APPENDIX F: WATER QUALITY MONITORING PLAN (WQMP)

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WATER QUALITY MONITORING PLAN (WQMP)

1.0 Introduction

Duke Energy Carolinas, LLC (the "Licensee") is applying for a new operating license ("New License") from the Federal Energy Regulatory Commission (FERC) for the Catawba-Wateree Hydro Project (the "Project'). Along with development of its license application, the Licensee has convened six stakeholder teams and has developed a comprehensive agreement (the Catawba-Wateree Relicensing Final Agreement (FA)) to address many Project-related issues as well as other issues of stakeholder interest.

The purpose of this WQMP is to provide a plan to implement the Licensee's monitoring and reporting activities stated in the FA. This plan has been prepared in consultation with resource agencies and will be included with the Licensee's Section 401 Water Quality Certification applications pursuant to the relicensing process in both North Carolina and South Carolina. During the Section 401 Water Quality Certification process, this plan will be reviewed by the North Carolina Division of Water Quality (NCDWQ) and the South Carolina Department of Health and Environmental Control (SCDHEC), and those agencies will approve, modify or deny the plan, as appropriate. The Licensee will also submit one Quality Assurance Project Plan (QAPP) to each state water quality agency with its application for Water Quality Certification for each state. The QAPP will provide the details for project management, measurement/data acquisition procedures and calibration, data validation, and reporting requirements as specified by the United States Environmental Protection Agency (USEPA 2001).

The monitoring activities described in this document will be accomplished by a combination of United States Geological Survey (USGS) stream gages and Licensee monitoring responsibilities (i.e., compliance monitoring, supplemental trout habitat monitoring and monitoring trends in water quality for streamflows entering the Project developments).

2.0 Hydro Project Compliance Monitoring

2.1 Background

The New License for the Project will specify flows to be released from various Project developments. Figure F-1 provides a flow routing and compliance flow schematic for the entire Catawba-Wateree Project. These required flows in the riverine reaches are designed to enhance fish and wildlife habitat (continuous flows), to meet the needs of downstream water users, to provide periodic higher flows for recreational activities (water sports) and ecological purposes, and to meet water quality standards.

Water quality issues that are relevant to the Project include continuous flows, temperature, and dissolved oxygen (DO) concentrations. Compliance with state DO standards in water released from all of the Project developments will be a requirement for both North and South Carolina's 401 Water Quality Certifications.

2.2 Sensor Locations

The proposed sites for compliance monitoring of the Project were based upon the various flow and reservoir level requirements and water quality requirements referenced in Table F-1 and the following criteria:

1. Representative of water quality conditions at all Project flows and operations;
2. Secure (minimize probability of vandalism);
3. Accessible for maintenance at all flows; and;
4. Small time-lag between changes in Project operations and monitor response (minimize downstream distance of sensor).

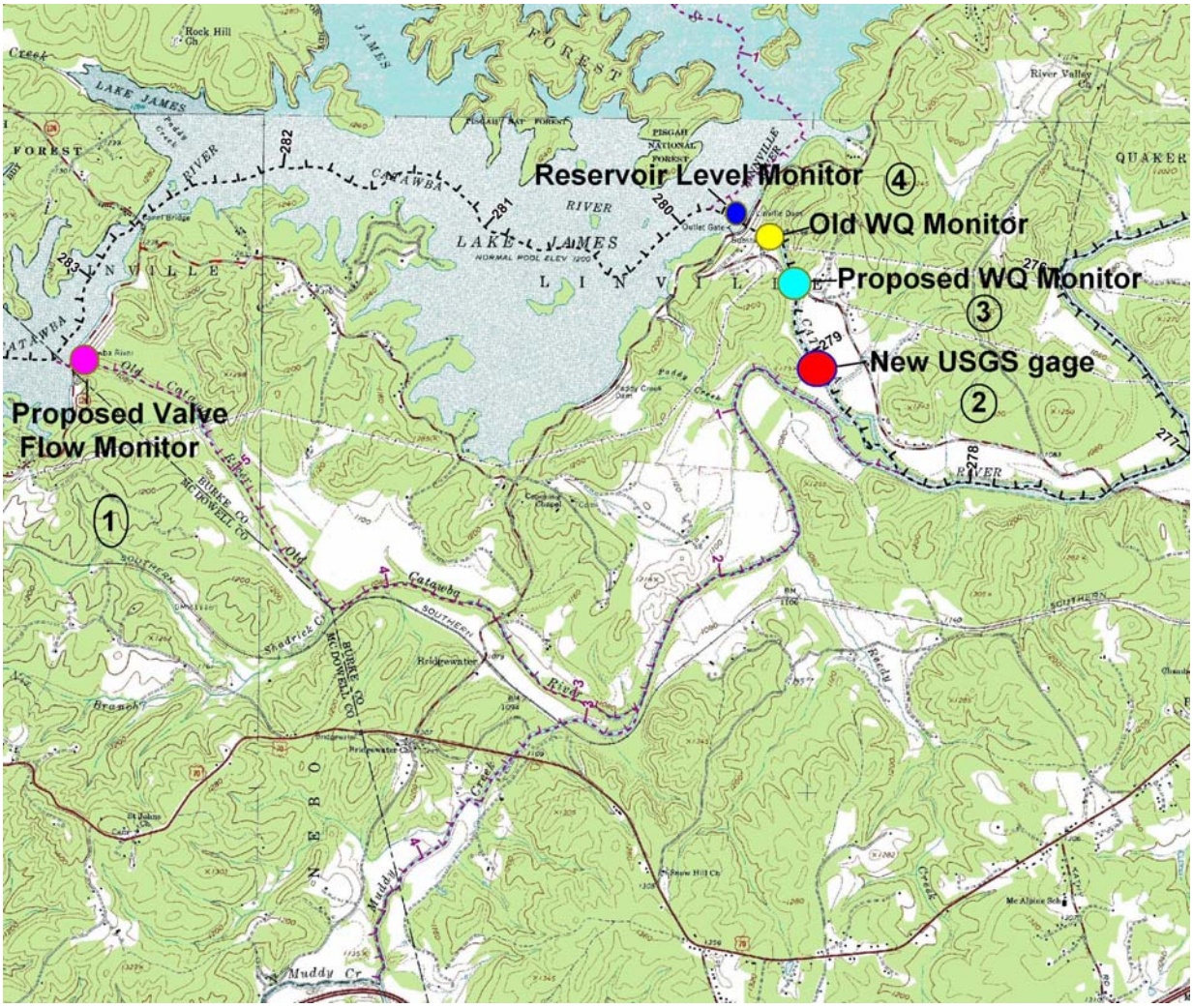
Table F-1. Summary of Project Compliance Verification and Reporting

Final Agreement Requirement	Developments *
Flow and Reservoir Level Requirements	
Bypassed Reaches Minimum Continuous Flow Release	BW, GF
Recreational Flow Releases	BW, OX, WY, GF, WA
Minimum Continuous Flows	BW, OX, LS, WY, GF, WA
Minimum Average Daily Flows	RH, CF, MI, FC, CC
Reservoir Elevations	All
Spring Reservoir Level Stabilization	BW, CF, WY, WA
Compliance Monitoring	All
Water Quality Requirements	
Dissolved Oxygen Concentrations	All
Minimum Flows	BW, OX, LS, WY, GF, WA
Compliance Reporting	All

* BW = Bridgewater (Lake James)
RH = Rhodhiss
OX = Oxford (Lake Hickory)
LS = Lookout Shoals
CF = Cowans Ford (Lake Norman)
MI = Mountain Island
WY = Wylie
FC = Fishing Creek
GF = Great Falls-Dearborn (Great Falls Reservoir)
CC = Rocky Creek-Cedar Creek (Cedar Creek Reservoir)
WA = Wateree

The following pages provide maps or aerial photos for each hydro development in the Project indicating existing and proposed compliance monitoring locations with amplifying information.

