DRAFT

ENVIRONMENTAL ASSESSMENT

For

Direct Impacts of the Proposed Jordan Lake Aeration System For the Cary/Apex Water Treatment Facility Chatham County, North Carolina

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1 Introduction

B. Everett Jordan Dam and Lake (Jordan Lake) is under the stewardship of the U.S. Army Corps of Engineers (USACE), Wilmington District. Jordan Lake was formed by the construction of the Jordan Dam, previously referred to as the New Hope Dam, on the Haw River in the Upper Cape Fear River Basin. The Dam is located in Chatham County, NC, approximately 4.2 miles above the mouth of the Haw River, 25 miles southwest of Raleigh, and 25 miles north of Lillington (Exhibit 1). The drainage area above Jordan Dam is 1,690 square miles and includes parts of Alamance, Caswell, Chatham, Durham, Forsyth, Guilford, Orange, Randolph, Rockingham, and Wake Counties. Jordan Lake covers an area of 13,940 acres at elevation 216 feet above mean sea level (AMSL), which is at the top of the conservation pool and the normal operating level.

Jordan Lake was authorized by Public Law 88-253, which was enacted by the 88th Congress on December 30, 1963 in accordance with the Chief of Engineers in House Document 508, 87th Congress. The Lake is authorized for flood control, water supply, water quality (low flow augmentation), fish and wildlife conservation, and recreation. Jordan Lake has a total conservation storage volume of 140,400 acre-feet. Water supply storage within Jordan Lake comprises 45,800 acre-feet, which provides an estimated water supply yield of 100 million gallons per day (mgd), and currently serves as a regional source of drinking water supply. The remaining conservation storage volume (94,600 acre-feet) is allocated to low-flow augmentation. The contract for construction of the dam and spillway was awarded in 1970. Filling of the reservoir began in 1981 and the Lake reached the normal operating level in February 1982. Maximum depth of the Lake is approximately 66 feet with a mean depth of 16.5 feet.

The National Environmental Policy Act of 1969, as amended (NEPA), requires consideration of the environmental impacts for major federal actions. This Environmental Assessment (EA) addresses a request for a proposed Jordan Lake Aeration System that would be located in the vicinity of the existing Cary/Apex Water Treatment Facility (CAWTF) raw water intakes (Exhibit 2). The Town of Cary (Town) proposes to implement the aeration system to address raw water quality concerns, particularly poorer water quality present at the lower Lake elevations. The Town has requested the use of land/water from the USACE and would operate and maintain the aeration system subjected to USACE approval. The purpose of this EA is to ensure the environmental consequences of the proposed action are considered and that environmental and project information are available to the public. This EA has been prepared in accordance with the National Environmental Policy Act of 1969, the Council on Environmental Quality (CEQ) regulations (40 CFR Parts 1500-1508), and Engineering Regulation 200-2-2.

1.1 Background

The Town operates and maintains the CAWTF located at 1400 Wimberly Road, Apex, NC. The Town of Cary jointly owns the CAWTF with the Town of Apex. The CAWTF commenced operation in 1993 and has been in compliance with regulatory standards since its opening. The water treatment plant is six miles from Jordan Lake.

The CAWTF provides water service to customers within the Towns of Cary, Morrisville, and Apex; Raleigh-Durham Airport; the Wake County portion of the Research Triangle Park; and the western portion of Wake County. The Town maintains interconnections with the City of Raleigh and City of Durham and mutual aid agreements with the City of Durham and Orange Water and Sewer Authority. The Raw Water Pump Station (RWPS) also supplies up to 3 mgd of raw water to Chatham County for subsequent treatment.

Two existing (54-inch) intakes in Jordan Lake supply raw water to the CAWTF via the RWPS. The existing raw water intakes were constructed under General Permit No. 198200079 as issued by the Operations Division of the USACE and are currently located at centerline elevations of 202 feet and 207 feet AMSL. Raw water is transferred from the RWPS to the CAWTF through dual raw water transmission lines located along US Highway 64. The RWPS is located on the east side of the Lake and north of US Highway 64. The existing RWPS and intake on Jordan Lake were constructed during the initial 16 mgd plant construction in 1993. The RWPS and treatment plant were expanded to 40 mgd in 2002 and an expansion to provide a total potable water treatment capacity of 56 mgd is currently in the design stage.

Jordan Lake is the sole raw water supply for the CAWTF. Jordan Lake has a total conservation storage volume of 140,400 acre-feet. Water supply storage comprises 32.62 percent of the conservation storage volume. The water supply storage volume is 45,800 acre-feet, which has an estimated 50-year safe yield of 100 mgd. Per G.S. 143-354(a)(11), the NC Environmental Management Commission (EMC) has assigned Level I and Level II Jordan Water Supply Storage allocations. The Towns of Apex and Cary have been granted a combined average day water supply allocation of 32 percent of the water supply pool, which is equivalent to an estimated 50-year safe yield of 32 mgd. RTP South and the Town of Morrisville have also been granted separate raw water supply allocations of 3.5% each, or 3.5 mgd each (7 mgd total). The total allocated raw water supply allocation for the CAWTF is 39 mgd. Chatham County has a Level 1 raw water supply allocation of 6%, or 6 mgd.

1.2 Project Study Area / Location

The project is located in Chatham County. Exhibit 1 shows a general location map of the project area, which is north of US Highway 64 and west of Farrington Road near the CAWTF raw water intakes and RWPS. This area falls within the Piedmont physiographic province, specifically in the Triassic Basin sub-region. The RWPS is situated adjacent to the eastern shore of Jordan Lake and is immediately north of US Highway 64 in Chatham County.

The study area includes the surface water of the northern sub-Lake of the Lower New Hope Arm of Jordan Lake, a launching area at the Crosswinds Marina at Jordan Lake and the RWPS (Exhibit 3). The study area is approximately 2,589 (4.05 square miles) acres in size.

2 Purpose and Need for Proposed Action

The purpose of the proposed Lake Aeration System is to assist with improving raw water quality for subsequent treatment at the CAWTF. The aeration system would also likely reduce the proliferation of algae blooms in the vicinity of the intake, reduce dissolved manganese and iron concentrations, reduce taste and odor issues, and improve the overall Lake quality in the area in which the intakes are located. Providing better Lake water would reduce energy demands, chemical treatment requirements and resulting waste residuals generated at the CAWTF. In addition, it would allow the Towns to continue to maintain their high levels of service in providing a reliable and safe drinking water to customers while holding down costs of treating the Jordan Lake supply and provide more flexibility to treat water during droughts.

When the Lake stratifies in the summer, the water quality in the hypolimnion (lowest layer in a thermally stratified Lake) is characterized by high dissolved manganese and iron concentrations, low pH, zero dissolved oxygen (D.O.), and elevated total organic carbon (TOC). The epilimnion, or upper layer, has large concentrations of blue green algae which generate tastes and odor compounds. This water is more difficult to treat at the CAWTF and can result in reduction of plant capacity due to additional chemical requirements, reduced filter run times, and increased waste residuals generated. Poor raw water quality places a greater burden on the CAWTF to comply with the Safe Drinking Water Act (SDWA).

Stratification is even a greater concern during droughts as Lake levels drop and water quality often deteriorates. When Lake levels are lower - typically from drought or increased releases from the dam - the Towns have to use the lower intake. Severe droughts were experienced in 2002 and 2007 and there is concern that droughts may become a more frequent occurrence due to changing climate factors.

The frequency and magnitude of poor water quality can also be impacted by excessive nutrient loadings resulting in eutrophication. Jordan Lake is listed as impaired on the 303 (d) list for chlorophyll-a violations and high pH and has also been classified by the EMC as a Nutrient Sensitive Water (NSW). Excessive nutrients and resulting eutrophication can deplete D.O. concentrations within the lower portions of the Lake, further contributing to poor raw water quality conditions for drinking water treatment.

Recommended improvements of the CAWTF expansion to 56 mgd, which are currently in the design phase, include modifications to the raw water intakes to improve the reliability of the sole water supply should future drought conditions result in lower than currently predicted operating levels. The recommended improvements include lowering the elevation of the existing bottom intake back to its original elevation of 197 feet AMSL and installing a new emergency level intake that would be located at an approximate centerline elevation of 185.5 feet AMSL. There are concerns that recurring droughts, climate change, and future withdrawals from the Lake from other users may increase variability of Lake operating levels and result in more frequent use of the existing lower intake which typically experiences poorer raw water quality conditions.

Jordan Lake is congressionally authorized for the purposes of flood control, water supply, water quality (low flow augmentation), fish and wildlife conservation, and recreation (Table 1). Maintaining Jordan Lake as a reliable regional water supply is consistent with the congressionally authorized purposes of the Lake.

TABLE 1. Jordan Lake Congressionally Authorized Uses

Authorized Purpose	Public Law	Statute	Date	Common Name
Flood Control	PL 88-253	77 Stat 840	Dec. 30, 1963	River Basins, Flood Control
Water Supply	PL 88-253	77 Stat 840	Dec. 30, 1963	River Basins, Flood Control
Water Quality	PL 88-253	77 Stat 840	Dec. 30, 1963	River Basins, Flood Control
Fish/Wildlife	PL 88-253	77 Stat 840	Dec. 30, 1963	River Basins, Flood Control
Recreation	PL 88-253	77 Stat 840	Dec. 30, 1963	River Basins, Flood Control

3 Alternatives

As part of the preliminary evaluation phase of the CAWTF Phase III Expansion, the Town evaluated how to effectively address raw water quality concerns, particularly poorer water quality present at the lower Lake elevations which may need to be used more frequently in the future as a result of more frequent drought events. A Lake Aeration System was identified as the best low-cost alternative for addressing poor raw water quality (HDR 2010). Objectives and benefits gained through implementation of a Lake Aeration System include:

- Reduce filter clogging algae production to achieve longer filter runs and produce less waste at the CAWTF.
- Reduce blue green algae production, which would reduce taste and odor issues and chemical requirements (powder activated carbon and ozone) to address taste and odor issues.
- Oxidize soluble iron and manganese, which would reduce ozone demand at the CAWTF.
- Minimize water quality variability, which would improve reliability during maximum demand periods at CAWTF.
- Provide more flexibility to operate both existing raw water intakes.
- Lower operating costs by reducing chemical requirements, energy demands, and peak residuals production rates.
- Reduce or lower stratification zone and increase D.O. in the Lake, which would improve aquatic habitat.

Lake Aeration Systems have been used in similar applications to address algal and/or stratification related poor water quality conditions. Lake Aeration Systems can generally be categorized as destratification systems, hypolimnetic aeration systems, or epilimnetic aeration systems. Destratification systems mix throughout the depth of the water column, lowering or eliminating the temperature thermocline. Hypolimnetic aeration systems are aimed at aerating within the hypolimnion region of water body while preserving the temperature thermocline. Epilimnetic aeration systems are intended to limit aeration to within the epilimnion region of the water body. There are various systems that achieve destratification, hypolimnetic aeration, and epilimnetic aeration using different approaches. Three alternative destratification systems were evaluated as part of the CAWTF Phase III Expansion Preliminary Engineering Report (PER) (HDR 2010). Based on this alternatives evaluation, a mechanical destratification system was identified as the preferred alternative.

This alternatives evaluation presents alternative destratification systems considered as part of the PER, and compares these systems to the no action alternative. This alternatives evaluation also describes hypolimnetic aeration systems and epilimnetic aeration systems and why these do not meet the project purpose and need. The alternatives evaluation presents the following alternatives:

- No Action
- Artificial Circulation via Bottom-Mounted Diffused Aeration System
- Hypolimnetic Aeration Systems, including Oxygen Injection and Air Injection Systems
- Mechanical Aeration System, including both Upward Circulation Systems (Solar Bee System) and Downward Circulation System (WEARS system)

3.1 No Action

Jordan Lake is the sole raw water supply for the CAWTF. To improve raw water quality, a Lake Aeration System is recommended. Not installing a Lake Aeration System (No Action Alternative) would not address the poor water quality that historically occurs when the Lake stratifies and could result in increased taste and odor issues, high dissolved iron and manganese levels, increase in chemical consumption and residuals generation, reduced treatment efficiency, and increased risk of SDWA violations at the CAWTF during periods of poor water quality. There are also concerns that recurring droughts, climate change, and future withdrawals from the Lake from other uses may increase variability of Lake operating levels and result in more frequent use of the existing lower intake which typically experiences poorer raw water quality conditions.

Additional treatment systems would need to be implemented at the CAWTF to accommodate poor raw water quality. In the CAWTF Phase III Expansion PER, additional treatment requirements were outlined for treating poorer quality water at the plant as compared to using a Lake Aeration System. A cost comparison of these options is presented in Table 2 and demonstrates that Lake management is a more cost-effective strategy for addressing poor raw water quality than providing additional treatment systems at the CAWTF for accommodating poor raw water quality. It is therefore concluded that the No Action Alternative does not meet the project purpose and need.

