SAFE YIELD ANALYSIS FOR CONESUS LAKE

Livingston County Planning Department

Schnabel Reference 21C25014.00
December 21, 2021

Conesus Lake, July 2021

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December 21, 2021

Ms. Heather Ferrero, AICP
Deputy Planning Director
Livingston County Planning Department
6 Court Street
Geneseo, NY 14454

Subject: **Safe Yield Analysis for Conesus Lake**
                      Livingston County, New York (Schnabel Reference 21C25014.00)

Dear Heather Ferrero:

SCHNABEL ENGINEERING OF NEW YORK (Schnabel) is pleased to provide you with our final report: Safe Yield Analysis for Conesus Lake. We look forward to receiving your comments.

This report begins with an introduction to the project. Next we provide a summary of the Safe Yield Model development, with discussion of data and documents that were reviewed to support the effort. We outline our approach to the Safe Yield Analysis, discuss key assumptions, and explain the model calibration process. We then show how the calibrated model is used to evaluate the safe yield, along with an explanation of the model's sensitivity to various constraints. The report concludes with commentary and recommendations.

This study was performed in accordance with our proposal dated March 29, 2020, that was authorized on May 6, 2021. Key assumptions and methodologies were developed collaboratively with stakeholders, as outlined in the final work plan dated September 20, 2021. A draft report was submitted on October 29, 2021, and this report incorporates feedback from stakeholders.

We appreciate the opportunity to be of service for this project. Please call us if you have any questions regarding this report.

Sincerely,

SCHNABEL ENGINEERING OF NEW YORK

Gregory J. Daviero, PhD, PE
Principal

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SAFE YIELD ANALYSIS
CONESUS LAKE
LIVINGSTON COUNTY PLANNING DEPARTMENT

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EXECUTIVE SUMMARY

Objective

The *2021 Safe Yield Analysis of Conesus Lake* was prepared as a resource to support future water supply management decisions affecting Livingston County communities. Safe Yield for water supply represents the volume of water that can be continuously withdrawn during the drought of record or a statistically defined drought (such as a drought with a probability of recurring once in 100 years) while still meeting regulatory and operational constraints. For lakes and reservoirs, Safe Yield is calculated considering water inflows, outflows, storage, and evaporation.

Safe Yield calculations for sustainable public water supply are an essential element of resource management planning. However, Conesus Lake supports multiple uses. Management decisions must also consider flood risk, aquatic habitat, fisheries, economic development, recreational users, water quality, and other components of the broader ecosystem. Evaluation of related ecosystem impacts is outside of the scope of this analysis, which focuses on calculating the availability of public water supply during an extreme drought.

The importance of calculating a Safe Yield for Conesus Lake has been discussed for decades; a recommendation to assess the lake's potential as a sustainable public water supply was included in the 1991 Livingston County Comprehensive Water Supply Study, the 2003 Conesus Lake Watershed Management Plan, and the 2020 update to the Livingston County Comprehensive Water Supply Study. In 1994, representatives of the New York State Department of Environmental Conservation (NYS DEC) completed a related calculation referred to as Conesus Lake's "dependable yield". The NYS DEC calculation considered two primary functions of the lake: public water supply and release of water through the gated outlet on Conesus Creek at the lake's northern end to protect downstream water quality and habitat. This 2021 analysis evaluates public water supply and includes downstream release requirements as a constraint, along with adherence to seasonal lake level targets.

The *2021 Safe Yield Analysis of Conesus Lake* was prepared by Schnabel Engineering of New York in accordance with current definitions and standard practices for calculating Safe Yield for public water supplies. The project team utilized long-term data sets and updated modeling tools for the analysis; these data sources and modeling assumptions are documented within the report. By calculating Safe Yield using the accepted practice for water supplies and documenting all assumptions, this resource will provide future water resource managers with the information needed to guide decisions. The Schnabel Team thanks Dr. Liz Moran of EcoLogic, LLC who was the primary author of this Executive Summary.

Approach

The Safe Yield Analysis is based on a hydrologic budget, or water balance, of Conesus Lake. The hydrologic budget compiles measurements and estimates of inflow from the 70 square mile watershed, outflow through Conesus Creek, public water supply withdrawals, and loss by evaporation from the lake surface. Groundwater flux into and from the lake was not addressed directly but was accounted for within the estimation of inflow (Figure ES-1). The net of water inflow, outflow, withdrawals, and evaporative loss is reflected in the lake's storage volume, as recorded by water surface elevation (lake level).
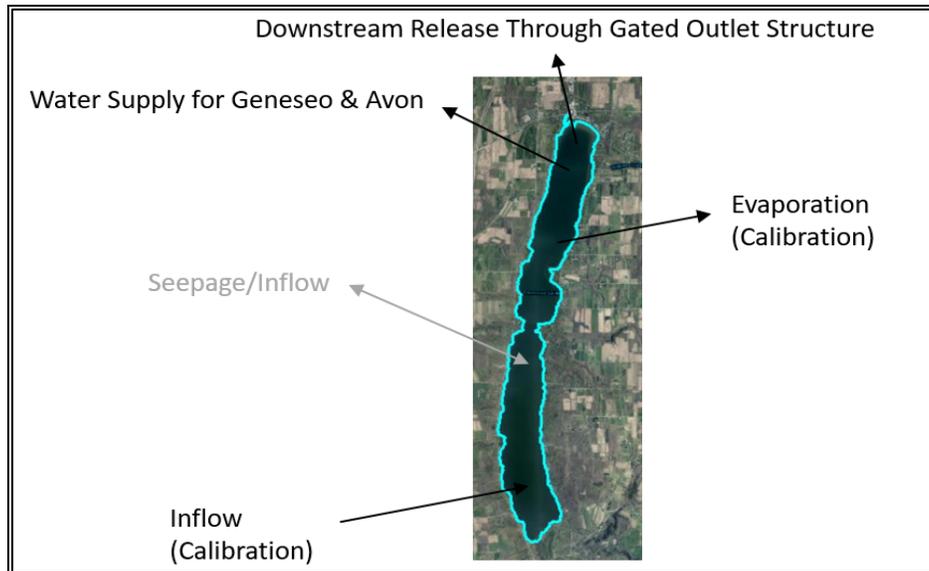
Figure ES-1: Schematic of Water Inflows and Losses from Conesus Lake Used in the Model

A mathematical model is required to track how the volume of water in Conesus Lake varies each day in response to meteorological conditions (precipitation and evaporation) and human interventions (downstream release and withdrawal for water supply). The water resources engineers on the Schnabel team selected the widely accepted modeling software HEC-ResSim (version 3.1) created by the United States Army Corps of Engineers (USACE) Institute for Water Resources to complete this task. As summarized below, and described in detail in the report, model input files were carefully selected to capture available data and information specific to Conesus Lake.

The Safe Yield Analysis incorporates operational constraints, including target lake levels, existing permit allocations for water withdrawals, and the regulatory requirement for the Livingston County Water and Sewer Authority (LCWASA) to ensure a minimum downstream release for water quality and habitat protection. These factors inform the calculation of the volume of water available for public supply during an extreme drought.

As described above, Conesus Lake supports multiple uses. The USACE developed guidance for managing the water level of Conesus Lake to balance its multiple uses while reducing flood risk. These seasonal guidelines are part of a Rule Curve, which is supplemented by an Operations Manual. Key targets for lake levels are summarized in Table ES-1.

Table ES-1: Summary of Key Elevations of Conesus Lake

Lake Level Elevation referenced to NGDV29 (source: ACOE 2010 Regulation Manual).	
Pool elevation of record (June 1972- Hurricane Agnes)	822.5 ft
Top of flood control pool	819.5 ft
Top of Dam/ Top of Gate	818.7 ft
Operational Target: Spring (Spawning habitat)	818.7 ft
Operational Target: Summer (Recreation)	818.5 ft
Operational Target: Winter (Drawdown for flood control)	816.5 ft

The Villages of Avon and Geneseo hold permits to draw water from Conesus Lake for public supply. There is also a requirement in the discharge permit for the Lakeville Wastewater Treatment Plant to ensure a minimum stream flow in Conesus Creek of 10 cubic ft per second (cfs), a volume equivalent to 6.5 million gallons per day (mgd). Compliance with the Lakeville Wastewater Treatment Plant permit for minimum streamflow is assessed using stream flow data measured at the Unites States Geological Survey (USGS) stream gage located approximately one mile downstream of the Treatment Plant. The water supply permit allocations and the required downstream release are summarized in Table ES-2.

Table ES-2: Current Water Supply Allocations and Required Downstream Release
(Million Gallons per Day, mgd)

	Allocation/Permit	Actual Withdrawal/Release
Village of Avon	3.5 mgd	0.75 mgd (2018-2020 average)
Village of Geneseo	3.0 mgd	0.98 mgd (2018-2020 average)
Minimum Downstream Release	6.5 mgd	Consistently at or above 6.5 mgd

While records exist for lake level, water supply withdrawals, and outflows, none of the tributaries to Conesus Lake have a gage installed to measure and record water flow. An early challenge for the project engineers was to identify a nearby similar watershed with a long-term flow record that could be used to estimate flows in the Conesus Lake tributary streams during historical drought periods. Ultimately, the stream gage Cohocton River near Campbell (USGS 01529500) was selected based on its proximity to the site, comparable watershed response, and available period of record.

A similar challenge was to estimate daily evaporative losses from the lake surface. While there is no weather station within the Conesus Lake watershed recording this information, the project team worked with the Northeast Regional Climate Center at Cornell University to compile and review estimates from ten regional weather stations. Ultimately, evaporation data from the Rochester weather station were selected for use in the hydraulic model.

Once the best available datasets were identified and compiled, model parameters were adjusted within defined ranges to simulate a portion of the historical record encompassing an historical drought period (a process called calibration). The calibrated model was then tested for its accuracy in simulating a different part of the record (a process called verification). The Schnabel team focused their model calibration and verification efforts on optimizing the match between predicted and observed Conesus Lake water levels during periods of drought in the historical record. Once verified, the model can be used in a predictive manner to evaluate how lake levels would respond to meteorological conditions and management alternatives. This is the foundation of a Safe Yield Analysis.

The Conesus Lake Safe Yield is defined as the volume of water available to meet a constant demand for water supply during an extreme drought period, while meeting the NYS DEC regulatory limit for minimum downstream water release and operating within the USACE Rule Curve guidance for summer and winter lake level targets (refer to Table ES-1). The Safe Yield Analysis assumes that all permitted water purveyors continually operate at a constant rate of withdrawal during the extreme drought. The calculations do not incorporate provisions for operational interventions such as water use restrictions

during the drought which would likely be implemented under such circumstances. These conservative assumptions provide an additional margin of safety for water supply.

Key Findings

The Safe Yield Analysis for Conesus Lake is summarized in Table ES-3 and discussed below. Note that the volume available for public water supply during an extreme drought is calculated considering the system constraints: rule curve, required downstream flows of 10 cfs, and continuous withdrawal for public water supply at maximum allocation.

Table ES-3: Summary of Safe Yield Analysis

At a Minimum Lake Elevation of:	Estimated Safe Yield for Water Supply only *during extreme drought*	Notes
816.5 ft	Not practical	
815.5 ft	4.2 mgd	815.5 ft is assumed to represent the minimum lake elevation to deliver 10 cfs downstream by gravity
815.5 ft	1.6 mgd	Safe yield for water supply to maintain minimum elevation of 815.5 ft if 14 cfs is released through the gated outlet structure
814.5 ft	7.7 mgd	814.5 ft represents minimum lake level for optimal operation of the existing Village of Avon water supply intake pumps
814.5 ft	5.3 mgd	Safe yield for water supply to maintain minimum elevation of 814.5 ft if 14 cfs is released through the gated outlet structure

The first key finding of the Safe Yield Analysis is that maintaining the USACE Rule Curve winter target for Conesus Lake (elevation 816.5 ft) is not achievable during an extreme drought. The lake level would fall below this target elevation if required to simultaneously deliver a continuous supply of water to the Villages of Geneseo and Avon at their maximum allocations and maintain the permit required downstream release. Moreover, the calculations indicate that there is no Safe Yield available for water supply during an extreme drought if the current Rule Curve is strictly followed; the minimum lake level must fall to 816 ft to provide any Safe Yield for water supply. Evaporative losses and the required downstream release are enough to draw the lake level below the Rule Curve target elevations. This finding is consistent with the conclusions of the 1994 NYS DEC report.

The second key finding is that Safe Yield for water supply is available with adoption of changes that would tolerate lower lake elevations during periods of extreme drought. Temporarily relaxing strict adherence to the USACE Rule Curve and/or implementing water conservation measures would ensure that public water supply demands would be met. In addition, deepening the lake outlet channel by dredging may enable gravity flow from the lake to meet the regulatory permit requirement for downstream release at a lower lake level elevation. This finding is tentative, as the 2009 bathymetric survey of Conesus Lake did not extend into the outlet channel. Another alternative to meet the downstream release requirement at lower lake elevation, where gravity flow is not sufficient, would be to pump water

over the outlet dam downstream into Conesus Creek. Finally, Livingston County stakeholders may elect to renew discussions with the USACE to clarify meeting rule curve targets under extreme weather conditions (both flooding and drought).

Climate Influences

The available Safe Yield for Conesus Lake depends on numerous factors, many of which are highly influenced by climate. One of the most significant influences is precipitation. Even in a relatively small watershed, there is spatial variability in the intensity, duration, and total amount of precipitation. The lack of site-specific discharge measurements on lake tributaries is a source of uncertainty.

Another source of uncertainty is the extent to which past meteorological records are predictive of future conditions. The NRCC publication *Climate Science Special Report (CSSR): Fourth National Climate Assessment (U.S. Global Change Research Program)* reports projected increases in annual precipitation throughout the Northeast including Livingston County. Although climate models predict increasing variability, projections for this region indicate that the current trend of increasing annual precipitation will continue. Higher precipitation would increase inflows to Conesus Lake, reducing risk of an extreme drought that would constrain available water supply.

Recommendations

The Schnabel team developed the following recommendations for consideration.

- Modify the Conesus Outlet dam to enable the Compact of Towns and the Livingston County Water and Sewer Authority to improve precision and accuracy of water release from the lake to comply with NYS DEC regulatory permit requirements. A hydraulic model of Conesus Creek would support efforts to ensure that water releases meet regulatory limits.

  As described in this report, it is challenging to manage the existing outlet structure to deliver the required minimum release (10 cfs). To ensure that the regulatory permit requirement is met, operators tend to release more water. Improved precision and accuracy of the outlet structure would increase water available to meet public supply and maintain desired water levels. A hydraulic model of Conesus Creek would provide additional information needed to quantify relationships of lake level, water release, and measured streamflow at the USGS gage downstream of the Lakeville Wastewater Treatment Plant.

- Discuss options with the USACE to modify the Rule Curve during defined periods of extreme conditions.

  Specifically, the winter pool drawdown target of 816.5 ft and the rate of lake drawdown from summer to winter pool elevations have a significant impact on calculated Safe Yield for public water supply. Discussion with USACE representatives may help identify conditions under which strict adherence to the current Rule Curve guidelines could be modified with minimal risk to the lake's multiple uses.

- Install a stream gage within the Conesus Lake watershed.

Since precipitation is spatially variable, site-specific data on stream inflows will help reduce uncertainty in the water balance.

- Periodically review the Safe Yield Analysis and update in response to new information, advances in hydraulic modeling, or a qualifying event.

Updates would be appropriate following collection of a long-term record of stream discharge within the watershed or based on a qualifying event such as implementation of channel dredging, marked changes in regional meteorology, water system upgrades, or NYS DEC permit modifications.

1.0   INTRODUCTION

Schnabel Engineering of New York has been engaged by the Livingston County Planning Department to perform a Safe Yield Analysis for Conesus Lake. The Safe Yield Analysis described in this report utilized state-of-the-practice software to develop a hydrologic model that was calibrated to the 2001 drought. The model was developed using historic data such as the recorded reservoir levels, water supply flow rates, evaporation records, and nearby United States Geologic Survey (USGS) stream gages. Recent bathymetric mapping of the reservoirs was also incorporated. Once the model was calibrated to the 2001 drought, the model was used to simulate the behavior of the system through a 100-year period of record considering various water supply flow rates to determine the safe yield. Sensitivity evaluations were then performed to understand the importance of various system constraints. The minimum lake elevation was varied, release rates to the downstream channel were varied, and modifications to the rule curve were tested.

1.1   Background and Prior Studies

Conesus Lake, the westernmost Finger Lake, is located in the Genesee River Basin. It is situated about 22 miles south of Rochester in the Towns of Conesus, Geneseo, Groveland, and Livonia in Livingston County. Conesus Lake has an average width (east-west) of 0.6 miles and an average length (north-south) of 7.8 miles. It has a surface area of approximately 5 square miles (mi^2) with a reported depth ranging from an average of 55 feet (ft) at the southern end to an average of 38 ft at the northern end. The deepest portion of the lake, located within the southern basin, is approximately 72 ft deep.

The lake serves as a recreational resource, a water supply source for the Villages of Avon and Geneseo (and formerly for the Town of Livonia) and as a water source supporting waste assimilation for the Lakeville Wastewater Treatment Plant located downstream on Conesus Creek. Currently, the Village of Avon is allocated 3.5 million gallons per day (mgd), the Village of Geneseo is allocated 3.0 mgd, and the required release flow for the Livingston County Water and Sewer Authority (LCWSA) Lakeville Wastewater Treatment Plant (Lakeville WWTP) is 6.5 mgd (or 10 cubic ft per second[cfs]) for a total water supply allocation of 13.0 mgd. Until 1994 the Town of Livonia also used Conesus Lake and was allocated 0.4 mgd for their water supply, when Hemlock Lake became the Town's new water source. Prior to 1994, the total Conesus Lake water supply allocation was 13.4 mgd rather than its current 13.0 mgd.

Livingston County performed a Comprehensive Water Supply Studies (CWSS) in 1991 and again in 2020. Both the original and updated CWSS identified two primary goals; to ensure adequate quantities of potable water that will meet the appropriate drinking water standards and to provide adequate and reliable water supply to areas within the County to support economic development. Both of these studies recommended that Livingston County perform a safe yield analysis for Conesus Lake to better understand the available resource and to assess its ability to support the NYS DEC water supply allocations as well as its potential for supporting additional future water supply uses.

The term *safe yield* is generally defined as the maximum daily water supply flow rate that can be continuously delivered by a water source without interruption through the historic drought of record or a design recurrence interval drought (i.e., 100-year or 0.01 annual exceedance probability). The safe yield of any water supply source is primarily dependent upon the productivity of the source watershed (the amount of water it provides to Conesus Lake), the historical droughts on record, the available reservoir storage, and the ability of the constructed infrastructure to withdraw and convey water as necessary.

Within this report, the term safe yield refers to the available water supply flow rate, excluding the flows released from the gated outlet structure for waste assimilation. Previous studies have evaluated the *dependable yield*, which is inclusive of both the water supply and the downstream release.

Following the 1991 CWSS, the New York State Department of Environmental Conservation (NYS DEC) performed a Dependable Yield Study in 1994 for Conesus Lake to evaluate potential water source allocation conflicts between the competing water supply and waste assimilation objectives. The permitted water supply allocations were compared to the NYS DEC's Dependable Yield determinations resulting in a reported over allocation of water from the lake; that is, the sum of the water supply allocations and the regulated environmental release exceeded NYS DEC's predictions for the Lake's Dependable Yield. The report describes the NYS DEC calculations that were performed using an in-house PC-based mathematical model, and notes several key findings and supporting assumptions:

- Dependable Yield is defined as "…the maximum volume of water that can be withdrawn, at a constant rate, during the drought of record, without exceeding the available storage capacity." This definition includes both the water withdrawn for water supply and released downstream for waste assimilation through the gated outlet structure.
- At a lake drawdown of 2.5 ft, 3.0 ft, and 3.5 ft, the dependable yield is reported as 4.9 mgd, 7.8 mgd, and 9.6 mgd, respectively. All predictions indicate that insufficient water exists to meet the required allocation without expanding the lake's operational range.
- Given a permitted demand of 13.4 mgd (6.5 mgd downstream release and 6.9 mgd permitted water supply withdrawal), the lake is over-subscribed by 8.5 mgd, 5.6 mgd, or 3.8 mgd, respectively. *Note that the current permitted demand is now 13.0 mgd, as the Town of Livonia no longer withdraws water from Conesus Lake.*
- Although actual water supply withdrawals are typically in the range of 3 to 4 mgd, even this suggests a shortfall of 0.4 mgd to 5.1 mgd.

The 2020 CWSS addressed the finding of the NYS DEC Dependable Yield Study and recognized that the NYS DEC study "implies that more water has been allocated for water supply and downstream uses than is available during a drought." The 2020 CWSS recommended that an update to the safe yield study was warranted to reflect up to date techniques and conditions as well as provide a tool for assessment of recommendations and alternatives.

Schnabel Engineering of New York was engaged by the Livingston County Planning Department to perform the recommended Safe Yield Analysis for Conesus Lake. The remainder of this report describes the basis for, findings, and recommendations resulting from this work.

1.2 Elevation Datum

Elevations in this report are in feet (ft) and are referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29) unless otherwise noted. The abbreviation "EL" represents Elevation. The NGVD 29 datum appears to be consistent with elevations referenced by the United States Geological Survey (USGS) for Conesus Lake, bathymetric data collected by CR Environmental, Inc., and most historic documentation for the gated outlet structure including the United States Army Corps of Engineers (USACE) regulation curve.

1.3 Gated Outlet Structure

The structure at the outlet of Conesus Lake has undergone several modifications over its history. We understand the timeline of the outlet structure configurations as follows:

- 1930 – 1952   No Formal Structure
- 1952 – 1964   1st Dam: Pile and Plank Dam
- 1964 – 1988   2nd Dam: Metal Sheet Pile Weir with Movable Boards
- 1988 – Present   Current Gated Outlet Structure (USACE Gated Outlet Structure)

The first structure built to control flooding on the lake was constructed in 1952. An article published in the fall-winter 2008 edition of the Conesus Lake Association newsletter refers to it as a "crude pile and plank dam." According to the 2010 *Reservoir Regulation Manual,* the first "formal" control structure was constructed in 1964, which we refer to as the 2nd dam. It was located 1,400 ft downstream of the lake. The structure was 4 ft high, 20 ft wide, and consisted of sheet piling, channels and wooden stoplogs. The lake was regulated manually by raising and lowering the stoplogs.

The current gated outlet structure was completed in 1988. The primary rationale for constructing the current outlet structure was to manage water levels and reduce the risk of flooding lakeshore properties. Subsequent agency review of the dam's operation incorporated additional consideration of recreational uses and aquatic habitat. The current gated outlet structure is pictured in Figures 1.1 and 1.2.

Figure 1.1: Current Gated Outlet Structure, Upstream Side (July, 2021)

Figure 1.2: Current Gated Outlet Structure, Downstream Side (July, 2021)

The structure comprises 11 pre-fabricated 5 ft high x 6 ft wide aluminum slide gates. The gates rest on a reinforced concrete sill and are attached to "H" piles that support a walkway. The crest of the control structure (top of gates in closed position) is at EL 818.7. The gates are operated manually, with flows typically passing below the gates, although elevated pool levels could result in flows passing over the top of the gates.

Upon completion of the gated outlet structure in 1988, the Buffalo District of the USACE produced the *Operation and Maintenance Manual for Local Flood Protection at Conesus Lake, New York*, which included the *Conesus Lake Regulation Manual* (1988 Regulation Manual) as an attachment. These documents outlined the operational strategies for flood protection, including the seasonally-varying target elevations. In 2010 the USACE Buffalo District released another Reservoir Regulation Manual (2010 Regulation Manual). This report evidently served as an update to another Regulation Manual that was reportedly released in 1991, although the 1991 Regulation Manual was not available for review.

A summary of information regarding the lake and gated outlet structure is provided in Table 1.1.

