacity of 2.3 billion gallons and the current capacity is 2.2 billion gallons at the elevation spillway of 1015.92 feet (MSL). The elevation of the dam crest is 1017 feet above sea level. Average depth in Lake Koon is 17 feet, and the maximum depth is 70 feet. Lake Koon has a hydraulic residence time of 0.71 years, or 259 days (FX Browne, 1998).

Water enters Lake Koon primarily from Evitts Creek. A secondary tributary, Growden Run, feeds the lake as well, creating a northwest finger in Lake Koon (see Figure 1). Lake Gordon backs up to the dam at Lake Koon, unlike other linked reservoir systems in the state, which are located farther apart (e.g. Baltimore City, WSSC). The primary source of water into Lake Gordon is from releases on Lake Koon. In addition to the water from Lake Koon, there is a small tributary, Oster Run, which enters the western edge of the Lake Gordon. Evitts Creek is part of the North Branch of the Potomac watershed, a 499-square mile watershed that drains portions MD, PA, and Wva. According to Maryland regulations, Evitts Creek is classified as a Class IV-P stream; it is a naturally reproducing trout stream that also provides water supply. Class IV-P water has the same protections as Class I-III (fishable & swimmable), with additional regulations regarding thermal pollution. However, only the lower portion of Evitts Creek, below both lakes, is located in Maryland. Evitts Creek has its headwater region near the community of Burning Bush along Rt. 220 in Cumberland Valley Township. The main stem travels for approximately for 12.5 miles before emptying into Lake Koon. There are numerous secondary and tertiary tributaries entering Evitts Creek before its confluence with the lake. According to a 1998 study average discharge from Evitts creek over a two-year period was 10.56 cubic feet per second (cfs)(FX Browne, 1998). Growden Run, which flows directly into Lake Koon, is the largest sub-

tributary in the watershed. Growden Run drains the forested eastern slope of Wills Mountain before emptying into a wetland-type setting on the lake. Oster Run, another main tributary, flows directly into Lake Gordon; it also drains the eastern slope of Wills Mountain.

Evitts Creek flows between two ranges of the Allegany Mountains, Wills Mountain and Evitts Mountain. These ranges trend southwest to northeast and form the border of the source water protection area for lakes Gordon and Koon. The source water protection area, or watershed, for the drinking water intake on Lake Gordon encompasses approximately 50.8 square miles (33,200 acres) of mostly forested land with some agricultural land use in the Cumberland valley. Since Lake Koon flows into Lake Gordon, the intake watershed includes all of the land directly draining into Lake Koon, and land that drains directly into Lake Gordon, which comprises about 16% of the entire watershed (FX Browne, 1995). The watershed is located entirely within Bedford County, Pennsylvania. The Cumberland Valley Township is relatively flat, and slopes gently down to Evitts Creek. However, the slopes in the valley become much steeper (8-25%) along the flanks of Wills and Evitts Mountain. These two mountain ranges are part of the Valley and Ridge geological province (FX Browne, 1995). Maximum elevation along these mountain ridges is between 2400 – 3300 feet above sea level, while elevations in the rolling valley range from 1200 – 900 feet above sea level, with elevation generally dropping from north to south.

Several geological formations underlie the source water protection watershed. These include the Onondaga/Old Port, Tuscarora, and Bald Eagle formations. The rock formations are mostly composed of shales and sandstones. The major soil group found in Bedford County, and common to the northeastern U.S., is the major Gray-Brown Podzolic soil grouping. These soils are derived from shale, limestone, and sandstone. Local soil series near the lakes include the Hazeltine-Clymer, Buchanon, and Morrison, Channery Silt-Loam. These soils are moderate to highly erodable, and contain limestone (FX Browne, 1995).

D. Source Water Protection Site Visit

Personnel from the Maryland Department of the Environment's Water Supply Program visited the Evitts Creek Water Company system on January 19, 2000 to discuss the assessment of the Lakes Gordon/Koon, and to describe the source water protection program. Main objectives of this 1st site visit included: obtaining an accurate GPS location of the water supply intake, inspecting the integrity of the intakes, and documenting operator's source water concerns. A windshield survey of the watershed was also undertaken, and further trips have been made to both the lakes and the watershed.

Intake Integrity

Cumberland's water intake is located in a tower adjacent to the Lake Gordon Dam. There are four intake levels, or gates, but usually only two gates are used. These two gates are gravity flow and are located at a depth of 8 and 28 feet. Very high demand or low reservoir levels would necessitate the use of the two pumped intake gates, at 18 and 38 feet. Water from these two gates enters a wet well where there are two low-level 9 MGD pumps. Each intake sluice gate has a 3x3 feet opening. All of the intake gates are screened and manually cleaned when the need arises. The screens can be cleaned by reverse pumping and blowing debris back out of the intakes (MDE Inspection Report). From the intake structure, water is transferred to the treatment plant (several hundred feet) by a 36-inch gravity flow pipe. City officials expressed no concerns with the current intake structure, but expressed the desire for the construction of an entirely new intake in the future.

Operator Concerns and Site Visit Observations

In addition to informally inspecting the dam/intake structure, a watershed survey (by car) and a discussion with plant operators and officials was undertaken to determine potential sources of contamination to the water source. Below is a list of concerns that may affect the water quality in the lake/watershed system. This list reflects operators concerns from the original meeting; a questionnaire filled out by city officials, and MDE (multiple) site visit observations:

1. High sedimentation rates in Lake Koon
2. Algae blooms, especially winter blooms of *Synuria.*
3. Spills due to accidents along Route 220.
4. Concentrated agricultural facilities, future plans for corporate hog farms.
5. Non-point sources of pollution listed in FX Browne's 1998 Watershed Report.

E. Watershed Characterization

Source Water Assessment Area Delineation Method

An important aspect of the source water assessment process is to delineate the watershed that contributes to the source of drinking water. A source water protection area is defined as the whole watershed area upstream from a water plant's intake (MDE – SWAP, 1999). Delineation of the source water area was performed by using ESRI's ArcView Geographic Information System (GIS) software, utilizing existing GIS data, and by collecting location data using a Global Positioning System (GPS). A GPS point location was taken at Frostburg's intake on the reservoir during the initial site visit and differentially corrected (for an accuracy of +/- 2 meters) at MDE. Once the intake location was established, the watershed was delineated based on existing Pennsylvania digital watershed data and on EPA and USGS Reach files I and III; vector stream coverages. Digital USGS 7.5 topographical quad maps, obtained through the Pennsylvania Spatial Data Access website, were also used to perform "heads up" digitizing, or editing, of watershed boundaries when needed.

General Characteristics

The source watershed above the Lake Gordon dam is approximately 13.5 miles from the dam to the headwaters of Evitts Creek, near the community of Burning Bush. The watershed has an almost uniform width (with a maximum width of around 4.8 miles). The width of the agricultural Cumberland Valley is between 1-2 miles above the reservoirs. The entire watershed encompasses approximately 50.8 square miles (33,200 acres). A majority of land within the watershed is forested, with most concentrated along the slopes of Wills and Evitts Mountain. There is a substantial amount of agricultural land, including pasture, which is primarily located in the valley along the Route 220 corridor.

The City of Cumberland owns approximately 4,100 acres in the watershed, adjacent to the two lakes. Other large tracts of public land in the watershed include portions of the Buchanan State Forest (1350 acres), and State Game Land No.48 (3672 acres). Buchanan State Forest is located on Evitts Mountain. State Game Land No.48 runs the ridge and eastern slope of Wills Mountain on the western boundary of the watershed (see Figure 3). All of these properties are heavily forested.

Below is a summary of land use in the Lake Gordon/Koon watershed. This data is from the Multi-Resolution Land Characterization Consortium (MRLC), a partnership of federal government agencies that produce or use land cover data. The data is based on 30-meter Landsat thematic mapper (satellite) data, and is commonly referred to as the National Land Cover Data

set. The MRLC data was designed for use in hydrologic and water quality models. The data below is from the 1997 MRLC data set for EPA Region III (also see Figure 2):

Land Use	Total Area in Acres	Percent of Total Watershed
Open water	421.1	1.3
Low Residential	10.0	<0.1
Commercial/Industrial	14.5	<0.1
Pasture/Hay	833.0	2.5
Cropland	5216.8	15.9
Evergreen	210.1	0.6
Mixed Forest	930.5	2.8
Deciduous Forest	24692.3	75.2
Wooded Wetlands	32.7	0.1
Wetlands	32.4	0.1
Transitional	439.2	1.3

Table 1. Land Use

According to the 1998 FX Browne watershed management report, the percentage of agricultural land in the watershed is almost double compared to the MRLC data used in this assessment. Land use data for the FX Browne report was gathered from a variety of sources, including the Bedford County Soil Conservation District, Bedford County Planning Commission, and the City of Cumberland. However, both data sources agree that most of the watershed is forested, with very little residential, industrial or commercial properties within the source watershed. The percentage of agricultural land use is somewhere between 18-35% of the total watershed area, depending on the data being analyzed. Based on field inspections and the 1998 report, most of the agricultural land is located in the valley along the Route 220 corridor, and consists mainly of dairy and cattle farms. A majority of the forested land in the watershed is privately held (FX Browne, 1998).

Subwatersheds

Maryland's Source Water Assessment Plan states that larger source water areas will be segmented into smaller sub-watersheds to assist in the assessment and identify watersheds of concern. The Lake Gordon/Koon source watershed is segmented into four sub-watersheds for the purpose of this report (see Figure 3).

Below is a breakdown of land use in the major subwatersheds; Evitts Creek above Lake Koon, Growden Run, Oster Run, and land that drains directly into the lakes. Based on the 1997 MRLC data, major land use classifications are summarized:

Table 2. Subwatershed Land Use

Sub-Watershed	Total Acres	Forest	Agriculture	Other
Evitts Creek	20057	79.5	19.9	0.7
Growden Run	5218	75.2	24.5	0.3
Oster Run	2349	72.0	22.3	5.7
Lake Drainage	5157	82.0	5.1	13.0*

* mostly Open water

Evitts Creek

The largest sub-watershed, and main tributary to the lakes, it includes many smaller tributaries that drain down the slopes of Wills and Evitts Mountain. The main stem of Evitts Creek runs down the valley floor and is primarily bordered by agricultural land. The watershed is mostly forested, with the agricultural land concentrated along the valley and Route 220 corridor (see Figure X). Residential areas within this sub-watershed include the communities of Centreville and Patience, which are the two largest population centers in the entire source watershed. The 1998 watershed report noted that Evitts Creek was the main contributor of phosphorous, nitrogen, and suspended solids to Lake Gordon/Koon system, both in total pounds per year, and total pounds per acre/year. The same report identified several non-point pollution sites in the sub-watershed, including areas of agricultural runoff and stream bank erosion. There are two small point sources of pollution within this subwatershed; an elementary school wastewater discharge directly into Evitts Creek, and a small residential wastewater discharge into Sand Run, a tributary to Evitts Creek.