Bridgewater



Map Location	Data	Recommended Location	Approximate Distance Downstream (miles)	Comments	Data Collection
1	Bypassed Reach Minimum Continuous Flows	Catawba Dam	0.00	Flow sensor at flow release valve	Wireless Telemetry to Station Computer and Staff Gage for Visual
2	Minimum Continuous Flows Recreational Flows Project Hourly Flows	Downstream of 1st Bridge Powerhouse Road	0.65	USGS Gage (New Gage)	USGS Gage and Turbine Generation Records

Map Location	Data	Recommended Location	Approximate Distance Downstream (miles)	Comments	Data Collection
3	Temperature Dissolved Oxygen	1st Bridge Powerhouse Road Linville River Downstream Bridgewater Hydro	0.25	*In Situ* - Pipe and Instruments on Bridge (NCDOT approval required)	Wireless Telemetry to Station Computer
4	Reservoir Levels	Bridgewater Forebay	n/a	Current Device on the Intake Structure	Wired to Station Computer

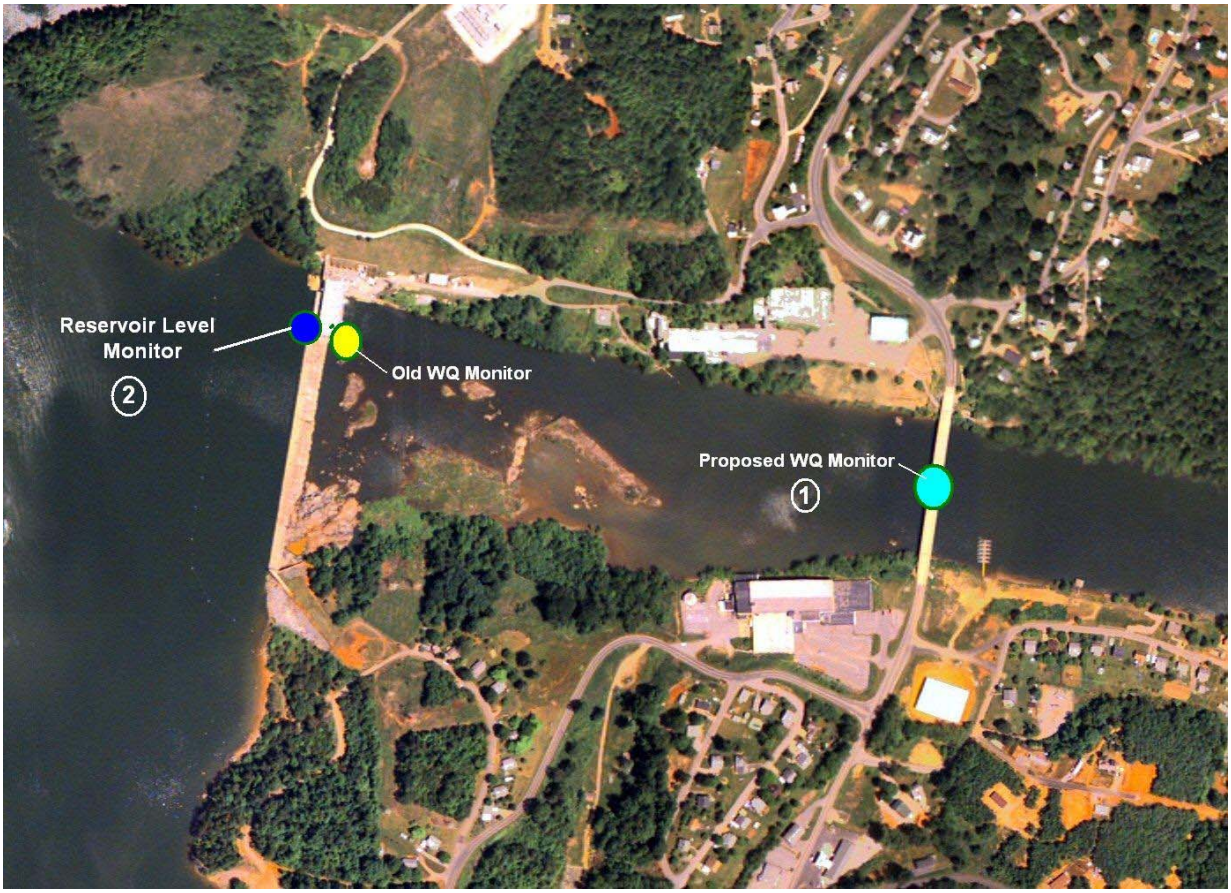
Device Location Rationale

The valve at the Catawba Dam will be designed to supply seasonal minimum continuous flows in the Catawba River Bypassed Reach (Location 1). A sensor in the flow pipe or valve, calibrated for flow, will provide a continuous reading of the flow being released into the Catawba River Bypassed Reach. Since the sensor is located directly on the valve or flow pipe, which is on the dam, the sensor should be secure from vandals.

The channel configuration at the proposed site for the new USGS gage is ideally suited for the expected range of flows originating from the Linville Dam. The site is located on private property providing a measure of security.

The previous water quality monitoring site was located on the downstream side of the powerhouse. Even though that site adequately represented the turbine flow water quality, the future configuration of the Bridgewater Powerhouse is not known, and, therefore, the recommendation for the future water quality monitoring location is at the first downstream bridge (on Powerhouse Road). The bridge provides an existing structure to place the water quality monitor in the center of the narrow river channel. The temporary monitors placed at this site during the Bridgewater downstream investigations (Knight 2003) illustrated similar water quality values to the tailrace monitor at all flows except the 50 cfs leakage flows that will be replaced by 75, 95 or 145 cfs minimum continuous flows in the future depending on the month. This site will represent the water quality conditions of any combination of hydro unit flow (including minimum flow). In addition, the site would be accessible under all Project flows, and would provide a rapid response at the station to water quality conditions. Security from vandals is a concern at this site. Temperature will be monitored at this site to support state trout management initiatives on the downstream section of the river.

Rhodhiss



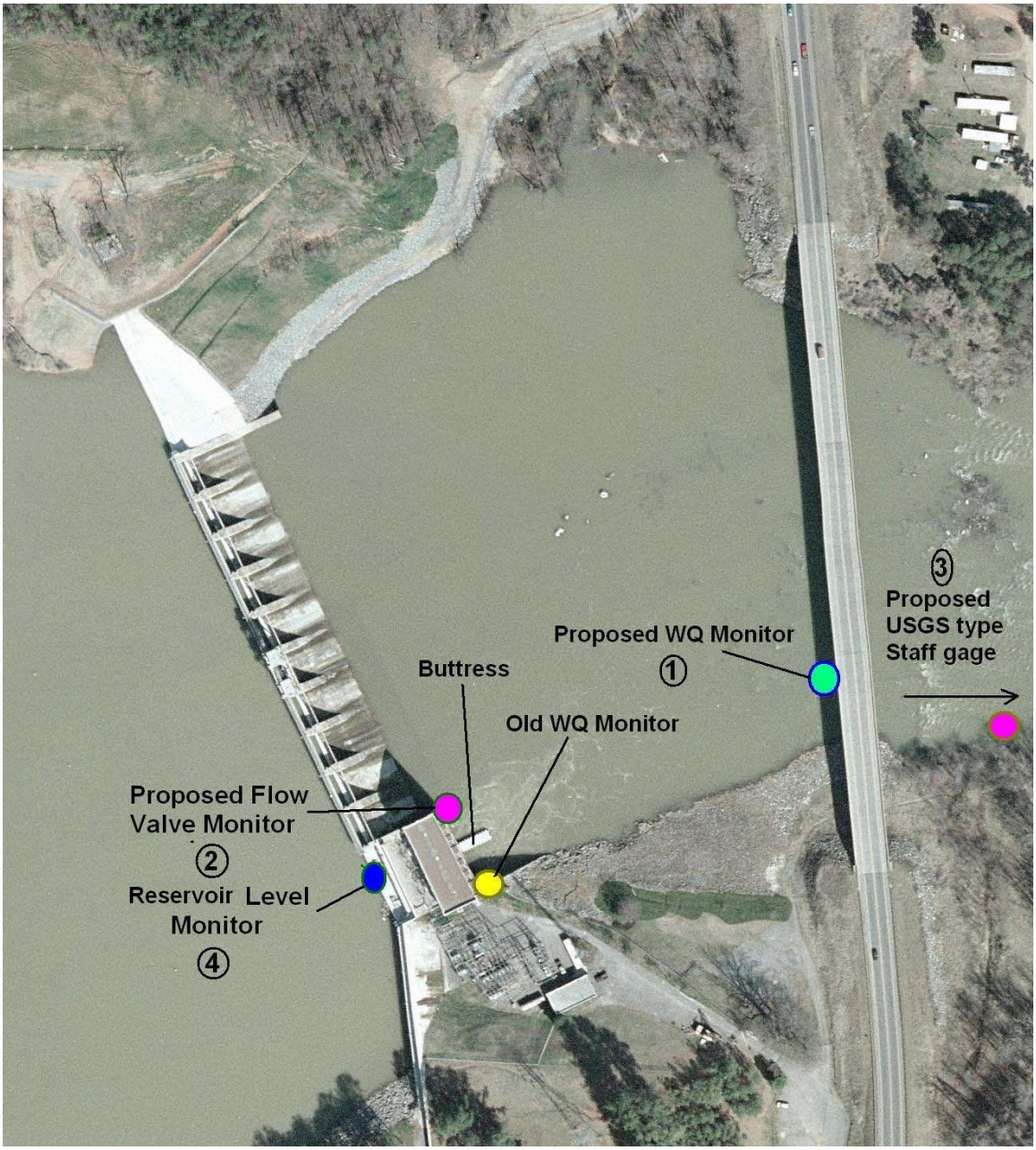
Map Location	Data	Recommended Location	Approximate Distance Downstream (miles)	Comments	Data Collection
1	Temperature Dissolved Oxygen	Rhodhiss Road Bridge Downstream Rhodhiss Hydro	0.35	*In Situ* - Pipe in Center of Channel and Instruments Mounted on Bridge (NCDOT approval required)	Wireless Telemetry to Station Computer
2	Reservoir Levels	Rhodhiss Forebay	n/a	Current Device on the Intake Structure	Wired to Station Computer