Table 1.1: Summary of Conesus Lake, Gated Outlet Structure and Operational Targets

Conesus Lake	
Surface Area	5.07 mi^2
Storage Capacity at Pool EL 818	38,940 mgal
Drainage Area at Gated Outlet Structure	70 mi^2 per USGS StreamStats and USGS Lake Level Gage 04227980 "Conesus lake near Lakeville." This value is inclusive of the surface area of Conesus Lake.
Drainage Area at Conesus Creek Confluence with Geneseo River	92 mi^2
Current Gated Outlet Structure	
Purpose	Flood control and waste assimilation
Location	Conesus Creek Outlet, 1,200 ft downstream of Conesus Lake and 30 ft upstream of the Route 20A bridge
Construction	1986 – 1988
Type	Sheet pile with pre-fabricated aluminum gates
Length	78 ft
Number of gates	11
Top of Dam / Top of Gate Elevation	818.7 ft
Invert of Gate Elevation	813.7 ft
Gate Height	5.0 ft
Gate Width	6.0 ft
Operational Target Elevations	
Spring Pool Elevation	818.7 ft
Summer Pool Elevation	818.5 ft
Winter Pool Elevation	816.5 ft

1.4   Historical Droughts

The Safe Yield Analysis needs to account for either the drought of record, or another statistically derived reference drought, such as the 100-year drought. In order to identify potential droughts of interest for the Safe Yield Analysis, we reviewed the Standard Precipitation Index (SPI) data for Livingston County, presented in Figure 1.3, which is available from the National Oceanic and Atmospheric Administration (NOAA) and the affiliated National Integrated Drought Information System (NIDIS). The SPI is a blended dataset that accounts for precipitation and temperature, and is a general indicator of regional drought potential. The dark red color, for example, represents periods of exceptional drought, which is measured as four standard deviations below the average. Our review of SPI data indicates that there are at least three potentially significant droughts during the available period of record, which occurred during the 1930s, 1960s and 2000s. Numerous other droughts are shown to have occurred during the period of record such as during the 1940s which might also limit the available water supply at Conesus Lake. Since the drought conditions that would impact water supply availability at Conesus Lake are not necessarily the same as those illustrated in the SPI data, the Safe Yield Analysis was performed by modeling the available period of record using the calibrated inflow data set.

Standard Precipitation Index (SPI) for Livingston County, 1900 to Present:

1930s   1940s   1960s   2000s

D0 - Abnormally Dry	D1 - Moderate Drought	D2 - Severe Drought	D3 - Extreme Drought	D4 - Exceptional Drought
W0 - Abnormally Wet	W1 - Moderate Wet	W2 - Severe Wet	W3 - Extreme Wet	W4 - Exceptional Wet
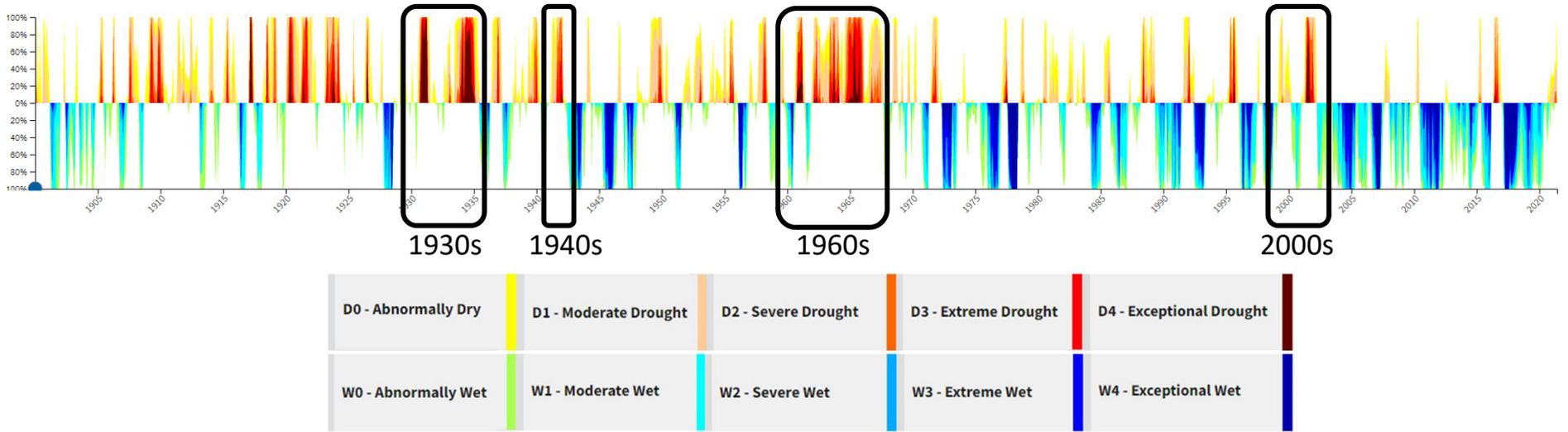
Sample of SPI Data Summary for Livingston County, May 1965:

Time Period (Years): 1900 to 2021   Update Graph   Reset Graph

Month of May 1965

Drag to update map and legend.

State Select: New York   County Select: Livingston County

D0 - Abnormally Dry	100% of Livingston County (D0-D4)		W0 - Abnormally Wet	0% of Livingston County (W0-W4)
D1 - Moderate Drought	100% of Livingston County (D1-D4)		W1 - Moderate Wet	0% of Livingston County (W1-W4)
D2 - Severe Drought	100% of Livingston County (D2-D4)		W2 - Severe Wet	0% of Livingston County (W2-W4)
D3 - Extreme Drought	100% of Livingston County (D3-D4)		W3 - Extreme Wet	0% of Livingston County (W3-W4)
D4 - Exceptional Drought	94.2% of Livingston County (D4)		W4 - Exceptional Wet	0% of Livingston County (W4)
No Data Available	0% of Livingston County			

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CONESUS LAKE SAFE YIELD LIVINGSTON COUNTY PLANNING DEPARTMENT PROJECT NO. 21C25014.00	FIGURE 1.3 HISTORICAL DROUGHTS

2.0   SAFE YIELD MODEL DEVELOPMENT

Determining the safe yield for Conesus Lake required careful consideration of inflows, outflows, and storage. In order to account for these various parameters, a safe yield model was developed in HEC-ResSim Version 3.1, a hydraulic modeling software created by the USACE, Institute for Water Resources, Hydrologic Engineering Center. The software has the capability of modeling reservoir operations based on a variety of operational goals and constraints. It can represent both large and small scale reservoirs and reservoir systems through a network of elements (junctions, routing reaches, diversions, and reservoirs) that the user builds to simulate the prototype. For this analysis, the model included elements that represent watershed/tributary inflows, storage within Conesus Lake, the gated outlet structure operation, evaporation, and the water supply delivered to the Villages of Geneseo and Avon. The model is executed at a daily time step, consistent with the shortest data period in the available record. A schematic of the modeled Conesus Lake system is provided in Figure 2.1.
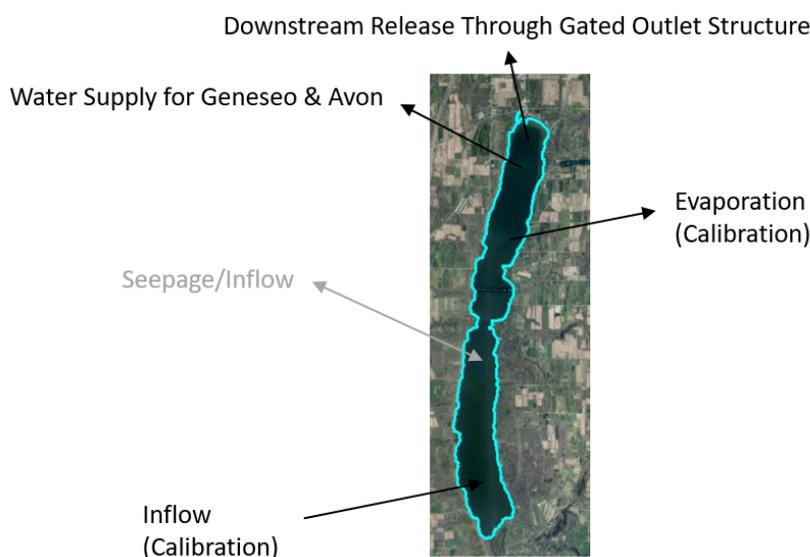
Figure 2.1: Safe Yield Model Schematic

The safe yield model was developed using the latest available data sets defining the key inflow and outflow components necessary for the analyses. The fundamental process replicates the prior work completed in 1994 by NYS DEC but benefits from an additional 60+ plus years of recorded data (capturing years since their work was complete, and prior to what they considered), new bathymetric data, and significantly advanced analytical tools for processing and refining the data.

Numerous documents, data sources, and reference materials were reviewed in the course of developing the safe yield model and performing the analysis. The following list highlights the most important:

- 1964 Water Withdrawal Permits (Avon & Geneseo)
- 1981 *Stage III Detailed Project Report and Environmental Impact Statement Conesus Lake, NY,* USACE
- 1988 *Operations and Maintenance Manual for Local Flood Protection at Conesus Lake, NY,* USACE

- 1991 *Livingston County Comprehensive Water Supply Study,* Livingston County
- 1994 *Conesus Lake Dependable Yield Study,* NYS Department of Environmental Conservation (NYS DEC)
- 2002 *State of Conesus Lake: Watershed Characterization Report,* Livingston County
- 2005 Drawings for Town of Livonia Vitale Park by Clark Patterson Associates
- 2009 Conesus Lake Bathymetry, CR Environmental, Inc.
- 2010 *Reservoir Regulation Manual Conesus Lake, Livonia, NY,* USACE
- 2017 State Pollutant Discharge Elimination System (SPDES) Permit, NYS DEC
- 2017 Responsiveness Summary regarding the draft SPDES permit, NYS DEC Bureau of Water Permits
- 2020 *Livingston County Comprehensive Water Supply Study Update,* Livingston County
- Conesus Lake Levels (1930–Present, USGS)
- Village of Geneseo Water Use (Monthly, 1992–Present)
- Village of Avon Water Use (Various Frequency Data, 1970–Present)
- USGS Stream Flow and Lake Level Gages (Various Stations)
- Northeast Regional Climate Center (NRCC) Evaporation Data (Various Stations)
- Standard Precipitation Index (SPI) provided by the National Oceanic and Atmospheric Administration (NOAA) and National Integrated Drought Information System (NIDIS)

2.1   Lake Storage, Key Elevations, and Target Rule Curve

Reservoir storage capacity is a key component of the system's safe yield. Schnabel calculated the elevation-storage relationship for Conesus Lake based on the 2009 bathymetric data collected by CR Environmental, Inc., and the area hydrography data from the NYS GIS Clearinghouse. Bathymetric maps are included as Appendix A.

The vertical datum used for the bathymetric data was not explicitly mentioned; however, it is stated that the "*elevations are relative to a water surface elevation of 817.71 ft as provided by the Conesus Lake Watershed Manager on October 19, 2009*." The lake level on this date corresponds to the lake level collected by the USGS gage on Conesus Lake for this date, which uses the NGVD 29 datum. From this, we conclude that the bathymetric data refers to the NGVD 29 vertical datum. The total storage at EL 817.71 was found to be approximately 38,630 million gallons (mgal), or 38.6 billion gallons, or 118,559 acre-ft.

The Conesus Lake elevation-storage curve is presented in Figure 2.2, annotated with key elevations.

Elevation vs. Storage Volume
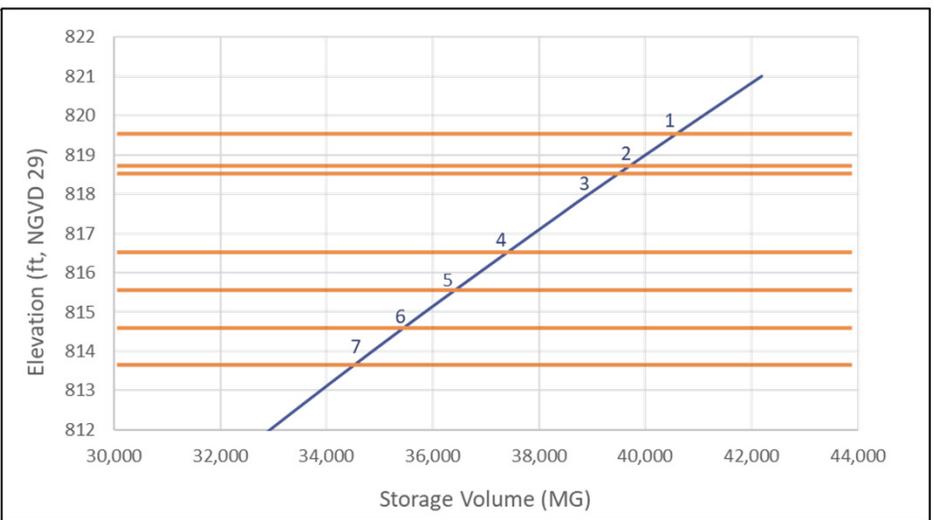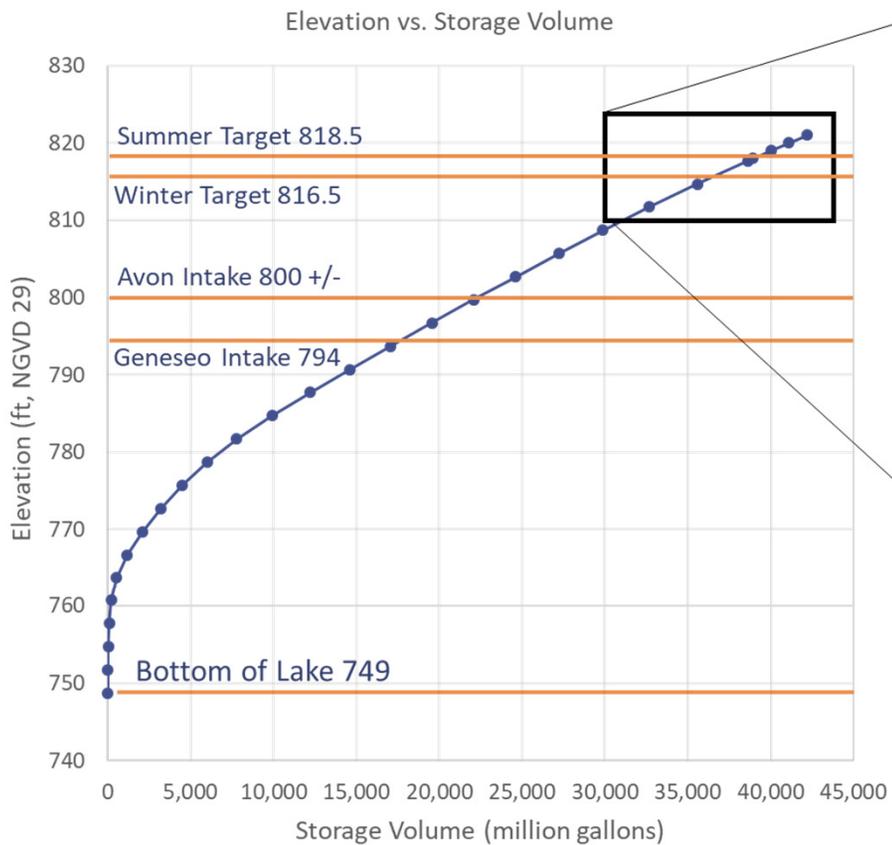
1: 819.5 – Top of Flood Control Pool
2: 818.7 – Spring Target/Top of Gate
3: 818.5 – Summer Target
4: **816.5 – Winter Target**
5: **815.5 – Bottom of Outlet Channel (approximate)**
6: **814.5 – Avon Pumps Operational Limit (approximate)**
7: 813.7 – Gate Minimum

CONESUS LAKE SAFE YIELD
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FIGURE 2.2
CONESUS LAKE
ELEVATION-STORAGE

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A list of key elevations for Conesus Lake is provided below, along with source information:

- Pool Elevation of Record: 822.5 (2010 Regulation Manual, Hurricane Agnes, 1972)
- Top of Flood Control Pool: 819.5 (2010 Regulation Manual)
- Top of Gate: 818.7 (2010 Regulation Manual)
- Spring Spawning Habitat Target: 818.7 (2010 Regulation Manual)
- Summer Recreation Target: 818.5 (2010 Regulation Manual)
- Winter Drawdown Target: 816.5 (2010 Regulation Manual)
- Bottom of Upstream Diversion Channel Leading to the Gated Outlet Structure at the Lake Boundary: 815.5 (2010 Regulation Manual)
- Avon Water Supply Minimum Pumping Elevation: 814.5 (MRB Group, Village of Avon Engineer)
- Gate Minimum: 813.7 (2010 Regulation Manual)
- Avon Water Supply Intake: 800 +/- (MRB Group)
- Geneseo Water Supply Intake: 794 (2010 Water Supply Study Update, datum unknown)
- Bottom of Lake: 749 (2009 Bathymetry)

The rule curve target elevations for Conesus Lake are shown in Figure 2.3, as provided by the 2010 Regulation Manual.
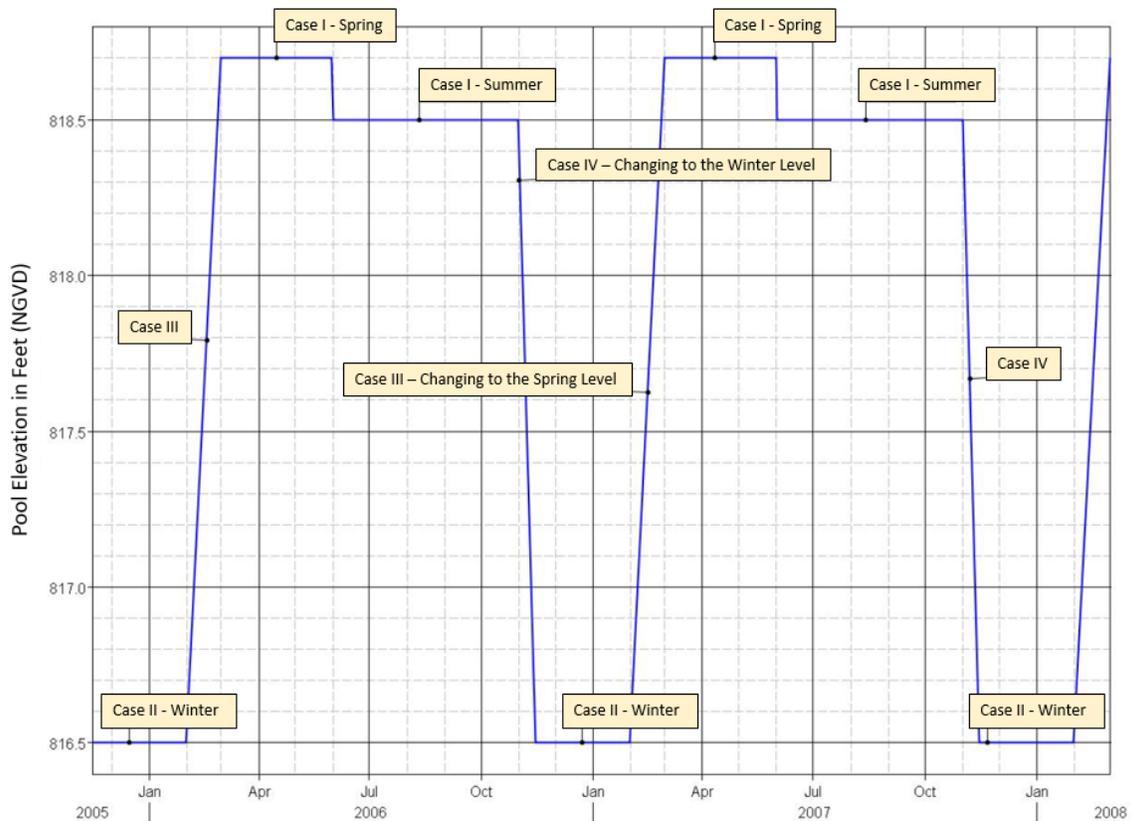

Figure 2.3: Conesus Lake Rule Curve from 2010 Regulation Manual (Two Cycles Shown)

The winter drawdown target of 816.5 has been reported as the minimum lake level necessary to maintain a downstream flow of 10 cfs (Source: 2010 Regulation Manual, p16, and USACE letter dated Sept 29, 1981). However, the gated outlet structure rating curves from that document indicate that 10 cfs might be delivered at lake levels as low as 815.5. In order to improve our understanding of current gate operations, Schnabel conducted a meeting with Mark Kosakowski (LCWSA Director of Operations) on August 27, 2021. Mr. Kosakowski has overseen gate operations since approximately 2010. During our conversation we inquired about the minimum lake level required to deliver 10 cfs. He had not personally operated the gates when the lake levels were as low as 815.5, although he reported no difficulty in delivering 10 cfs at lake levels of approximately 816.5 ft, with the exception of instances when debris blocks the gate openings. For the purposes of the Safe Yield Analysis, we assume that 10 cfs cannot be released downstream below lake levels of 815.5, limited by the configuration of the outlet channel.

2.2   Flow Regulation (Gated Outlet Structure Operations)

The 2010 Regulation Manual emphasizes flood control, and it does not offer specific guidance regarding operations during drought conditions. The operating instructions are generally based on the rate of change in lake level, referred to as "R" in the Manual. We understand from the Manual that these lake levels are read from the USGS gage. There are four (4) different cases related to various target levels, and each case has an operation for falling and rising lake levels. Figure 2.4 presents one of the operational conditions as an example. This specific operational condition is *Case I: Maintaining a Spring or Summer Target Level, with levels below target and falling*. The operations for all operational conditions are outlined in the 2010 Regulation Manual.

Levels Below Target - Falling Lake Level

If all gates are not closed, close additional gates by the amounts listed for the appropriate range of R.

$$R \text{ (Rate of Change (in/hr))} = \frac{\text{Current reading minus previous reading in inches}}{\text{Time in hours between readings}}$$

R in/day	# of Gates to Close
Less than 1"/day	½
1"/day to 5"/day	1
Greater than 5"/day	5

Figure 2.4: Sample Gate Operation Instructions

The Conesus Lake Compact of Towns has responsibility for managing the Gated Outlet Structure, and the Compact has a contract with the Livingston County Water & Sewer Authority for operation of the gates. Following our conversation with the Livingston County Water and Sewer Authority on August 27, 2021, we understand that the actual gate operations do not strictly follow the prescribed actions in the 2010 Regulation Manual. Rather, the gates are operated based on long-term experience of operating the system through numerous wet weather events and dry periods utilizing seasonal elevations of the rule curve as the performance goal. Additionally, the actual gate operations incorporate predictive action, such as lowering the pool in advance of forecasted large storm events. This is consistent with our review of the gate operator's logbooks from 2003 – 2005, which indicate that the gate operations are generally in

accordance with the target rule curve, but do not appear to strictly follow the prescribed incremental gate operations.

2.3 Lake Level Data

Lake levels for Conesus Lake are recorded year-round by USGS Gage 04227980 – Conesus Lake near Lakeville, which is located on the western shore of Conesus Lake in the vicinity of Blue Heron Drive. The USGS website provides daily, monthly, and annual data for this gage from 1963 to present. USGS lake level data prior to 1963 was also obtained through Livingston County. The document provided monthly high and low lake levels from 1930–1963, and daily levels from 1964–1992. The data from 1964–1992 was identical to that found on the USGS website.

The lake levels from USGS are presented in Figure 2.5. The construction of the 1st dam in 1952 appears to have raised the typical lake levels relative to the 1930–1950 period, during which there was no formal lake level control. The 2nd dam, constructed in 1964, appears to have further raised the typical lake levels. When the current gated outlet structure was built in 1988, it appears not only to have maintained the minimum elevations established by the earlier dams, but also limited peak elevations, resulting in a narrower band of normal operation.