Growden Run

The Growden Run subwatershed is approximately 8.2 square miles (5200 acres), making it the second largest subwatershed in the source water protection area. Like Evitts Creek, Growden Run discharges directly into Lake Koon. Similarly, most of the forested land (~75%) is located on the eastern slope of Wills Mountain, with agricultural land (~24%) located in the lower valley. Route 220 passes through the subwatershed, and there are scattered residences along this main transportation corridor. Analyses of digital orthophotoquads (aerial photography) show numerous forest roads leading up into PA State Game Land No.48. Six non-point source pollution sources (bacteria, sediment, nutrient runoff) were identified by the Bedford County Planning Commission in this subwatershed (FX Browne, 1998).

Oster Run

The Oster Run subwatershed is the smallest in the source watershed encompassing only 3.7 square miles (2376 acres), but is important, because it is the only tributary enters directly into Lake Gordon. The subwatershed is bordered by Wills Mountain to the west, and the smaller Shriver Mountain to the east. The main stem of Oster Run runs southeast for approximately 2.5 miles from its headwaters before discharging into a wetland area adjacent to the lake. The watershed is heavily forested (~72%) with some agricultural land located in the valley, which is less than a mile wide in this area. According to the Bedford County Planning Commission, there are at least seven non-point pollution sources, or impacted areas, within this relatively small watershed, including agricultural runoff, excessive sedimentation, and sewage disposal problems. The MRLC land use data identifies a large area of transitional land on the slope of Wills Mountain, which may be the remnants of a forest harvesting operation. Analysis of DOQQ photos depicts several forest roads in this area.

Lake Drainage

This subwatershed (see Figure 3) includes all of the land that drains directly into both lakes, excluding Oster Run, and Evitts Creek. A significant portion of this subwatershed is forested (~82%) and owned by the City of Cumberland. There is very little agricultural land (~5%) adjacent to the lakes. Open water accounts for approximately 8% (~400acres) of the land use in this subwatershed. There are several small roads in the watershed, including Evitts Creek Road (SR 3009), which is adjacent to both reservoirs and crosses Lake Gordon and the Lake Koon Dam.

Local Characteristics

The land surrounding the reservoir is heavily forested and owned by the city of Cumberland. The city owns approximately 4000 acres around the lakes and in the watershed. Under an agreement with the PA Fishing and Boat Commission, fishing is permitted on the lakes by boats with electric motors. The commission in turn increased patrols around the lake and watershed (littering, dumping, camping prohibited). The city manages the forest property as an uneven aged tree stand, and past thinning (logging) operations have occurred on at least 1000 acres of city-owned land (FX Browne, 1998). Very little clear cutting is permitted, and the city has a forestry management plan in place.

F. Potential Sources of Pollution

Non-Point Pollution Sources

Without any urban area in the watershed, Lakes Gordon and Koon are not threatened by urban non-point pollution runoff. Analysis of land use data, aerial photography, and watershed surveys show that the watershed does not contain any significant sources of contaminants associated with urban or commercial runoff, such as oil, grease, and toxic chemicals. The data also shows that the watershed is mostly forested with patches of agricultural land use. The EPA considers non-point agricultural runoff (nutrients, sediments, pesticides) the number one water quality impairment of lakes and streams in the United States. Non-point pollution sources associated with residential, agricultural, and forested land will be discussed below.

Residential Land

Most of the population in the Cumberland Valley lives in the two small communities of Patience and Centreville, both located on Route 220. There are approximately 60 residences in and around Centreville, and less than that around Patience (FX Browne, 1998). Most residences in the watershed are not located within a sewer service area (or planned area), and rely on domestic septic systems. If septic systems fail, they become potential sources of contamination conveying pathogenic protozoa, viruses, and bacteria into receiving streams. Past reports in the watershed indicate that failing or improperly working septic systems occur within the Lake Gordon/Koon watershed. A 1994 sanitary survey done by the city as part of a permitting process identified failing septic systems at various locations throughout the watershed as pollution sources. According to MRLC land use data, less than 1% of the watershed is used as residential land. However, residences and farmsteads are spread throughout the watershed, and may not be depicted in the land use because of the pixel limitation of the MRLC data. There were several sewage disposal problem areas identified in the 1998 watershed report. Most were located in the Evitts Creek subwatershed, and involved septic leachate discharging from single residential homes into small tributaries. To address these problems, the City entered into an agreement with Cumberland Valley Township in February, 2000 to accept septic tank waste at the Cumberland WWTP without a disposal fee. The agreement is contingent upon an approved on-site sewage system plan as required by the State of Pennsylvania.

Agriculture

According to the MRLC land use data, almost ~18% of the watershed is used for agricultural purposes (15.9% cropland, 2.5% pasture). However, previous studies have reported agricultural land use at around 35% of the land area (FX Browne, 1998). Also, the percentage of pastureland is most likely a greater part of the total agricultural land use, based on field inspections. In general, most of the agricultural land in the source watershed is comprised of pasture or crop

fields for dairy or cattle operations, and a majority of this land is located in the lower valley along the Route 220 corridor (see Figure 2).

Land used to grow crops can be a source of nutrients (from fertilizer), and synthetic organic compounds (pesticides). Agricultural land can also be a source of sediment runoff from erosion. Areas of excessive sedimentation have been identified in both Lake Gordon and Koon, and plant officials have expressed their concern with sedimentation in the reservoirs. The 1998 watershed report identified agricultural land use as the main source of nutrient and sediment pollution in the reservoirs.

Pastures used to graze livestock can be sources of pathogenic protozoa, viruses, and bacteria from animal waste; additionally animal waste from pastures can also contribute to excessive nutrient (nitrogen and phosphorous) loading. If livestock are allowed unfettered stream access, they can also contribute to stream bank erosion. There are a number of dairy and cattle farms within the watershed, where livestock density is high. These areas are generally referred to as concentrated agriculture feeding operations, or CAFOs. CAFOs have the potential to be serious pollution sources. In general, they can generate over a 1000 times more nutrients per acre than forested land.

Previous studies, by the Army Corps of Engineers and the Interstate Commission for the Potomac River Basin, identified areas and locales where non-point sources were detrimental to the water quality of the system. The original study by the Corps identified 27 problem areas; the Commission study looked at 13 farms in the watershed and assessed the potential of Best Management Practice (BMP) implementation. The 1998 FX Browne report updated these sites, and produced a map depicting the areas with the help of the Bedford County Planning Commission (a copy of this map is included in the Appendix). Since 1998, however, it is believed that some of these sites have implemented BMPs, such as stream fencing, manure storage facilities, cattle crossings, etc. (personal communication, water plant official). Still, agricultural non-point source pollution is the biggest factor affecting the water quality of Lakes Gordon and Koon.

Forestry

A timber harvest operation can disturb 8-10% of the total work area by road building and creating landing sites. These areas, if not maintained, can contribute to erosion in streams and sedimentation in receiving waterways. The City of Cumberland owns approximately 4000 acres of forestland in the Lake Gordon/Koon watershed, mostly around the reservoir. This accounts for a small portion of the total forested land in the watershed. It is estimated that 17,902 acres of forest is privately held. The city land is timbered to generate revenue and manage the forest, and harvesting follows a management plan designed by a private contractor in 1986. The city timbers the land regularly, and the predominant practice is select cutting, which involves removing only desirable trees from the cut area (check on this). Clear cutting is not permitted on city property, except for very small stands (FX Browne, 1998). Clear cutting is the most controversial method of tree harvesting, and usually increases soil erosion. In addition, the forested slopes in the watershed are generally high, which can escalate the potential problems associated with forestry harvest. All timber contracts between the city and private lumbering companies contain PA Forestry Association Timber Harvesting Guidline provisions that must be followed. A major objective of these provisions is to ensure that Lake Koon and Gordon are protected from increased sedimentation.

According to the 1998 watershed report, timbering operations are present throughout the watershed. This includes state-owned land, such as Buchanan State Forest, which occupies 1350-

forested acres of the source watershed. Harvesting on state land is done by the PA Department of Conservation and Natural Resources, Bureau of Forestry, and all operations require acceptable forestry management standards designed to reduce sedimentation and water pollution as a result of logging. Logging is also performed in State Gameland #48. The Bedford County Conservation District is responsible for administering forestry permits on private land within the watershed. Permits are only granted if proper soil erosion and sediment pollution control plans are in place. The district conducts field inspections and has enforcement powers through PA Law (Chapter 102 Clean Stream Law). The 1998 water shed report estimated that ~30% of the suspended solids (sediments) entering the Lake Gordon/Koon system originate in the forested portions of the watershed (FX Browne, 1998). At least two harvesting sites in the watershed, both located on Will Mountain, were identified as problems (sediment and nutrient runoff). Disturbance to these forested areas may increase the amount and percentage of solids from this land; especially if proper forestry management practices are not in place.

Mining

Wills and Evitts Mountain are east of the coal seam bearing mountains in Pennsylvania, Maryland, and West Virginia. A review of spatial data from PA shows that there are no active coalmine areas in the watershed. The existence of mines (coal or otherwise), and impacts on water quality due to mining operations have not been documented in previous watershed studies, and it believed that the Lake Gordon/Koon system is not threatened from mining impacts.

Point Discharge Concerns

There are three small permitted dischargers located within the Lake Gordon/Koon watershed. All three discharges are treated wastewater. The largest, near Centreville, is the Cumberland Valley Elementary School, which is a 2500-gallon per day (gpd) facility. Wastewater is discharged into a small tributary, Wentling Run, about a mile west of Evitts Creek. The discharge is approximately 5.2 river miles above Lake Koon. The other two wastewater discharges are from residential family units, and both are relatively small. One is a single family residence that discharges 400 gpd into Oster Run, and the other is a 2-family residential treatment plant that disharges 700 gpd into Sand Run, a tributary of Evitts Creek (FX Browne, 1998). All of these discharges are relatively small and are located a significant distance from Lake Koon, and the intake on Lake Gordon. If working properly, they do not pose a serious threat of contamination to the reservoirs.