Device Location Rationale

The previous water quality monitoring site was located on the south corner on the downstream side of the powerhouse. That site adequately represented the water quality of the turbine flow when all the units were identical, however, the turbine venting tests (Duke Power 2005a), indicated that this location was not representative of the combined flows from units with differing aeration capability. Therefore, the monitor should be moved to the center of the river channel at the downstream bridge (Location 1). The bridge not only provides an existing structure to place the water quality monitor in the

center of the channel, but this site represents the water quality conditions of any combination of hydro unit flows (Duke Power, 2005a). This site is accessible under all Project flows, and may provide a rapid response at the station to water quality conditions. Security from vandals may be a slight concern at this site.

Oxford


Proposed WQ Monitor
①
Buttress
Old WQ Monitor
③
Proposed
USGS type
Staff gage
Proposed Flow
Valve Monitor
②
Reservoir Level
Monitor
④

Map Location	Data	Recommended Location	Approximate Distance Downstream (miles)	Comments	Data Collection
1	Temperature Dissolved Oxygen	Highway 16 Bridge Downstream Oxford Hydro	0.15	*In Situ* - Pipe South Channel and Instruments Mounted on Bridge (NCDOT approval required)	Wireless Telemetry to Station Computer
2	Minimum Continuous Flows	Oxford Dam	0.00	Flow sensor at flow release valve	Wireless Telemetry to Station Computer
3	Recreational Flows Project Hourly Flows	Riverbend Park Turbine Records	0.30	USGS-Type Plate Gage	Staff Gage for Visual and Turbine Generation Records
4	Reservoir Levels	Oxford Forebay	n/a	Current Device on the Intake Structure	Wired to Station Computer

Device Location Rationale

An aerating flow valve will be designed to supply and measure a constant minimum continuous flow in the downstream channel (Location 2). A sensor in the discharge pipe or valve, calibrated for flow, will provide a continuous reading of the flow being released into the river channel. Since the sensor is located directly on the valve or flow pipe, which is on the dam, the sensor should be secure from vandals. The flow valve will provide the minimum continuous flow during periods of no hydro unit generation.

Generation and recreational flow requirements will be recorded from the generation records for each turbine. A manually read, USGS type plate staff gage will be placed at the boat put-in at Riverbend Park (Location 3) for independent verification.

The previous water quality monitoring site was located in the corner of the powerhouse and wingwall. That site adequately represented the water quality of the turbine flow when all the units were identical and prior to the recent installation of the tailrace buttresses. However, this site would probably not be representative of the combined flows from hydro units with differing aeration capability and the buttresses would effectively prevent Unit 2 water from reaching the sensor when Unit 1 was generating. Therefore, the monitor should be moved to the Highway 16 Bridge immediately downstream of the turbines (Location 1). The bridge not only provides an existing structure to place the water quality monitor in the channel, but this site will represent the water quality conditions of any combination of hydro unit flows. This site will be accessible under all Project flows, and will provide a rapid response of the station to water quality conditions. Security from vandals may be a concern at this site.

Lookout Shoals

Map Location	Data	Recommended Location	Approximate Distance Downstream (miles)	Comments	Data Collection
1	Temperature Dissolved Oxygen	East Wingwall - Tailrace	0.01	*In Situ* - Pipe, Monitor Location Unchanged	Wired to Station Computer
2	Minimum Continuous Flows Project Hourly Flows	Turbine Records	n/a	n/a	Turbine Generation Records
3	Reservoir Levels	Lookout Forebay	n/a	Current Device on the Intake Structure	Wired to Station Computer

Device Location Rationale

The minimum continuous flow will be provided by either one of the small auxiliary hydro units (Location 2) during periods when the larger hydro units are not operating. The configuration of the Lookout Shoals tailrace (large pool upstream of first downstream hydraulic control) exhibits very little stage change with or without the auxiliary hydro unit generation. In addition, the elevation of the tailrace is also a function of Lake Norman's

reservoir level (at full pond, the reservoir level extends upstream of the hydraulic control). Therefore, the minimum continuous flow and hourly flow rates would be best monitored by the individual generation records of each hydro unit at Lookout Shoals Hydro.

The previous water quality monitoring site was located on the east wingwall downstream of Unit 1. That site adequately represented the water quality of the turbine flow when all the hydro units were identical. The nearest downstream structure to place a monitor in the center of the channel is the I-40 Bridge which is 1.3 miles downstream. The I-40 Bridge site is strongly influenced by Lake Norman's reservoir level, and the long travel time of the minimum flow would influence the water quality at minimum flow. Therefore, the I-40 Bridge location is not preferred for water quality monitoring. Since no other downstream structure exists to place a monitor in the center of the river, the wingwall site (Location 1) represents the best logistical option available for water quality monitoring. This wingwall site will be accessible under all Project flows, and will provide a rapid response of the station to water quality conditions. The monitor will be secure since it is located inside the security fence.

Cowans Ford

Map Location	Data	Recommended Location	Approximate Distance Downstream (miles)	Comments	Data Collection
1	Temperature Dissolved Oxygen	Railroad Bridge Downstream Cowans Ford Hydro	0.50	*In Situ* - Pipe West Channel and Instruments Mounted on Bridge (Railroad approval required)	Wireless Telemetry to Station Computer
2	Reservoir Levels	Cowans Ford Forebay	n/a	Current Device on Intake Structure	Wired to Station Computer

Device Location Rationale

Even though the previous monitor was placed on the tail-deck of the hydro, this location probably represented the water quality of the released flow. However, under multi-unit operation, the monitor would only record data from the hydro unit flows adjacent to the

monitor. In addition, security at the Cowans Ford Hydro facility is controlled by the McGuire Nuclear site (Nuclear Regulatory Commission guidelines) and is difficult to enter when operators are not present. This security issue limits maintenance accessibility. Therefore, the recommended site for the future temperature and dissolved oxygen monitoring is at the railroad bridge 0.5 miles downstream (Location 1). This site would enable the monitor to measure water quality from the high-volume hydro unit flow as well as provide a somewhat secure and accessible site. Location of the monitor just west of the downstream tip of the island would insure that the monitor would be out of the influence of the wastewater discharge from McGuire Nuclear Station.

Mountain Island

Map Location	Data	Recommended Location	Approximate Distance Downstream (miles)	Comments	Data Collection
1	Temperature Dissolved Oxygen	Tail Deck - Tailrace	0.00	*In Situ* - Pipe, Monitor Location Unchanged	Wired to Station Computer
2	Reservoir Levels	Mt. Island Forebay	n/a	Current Device on Intake Structure	Wired to Station Computer

Device Location Rationale

Even though the present monitor is on the tail-deck of the hydro (Location 1), this location probably represents the water quality of the released flow. However, under multi-unit operation, the monitor would only record data from the hydro unit flows adjacent to the monitor. Since no other structure, (e.g., bridge), exists in the center of Mountain Island's tailrace, this tail-deck location represents the best logistical location available. It is secure and provides ready access for maintenance.

Wylie

Map Location	Data	Recommended Location	Approximate Distance Downstream (miles)	Comments	Data Collection
1	Temperature Dissolved Oxygen	~ ½ mile Downstream from Hydro (pier on Ferrell Island)	0.50	Flow-Through System Auto Calibration Sensor (Island property owner's approval required)	Wireless Telemetry to Station Computer
2	Minimum Continuous Flows	Small Unit Turbine Records Highway 21 USGS Gage	0.00 3.60	USGS Gage (Catawba River near Rock Hill, SC) (02146000)	USGS Gage and Turbine Generation Records

Map Location	Data	Recommended Location	Approximate Distance Downstream (miles)	Comments	Data Collection
3	Recreational Flows Project Hourly Flows	Turbine Records Highway 21 USGS Gage	0.00 3.60	USGS Gage (Catawba River near Rock Hill, SC) (02146000)	USGS Gage and Turbine Generation Records
4	Reservoir Levels	Wylie Forebay	n/a	Current Device on the Intake Structure	Wired to Station Computer

Device Location Rationale

The USGS gage at the Highway 21 Bridge (Location 2/3) is well established and will be used for verification of minimum continuous flow, recreational flows, and hourly Project flows. In addition, generation records will be used to supplement the USGS data.