Lake level data was also obtained from NYS DEC, specifically a 1967 NYS Water Resources Commission Conservation Department document titled, *Application for a Permit for the Construction, Reconstruction or Repair of a Dam or Other Impoundment Structure under Conservation Law*. The levels in this document are similar to the USGS data, so the USGS data was used as the basis for the current analysis.
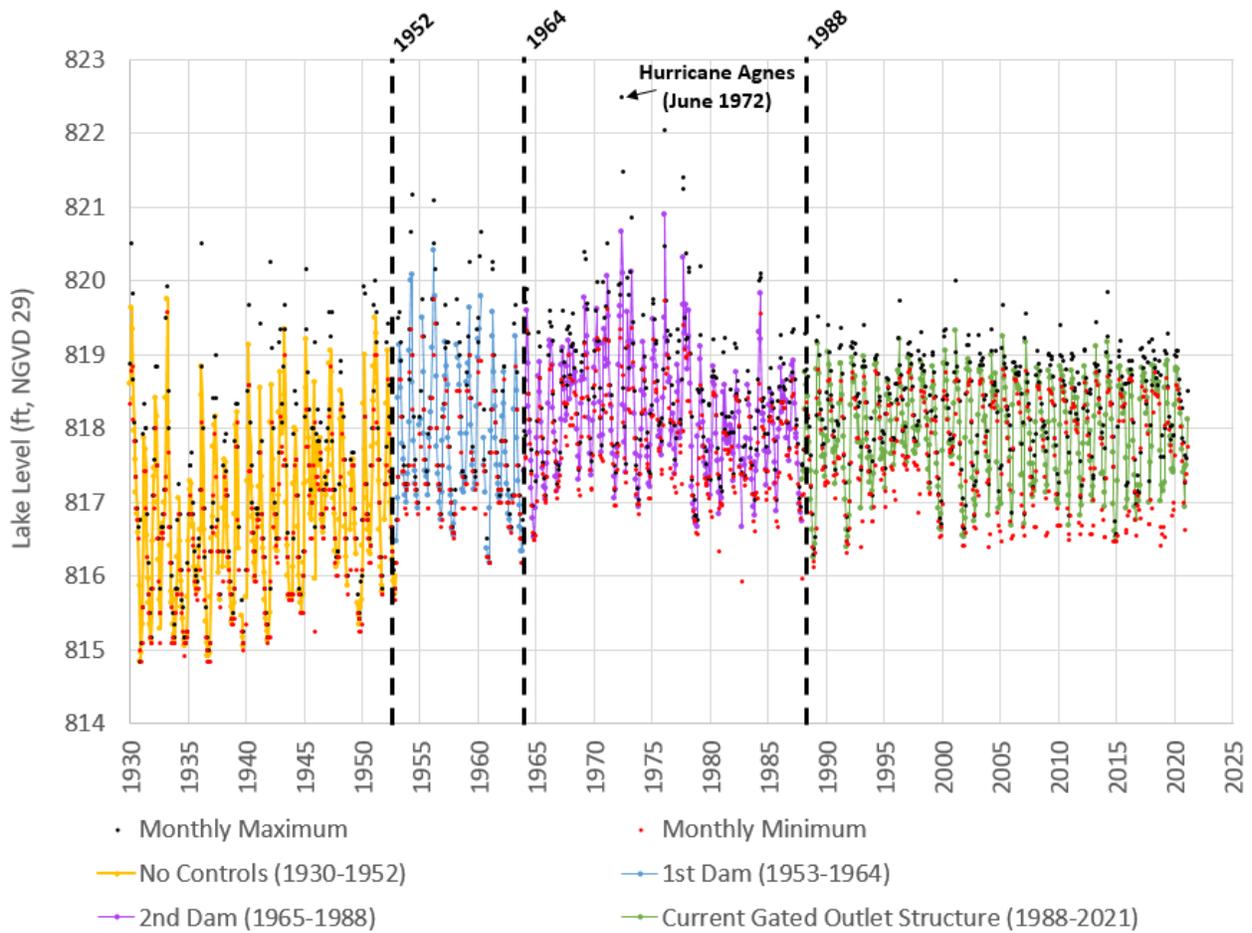
Figure 2.5: Conesus Lake Levels

2.4   Conesus Lake Inflows

The Conesus Lake watershed basin, or the area that drains to the lake, is approximately 70 mi^2 including the lake surface. Figure 2.6 presents the watershed boundary on a topographic map. The inflows to Conesus Lake are reported to arrive primarily via the Conesus Inlet, which flows into the southern end of the lake. The 2010 Regulation Manual describes the runoff from the watershed as "flashy and of short duration because of the limited upland storage capacity and the relatively steep gradient." For reference, this figure also includes the watershed for the downstream USGS streamgage on Conesus Creek.

USGS 04227995
Conesus Creek near Lakeville
(Watershed Area 72.0 Square Miles)

Conesus Lake Gated Outlet Structure
(Watershed Area 69.8 Square Miles)
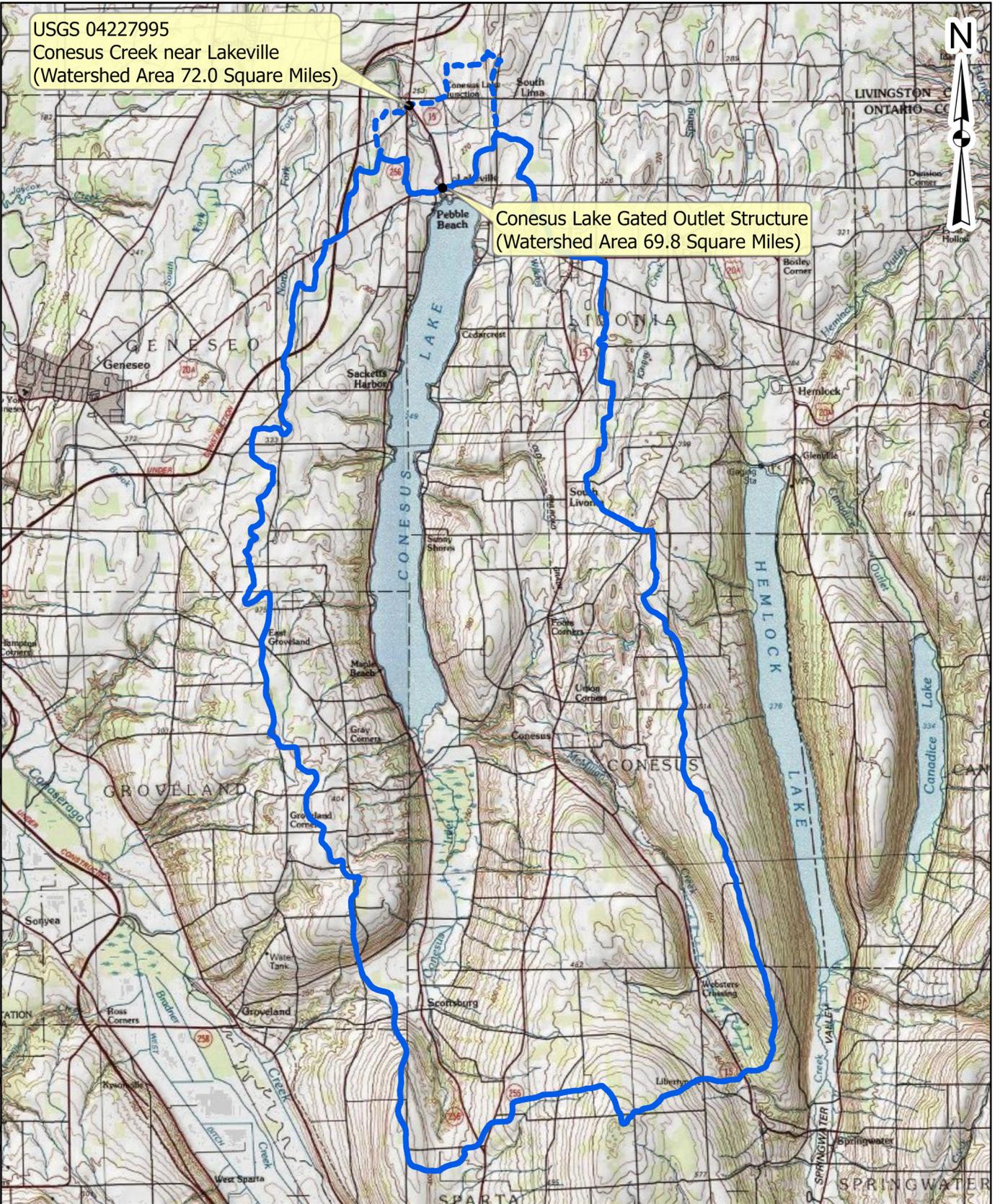
0 1 2 4 Miles
1 inch equals 2 miles

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FIGURE 2.6
CONESUS LAKE
WATERSHED

The composite inflow to Conesus Lake contributed from all tributary inflow sources and direct precipitation can be simulated with an inflow hydrograph derived from a gaged watershed record. Because the Conesus Lake watershed is not gaged, the modeled inflows can be estimated based on nearby and hydrologically similar gaged watershed records translated using a ratio of watershed areas. If sufficient data exists, these inflows (as well as other modeled contributions) can be refined through a detailed calibration process. Several nearby USGS stream gages were reviewed for the purpose of developing the synthetic inflow hydrograph. Ultimately, the streamgage Cohocton River near Campbell (USGS 01529500) was incorporated into the analysis based on its proximity to the site, comparable watershed characteristics, and available period of record. The particulars for the development of these inflows and selection of the Cohocton River near Campbell gage are discussed in detail within *Section 3 – Model Calibration*.

2.5   Releases from Conesus Lake to Conesus Creek

Conesus Lake releases flow to Conesus Creek via the gated outlet structure at the northern end of the lake. Conesus Creek runs in a northerly direction for 10.5 miles before entering the Genesee River.

The Lakeville WWTP is located approximately 0.75 miles downstream of the gated outlet structure, and a streamgage (USGS 04227995 Conesus Creek near Lakeville) is located approximately 1.75 miles downstream of the gated outlet structure. A schematic of the Conesus Lake outlet is provided in Figure 2.7.
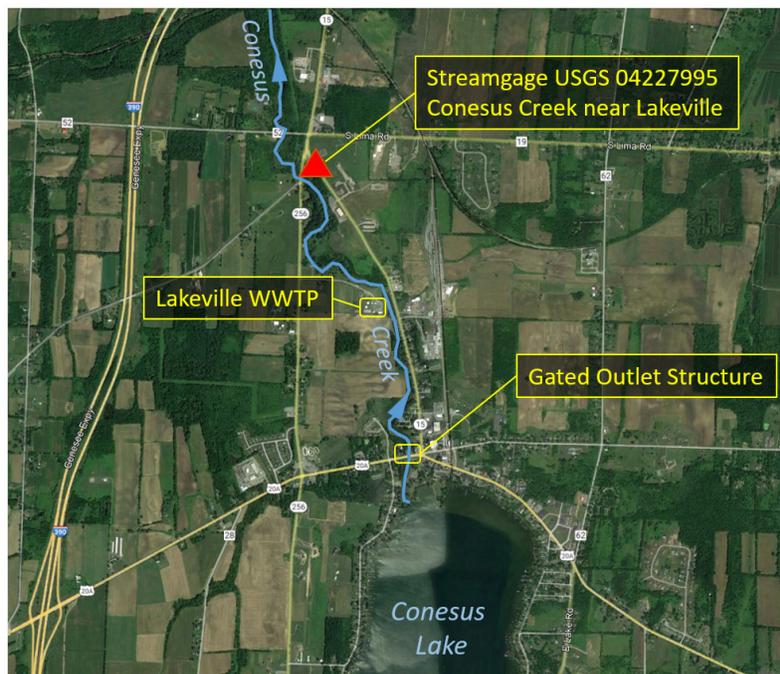
Figure 2.7: Schematic of Conesus Lake Outlet

The Lakeville WWTP is permitted to discharge a monthly average of 1.27 mgd to Conesus Creek. A daily minimum release of 10 cfs is required from the gated outlet structure to satisfy water quality criteria in the creek. According to the State Pollutant Discharge Elimination System (SPDES) permit for the Lakeville

WWTP, this mandatory flow is measured at the USGS streamgage located a mile downstream of the Lakeville WWTP.

The flow measured at the streamgage includes all discharges from Lakeville WWTP into the creek, as well as other tributary inflows entering Conesus Creek downstream of the Gated Outlet Structure. During the data review process, we considered the possibility that the required release from Conesus Lake via the Gated Outlet Structure might be less than 10 cfs if these downstream flows are accounted for. In other words, since other flows are entering Conesus Creek downstream of the Gated Outlet Structure, are these other flows great enough and reliable enough to reduce the flow discharged at the Gated Outlet Structure to something below 10 cfs? However, our review of available data indicated that the flows are not great enough or reliable enough to warrant a reduction of the minimum flow from the Gated Outlet Structure below 10 cfs for this Safe Yield Analysis. The monthly average discharges from the WWTP are as low as 0.4 mgd (approximately 0.6 cfs) as shown in Figure 2.8, indicating that daily minimum flows would be even less. Furthermore, downstream tributary inflows may be very low during drought conditions. Since the WWTP flows and tributary inflows to Conesus Creek are sometimes very low, we assume that at least 10 cfs must be continuously released from the dam to satisfy the SPDES permit and our modeling objectives.
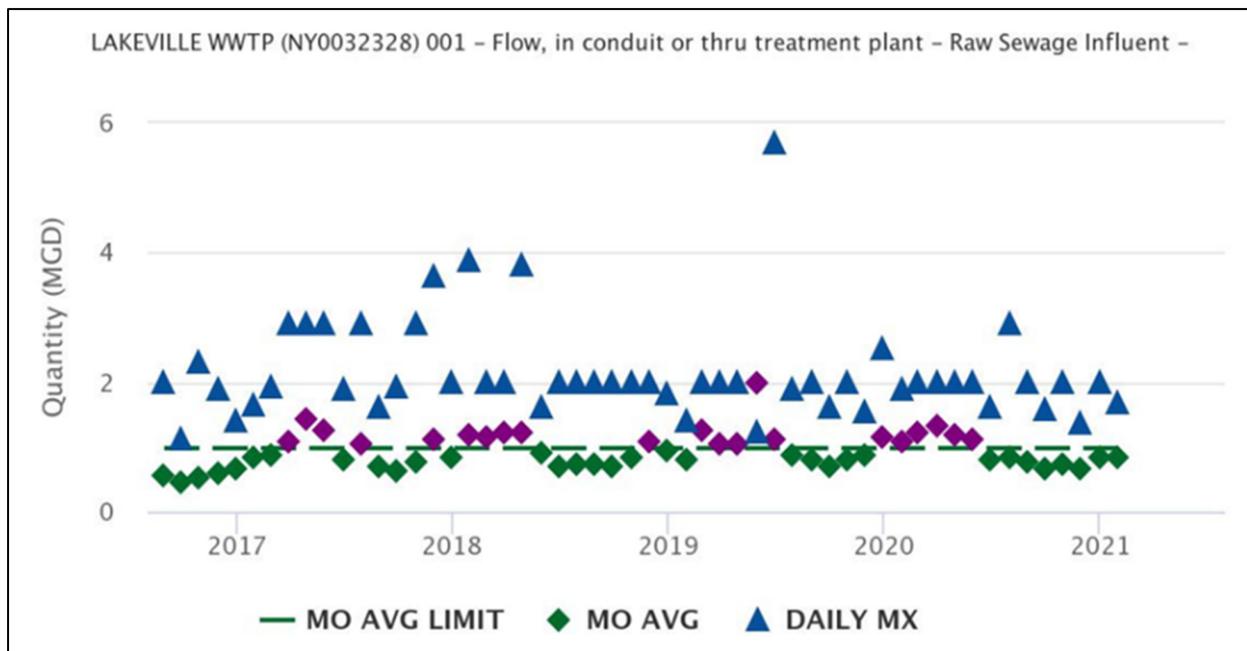
Figure 2.8: Lakeville Wastewater Treatment Plant Flows

Daily flows at the USGS gage on Conesus Creek are presented in Figure 2.9. Flows in Conesus Creek have occasionally fallen below the permitted daily minimum of 10 cfs, although this has occurred only a few times in the last 10 years.
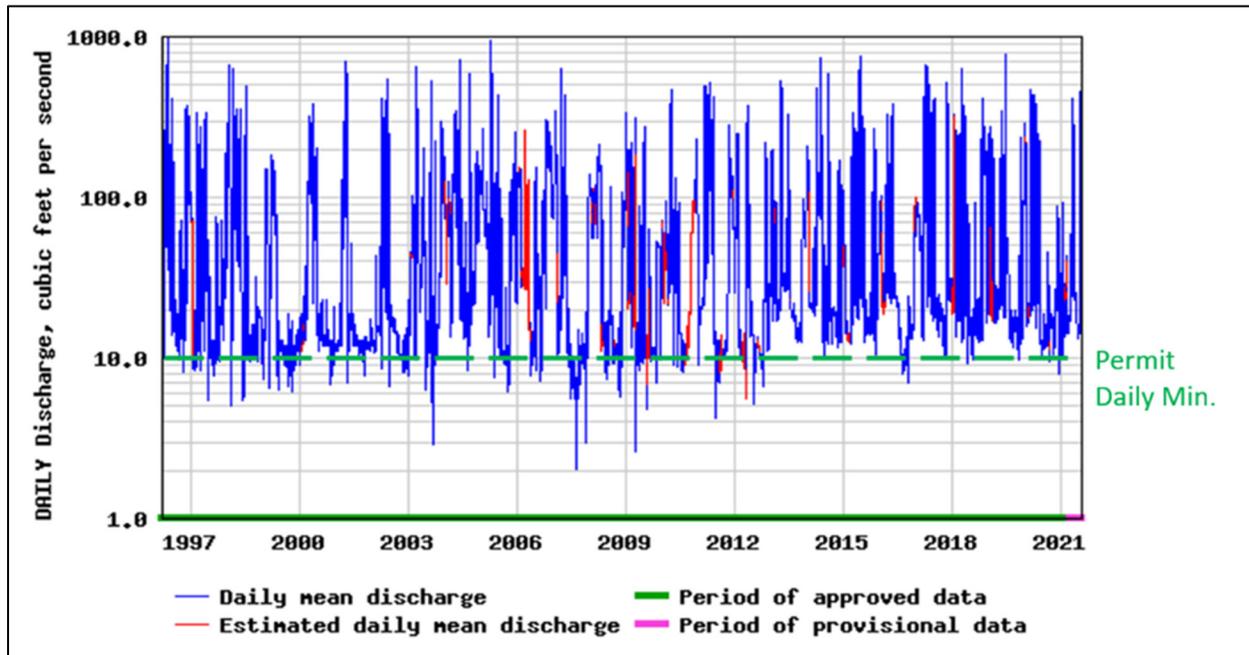
Figure 2.9: USGS Conesus Creek near Lakeville (Downstream Release)

The streamgage for Conesus Creek near Lakeville (USGS 04227995) has an available period of October 1919 through September 1934; and from April 1996 to the present day. Prior to April 1996, the data was published as USGS 04228000.

2.6 Water Supply

The Village of Avon and the Village of Geneseo currently draw water from Conesus Lake. The Village of Avon currently uses 0.75 mgd and the Village of Geneseo currently uses 0.98 mgd (2018-2020 averages). Note that their average daily water uses are significantly less than their water supply allocations. The Village of Avon is allocated 3.5 mgd and the Village of Geneseo is allocated 3.0 mgd. The Town of Livonia also used Conesus Lake for their water supply until 1994. The data provided for water supply from the Villages of Avon and Geneseo are shown in Figure 2.10.
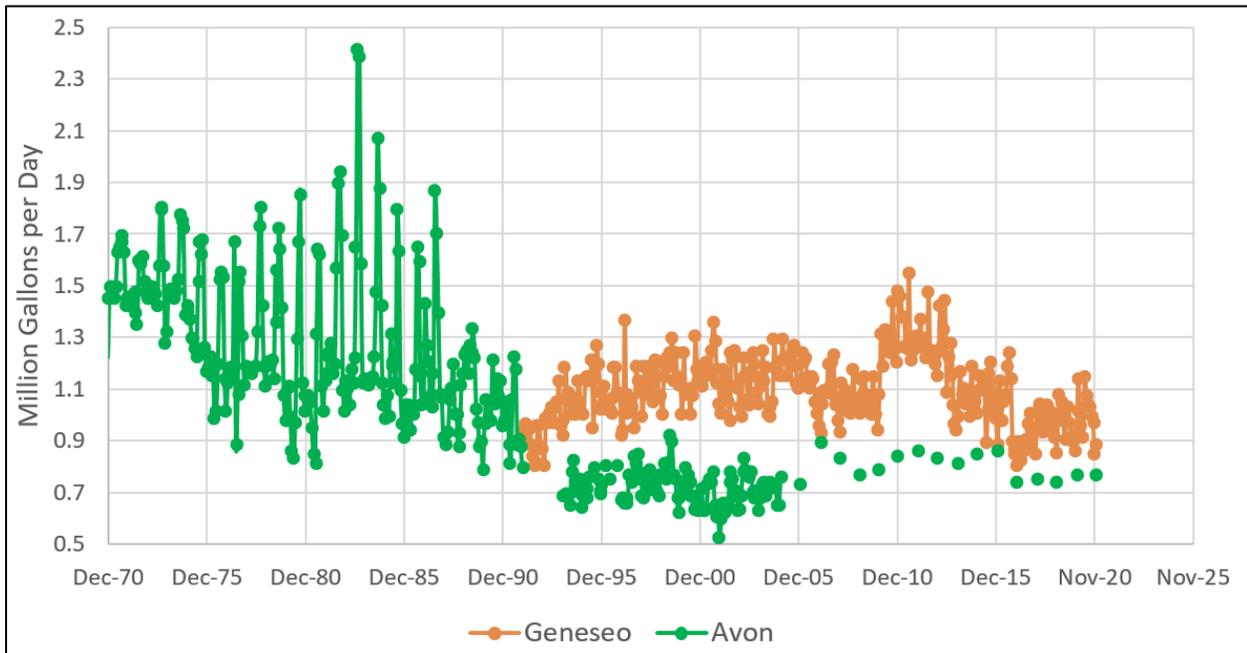
Figure 2.10: Average Daily Water Use

Upon reviewing the water supply data, we noted that the Village of Avon began to draw significantly less water in the early 1990s. This is reportedly due to changes in operations at a Birds Eye frozen vegetable plant. The plant had been utilizing approximately 1 mgd, but then gradually began phasing out certain products and reducing their water use. In addition, water conservation measures were introduced in the Village of Avon around the same time.

## 2.7	Evaporation

Evaporation measurements and estimates were obtained through the Northeast Regional Climate Center (NRCC) for ten regional weather stations. The locations of these weather stations are illustrated in Figure 2.11.
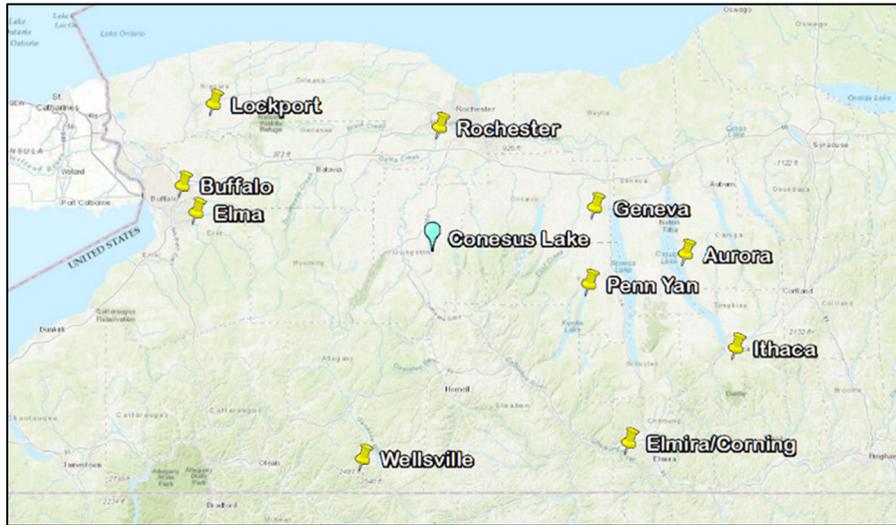
Figure 2.11: Regional NRCC Weather Stations

Evaporation Pan Estimates from the Rochester station were incorporated in the model, and refined in the calibration process as described in *Section 3 – Model Calibration*.

## 2.8	Groundwater Inflows and Seepage

The belowground flow of water may occur at Conesus Lake. This may include groundwater flows into the lake, or seepage out of the lake. Data is not readily available to support estimates of these flows. Below-ground inflows and seepage are assumed to be minor and accounted for within the calibration of watershed inflows and evaporative losses.

3.0   MODEL CALIBRATION

The model calibration process involves modifying model input parameters such that the model predictions replicate observed conditions. Once the model is demonstrated to reproduce documented events, it can be utilized to evaluate other alternative operations and predict the system's response to those operations. The goal of the safe yield model calibration is to produce a tool that accurately predicts the system's response during drought conditions.

Model calibration for a safe yield analysis is typically performed for a significant drought event for which most or all data is available (i.e., inflow/outflows, gate operations, and lake levels). For Conesus Lake the available data supports a calibration of the model to the drought that occurred in 2001-2002. Prior droughts were not utilized for calibration due to insufficient water supply usage records for those periods. Various model parameters can be adjusted to calibrate the model. For example, the calibration process establishes the evaporation, and operational controls for the period of record. Most importantly, the calibration attempts to identify a streamgage that best represents the Conesus Lake inflows. The data processing methodologies utilized to calibrate the model are then applied to the entire period of record, and the calibrated model is executed to determine the safe yield during the period of record. This approach is summarized in Table 3.1.

Table 3.1: Safe Yield Modeling Approach

	Calibrate Model to a Significant Drought Event (2000s)	**Apply Calibrated Safe Yield Model to Period of Record (Drought of Record)**
Lake Levels	Known	Predicted by Model
Inflows	Calibration (based on Regional Gages)	Estimated Based on Calibration
Evaporation	Calibration (based on Regional Station Data)	Estimated Based on Calibration
Geneseo and Avon Water Usage	Known	Determinant (This is the Safe Yield)
Downstream Release	Known	Predicted by Model
Outlet Structure / Rule Curve	Downstream release modeled based on measured downstream flows corrected for watershed area and WWTP flows	Gated Outlet Structure Operations based on Rule Curve

A significant historical data record exists which allowed the model to be calibrated using the drought of 2001-2002, including measured water surface elevations, water supply withdrawals, and downstream releases. For calibration, the model was configured to withdraw specified flows from Conesus Lake to represent the water supply and the downstream releases, consistent with the historical recorded values. Two parameters within the safe yield model were subject to calibration: watershed inflows (including direct precipitation to Conesus Lake), and evaporative losses from Conesus Lake. By modifying these two parameters, the model was calibrated to match historic lake level observations.