Transportation Related Concerns

Potential contaminants related to transportation include; runoff from paved surfaces, toxic chemicals, and the potential for hazardous spills. There are numerous state and unimproved roads in the Lake Gordon/Koon watershed, but the only substantial road is Route 220, which runs through the watershed for approximately 15 miles down the center of the Cumberland valley. Route 220 is the main north-south transportation corridor in this area, and transportation of hazardous material along this route is most likely a common occurrence. Operators expressed a concern over a potential spill on Route 220. There are several stream crossings along the route, and the road runs adjacent to Evitts Creek in the far reaches of the watershed. However, the areas with the most spill potential damage are the road crossings over Oster Run and Growden Run because of their proximity to the reservoirs. Route 220 crosses Oster Run approximately 500 yards above Lake Gordon.

Other main roads through the watershed include Evitts Creek Road (State Route 3009), and the unnamed State Route 3011, both run in a north-south direction east of Evitts Creek and the reservoirs, along the base of Evitts Mountain. Evitts Creek Rd. runs adjacent to Lake Koon for approximately 2 miles before crossing over the Lake Koon dam and continuing down the west

side of Lake Gordon. There is one bridge/reservoir crossing on Lake Gordon. The potential for hazardous spills along Evitts Creek Road is probably minimal, but its location could make a hazardous spill dangerous because of its proximity to Evitts Creek and the reservoirs.

Analysis of DOQQ photos show that there are numerous unimproved access/forest roads in the city's property, on Wills and Evitts Mountains, and throughout the watershed in general. Stormwater runoff from these roads may contribute to erosion and sedimentation problems.

Operators and previous reports have not expressed any water quality concerns over the application of salt compounds to de-ice winter roads. However, road salt application along Route 220 is probably common in the winter months. Similar reservoirs in the immediate region, such as Piney Reservoir near Frostburg, have documented high concentrations of sodium and chloride in surface waters.

A petroleum pipeline is apparent in topographic maps in the northern extremity of the source watershed, and is referred to in the 1998 FX Browne report as Texas East pipeline. The pipeline travels for approximately ~1 mile through the upper watershed, miles above Lake Koon, but fairly close to the headwaters Evitts Creek. The existence of a pumping station is also mentioned in the report. Leaks from the pipeline and/or station could result in volatile organic compound contamination.

G. Review of Water Quality Data

Several sources of water quality data were reviewed for the City of Cumberland's source water assessment. Included in the review is data from multiple sources, including MDE collected data as part of the Safe Drinking Water Act amendments, Monthly Operating Reports (MORs) from the Evitts Creek Water Company treatment plant, City collected bacteriological data, and data from a city sponsored water quality monitoring project in 1994 and the 1998 319-watershed management project completed by FX Browne, for the city, the PA Department of Environmental Protection, and the Bedford County Soil Conservation district.

MONTHLY OPERATING REPORTS

Existing Plant Data-Raw Water

The City of Cumberland is required to record and submit water quality testing in a monthly operating report to MDE's Water Supply Program. These reports include some testing of the reservoir and groundwater supplies, or "raw" water. Turbidity, pH, Iron, and Alkalinity are the parameters tested daily at the treatment plant. Review of this data shows that the raw water usually have a very low turbidity an acceptable pH. Turbidity is a measure of the waters "cloudiness" and is used as a surrogate indicator of pathogenic organisms, such as bacteria. Raw water turbidity data was analyzed during the March 2000 MDE Comprehensive Performance Evaluation of the Evitts Creek water treatment plant. From March 1999 to February 2000 daily turbidity readings had a mean value of 1.8 NTU (median value = 1.5, with a maximum value of 5.2 NTU recorded in November 1999. MOR data was also reviewed for 2001. Monthly turbidity averages ranged between 0.55 – 1.62 NTU. Alkalinity (avg. = 68 mg/L) and pH (avg. = 7.6) values were within drinking water limits. High concentrations of iron and manganese are usually associated with aesthetic and nuisance effects such as taste and odor problems and fixture staining, but are not necessarily public health concerns. Iron was tested in the raw water in the early months of 2001. Then in October of 2001, Cumberland stopped testing for iron and began

monitoring the concentration of manganese. The secondary MCL for Iron is 0.3 mg/L, data from the first half of 2001 shows that iron concentrations did not exceed this standard. Manganese has a secondary guideline concentration of 0.05 mg/L. Data from the plant shows that this standard was exceeded, by almost double, in the later half of 2001. Manganese concentrations in Lake Gordon averaged 0.40 mg/L during the late summer and fall of 2001. Most likely manganese is released from the sediments and bottom waters during the late summer and fall due to low dissolved oxygen conditions in the hypolimnion of the lake, increasing concentrations at the raw water intake. In response to these high concentrations, the Evitts Creek Water Company installed aerators on the bottom of Lake Gordon in 2002 to mix oxygen throughout the water column, and reduce the amount of manganese released from the sediments during anoxic conditions.

At MDE's request, the City of Cumberland initiated a two-year bacteriological monitoring program to assist in the source water assessment. Sampling began in Lake Gordon in September 2000 with bi-weekly samples taken from the reservoir. Below is a summary of this data:

> *Fecal Coliforms* –18 of 27 samples had concentrations of 1.1 MPN/100ml or less. The maximum concentration of fecal coliform was 23 MPN/100ml in September 2000.
>
> *E.coli*. – 18 of 25 samples tested for E.Coli had concentrations of 1.1 MPN/100ml or less. The highest concentration of E.Coli observed was 12 MPN/100mL in April 2001.

REGULATED TESTING

The City of Cumberland is also required to test for regulated contaminants in its finished water supply produced at the water treatment plant. These contaminants are listed by the EPA as the National Primary Drinking Water Regulations, and have been assigned maximum contaminant levels (MCLs). A large number of these samples are collected by MDE and analyzed by the Department of Mental Health and Hygiene, or a private environmental laboratory. The data is reported to MDE's Water Supply Program. Tests for Synthetic Organic Compounds (SOCs), Volatile Organic Compounds (VOCs), and Inorganic Compounds (IOCs), are required on an annual basis. Below are summaries of these regulated contaminants from Cumberland's treated drinking water.

Inorganic Compounds

IOCs have been annually tested in drinking water for some time, depending on the contaminant. Most metals and nitrates have been tested regularly since 1977, but in 1993, nitrite and several other metals (such as selenium and thallium) were regulated. MDE's Water Supply database contains sample results since 1993.

Nitrate and Nitrite

Since 1993, nitrate is the most commonly detected IOC in the Cumberland finished drinking water. According to the MDE Water Supply database, there have been 13 detections. The MCL for nitrate is 10 mg/L. The mean concentration of nitrate from these detections was 0.60 mg/L, with a median value of 0.5 mg/L, both well below the MCL. The highest sample concentration of 1.0 mg/L (nitrate) was detected in May 1996. Cumberland is not required to test for nitrite because previous samples were well below the MCL. Three detections of nitrite from the 1990's averaged 0.006 mg/L, significantly below the MCL of 1.0 mg/L.

Trace Metals
Several metals have been detected in Cumberland's finished water supply including: barium (five times), chromium (2), and thallium (1). Detections for barium and chromium were well below 50% of the MCLs for each metal. Most concentrations were just above the standard detection limit. Barium, the most common detect, had an average concentration of 0.035 mg/L, well below the MCL of 2.0 mg/L. Thallium, though only detected once in 1993, had a sample concentration equal to the regulated MCL of 0.002 mg/L.

Radionuclides
Radionuclide testing for Alpha and Betta emitters is required once every four years. There were no detections of radionuclides in 1996. Gross beta radiation was measured at 2 pC/L in May 2000, well below the MCL of 50 pC/L. There were no Gross Alpha or radium detections in 1996 or 2000.

Other Inorganic Compounds
Several other IOCs have been detected in the finished water supply namely: sodium (7), sulfate (9), fluoride (3), chloride (2), and cyanide (1). Some of these contaminants are covered by the secondary drinking water regulations, which are non-enforceable guidelines to limit aesthetic and nuisances effects in drinking water. Concentrations for fluoride, sulfate, and sodium, and chloride have been below recommended limits. Cyanide, which has a regulated MCL of 0.2 mg/L, was detected in 1993 with a concentration of 0.01 mg/L, just above the detection limit and well below the MCL.

Synthetic Organic Compounds
MDE tests for regulated and un-regulated SOCs annually from the finished water supply at Cumberland. Since 1995, there have been 11 detections, including: Dalapon (3), Di(2-ethyhexyl) Adipate (3), Di(2-ethyhexyl) Phthalate (4), and Pentachlorophenol (1). These detections have been significantly less than the regulated contaminant MCLs.

Volatile Organic Compounds
VOCs were regulated in 1993, and several more were added for monitoring in 1998. There have been only two regulated VOC detections in the Cumberland's water supply since sporadic testing began in 1989; tests are now conducted on an annual basis. The two compounds detected were ethylbenzene and xylene. Both of these VOC detections were less than the MCL. The last regulated VOC detection in Cumberland's raw water supply was in 1990.

Disinfection Byproducts
In addition to the regulated (and un-regulated) VOC testing, compounds known as Trihalomethanes (THMs) are also tested in the Cumberland finished water supply. THMs are the result of residual organic matter combining with chlorine during the disinfection process of water treatment. THMs, of which there is four different recognized compounds, are regulated on a total concentration basis. THM data has been collected since 1991. Since testing began, the *total* concentration of THMs has averaged 30.3 µg/L, with a maximum total concentration of 107.8 µg/L detected in July 2000.

Haloacetic acids (HAAs), are another form of disinfection byproducts (DPBs). Like THMs they are regulated on a total concentration basis, and the current MCL of 60 µg/L for HAAs went into effect on January 1, 2002 for systems serving greater than 10,000 people, which includes Cumberland. HAAs have been detected in 40 samples taken by Cumberland in its distribution

system since 1999. The average concentration of HAAs in these samples is 19.8 µg/L, with a maximum observed concentration of 58.3 µg/L in November 2000.