TABLE 2. Treatment Alternatives to Address Poor Water Quality at CAWTF Compared to a Lake Aeration System

Measure	Construction Costs	Comments
Raw Water Management Option		
Lake Aeration System and Intake Management	$2M	Reduced Operating Costs
CAWTF Liquid Treatment Management Options		
MIEX Ion Exchange	$14.2M	High Operating Costs
Expanded Chemical Feed Facilities	$11.8M	High Operating Costs
GAC Contactors	$15.3M	High Operating Costs
Ozone / Biofiltration	$6.9M	Requires Lake Aeration System for Mn reduction or Mn contactors

$M = Million Dollars

3.2 Artificial Circulation via Bottom Mounted Diffused Aeration System

This alternative considers use of a bottom mounted diffused aeration system that would artificially circulate the Lake, resulting in destratification. Air injections systems are one of the most common methods for destratification. In this system, a compressor located on the shore provides air to diffusers placed on or near the Lake bottom. The air bubbles cause the colder water in the hypolimnion to rise into the epilimnion. Because the colder water has a higher density, it will sink back down, mixing with the warmer water in the epilimnion.

Figure 1 shows a proposed layout of laterals for a bottom mounted diffused aeration system by General Environmental Systems. This system was considered during the evaluation of alternative systems completed as part of the CAWTF Phase III Expansion PER (HDR 2010). An alternative bottom mounted aeration system was also proposed by Aqua Sierra Inc. during project scoping for the EA (Appendix B). Aqua Sierra's proposed system included a bottom mounted diffused aeration system coupled with an ozone injection system. The proposed diffuser layout is similar to the bottom-mounted system presented in Figure 1 and capital costs were also found to be similar to the previously developed alternative. Therefore, Aqua Sierra's proposal was considered within this alternative.

The primary advantage of a bottom-mounted system is that it minimizes impacts to boaters. However, to be effective, the aeration system must cover a large area around the intake to account for current patterns in the Lake. Therefore, this system requires a much larger construction area and easement area in comparison to the preferred alternative.

FIGURE 1. Example of Bottom-Mounted Diffuser Layout

A bottom mounted diffused aeration system would achieve similar water quality benefits in comparison to the preferred alternative and has a similar present worth cost to the preferred alternative. Water quality benefits would include increased D.O. concentrations at the lower levels of the Lake, reduced dissolved iron and manganese concentrations, and reduced algal growth. However, the upward flow pattern generated by a bottom-mounted diffuser has the potential for poor raw water quality to be brought to the surface during initial start-up. In addition, improperly sized systems have the potential to increase turbidity, phosphorus concentrations, and algal blooms (Cooke and Carlson 1989, USEPA 1988).

Another major disadvantage of a bottom-mounted diffuser is that it is more difficult to access for maintenance than a surface aeration system. In addition, maintenance for this system is anticipated to be higher in comparison to a surface aeration system. On-going maintenance of diffusers is required to address fouling that occurs over time. Snagging of the diffuser lines by fishing lines and anchors is also a potential concern. Additional maintenance of the diffusers may result from snagging damage.

For these reasons outlined above, it is concluded that the surface aeration system (ResMix™ system described in Section 3.5) is preferred to a bottom-mounted diffused aeration system.

The advantages and disadvantages of this alternative are summarized as follows:

Advantages	Disadvantages
Provides oxygen to the lower portion of the lake reducing levels of dissolved iron and manganese, and other problem constituents in the hypolimnion.	Consumes more power than other options.
Bubble aeration would help break the stratification layer reducing the proliferation of algae blooms.	Diffuser lines can be snagged by fishing lines.
Air diffusers mounted on the bottom do not interfere with boaters. Aeration compressors and equipment are mounted on the shore.	System would require substantial on-going maintenance.
Diffusers can be floated for maintenance.	Only improves the water quality in the immediate vicinity of the intake.
Lowest capital cost	Flow pattern from hypolimnion to epilimnion increases concern for poor water quality being brought to the surface during initial start-up.

3.3 Hypolimnetic Aeration via Oxygenation / Aeration

Several studies have shown that hypolimnetic aeration can increase D.O. in the hypolimnion through diffusion and bubble aeration. Oxygen can be introduced using either a compressed air system or pure oxygen system.

Hypolimnetic aeration systems are designed to aerate only within the hypolimnion and do not achieve destratification. Hypolimnetic aeration can be achieved using both oxygen and air injection systems and there are several different types of systems that have been installed.

An example of a full or partial air lift system is shown in Figure 2. This system typically includes a vertical riser tube, a diffuser, an air-water separation chamber at the top of the riser, and one or two return pipes. Water is pulled in from the bottom of the water column, oxygenated in the tube and recirculated back to the hypolimnion.

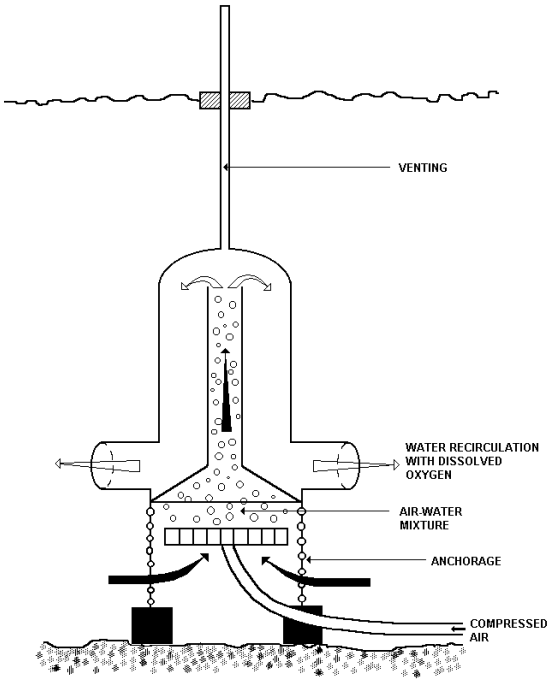

FIGURE 2. A typical air lift system (Hudnell 2009)

An example of a hypolimnetic aeration system using pure oxygen is illustrated on Figure 3. This aeration system, referred to as the ECO2 Superoxygenation system, uses a conical contact chamber to transfer oxygen to water pumped from the hypolimnion to the contact chamber.

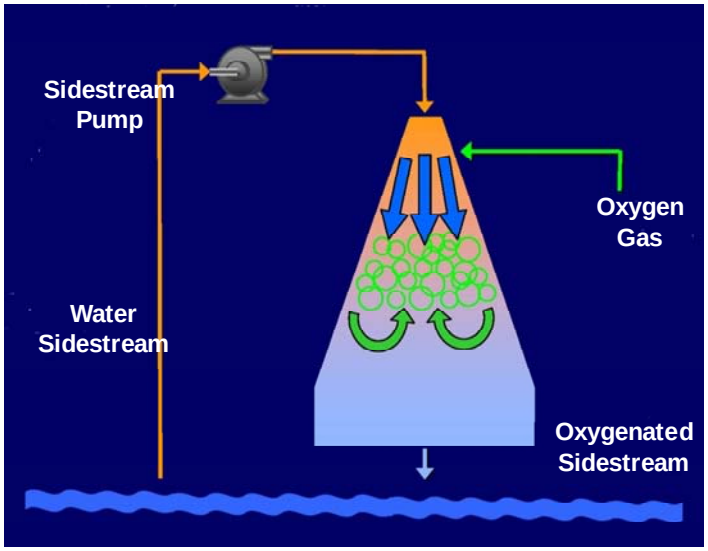

FIGURE 3. Speece Cone (Source:http://www.eco2tech.com)

Bottom-mounted diffusers can also be used to achieve hypolimnetic aeration. These systems must use smaller bubbles so that the oxygen is completely dissolved before reaching the epilimnion. If the bubbles are too large, destratification will occur.

The primary advantage of a hypolimnetic aeration system is that it does not eliminate the temperature thermocline within the water column and improves habitat for cold water fisheries by increasing D.O. concentrations within the hypolimnion. Hypolimnetic aeration systems have been shown to be effective in increasing D.O. concentrations in the hypolimnion and reducing poor water quality constituents associated with low red-ox conditions, such as elevated dissolved iron and manganese concentrations. However, because hypolimnetic aeration systems do not achieve mixing within the entire water body, these systems do not reduce algal growth and therefore do not address taste and odor and water treatment issues associated with blue green algae blooms.

Hypolimnetic aeration systems require a sufficiently large hypolimnion to work effectively (USEPA 1988). They are most commonly used in deep, cold-water reservoirs to improve habitat for cold-water fisheries or improve raw water quality of cold water intakes.

Fish species present in Jordan Lake, as noted by North Carolina Wildlife Resources Commission (NCWRC) in its September 2011 scoping comments, are characterized as warm water species (Appendix B). In addition, Jordan Lake is considered a medium depth reservoir and does not have a significantly large hypolimnion. Further, the CAWTF intakes are located at various depths within the water column, making it more desirable to achieve water quality improvements across the water column than just within the hypolimnion. Finally, because hypolimnetic aeration systems do not impact blue green algal growth, these systems would not address taste and odor issues associated with blue green algal blooms and do not fully address the purpose and need for the proposed Lake Aeration System. For these reasons, hypolimnetic aeration systems are not considered the appropriate technology for the project area.

The advantages and disadvantages of this alternative are summarized as follows:

Advantages	Disadvantages
Provides oxygen to the lower portion of the lake reducing levels of dissolved iron and manganese, and other problem constituents in the hypolimnion.	Does not address blue green algal growth and associated taste and odor issues
For cold water reservoirs, increases habitat for cold water fisheries	Better suited for deep reservoirs with large hypolimnion
Bottom mounted technologies result in lower interference with boaters in comparison to floating mixers. Aeration compressors and equipment are mounted on the shore.	Does not address water quality concerns in the epilimnion
	Does not fully address project purpose and need

3.4 Mechanical Aeration using Solar Bee Aeration System

An alternative mechanical aeration system to the preferred alternative is the Solar Bee System. An example of the Solar Bee System is shown in Figure 4. This system consists of a floating, solar powered unit with a mixer and intake hose. The intake hose is used to establish the aeration depth. Water is pulled from the intake hose up through the mixer, so water flows in an upward direction. The intake hose can be placed at a shallower depth to provide aeration only within the epilimnion or at a lower depth within the hypolimnion to increase the D.O. concentrations at the lower depths of the reservoir. Because of the mixing mechanism employed, the hypolimnetic mixing may result in lowering of the epilimnion or partial destratification.

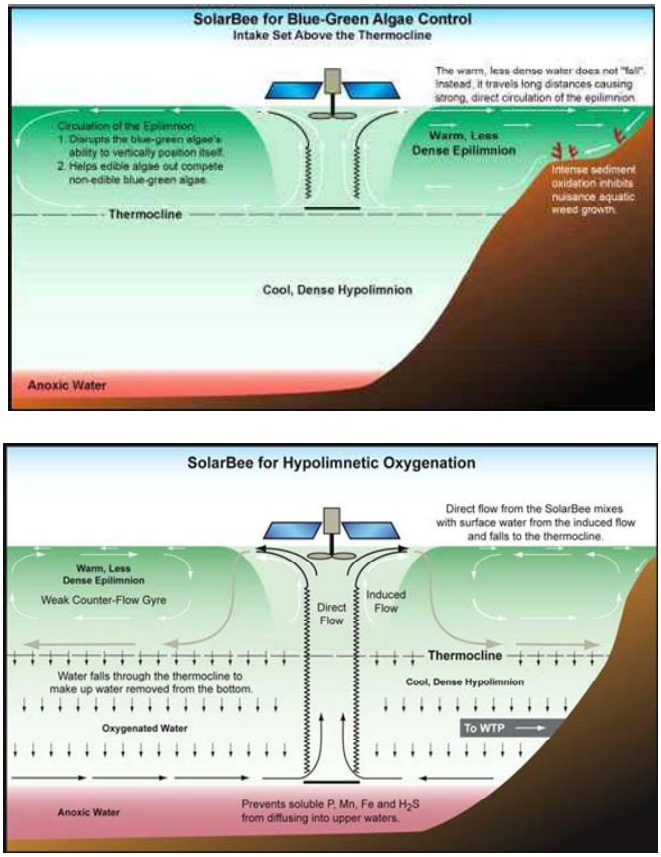

FIGURE 4. Solar Bee operation (Source:http://www.solarbee.com)

This system was not selected as the preferred alternative because it would require an estimated 20 floating aerators in the Lake, resulting in significantly higher navigational and recreational impacts in comparison to the proposed alternative. In addition, there are concerns with poor water quality being brought to the surface with the flow pattern.

A summary of the advantages and disadvantages of the Solar Bee System follows.

Advantages	Disadvantages
Mixes both the epilimnion and the hypolimnion.	Requires 20 mixers to achieve needed aeration.
Destratification of the Lake would reduce the proliferation of algae blooms and improve overall Lake quality in the sub-Lake in which the intakes are located.	Would cause significant interference to boat traffic.
Lowest energy cost for active Lake quality improvements alternatives by use of solar energy.	Flow pattern from hypolimnion to epilimnion increases concern for poor water quality being brought to the surface during initial start-up.
Aerators can be accessed for maintenance.	