The previous water quality monitoring site was located in the corner of the powerhouse and wingwall. Extensive monitoring of dissolved oxygen concentrations in the Wylie tailrace was conducted during the 2002 turbine venting test (Duke 2005a). These results indicated that the proposed monitoring location was the closest point to the hydro that best represented the water quality of the multi-unit flows (Location 1). This test included detailed water quality sampling along several downstream transects, as opposed to just at the monitoring site. Furthermore, the Wylie tailrace is very complicated since the island immediately downstream of the powerhouse splits the water released from the hydro. The flow, from either a single unit or multiple unit operation, moves around the island and finally merges just upstream of the small island across the channel from the proposed monitoring location. Use of this location is contingent on being able to get permission for access from the property owner and on obtaining any necessary easements. Security from vandals is of some concern at this site.

Fishing Creek

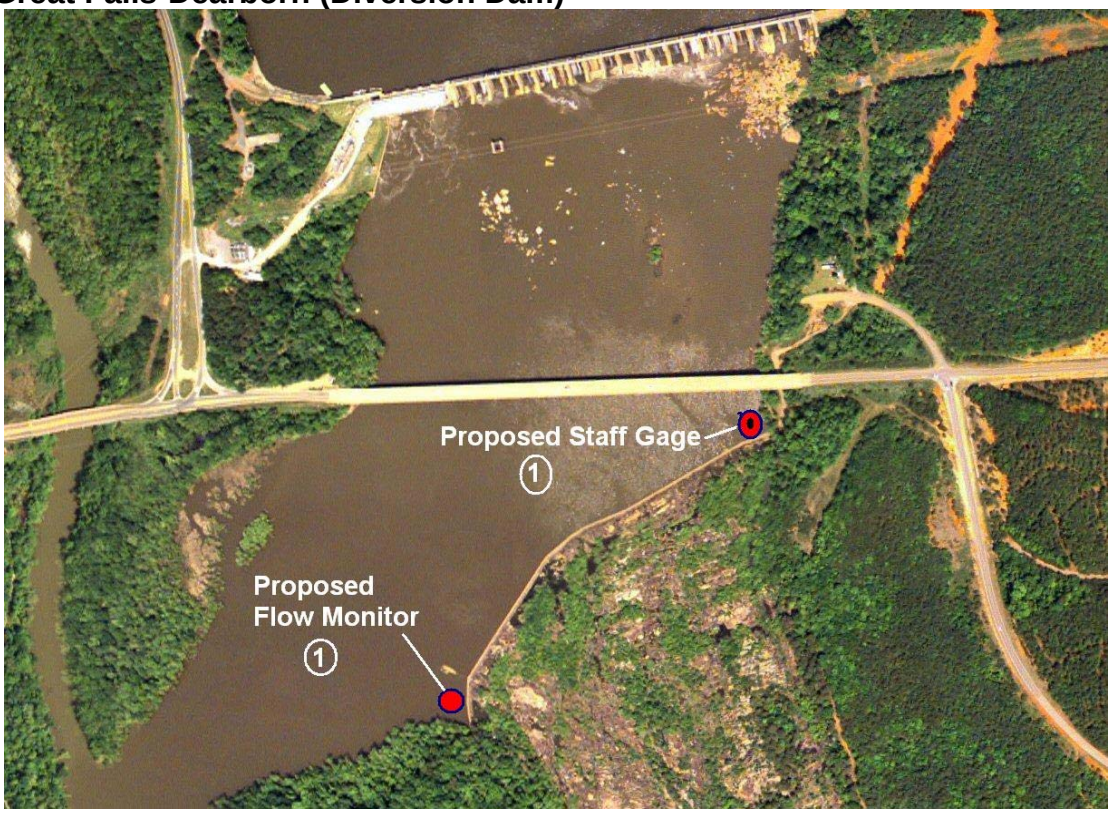
Map Location	Data	Recommended Location	Approximate Distance Downstream (miles)	Comments	Data Collection
1	Temperature Dissolved Oxygen	Highway 97/200 Bridge Downstream Fishing Creek Hydro	0.15	*In Situ* - Pipe West Channel and Instruments mounted on Bridge (SCDOT approval required)	Wireless Telemetry to Station Computer
2	Reservoir Levels	Fishing Creek Forebay	N/A	Existing Device on the Intake Structure	Wired to Station Computer

<u>Device Location Rationale</u>

The previous water quality monitoring site was located on the wingwall, west of the Fishing Creek Powerhouse. That site adequately represented the water quality (temperature and dissolved oxygen) of the turbine flow when all the hydro units were identical and prior to the recent installation of the tailrace buttresses. However, this site would probably not be representative of the combined flows from hydro units with differing aeration capability since the flows will be directed downstream due to the newly

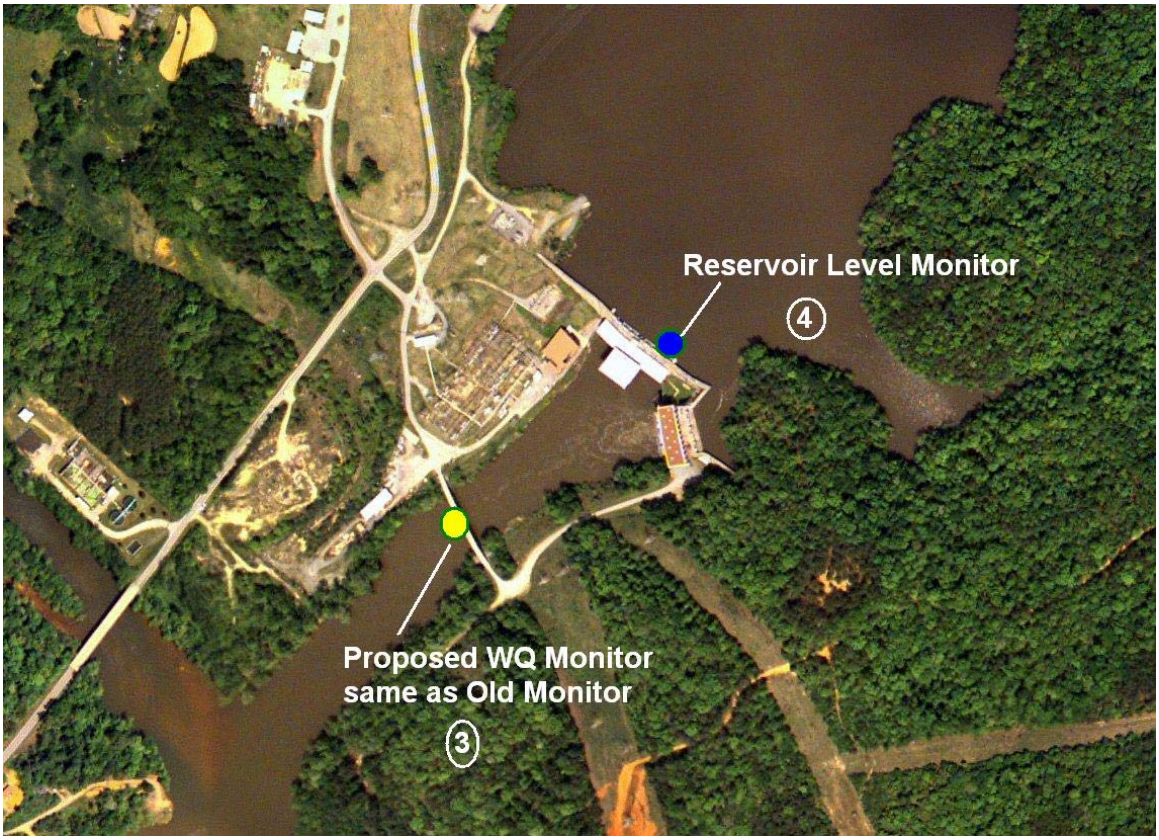
installed buttresses. Therefore, the monitor will be moved to the Highway 97/200 Bridge immediately downstream of the turbines (Location 1). The bridge not only provides an existing structure to place the water quality monitor in the channel, but this site will represent the water quality conditions of any combination of hydro unit flows. This site is accessible under all Project flows, and will provide a rapid response of the station to water quality conditions. Security from vandals may be a concern at this site.