3.1 Establishing the Downstream Releases for Model Calibration

The downstream releases through the gated outlet structure for the calibration period were computed based on recorded flows at Conesus Creek at Lakeville (USGS 04227995) adjusted to account for downstream tributary inflows as well as discharge from the Lakeville WWTP. To account for the contribution of downstream tributary inflows, the discharge through the gated outlet structure was reduced from the recorded flows at the streamgage based on the ratio of the watershed areas (70 mi^2 at the outlet structure versus 72 mi^2 at the streamgage location). The recorded flows at the Lakeville WWTP were then subtracted from the adjusted total flow.

The equation below shows how the streamgage data from Conesus Creek near Lakeville (USGS 04227995) was adjusted to reflect gated outlet structure releases for the purpose of model calibration.

Estimated Releases from Gated Outlet Structure=
USGS Streamgage Recorded Flow scaled for Watershed Area (70 mi^2 / 72 mi^2) - Lakeville WWTP Discharge

Figures 3.1 and 3.2 illustrate the recorded flow relative to the modified flow, with the differential plotted independently. The first figure uses a standard vertical axis, and the second figure uses a logarithmic vertical axis to exaggerate the lower range of flows. The figures show that the adjustment to the streamgage data is typically between 10 and 20 cfs during springtime when flows to Conesus Creek are highest, while an adjustment of 2 to 3 cfs is more typical of low flow periods.
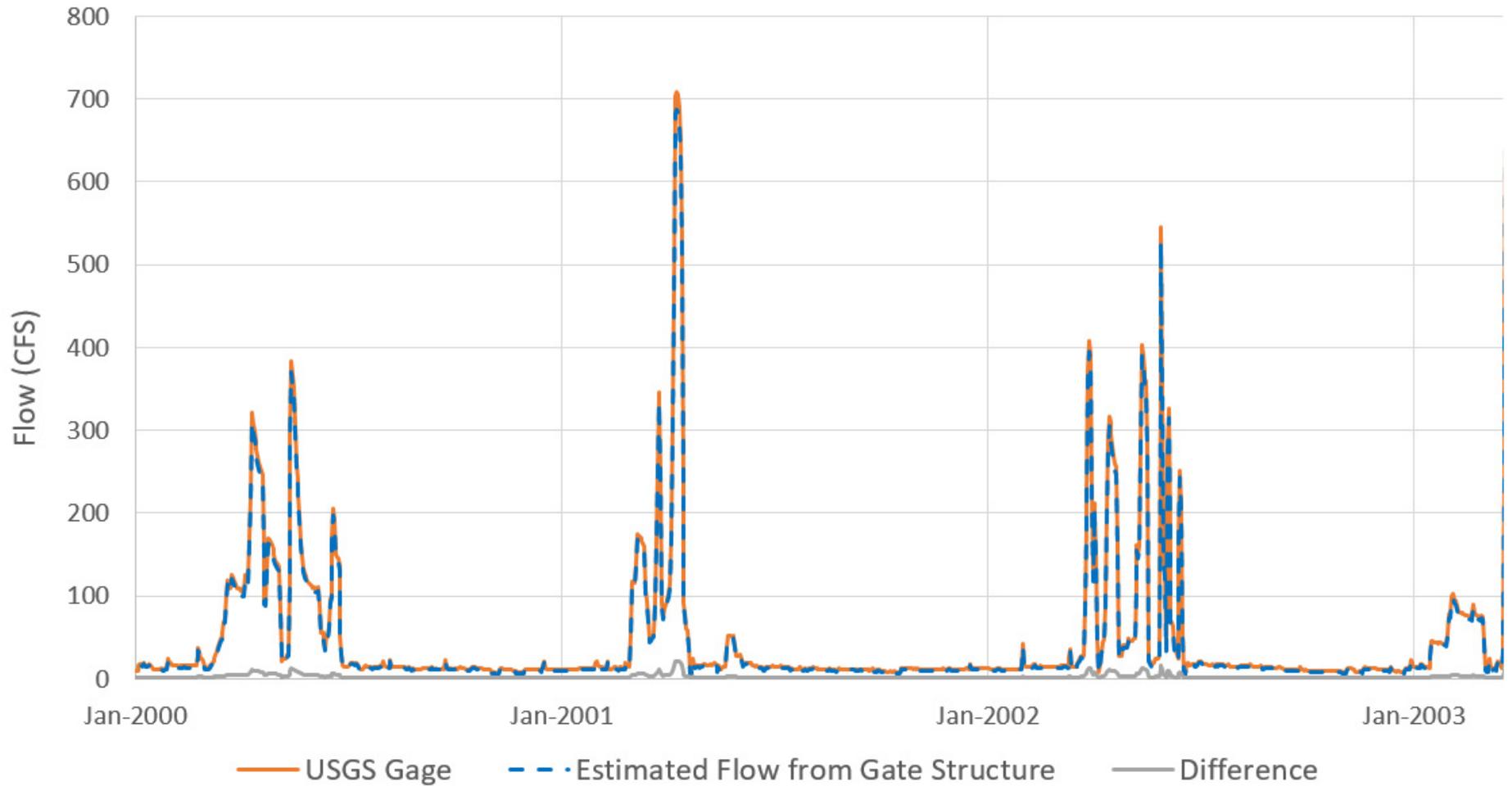
Jan-2000   Jan-2001   Jan-2002   Jan-2003

—— USGS Gage   – – · Estimated Flow from Gate Structure   —— Difference

| | CONESUS LAKE SAFE YIELD | FIGURE 3.1 |
| **Schnabel** ENGINEERING | LIVINGSTON COUNTY PLANNING DEPARTMENT PROJECT NO. 21C25014.00 | DOWNSTREAM FLOW ADJUSTMENT (STANDARD VERTICAL AXIS) |
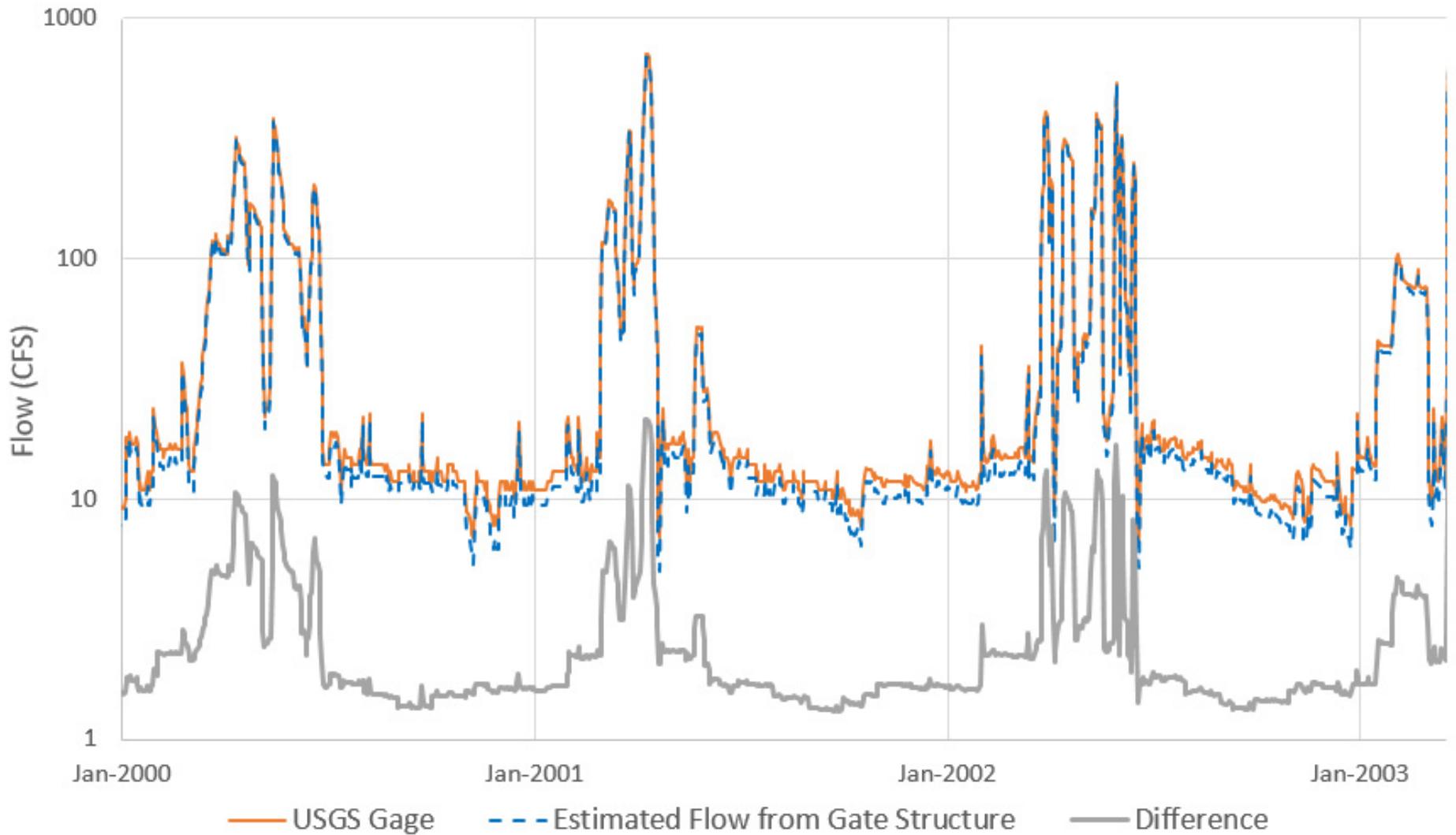
	CONESUS LAKE SAFE YIELD	FIGURE 3.2
Schnabel ENGINEERING	LIVINGSTON COUNTY PLANNING DEPARTMENT PROJECT NO. 21C25014.00	DOWNSTREAM FLOW ADJUSTMENT (LOGARITHMIC VERTICAL AXIS)

3.2 Calibrating Inflows to Conesus Lake

The most significant unknown for the safe yield model is the inflow from the Conesus Creek watershed, and therefore it is the primary focus of the model calibration. Because the watershed is ungaged, inflows were estimated based on other nearby gaged watersheds. Part of the calibration process was to create a synthetic inflow hydrograph for the Conesus Lake watershed that, when modeled with the documented water supply withdrawals and downstream releases and evaporative losses, resulted in water surface elevations at the lake that matched the historical record. Multiple nearby USGS stream gages were reviewed to determine which gage best represents the Conesus Lake inflows, and could therefore serve as the basis for developing the synthetic inflow hydrograph.

Table 3.2 summarizes the regional streamgages that were reviewed as candidates for developing the synthetic inflow hydrograph, and Figure 3.3 shows the geographic boundaries of these watersheds in relation to Conesus Lake. For reference, this figure also includes the Conesus Lake watershed, the gated outlet structure, and the watershed for the downstream USGS streamgage on Conesus Creek.

Table 3.2: Regional USGS Streamgages Considered During Calibration

Gage Number	Gage Name	Period of Record	Drainage Area (mi²)
04225000	Canaseraga Creek near Dansville	Oct 1910 – Sept 1976	152
04224775	Canaseraga Creek Above Dansville	Aug. 1974 – Current	88.9
01521500	Canisteo River at Arkport	Jan. 1937 – Current	30.6
01523500	Canacadea near Hornell	Oct. 1940 – Sept 1942 Oct. 1944 – Current	57.9
01529500	Cohocton River near Campbell	July 1918 – Current	470
04229500	Honeoye Creek at Honeoye Falls	Oct. 1945 – Current	196
04230500	Oatka Creek at Garbutt	Oct. 1945 – Current	200
04228500	Genesee River at Avon	Aug. 1955 – Current	1,673
04227980	Conesus Lake near Lakeville (Lake Levels)	Jan. 1930 – Current	69.8

FIGURE 3.3
USGS GAGED
WATERSHED MAP

CONESUS LAKE SAFE YIELD
LIVINGSTON COUNTY PLANNING DEPARTMENT
NEW YORK
PROJECT NO. 21C25014.00
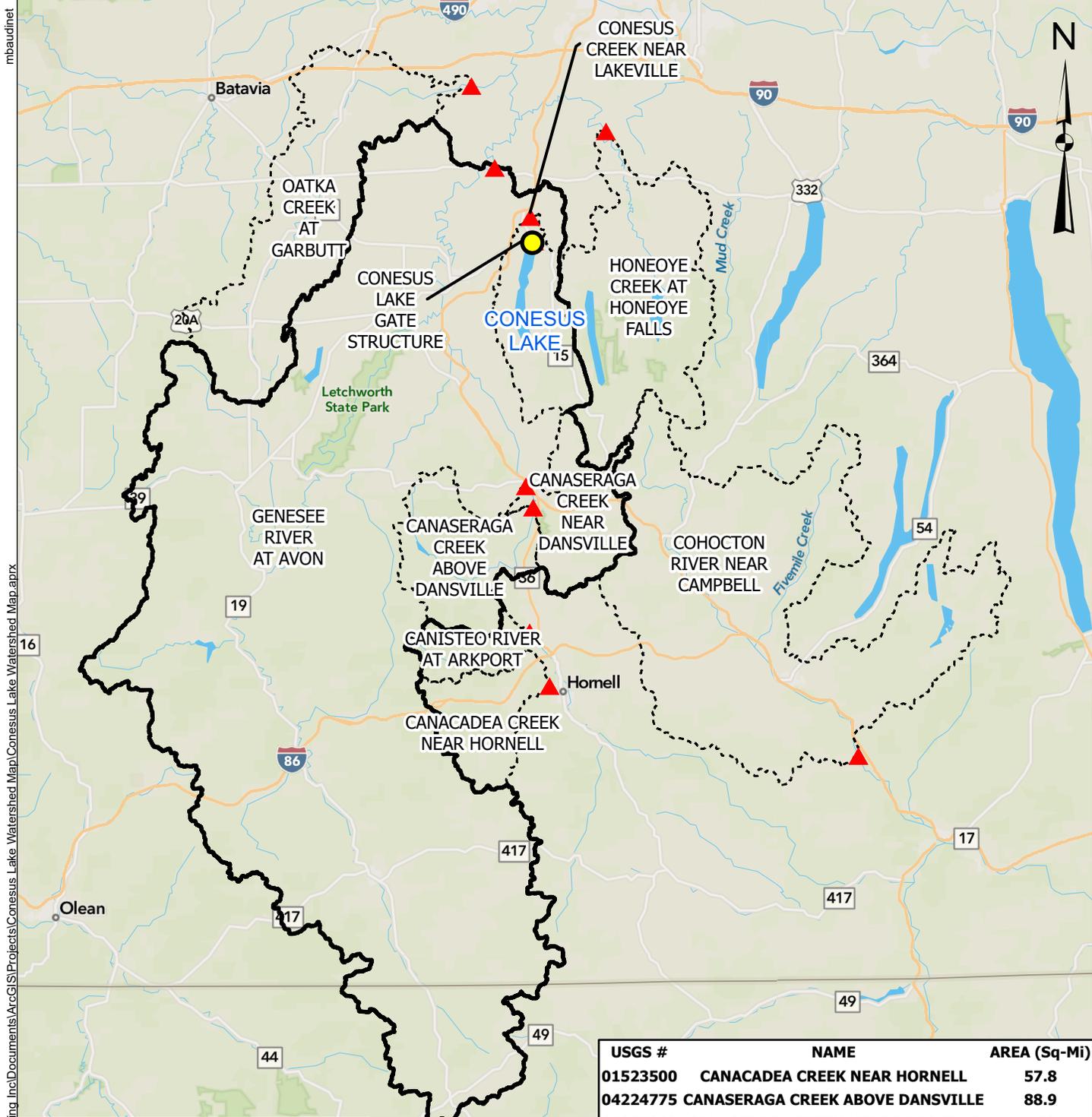
Legend

▲ Streamgage Location

┈ Watershed Boundaries

━ Genesee River Watershed Boundary

USGS #	NAME	AREA (Sq-Mi)
01523500	CANACADEA CREEK NEAR HORNELL	57.8
04224775	CANASERAGA CREEK ABOVE DANSVILLE	88.9
04225000	CANASERAGA CREEK NEAR DANSVILLE	152
01521500	CANISTEO RIVER AT ARKPORT	30.6
01529500	COHOCTON RIVER NEAR CAMPBELL	470
04229500	HONEOYE CREEK AT HONEOYE FALLS	196
04230500	OATKA CREEK AT GARBUTT	200
04228500	GENESEE RIVER AT AVON	1673
04227995	CONESUS CREEK NEAR LAKEVILLE	72

Source: Community: data.pa.gov, Esri Canada, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS
Projection: NAD 1983 2011 StatePlane New York West FIPS 3103 Ft US

Scale:1 in = 12 mi

0   6   12   24 Miles

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10/22/2021 C:\Users\mbaudinet\OneDrive - Schnabel Engineering Inc\Documents\ArcGIS\Projects\Conesus Lake Watershed Map\Conesus Lake Watershed Map.aprx

mbaudinet

The preliminary model results for each regional streamgage and the observed values are illustrated in Figure 3.4, with modeled inflow hydrographs having been developed from gaged streamflow records adjusted for Conesus Lake using a direct watershed area ratio. After scaling the gaged flows based on drainage areas, the Cohocton River near Campbell streamgage appears to produce the best fit relative to observed lake levels.

Secondary adjustments were made to the other candidate gages to determine if a better fit could be accomplished. The original direct watershed area ratio was modified with an additional increase or decrease of the flows at a fixed percentage. Ultimately, these attempts to customize the scaling ratio for other gages did not produce an inflow hydrograph that outperformed the Cohocton River near Campbell gage.

The Cohocton River near Campbell streamgage (USGS 01529500) was therefore selected as the basis for the calibrated synthetic inflow hydrograph. The gage's period of record for mean daily flow is July 1918 to present and the gage is located approximately 47 miles southeast of the Conesus Lake Gated Outlet Structure. The watershed area of the Cohocton River near Campbell gage is 470 square miles, and the watershed of Conesus Lake at the gated outlet structure is 69.8 square miles; therefore, Cohocton River near Campbell gage flows were multiplied by 0.1485 to scale them down to the Conesus Lake watershed based on the area-ratio method.

Figure 3.5 illustrates a model simulation using the Cohocton River near Campbell streamgage as the inflow hydrograph. The top portion of the chart shows the model performance relative to observations. The model reproduces observations during the drought condition very well, and also demonstrates similar trends over the course of the three-year modeled period. The bottom portion of the chart shows the corresponding modeled inflow and outflow hydrographs.
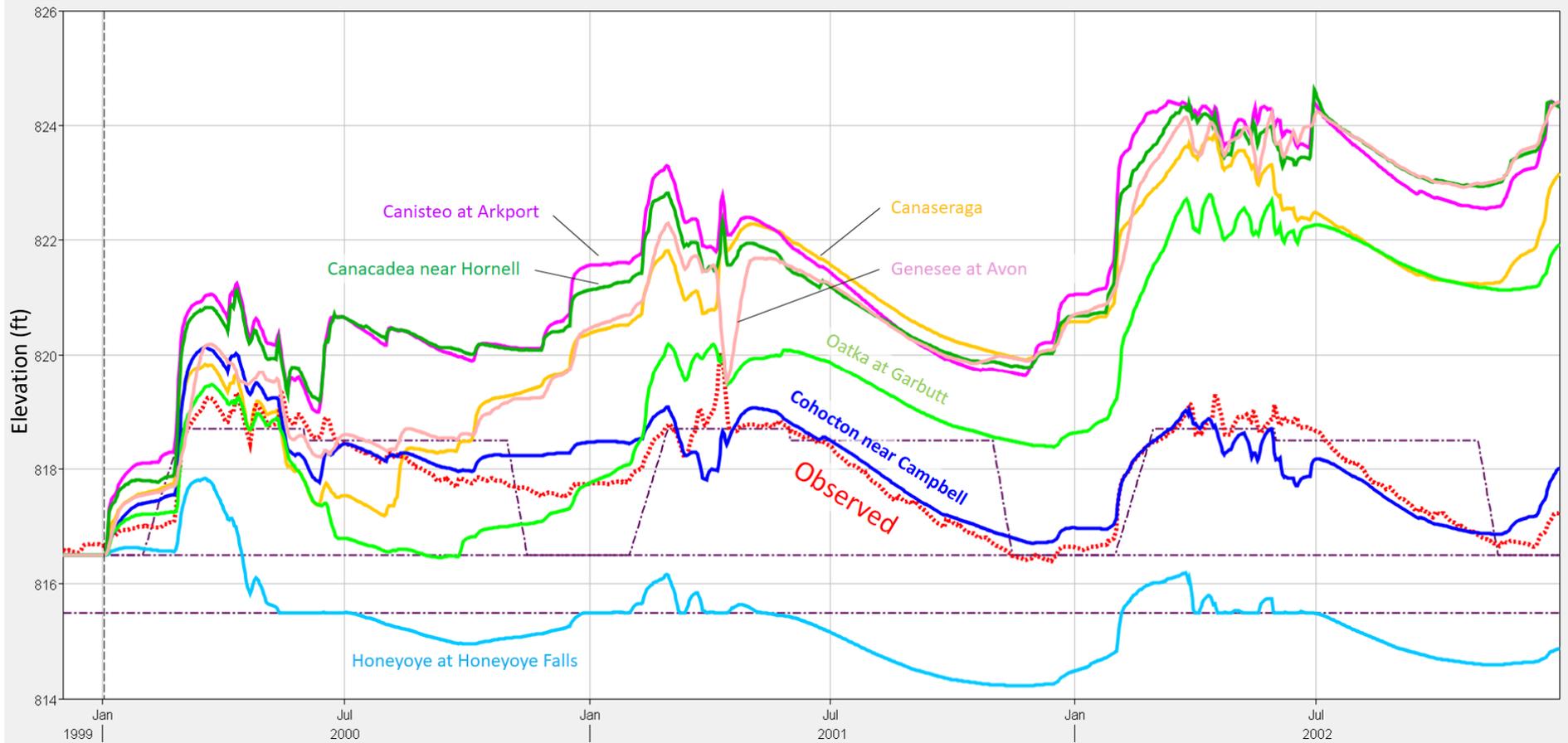
Figure showing elevation (ft) plotted over time from January 1999 through 2002, with the following labeled series:
- Canisteo at Arkport
- Canacadea near Hornell
- Canaseraga
- Genesee at Avon
- Oatka at Garbutt
- Cohocton near Campbell
- Observed
- Honeyoye at Honeyoye Falls

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FIGURE 3.4
PRELIMINARY RESULTS FOR
CALIBRATION BASED ON
REGIONAL STREAMGAGES

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Upper chart (Elevation):
Y-axis: Elevation (ft) — 815, 816, 817, 818, 819, 820, 821

Model Results based on Scaled Inflow from
USGS 01529500 Cohocton River near Campbell

Observed Lake Level

Drought of 2001-2002

Lower chart (Flow):
Y-axis: Flow (cfs) — 0, 200, 400, 600, 800, 1,000

Inflow to Conesus Lake
(Scaled from USGS 01529500 Cohocton River near Campbell)

Outflow from Conesus Lake Gated Outlet Structure
(Adjusted USGS 04227995 Conesus Creek near Lakeville)

Drought of 2001-2002

X-axis: Jan 1999, Jul 2000, Jan, Jul 2001, Jan, Jul 2002

Title block:

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E N G I N E E R I N G

CONESUS LAKE SAFE YIELD
LIVINGSTON COUNTY PLANNING DEPARTMENT
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FIGURE 3.5
MODEL REUSLTS
BASED ON CALIBRATED
INFLOW HYDROGRAPH

3.3 Calibrating Evaporative Losses from Conesus Lake

The previous models had been executed based on long-term monthly evaporation averages, and by applying a coefficient of 0.7 to evaporation pan estimates based on guidance from the NRCC, as summarized below:

> *Annual lake evaporation estimates are usually obtained by multiplying the annual pan data by an appropriate coefficient. These coefficients have been computed for a number of water bodies and for a US NWS Class A pan and tend to range in value from 0.65-0.85 (U.S. Department of Commerce 1968; World Meteorological Organization 1973)... A coefficient of 0.7 is applicable when water and air temperatures are approximately equal (Kohler et al. 1955, 1958).*

> *Source: email correspondence with NRCC dated February 26, 2021.*

In order to refine the model, monthly evaporation pan estimates from the Rochester station were calibrated by adjusting the evaporation coefficient. The pan estimates were adjusted using a calibrated monthly correction factor (or coefficient) ranging from 0.5 to 1.25, provided in Table 3.3.