3.5 Proposed Action

The proposed aeration system is a mechanical aeration system that would destratify the Lake by slowly circulating aerobic water from the surface to the lower portion of the Lake, which would help to reduce dissolved iron and manganese concentrations and other problem constituents in the hypolimnion and improve raw water quality for subsequent treatment at the CAWTF. Destratification of the Lake with the proposed mechanical aeration system would also likely reduce the proliferation of algae blooms near the intakes and improve the overall Lake quality in the portion of the Lake in which the intakes are located.

The recommended Lake Aeration System is the ResMix™ System, manufactured by WEARS Australia. The ResMix™ system uses draft tubes to circulate oxygen rich water from the surface of the Lake at a low velocity downward into the oxygen poor Lake depths. Figure 5 shows an example of the aeration action that occurs with the proposed ResMix™ system. Through axial flow pumps, the system circulates oxygen-rich surface water from the epilimnion to the hypolimnion. The water passes through the draft tube at a variable rate with a maximum velocity of approximately 0.67 feet/second (ft/sec), which is similar to the NCWRC recommended 0.5 ft/sec maximum allowable velocity for intake screen systems (Appendix B) and below North Carolina Department of Environment and Natural Resources' (NCDENR) maximum allowable velocity of 0.83 ft/sec for raw water intakes in reservoirs (15A NCAC 18C .0602). The higher D.O. water from the surface in a stratified Lake is less dense than the lower D.O. water present within hypolimnion; thus, the higher D.O. water will return back to the surface, creating the aeration pattern shown in Figure 5. This process results in gradual lowering and/or elimination of the thermocline through the mixing of the higher D.O. water with the lower D.O. water. Because the process relies on density differentials of the high and low D.O. water, the process does not result in higher density, low D.O. water being brought to the surface at start-up. The flow pattern results in an increase in D.O. concentrations within the hypolimnion and improvement in water quality in the hypolimnion.

Because the ResMix™ System is designed to simulate natural reservoir circulation, this system does not result in a sudden shock loading or poor water quality being brought to the surface and therefore avoids odor issues associated with this poor water quality being brought to the surface (WEARS 2012a).

The mixing pattern generated by the ResMix™ System has also been shown to reduce algal populations and reduce or eliminate high level algal blooms (Queensland Government Environmental Protection Agency 2003 and WEARS 2009). The downward circulating pattern results in algae spending more time at lower depths away from sunlight needed for growth and thus disrupts the growth cycle. Because of the circulating pattern, algal populations tend to be highest in the immediate vicinity of the mixing system but with a net reduction of algal growth achieved throughout the aeration area. The area of influence for this project is expected to be the entire sub Lake located between US Highway 64 and Farrington Road bridge crossings. WEARS reports that their experience shows that, with ResMix™ System operating, biomass, including zooplankton species, are more balanced with no individual organism dominating. This system is therefore expected to result in a net decrease in algal growth within the subbasin and not cause algal blooms getting pulled into the intake area (WEARS 2012b).

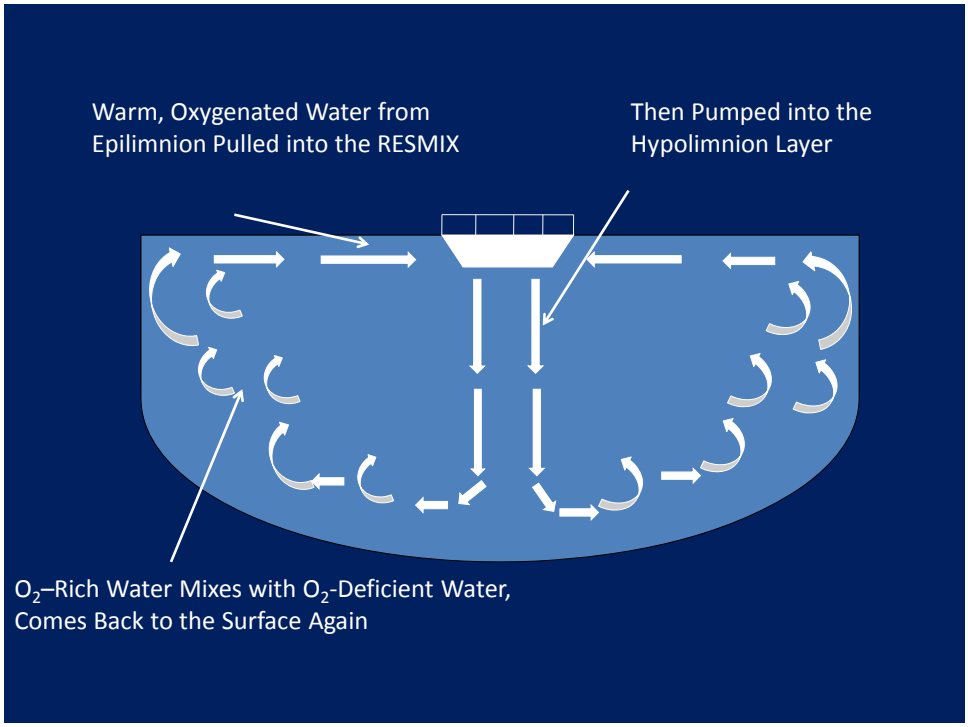

FIGURE 5. D.O. Aeration Pattern for Proposed Destratification System

The proposed ResMix™system would be comprised of two aerator systems that would circulate oxygen rich water from the surface of the Lake to the oxygen poor Lake depths resulting in better circulation in the Lake for overall improved water quality. The proposed system consists of two floating platforms located approximately 100 feet apart (Exhibit 2) and approximately 2,500 feet from the existing RWPS. Each platform contains two 15-feet diameter aeration units located approximately 12-feet apart from each other. Each aerator would be equipped with an 7.5 horsepower (HP) electric motor driven by a

variable frequency drive. Other components of the aeration system include a connecting walkway between the two aeration units, aeration pumps, a standing platform, baffle curtains, anchoring cables, anchoring concrete blocks, and a power supply.

Each aeration pair would be anchored to the Lake bottom with four to six anchoring cables which would be connected to concrete anchors on the Lake bottom. The floating platform therefore moves with the operating water level. The typical weight of each concrete anchor is approximately 125 pounds (lbs) (approximately 1-foot x 1-foot x 1-foot concrete block). Anchor requirements would vary based on Lake bottom conditions, weight, and design wind conditions. The anchor size and weight would be determined during final design. The anchor system can be designed to accommodate sudden rises in the water level, as might be expected during a significant rain event. WEARS reports that they have existing ResMix™ installations where the water level rises and falls over 70 feet.

Exhibit 4 shows an example layout of one of the proposed aeration pair system. Figure 6 shows a picture of a similar aeration pair system. Figure 7 illustrates a typical draft tube / skirting for an aeration unit.

FIGURE 6. Typical WEARS Aeration Pair System

FIGURE 7. Example of Typical Draft Tube / Skirting for Proposed Aeration Unit

Power would be supplied to the aeration system via the RWPS. Two construction options for the submersible cable include surface lay or burial in a trench. Survey and geotechnical borings would need to be conducted for the proposed route to determine Lake bottom conditions and identify any potential obstructions to the proposed cable route. The appropriate construction method and cable type depend on Lake bottom conditions. If soil conditions are such that the submersible power cables can not be pushed into the lakebed and no obstructions are present, then surface lay of a submersible cable would be recommended. Surface lay of submersible cables have been used in other WEARS aeration system applications. If trenching is required and soil conditions are found to be soft, then the cable can be pushed into the soil. If conditions allow, the soil can also be softened prior to pushing the cable into the soil. For harder soil conditions, the trench must be dug, which can be completed using a dredge or marine trencher. If rocky conditions do not allow for trenching, then a surfaced lay armored cable would need to be installed.

A temporary assembly and launching area would be required to assemble the aeration systems and for launching the systems with a crane into the Lake. The estimated temporary assembly/launching area requirement is 100 feet x 100 feet. The proposed assembly/launching area is the marina located northeast of the existing RWPS site. The temporary assembly/launching areas are shown on Exhibit 2. The marina was used previously for temporary launching of construction equipment in 2002 associated with raising the existing lower raw water intake unit. The existing RWPS site was considered as a potential assembly/launching area but was found to be unsuitable due to steeper grades along the perimeter of the site, insufficient area, shallow water in the area of the shore line, limited access for the crane, and removal of trees for access to the Lake.

The Town of Cary has requested approximately 60,000 square feet (1.4 acres) for the proposed aeration system to be added to their existing easement on government property. Approximately 0.8 acre of the requested easement would include areas for the aeration units, the anchoring cables, the concrete anchors, the submersible electrical cable, and a buffer area for establishing a no boating or recreational

activities area around the aeration units. The remaining 0.6 acre of easement area was requested for a maintenance corridor to access the submersible electrical cable. The estimated easement area for the submersible electrical cable is based on a 10-feet wide easement along the length of the cable and 2,500 feet distance between the RWPS and the aeration system location.

A feature of Jordan Lake that affects how it would be mixed is the way that US Highway 64 and Farrington Road cross the Lake. These roadways are built on fill with 100 yard openings located at the previous river channels to allow for boat travel and flow. The effect of these road fills is to create four separate, smaller sub-Lakes. To improve water quality at the intakes, only the sub-Lake north of US Highway 64 and west of Farrington Road would need to be mixed. The approximate area of this sub-Lake is 2,587 acres with an estimated normal volume of 60,000 acre-feet.

The proposed location of the recommended system is based on placing the aerators over the Old New Hope River channel, where the bottom elevation is the lowest in this portion of the Lake. This proposed location is recommended based on where the aeration system would be most efficient and effective in terms of number of aeration units required and providing sufficient vertical mass flow rate to maintain momentum to effectively increase D.O. concentrations throughout the water column. Oxygenation is a function of the mass flow rate; if the vertical velocity is reduced to accommodate shallow depths then more units would be required to produce the same flow rate. Alternative locations outside of the old river channel are considered less desirable due to shallower depths, which could increase disturbance in bottom sediments, and may result in the need for additional aeration units. In addition, locations closer to the raw water intake are less desirable due to the potential for algae and sediment carryover to the raw water intake and less time for oxidation of iron and manganese following aeration.

The recommended spacing of the two aeration units is based on ease of anchoring; minimizing the footprint of the system; reducing the power cable run; selecting a site relatively close to power supply; reducing recirculation by selecting a deeper zone and; maximizing vertical flow and aeration efficiency (WEARS 2012c).

It is anticipated that the proposed Lake Aeration System could be operated continuously (year-round). The most critical operational period would generally occur between April and October when poorer raw water quality conditions historically occur. Once installed, the Town would further evaluate the benefits of operating the system year-round compared to seasonally.

The advantages and disadvantages of the proposed alternative are summarized as follows:

Advantages	Disadvantages
Provides aerobic water from the surface to the lower portion of the Lake reducing levels of dissolved manganese, and other problem constituents in the hypolimnion, which would improve treatment reliability at CAWTF.	Does provide some limited interference to boaters.
Destratification of the Lake would reduce the proliferation of algae blooms and improve overall Lake quality in the sub-Lake in which the intakes are located.	One installation in the U.S. to date in a smaller reservoir. All other installations are overseas.
Small footprint minimizes impacts to boaters.	Single submersed electrical cable to power units.
Aerators can be accessed for maintenance.	
Lower energy cost compared to bubble aeration.	
Reduce or lower stratification zone and increase D.O. in the Lake, which would improve aquatic habitat.	

Several WEARS mixing systems have been installed in Australia and Europe to improve water quality conditions. The mechanics and principles of the WEARS mixing systems are the same whether installed in cool or warm climate applications and the system would be expected to perform similarly in Jordan Lake compared to these other applications. Water quality data available from these installations was provided by the manufacturer and is included in Appendix A.

4 Environmental Effects

4.1 Physical Environment

Construction of the proposed project would have minimal adverse impacts to the physical environment. Best management practices would be used to avoid adverse impacts during construction and the overall purpose of the project is to improve water quality. The effects of the proposed project on the physical environment are discussed in the following section and summarized in Section 4.4.

4.1.1 Geology

The study area lies within the Triassic Basin (Griffith et al 2002). The entire study area is located in the Durham-Sanford sub-basins of the Triassic Basin, which is characterized by compacted sediments that include sandstone, siltstones, shale, and conglomerates (NCGS 2007). These sedimentary rocks formed about 200-190 million years ago when a land west of the Jonesboro fault, produced a large trough known as the Durham-Sanford Basin and erosion in the higher areas produced sediment which accumulated in the trough. Mayodan, Creedmoor, and White Store soils occupy the largest area of the

basin (Daniels et al 1999). The proposed project would not affect any geological aspects within the study area.