LAKE KOON & LAKE GORDON WATERSHED MANAGEMENT PLAN, 1998

Due to pollution concerns in the reservoirs, which included sedimentation, algal blooms, and low dissolved oxygen levels, the City of Cumberland funded a water quality study in the early 1990's designed to assess the baseline condition of the reservoirs and major tributaries. This preliminary study, along with additional data collection in 1997, led to the 1998 Watershed Management Plan, which was sponsored by the city, the Bedford County Soil Conservation district, and the PA Department of Environmental Protection. This comprehensive study identified sources of pollution, calculated pollution loads and hydrologic budgets, and determined the ecological health of the reservoirs. An executive summery of this watershed management report is included in the appendix. Below is a summary of the findings from both the preliminary study, referred to as the *Preliminary Water Quality Study of Lake Koon & Lake Gordon (FX, Browne, 1995),* and the comprehensive *Lake Koon & Gordon 319 Watershed Assessment (FX Browne, 1998).*

***General*:**

1. Lake Koon acts a settling basin for Lake Gordon, removing phosphorous and sediment, however, sediment from Lake Gordon had higher amounts of nitrogen and organic matter, which could increase the formation of disinfection byproducts in finished drinking water.
2. Phosphorous is the limiting nutrient in both lakes, and based on chlorophyll a, secchi depth, and total phosphorous, Trophic State Indices for both lakes ranged from 37-55.
3. Nutrients, suspended solids, and fecal bacteria concentrations increased an order of magnitude during storm water runoff conditions.

Lakes

Temperature & Dissolved Oxygen

During the study period, a thermocline appeared in both lakes in the late spring and lasted until late fall. The thermocline depth in Lake Koon and Lake Gordon occurred at approximately 6.0 and 9.0 meters respectively (FX Browne, 1998). Thermal stratification was greatest in July and August of 1994. Low dissolved oxygen concentrations occurred in the hypolimnion of both lakes during stratification. Dissolved oxygen concentrations below 5.0 mg/L were found below 4 meters in Lake Koon, and 7 meters in Lake Gordon. During stratification, bottom waters were close to anoxic condition, with dissolved oxygen concentrations less than 1 mg/L. Stratification broke down by mid-December in both lakes, and water temperature and oxygen was completely mixed.

Total Suspended Solids (TSS)

TSS concentrations in the reservoirs were considered moderate (FX Browne, 1998). Samples were taken from near the surface and bottom of each lake. Average TSS concentrations in Lake Koon were 3.6 mg/L (surface) and 4.8 mg/L (bottom). Similarly, average concentrations in Gordon were 2.8 mg/L and 2.3 mg/L. Secchi depth was also measured for water clarity and used as an indices for calculating the Trophic Status of each lake. Annual mean secchi depth for Lakes Koon and Gordon was 2.7 meters (8.8 feet), and 3.3 meters (10.8 feet), respectively.

Nutrient Concentrations

While nutrients in both lakes do not pose an immediate health risk to the drinking water supply (phosphorous does not have a regulated MCL), nutrient concentrations affect the biological productivity in a reservoir, which can lead to eutrophication, and the water quality problems associated with that process. With that said, several nutrient compounds were tested for in the surface and bottom waters of both lakes; including: dissolved phosphorous, total phosphorous, ammonia, nitrate/nitrite, and total Kjeldahl nitrogen.

Nitrate/Nitrite is the only regulated contaminant under the Safe Drinking Water Act. The MCL for nitrate/nitrite is 10 mg/L; annual average nitrate concentrations in Lake Koon (0.16 mg/L surface, 0.32 mg/L bottom) and Lake Gordon (0.14 mg/L surface, 0.30 mg/L bottom) were well below the established drinking water regulation. Additionally, there were no observed samples in either lake that exceeded 1 mg/L nitrate.

Most of the inorganic nitrogen in both lakes surface water was nitrate/nitrite. Ammonia concentrations were greater in the bottom waters due to anoxic conditions, which allow it to remain stable. Concentrations in Lake Koon were 0.24 mg/L and Lake Gordon, 0.47 mg/L. Ammonia in the surface waters averaged 0.1 mg/L in Lake Gordon, and less than 0.1 mg/L in Koon. Organic nitrogen (Total Kjeldahl nitrogen – ammonia) concentrations for surface waters were 0.66 and 0.51 mg/L N, in Lake Koon and Gordon, respectively (FX Browne, 1998).

The annual mean *total* phosphorous concentrations in Lake Koon and Gordon were 0.028 mg/L and 0.030 mg/L, respectively. Total phosphorous concentrations were generally higher than in bottom waters, which was attributable to phosphorous release from the bottom sediments in both lakes during anoxic conditions (FX Browne, 1998). Dissolved phosphorous concentrations in the surface waters of both lakes were lower (than surface waters) most likely due to biological uptake by algae.

Phytoplankton and Chlorophyll a concentrations

In Phase 1 of the study, algal species were sampled, identified, and enumerated for biomass. Most importantly, it was determined that blue-green algae dominated the phytoplankton community from the August – December time period. *Anabaena* and *Aphanizomenon* were the two most dominant genus found. Blue-green algae blooms can clog water treatment plant filters and cause taste and odor problems.

Synuria, a golden brown algae, has historically been a problem in the Cumberland water supply. *Synuria* was detected in Phase 1 of the study, but not in a 1997 sample during the watershed assessment (FX Browne, 1998). High concentrations of *Synuria* can give drinking water a fishy odor, and at lower concentrations, a spicy cucumber odor and bitter taste. As a result of past *Synuria* blooms, the Evitts Creek treatment plant installed costly additional treatment units to mitigate the problems associated with this algal species.

Chlorophyll a is used a surrogate to measure the amount of biological productivity in a lake because it can be directly related to algal biomass. Concentrations in Lake Koon were typically higher than in Lake Gordon (FX Browne, 1998). The annual mean chlorophyll a concentration in Lake Koon was 14.4 µg/L, with a maximum observed concentration of 28.7 µg/L. In Lake Gordon, the average concentration was 9.2 µg/L, with a maximum concentration of 23.1 µg/L.

Sediment Analysis and Biological Oxygen Demand (BOD)

One sediment sample was taken from each lake in 1994, percent solids, percent volatile solids, and total phosphorous, and BOD was tested. Most of the sediment sample was composed of

water (82% for Lake Koon, ~90% for Lake Gordon). Lake Koon solid portion of sediment was composed of 13.4% volatile solids (organic matter), and Lake Gordon's percentage was slightly higher at 17.2%.

Stream Water Quality

Baseflow and storm flow samples were taken from four different sampling sites in 1994-1995, and further storm water samples were taken in the assessment process in 1997. Sampling sites included two locations on Evitts Creek, one above the reservoirs and one below the Gordon dam, and one each near the mouths of Oster Run and Growden Run. In general, concentrations of phosphorous, nitrogen, fecal coliforms, fecal streptococcus, and total suspended solids were higher during storm water events at all stations above the lakes. Mean concentrations for the above pollutants were very similar between sites for both baseflow and storm water samples, there were no distinct differences. However during 1994-1995 baseflow sampling, Growden Run had the highest mean concentration of dissolved phosphorous, total nitrogen, suspended solids, fecal coliforms, and fecal streptococcus. Also, Oster Run and Growden Run had a higher TSS concentration during storm sampling, when compared to Evitts Creek.

Below is a table summarizing data from the three sampling sites from tributaries that discharge into the lakes (information taken from FX Browne, 1998). All values are mean concentrations. Baseflow samples were taken in 1994-1995, and storm water sampling for fecal bacteria occurred only in 1994-1995.

Table 3.

Sample Site/Pollutant	DP	TP	TN	TSS	F. Coliform	F. Streptococcus
	mg/L				colonies per 100/mL	
EVITTS CREEK						
base	0.008	0.029	0.075	3.8	282	222
storm	0.022	0.104	0.98	19.5	2879	2598
OSTER RUN						
base	0.007	0.022	0.8	3.9	233	118
storm	0.022	0.141	0.96	57.28	1966	2594
GROWDEN RUN						
base	0.008	0.024	0.82	4.8	453	294
storm	0.018	0.156	0.93	41.02	2238	2225

DP = Dissolved Phosphorous
TP = Total Phosphorous
TN = Total Nitrogen
TSS = Total Suspended Solids

H. Susceptibility Analysis

Each class of contaminants that were detected in the water quality data will be analyzed based on the potential they have of contaminating Cumberland's water supply. This analysis will identify suspected sources of contaminants, evaluate the natural conditions in the watershed that may increase or decrease the likelihood of a contaminant reaching the intake, and evaluate the impacts that future changes may have on the susceptibility of the intake. According to the Maryland

Source Water Assessment Plan, if any contaminant of concern sample falls above 50% of the regulated MCL, in ten percent of the total samples taken, then a detailed analysis is required. The 50/10 criteria was not met by any pollutants, but a discussion on each group of contaminants is included below. Additionally, the ecological status of Lake Koon and Gorden will also be addressed.

Microbial Contaminants

Under current regulations, the City of Cumberland is required to collect total coliform samples each month of finished drinking water at the water plant. These bacteriological samples are collected at various points in the distribution system. It would be difficult to use this data for the assessment because it does not adequately give an indication of contamination in both raw water supplies. Because of this lack of data, raw water bacteriological monitoring began in September 2000 at the plant. Samples are taken from the raw water line, directly from Lake Koon. As seem above, in the water quality section, concentrations of fecal coliforms and E. coli have been extremely low, with most sample result concentrations less than 1.1 MPN/100mL.

Streams which receive non-point source water runoff from pastures and concentrated livestock areas can have high concentrations of bacteria associated with eroding soil during periods of high flow. These bacteria can remain viable for long periods of time and attach to soil particles. During a storm, erosion of land surfaces may increase and previously eroded sediment in the streambed can be re-suspended, leading to increased bacteria concentrations.

Reservoirs, in general, can reduce the number of viable bacteria within a water body, but this is dependent on many environmental factors. In general, potential sources of non-point sources of pathogenic protozoa, viruses, and bacteria in the Lake Koon/Gordon watershed include pasture (livestock), residential septic systems, and wildlife. Most of the farmland and residences in the watershed are located in the Cumberland valley. Specifically, potential sources include cattle/dairy operations, some which were noted to have direct runoff into tributaries and cattle access to streams (FX Browne, 1998). Additionally, wildlife, especially resident Canadian geese, can be a source of contamination.