Table 3.3 - Monthly Evaporation Correction Coefficients (Calibrated)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Coefficient	1.0	0.8	0.5	0.5	0.5	0.7	0.9	0.75	0.75	1.0	1.25	1.0

The monthly evaporation pan estimates (reported as inches of water) for the Rochester station are available as far back as January 1949. Figure 3.6 illustrates the modeled evaporation values using the calibrated monthly coefficients. From January 1949 until present, the modeled evaporation is calculated by applying the monthly correction factor to the monthly evaporation pan estimates. Prior to January 1949, where monthly pan estimates were not available, the modeled evaporation is calculated by applying the monthly correction factor to the monthly average computed over the 1949 through 2020 period of record for the Rochester pan estimates.
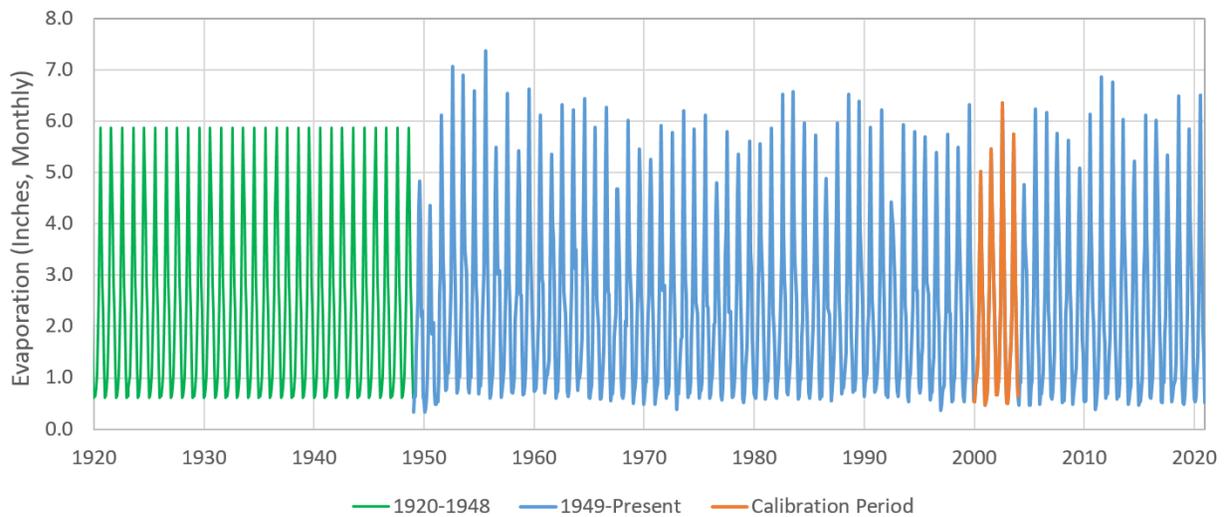
Figure 3.6: Modeled Evaporation Values using Calibrated Monthly Coefficients

The monthly evaporation for the calibration period is shown in orange on Figure 3.6 and extracted and shown in more detail on Figure 3.7. Figure 3.7 also shows the calibration estimates relative to a uniform coefficient of 0.7 illustrating that the calibrated results do not differ significantly from a baseline evaporation estimate despite the coefficients being outside the typical range suggested by NRCC.
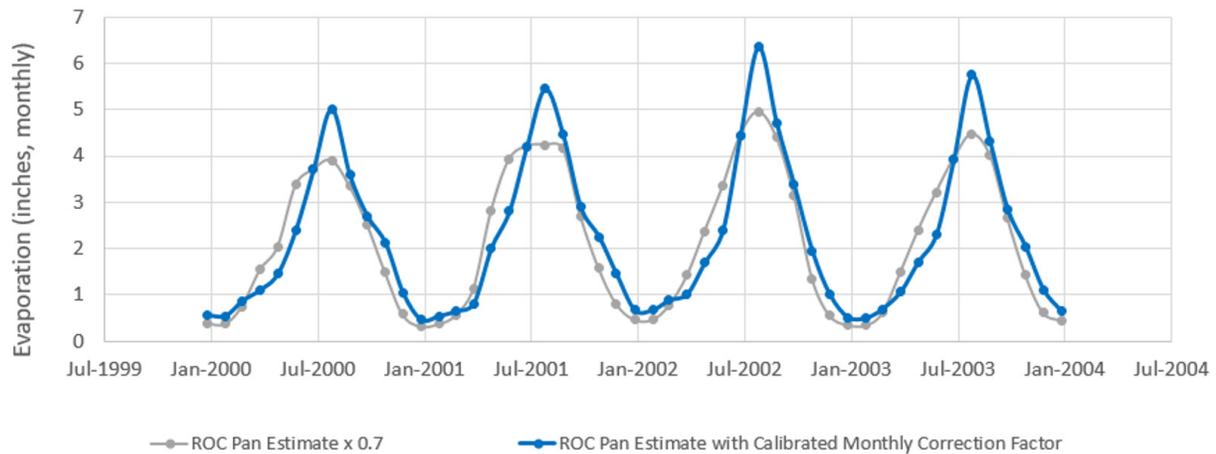
Figure 3.7: Calibrated Monthly Evaporation Estimates

Figure 3.8 shows the model results with the evaporation values calibrated to account for monthly variation. The model results shows a stronger correlation during the drought of 2001-2002, as well as a better correlation during the overall calibration period of 2000-2002.
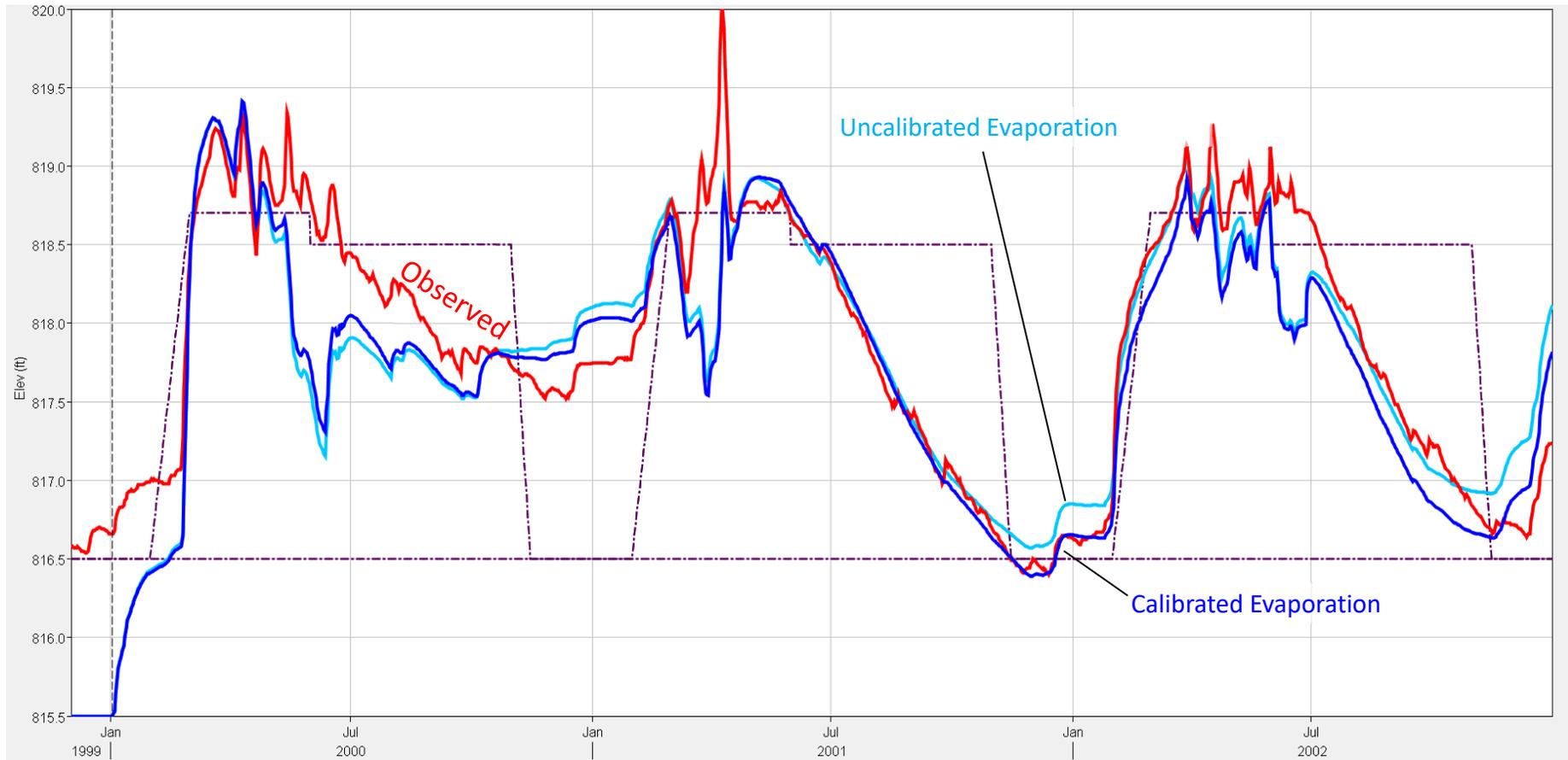
CONESUS LAKE SAFE YIELD
LIVINGSTON COUNTY PLANNING DEPARTMENT
PROJECT NO. 21C25014.00

FIGURE 3.8
MODEL REUSLTS
BASED ON CALIBRATED
EVAPORATION

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ENGINEERING

3.4 Calibrated Model Summary

The Conesus Lake model, presented in Figure 3.9, has been demonstrated to serve as a reasonable representation of the Conesus Lake system, particularly during drought conditions. This represents the calibrated Conesus Lake safe yield model. The upper portion of the figure illustrates that the model closely replicates the recorded historic lake levels. From May 2001 to January 2002 (the drought period indicated on the Figure 3.9) the model-predicted lake levels on any given day do not differ from the recorded lake levels by more than 0.2 ft. The middle portion of the figure shows the calibrated Conesus Lake inflow when using the scaled Cohocton River near Campbell streamgage flows in combination with the downstream releases estimated from the downstream gage on Conesus Creek. The lower portion of the figure is an expanded look at the low flow regions of the middle plot and illustrates the relative magnitude of the calibrated evaporation values in comparison to the recorded water supply flows. Note that the evaporation represents a significantly greater outflow component than the water supply use during the calibration period.

With the HEC-ResSim model calibrated to the 2001 drought, it can then be modified to understand how the system responds over the available period of record (approximately 100 years) and leveraged to determine the available safe yield of the system under various operating configurations. Since the Safe Yield Analysis approach was to evaluate the drought of record by performing model simulations using an inflow data series encompassing approximately 100 years, the drought of record could also be approximately characterized as the 100-year drought.
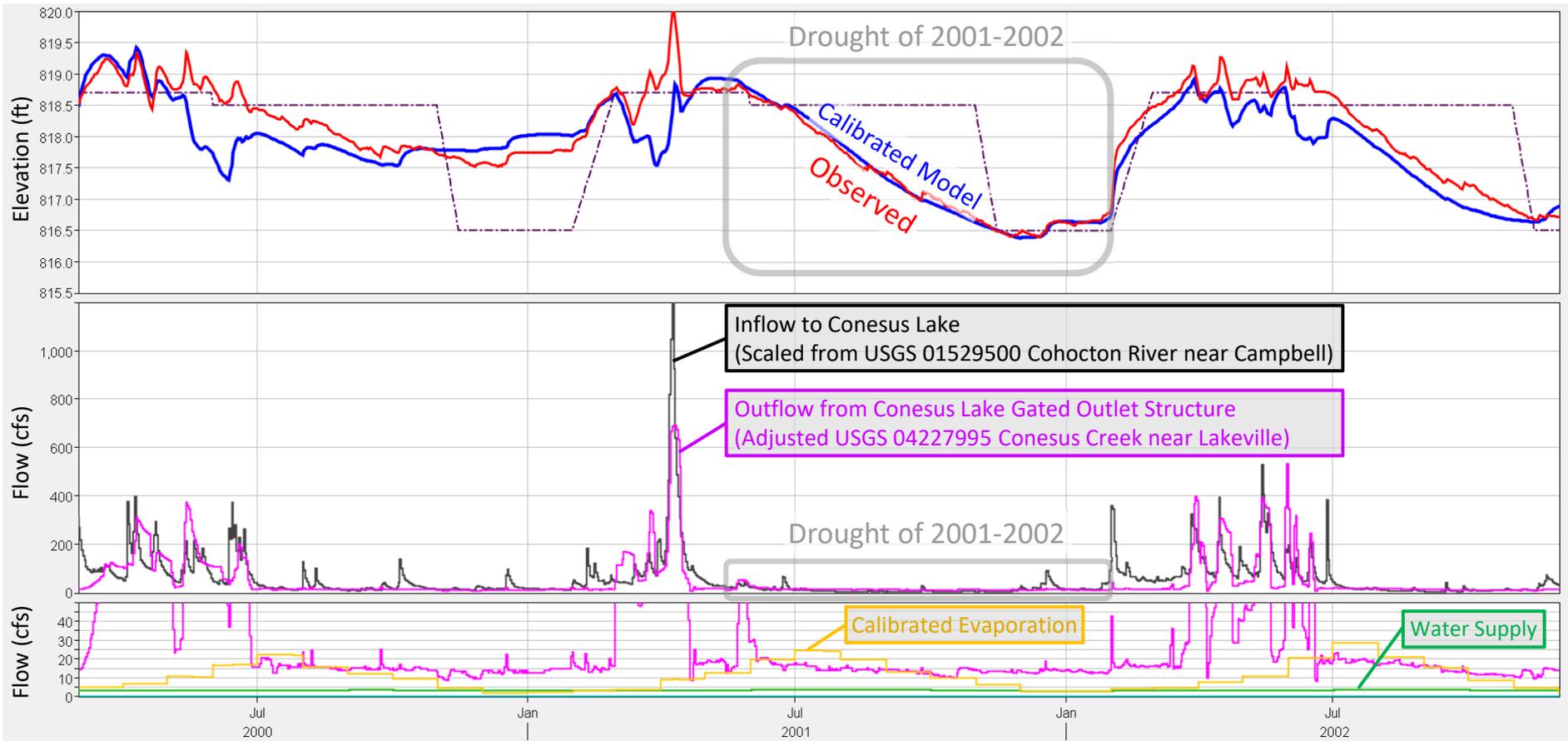
Figure 3.9 — Model Calibration for Conesus Lake

CONESUS LAKE SAFE YIELD
LIVINGSTON COUNTY PLANNING DEPARTMENT
PROJECT NO. 21C25014.00

FIGURE 3.9
MODEL CALIBRATION
FOR CONESUS LAKE

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4.0   SAFE YIELD AND SENSITIVITY EVALUATIONS

The calibrated HEC-ResSim model was used to estimate the safe yield for various system configurations by applying a constant water supply demand to Conesus Lake and then examining the resulting minimum lake level. Note that a safe yield analysis maintains a constant demand through the drought period and does not include operational changes that might be implemented during an actual drought condition, such as water-use restrictions.

The model simulates gate operations previously discussed in Section 2 of this report. The model releases excess water when the lake level is above the target level, and conserves water when the lake level is below target, while always releasing the specified or permitted minimum flow to the downstream channel.

Among numerous project meetings that were held, four (4) workshops were conducted with the Conesus Lake Watershed Council (CLWC) Technical Committee to inform them of the ongoing project activities and to incorporate regular feedback to help steer the project direction. A workshop was held on August 4, 2021 to discuss the findings of Schnabel's document and data review and how that shaped the planned calibration and modeling approach for performing the Safe Yield Analysis. The group collectively identified and defined the constraints under which the safe yield would be computed, and discussed potential sensitivities to assess with the model. A second workshop was held on September 15, 2021 to discuss the outcome of the calibration process and confirm how the model would be used predict the system safe yield and respond to the changes in modeling constraints that influence the predicted safe yield results. A meeting was held on September 24, 2021 to provide a status update. A final workshop was held on October 20, 2021 to present the findings of the model simulation to the group and discuss the results.

Based on the outcomes of the these workshops, the following scenarios were defined and evaluated to determine the maximum allowable water supply, using model simulations based on 100 years of calibrated inflow records:

- Safe Yield Analysis (See Section 4.1)
    - Operators meet the minimum downstream release requirements of 10 cfs using the existing gated outlet structure.
    - The seasonal target elevations of the rule curve are followed, and the minimum allowable lake level of EL 816.5 consistent with the winter drawdown target.
- Sensitivity #1 - Remove target lake level constraints (See Section 4.2)
    - Operators meet the minimum downstream release requirements of 10 cfs using the existing gated outlet structure.
    - Maintain a minimum lake level of EL 815.5, which is assumed to be the lowest elevation at which 10 cfs can be released downstream to Conesus Creek by gravity. (No pumping or dredging of the outlet channel is assumed to be necessary.) This is comparable to NYS DEC prediction for a 3 ft drawdown.
- Sensitivity #2 - Remove outlet channel constraints (See Section 4.2)
    - Operators meet the minimum downstream release requirements of 10 cfs using the existing gated outlet structure.

        o   Maintain a minimum lake level of EL <u>814.5</u>, which is assumed to be the lowest reliable elevation for maintaining Village of Avon water supply pumping operations. This is below the elevation at which we assume 10 cfs can be released to Conesus Creek by gravity, so pumping or dredging of the outlet channel may be required.

- Sensitivity #3 – Assess the importance of adhering to the permitted environmental release rate (See Section 4.3)
    - Operators meet a minimum downstream release of 14 cfs using the existing gated outlet structure (i.e., the minimum downstream release is revised from 10 cfs to 14 cfs).
    - Multiple minimum lake levels are evaluated.
- Sensitivity #4 - Modification to the Rule Curve (See Section 4.4)
    - Operators meet the minimum downstream release requirements of 10 cfs using the existing gated outlet structure.
    - Allow deviation from the rule curve by eliminating requirement to draw lake level down to winter pool target of 816.5 in November. This would be analogous to a more gradual release of water, and achieving the winter target pool later in the cycle – either in late fall or during winter.

4.1   Safe Yield Analysis

The first key finding of the Safe Yield Analysis is that maintaining a minimum lake level of EL 816.5 (rule curve winter target) is not a practical requirement during drought conditions while providing a downstream release of 10 cfs and while reliably delivering a continuous water supply to the Villages of Geneseo and Avon.

In the following safe yield charts, we present our results side by side with those of the 1994 NYS DEC study, converting the NYS DEC *dependable yield* to *safe yield* in an effort to provide direct comparison and context. Based on the available documentation, we are uncertain whether the dependable yield reported by the NYS DEC is inclusive of a 1.5 mgd assumed water supply, as well as the allocated water supply and downstream release. Therefore, the NYS DEC equivalent safe yield is presented as a range on the safe yield charts. As shown in Figure 4.1, the 10 cfs downstream release and evaporative losses, by themselves, are predicted to draw the pool down to as low as EL 815.9 allowing for no water supply availability within the allowable lake level range.

This is consistent with the 1994 NYS DEC conclusion that the lake is "over-subscribed." The target of EL 816.5 used in this study would correspond to a 2 ft drawdown in the NYS DEC study, though the NYS DEC only evaluated the 2.5, 3.0, and 3.5 ft drawdown scenarios. When presented as safe yield, the findings presented in the 1994 NYS DEC report concurs that no water supply safe yield is available when constrained to a minimum pool of EL 816.5. The chart illustrates that the minimum lake level must be at least as low as approximately EL 816 for there to be any reliable safe yield available for water supply use. Furthermore, the results indicate that for at all minimum allowable lake elevations less than 815.9, our study predicts that more water is available for water supply use than the NYS DEC study predicted.
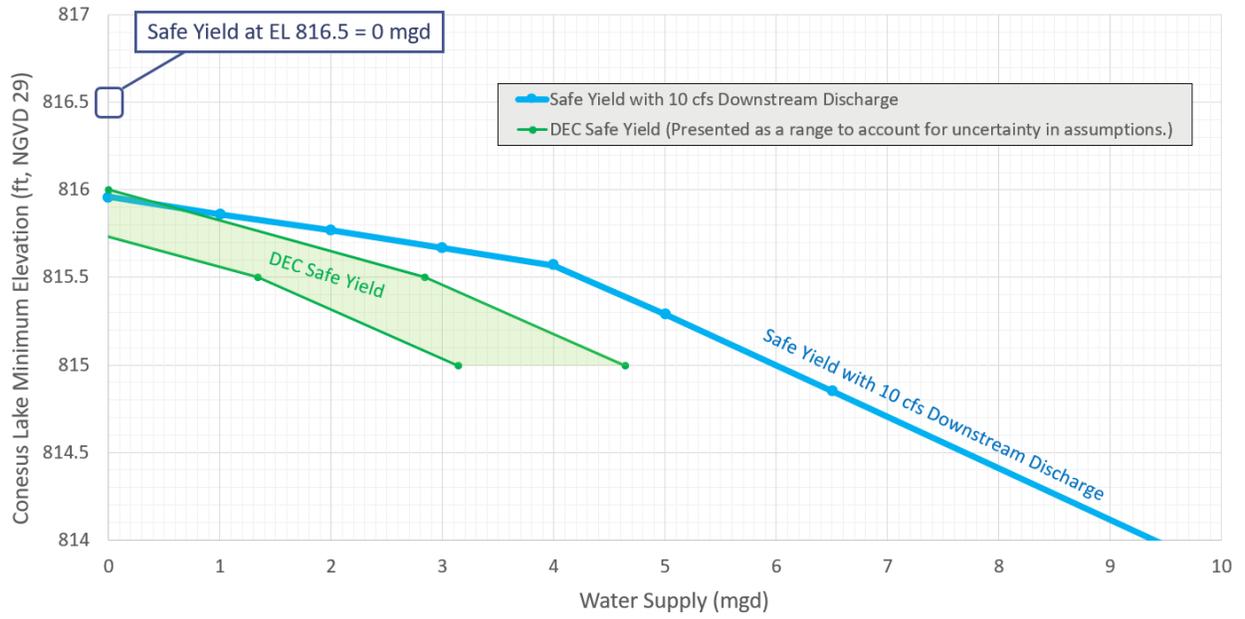
Figure 4.1: Safe Yield Results

4.2   Sensitivity #1 and Sensitivity #2

The first two (2) sensitivity analyses, illustrated in Figure 4.2, provide insight to the available water supply if lower lake elevations can be temporarily tolerated, during periods of severe drought. With a minimum elevation of 815.5 and a minimum downstream release of 10 cfs, a safe yield of 4.2 mgd is available. At a minimum elevation of 814.5, a safe yield of 7.7 mgd is available. Recall that EL 815.5 is assumed to be the minimum elevation at which 10 cfs can be released by gravity through the gate structure and EL 814.5 is assumed to be the lowest elevation at which the Village of Avon can maintain water supply pumping operations. The Village of Geneseo intake is deeper than the Avon intake. Allowing the lake to reach lower elevations during severe drought conditions has a significant positive effect on the available water supply.
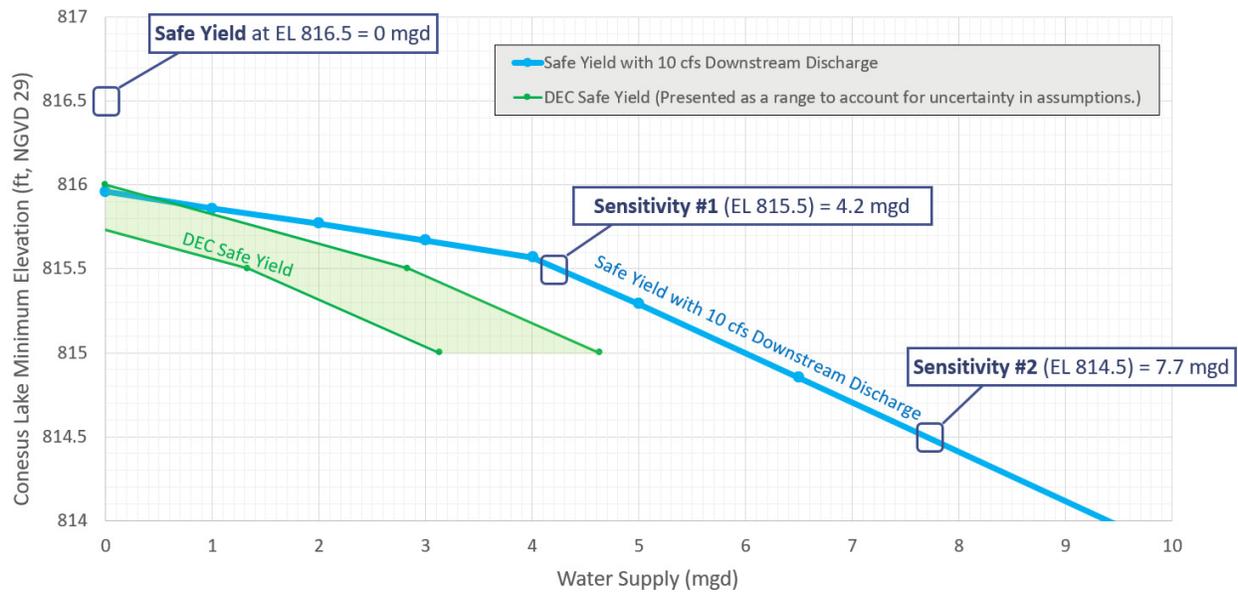
Figure 4.2: Safe Yield Sensitivity #1 and Sensitivity #2 Results