4.1.2 Topography

The study area is located on the Farrington, Green Level, Merry Oaks, and New Hill United States Geological Survey topographic quadrangles (USGS 1993) in Chatham County. This county lies within the Piedmont physiographic region of North Carolina, which is characterized by gently rolling topography in the uplands and moderately steep slopes along the major drainages; however, the Triassic Basin tends to have wider stream valleys, less local relief and elevation, and more erodible soils. Elevations within the study area range from 180 feet AMSL within Jordan Lake to 238 feet AMSL at the RWPS built-upon area.

The temporary grading and excavation associated with construction and installation of the aeration system would be returned to pre-construction contours. The proposed project would not affect topography within the study area.

4.1.3 Soils

The Creedmoor-Green Level complex (CrB/CrC) soil series is the dominant soil type within the study area (Exhibit 5) according to the Natural Resources Conservation Service Soil Survey of Chatham (Hayes 2006). Other soil types found within the study area are listed in Table 3.

TABLE 3. NRCS Soils

Soil Symbol	Soil Series Name	Acres (% of Study Area)
CrB	Creedmoor-Green Level complex (2-6 percent slopes)	0.05 (< 1)
CrC	Creedmoor-Green Level complex (6-10 percent slopes)	1.84 (< 1)
UdC	Udorthents loamy (2-10 percent slopes)	0.42 (< 1)
W	Open Water	2,587 (99)

Creedmoor soils (Fine, mixed, semiactive, thermic, Aquic Hapludults) consist of very deep, moderately well drained and somewhat poorly drained, very slowly permeable soils that formed in residuum weathered from Triassic material of the Piedmont uplands. Slopes of these soils range from 0 to 15 percent.

Green-Level soils (Fine, mixed, active, thermic Vertic Hapludults) consist of very deep, somewhat poorly drained, very slowly permeable soils that formed in residuum weathered from Triassic sandstone, mudstone, siltstone, shale and conglomerate. Slopes of these soils range from 0 to 15 percent.

Udorthents soils (Typical pedon not available) consist of borrow areas where soil has been removed and placed on an adjacent site, cut and fill areas where soil has been extensively graded. Soil properties are variable. The soil profile tends to be moderately deep to very deep, drainage is variable ranging from excessively drained to moderately well drained, permeability is moderate to very slow, and the high water table tends to be perched or apparent.

The majority of the study area is open water of Jordan Lake with less than 3 acres of upland soils existing in the study area. Upland soils are located at the RWPS and the marina launch area.

The NRCS document, "Important Farmlands of North Carolina", was reviewed to determine the presence of soils that have potential for agriculture (USDA 2009) as well as the Chatham County Soil Survey (Hayes 2006). The Creedmoor-Green level complexes (depending on slope) are listed as Prime Farmland or Farmland of Statewide Importance. However, no areas with potential impacts are currently farmed or likely to be farmed due to location and ownership. Thus, no important farmlands of North Carolina would be disturbed due to the proposed project.

Upland soil impacts realized from the proposed aeration system's electrical cable would be approximately 300 feet in length from the RWPS building to the edge of the water surface. A 10 foot wide construction corridor would be required for the Ditch Witch trencher system to excavate a small trench 1 foot wide and no deeper than 2 feet. This temporary impact associated with the aeration system electrical cable would be approximately 0.07 acre and appropriate sediment and erosion control devices would be installed to minimize impacts to adjacent resources.

Approximately 0.6 acre of temporary disturbance to the Lake bottom would occur during installation of the 2,500 feet submersible electrical cable and 8-12 concrete anchors (125 lbs each). Determination of either burial or surficial installation of 2,500 feet of submersible electrical cable would be determined after further geotechnical studies. The footprint of each concrete anchor is 1 square foot and the area of impact during installation of each anchor is approximately 9 square feet. Total temporary anchor impacts would not exceed 108 square feet.

The aeration system would be placed at the deepest part of Jordan Lake which also is the old stream bed of New Hope River and where downstream flows are the highest. In order to minimize turbidity from the area surrounding the aeration system, a deflector plate could be installed beneath the aeration unit. The deflection plates would be approximately 43 square feet in size and would be suspended below the unit using stainless steel 0.5 millimeter cables. A single winch would be used to adjust the depth.

In order to assemble and transport the aeration system to the proposed location, a temporary staging and assembly area would be required. The Crosswinds Marina at Jordan Lake, located to the northeast of the RWPS, has been proposed as the optimal launching site. This marina was used for the launching of construction equipment for the raw water intake repairs in 2002. The area would be approximately 0.23 acre (100 feet x 100 feet) in which there would be no associated soil impacts since it is currently impervious surface.

4.1.4 Floodplains

The study area contains Federal Emergency Management Agency (FEMA) designated 100-year floodplains and would require construction through an area classified as Zone AE. Zone AE is defined as "areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods" (NCFMP 2011). Exhibit 6 shows the areas within the FEMA floodplain and Table 4 describes the floodplain characteristics (NCFMP 2009). The built upon area at the RWPS encompasses 0.12 acres of Zone X un-shaded. Zone X un-shaded areas are outside the 0.2% (500 year) annual chance of flood and have no FEMA jurisdiction.

TABLE 4. FEMA Designated Floodplain

Stream/Surface Water	Watershed	Zone	Acres in Study Area
B. Everett Jordan Lake	Cape Fear	AE	2588.8

The impacts to the FEMA regulated floodplain associated with the proposed project are negligible. No items associated with the project would create a rise in the existing flood elevations. There would be temporary equipment staging within the floodplain and some excavation; however, these areas would be returned to pre-construction conditions. The aeration system is a floating unit and is made to rise and fall with Lake levels. Coordination with the Chatham County Floodplain Administrator would occur to ensure compliance with the Chatham County Flood Ordinance and 44 CFR 60.3.

4.1.5 Surface Hydrology

Jordan Lake is located within the Cape Fear River Basin which flows from the north central piedmont region of the state, near Greensboro, to the Atlantic Ocean. The mainstem of the Cape Fear River is formed by the confluence of the Deep and Haw Rivers just downstream of the B. Everett Jordan Reservoir Dam (NCDWQ 1996). Although the proposed project occurs in waters which eventually discharge to the Atlantic Ocean and traverse through Coastal Area Management Act (CAMA) counties, there would be no changes to the amount of water discharged from the dam or downstream of the Lake due to this project. The project's purpose is to assist with water quality within the sub-Lake and should have no reasonable foreseeable effect on North Carolina's coastal area.

The project is located in the Lower Cape Fear Hydrologic Unit No. 03030002060. The North Carolina Division of Water Quality (NCDWQ) Sub-basin designation for the affected portion of the watershed is 03-06-05 (B. Everett Jordan Lake-New Hope River Watershed) (NCDWQ 2005). The study area, that is surface water, is located entirely within the surface waters of the New Hope River Arm of Jordan Lake. The State of North Carolina surface water classifications are designations applied to surface water bodies that define the best uses to be protected within these waters and carry with them an associated set of water quality standards to protect those uses. The New Hope River Arm of Jordan Lake is classified as a WS-IV; B; NSW; CA. As defined by NCDENR, Class WS-IV waters are used as sources of water supply for drinking, culinary, or food processing purposes where a WS-I, II or III classification is not

feasible. WS-IV waters are generally in moderately to highly developed watersheds or Protected Areas. Class B waters are protected for all Class C uses (secondary recreation, fishing, wildlife, fish consumption, aquatic life including propagation, survival and maintenance of biological integrity, and agriculture) in addition to primary recreation. Primary recreation includes uses involving human body contact with the water where the activities occur in an organized manner or on a frequent basis. NSW is a supplemental classification intended for waters needing additional nutrient management due to being subject to excessive growth of microscopic or macroscopic vegetation. Jordan Lake was designated as a NSW in 1983 and the study area is within the designated Critical Area (CA).

TABLE 5. Surface Water Classifications

Stream/Water Body	Watershed	NCDWQ Subbasin	Class	NCDWQ Index #
New Hope River Arm of Jordan Lake	Cape Fear	03-06-05	WS-IV; B; NSW; CA	16-41-(3.5)a

There would be minimal surface water impacts from the proposed project. Impacts of the proposed project on surface water would total 0.06 acre and would be attributed to the permanent installation area of the proposed aerator system. Table 6 describes the permanent surface water impacts caused by each aerator system feature.

TABLE 6. Surface Water Impacts

Feature Impact	Quantity	Feature Dimensions	Type of Impact	Impact Acreage
Aerator platforms	2	20 feet x 60 feet	Permanent	0.06 (2,400 sq ft)

4.1.6 Water Quality

Section 303(d) of the Clean Water Act (CWA) requires that states develop a list of waters not meeting water quality standards or having impaired uses. The NC Clean Water Responsibility Act of 1997 (House Bill 515) includes legislation to address water quality problems in NSW waters like Jordan Lake. This Act established that a calibrated nutrient response model be developed by NCDWQ in conjunction with affected parties. This model, accepted by the Environmental Management Commission in 2002, predicted a high frequency of violations of the chlorophyll *a* standard in the upper New Hope Arm (above SR 1008, Farrington Point Road). This is located upstream of the proposed aeration project study area. This prompted the Upper New Hope Arm of Jordan Lake to be placed on the 2002 303(d) list of impaired waters. The CWA requires that a Total Maximum Daily Load (TMDL) be developed for each of the waters appearing on the 303(d) list. A TMDL was developed for Jordan Lake and was approved by USEPA in 2007. The study conducted from January 2005 thru September 2008 found elevated nutrient and chlorophyll *a* throughout the Lake. The lower New Hope River Arm (downstream of SR 1008) was also found to be impaired by chlorophyll *a.* Water quality was assessed by NCDWQ in Jordan Lake in

2010 (NCDWQ 2010). Two locations (CPF087B3 and CPF087D) within the lower New Hope area of Jordan Lake were sampled. Total phosphorus, total nitrogen (TKN), chlorophyll *a*, and turbidity were taken in the photic zone while D.O. and pH were taken at the surface. During this sampling collection only chlorophyll *a* exceeded state water quality standards; it was found 3 out of the 17 samples pulled were 18% above state water quality levels for chlorophyll *a*. All other parameters tested were in compliance with state water quality standards. This is a new phenomenon because this section of the Lake had not previously exhibited impairment for chlorophyll *a*. The total turbidity values in this section of the Lake were 26% greater than the NCDWQ standard of 25 NTU.

Development of the Jordan Lake Nutrient Strategy began in the late 1990's and was signed into Session Law in 2009 (NCGA 2009a, b). In its final form, there are 13 rules designed around nitrogen and phosphorus reduction goals for the reservoir.

The overall effects of the aeration system on water quality in the study area are anticipated to be positive. Lake thermal stratification occurs in the summer and during this time the bottom Lake layers (hypolimnion) typically have minimal to zero D.O., higher total organic carbon (TOC) and higher levels of dissolved iron and manganese than the Lakes upper layers (epilimnion and mid-hypolimnion). Water with these characteristics is difficult to treat since iron and manganese are expensive to remove from the raw water. Additionally, manganese is regulated in drinking water for aesthetic reasons and is also found to be associated with neurological health risks.

Odor issues have been encountered with air injection systems since deep waters contain high levels of sulfides that are brought to the surface of the Lake. The proposed aeration system is a technology aimed at simulating the natural reservoir circulation by using low energy inputs (lower aeration requirements in comparison to diffused aeration system resulting in low velocity currents) and only using oxygen rich surface waters. The system aims to pump epilimnion water (high D.O. water) from the surface to the hypolimnion zone by draft tubes. Air injection technology is not used in the proposed aeration system (WEARS 2012a).

Water would be pumped down the inside of the 8-10 foot baffle curtain. The depth to which the Lake surface water would penetrate is a function of velocity and density difference of the Lake layers. The system can be set to determine what the desired depth of infiltration may be. It is not expected that cool, low oxygen water would be displaced quickly as cold water is denser. It is anticipated that the bottom water would be slowly and progressively mixed and oxygenated and the mixed layer propagates and spreads as a natural gravity current (See Figure 5) (WEARS 2012a).

Immediately after start-up the system has the capacity to pump 470,000 gallons per minute (gpm) of oxygenated surface water at approximately 8 milligrams per liter (mg/L) or 240,000 milligrams per second (mg/s) of oxygen. The effect of the aerators can be immediately measureable; however, it would takes several weeks for the entire study area to be affected. Thermal uniformity would be reached over a few weeks (WEARS 2012a).

The aeration system would move oxygen rich water from the top of the Lake to the bottom thereby increasing D.O. Increasing D.O. has been known to lower dissolved iron, manganese and TOC levels by altering the biogeochemical cycling of these chemical species. These changes occur through the precipitation of iron and manganese out of the water column and into the benthic sediment through microbial driven processes (oxidation). The levels of soluble iron and manganese would be reduced through the use of the aeration system and raw water would be more easily treated. The area of impact from the proposed aeration system is considered to be the entire sub-Lake or all the surface waters within the study area.