Concentrations of harmful bacteria in Cumberland's water supply are relatively low. This is most likely attributable to the characteristics of a reservoir (acts as a sink). Even the highest concentrations recorded for fecal and E. coli bacteria were below the Maryland use I-P regulations of maximum fecal concentrations at 200 MPN/L, for a portion of samples taken during a given period. However, the sampling period covered since September 2000 was considered relatively dry with the absence of many storm events in the region. Data from the 1998 watershed assessment report documented increased bacteria concentrations due to storm runoff (see Table 2). Concentrations in the reservoir, like most reservoirs in the state, likely increase during and after high runoff events such as rainstorms and snowmelt. The link between Koon and Gordon, may further increase the buffering capacity of the reservoirs to bacterial contamination. Water released directly from Lake Koon into Gordon, would likely have lower concentrations of harmful bacteria (and other pathogens) then water entering Lake Koon from Evitts Creek. Consequently, Oster Run, which enters Lake Gordon directly, and had relatively high storm runoff concentrations of fecal coliforms and streptococcus, may be considered more of a threat to the raw water supply. Oster Run has a substantial amount of agricultural land (~22%), and has had documented septic discharge problems within its watershed (FX Browne, 1998).

Cumberland has never tested for species of *Giardia* or *Cryptosporidium* in the raw water supply. Both of these microscopic protozoa are believed to be fairly common in surface waters of the United States. High turbidity and elevated bacteria concentrations can be an indicator for the

presence of these pathogens. Sources of contamination include human and animal waste, including birds. Water filtration does not always provide a 100% effective barrier; especially against the smaller *Cryptosporidium* oocysts. Most surface water sources in Maryland are potentially susceptible to these pathogens.

At this time, Cumberland's raw water is not susceptible to regular contamination by pathogenic organisms under base flow conditions. Under certain hydrologic conditions, such as snowmelt or a rainstorm, concentrations of these pathogens are expected to increase similar to other reservoirs in the state. Potential sources of these contaminants exist in the source watershed, and monitoring should continue after this assessment to ensure that future changes in the raw water quality are recognized.

Turbidity and Sediment

Highly turbid water can cause additional demands on water treatment plants and sediment can carry harmful microorganisms and compounds into drinking water supplies. Turbidity is used as a surrogate indicator for the presence of *Cryptosporidium* and *Giardia*, and increased water turbidity is indicative of elevated bacteria concentrations. Turbidity is caused by erosion of materials from the contributing watershed. Turbidity may be from a wide variety of materials, including soil particles and organic matter created by the decay of vegetation. During storm events and/or snowmelts surface runoff increases. Runoff during a storm event occurs when the rate of precipitation exceeds the rate of infiltration. As runoff increases during a storm and/or snowmelt, the increased flow of water can cause soil and other material to erode, increasing suspended solids, and raising the turbidity.

The mostly forested (~79%) Lake Koon/Gordon watershed helps mitigate the effect of storm events, evidenced by the fact that raw turbidity levels in the reservoir seldom rise to problematic conditions. In general, lakes and reservoirs provide longer water retention times, allowing the larger suspended solids and organic material that contribute to turbidity to settle out. While this factor reduces the raw water turbidity entering the Cumberland plant, data from the watershed study showed that total suspended solid (TSS) concentrations from the watershed tributaries could be high, especially during storm events. TSS may not be the best surrogate for suspended sediment, but it has been used as a reference. Below is a summary of TSS data taken from the FX Browne 1998 report:

Table 4.

Tributary	Total Suspended Soilds		
	lb/acre/yr	baseflow median mg/L	stormflow median mg/L
Evitts Creek	4.52	3.2	14.8
Growden Run	1.67	4.6	13
Oster Run	1.58	4.6	17.2

Most of the suspended solids entering the reservoir system come from the largest and main tributary, Evitts Creek. In fact it was estimated that 90% of the total pounds/TSS (95,250 total pounds) entering Lake Koon each year was from Evitts Creek. About half this amount (46,890 pound/s TSS) ends up discharging from Lake Koon to Lake Gordon. Overall, Lake Koon contributes 81% of the TSS load to Lake Gordon. Oster Run contributes approximately 7.6% of the TSS yearly load to Lake Gordon. Excessive sedimentation has been documented in both reservoirs. These locations include the mouths of Oster Run and Growden Run, Evitts Creek at Lake Koon, and below the Lake Koon dam in Lake Gordon (FX Browne, 1998). Management plans have recommended spot dredging in these areas.

There are several factors in the watershed that can contribute to increased turbidity/sediment. Runoff from paved surfaces (residential, commercial, roads) increases the amount of flow in tributaries quickly and leads to bank erosion. Unfettered cattle access to streams destroys protective vegetation along riparian areas where soils can runoff directly into a waterway. Also, row cropping on steep slopes, and forestry operations throughout the watershed, may contribute to increased sediment and turbidity. However, it was calculated that 68% of the TSS load to the lakes comes from agricultural land. Numerous areas of agricultural runoff and streambank erosion were documented in the non-point source pollution map created by the Bedford County Planning Commission. These problem areas were distributed throughout each subwatershed. There were also several documented silviculture areas with runoff/sediment problems; these sites were identified along Wills Mountain. A copy of this map is included in the appendix.

While raw water turbidity is usually very low in Cumberland's raw water, the reservoir-watershed system is still susceptible to turbidity and sedimentation. The presence of sources within the watershed along with the potential for future contamination (agricultural erosion, forestry) make turbidity and sedimentation an important water quality concern for the Cumberland water supply.

Inorganic Compounds

Nitrate & Nitrite

Data from Cumberland's water plant indicate that nitrate and nitrite are present in the finished drinking water supply, usually at levels well below 50% of the MCL. Concentrations in recent annual samples have been low. Nitrite testing is no longer required; Cumberland received a sampling waiver, because past samples showed low concentration levels.

Data from the watershed assessment study indicate that nitrate concentrations in the reservoirs and tributaries were almost always below 1.0 mg/L, even during storm water runoff conditions. Out of 51 nitrate/nitrite samples taken from 1994-1995 and 1997, only two samples exceeded 1.0 mg/L.

At this time Cumberland's water supply is not susceptible to nitrate or nitrite contamination. However, changes in land use, especially de-forestation, could lead to increased input of nitrogen species into the reservoir. While nitrate and nitrite are not a direct threat to the safety of drinking water at this time, nitrogen is directly involved in the ecological processes within the reservoir, which can lead to additional water quality problems.

Trace Metals

There have been several detections of primary drinking water standard metals in the Cumberland water supply. Detectable concentrations have been below 50% of the appropriate MCLs, and only barium has been identified in 10% of the total samples since 1993. However, one thallium detection in 1993 was equal to the regulated MCL. However, subsequent sampling on an annual basis has not included any further thallium detections. Thallium, whose sources include leaching from ore-processing sites and discharge from industrial factories, is not a threat to the Cumberland water supply. There are no known man made sources of thallium in the source watershed. Without the absence of any point sources in the watershed, most metals are probably naturally occurring. Lake Koon and Gordon are not susceptible to heavy metal contamination.

Iron and manganese are common elements in western Maryland and Pennsylvania waters, and can be associated with aesthetic and nuisance effects such as taste and odor problems and fixture staining, but high concentrations are not necessarily a public health concern. The secondary

drinking water standard for Iron is 0.3 mg/L, for manganese 0.05 mg/L. Raw water data from Evitts Creek Water Plant monthly operating reports, showed high concentrations of manganese in the Lake Gordon reservoir. Anoxic conditions in the hypolimnion during the summer months probably result in the release of stored manganese from the sediments. In response to this situation, the water company and city installed hypolimnetic aerators in the lake near the Gordon dam intake, to ensure adequate dissolved oxygen concentrations in bottom waters. Aeration was recommended as an in-lake treatment restoration alternative in the 1998 watershed assessment report, and according to water officials, it has been successful in lowering the release of compounds from sediments (R.Marvin, personal communication).

Radionuclides

The Cumberland water supply is not susceptible to any form of radionuclides. There are no known point sources in the watershed, and radionuclide detections are most likely from the natural breakdown of elements in the watershed. Detections have been well below 50% of the MCLs. Data will continue to be collected by MDE, and if sample concentrations increase, a more detailed investigation into potential sources will be done.

Other Inorganic Compounds

Sodium, chloride, and fluoride are occasionally detected in the finished drinking water produced at the Evitts Creek plant. However, detectable concentrations have always been below the recommended secondary standard for public health. They are not a concern to the raw water supply and are most likely naturally occurring. Sodium and Chloride concentrations would be expected to be higher if there was a substantial amount of road salt contamination in the watershed/lake system. Sulfate is commonly detected in the raw water, detect concentrations have averaged 16.4 mg/L, well below the secondary MCL of 250 mg/L.

Cyanide was detected once in the in the finished water supply in 1993. The sample concentration was just above the detection limit, 0.01 mg/L, significantly less than the established MCL of 0.2 mg/L. Cyanide has not been detected since 1993, and no source of cyanide was found within the watershed. Cumberland's water supply is not susceptible to these inorganic compounds.

Volatile Organic Compounds

There have been only two VOC detections in the Cumberland water supply since 1998. These detections were an order of magnitude below corresponding MCLs, and both occurred in over a decade ago in 1990. The only VOC threat to the watershed is the potential of a hazardous spill, or local contamination due to leaks in a pipeline/pumping station. This is discussed in the Transportation Related Concerns in the Potential Sources of Contamination section. Cumberland's water supply is nor susceptible to regular VOC contamination.

Disinfection Byproducts

During the water treatment process disinfectants, like chlorine, interact with naturally occurring organic matter (NOM) in the raw water to produce disinfection byproducts, which are associated with human health risks (Cooke, 2001). Testing for Trihalomethanes and Haloacetic acids are required by state and federal regulations.

Since 1997, the **mean** total THM concentration in collected samples from Cumberland is 30.3 µg/L, which is lower than 50% of the established MCL of 80 µg/L (MDE Database). Maximum total THM concentration detected was 107.8 mg/L in July 2000. Since testing began in 1999, the mean HAA concentration is 19.8 µg/L (MDE Database). The MCL for HAAs under the Disinfection Byproduct Rule is 60 µg/L. Collected data indicates that, on average, the finished

water supply is not prone to high concentrations DBP formation. However, THM and HAA concentrations occasionally exceed the MCL and frequently are greater than 50% of the MCLs.