Great Falls-Dearborn (Diversion Dam)



Great Falls-Dearborn (Headworks)

Great Falls-Dearborn (Main Dam)



Map Location	Data	Recommended Location	Approximate Distance Downstream (miles)	Comments	Data Collection
1	Bypassed Reaches Minimum Continuous Flows Recreational Flows	Diversion Dam Long Bypassed Reach Downstream Fishing Creek Hydro	0.25 mi. from Fishing Creek Dam	Pressure Sensor calibrated to correspond to minimum continuous flow pond level. Pressure Sensor calibrated to correspond to recreational flows and pond level.	Wireless Telemetry to Station Computer and Staff Gage for visual
2	Bypassed Reaches Minimum Continuous Flows Recreational Flows	Headworks Short Bypassed Reach Downstream Fishing Creek Hydro	1.95 mi. from Fishing Creek Dam	Gate Position Sensor calibrated to gate opening corresponding to minimum continuous flow. Pressure Sensor calibrated to correspond to recreational flows and pond level.	Wireless Telemetry to Station Computer and Staff Gage for visual
3	Temperature Dissolved Oxygen	Duke Bridge Downstream of Hydros	0.1 mi. from Great Falls – Dearborn Dam	*In Situ* - Pipe, Monitor Location Unchanged	Wired to Station Computer

Map Location	Data	Recommended Location	Approximate Distance Downstream (miles)	Comments	Data Collection
4	Reservoir Levels	Great Falls Forebay	N/A	Existing Device on the Intake Structure	Wired to Station Computer

Device Location Rationale

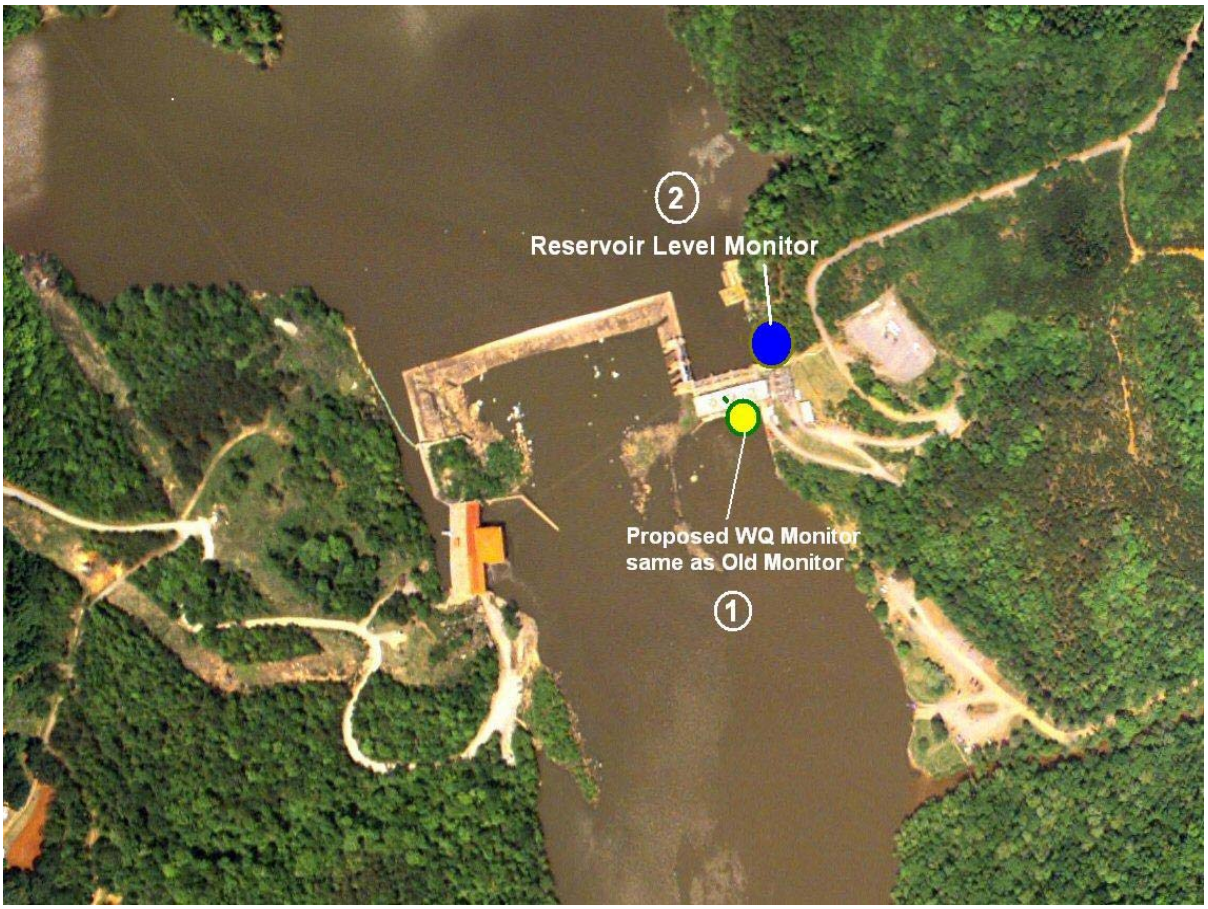
Ideally, measurement of the minimum continuous flows and recreational flows in the Great Falls Long and Short Bypassed Reaches would be taken directly in the respective channels. However, the irregular channel configuration in both reaches prevents accurate flow measurements from stage changes. In addition, the difficult access to the bypassed reaches poses substantial personnel safety limitations to the calibration and maintenance of the gages. Therefore, the best measurement of the flow in the bypassed reaches is at the source of the flows (Locations 1 and 2).

Although the exact design of the minimum continuous flow delivery mechanism has not been completed, the measurement of flow will be a stage-discharge relationship between the pond level and the flow being delivered. Continuous flow monitoring for the Long Bypass will be located at the Great Falls Diversion Dam immediately downstream of Fishing Creek Hydro (Location 1). The continuous flow monitoring for the Short Bypassed Reach will be provided at the Great Falls Headworks spillway, both upstream and downstream of the headworks structure (hence a flow measurement system upstream and downstream of the headworks) (Location 2).

Recreational flows will be provided as spill over the Great Falls Diversion Dam and the Great Falls Headworks. Again, the water level over the spillways will be measured and stage-discharge equations will relate stage to flow. Manually read, new USGS type plate staff gages will be placed at the Great Falls Diversion Dam and upstream of the Great Falls Headworks.

The previous water quality monitor mounted on the Duke Energy bridge immediately downstream of Great Falls and Dearborn Hydros is ideally located since it is in the center of the channel (Location 3). This position captures the water quality (temperature and dissolved oxygen) from both hydros and is in a secure location.

Rocky Creek-Cedar Creek



Map Location	Data	Recommended Location	Approximate Distance Downstream (miles)	Comments	Data Collection
1	Temperature Dissolved Oxygen	Downstream Face of Cedar Creek Powerhouse	0.00	*In Situ* - Pipe, Monitor Location Unchanged	Wired to Station Computer
2	Reservoir Levels	Cedar Creek Forebay	n/a	Current Device on the Intake Structure	Wired to Station Computer

<u>Device Location Rationale</u>

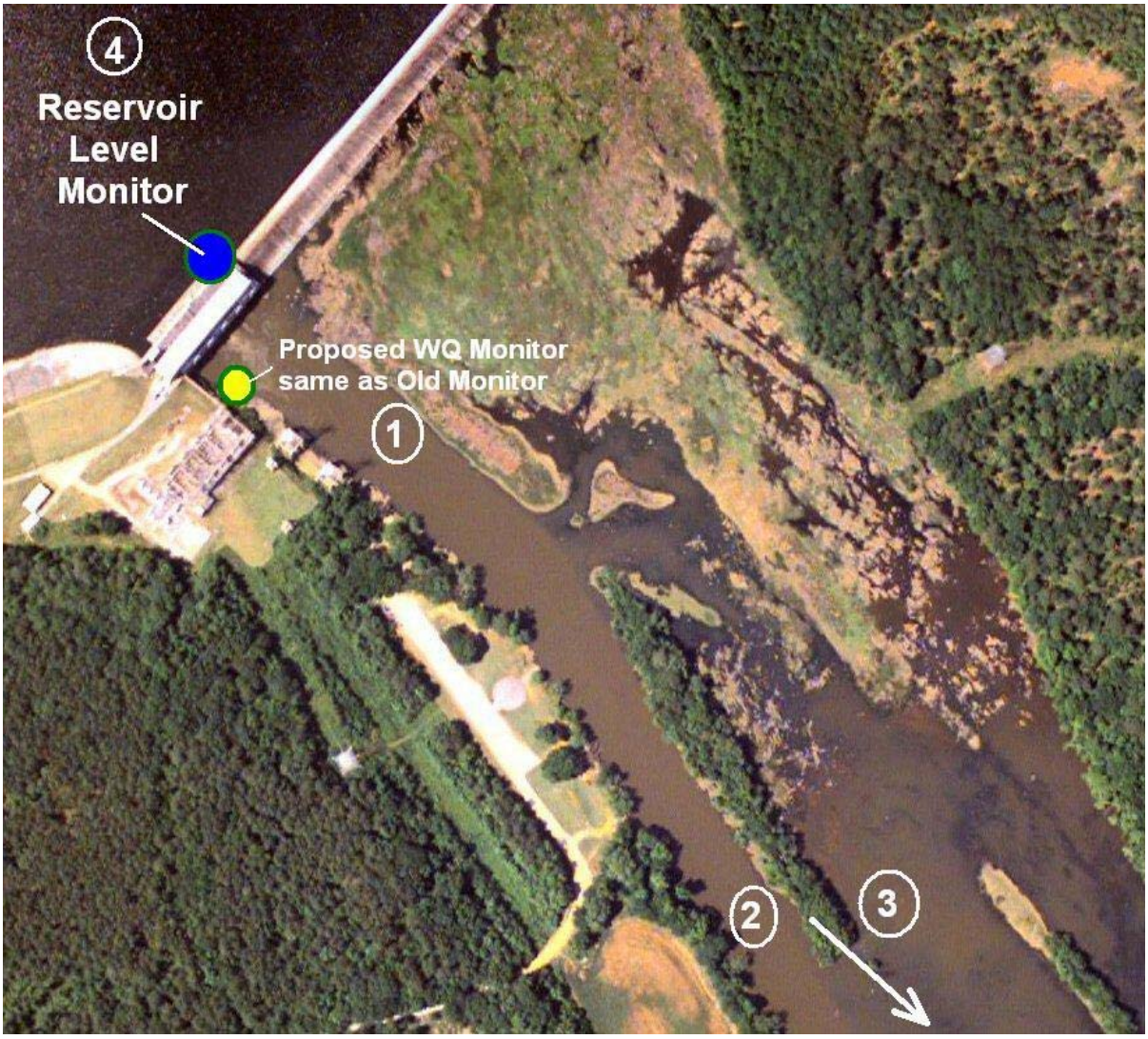
The previous water quality monitor is located in the center of the Cedar Creek tailrace. It was mounted directly on the powerhouse. Since the hydro units at Cedar Creek were identical, the temperature and dissolved oxygen monitor adequately measured the water quality released from Cedar Creek Powerhouse (Location 1).