As noted above, chlorophyll *a* has been detected above state standards and therefore evidence of excessive algae has been a problem in the study area. This parameter is a measurement unit for algae and ultimately photosynthetic activity in the Lake. Algal blooms occur when excessive nitrogen and/or phosphorus coincide with extended photoperiods during the summer, and stagnant waters. These blooms tend to raise the pH and produce supersaturated levels of D.O. in the water column, followed by respiration of algae which leads to little or no oxygen in the water column. The aeration system would be oxygenating these waters and would relieve stagnant water conditions and make the conditions less favorable for algal blooms. By pumping water down deeper into the water column, algae are "controlled" from forming blooms and cells are destroyed before entering the treatment plant. The manufacturer has commented that the biomass including zooplankton species are more balanced without one individual organism dominating (WEARS 2012b).

During construction activities, the contractor would be required to minimize impacts to water quality through implementation of construction best management practices (BMPs), reflecting state and federal guidelines. These areas would be marked clearly and appropriately with buoys and markers to keep boaters out of the areas during construction.

Overall, the impacts to reservoir water quality would be positive and are anticipated to only affect the sub-Lake study area portion of Jordan Lake. The intended purpose of the project is to address water quality issues with the naturally occurring thermocline. The Towns located within the project service area have progressive stormwater controls which help with water quality by reducing loads to the watershed; however, the raw water quality issues associated with the thermocline are not directly impacted by stormwater and improvements in stormwater quality would not alleviate poor raw water quality that occurs when the Lake stratifies. Therefore, improving stormwater controls alone does not alleviate the need for Lake Aeration. Reduction of dissolved iron and manganese concentrations, increased D.O. in the hypolimnion layers, and potential reduction in algal blooms are positive water quality benefits that would result from the proposed aeration project.

The appropriate USACE 401/404 and NCDWQ permits would be obtained and the proposed project would be in compliance with Jordan Lake Buffer Rules. The project would impact the Jordan Lake buffers; however, plans are to utilize the existing maintained area from the RWPS to the edge of the Lake for the placement of the electrical cable. This avoids having to clear any areas currently forested

and the area would be re-vegetated with an appropriate seed mix for the existing conditions immediately following construction.

4.1.7 Air Quality

The Clean Air Act, last amended in 1990, requires US Environmental Protection Agency (USEPA) to set national ambient air quality standards (NAAQS) (40CFR part 50) for six pollutants based on primary (health-based) and secondary (welfare-based) considerations. These six pollutants, which are called criteria pollutants, include; carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM) and sulfur dioxide (SO_2). Chatham County is currently considered in attainment for the national ambient air quality standards and there are no known air quality concerns in the area (NCDAQ 2011).

The AirData Air Quality Index Summary Report displays an annual summary of Air Quality Index (AQI) values for counties across the United States (USEPA 2011). AQI is an indicator of overall air quality and the index is divided into six categories. These categories include; good, moderate, unhealthy for sensitive groups, unhealthy, very unhealthy, and hazardous. The AQI was revised on March 12, 2008 for ozone and reflects changes to the NAAQS for ground-level ozone. The other categories have had similar changes applied in the last few years as USEPA has scientifically reviewed the "criteria pollutants" standards.

AQI values during 2009, 2010, and 2011 in Chatham County were "moderate" or better 100 percent of the recorded days. In the past five years (2007-2011), for which annual data is recorded, air quality was recorded as unhealthy for sensitive groups only four days and one day was recorded as unhealthy levels for the same time period (Table 7).

TABLE 7. Chatham County Air Quality Index

Year	Number of Recorded Days (% of Recorded Days)				Main / Secondary Pollutants	Highest Annual Daily AQI Value
	Good (*0-50)	Moderate (51-100)	Unhealthy for Sensitive Groups (101-150)	Unhealthy (151-200)		
2007	191 (73)	66 (25)	3 (1)	0 (0)	O_3/PM2.5	116
2008	325 (89)	39 (11)	1 (0.3)	1 (0.3)	O_3/PM2.5	155
2009	248 (94)	16 (6)	0 (0)	0 (0)	O_3/PM2.5	87
2010	229 (88)	31 (12)	0 (0)	0 (0)	O_3/PM2.5	93
#2011	243 (89)	30 (11)	0 (0)	0 (0)	O_3/SO_2/ PM2.5	84

** AQI Value ranges*
#2011 data in the table are not final until May 1, 2012

The main air pollutant in Chatham County is O_3 and due to implementation of new SO_2 monitoring requirements, SO_2 is now the secondary pollutant in 2011, replacing PM2.5. Ozone is not emitted directly by car engines but is formed by the reaction of sunlight on air containing hydrocarbons and nitrogen oxides that react to form ozone. SO_2 is mainly emitted from fossil fuel at power plants and other industrial facilities.

The proposed project's impact on air quality would consist of the temporary use of construction equipment. The types of construction equipment employed would consist of a Ditch Witch trencher system for burial of the electrical cable, truck/crane for the movement of the units from the loading truck to boat, a crane-motor boat installation method for the aerator units, and hand held power tools to assemble the aerator units. The submersible electrical cable would utilize the following equipment depending on soil conditions: a marine trencher if soils are considered hard; a boat would lower the cable if surface laying is ideal, or a trencher would soften the soils to allow the cable to be pushed into the soil.

Due to the temporary and localized nature of the construction equipment and the fact that the county is currently in attainment, the project is not anticipated to adversely affect the air quality of the immediate and surrounding areas. In addition, the aeration system motors are electric and would not negatively impact air quality.

4.1.8 Noise

Elevated noise levels have been documented as negatively affecting human health and welfare. Wildlife behavior patterns such as migration, breeding, hunting and predator avoidance have also been documented as being disrupted by human induced noise. Noise levels are measured in terms of the A-weighted decibel (dB(A)) and are measured through a sound level meter having characteristics defined by the American National Standards Institute (ANSI). The existing sources of noise pollution of the study area include traffic along the roadways including US Highway 64 and other ambient day-to-day noise representative of the residential, forested, recreational and agricultural land uses.

Federal, state and local governments have established noise standards and guidelines to protect citizens from potential hearing damage and various other adverse physiological and social effects associated with noise. Construction operations from 7:00am to 9:00pm on weekdays are exempt from the Chatham County Noise Ordinance (Chatham County 2006).

To reduce disturbances to adjacent properties, temporary increases in noise levels would only occur during normal working hours (weekdays from 7:00 am to 6:00 pm) for the installation of the proposed aeration system components. No noise receptors are located within the vicinity of the RWPS and Crosswinds Marina due to a lack of nearby residences. Temporary staging and launching of the aerators would occur for approximately 2 to 4 weeks at the marina and within Jordan Lake.

Noise impacts are directly related to the motors needed to supply energy to the four 15-foot diameter aerators. Two 7.5 HP motors, each with variable frequency drives (VFDs), would be installed within each of the two platforms. Even if the motors were to run continuously every day of the year, the decibel

levels (dB(A)) of the motors are anticipated to be negligible. The reported dB(A) levels of the motor and gear box running at full speed are reported at 48dB(A) at 3 feet from the frame. At this dB(A) level, noise levels from the Lake Aeration System should not be detectable at the shore line. In addition, it is noted that the noise levels are considerably lower than reported noise levels for motor boats; for most states that have adopted boat maximum noise levels, the standard for maximum noise level ranges from 75 to 90 decibels (National Association of State Boating Law Administrators 2000). According to the Chatham County Noise Ordinance, noise threshold levels for receiving lands must be below 60 dB(A) from the hours of 8:00 am to 10:00 pm and below 50 dB(A) from 10:00 pm to 10:00 am (Chatham County 2006).

4.1.9 Cultural Resources

Authorized under the National Historic Preservation Act of 1966, the National Register of Historic Places (NRHP) houses the formal repository of information pertaining to historic structures and districts worth preservation. A database search of the National Register of Historic Places did not indicate any listed existing structures or historic districts present within the study area (NPS 2011). A database search of the North Carolina State Historic Preservation Office (SHPO) also did not list any existing structures or historic districts within the study area (SHPO 2011). The closest structure to the study area is Patrick Barnes, Sr. House, located on McCoy Road off of Farrington Road, approximately a quarter mile from the eastern edge of the study area.

No impacts to archaeological or historical resources are anticipated by the installation and construction of the proposed aeration system. The state and federal databases indicated that there are no listed structures or historic districts present within the study area. Therefore, no direct impacts to areas of historical value would occur. Potential for archaeological resources is severely limited due to the disturbed nature of the study area. A scoping response of “no comment” was received from the SHPO on October 25, 2011 (Appendix B).

4.1.10 Hazardous Waste Sites

All toxic substances during the installation of the aeration system would be controlled. Any fuels and oil for construction equipment would be located in a predetermined location within the marina launch area or on any of the boats used for installation of the aerator units and electrical cable. Equipment would be properly maintained to prevent leakage of fuel and oil. Other chemicals and cleaners would be controlled on the marina launch and/or boat in a similar manner. These measures would be included in construction specifications, and compliance would be confirmed through the construction management engineer. No chemical storage would be required within the study area.

No hazardous waste sites are known within the study area. A review of GIS layers available through the NCDENR Division of Waste Management found no recorded sites within the study area (NCDWM 2011). The proposed project is not anticipated to produce hazardous waste or disturb any known hazardous waste sites.

4.1.11 Aesthetics

The proposed aeration system would be placed at approximately 35˚ 44’ 43.185” N Latitude and 79˚ 1’ 19.528” W Longitude. This location serves as the optimal placement of the system and is somewhat in the middle of the sub-Lake. The system would occupy a small area in the vast Lake. To illustrate the visual impacts of the system on to the public, visualizations have been created from different locations on the Lake’s shoreline (Exhibits 7, 8, and 9). The vantage points include the Marina, US Highway 64 crossing, and the Campground. The overall impacts to aesthetics at the Lake would be minimal due to the proposed aeration system.

4.2 Natural Resources

Construction of the proposed project would have minimal adverse impacts to natural resources. Best management practices would be used during construction and design and placement of the system was assessed to minimize negative impacts. The effects of the proposed project on natural resources within the study area are discussed in the following section and summarized in Section 4.4.

4.2.1 Vegetation

A site visit (January 20, 2012) and GIS aerial analysis indicate that vegetative resources within the study area are primarily maintained grassy areas and disturbed forest areas within the RWPS area. Limited, naturally regenerating forest resources are present within the study area. Natural woody vegetation at the RWPS consisted of mid-successional red maple (*Acer rubrum*), loblolly pine (*Pinus taeda*), eastern red cedar (*Juniperus virginiana*), winged sumac (*Rhus copallinum*), black gum (*Nyssa sylvatica*), green ash (*Fraxinus pennsylvanica*), American elm (*Ulmus americana*), willow oak (*Quercus phellos*), red oak (*Quercus rubra*), white oak (*Quercus alba*), tag alder (*Alnus serrulata*), yellow poplar (*Liriodendron tulipifera*) and sweetgum (*Liquidambar styraciflua*). Lespedeza (*Sericea lespedeza*), an invasive forb, has been planted for stability in the maintained areas at the RWPS station and has infiltrated some of the understory of the forested edges. Maintained grasses/ornamentals were noted surrounding the RWPS buildings, and the maintenance area for the dual 54-inch intake pipes leading to the Lake waterfront. Acreage for both forested areas and maintained areas are 0.71 and 0.67 acre, respectively (Exhibit 10). Impervious surface within the study area boundary is 0.09 acre and is attributed to the pump station building.

The upland electrical cable would start at the northwest corner of the pump station building and would skirt the edge of the eastern forested area within the RWPS. A ten foot wide work corridor would be needed to install the electrical cable and would temporarily impact 0.07 acres (~300 feet in length) of maintained grassy areas (Exhibit 10). Temporarily impacted areas would be re-vegetated with seed mixes appropriate for the existing conditions. All applicable Town and County ordinances and State regulations would be followed and permitted accordingly.

4.2.2 Fish and Wildlife

Terrestrial species that use Jordan Lake are numerous. Songs birds, migratory birds, small and large mammals, reptiles and amphibians utilize Jordan Lake for different habitat niches that include foraging, watering, nesting, migratory resting, and spawning. The only terrestrial species noted during the January 20th site visit were seagulls (*Larus* spp.) and an individual double-crested cormorant (*Phalacrocorax auritus*). Other common species known to inhabit Jordan Lake and areas surrounding it include, but are not limited to, white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), eastern cottontail (*Sylvilagus floridanus*), eastern box turtle (*Terrapene carolina*), five-lined skink (*Eumeces anthracinus),* eastern fence lizard (*Sceloporus undulates*), corn snake (*Elaphe guttata),* black rat snake *(Elaphe obsolete obsolete),* Carolina chickadee (*Poecile carolinensis*), turkey vulture (*Cathartes aura), blue jay (Cyanocitta cristata), American crow (Corvus brachyrhynchos), bald eagle (Haliaeetus leucocephalus), wood duck (Aix sponsa),* and *Canada goose (Branta canadensis)*.