4.3 Sensitivity #3

The third (3) sensitivity analysis, illustrated in Figure 4.3, demonstrates the significance of downstream releases with respect to available water supply. In order to meet 10 cfs in the downstream channel reliably, gate operations typically target a higher flow rate which has been estimated by representatives of the Conesus Lake Association (CLA) to average approximately 14 cfs. The model was therefore used to evaluate a 14 cfs downstream release. At a minimum lake level of 815.5, the increase in downstream release reduces the available safe yield from 4.2 mgd to 1.6 mgd. At a minimum lake level of 814.5, the increase in downstream release reduces the available safe yield from 7.7 mgd to 5.3 mgd. The importance of targeting a 10 cfs downstream release to preserve the available water supply is evident, although this presents an operational challenge. If 10 cfs is targeted, minor fluctuations could result in a potential permit violation, such as in the event of a debris blockage at the gated outlet structure. Furthermore, the gate operator will not necessarily know when a drought is beginning, and will therefore not know when targeting 10 cfs is of greatest importance.
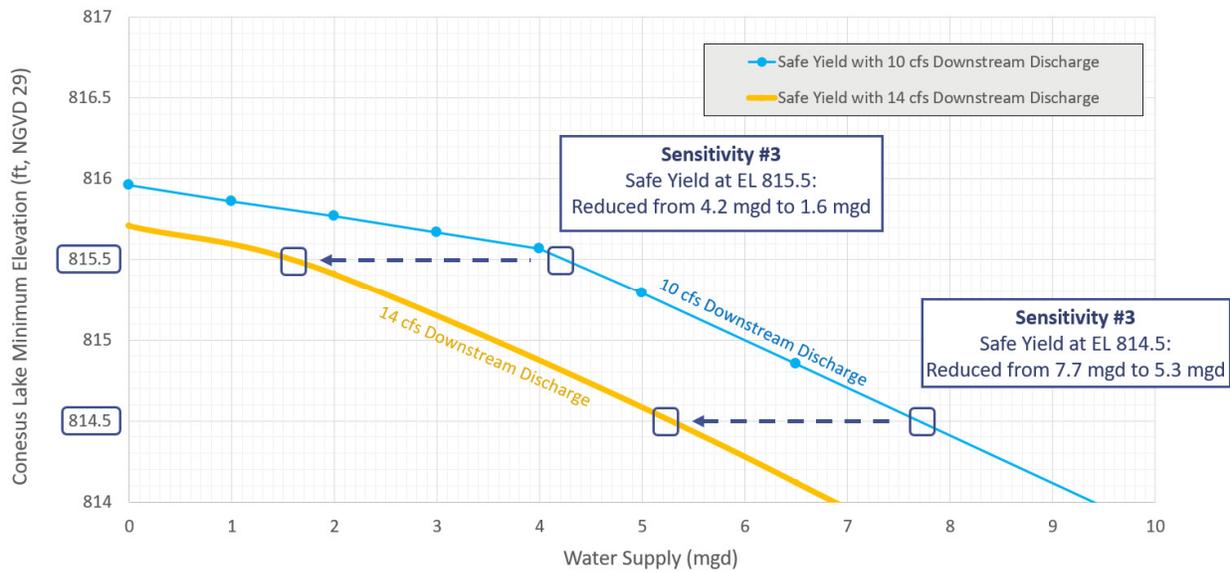
Figure 4.3: Safe Yield Sensitivity #3 Results

4.4 Sensitivity #4

The model results reinforce the general understanding that the various uses of Conesus Lake occasionally conflict. For instance, the fourth sensitivity evaluation demonstrates that rule curve modifications (i.e. removing or relaxing the winter drawdown requirement) could increase the available water supply under some conditions.

The 1960-1961 drought serves as a good example, and is presented in Figure 4.4. With a lake level of approximately EL 817.5 in October, the rule curve indicates that the pool should be drawn down in November to the winter pool of EL 816.5. This particular year, there was very little inflow to Conesus Lake during the fall and winter, and water supply withdrawals and evaporation continue to draw the lake down to 815.8 (see blue line). Without this winter pool drawdown, the Lake would have remained a foot higher at 816.8 (see magenta line). The rule curve was developed for flood control, which in some circumstances may have a negative effect on available water supply. The safe yield results for the modified rule curve are shown in Figure 4.5. Note that the impacts of the modified rule curve have not been studied with respect to flood control, and such an operational modification is therefore not recommended without further study.
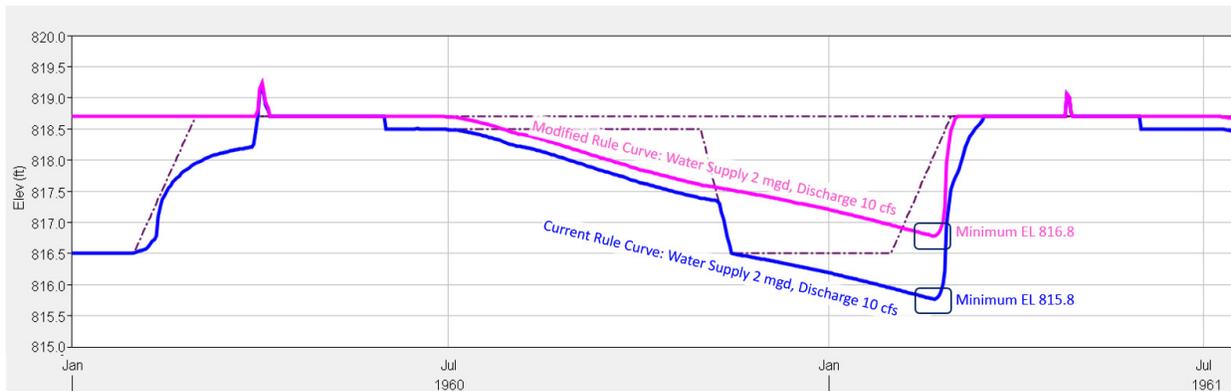
Figure 4.4: 1960's Safe Yield Sensitivity #4 Example
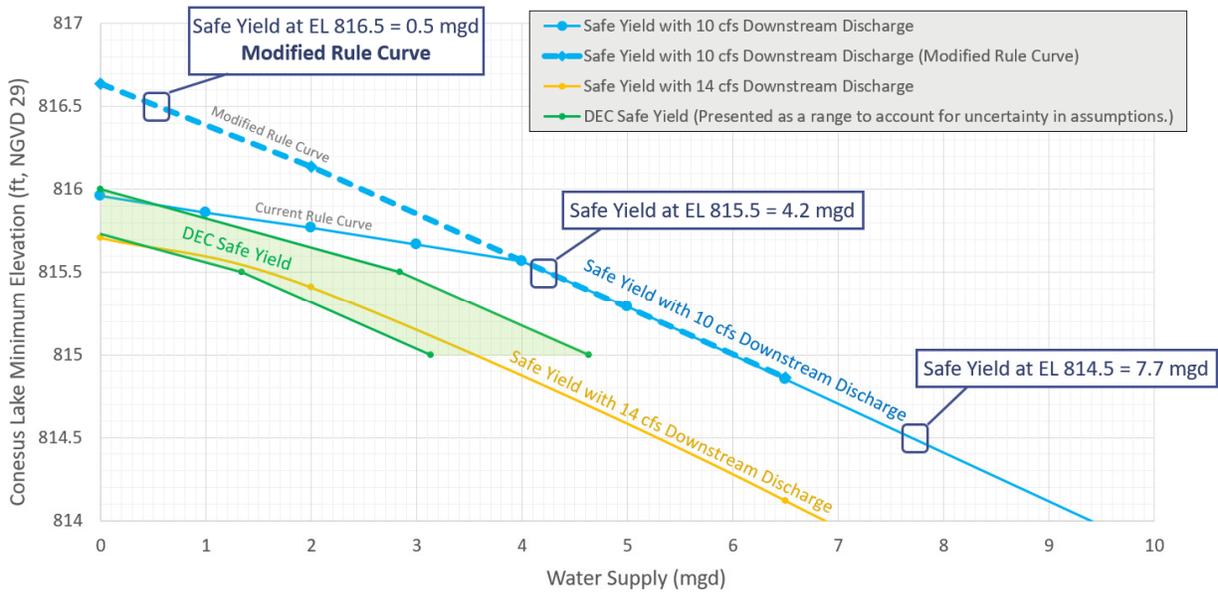
Figure 4.5: Safe Yield Sensitivity #4 Results

4.5 Summary of Results for the Safe Yield Analysis and Sensitivity Evaluations

The results of the Safe Yield Analysis and sensitivity evaluations are summarized in Table 4.1.

Table 4.1: Safe Yield Summary

	Minimum Lake Elevation	Estimated Safe Yield [1]	Sensitivity #3 (Downstream Release of 14 cfs vs 10 cfs)	Sensitivity #4 (Rule Curve Modification)
Safe Yield (Baseline Analysis)	816.5 ft	Not Practical	Not Practical	0.5 mgd
Sensitivity #1	815.5 ft	4.2 mgd	1.6 mgd	4.2 mgd
Sensitivity #2	814.5 ft	7.7 mgd	5.3 mgd	7.7 mgd

(1) The tabulated Safe Yield values represent the available water supply during severe drought conditions. The values are in addition to the required 6.5 mgd downstream release, which is accounted for in the model separately.

With the existing outlet channel configuration, a minimum lake elevation of 815.5 is assumed to deliver 10 cfs (6.5 mgd) by gravity to the downstream channel, without the need for pumping water from the lake to the downstream channel or outlet channel modifications. At this minimum elevation, the water supply safe yield is 4.2 mgd. With downstream release, a total of 10.7 mgd dependable yield.

Allowing for pumping of water from the lake to the downstream channel or outlet channel modifications, the minimum lake elevation is assumed to be 814.5, limited by the current Village of Avon water supply pumps. This additional 1 ft of drawdown increases the water supply safe yield from 4.2 mgd to 7.7 mgd. With downstream release, a total of 14.2 mgd dependable yield.

It is important to note that a safe yield analysis does not account for actions that a community might take during a drought to reduce water use, such as water use restrictions and conservation measures.

4.6 Comparison of Safe Yield Results with Previous Studies

In order to provide context with previous safe/dependable yield studies, we have attempted to draw comparison, focusing primarily the most recent study which is the 1994 NYS DEC Dependable Yield Study. The safe/dependable yield was also previously considered by Weston Inc. and Teetor-Dobins, although these reports were not available for review by Schnabel but were reviewed by NYS DEC and discussed in their 1994 Dependable Yield Study. Their summary is repeated in Table 4.2. We refer the reader to the 1994 NYS DEC Dependable Yield Study for a more detailed description of these previous analyses. It should be noted that both of the studies prior to 1994 study were developed in advance of the USACE rule curve or construction of the existing gated outlet structure.

Table 4.2: Previous Safe/Dependable Yield Studies

Source/Author	Year of Report	Available Water Supply + Downstream Release
NYS DEC	1994	7.8 mgd [1]
Weston Inc.	1987	10.7 mgd (20-yr drought) 7.6 mgd (40-yr drought) [2]
Teetor-Dobins Consulting Engineers	1970	12 mgd

(1) *This value is based on a 3 ft drawdown, assumed to result in a lake minimum of EL 815.5. Based on the available documentation, we are uncertain whether the dependable yield reported by the NYS DEC is inclusive of a 1.5 mgd assumed water supply, as well as the allocated water supply and downstream release. Refer to discussion in Section 4.1.*

(2) *Estimated by NYS DEC in their 1994 report*

Table 4.3 is a direct comparison of our findings with those of the 1994 NYS DEC Study. As indicated in the discussion around Figure 4.1, our study predicts more water is available for use than the NYS DEC study predicted. Note that at a minimum lake level of 815.5, where the model predicts a safe yield of 4.2 mgd, and a corresponding dependable yield of 10.7 mgd, the Conesus Lake is oversubscribed by 2.3 mgd, relative to the total allocation of 13.0 mgd.

Table 4.3: Comparison of Results with 1994 NYS DEC Dependable Yield Study

	Schnabel 2021			NYS DEC 1994	
Min Lake Elevation (ft)	Estimated Safe Yield, mgd (Water Supply)	Release, mgd (10 cfs = 6.5 mgd)	Dependable Yield, mgd (Water Supply & Release)	Drawdown (ft)	Dependable Yield, mgd [2]
816.5	*Not Practical*	*Not Practical*	*Not Practical*	2.0	*Not Reported*
816.0	-0.1	6.5	6.4	2.5	4.9
815.5 [1]	**4.2**	**6.5**	**10.7**	**3.0**	**7.8**
815.0	6.0	6.5	12.5	3.5	9.6
814.5	7.7	6.5	14.2	4.0	*Not Reported*

Notes:
(1) Above EL 815.5, it is assumed that downstream release of 10 cfs can be accomplished by gravity (through the gated outlet structure); below that elevation it is assumed that pumping or outlet channel modifications would be required to convey flow from the lake to the downstream channel.
(2) Based on the available documentation, we are uncertain whether the dependable yield reported by the NYS DEC is inclusive of a 1.5 mgd assumed water supply, as well as the allocated water supply and downstream release. Refer to discussion in Section 4.1.

4.7 Uncertainty

Notwithstanding the calibration process discussed in Section 3 of this report, the Safe Yield Analysis inherently involves uncertainty. For instance, the inflows to Conesus Lake, which are perhaps the most significant unknown for this analysis, were estimated based on USGS streamgage data from a nearby watershed. Evaporation was another parameter estimated from regional data that can vary significantly based on local conditions. The calibration and verification process showed that the model provides a reasonable representation of Conesus Lake during drought conditions. Furthermore, historical performance is not a guarantee of future performance. Although the model was used to review 100 years of historical data, and the safe yield values presented herein are therefore representative of the 100-year drought, a more severe drought which produces lower lake levels than those predicted by this study might occur in the future.

To account for such modeling and environmental uncertainties, a safe yield analysis may include a safety factor. For a water supply reservoir, maintaining a 30-day reserve storage is typical. At the current water supply allocation of 6.5 mgd, the equivalent storage volume is 195 million gallons. Based on a Conesus Lake surface area of approximately 3,000 acres, the change in lake elevation required to provide the 30-day storage would be approximately 0.2 ft. It would therefore be reasonable to subtract 0.2 ft from the elevations presented in Table 4.1 as a safety factor. Table 4.1 does not currently apply such a safety factor, because the continuity of the water supply does not appear to be in jeopardy and is not the sole objective of Conesus Lake operations.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The work performed for this study resulted in a model that can be utilized to predict the water supply safe yield during the drought of record, based on a calibrated 100-year inflow estimate and other calibrated model parameters such as evaporation. This model was first utilized to estimate the water supply safe yield based on a specific set of constraints, then the model was utilized to evaluate the sensitivity of the system to various constraints. Our conclusions are as follows:

- Maintaining a minimum lake level of EL 816.5 (rule curve winter target) is not a practical requirement during drought conditions while providing a downstream release of 10 cfs and while reliably delivering a continuous water supply to the Villages of Geneseo and Avon. This is consistent with the 1994 NYS DEC conclusion that the lake is "over-subscribed."
- For all minimum allowable lake elevations less than 815.9, our study predicts that more water is available for use than the 1994 NYS DEC study predicted.
- Allowing the lake to reach lower elevations during severe drought conditions significantly increases the available water supply.
- The seasonal timing of the lowest lake levels should be considered when determining the allowable Safe Yield. During a severe drought, the lake level is expected to reach its lowest point during the winter. For example, for a water supply flow rate of 6.5 mgd (the current combined water supply allocation for the Villages of Geneseo and Avon) the lake level reaches its lowest elevation of 814.9 in February/March. For all scenarios evaluated in this report (water supply flow rates up to 7.7 mgd) Conesus Lake is predicted to recharge to the spring target level of 818.7 during the spring runoff.
- The release of flow to the downstream channel has a significant impact on the available water supply. Closely adhering to the 10 cfs target preserves the available water supply, while operating with a safety factor (i.e. 14 cfs) reduces the available water supply.
- The rule curve was developed for flood control, which in some circumstances may have a negative effect on available water supply.

Based on the results of the current Safe Yield Analysis and sensitivity evaluations, Schnabel offers the following recommendations:

1. Consider surveying the outlet channel and developing a hydraulic model of Conesus Creek in order to better define the controlling lake levels with respect to downstream releases and to better assess the operational performance expectations of planned improvements to the gated outlet structure. No data is currently available to support a hydraulic analysis of the outlet channel.
2. Based on the results of the channel survey and hydraulic modeling of Conesus Creek:
   a. Consider dredging the Conesus Lake outlet channel to facilitate the required environmental release of water by gravity at lower lake elevations. The model-predicted minimum lake elevations typically occur in the late winter, just prior to the spring runoff. Lower lake levels during this part of the season might be acceptable to the community, and should be further considered.
   b. Consider entering into discussions with the USACE about revising the rule curve target elevations, specifically the winter drawdown target of 816.5 and the rate of drawdown from the summer pool to the winter pool. If rule curve revisions are ultimately pursued, we would recommend conducting a follow-up study to better understand the impacts of

lower lake levels. The scope of these studies should consider ecological, flood control, and recreational impacts.

3. Consider advocating for, or funding, the installation of a new streamgage within the Conesus Lake watershed. Such data collection could improve future water supply studies, and could facilitate improved and predictive operations at the gated outlet structure. Effectiveness of a streamgage within the watershed would depend on stream size and relative contribution to the lake's inflow, whether streamflow is permanent or intermittent, channel gradient, and availability of stable cross-sectional areas (such as bridges or culverts). Additional field surveys and engineering analyses would be required to recommend a location for the streamgage.

4. Consider electrically actuating the outlet gates and implementing remote operations capabilities and/or a Supervisory Control and Data Acquisition system for real time gate control and improved ability to meet the 10 cfs regulatory release.

5. Periodically update the Safe Yield Analysis. Updates would be appropriate following a long-term collection of new Conesus Lake watershed streamflow records or based on a qualifying event such as implementation of channel dredging, water system upgrades, or NYS DEC permit modifications.

6.0 COMMENTARY

6.1 1994 NYS DEC Dependable Yield Study

We have reviewed the various recommendations presented in the 1994 Dependable Yield Study, and offer commentary based on the current Safe Yield Analysis.

- 1994 NYS DEC Dependable Yield Study, Page 7: "*The ecosystems of both the Lake itself and Conesus Lake Outlet are affected by Lake operation. A limited amount of study has been made of the fisheries related aspects of the Conesus Lake ecosystem, and the results of such study were apparently factored into the operating rule curve developed by the U.S. Army Corp of Engineers. However, broader concerns encompassed by the entire aquatic ecosystem do not appear to have been evaluated. For example, what effects do lake drawdown have upon water birds or non-game aquatic life? These questions, among others, are not yet answered. There would appear to have been little, if any, study made of the Outlet ecosystem and how lake operation might affect this system. This would seem particularly important if consideration is given to decreasing downstream release requirements from the Lake.*" Similarly, the report notes on Page 9: "*It is recommended… that the existing operating rule curve be revisited and, if necessary, modified so as to accurately reflect all uses of the resource. Should this be attempted, it should be understood that significant effort was expended in the initial development of the rule curve, and it is conceivable that all that is needed is a more extensive description of the initial process.*"

  The current safe yield model illustrates that opportunities exist for improving water supply that involve modifications to the rule curve. Prior to any such rule curve modification it would be prudent to review the changes with respect to other uses of Conesus Lake, including flood control, ecological, and recreational considerations.

- Page 8: "*Consideration should also be given to scaling back existing permits to the degree necessary for avoidance of a deficit scenario. The fact that existing permittee's (sic) are presently withdrawing less than permitted quantities should make this relatively palatable.*"

  The current safe yield model suggests that the water supply allocations set forth by NYS DEC are achievable through the relaxation of minimum lake level targets, with pumping or channel modifications required to achieve the permitted downstream release requirement during extreme drought conditions. Maintaining the current water supply allocations for the Villages of Avon and Geneseo puts these communities in a position to grow.

- Page 8: "*… given the fact that loadings, at least with respect to flow, are considerably less than permitted, it is conceivable that the down stream release requirement could be relaxed if the SPDES permit were modified. This, of course, does not consider ecological concerns relating to stream flow.*"

  The current safe yield model demonstrates that the available water supply is sensitive to the downstream release rate. The existing SPDES permit was updated in February 2021 (valid

through January 21, 2026) and the review process has recently included stakeholder discussion related to ammonia and the minimum downstream release. That permit renewal effectively reaffirmed the 10 cfs downstream release requirement. Attention should be paid to this release requirement during future permit renewals, as any increase or decrease would have an impact on the available water supply and the corresponding minimum lake levels.

6.2 System Performance at the Current Water Supply Allocation

The calibrated safe yield model was utilized to assess the performance of the system assuming the communities were to withdraw their NYS DEC water supply allocation over the 100 years of historical record. This would result in a continuous withdrawal of 13.0 mgd (3.5 mgd for the Village of Avon, 3.0 mgd for the Village of Geneseo, and 6.5 mgd [10 cfs] for waste assimilation).

Below an elevation of 815.5 ft, it is assumed that pumping (or some outlet channel modification) would be required to release 10 cfs to the downstream channel. Based on the model simulation, Conesus Lake is predicted to reach a minimum level of EL 814.9 as shown in Figure 6.1. This result indicates intervention, assumed to be pumping, would be required to release 10 cfs to the downstream channel when the Lake level falls below EL 815.5. As show in Figure 6.2, the model predicts that there would be a total of six (6) instances over the 100-year period where the lake level falls below EL 815.5, and therefore six (6) instances where intervention would have been required. Note that the duration of pumping may be significant. As an example, the longest duration of pumping predicted is 108 days, occurring between November 22, 1941 and March 9, 1942. It is noteworthy that the lake refills to its target spring pool level each year during the spring runoff at the current NYS DEC water supply allocation.
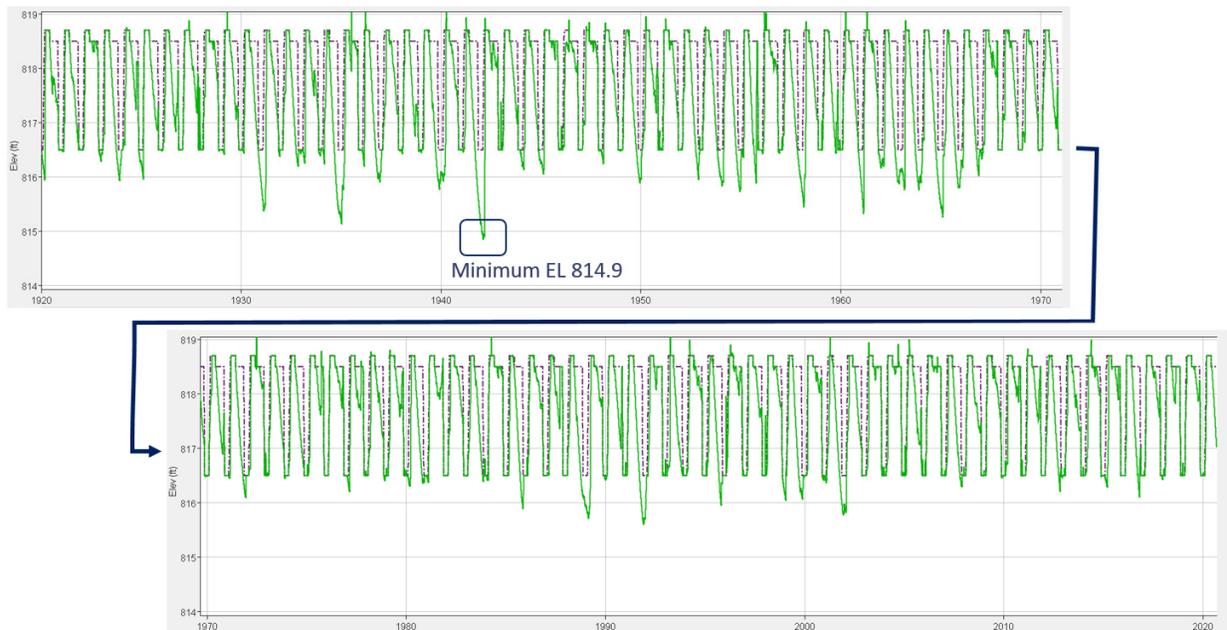
Figure 6.1: 100-Year Simulation of Lake Level for Current Water Supply Allocation
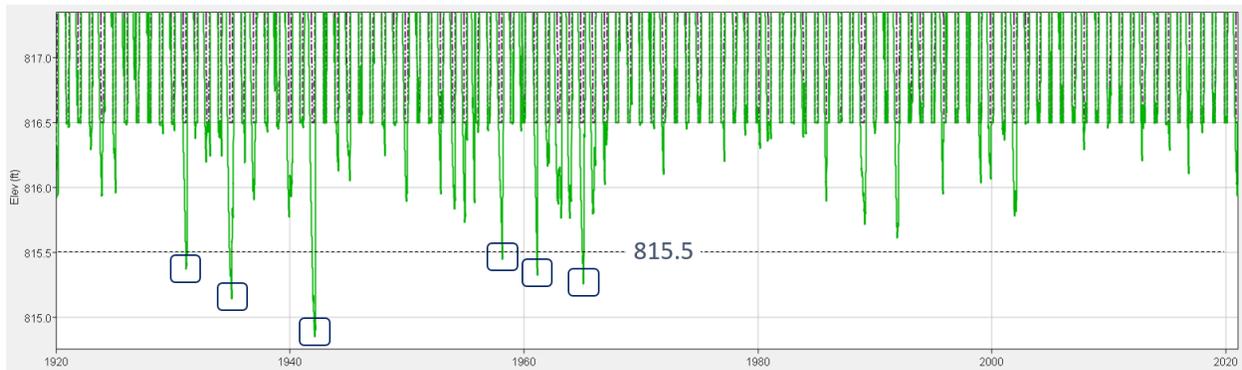
Figure 6.2: 100-Year Simulation of Lake Level for Current Water Supply Allocation
(Low Elevation Detail Showing Instances below EL 815.5)

Recall that the model predicted an available safe yield of 7.7 mgd consistent with a minimum lake elevation of 814.5 governed by the Village of Avon water supply pumping limitations. A similar review was performed for this water supply flow rate which predicts nine (9) occasions where the lake level would fall below EL 815.5 during the 100-year period.