The water quality of the Cedar Creek hydro flow represents the overall tailrace water quality since:

- Cedar Creek Powerhouse flow is significantly greater than Rocky Creek Powerhouse flow and dominates the downstream flow (capacity of Cedar Creek units is three times the capacity of the Rocky Creek units).
- Rocky Creek Hydro is operated infrequently; it is operated only after Cedar Creek Reservoir pond level cannot be maintained by Cedar Creek Hydro (three Units at Cedar Creek).
- Both hydros draw water from the same forebay and the water quality is similar.

Thus, no water quality monitoring device is necessary at the Rocky Creek Hydro. Unlike Great Falls-Dearborn, there is no structure downstream of Cedar Creek Powerhouse to mount a water quality monitor in the center of the channel.

Wateree



Map Location	Data	Recommended Location	Approximate Distance Downstream (miles)	Comments	Data Collection
1	Temperature Dissolved Oxygen	West Platform – Tailrace	0.02	Probably Flow-Through System Auto Calibration Sensor	Wired to Station Computer
2	Minimum Continuous Flows	Highway 1/601 USGS Gage	7.4	USGS Gage (Wateree River near Camden, SC) (02148000)	USGS Gage and Turbine Generation Records

Map Location	Data	Recommended Location	Approximate Distance Downstream (miles)	Comments	Data Collection
3	Recreational Flows Project Hourly Flows	Turbine Records Highway 1/601 USGS Gage	7.4	USGS Gage (Wateree River near Camden, SC) (02148000)	USGS Gage and Turbine Generation Records
4	Reservoir Levels	Wateree Forebay	n/a	Current Device on the Intake Structure	Wired to Station Computer

Device Location Rationale

The USGS gage at Highway 1/601(Location 2/3) is well-established and will be used for verification of minimum continuous flow, recreational flows, and hourly Project flows. Generation records will be used to supplement the USGS data.

The Wateree tailrace is a relatively simple channel, with the flows from the various hydro units moving directly downstream. However, the tailrace does not lend itself to simple water quality monitoring due to the various aeration capabilities of the individual hydro units and subsequent multi-unit flow patterns (Duke Power 2005a). Moving the monitor location downstream to capture a multi-unit flow is not an option because, at flows greater than provided by 2-3 unit operations, a significant volume of water flows out of the main channel to the east within a few hundred yards of the powerhouse.

The existing monitor location (Location 1) was built to extend a short distance into the tailrace with the goal of better measurements than at the face of the powerhouse. The existing monitor location is the best logistical location available to measure water quality because no structure exists in the center of the channel, nor is the east side of the channel a viable option because that area is heavily used by fisherman (creating damage and security issues) and is prone to flooding and further potential damage or loss.

The next available location at the Highway 1/601 Bridge is not suitable because of its distance from the Powerhouse and the presence of aquatic plants and shoals between the Powerhouse and bridge that significantly influence the DO levels.

2.3 System Requirements

The formulation of this plan was based upon the work by Wagner et al. (2000) and modified to meet specific monitoring objectives described in the FA. The basic components of the monitoring system are (1) sensors that measure the required parameter, either directly (e.g., dissolved oxygen) or indirectly (e.g., flow calculated from stage), (2) a means of getting the sensor data to an appropriate database, and (3) a database capable of meeting the operational and reporting requirements.

Data Collection

Real-time data[1] accessibility is the criteria driving the choice of the hardware and software requirements. Real-time data accessibility is needed for operations personnel

[1] Real-time data is defined as data that is immediately available upon sensor reading to the hydro operators. The operators then use that data to make decisions regarding plant operations.

to view, and, if necessary, adjust station operations to meet license requirements and conditions. Operators at each individual hydro, as well as at the Licensee's central operations center, will have access to all real-time sensor data and a software display indicating compliance status.

Database requirements include the ability to retrieve data for short-term evaluations of compliance as well as long-term retrieval for yearly reporting requirements.

Sensor Technology

General considerations and sensor options include:

1. General Requirements
    a. Digital for Real-time Communications
    b. Programmable Time Interval for Data Capture
2. Flow
    a. Continuous (pipe, flume, etc.)
    b. Open Channel (rating curve of stage/discharge)
    c. Supplemental manual gage
3. Water Quality
    a. Temperature only
    b. Temperature and Dissolved Oxygen
        (1) Polarographic
            - Membrane rate dependent
            - Membrane rate independent
            - Contained for auto calibration
        (2) Optical (Luminescence Quenching)(Mitchell 2006)

The Licensee is currently evaluating available technologies to provide accurate data while maximizing reliability and minimizing the maintenance required for calibration. The Licensee will propose sensor type, calibration, and maintenance in the QAPP. The evaluation of "new" equipment and technologies will no doubt be an ongoing process throughout the duration of the New License.

2.4 Reporting Requirements

Historic records indicate that dissolved oxygen concentrations have consistently exceeded state water quality standards during the winter months. Therefore, compliance monitoring for temperature and dissolved oxygen will commence on 1 April and end on 30 November each year during the term of the New License, unless additional monitoring is determined necessary by the state water quality agency (e.g., for extended low dissolved oxygen periods, unusual meteorological periods). Flows and reservoir levels will be recorded year-round.

Routine monthly data (hourly and daily averages in spreadsheet format) will be supplied for information purposes to NCDWQ and SCDHEC by the last day of the following month, (e.g., April data due 31 May) via electronic mail. Discrepancies or deviations from required flows, reservoir levels, or state water quality standards will be briefly noted, evaluated, and discussed. A more detailed assessment along with the corrective actions will be supplied in the annual report.

An annual report, summarizing the monthly reports for the previous calendar year will be filed with the appropriate agencies by June 30 of each full calendar year during the term of the New License (reference the proposed Water Quality Monitoring Plan License Article in the FA).