According to the NCWRC, Jordan Lake supports a diverse fishery including sunfish (*Lepomis* spp.), crappie (*Pomoxis* spp.), catfish (*Ictalurus* spp.), largemouth bass (*Micropterus salmoides*), and striped bass (*Morone saxatilis*) (Appendix B). Habitat for these fish includes quiet areas of lakes and streams with muddy bottoms, rock ledges, logs, brush mats and vegetation. In addition to natural habitat areas, artificial and natural structures that attract and concentrate fish have been submerged near shore. Over 40 artificial fish attractor structures have been installed by the NCWRC since 1999 (NCWRC 2010). Recently in early 2011, 80 evergreen trees were bundled and sunk to create hot spot fishing areas (NCWRC 2011). These sunken evergreen trees and artificial structures on Jordan Lake have been clearly marked with white buoys with orange markings, black lettering and a green NCWRC habitat enhancement sign. The closest fish attractor structures are located directly northeast of the proposed aeration system approximately 50 feet offshore the peninsula due north (35.748583, -79.01593 and 35.7484, -79.01645). The aeration system and electrical lines would be clearly marked by buoys and signs to avoid obstruction by future artificial/natural fish attractor placement.

Below are descriptions of the three fish species that are of concern to the NCWRC: striped bass, black crappie (*Pomoxis nigromaculatus*) and white crappie (*Pomoxis annularis).*

Striped bass (also known as striper, rockfish or rock) is a silver-white fish with seven to eight horizontal black stripes along its sides. Its back is often greenish-blue and its underside white. It has two separate dorsal fins along its back. The front dorsal fin has a series of nine spines, whereas the second dorsal fin has one spine with a series of soft fin rays. Most adult striped bass are 1 to 3 feet long and weigh 2 to 20 lbs.

Striped bass are native to the coastal rivers, sounds and estuaries of North Carolina and other states along the Atlantic coast and eastern Gulf of Mexico. Striped bass can live in freshwater and are stocked in North Carolina reservoirs including Lake Norman, Lake Gaston, and Jordan Lake (NCWRC 2012a). Their food source as juveniles includes zooplankton and freshwater invertebrates and small fish. As adults they favor crayfish, golden shiners, herring and shrimp for survival. Their natural habitat in North

Carolina ranges from coastal estuaries (for most of their life) to the coastal plain/piedmont fall line (for spawning). They are known to spawn in the Tar-Pamlico, Neuse, White Oak, and Cape Fear River basins in the spring. Its natural habitat does not include Jordan Lake and is considered a warm water game fish by the NCWRC. Though it is not native to Jordan Lake, the NCWRC stocks Jordan Lake and 12 other actively managed reservoirs for recreational fishing with striped bass. In 2011, 70,000 young striped bass (1-2 inches long) were released at the NCWRC Farrington Point boating access area at Jordan Lake. Hybrid striped bass were stocked from 1983 to 2001 by NCWRC, but was terminated when managers began to plan for the recovery of the Cape Fear River striped bass stock due to hybrid abundance in the Cape Fear River (NCDMF and NCWRC 2004).

Striped bass population success depends on a combination of system productivity and environmental conditions that is not completely understood. In the southeastern U.S., constraints imposed by temperature and low D.O. have been the main focus of striped bass research. Typically water temperature that is greater than 27˚C induces fish to cease feeding (Zale et al 1990) and above 28˚C mortality increases. The accepted temperature range for striped bass is 20-22˚C. In the summer months, habitat for striped bass can be restricted between the ceiling of thermal intolerance in the epilimnion and the cooler but often hypoxic hypolimnion. Recent research in North Carolina reservoirs (including Jordan Lake) shows striped bass can withstand temperatures above 27˚C and that food availability (small fish species, zooplankton) was more important (Davias 2006). Based on 2004 Jordan Lake data at 2 meters below water surface near the dam, striped bass experience one to three months in very warm (≥27˚C) water with the average temperature of 25.3˚C between May 1 and October 31 (Davias 2006). Another reservoir study performed in Badin Lake leads to evidence that summer habitat selection is driven more by D.O. rather than temperature (Thompson et al 2010). Accepted research levels of D.O. concentrations required for healthy striped bass populations must be at least 2-3 milligrams per liter (mg/L) (Coutant 1985).

Jordan Lake is a productive system with mean summer chlorophyll-*a* at 38 micrograms per liter (ug/L) and has some of the greatest reservoir productivity in North Carolina. This evidence suggests ample food is available to striped bass and other fish species all year round in Jordan Lake. Overwintering of striped bass is controlled by Lake stratification and where the optimal D.O./temperature combination is located; these phenomena are driven by climatic patterns. Typical lake depths for overwintering are not well documented for striped bass in Jordan Lake.

Black crappie and white crappie are both members of the sunfish family. The black crappie is distinguished by irregularly spaced black splotches on its silvery-green to yellowish sides. In the white crappie these blotches often form vertical bars. The black crappie has 7 to 8 spiny dorsal fin rays, while the white crappie only has 5 to 6. Crossbreeding sometimes occurs between the two species and the best method for distinction is counting spiny dorsal fin rays (NCWRC 2012b). For both species, most adults reach lengths ranging from 5 inches to 21 inches and typically white crappies are the larger of the two species. Crappies can weigh up to 3 or 4 lbs but they typically reach a weight of ¼ to ½ lb.

Crappies are native to North Carolina and are found throughout the state's waters. Black crappie is mainly in the lower Piedmont and coastal plain while white crappie is found throughout the state's waters. They are tolerant of a wide range of environmental conditions and are abundant in the Piedmont reservoirs and Coastal Plain rivers. They have high reproduction rates and the spawning season for both species in North Carolina lasts from March through May, when water temperatures warm to the 60- to 68-degree range. The white crappie prefers water temperatures that reach the 58- to 64-degree range. Males select the nest sites and clear circular beds 8 to 15 inches in diameter. The bed depths range from 3 to 8 feet of water. The preferred nest substrate of the black crappie is gravel or soft muddy river/lake bottoms and for white crappie the nests are typically found next to brush piles, stumps or rock outcrops. The nesting sites are typically built in groups. Food sources of both species include zooplankton, crustaceans, insects and fish. Adults feed primarily on fish but also feed on insects.

Crappies are not stocked by the NCWRC since they spawn prolifically. They are the most encountered fish by anglers and fishing for them is very popular due to their culinary appeal. For these reasons, they are an important fisheries resource.

The NCWRC is concerned about the direct impacts of the aeration system on aquatic resources. Specifically, NCWRC is concerned about protection of overwintering habitat and critical staging area for striped bass and crappie populations in the immediate vicinity of the proposed aeration system at the confluence of New Hope River and White Oak Creek (Appendix B).

Crappies, striped bass and other fish are found deeper in the water column during the winter where it is warmer and this is considered the overwintering and staging time of the fish. Overwintering and staging areas would not be negatively affected by the aeration system as the system utilizes a low energy technology that would deliver oxygen rich water to deeper areas that would likely increase fish habitat at the lake bottom. Additionally, the elimination of the lake thermocline during the winter months would not affect fish habitat since lethal temperatures are not an issue this time of year. The low energy technology used to accomplish destratification disperses oxygen under low flow with a maximum velocity at the intake screen of 0.67 ft/sec. This flow would dissipate moving away from the intake and baffle curtain structure and would not affect fish behavior deeper in the water column surrounding the proposed aeration system during fish overwintering and staging periods. Jordan Lake typically stratifies between May and September, creating less than ideal temperature and D.O. in the hypolimnion for fish species. This time of year is when the aerators would be needed most to improve water quality. The proposed aeration system's manufacturing team has documented anecdotal evidence of improvements to fish habitat, fish stocking rates, fish growth rates, fish health, and reduction or elimination of potential fish kills due to water quality issues and elimination of anoxic water and the toxic compounds of anoxic decomposition. The proposed aeration system technology is currently used in Australia in the Cotter reservoir and has not only protected, but also improved fish habitat and lake conditions for federally protected species and other fish species (ACTEW 2009).

The water inflow passes through the baffle curtains at a variable rate with a maximum of approximately 0.67 ft/sec, which is similar to the 0.5 ft/sec velocity threshold for intake screen systems recommended

by the NCWRC (Appendix B) and below the NCDENRs' maximum allowable velocity of 0.83 ft/sec for raw water intakes in reservoirs (15A NCAC 18C .0602). The movement of this water is not intense and the system produces low velocity currents akin to stream flow. Most fish species found within the Lake and of concern have documented swim burst speeds much greater than the 0.67 ft/sec velocity (Appendix D). The aeration unit, as seen in Exhibit 4, pushes water down through the baffle curtains. The 8-10 foot baffle curtains surrounding each of the four aerators create a barrier between the fish and the aerator units (WEARS 2012a).

The proposed aeration system would not significantly impact the fisheries within the study area. Research shows that the proposed aeration system would provide favorable habitat in the form of oxygen rich waters in the hypolimnion during the summer months and would not entrain fish due to the low intake velocity. Furthermore, improved fish habitat evidence exists from the currently installed aeration systems in the Australian Cotter reservoir. Additional research conducted on the impact of artificial destratification systems on aquatic habitat and aquatic species supports that artificial destratification systems improve water quality by increasing D.O. throughout the water column thereby increasing aquatic habitat volume for warm water fisheries (Fast 1968, Kortmann et al 1994, Milstein et al 2001, Toetz et al 1972).

4.2.3 Endangered and Threatened Species

Under the provisions of the Endangered Species Act (ESA) of 1973 as amended, any action likely to adversely affect a species classified as federally protected is subject to review by the United States Fish and Wildlife Service (USFWS). Plants and animals with Federal classifications of Threatened or Endangered are protected under the provisions of Sections 7 and 9 of the ESA. Federal Species of Concern (FSC) are also a priority of the USFWS but are not protected under the ESA. Species listed as Endangered or Threatened by the State are afforded limited State protection under the North Carolina State Endangered Species Act and the North Carolina Plant Protection and Conservation Act of 1979.

The North Carolina Natural Heritage Program (NCNHP) and the USFWS databases were reviewed for known occurrences of protected species in Chatham County. Table 8 reflects the four federally protected species documented within Chatham County. A site visit was conducted on January 20th, 2012 and no occurrences of any federally listed species were noted within the study area. The bald eagle is protected under the Bald and Golden Eagle Protection Act (BGPA) (16 U.S.C. 668-668d). Descriptions of the listed species are included below. The USFWS and NCNHP county lists are also provided in Appendix C.

TABLE 8. Federally Listed Species for Chatham County

Scientific Name	Common Name	State Status	Federal Status	County Status
Haliaeetus leucocephalus	Bald eagle	n/a	BGPA	Current
Notropis mekistocholas	Cape Fear shiner	E	E	Current
Picoides borealis	Red-cockaded woodpecker	E	E	Current
Ptilimnium nodosum	Harperella	E	E	Current
E = Endangered *BGPA = Bald and Golden Eagle Protection Act*				

The bald eagle is the second largest bird of prey in North America with an average wingspan of 7 feet. It has a distinctive white head and white tail against a dark brown body and wings in adult birds. The females are about 25% larger than males and are otherwise similar in appearance. The species builds large stick nests (up to 6 feet across) lined with soft materials, and the same pair of eagles will use the nest for several years. The breeding range of the bald eagle is associated with aquatic habitats (coastal areas, rivers, lakes, and reservoirs) with forested shorelines or cliffs. Eagles select large, super-canopy roost trees that are open and accessible, mostly conifers. They winter primarily in coastal estuaries and river systems (USFWS n/d).

Jordan Lake provides optimal shallow water forage habitat as well as mature pine stands for bald eagle nesting. There were 9 active nests with 46 individuals (28 adults, 18 immature) documented at 6 sites on Jordan Lake in April of 2012 (USACE 2012a). During the summer of 2011, 100 eagles were observed within the vicinity of the Lake (USACE 2012a). The NCNHP database has not documented bald eagle nests within a mile radius of the study area. The closest nest occurrence is located 2.0 miles northwest of the study area on Bush Creek. However, the study area is considered optimal foraging habitat for the bald eagle. The NCNHP has designated 6,000 acres north of Farrington Road/Farrington Point area of Jordan Lake as Jordan Lake Bald Eagle habitat (Exhibit 11).

The Cape Fear shiner was described as a new species in 1971. It is an approximately 2 inch long, yellowish minnow with a black band along the side of its body. Its fins are yellow and somewhat pointed. Its habitat is associated with gravel, cobble, and boulder substrates and has been observed in slow pools, riffles and slow runs. The Cape Fear shiner can be found swimming in schools of other minnow species but is never the most abundant species. Spawning season is from May through July, and the adults move to slower flowing pools to lay eggs on the rocky substrate. This species is endemic to the upper Cape Fear River Basin and is known to occur in the tributaries and mainstreams of the Deep, Haw and Rocky Rivers in Chatham, Harnett, Lee, Moore and Randolph Counties (USFWS 2006). Suitable habitat does not exist within the study area and the project would have no impact on the Cape Fear shiner.