The amount of organic matter in Lake Koon/Gordon system is probably high due to the nature of the watershed and the existing condition of each reservoir. The watershed is most likely the major source of DBP precursors. The source watershed is made up almost entirely of agricultural and forested areas (MRLC 1997 data), and runoff from these areas contribute to the delivery of particulate and dissolved organic matter to the lake. There is no available data on organic carbon concentrations in each lake, although organic matter in Lake Gordon sediment was higher than Lake Koon. In-reservoir processes (algae blooms) may also produce a significant amount of DBP precursors. Inputs of nitrogen and phosphorous can trigger algae growth, whose decay and decomposition increase the amount of natural organic matter (NOM) in the lakes. In addition, macrophyte growth in both reservoirs is somewhat extensive, especially in the shallow fingers of both lakes (personal observation, MDE). Aquatic plant decomposition can increase NOM in lakes.

Due to the nature of the watershed, the biological status of the reservoir, and occasionally high sample concentrations of HAA and THM, the Cumberland water system is susceptible to disinfection byproducts.

Synthetic Organic Compounds

All of these detections have been significantly lower than the MCL regulation and 50% trigger for each contaminant. The most common compound found, Di(2-ethylhexyl) Phthalate, was detected four times from 1996-2000, and is a resin commonly found in plastics. Its prevalence in plastics makes it a hard substance to sample and test. Because this compound, and the closely related Di(2-ethylhexyl) adipate, appears in laboratory blanks when detected, the reported quantities are not likely reflective of levels in the environment, but rather laboratory artifacts. Dalapon is a herbicide commonly used on right-of-ways and transportation corridors. Concentrations of dalapon detections (three total) averaged ~ 1.2 µg/l, well below the MCL of 200 µg/L.

According to the 1998 watershed assessment report, the Texas Eastern Pipeline pumping station, in the extreme northern portion of the watershed and Evitts Creek, has historically had problems with PCB contamination. There is no water quality data to confirm or dismiss this report, but if there is local contamination it has not reached the raw water supply. The city and water company may need a further investigation into local PCB, and VOC, contamination.

Cumberland's water supply is not currently susceptible to SOC contamination. It is unlikely that the threat of SOCs entering the water supply will increase in the future, unless major land use changes occur and/or pesticide application to crops and residential yards increase dramatically. SOCs will continue to be sampled annually by MDE, and if detections become more frequent or concentrations increase, a further investigation could be undertaken.

Lake Eutrophication

Eutrophication can be defined as the addition of dissolved and particulate organic and inorganic materials to a reservoir or lake at rates sufficient to increase biological production and decrease storage due to sedimentation (Cook, 2001). The flux of nutrients into the lakes from the watershed, and the possible cycling of nutrients from the reservoir sediments, is driving the eutrophication process in Lakes Gordon and Koon. The increase in biological productivity can negatively effect water quality in the reservoir and make it increasingly difficult to treat properly.

The trophic status of the reservoir was studied extensively in the 1998 watershed assessment report. The Carlson Trophic State Index was used to determine the trophic status of both lakes. This widely used index, uses total phosphorous concentrations, secchi disk depth, and chlorophyll a concentrations to determine the biological status of a water body. Based on the index, concentrations of total phosphorous and chlorophyll a indicate that Lake Koon and Lake Gordon are classified as eutrophic and highly mesotrophic, respectively (FX Browne, 1998). Secchi disk depths were surprisingly good compared to the other indices, and were noted in the report to be unusual. Lake Koon and Gordon show characteristics of eutrophic lakes: anoxia in the hypolimnion in the summer months, increased iron and manganese problems during stratification, heavy macrophyte growth, and blue-green algae blooms. These conditions can increase the amount of disinfection byproduct precursors in the reservoir and lead to further sedimentation.

If conditions in the watershed and reservoir remain the same or worsen due to adverse land use changes, taste and odor problems, increased DBPs, and algae blooms are likely to continue and become more frequent in the future. Lake Koon and Gordon are susceptible to water quality impacts associated with eutrophication.

I. Recommendations for Source Water Protection Plan

A source water protection plan for the Lake Koon/Gordon system is the underlying goal of the source water assessment process. The City of Cumberland, and its partners in Pennsylvania, is in a good position to implement, and build upon, an existing watershed management protection program. Unlike most of western Maryland water systems, a watershed management plan has been produced for the city, and has to some degree been implemented. The city is also very active in managing its portion of the watershed. Watershed activities are focused through the Evitts Creek Steering Committee, which has been in existence for several years., and includes representatives from the city and various Pennsylvania and county environmental agencies.

Cumberland should use the recommendations mentioned in previous management plans to form a new source water protection plan for both lakes. The recommendations from the 1998 report are still valid, however, some potential solutions to improving water quality are very costly. However, according to previous reports and personal communication with city and water company officials, various BMP's have been implemented in the watershed over the past several years.

Recommendations to improve water quality in the watershed and lakes are included in previous reports, namely the 1998 FX Browne study, and to a lesser extent the ICPRB and a Army Corps of Engineers study. Included with this source water assessment for Cumberland are copies of the executive summary of the FX Browne Lake Koon and Gordon Watershed Management Plan, which includes a brief overview of suggested recommendations. A detailed copy of recommendations from this report can be obtained either from the MDE Water Supply Program by calling 410-631-3714, or by contacting the City of Cumberland.

REFERENCES

Allegany County, 1997. Allegany County Water & Sewer Plan 1997 Update. Allegany County Department of Planning, 72p.

Browne, F.X, 1998. Lake Koon and Lake Gordon Watershed Management Plan, 83pg. plus Appendices. F.X. Browne, Inc.

City of Cumberland, ~1970. Cumberland Filtration Plant. Brochure, Water Department, 4pg.

Cooke, G.D. and R.H. Kennedy. 2001. Managing Drinking Water Supplies. Lake and Reservoir Management. 17(3):157-174.

MD Department of the Environment, 2000. Comprehensive Performance Evaluation of the City of Cumberland's Evitts Creek Water Treatment Plant, Frostburg – Allegany County, Maryland. Prepared by the Water Supply Program, 25pg.

MD Department of the Environment, 1999. Maryland's Source Water Assessment Plan. Water Supply Program, 36pg.

MD Department of Geology, Mines, and Water Resources State of Maryland, 1954. Geology and Water Resources of Garrett County. 339pg.

Other Sources of Information and Data

- MDE Water Supply Inspection Reports
- MDE Water Supply reader file for the City of Cumberland (PDWIS ID 0010008)
- MDE Water Supply Program Oracle Database (PDWIS)
- City of Cumberland Monthly Operating Reports (MORs) and Self-Monitoring Reports
- Digital USGS Topographic 7.5-Minute Quadrangles, SureMaps Raster
- GIS Data from PA Spatial Data Access website, http://www.pasda.psu.edu/
- EPA Chemical Fact Sheets, http://www.epa.gov/safewater/mcl.html

Susceptibility Analysis Summary Table - City of Cumberland

Contaminant	*Water Quality* (50% MCL Exceeded?)	*Potential Sources*	*Natural Attenuation in Watershed*	*Evaluation of Change to Natural Conditions*	*Intake Integrity*	*Currently Susceptible?*
Volatile Organic	N	Spills, Tanks	Y	P	N	N
Synthetic Organic	N	Agriculture, Lawns	Y	P	N	N
Heavy Metals	N	Natural Deposits	Y	P	N	N
Nitrate/Nitrite	N	Agriculture/Septic	N	P	N	N
Fluoride	N	Natural Deposits	NA	P	N	N
Cyanide	N	None	Y	P	N	N
Asbestos	N	None	NA	P	N	N
Radionuclides	N	Natural Deposits	Y	P	N	N
Total/Fecal Coliform	Y	Agriculture/Septics	N	N	N	Y
Protozoa	I	Agriculture/Septics	N	N	N	Y
Viruses	I	Agriculture/Septics	N	N	N	Y
Disinfection Byproducts	Y	Organic Material	N	N	N	Y
Turbidity	Y	Erosion, Storm Water	N	N	N	Y

KEY:

Water Quality:
Y = Yes, data shows that a sample was greater than 50% of the MCL
N = No sample data was found above 50% of the MCL
I = Insufficient data

Potential Sources
(List of Sources, point and non-point)

Natural Attenuation in Watershed
Y = Highly probable that contaminant type is attenuated under natural conditions in the watershed
N = Contaminant is not attenuated naturally in the watershed
U = Unknown

Evaluation of Change to Natural Conditions
N = Future changes in the natural conditions of the watershed will likely increase the susceptibility of this intake to the contaminant type
P = Future changes in the natural conditions of the watershed are **not** likely to increase the susceptibility of this intake to the contaminant type

Intake Integrity
Y = Intake is vulnerable, or adds to the susceptibility of contaminant type
N = Intake does not contribute to vulnerability of contaminant type