6.3 Climate Change

The available safe yield for Conesus Lake is dependent on numerous factors, many of which are subject to change as a result of climate influences. One of the more significant influences on safe yield is precipitation. The NRCC published precipitation trends in the *Climate Science Special Report (CSSR): Fourth National Climate Assessment (U.S. Global Change Research Program)*, including the Figures 6.3 and 6.4. These indicate an anticipated increase in the annual precipitation throughout the Northeastern regions of the United States including Livingston County. Although we recognize that "higher highs and lower lows" are often discussed with respect to climate change, this report indicates an overall increase in precipitation in the Northeast, which should correlate to an increase in inflow to Conesus Lake and subsequently an increase in the available water supply.
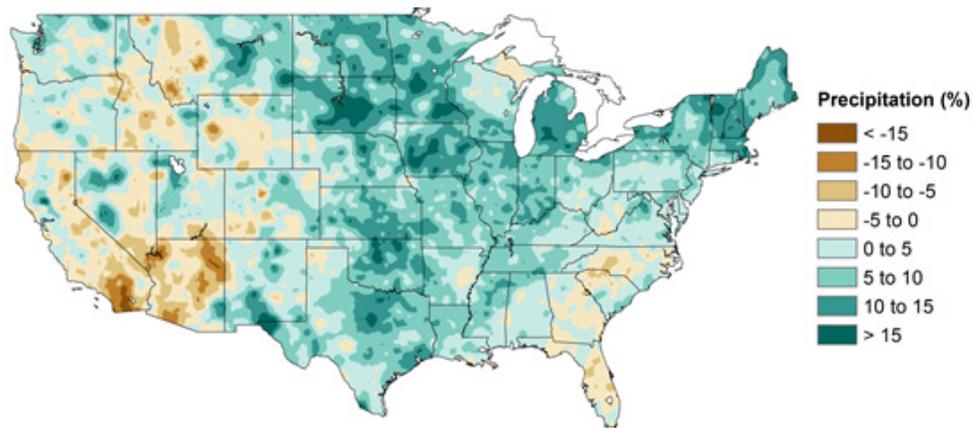
Figure 6.3: Observed Change in Annual Precipitation (1986-2015) – (1901-1960) Reported by NRCC
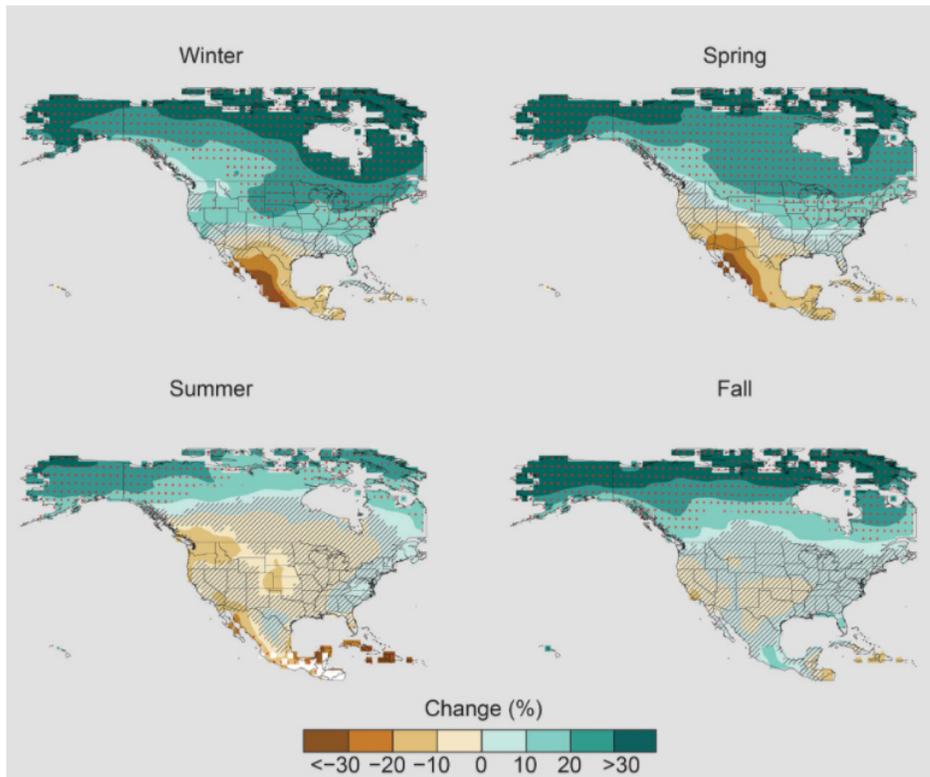
Figure 6.4: Projected Change (%) in Seasonal Precipitation Reported by NRCC

Schnabel also reviewed precipitation data for the nearby Hemlock Weather Station. Figure 6.5 illustrates the overall trend of increasing annual precipitation, consistent with the NRCC publication.
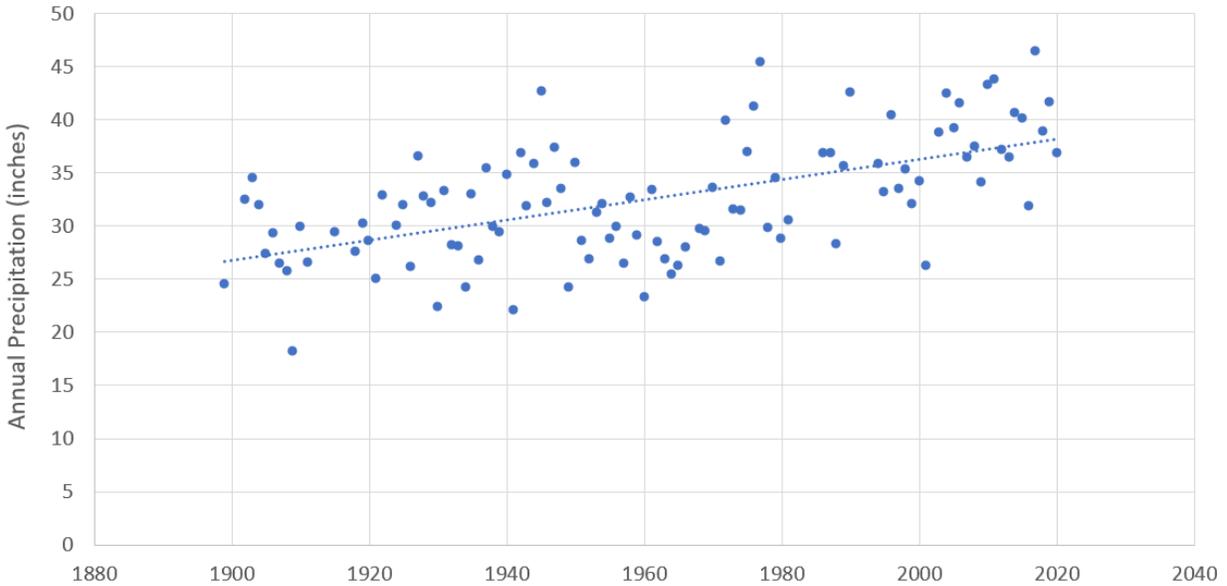
Figure 6.5: Annual Precipitation at Hemlock Weather Station

The safe yield modeling results seem to further support these findings. At the current NYS DEC water supply allocation of 6.5 mgd for the Villages Avon and Geneseo previously shown in Figures 6.1 and 6.2, Conesus Lake is predicted to fall below elevation 815.5 on six (6) occasions. All of these instances occurred prior to 1970, in the first 50 years of the simulation. The modeled lake level does not go below 815.5 between 1970 and 2020, the second 50 years of the simulation. Similarly for model results at a safe yield of 7.7 mgd, Conesus Lake is predicted to fall below 815.5 on 9 occasions. Seven (7) of these instances occurred prior to 1970 (in the first 50 years of the simulation) and two (2) of these instances occurred after 1970 (in the second 50 years of the simulation).

7.0   LIMITATIONS

The analyses and recommendations submitted in this report are based on the information revealed by our review of the available documentation, our understanding of the site and facilities, and our experience from other projects similar in nature. We have endeavored to complete the services identified herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions as this project. No other representation, express or implied, is included or intended, and no warranty or guarantee is included or intended in this report or any other instrument of service.

We prepared this report to aid in the evaluation of the safe yield of Conesus Lake, specifically with respect to the available water supply. We intend it for use concerning only this specific purpose. The results as reported are not intended to sanction a particular drawdown or operational strategy, as any such action requires additional study.

APPENDIX A

Bathymetric Mapping
CR Environmental, Inc., October 2009

**Bathymetric Contour Map of Depths in
Conesus Lake, Livingston County, NY
Contour Interval = 1 ft
Depths Relative to Water Surface Elevation of 817.71 ft**
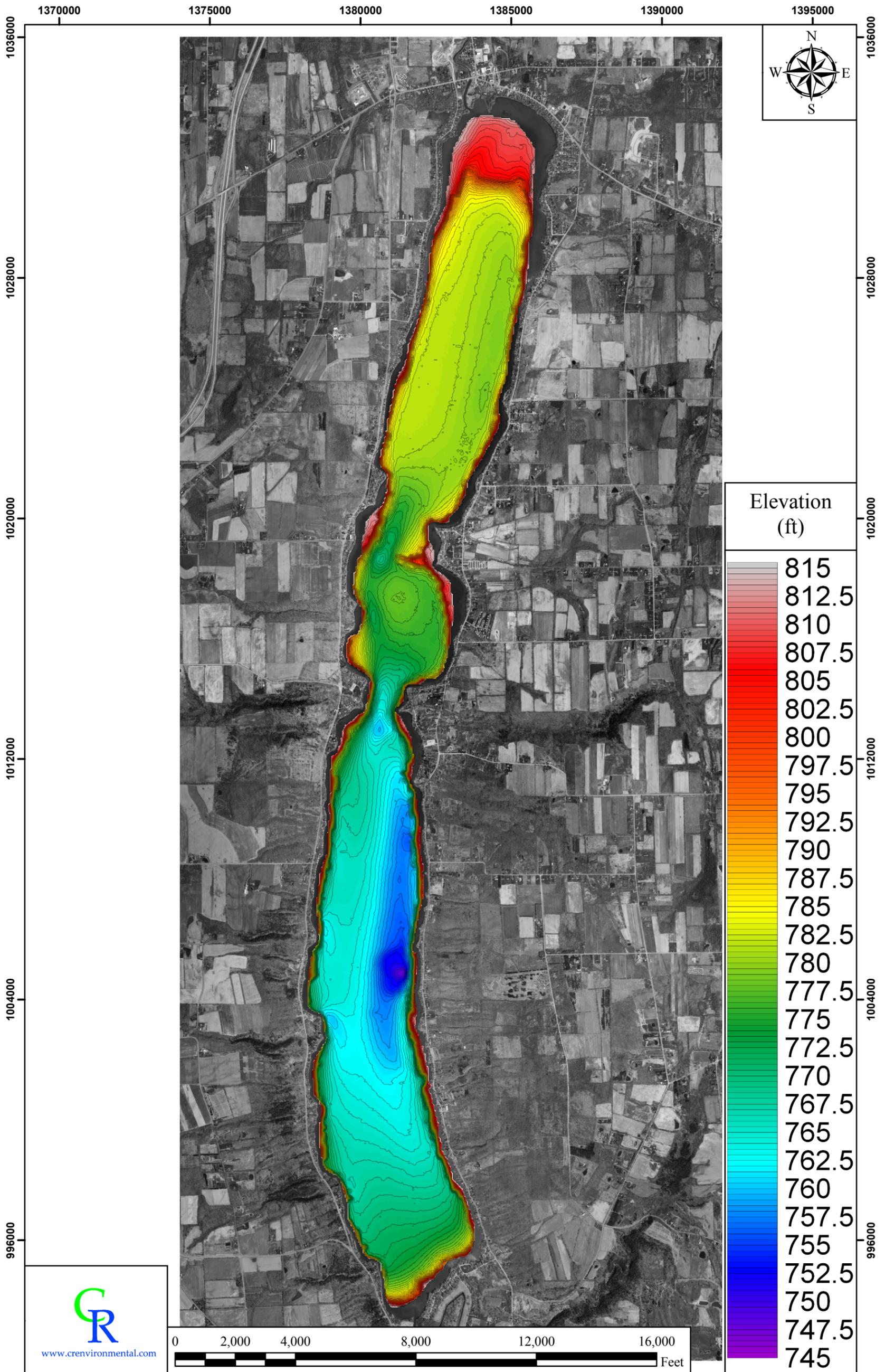
Survey Date: 10/19/2009 through 10/22/2009
Grid/Projection: New York State Plane, West
Zone, NAD-83, U.S. Survey Feet
Not for Navigation
Scale: 1 inch equals 3,214 feet

www.crenvironmental.com

Figure 2

Depth
(ft)

0
-3
-6
-9
-12
-15
-18
-21
-24
-27
-30
-33
-36
-39
-42
-45
-48
-51
-54
-57
-60
-63
-66
-69
-72
-75

0   2,000   4,000   8,000   12,000   16,000
Feet

Elevation (ft)

815
812.5
810
807.5
805
802.5
800
797.5
795
792.5
790
787.5
785
782.5
780
777.5
775
772.5
770
767.5
765
762.5
760
757.5
755
752.5
750
747.5
745

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0   2,000   4,000   8,000   12,000   16,000
Feet

Survey Date: 10/19/2009 through 10/22/2009
Grid/Projection: New York State Plane, West
Zone, NAD-83, U.S. Survey Feet
Not for Navigation
Scale: 1 inch equals 3,214 feet

**Bathymetric Contour Map of Elevations in
Conesus Lake, Livingston County, NY
Contour Interval = 1 ft
Elevations Relative to Water Surface Elevation of 817.71 ft
as given by Conesus Lake Watershed Manager on 10/19/2009**

Figure 3

APPENDIX B

Hydrologic References

Conic Method for Reservoir Volume
Conesus Lake, Livingston County, NY

Date:	6/4/2021	
By:	KJR	
Checked:	DMR	

$\Delta V = (\Delta h / 3) \times (A1 + A2 + \sqrt{(A1 \times A2)})$
Δh = Change in elevation across volume interval
$A1$ = Area at low elevation of volume interval
$A2$ = Area at high elevation of volume interval

	Relative EL (ft)	NAVD 29 EL (ft)	Area (sf)	Area (ac)	ΔV (cf)	ΔV (ac-ft)	Vol (cf)	Vol (ac-ft)	Source Info
Bottom of Lake	0	748.71	30,291	0.70	--	--	--	0	Bathymetry Data
	3	751.71	245,244	5.63	361,725	8.30	361,725	8	Bathymetry Data
	6	754.71	1,043,394	23.95	1,794,490	41.20	2,156,215	49	Bathymetry Data
	9	757.71	3,890,889	89.32	6,949,160	159.53	9,105,375	209	Bathymetry Data
	12	760.71	8,952,685	205.53	18,745,599	430.34	27,850,974	639	Bathymetry Data
	15	763.71	20,236,111	464.56	42,648,645	979.08	70,499,619	1,618	Bathymetry Data
	18	766.71	36,437,011	836.48	83,827,190	1924.41	154,326,809	3,543	Bathymetry Data
	21	769.71	46,723,405	1,072.62	124,421,308	2856.32	278,748,117	6,399	Bathymetry Data
	24	772.71	53,897,689	1,237.32	150,803,596	3461.97	429,551,713	9,861	Bathymetry Data
	27	775.71	61,791,917	1,418.55	173,399,584	3980.71	602,951,297	13,842	Bathymetry Data
	30	778.71	69,298,004	1,590.86	196,527,345	4511.65	799,478,643	18,354	Bathymetry Data
	33	781.71	89,834,991	2,062.33	238,034,108	5464.51	1,037,512,750	23,818	Bathymetry Data
	36	784.71	101,558,241	2,331.46	286,910,161	6586.55	1,324,422,911	30,405	Bathymetry Data
	39	787.71	105,207,438	2,415.23	310,132,416	7119.66	1,634,555,327	37,524	Bathymetry Data
	42	790.71	107,746,113	2,473.51	319,422,760	7332.94	1,953,978,087	44,857	Bathymetry Data
	45	793.71	109,720,106	2,518.83	326,194,849	7488.40	2,280,172,936	52,346	Bathymetry Data
	48	796.71	111,361,171	2,556.50	331,618,870	7612.92	2,611,791,806	59,958	Bathymetry Data
	51	799.71	112,944,541	2,592.85	336,455,774	7723.96	2,948,247,580	67,682	Bathymetry Data
	54	802.71	114,668,743	2,632.43	341,416,661	7837.85	3,289,664,240	75,520	Bathymetry Data
	57	805.71	116,972,959	2,685.33	347,456,823	7976.51	3,637,121,063	83,497	Bathymetry Data
	60	808.71	121,361,375	2,786.07	357,481,298	8206.64	3,994,602,362	91,703	Bathymetry Data
	63	811.71	126,392,912	2,901.58	371,605,882	8530.90	4,366,208,244	100,234	Bathymetry Data
3ft depth	66	814.71	132,696,496	3,046.29	388,595,765	8920.93	4,754,804,009	109,155	Bathymetry Data
Normal Pool	69	817.71	140785926	3,232.00	410,163,800	9416.07	5,164,967,809	118,571	Area Hydrography
		818	141368668	3,245.38	40,912,387	939.22	5,205,880,196	119,511	USGS DEM
		819	143942457	3,304.46	142,653,628	3274.88	5,348,533,823	122,785	USGS DEM
		820	146009181	3,351.91	144,974,591	3328.16	5,493,508,415	126,114	USGS DEM
		821	148131218	3,400.62	147,068,924	3376.24	5,640,577,338	129,490	USGS DEM

USGS Water Resources

Data Category:
Current Conditions ⌄

Geographic Area:
United States ⌄   GO

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- Full News 🔊

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We're modernizing Water Data for the Nation delivery. Find out what this means for you.
This page will be discontinued Jan.1, 2023.

USGS 04227980 CONESUS LAKE NEAR LAKEVILLE NY

PROVISIONAL DATA SUBJECT TO REVISION

Available data for this site   Time-series: Current/Historical Observations ⌄   GO

Click to hidestation-specific text

Funding for this site is provided by:

NYS Department of
Environmental Conservation

Cooperative Water Program

▼ **Site Information**
   LOCATION.--Lat 42°47'39.3", long 77°43'14.7" referenced to North American Datum of 1983, Livingston County, NY, Hydrologic Unit 04130003, on west shore of Conesus Lake at Geneseo Water Works pumping station, 300 ft east of State Highway 256, and 3.0 mi south of Lakeville.
   DRAINAGE AREA.--69.8 mi².
   PERIOD OF RECORD.--January 1930 to current year (daily gage heights prior to October 1975, elevations thereafter). January 1930 to June 1963 in files of village of Geneseo.
   REVISIONS HISTORY.--WDR NY-82-3: Drainage area.
   GAGE.--Water-stage recorder. Datum of gage is NGVD of 1929. To convert elevations to NAVD of 1988, subtract 0.52 ft. Prior to Oct. 1, 1970, nonrecording gage at site 200 ft downstream at datum 796.59 ft higher. Oct. 1, 1970 to Sept. 30, 1971, at datum 800.00 ft higher.
   REMARKS.--Lake elevation regulated by gates at outlet. Area of water surface, 5.08 mi². Daily average of about 2 ft³/s diverted from lake for water supply for Avon, Geneseo, and Lakeville Water District.
   EXTREMES FOR PERIOD OF RECORD.--Maximum elevation, 822.50 ft, present datum, June 24, 1972; minimum elevation, 816.11 ft, Dec. 22, 24, 1988.

► **WaterNow** – get the latest gage data from your mobile phone or email.

► **WaterAlert** – get an email or text (SMS) alert based on your chosen threshold.

► **Rating Information**

► **Peak Chart**

▼ **Additional Site Information**

Peak Flow and Stage Information

NAVD 1988 Datum Conversion Information

Station image

This station managed by the NY Water Science Center Ithaca.