The red-cockaded woodpecker is 18 to 20 centimeters long with a wing span of 35 to 38 centimeters. Horizontal black and white stripes are located on the back, its cheeks and under parts are white. Its

flanks are black streaked and the cap and stripe on the side of the neck and the throat are black. Males have small red spots, or cockades, on either side of the black cap. Their population is closely tied to the distribution of mature longleaf (*Pinus palustris*) and loblolly pine forests in the southeastern United States. Historically, the species occurred from east Texas and Oklahoma, to Florida, and north to New Jersey; however, this range has been reduced and has lead to the federal listing of the species. Nesting occurs in excavated cavities carved into living pine trees. These are most often mature longleaf pines; however, mature loblolly pines are also utilized. Foraging habitat is provided in pine and pine hardwood stands 30 years old or older with pines greater than 10 inches in diameter being preferential (USFWS 2008). Suitable habitat is lacking and no known occurrences of red-cockaded woodpecker are located within the study area. The proposed project would have no impact on the red-cockaded woodpecker.

Harperella is an annual herb that grows to a height of 6 to 36 inches. The leaves are reduced to hollow, quill-like structures and the small white flowers occur in heads or umbels. Harperella inhabits pond and riverine habitats. In pond habitats it flowers in May, while the riverine populations flower much later, beginning in late June or July and continuing till the first frost. The species typically occurs in rocky or gravel shoals and margins of clear, swift flowing stream sections; and in the coastal plain they are located at the edges of intermittent pineland ponds. Only 12 extant populations are known and one population occurs in Chatham County (USFWS 2011). Suitable habitat does not exist for Harperella within the study area; therefore, the project would have no impact to the species.

4.2.4 Wetlands

Jurisdictional waters of the United States include wetlands and streams under the authority of the CWA Section 404 enforced by the USACE. The assessment of the jurisdictional waters of the U.S. conformed to the 1987 Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) and the Interim Eastern Mountains and Piedmont Regional Supplement (USACE 2010). The study area, with the exception of the RWPS area and Crosswinds Marina launch, encompasses surface waters within the identified study area sub-Lake. According to the National Wetland Inventory data no wetlands exist within the study area. Only fresh water pond and lake areas are identified within the study area.

Direct impacts to state and federally jurisdictional wetlands can result from construction activities such as clearing, draining, and filling. A site visit on January 20th, 2012 was conducted and verified no USACE jurisdictional wetlands are present within the study area. Fringe wetlands may or may not be present within the study area depending on the slope of the land adjacent to the Lake edge. A USACE approved jurisdictional determination and 404 permit as well as an appropriate NCDWQ water quality certification (401) would be applied for before the commencement of construction.

Best management practices and all associated USACE and NCDWQ permit requirements would be adhered to for work associated with the installation of aeration system components. Appropriate sediment and erosion control devices would also be used to maintain water quality in the vicinity of the electric cable from the RWPS to the edge of the Lake. In order to control sediment loss from the edge of the launching area, contractors would utilize removable fabrics and crushed stone where necessary for the crane to access the boat. From the aerator units to the RWPS edge of water, any equipment

necessary to install the submersible electrical cable would be properly controlled for sediment loss. BMPs for in water work would be determined after determination of the type of installation method required for laying the submersible electrical cable. The proposed aeration system is not anticipated to permanently impact wetlands and streams or alter the functional qualities of wetlands adjacent to the study area.

4.3 Socioeconomic Characteristics

Construction of the proposed project would have no impacts to most socioeconomic characteristics within the study area. Minimal adverse impacts could be seen in the areas of recreation by watercraft users who may traverse through the proposed easement associated with the aeration units. However, the Lake is vast with plenty of room to accommodate both uses of the Lake. The effects of the proposed project on the socioeconomic characteristics are discussed in the following section and summarized in Section 4.4.

4.3.1 Land Use

The proposed project is located in Chatham County which has an established land zoning code. The current zoning of the entire study area is Unzoned by Chatham County (Exhibit 12). Disturbed forested areas are located within the RWPS site and disturbed, impervious surface is located within the Marina launch area; the remaining areas are surface waters of Jordan Lake. Jordan Lake is used recreationally to boat, fish and swim. Crosswinds Marina, Farrington Point, White Oak and Parkers Creek are the available recreational, non-gameland areas maintained by North Carolina State Parks that abut the study area (Exhibit 11).

No changes to land use would occur as a result of the installation of the aeration system. The adjacent properties, specifically the recreational areas and marina abutting Jordan Lake would maintain their current uses.

4.3.2 Vehicular Traffic

Vehicular traffic within and surrounding the study area is mainly attributed to US Highway 64, located on the southern border of the study area, and Farrington Road (SR 1008) which bounds east and north portions of the study area. US Highway 64 is a four lane divided highway where it crosses Jordan Lake and carries traffic east/west from the Raleigh/Cary/Apex area to Pittsboro and Chatham County. US Highway 64 is also utilized as an evacuation route for the Harris Nuclear Plant. No vehicular traffic on US Highway 64 or other local roads would be affected within or surrounding the study area due to the proposed project.

Boating traffic associated with the proposed project is the main traffic concern and is discussed in Section 4.3.3 and 4.3.6.

4.3.3 Recreation

The study area is located with the Jordan Lake State Recreational Area and the Jordan Game Land Area. Both areas are owned by the USACE and are considered public lands. The study area and surrounding areas of the Lake are leased to the North Carolina Division of Parks and Recreation for recreational purposes and to the NCWRC for use as game lands. The Crosswinds Marina is a privately operated, recreational use facility that is part of the study area and is the only Marina on the Lake. It is a full service boating marina that includes wet storage, dry storage on trailers, boat rentals, public launch ramps, tackle shops and an independent marine repair shop. Exhibit 11 shows the Managed Natural Areas and Public Lands within and surrounding the study area. No County recreational areas exist within the study area.

NCWRC operates three public fishing access areas within Jordan Lake and only the Rock Quarry Fish Area is located within the study area. The Rock Quarry Fish Area is located off of Big Woods Road (SR 1716) approximately 4.9 miles north of Big Woods Road intersection with US Highway 64. NCWRC also manages the Farrington Point boat ramp that additionally has designated fishing areas. The North Carolina Division of Parks and Recreation manages two public recreational areas, Parkers Creek and White Oak, adjacent to the study area. Parkers Creek Recreational Area includes camping (RV and tent), boating, fishing, swimming, picnicking shelters and trail access. The White Oak Recreational Area offers boating, fishing, swimming, picnicking shelters and trail access. Another recreational activity that is popular at Jordan Lake is bird watching. The Lake and surrounding public lands have been designated as an important birding area by the Audubon Society (Audubon 2010).

The daily operations of the marina would not be disturbed due to the 100 feet x 100 feet (0.23 acre) proposed aeration system assembly/launching site (shown in Exhibit 6). The aeration system area, north of the RWPS easement, would require the Town to acquire additional easement from the USACE. Exhibit 2 shows the Town's current easement associated with the RWPS and the proposed 1.4 acre easement requested by the Town. The proposed aeration system units, totaling 0.8 acre, would be off limits to boaters and other recreational watercraft. This area would be marked appropriately to protect the recreational safety of Jordan Lake users during day and night. This marking system is explained further in Section 4.3.6. The maintenance easement for the submersible electrical cable, totaling 0.6 acre, would not affect boaters or other watercraft. Depending on Lake bottom conditions, the submersible electrical cable would be laid across the Lake bottom or buried either by cable pushing or trenching with a dredge or marine trencher. If the burying methods are possible, the electrical cable would not impede any recreational use; however, if the cable must be laid across the bottom, then the line would require markers to avoid any conflicts with boaters with snagging of anchors or fishing lines . A graphic depicting example markings with buoys at 200-foot spacing along the electrical line has been included (Exhibit 13).

Minimal disturbances to recreation areas would occur as a result of the aeration system installation. During the placement of the submersible electrical cable and aeration system units, the Town has committed to placing barriers and signs in the water to warn boaters of the construction area. The

Town has also agreed to permanently install buoys and lights within the proposed aeration system unit to ensure recreational safety.

4.3.4 Water Supply and Conservation

Jordan Lake is operated by the USACE as a multipurpose reservoir to supply water regionally, control flooding, improve flow downstream, and provide recreation. Currently, the Towns of Cary and Apex maintain two 54-inch water supply intakes in Jordan Lake. The Cary/Apex Raw Water Pump Station withdraws water via the two existing intakes and sends it to the Water Treatment Facility as well as approximately 3 mgd to Chatham County. A proposed third lower intake is currently being reviewed under a separate project to increase the reliability of the raw water supply under extreme long-term drought conditions. A Jordan Lake Partnership was also created in 2009 with the primary purpose of jointly planning for the expanded use of available water supply in Jordan Lake. This partnership is actively assessing potential locations for placement of another intake in the western portion of the Lake as well as opportunities to collaboratively enhance the sustainability and security of the region's water supply resources through conservation and efficiency, interconnection, and coordinated planning and development of the Jordan Lake water supply.

The proposed aeration system in Jordan Lake would not impact the quantity of water, water supply pool, or current or future allocations. The system is being proposed as a measure to assist with water quality in the Lake specifically in the area of the intakes. The No Action alternative would not assist with the poor water quality seen at the Lake during the summer when the Lake stratifies.

The current water supply allocations by municipality or county are noted in the table below. The Towns of Cary, Apex, and Morrisville, as well as Chatham County and RTP South, currently rely upon Jordan Lake for their regular potable water supply.

TABLE 9. Current Water Supply Allocations

Allocation Holder	Level I	Level II	Total
Towns of Cary and Apex	32	0	32
Chatham County	6	0	6
City of Durham	10	0	10
Town of Holly Springs	0	2	2
Town of Morrisville	3.5	0	3.5
Orange County	0	1	1
Orange Water & Sewer Authority	0	5	5
Wake County - RTP South	3.5	0	3.5
Total	**55 mgd**	**8 mgd**	**63 mgd**

Note: The members of the Environmental Management Commission approved the above (3rd round) Jordan Lake water supply storage allocations at their July 11, 2002 meeting.

4.3.5 Energy Needs

The energy needs of the proposed aeration system are minimal. Two 7.5 HP motors each with variable frequency drives (VFDs) would be installed within each of the two platforms. Energy to the proposed aeration system's two motors would be supplied from the RWPS through an electrical cable. The proposed system requires low energy inputs in comparison to a traditional diffused aeration system (HDR 2010). No adverse energy effects are expected to occur from the proposed aeration system.

4.3.6 Safety

Safety for the users of Jordan Lake and surrounding lands is important to all the federal, state and private entities involved in managing the areas resources. Specifically, the on water uses of Jordan Lake support an array of activities such as motorized and non-motorized boating, swimming, and off-shore and on-shore fishing. The USACE has a web site that hosts water safety information and links to educational trainings provided by the USACE, U.S. Coast Guard (USCG) Auxiliary, NCWRC, and the United States Power Squadrons (USACE 2012b). The USACE regulates the placement of buoys in all navigable U.S. waters. U.S. Aids to Navigation System (ATONS) is a sign navigation system that employs a simple arrangement of colors, shapes, numbers and light characteristics to mark navigable channels, waterways and obstructions adjacent to these. This system was developed by the USCG and is intended for the use in waters of the U.S. along with the use of nautical charts. The primary components of the system are buoys and beacons and the proposed aeration system would consider the elements of this system when finalizing the buoy and lighting plan.

The proposed aerator units are located in an area subject to boating traffic and are in close vicinity to the marina, and multiple boat launches in the study area. The location has been recommended based on aeration efficiency and to minimize disturbance to bottom sediments and therefore necessary steps would be taken to ensure the safety of the boating traffic. The proposed aeration system was determined to have lower impacts on Lake traffic due to its small dimensions and low number of units compared to other alternatives.

Permanent buoys and strobe lights would be installed at the location of the proposed aeration system to ensure the safety of all boating traffic. The Town would ensure that the markers comply with all USACE and USCG specifications. These features would protect boaters and allow for boating traffic to navigate around the aeration system. A total of 6 strobe lights would be mounted on each of the aerator platforms (20 feet x 60 feet). Four strobe lights would be placed at each of the aerator platform four corners and one at each of the midpoints of the longer sides. Keep out buoys would be placed within the aeration system easement to warn boaters to stay out of the area and would be located approximately 60 feet from the structures. If soil conditions allow for use of a submersible, surface lay electrical cable, then the electrical cable location would be marked with buoy-lines or signs. A graphic depicting markings with buoys at 200-foot spacing along the electrical line and 60-foot perimeter of the aeration units has been included as well as showing the lighting on the aeration units (Exhibit 13).

In the event of an emergency, such as a hurricane or an anthropogenic disaster, the proposed aeration system would be able to be shut off completely. The system can be operated from a pontoon, the shore, an existing SCADA connected PC, a local laptop or a remote PC via telephony. Operational protocols would be developed and would be based on the needs of the Town, agencies and consulting parties. The anchoring system would be able to adjust for water level rises or deficits therefore during a flood, or high winds it would be able to rise and fall with surrounding water levels. In other reservoirs, the proposed aeration system units are able to adjust to water levels that vary by over 70 feet. The aerator units would be serviced and accessed by the walk-on top platforms for any work associated with pumps and electrical issues. The baffle curtains, typically 8-10 feet deep, as seen in Exhibit 4, help keep debris away from the aerator units. The units would be checked periodically for maintenance and general working order (WEARS 2012a). Maintenance activities would be conducted on the aeration platforms and it is envisioned that the units would stay in place in a severe weather event. However, in the event of an emergency or major maintenance, the units could potentially be towed to shore.