Currently Susceptible
Y = Yes
N = No

APPENDIX

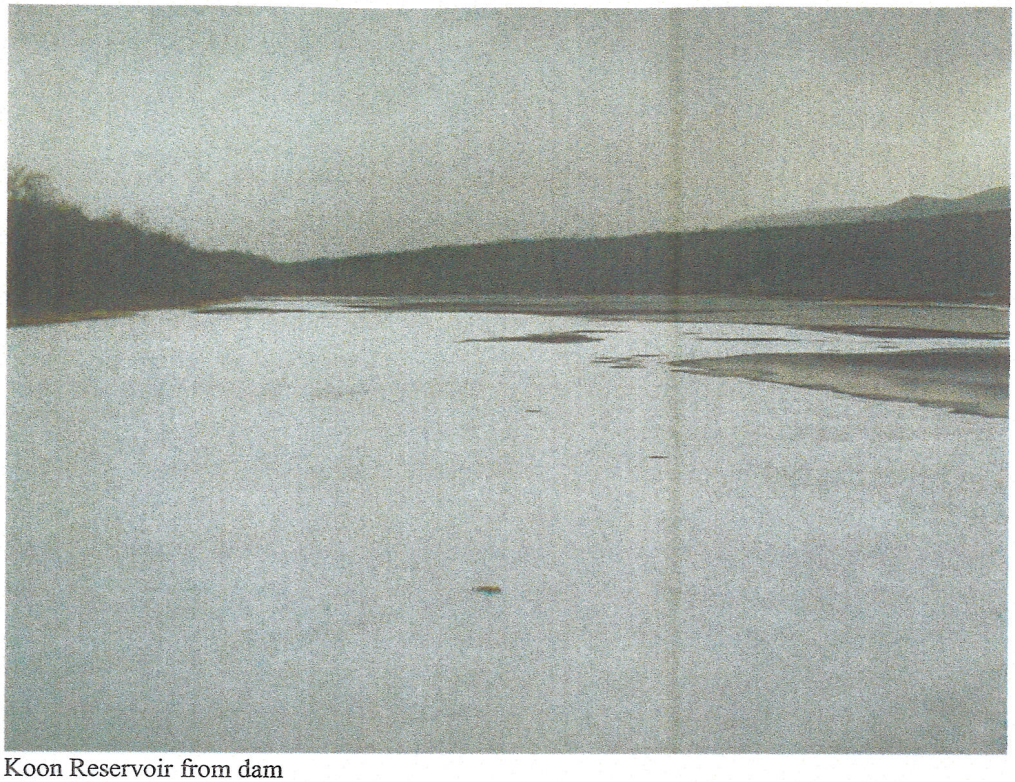
A. Figures

B. Photos

C. Executive Summary: "Lake Koon and Lake Gordon Watershed Management Plan," 1998, F. X. Browne, Inc.

Oster Run at Lake Gordon

Lake Gordon near Oster Run confluence, heavy macrophyte growth



Koon Reservoir from dam

Lake Gordon, just below Lake Koon Dam, picture from top of dam/road

A-101

LAKE KOON AND LAKE GORDON WATERSHED MANAGEMENT PLAN

FINAL REPORT

April 1998

Presented to:

Bedford County Conservation District
And
The City of Cumberland, Maryland

Prepared by:

F. X. Browne, Inc.
1101 South Broad Street
Lansdale, Pennsylvania 19446
(800) 220-2022

"report"

FXB File No. PA1365-01

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Acknowledgments

From May 1994 through October 1995, a Phase I Diagnostic Feasibility Study of Lake Koon and Lake Gordon was conducted. This study was funded by the City of Cumberland, Maryland. This current study is a continuation of the Diagnostic Feasibility Study and was funded as a Section 319 Watershed Assessment Study through the United States Environmental Protection Agency (EPA). The grant applicant was the Bedford County Conservation District, and the grant was administered through the Pennsylvania Department of Environmental Protection (DEP), Bureau of Land and Water Conservation.

Appreciation is extended to those listed below for their dedication and commitment toward preserving the water quality of Lake Koon and Lake Gordon. Special gratitude is extended to each entity for their invaluable perspective on the lakes and their surrounding watershed and their diligent assistance throughout the entire length of this study.

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- The Pennsylvania Game Commission, Tim Flannigan, land manager
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- The Bedford County Conservation District, Terry Miller, Mike Cessna, Richard Hershberger, and Jeanne Johnson
- The Bedford County Planning Commission, Jeff Kloss, Frank Burggraff
- The Evitts Creek Steering Committee, Bill Plank
- The City of Cumberland, John J. DiFonzo
- The Evitts Creek Water Company, Ron Thrasher
- The USDA Natural Resource Conservation Service, Louis Pearce

Executive Summary

Overview

Lake Koon and Lake Gordon are located in the Cumberland Valley of southeastern Pennsylvania. The connected reservoirs, the a combined capacity of 2.6 billion gallons, are the sole water supply source for the City of Cumberland, Maryland. Two streams feed directly into Lake Koon and include Growden Run and Evitts Creek. One stream, Oster Run, feeds into Lake Gordon. Evitts Creek is the only outlet stream. Lake and watershed characteristics are shown below:

Lake and Watershed Characteristics		
	Lake Koon	**Lake Gordon**
Lake Area (acres)	268	120
Watershed Area (acres)	26,921	32,164
Watershed to Lake Ratio	100:1	268:1
Average Depth (feet)	17	15
Maximum Depth (feet)	70	70

Pollution problems have been detected in both lakes, including, sedimentation, algal blooms, and low dissolved oxygen levels. These problems require that additional treatment be provided at the City of Cumberland's water treatment plant. These problems also adversely affect the recreational uses of the lakes.

A two-step approach to complete the Diagnostic-Feasibility Study of Lake Koon and Gordon was initiated. The initial diagnostic portion of the study was initiated and funded by the City of Cumberland, Maryland. The study was conducted to determine current water quality conditions. This effort identified existing water quality problems and determined the pollutants responsible for the observed problems. The lake and watershed monitoring programs for this portion of the study were designed and coordinated by F. X. Browne, Inc. and resulted in a final study report entitled *Preliminary Water Quality Study of Lake Koon and Lake Gordon* (F. X. Browne, Inc., 1995).

The current study, *The Lake Koon and Gordon 319 Watershed Assessment*, is the feasibility portion of the study and was funded through the EPA Clean Water Act Section 319 Nonpoint Source Pollution Control Program administered by the Pennsylvania Department of Environmental Protection. A watershed assessment was conducted to identify specific nonpoint source pollution problem areas in the watershed. Once specific problem areas were determined, a variety of lake and watershed restoration alternatives were evaluated and a comprehensive lake and watershed management plan was developed. A brief summary of the conclusions and recommendations of the Lake Koon and Lake Gordon 319 Watershed Assessment is provided below. Problem area locations are provided the Map in Appendix H.

Conclusions

As part of the Lake Koon and Gordon Phase I Study, an extensive lake and stream water quality monitoring program was conducted from May 1994 through April 1995. The data collected from the previous study were augmented by wet weather stream water quality data collected from April 1997 through August 1997. Based on both studies, the following conclusions were made:

Watershed Characteristics

- Soils within the watershed are moderately to highly erodible. The topography in this river valley is relatively flat near the lakes; however, Wills and Evitts mountains are very steep and prone to erosion. Such susceptibility to erosion requires a high degree of management.

- The most dominant existing land use within the watershed is forested (60%), followed by agricultural (35%), and developed (5%). Land use within the watershed is not expected to change significantly within the next ten years.

- Many of the lands immediately adjacent to the lakes are forested and are owned and managed by the City of Cumberland.

Water Quality

- Lake Koon acts as a settling basin for Lake Gordon, removing phosphorus laden sediments. Therefore, the sediment in Lake Koon has less organic materials and more phosphorus than sediment in Lake Gordon. Sediment in Lake Gordon contains higher nitrogen and organic matter.

- Both lakes are well-suited for warm water fish species; however, due to severe dissolved oxygen depletions in the bottom waters from June through October, coldwater species experience a moderate to high level of stress.

- Phosphorus appears to be the "limiting" nutrient in both lakes; however, the control of both phosphorus and nitrogen inputs to the lakes is important.

- The Carlson's Trophic State Index (TSI) values for Lake Koon are 54, 55, and 42 based on total phosphorus, chlorophyll a, and Secchi disk, respectively. The TSI values for Lake Gordon are 47, 47, and 37 for total phosphorus, chlorophyll a, and Secchi disk, respectively.

- Phosphorus, nitrogen, suspended solids, and fecal bacteria concentrations increase one order of magnitude higher during stormwater conditions than under baseflow conditions. Therefore, the highest nutrient, suspended solids, and fecal bacteria loadings to the lakes occur during storm events.

- Water quality is better in Evitts Creek downstream of the lakes, with the lakes serving as sinks for pollutants.

- Based on stream water quality and quantity information obtained as part of this study, a hydrologic and pollutant budget was calculated for Lake Koon and Lake Gordon. Based on pollutant budget, approximately 1,209 pounds of phosphorus entered Lake Koon during the one-year study period and 828 pounds of phosphorus entered Lake Gordon during the study period. Using this information, the Reckhow Anoxic model was used to predict the in-lake phosphorus concentrations in Lake Koon and Lake Gordon. The model predicted in-lake phosphorus concentrations very well.

Watershed Management Plan Recommendations

Based on the diagnostic and feasibility portions of the Lake Koon and Gordon Study, the following recommendations were developed as part of a Comprehensive Lake and Watershed Management Plan. The Lake Koon and Lake Gordon Watershed Management Plan focuses primarily on reducing nonpoint source pollution from identified agricultural, silvicultural, residential, and commercial problem areas. Nonpoint source pollution should be reduced through the continuation of successful, existing watershed programs. The plan recommends additional in-lake and watershed restoration techniques designed to further reduce nonpoint source pollution.

Each element of the recommended Lake and Watershed Management Plan for Lake Koon and Lake Gordon is described below.

Continuation of Existing Programs

- The Bedford County Conservation District is currently working with farmers in the watershed to voluntarily implement nutrient management plans and other agricultural best management practices. The development and implementation of nutrient management plans is extremely important to control nutrient and sediment pollutant loadings for agricultural land used within the watershed. This work should be continued and expanded to incorporate as many farms as possible. Agricultural nonpoint source pollution reduction strategies include construction of loafing pads, stream fencing, stream crossings, stream stabilization, manure storage facilities, and created wetlands.

- The Department of Conservation and Natural Resources, the Bedford County Conservation District, and the City of Cumberland are all currently working to manage the forestry resources in the watershed in an environmentally sensitive manner. This work should be continued and expanded to incorporate all timbering operations within the watershed. Erosion and sedimentation reduction strategies include the construction of waterbars as well as seeding and mulching all disturbed areas.

- The Evitts Creek Steering Committee is investigating innovative, low-cost wastewater treatment systems to solve existing on-site problems. This program should be continued.

Watershed Management Recommendations

- Stream channels with severe erosion should be stabilized through bioengineering techniques, such as vegetative measures, and structural methods, such as rip-rap, to reduce erosion and sedimentation.

- Created wetlands are recommended for several agricultural problem areas to treat stormwater runoff at these locations. A pond-wetland system should also be constructed where Oster Run and an unnamed tributary at Pine Ridge Road empties into Lake Gordon. The enhanced wetlands will reduce nutrient and sediment loadings to the lakes, create additional wildlife habitat, and provide additional stormwater detention.

- The current Act 537 Sewage Facilities Plan for Cumberland Valley Township should be updated to include a needs assessment as well as an on-lot wastewater management program. Funding should be pursued to explore the construction of package treatment plants as well as other methods to more effectively treat wastewater.

- Stormwater management basins and stormwater ponds should be constructed in problem areas to treat runoff from paved areas. Stormwater runoff at future development sites should be managed by reducing site imperviousness, using cluster development, preserving open space, and maximizing overland flow over pervious areas.