Available Parameters	Available Period
☐ All 2 Available Parameters for this site	
☑ 62614 Elevation, lake/res, NGVD29	2007-10-01 2021-12-21
☑ 62615 Elevation, lake/res, NAVD88	2021-08-23 2021-12-21

Output format
◉ Graph
◯ Graph w/ stats
◯ Graph w/o stats
◯ Graph w/ (up to 3) parms
◯ Table
◯ Tab-separated

Days (7)

Summary of all available data for this site
Instantaneous-data availability statement

GO

-- or --

Begin date
2021-12-14

Lake or reservoir water surface elevation above NGVD 1929, feet
Most recent instantaneous value: 817.62 12-21-2021   14:45 EST

End date
2021-12-21

StreamStats Data-Collection Station Report

USGS Station Number   **04227995**
Station Name   **Conesus Creek near Lakeville, NY**

[Click here to link to available data on NWIS-Web for this site.](#)

Descriptive Information

Station Type	Streamgage, continuous record
Location	Lat 42°51'15.0", long 77°42'55.0" referenced to North American Datum of 1983, Livingston County, NY, Hydrologic Unit 04130003, on right bank 100 ft upstream from bridge on West Lake Road (State Highway 256), 1.5 mi downstream from Lakeville, and 10.7 mi upstream from mouth.
Gage	Water-stage recorder and crest-stage gage. Datum of gage is 806.35 ft above NAVD of 1988. Prior to April 1996, at same site at different datum.
Regulation and Diversions	High flows regulated by Conesus Lake flood protection project. For information on gate openings or closures, call the Town of Livonia Water and Sewer District at (585) 346-3523. Mark Kosakowski is presently in charge of Conesus Lake dam operations.
Regulated?	True
Period of Record	
Remarks	
Latitude (degrees NAD83)	42.85389
Longitude (degrees NAD83)	-77.71528
Hydrologic unit code	04130003
County	051-Livingston
HCDN2009	No

Physical Characteristics

Characteristic Name	Value	Units	Citation Number
Descriptive Information			
Datum_of_Latitude_Longitude	NAD83	dimensionless	30
District_Code	36	dimensionless	30
Begin_date_of_record	3/15/1996	days	41
End_date_of_record	9/30/2003	days	41
Number_of_days_of_record	2756	days	41
Number_of_days_GT_0	2756	days	41
Basin Dimensional Characteristics			
Drainage_Area	72	square miles	203

Streamflow Statistics

Statistic Name	Value	Units	Citation Number	Preferred?	Years of Record	Standard Error, percent	Variance log-10	Lower 95% Confidence Interval	Upper 95% Confidence Interval	Start Date	End Date	Remark
Peak-Flow Statistics												
Systematic_peak_years	16	years	267	Y								
Regulated_est_50_percent_AEP_flood	541	cubic feet per second	267	Y	16							
Regulated_est_66_7_percent_AEP_flood	433	cubic feet per second	267	Y	16							
Regulated_est_20_percent_AEP_flood	795	cubic feet per second	267	Y	16							
Regulated_est_10_percent_AEP_flood	950	cubic feet per second	267	Y	16							
Regulated_est_4_percent_AEP_flood	1130	cubic feet per second	267	Y	16							
Regulated_est_2_percent_AEP_flood	1250	cubic feet per	267	Y	16							

		second					
Regulated_est_1_percent_AEP_flood	1360	cubic feet per second	[267](#)	Y	16		
Regulated_200_Year_Peak_Flood	1470	cubic feet per second	[267](#)	Y	16		
Regulated_500_Year_Peak_Flood	1600	cubic feet per second	[267](#)	Y	16		
Regulated_est_80_percent_AEP_flood	346	cubic feet per second	[267](#)	Y	16		

Flow-Duration Statistics

1_Percent_Duration	384	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
2_Percent_Duration	293	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
3_Percent_Duration	251	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
5_Percent_Duration	197	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
10_Percent_Duration	143	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
15_Percent_Duration	114	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
20_Percent_Duration	93	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
25_Percent_Duration	75	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
30_Percent_Duration	62	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
35_Percent_Duration	48	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
40_Percent_Duration	36	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
45_Percent_Duration	29	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
50_Percent_Duration	23	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
55_Percent_Duration	20	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
60_Percent_Duration	17	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
65_Percent_Duration	15	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
70_Percent_Duration	13	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
75_Percent_Duration	12	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
80_Percent_Duration	11	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
85_Percent_Duration	9.9	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
90_Percent_Duration	8.3	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
95_Percent_Duration	3.5	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
97_Percent_Duration	2.5	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
98_Percent_Duration	1.8	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
99_Percent_Duration	1.2	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015

Annual Flow Statistics

Mean_Annual_Flow	57	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
Stand_Dev_of_Mean_Annual_Flow	19	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
Maximum_Annual_Mean_Flow	101	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
Minimum_Annual_Mean_Flow	17	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015

General Flow Statistics

Minimum_daily_flow	0.4	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
Maximum_daily_flow	957	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015

		second				
Std_Dev_of_daily_flows	79	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
Average_daily_streamflow	57.346	cubic feet per second	[41](#)	Y	7	
Harmonic_Mean_Streamflow	13	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
Mean_of_Logs_of_Daily_Values	1.44745	Log base 10	[325](#)	Y	34	10/1/1919 9/30/2015
Std_Dev_of_Logs_of_Daily_Values	0.533537	Log base 10	[325](#)	Y	34	10/1/1919 9/30/2015
Skew_of_Logs_of_Daily_Values	-0.064484	Log base 10	[325](#)	Y	34	10/1/1919 9/30/2015
Non_Zero_Adjusted_Harmonic_Mean_Flow	13	cubic feet per second	[325](#)	Y	34	10/1/1919 9/30/2015
Base Flow Statistics						
Number_of_years_to_compute_BFI	7	years	[42](#)	Y	7	
Average_BFI_value	0.406	dimensionless	[42](#)	Y	7	
Std_dev_of_annual_BFI_values	0.15	dimensionless	[42](#)	Y	7	
Probabillity Statistics						
Probability_flow_durations_are_zero	0	dimensionless	[325](#)	Y	34	10/1/1919 9/30/2015

Citations

Citation Number	*Citation Name and URL*
41	[Wolock, D.M., 2003, Flow characteristics at U.S. Geological Survey streamgages in the conterminous United States: U.S. Geological Survey Open-File Report 03-146, digital data set](#)
42	[Wolock, D.M., 2003, Base-flow index grid for the conterminous United States: U.S. Geological Survey Open-File Report 03-263, digital data set](#)
203	[Lumia, Richard, Freehafer, D.A., and Smith, M.J., 2006, Magnitude and Frequency of Floods in New York: U.S. Geological Survey Scientific Investigations Report 2006�5112, 152 p.](#)
267	[Wall, G.R., Murray, P.M., Lumia, Richard, and Suro, T.P., 2014, Maximum known stages and discharges of New York streams and their annual exceedance probabilities through September 2011: U.S. Geological Survey Scientific Investigations Report 2014�5084, 16 p.](#)
325	[Granato G.E., Ries, K.G., III, and Steeves, P.A., 2017, Compilation of streamflow statistics calculated from daily mean streamflow data collected during water years 1901�2015 for selected U.S. Geological Survey streamgages: U.S. Geological Survey Open-File Report 2017-1108, 17 p.](#)

National Water Information System: Web Interface

USGS Water Resources

Data Category:
Site Information ▾

Geographic Area:
United States ▾   GO

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USGS 04227995 CONESUS CREEK NEAR LAKEVILLE NY

Available data for this site   SUMMARY OF ALL AVAILABLE DATA ▾   GO

Stream Site

DESCRIPTION:
    Latitude 42°51'15.0",   Longitude 77°42'55.0"   NAD83
    Livingston County, New York, Hydrologic Unit 04130003
    Drainage area: 72.0 square miles
    Datum of gage: 806.35 feet above   NAVD88.

AVAILABLE DATA:

Data Type	Begin Date	End Date	Count
Current / Historical Observations ([availability statement](#))	2007-10-01	2021-12-21	
Daily Data			
Discharge, cubic feet per second	1919-10-01	2021-12-20	14891
Daily Statistics			
Discharge, cubic feet per second	1919-10-01	2021-03-31	14627
Monthly Statistics			
Discharge, cubic feet per second	1919-10	2021-03	
Annual Statistics			
Discharge, cubic feet per second	1920	2021	
Peak streamflow	1920-03-17	2020-03-05	40

Field measurements	1995-04-27	2021-10-27	192
Water-Year Summary	2005	2020	16
Revisions	Available (site:1) (timeseries:0)		

OPERATION:

Record for this site is maintained by the USGS New York Water Science Center

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APPENDIX C

Stakeholder Comments

RESPONSIVENESS SUMMARY: SAFE YIELD ANALYSIS

12/21/2021 by Schnabel Engineering of New York

Reviewer- Conesus Lake Association				
Comment Number	**Section/Page**	**Comment**	**Response**	**Revision to Report**
CLA-1	Figure 6.2	Potential for negative impacts on lake level if water purveyors draw at permitted levels, concern is summer/fall season- current data document lake level below rule curve targets (graph of 31 yr. daily mean water level). Request additional figure of lake levels post 1989 (in addition to the 100 yr. graph).	Agree that summer/fall lake level is an important consideration. Detailed information (100 years) is presented although not averaged as requested (31 years)– refer to Figure 6.2. Impact of rule curve compliance is reflected in sensitivity run #4 and recommendation re rule curve evaluation. We note that since 2001, lake levels have been managed to adhere to the rule curve more closely.	No report revision required
CLA-2	Section 2.5 p.15	Since operationally not able to manage outflow at 10 cfs, consider either: calculate SY at 14 cfs, or commit to improvements to enable management of release at 10 cfs	NYSDEC requires a minimum 10 cfs discharge measured daily at the USGS downstream gage for water quality and habitat protection. The issue of calculating the Safe Yield at 14 cfs is addressed in sensitivity analysis and recommendations	Edited for clarity, adding schematic diagram (new Figure 2-7) to clarify location of outlet dam, outfall, and USGS gage
CLA-3	General environmental impacts	Need to consider other potential negative impacts. Who leads that consideration?	Safe Yield analysis is defined in terms of sustainable water supply during a drought of a statistically defined magnitude given existing constraints on the system (regulatory, guidance, and operational). Constraints on Conesus Lake were defined in collaboration with the Watershed Council's Technical Committee. Note that any change in permitted withdrawal for water supply from existing permit limits	We revised the report to clarify that the safe yield analysis is a consideration for water supply only, and added the following text to the Executive Summary: "Safe Yield calculations for sustainable public water supply are an essential element of resource management planning. However, Conesus Lake supports multiple uses. Management decisions must also consider flood risk, aquatic habitat, fisheries, economic development, recreational users, water

			would require SEQR; the lead agency would be identified through that process.	quality, and other components of the broader ecosystem. Evaluation of related ecosystem impacts is outside of the scope of this analysis, which focuses on calculating availability of public water supply during an extreme drought."
CLA-4	General public participation	Request public information session	A Safe Yield Analysis is essentially a technical engineering calculation/ hydrologic model projection that is defined by protocols developed and adopted by state and federal agencies (e.g., NYSDEC and ACOE). This standard approach enables comparability of results among systems and over time. The information sessions completed to date have focused on making the underlying model assumptions and site-specific Conesus Lake conditions clear and providing opportunities for clarification to the technical advisory committee and members of the Watershed Council. Public input is required for any proposed action that meets defined SEQR thresholds or requires a regulatory permit. The Planning Department is open to having the Schnabel consulting engineers present at a public information session at the Watershed Education Center as funding allows.	No report revision required
CLA-5	Comment on Executive Summary	Executive Summary should clarify if new permits are required before the Villages of Avon and/or Geneseo can expand withdrawal beyond the current approved combined water treatment plant capacities.	The 2021 Safe Yield Analysis is not a policy document; it is a resource. While the SYA projects water level impacts during an extreme drought if a full 6.5 MGD were drawn by the Villages of Avon and Geneseo, that is only one of the modeled scenarios. NYSDEC has not yet clarified	No report revision required

Comment Number	Section/Page	Comment	Response	Revision to Report
			their regulatory process for reviewing a future permit modification request from the Villages to expand treatment capacity and draw more of their allocation. The regulatory process is under active discussion at NYSDEC. No request for permit modification has been made.	
CLA-6	Comment on Executive Summary	Would potential adverse environmental impacts (ecological, environmental, recreational, economic, and more routine low lake levels in traditional high public use areas) be evaluated during a permit revision to enable the Villages to modify their water intake/treatment capacity?	See response to CLA-5. The NYSDEC has not yet clarified their regulatory process for a hypothetical request for permit modification. Decisions related to the need for and scope of any environmental impact assessment rest with NYSDEC.	No report revision required
CLA-7	Comment on Executive Summary	Safe Yield Analysis and Safe Yield Evaluation appear to have been used interchangeably in various communications	Comment noted.	Documents edited to consistently reference Safe Yield Analysis

Reviewer: Mark Grove (Livingston County Health Department)

Comment Number	Section/Page	Comment	Response	Revision to Report
DOH-1	Table 4.1	Clarify that tabulated values reference drought conditions. Add text/footnote indicating that the values are in addition to the 6.5 MGD required release	Noted	Clarification added- footnote to Table 4.1
DOH-2	2.5 (pg. 15)	Discuss what would be involved in negotiating a reduced downstream release rate (feasibility study parameters)	Any change to the NYSDEC permit requirement of minimum 10 cfs daily streamflow measured at the USGS gauge downstream of the Lakeville WWTP outfall would require statistical analysis of streamflow data; sampling, analysis, and	Additional text added to Section 2.5.

Comment Number	Section/Page	Comment	Response	Revision to Report
			modeling to calculate risk of exceedances of ambient water quality standards (particularly for ammonia N) and guidance values; and a detailed habitat evaluation (including benthos).	
DOH-3	General	Consider discussing frequency of updating SYA and what might trigger that decision (climate impacts, e.g.)	Hydrology of the Conesus Lake watershed, and Western NY in general, is projected to change and become more variable as the climate warms. In addition, modeling tools will continue to evolve. A periodic review to compare predicted and observed lake levels will help the Livingston County Planning Department determine when the Safe Yield Analysis tool needs to be updated. Updates would be appropriate following collection of a long-term record of stream discharge within the watershed or based on a qualifying event such as implementation of channel dredging, water system upgrades, or NYSDEC permit modifications.	Added a recommendation in Section 5.0 to periodically review and update the SYA based on recent data or qualifying events.

Reviewer: Karl Hanafin (CLA)

Comment Number	Section/Page	Comment	Response	Revision to Report
KH-1	Pg. 3 Section 1.3- Gated Outlet Structure	This is not historically accurate. The primary reason for the project was flood control. The quantitative justification was solely based on predicted reduction of local property damage from flooding. Subsequent review by DEC, U.S. Fish and Wildlife Service and others resulted in refinement of target lake levels and minimum	Comment noted, thank you for the clarification	Section 1.3 Edited: "The primary rationale for constructing the current outlet structure was to manage water levels and reduce the risk of flooding lakeshore properties. Subsequent agency review of dam's operation incorporated additional consideration of recreational uses and aquatic habitat. "

		outlet flow rate to minimize the impact of the new structure. This is an important aspect to understand because design and operation of the system does not include elements that would benefit a water supply reservoir such as accurate low-flow output controls and continuous inflow measurement.		
KH-2	Pg. 5 Table 1.1	Table 1.1 indicates that the gates are constructed using steel, I believe they are aluminum as indicated in the text on page 4.	Comment noted, thank you for the correction	Edited in Table 1.1
KH-3	Pg. 5	What is (are) the source(s) for the Conesus Lake data in table 1.1? Specifically, the "Drainage Area" of 70 mi2. The NYS DEC 2019 TMDL lists "Direct Drainage Area" as 41,429 acres (64.73 mi2) although this value excludes the lake area.	The drainage area of 70 mi^2 includes the surface area of Conesus Lake.	Table 1.1 footnoted for clarity
KH-4	Pg. 16	The report assumes 10 cfs as the minimum release from the lake. This level has not been maintained for any significant period during which the lake was at or below the target level. Even with a state-of-the-art control system, one would expect that the actual release would exceed the minimum to avoid potential permit violations. This is especially true given the absence of pressure on the operators to minimize outflow.	Comment noted. As discussed, the SYA includes a discharge of 10 cfs as a regulatory constraint, not an assumption. Across the Finger Lakes, the ACOE rule curves are targets for lake level management to support multiple uses. The challenge of managing the Conesus Lake outlet structure with sufficient accuracy and precision to meet 10 cfs is acknowledged in the report, reflected in the sensitivity analysis, and incorporated into the recommendations.	No report revision required

KH-5	Pg. 31	Was an effort made to quantify the uncertainty of your model and to extend that uncertainty to the safe yield estimates that result from the model? This would provide some indication of the accuracy of the results, a sort of tolerance.	As described during presentations, the HEC-ResSim model is a mass balance: estimating volumes of water entering and leaving Conesus Lake and projecting the change in storage (lake level) that results. Model input and output parameters are adjusted within defined ranges to simulate a portion of the historical record (calibration). The calibration process in performed to reduce uncertainty and the calibrated model is tested for its accuracy in simulating a different part of the record (verification). For the SYA model, the Schnabel team focused their calibration and verification on drought periods. There is no specific calculation of uncertainty. The uncertainty could be reduced after collection of a long-term record of streamflow data within the Conesus Lake watershed. Presumably, this data would be more representative of the watershed than the transposed Cohocton River data set.	No report revision required
KH-6	General	Was any consideration given to modification of the lake level target rule curve? Perhaps the winter draw down could end early in years of early ice-out dates. Target levels/dates could be adjusted based on snowpack and soil moisture measures. Seasonal changes in water use might influence the target levels, such as the arrival of students at SUNY Geneseo.	Across the Finger Lakes, the rule curve is used as a guidance for lake level management to support multiple uses. We agree that there may be useful environmental metrics to help guide the Compact of Towns and the Livingston County Water & Sewer Authority as they manage lake level. Modification of the rule curve was discussed in the report as reflected in sensitivity analysis #4.	No report revision required
Reviewer: Jason Molino (Livingston County Water and Sewer Authority)				

Comment Number	Section/Page	Comment	Response	Revision to Report
LCWSA-1	Pg. 11 section 2.2	Change the first sentence of the second paragraph to: "Following our conversation with the Livingston County Water and Sewer Authority on August 27, 2021, we understand that...."	Comment noted	Edited in Section 2.2, now third paragraph
LCWSA -2	p. 43, section 6	Authority agrees with recommendation to maintain current water supply allocations to Geneseo and Avon to enable future growth	Comment noted	No report revision required
LCWSA -3	Table 4.1	Clarify that tabulated values reference drought conditions. Add text/footnote indicating that the values are in addition to the 6.5 MGD required release	Comment noted	Clarification added as footnote to Table 4.1

Reviewer: MRB (on behalf of Village of Avon)

Comment Number	Section/Page	Comment	Response	Revision to Report
MRB-1	General	Additional safety factors/conservative assumptions: • Water conservation measure and restrictions to reduce water demand • Operational strategies to better manage potable water storage volumes during and prior to potential drought conditions	Comment noted, the standard process for a SYA does not explicitly "take credit" for the potential effect of additional actions that communities can embrace during critical drought conditions.	Commentary added in Section 6.0

MRB-2	General-model constraints	Minimum target lake level 814.9 during drought seems reasonable, given quick recovery	Water intake infrastructure constraint is 814.5 – lowest lake level to maintain pumping operations. Intervention will be required to reach a lake level of 814.9	No report revision required
MRB-3	Recommendations	Support recommendations	Noted	No report revision required
MRB-4	Model constraints-outflow	WWTP discharge volume likely to be lower during drought, less dilution required- potential to release less water?	Would require DEC approval for "emergency" waiver, testing, etc. A tool in the toolbox, but discharge requirement is not only for dilution (aquatic habitat)	No report revision required
MRB-5	General	Climate projections are for more rain, water supply capacity of Conesus would only improve	Comment noted. Climate projections also call for more variability.	No report revision required

Reviewer: Livingston County Planning Department Staff

Comment Number	Section/Page	Comment	Response	Revision to Report
LCPD-1 (a)	Pg. 1, Section 1.1	The document references the average depth of the north and south basins. Is there any benefit to referencing the deepest points in those basins?	Comment noted. The SYA calculates change in storage as a function of volume; lake volume incorporates bathymetry including maximum depth.	Additional lake depth reference added to Section 1.1
LCPD- 1(b)	Pg. 1, Section 1.1	In the last paragraph, the document states that the safe yield of any water supply source is primarily dependent upon the productivity of the source watershed… what is the	Productivity in this context refers to a watershed's yield, the amount of water it provides to Conesus Lake.	Clarification made in Section 1.1

		definition of productivity in this sentence?		
LCPD 2 (a)	Pg. 8	The first bullet should be split into two for the two documents listed.	Comment noted	Corrected in Section 2.0
LCPD 2 (b)	Pg. 8	The name of the document in the 8th bullet is "2020 Livingston County Comprehensive Water Supply Study Update".	Comment noted	Corrected in Section 2.0
LCPD-3	Pg. 10	The Avon supply water intake depth and Avon water supply minimum pumping elevation data are relying on the Village of Avon water supply operator communications. These email communications should be included in an Appendix to give future safe yield updates a context on where the data originated.	Comment noted	Additional reference added to Section 2.1
LCPD-4	Pg. 11 Sec. 2.2	Add that the Conesus Lake Compact of Towns has responsibility for managing the gates, and the Compacts has a contract with the Livingston County Water & Sewer Authority for operation of the gates	Comment noted	Added in Section 2.2
LCPD-5 (a)	Pg. 15 Sec. 2.5	Section 2.5 may fit better on page 3 where the gated outlet structure is described.	Section 2.5 is specific to how the model was influenced and developed by the available data.	No report revision required
LCPD-5 (b)	Pg. 15 Sec. 2.5	Include a zoomed in map showing the Conesus Creek gage and the dam and indicating where the 10 cfs is measured	Comment noted	Added Fig. 2.7
LCPD-5 (c)	Pg. 15 Sec. 2.5	The last paragraph of Section 2.5 on page 15 will need lay person	Comment noted	Section 2.5 edited

		science translation for a general audience		
LCPD-5 (d)	Pg. 15 Sec. 2.5	Please include Schnabel's explanation about negligible water released from the Wastewater Treatment Plant in this section	Comment noted	Section 2.5 edited
LCPD-6 (a)	Pg. 17 Sec, 2.6	Elaborate on the actual use, permitted use, and allocated use in the text for Avon and Geneseo	Comment noted	Section 2.6 edited
LCPD-6 (b)	Pg. 17 Sec, 2.6	Show the current permitted withdrawal limits on Figure 2.9	Comment noted. Because the permitted allocations are so much larger than the average daily use, we elected to add both the permitted and average daily use values to Section 2.6 text rather than modifying the scale of the Figure (Now Figure 2.10).	Section 2.6 edited
LCPD-7 (a)	Pg. 33	Add 9/24/21 meeting of the Conesus Lake Watershed Council to list	Comment noted	Section 4.0 edited
LCPD-7 (b)	Pg. 33	For bullets on the bottom of pg. 33 and top of pg. 34, elaborate on which options would require pumping to achieve the required downstream release of 10 cfs. Edit bullets to be more understandable to a general audience.	Comment noted	Section 4.0 edited
LCPD-7 (c)	Pg. 33	Reference the section numbers these bullets are referring to	Comment noted	Section 4.0 edited
LCPD-8 (a)	Pg. 34	Could the text for Sensitivity #4 include language on how this option allows for the gradual release of water to the winter target instead of the quick drawdown in November?	Comment noted	Sensitivity #4 text edited in Section 4.0

LCPD-8 (b)	Pg. 34	In Section 4.1, it would be helpful to add text about the actual use of the lake at this time for a full picture.	This comment is asking to compare the safe yield predictions to the average daily water use. This will be added to the commentary in Section 6.0	Commentary added in Section 6.0
LCPD-9 (a)	Pg. 35-36	It would be helpful to have the sections and graphs that are linked to those sections on the same page.	Comment noted- will adjust layout as possible	Report reformatted where possible
LCPD-9 (b)	Pg. 35-36, Sec. 4.2	Mention that the Geneseo intake is deeper than the Avon water intake	Comment noted	Section 4.2 edited
LCPD-9 (c)	Pg. 35-36, Sec. 4.3	Include explanation of why 14 cfs was chosen for Sensitivity #3.	Comment noted	Edited
LCPD-10(a)	Pg. 39, table 4.1	Second column, add "only" to the column heading so that it reads Estimated Safe Yield (water supply only)	Comment noted	Edited
LCPD-10(b)	Pg. 39, table 4.1	Add a column or indicate which scenarios might requiring pumping water to meet the 10 cfs release requirement	Comment noted	Edited
LCPD-10(c)	Pg. 39, sec 4.5	Elaborate on pumping details (time of year, duration, etc.) and include figure of the 180 days that the model predicted in the sensitivity where lake level 814.5 was modeled	Comment noted	Section 4.5 edited
LCPD-11	Pg, 40	Add table comparing DEC and Schnabel results that includes water allocations vs actual average water usage (from information presented to Watershed Council)	Comment noted	A comparison between allocation and average water supply values is available in Table ES-1, and water supply average values are discussed in Section 2.6. Comparison between Schnabel and DEC Safe Yield values is made in Table 4.3.
LCPD-12 (a)	Pg. 41	Number the four recommendations listed on Pages 41-42.	Comment noted	Section 5.0 edited

LCPD-12 (b)	Pg. 41	For Recommendation #1 (survey of the outlet channel), it would be helpful to state why this is important. With little current data available on the hydraulics of the outlet and outlet channel, there is a data gap. This recommendation would address that data gap.	Comment noted	Section 5.0, recommendation No. 1 edited
LCPD-12 (c)	Pg. 41	For Recommendation #3, are there recommended locations for new stream gages - at the inlet, in the outlet, in the creek before the wastewater plant, in the creek at the wastewater plant? Possible to include a general cost for a gage and whether it would be beneficial to have a gage tied in with USGS or kept independently?	Placement of a stream gage within the watershed is a highly site-specific decision; it depends on stream size and relative contribution to the lake's inflow, whether streamflow is permanent or intermittent, gradient, and availability of stable cross-sectional areas (such as bridges or culverts). Additional field surveys would be required to refine this recommendation.	Recommendation #3 edited
LCPD-13(a)	Pg. 43	Second bullet, second paragraph, first sentence: change "permitted allocations" to "NYSDEC allocation". This distinguishes between the water allocation and the permitted withdrawals from the existing water treatment plants.	Comment noted	Edited
LCPD-13(b)	Pg. 43	Include the comparison table of allocations vs dependable yield vs actual usage that was in the CLWC presentation on September 24, 2021.	Comment noted	A comparison between allocation and average water supply values is available in Table ES-1, and water supply average values are discussed in Section 2.6. Comparison between Schnabel and DEC Safe Yield values is made in Table 4.3.
LCPD-14	Pg. 44, sec. 6.1, first paragraph	Change "permitted allocations" to "NYSDEC allocation". This	Comment noted	Edited

		distinguishes between the water allocation and the permitted withdrawals from the existing water treatment plants.		
LCPD-15	Pg. 45, sec.6.1 and Fig. 6.2	Add text regarding the need to pump water over the outlet structure when lake level is below 815.5.	Comment noted	Edited
LCPD-16	Pg. 47	In the last paragraph, revise the second sentence from "At the current permitted water supply allocation ..." to "At the current NYSDEC allocation for the Village of Avon and Village of Geneseo water supplies ...". This distinguishes between the water allocation and the permitted withdrawals from the existing Avon and Geneseo water treatment plants.	Comment noted	Edited