3.0 Supplemental Trout Habitat Monitoring

3.1 Monitoring

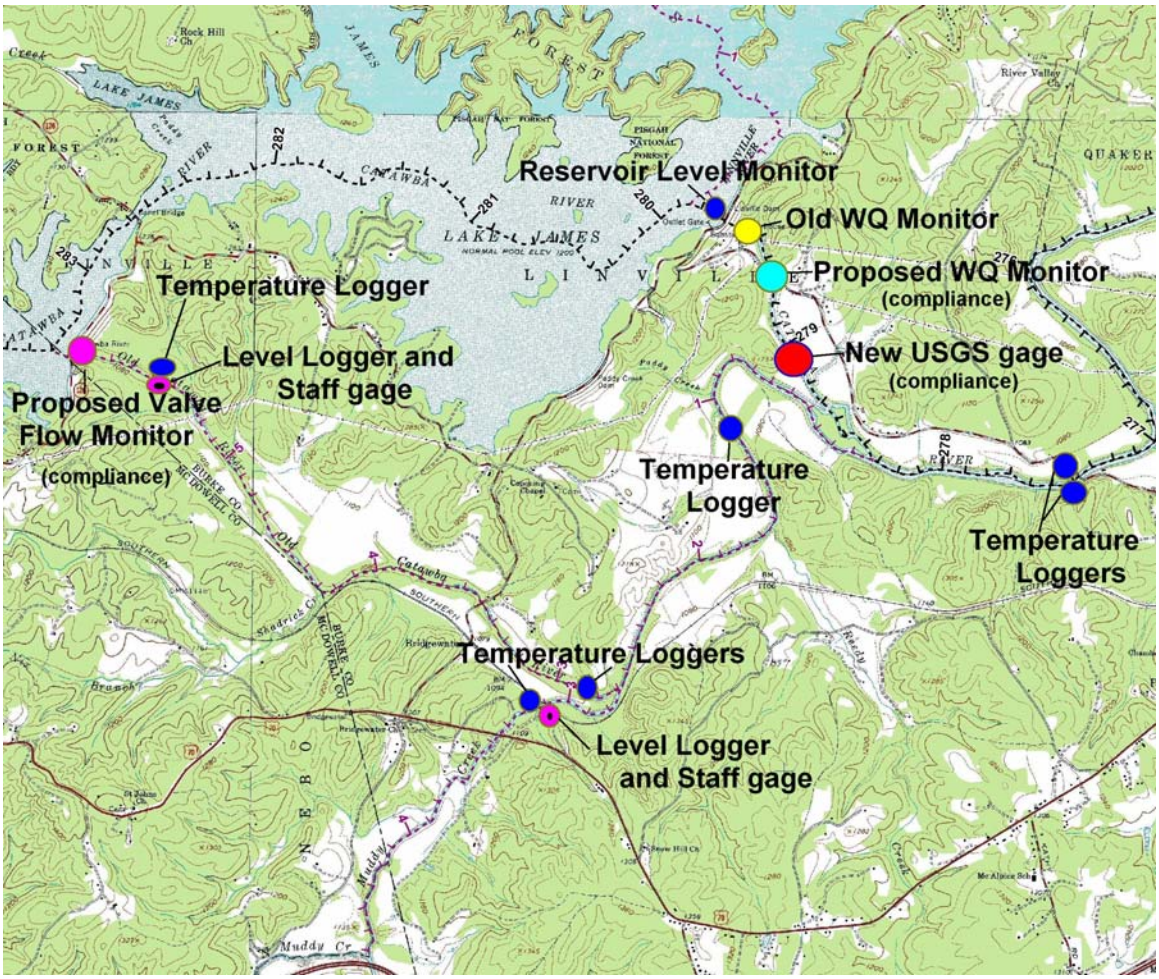
The Catawba River Bypassed Reach and Bridgewater minimum continuous flows have been selected and evaluated to provide flows and water temperatures suitable for protection and enhancement of mussels in the bypassed reach and the maintenance of a stocked trout fishery downstream of Bridgewater Hydro. The volume of warmwater flows provided to the Catawba River Bypassed Reach to maintain mussel habitat are balanced against the coldwater minimum flow from the Linville Dam to maintain suitable temperatures for trout downstream of the confluence of the Catawba River Bypassed Reach and the Linville River. The flows and temperatures provided to each channel to achieve the desired, but conflicting temperature requirements were analyzed by the CE-QUAL-W2 reservoir model and the River Modeling System (RMS). The results of these computer models were evaluated by the Aquatics/Terrestrial and Water Quality Resource Committees. Bypassed Reach and Linville Dam minimum continuous flows stated in the FA are the result of the recommendations from the evaluations by the resource committees.

Due to the hydraulic complexity and trout supplemental management interests in this area, supplemental monitoring will be used to support future evaluations of whether trout management goals in the mainstem Catawba River continue to be supported. This supplemental trout habitat monitoring will commence after the Bridgewater Powerhouse has been replaced with either a new powerhouse or valve system and compliance operations have begun and will continue through the next full NCDENR Catawba River Basinwide Assessment period, but not beyond Year 2019. Results of this monitoring may be used to determine if flow reductions need to be made in the Catawba River Bypassed Reach.

3.2 Sensor Locations

The temperature and level logger placement is designed to be able to record temperatures, flow (level logger with stage-discharge relationship) from the inflows, and empirically determine the temperatures at the appropriate downstream river reaches. An additional temperature and level logger will be provided at the Watermill Bridge (RM 271.7) in Glen Alpine, NC which is in the middle of the primary trout habitat.

Bridgewater Supplemental Trout Habitat Monitoring



3.3 System Requirements

Level loggers (devices to record river stage from which a stage-discharge relationship may be developed to calculate flow) and temperature loggers will be placed in the river and periodically downloaded to obtain the respective data. Stage-discharge curves will be developed at the level logger sites.

3.4 Reporting Requirements

Annual reports will be provided to NCDWQ and NCWRC (30 April) for the duration of the supplemental trout habitat monitoring detailing the previous calendar year's temperatures and levels. Flow-weighted temperatures will be calculated for the downstream sites.

4.0 Trend Monitoring of Water Quality Characteristics

4.1 Background

Dissolved oxygen deficits in the Project reservoirs have been shown to be related to organic and nutrient (nitrogen and phosphorus) loading (Duke Power 2005b). Increased organic and nutrient loadings to the system after the Licensee installs aeration

equipment designed to meet current deficits may impose additional oxygen deficits that the equipment was not designed to treat. To provide information to assess basin-wide growth and potential increased organic and nutrient loading, the Licensee will monitor trends in organic and nutrient concentrations to supplement state water quality databases. This monitoring is not required for compliance with the Section 401 Water Quality Certifications.

4.2 Sampling Locations

In cooperation with state agencies, the Licensee will identify sampling sites for future long-term organic and nutrient sample collections. Parameters collected will include total N, total P, nitrites, pH, dissolved oxygen, and temperature.

Hydro Tailraces

The Licensee will collect samples from the immediate tailraces at the time of routine maintenance and calibration of the water quality monitors.

Tributary Sites

Tributary sampling will focus on stream confluences draining major sub-watersheds into the Project reservoirs and downstream river sections. Tributary samples will be collected at the time of routine maintenance of tailwater monitors, but at least monthly.

The following tributaries will be monitored in North Carolina:

- Muddy Creek at Highway 70 (Burke Co.)
- Johns River at Highway 18 (Burke Co.) *
- Catawba River at Highway 18 (Burke Co.) *
- Lower Little River upstream of Confluence with Catawba River (Alexander Co.)
- Catawba Creek at SR 2435 (Alexander Co.)
- South Fork Catawba River at SSR 2201 (Gaston Co.) *

(* Three storm events will be sampled each year.)

The tributaries in South Carolina to be sampled will be chosen from the following list:

- Sugar Creek at SSR 36 (York Co.)
- Catawba River at Highway 9 (Chester and Lancaster Co.)
- Fishing Creek at SSR 77 (Chester Co.)
- Cane Creek at SSR 50 (Lancaster Co.)
- Rocky Creek at USGS Gage (Chester Co.)
- Big Wateree Creek at Highway 21 (Fairfield Co.)
- Beaver Creek at SSR 13 (Kershaw Co.)

4.3 Sampling Requirements

The samples will be collected and analyzed by state certified personnel and laboratories.

4.4 Reporting Requirements

Data derived from the long-term monitoring program will be stored electronically and reports provided as needed or requested by state agencies, such as to support the NCDENR's Catawba River Basinwide Assessment.

5.0 References

Duke Power. 2005a. *Catawba Hydros - Existing Aeration Capability and Downstream Aeration Tests*, Technical Report Series, Catawba-Wateree License. FERC No. 2232, Charlotte, NC.

Duke Power. 2005b. *CE-QUAL-W2 Calibration Reports*, Technical Report Series, Catawba-Wateree License. FERC No. 2232, Charlotte, NC.