- Cumberland Valley Township should adopt a stormwater management ordinance that controls post-development water quantity and water quality.

Additional Watershed Recommendations

- A riparian stream corridor buffer program should be adopted to protect streams from development and to enhance stream buffers.

- As development increases in the watershed, Cumberland Valley Township should re-evaluate existing ordinances to ensure that open space planning is encouraged. Open space provisions should be required in all new site developments.

- A comprehensive watershed education program should be developed for a wide variety of groups including the general public, public officials, engineers, planners, contractors, realtors, farmers, and students. The program should consist of an environmental study center, landowner fact sheets, educational curriculum, slide shows, seminars, and watershed education signs.

- Water quality monitoring of Lake Koon and Lake Gordon should continue in order to develop baseline environmental information and to document the benefits of implementing the lake and watershed management plan.

In-Lake Management Recommendations

- Based on existing water quality information, hypolimnetic (bottom water) aeration appears to be a feasible in-lake management alternative for Lake Koon and Lake Gordon to improve the cold water fishery and to reduce nutrient release from sediments during anoxic conditions. By reducing nutrient release during the summer months (anoxic conditions in the hypolimnion), overall water quality in the reservoirs should improve. Additional evaluation is required to determine the required size of the hypolimnetic aerators and the final design and construction costs. Detailed bathymetric surveys of both lakes should be conducted to more accurately determine the volume of the hypolimnion. With this additional information, the size and the cost of the aerators can be more accurately determined.

- The existing drinking water intake structure should be modified or replaced with a multi-port drinking water intake structure. This will enable drinking water to be withdrawn from several elevations and provide the Evitts Creek Water Company the flexibility of withdrawing water with the best quality at different times during the year. This flexibility will help to decrease the cost of treating the water for drinking water purposes.

- Spot dredging should be performed in four areas in Lake Koon and Lake Gordon to remove the accumulated sediments as well as the pollutants contributing to eutrophic lake conditions. Dredging will also increase the storage volume of the two reservoirs. Areas that should be dredged are shown on Map A. Before detailed design begins, a dredging feasibility study should be performed to determine the most appropriate dredging method, disposal options, permitting requirements and costs.

- Lake shoreline stabilization using bioengineering methods is recommended for the eastern shoreline of Lake Gordon below the Lake Koon Dam as well as for the southeastern shoreline of Lake Gordon north of the City of Cumberland's Water Treatment Facility.

Figure 1. Digital Orthophoto Qaurter Quad
Lake Gordon and Lake Koon

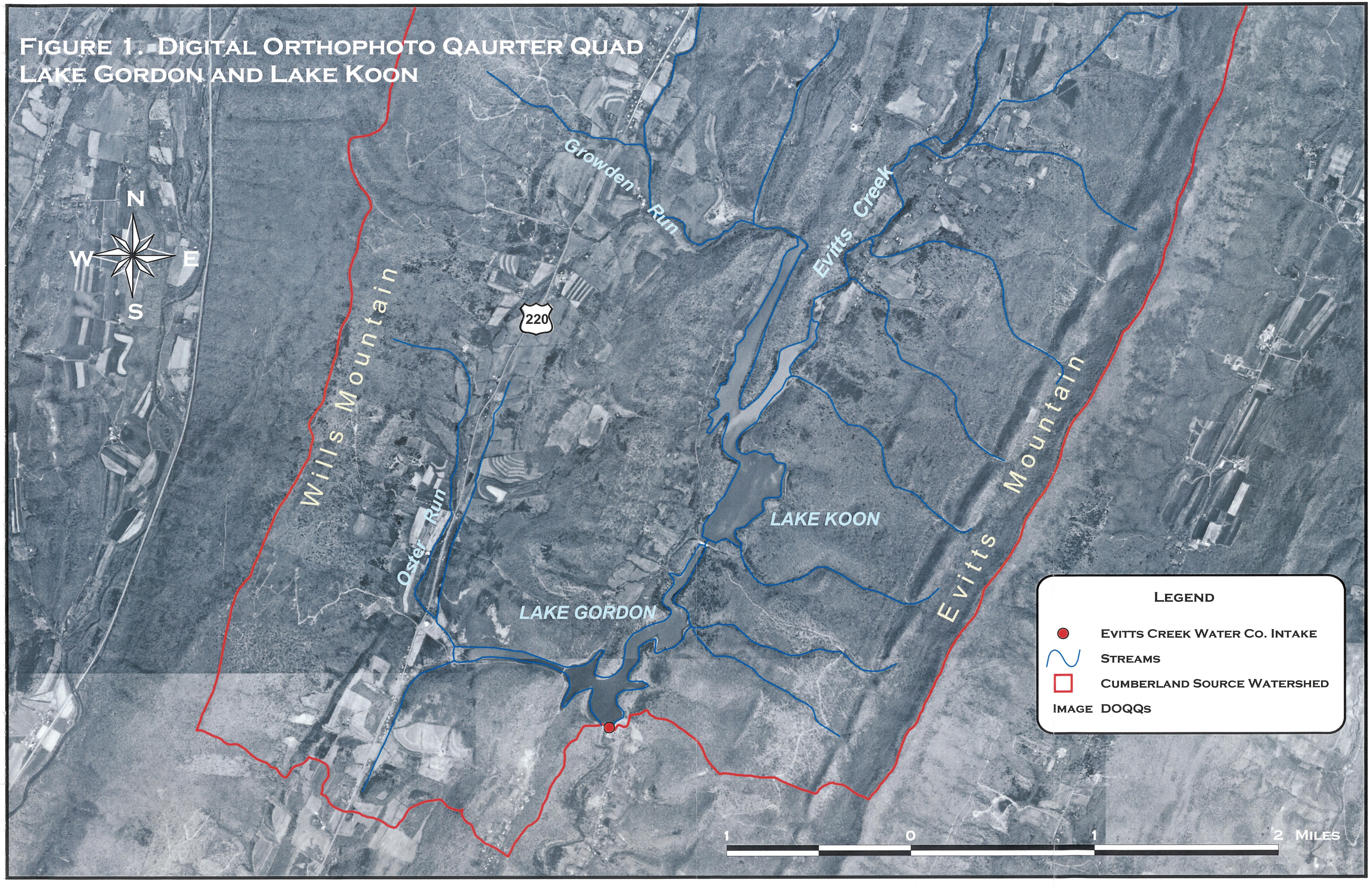

Figure 2. Land Use
Lake Gordon and Lake Koon

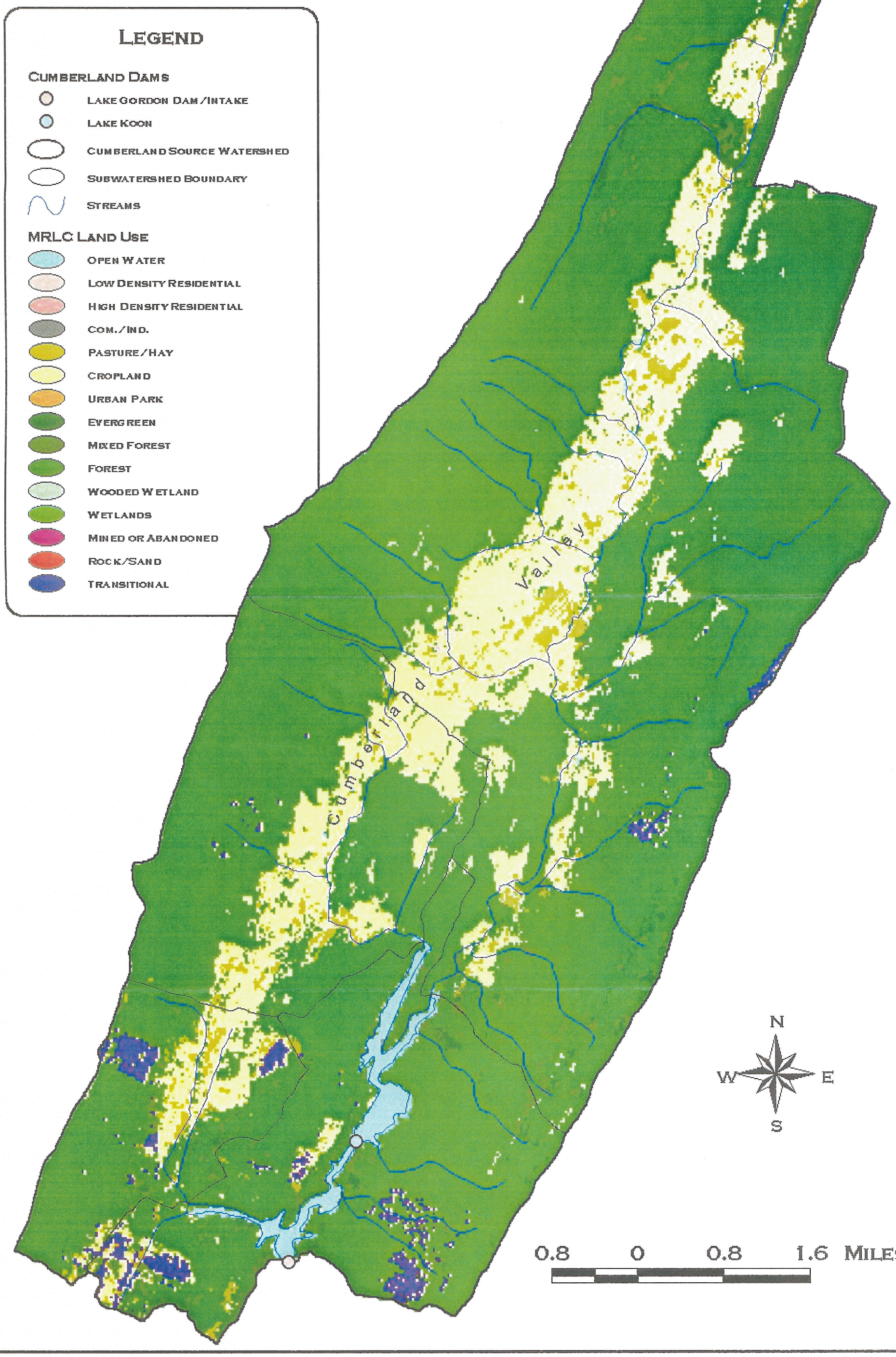

Figure 3. Roads and State Land
Lake Gordon and Lake Koon