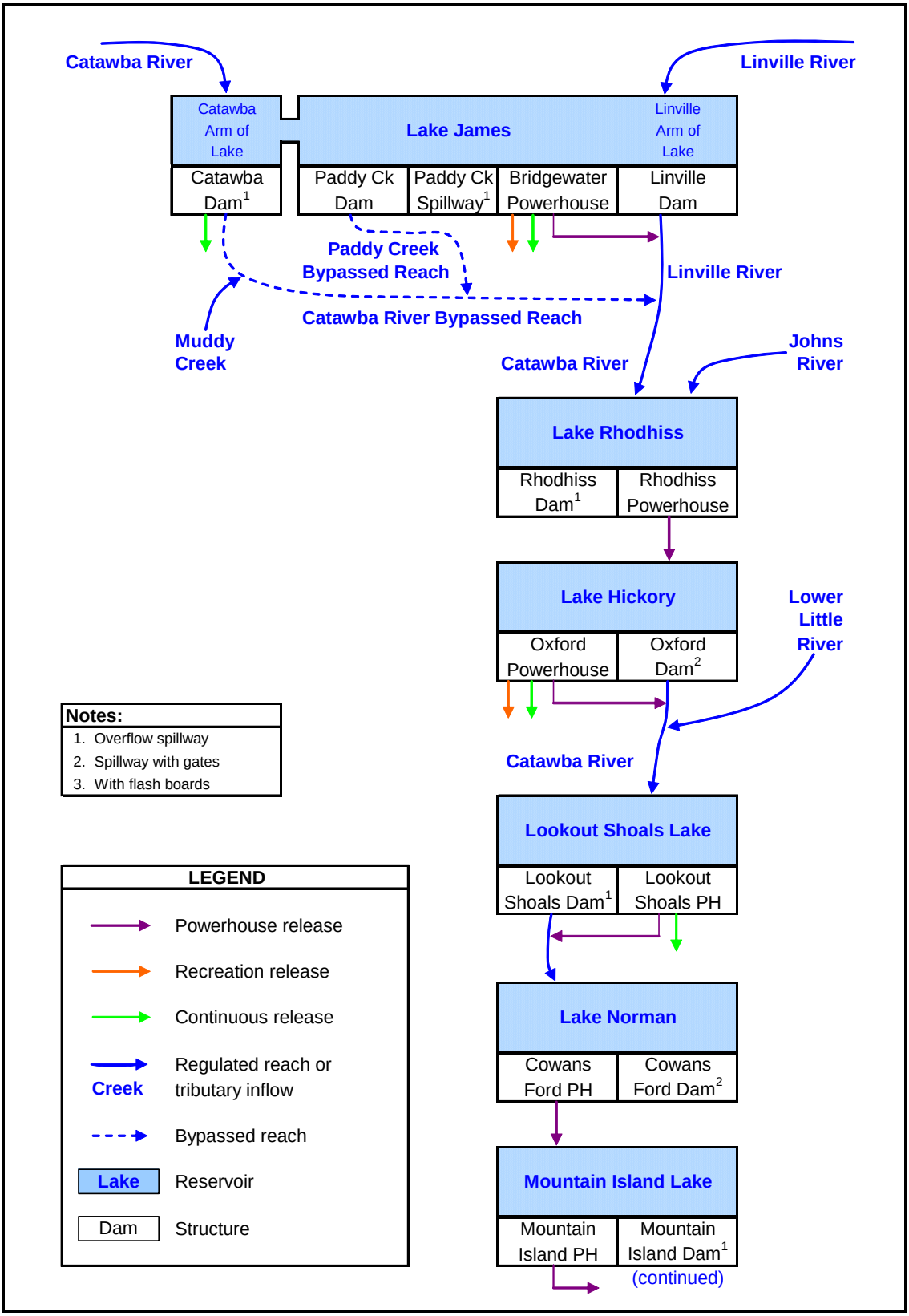
Knight, Jon, 2003. *Dissolved Oxygen Concentrations and Water Temperature from Bridgewater Hydroelectric Station*. Duke Power Company.

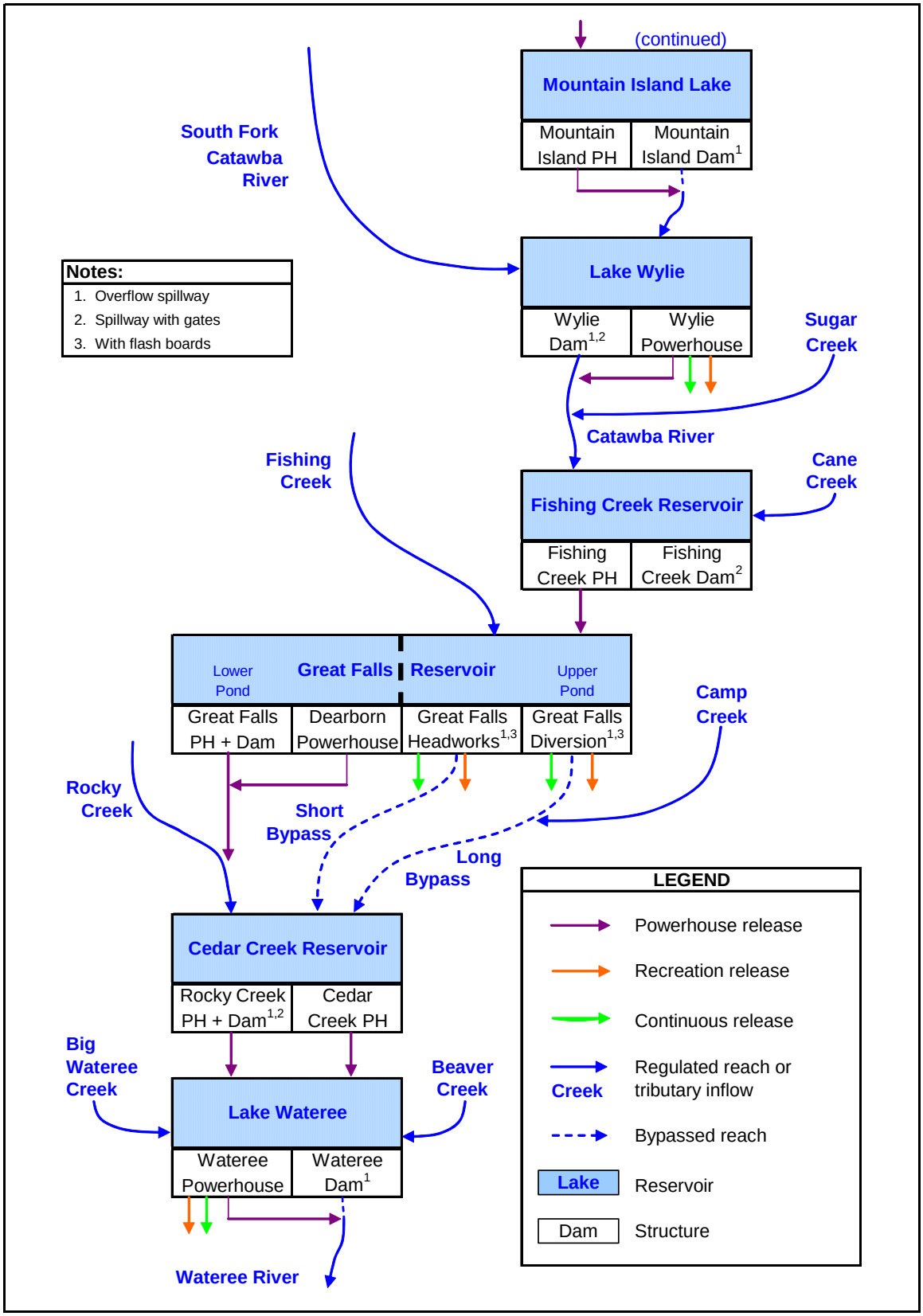
Mitchell, Thomas O. 2006. *Luminescence Based Measurement of Dissolved Oxygen in Natural Waters*. Hach Environmental. Loveland, CO.

Wagner, R.J., H.C. Mattraw, G.F. Ritz, and R.A. Smith. 2000. *Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation, and Reporting*. U. S. Geological Survey, Water-Resources Investigations Report 00=4252. Reston, Virginia.

United States Environmental Protection Agency. 2001. *EPA Requirements for Quality Assurance Project Plans.* EPA QA/R-5, EPA/240/B-01/003. USEPA, Office of Environmental Information, Washington D.C.

Figure F-1: Project Flow Routing Schematic




(continued)
Mountain Island Lake
Mountain Island PH
Mountain Island Dam1
South Fork Catawba River
Notes:
1. Overflow spillway
2. Spillway with gates
3. With flash boards
Lake Wylie
Wylie Dam1,2
Wylie Powerhouse
Sugar Creek
Catawba River
Fishing Creek
Cane Creek
Fishing Creek Reservoir
Fishing Creek PH
Fishing Creek Dam2
Lower Pond
Great Falls
Reservoir
Upper Pond
Great Falls PH + Dam
Dearborn Powerhouse
Great Falls Headworks1,3
Great Falls Diversion1,3
Camp Creek
Rocky Creek
Short Bypass
Long Bypass
Cedar Creek Reservoir
Rocky Creek PH + Dam1,2
Cedar Creek PH
Big Wateree Creek
Beaver Creek
Lake Wateree
Wateree Powerhouse
Wateree Dam1
Wateree River
LEGEND
Powerhouse release
Recreation release
Continuous release
Creek
Regulated reach or tributary inflow
Bypassed reach
Lake
Reservoir
Dam
Structure

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