During construction boats used for the installation of the proposed aeration system shall comply with USCG and state requirements, including lighting. All on water vessels shall be secured to withstand wakes from passing vessels, winds, waves, and Lake level fluctuations. The areas that would be off limits to boaters during installation of the proposed aeration system would be the same as the requested easement. The estimated construction length is two to four weeks and the scheduling of the installation timing would take into account public recreation use. Typically the heaviest boating use occurs from May through September and installation of the proposed aeration system would avoid this time period. The Town would coordinate directly with the State (Mr. Shederick Mole at North Carolina Department of Parks and Recreation) and the Crosswinds Marina operator to minimize potential conflicts with public use.

Public safety impacts from the proposed project would be minimal as all measures to the maximum extent practicable would be taken to ensure boater safety and emergency plan preparedness.

4.3.7 Consideration of Property Ownership

The study area is entirely under the ownership of the federal government, specifically the USACE. The Town has requested an additional 1.4 acre easement from the USACE for the proposed project.

4.4 Environmental Impact Comparison of Alternatives

Resource	Proposed Alternative	No Action
Geology	None	None
Topography	Minimal – would return grades to existing contours	None
Soils	Minimal – most soils in the project footprint were previously disturbed	None
Floodplain	Minimal – the proposed units float with anchors on the Lake bottom	None

Resource	Proposed Alternative	No Action
Surface Hydrology	Minimal – small footprint within Jordan Lake	None
Water Quality	Creates better water quality	Remains same
Air Quality	None – electric motors	None
Noise	Minimal – the proposed motors are smaller than the typical boat motor	None
Cultural Resources	None	None
Hazardous Waste	Temporary – construction equipment would be required; however, it is expected that it would be maintained properly for leaks, fueling, etc.	Greater potential for increased quantities of chemicals needed at the treatment plant for subsequent treatment of poor quality water
Aesthetics	Minimal – visualizations of the proposed aeration system are included	None
Vegetation	Minimal – vegetation in the proposed footprint is maintained	None
Fish and Wildlife	Minimal – Screens/velocities for the aeration system are similar to those required for the intakes, potential for increasing warm water fish habitat by increasing D.O. in the water column.	None
Endangered and Threatened Species	None	None
Wetlands	Minimal – potential for a small area of fringe wetlands to be impacted due to laying of the electric line depending on Lake level	None
Land Use	None	None
Vehicular Traffic	None	None
Recreation	Minimal – Small footprint, considerations for Lake user safety	None
Water Supply and Conservation	None	None
Energy Needs	Minimal – small motors required use less energy than other options	Greater as needs for subsequent treatment increase
Safety	Minimal – Buoys, lighting, etc would be used to ensure Lake user safety as well as the aeration units from damage	None
Consideration of Property Ownership	A request for additional 1.4 acres of easement would be required from the Corps of Engineers.	None

5 Executive Orders

5.1 Executive Order 11988 (Floodplain Management)

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. The proposed project would have no impact to floodplain management and thus be in compliance with EO 11988.

5.2 Executive Order 11990 (Protection of Wetlands)

The purpose of Executive Order 11990 is to "minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands". To meet these objectives, the Order requires federal agencies, in planning their actions, to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided. The proposed project is not anticipated to have impacts to wetlands and should be in compliance with EO 11990.

5.3 Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low Income Communities and Low Income Populations)

The USEPA defines environmental justice as the fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including a racial, ethnic, or socioeconomic group; should bear a disproportionate share of the negative environmental consequences of industrial, municipal, or commercial operations or the execution of federal, state, local, or tribal programs and policies. The nature and location of the proposed project would not have the potential for disproportionate health or environmental effects on minorities or low-income populations or communities. The project would be in compliance with EO 12898.

5.4 Executive Order 11593 (Protection and Enhancement of the Cultural Environment)

Executive Order 11593 directs Federal agencies to inventory their cultural resources and establish policies and procedures to ensure the protection, restoration, and maintenance of federally owned sites, structures, and objects of historical, architectural, or archaeological significance. It also requires agencies to avoid inadvertently destroying such properties prior to completing their inventories. The proposed project would be in compliance with EO 11593 as the study area has been cleared for any of the aforementioned resources.

5.5 Executive Order 13186 (Protection of Migratory Birds)

Executive Order 13186 directs federal agencies taking actions with a measurable negative effect on migratory bird populations to develop and implement a Memorandum of Understanding with the U.S. Fish and Wildlife Service that promotes the conservation of migratory bird populations. The proposed project is not anticipated to affect any migratory bird populations and therefore would be in compliance with EA 13186.

6 Unavoidable Adverse Impacts of the Proposed Action

Construction of the proposed aeration system is not anticipated to create any unavoidable adverse impacts. The project's sole purpose is to improve water quality in Jordan Lake in the area of the RWPS intakes in order to assist with subsequent treatment in providing safe and reliable drinking water to the service area.

7 Cumulative Impacts

Indirect or secondary effects and impacts are those that are reasonably foreseeable and caused by a project, but occur at a different time or place. Indirect or secondary effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density, or growth rate, and related effects on air and water and other natural systems. The purpose of the Proposed Action is to improve raw water quality in Jordan Lake in the area of the RWPS intakes for the Towns of Cary, Apex, and Morrisville. No indirect effects of the Proposed Action are anticipated. Growth and development in the service area are dependent upon the capacity of the water treatment plant. The CAWTF has a permitted capacity and is currently being designed for an increase in capacity to 56 mgd. This expansion was covered under an EA/Find of No Significant Impact (FONSI) in June 2012. The No Action alternative, on the other hand, could have indirect effects by requiring the implementation of more costly alternatives and/or additional treatment options at the CAWTF.

Cumulative effects have been defined by the CEQ in 40 CFR 1508.7 as: "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions." No other significant future actions have been identified in the Project Area; therefore, the impacts of the Proposed Action, when added to other past, present, and future actions, should be negligible. The No Action Alternative is not anticipated to have an appreciable cumulative impact.

Additionally, cumulative impacts for growth within the service area have been addressed through the Towns of Cary, Apex and Morrisville's Secondary and Cumulative Impacts Master Mitigation Plans (SCIMMP) and subsequent updates to those plans. Please refer to the SCIMMPs for additional information on secondary and cumulative impacts for the service area associated with the Aeration

System. This project is not anticipated to have any secondary and cumulative impacts related to growth in the service area as the project does not provide additional treatment capacity or quantity. Instead, this project is being proposed as a water quality measure to ensure a higher quality water to the residents of the service area. The table in Section 4.4 addresses the anticipated direct impacts from implementation of the proposed system.

8 Public Involvement/Scoping

Scoping letters were submitted to the NC State Clearinghouse on September 30, 2011 requesting input from State agencies regarding the Proposed Action. Additional letters requesting input were sent to agencies not included on the NC State Clearing House Distribution List. These included federal agencies such as the United States Fish and Wildlife Service (USFWS) and the United States Environmental Protection Agency (USEPA), in addition to State and local agencies such as the State Historic Preservation Office (SHPO), the Town of Cary, and the City of Raleigh. Comments received are included as Appendix B and have been considered in the construction of this document.

9 List of Recipients

This Environmental Assessment is being circulated for a 30-day review and comment period to the public and resource agencies. See Appendix E for a complete list of recipients.

10 Point of Contact

Any comments or questions regarding this Environmental Assessment should be addressed to:

U.S. Army Corps of Engineers
Attn: Justin Bashaw
69 Darlington Avenue
Wilmington, NC 28403
E-mail: Justin.P.Bashaw@usace.army.mil
Phone: (910) 251-4581

11 List of Preparers

Name	Position	Credentials
Peter D'Adamo, PhD, PE	Project Manager / Engineer	PhD in Engineering with over 34 years of experience as a biologist, environmental engineer, scientist, and water treatment plant operator, and has been directly responsible for the planning, evaluation, design, and construction management of numerous water treatment projects ranging in size from 0.1 to 318 mgd.
Erika Bailey, PE	Project Engineer	MS in Environmental Engineering with over 15 years of experience in experience in water/wastewater treatment process evaluation, design, and environmental permitting. She has assisted with development of several SEPA documents for water and wastewater upgrade projects.
Vickie Miller, AICP, PWS	Senior Environmental Scientist / Planner	MS in Environmental Science with over 13 years of experience leading and preparing NEPA/ SEPA documentation for complex transportation, water and wastewater projects. She is involved in 404/401 permitting, protected species surveys, wetland delineations, and stream and wetlands restorations.
Jessica Tisdale, CE	Environmental Scientist	MS in Forestry with 5 years of experience in conducting investigations to evaluate terrestrial and aquatic resources. She has been involved with 404/401 permitting, roadway borrow site analysis, protected species surveys, wetland delineations, and stream restoration assessment.

12 Finding

The proposed action should not significantly affect the quality of the human or natural environment; therefore, an Environmental Impact Statement (EIS) would not be required. If this determination is upheld following circulation of this EA, a Finding of No Significant Impact (FONSI) would be signed and circulated.

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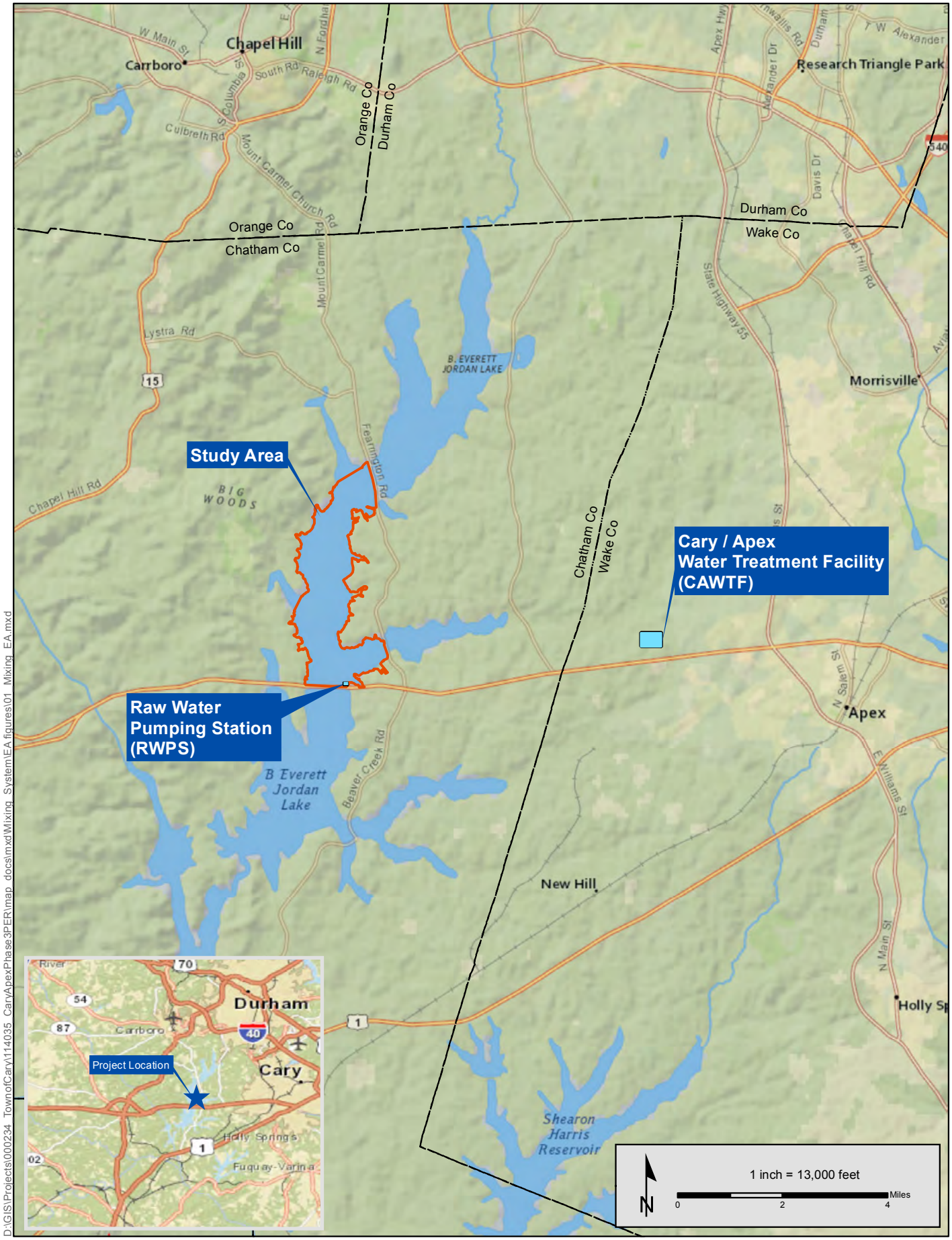
Figures



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General Project Location

Exhibit 1

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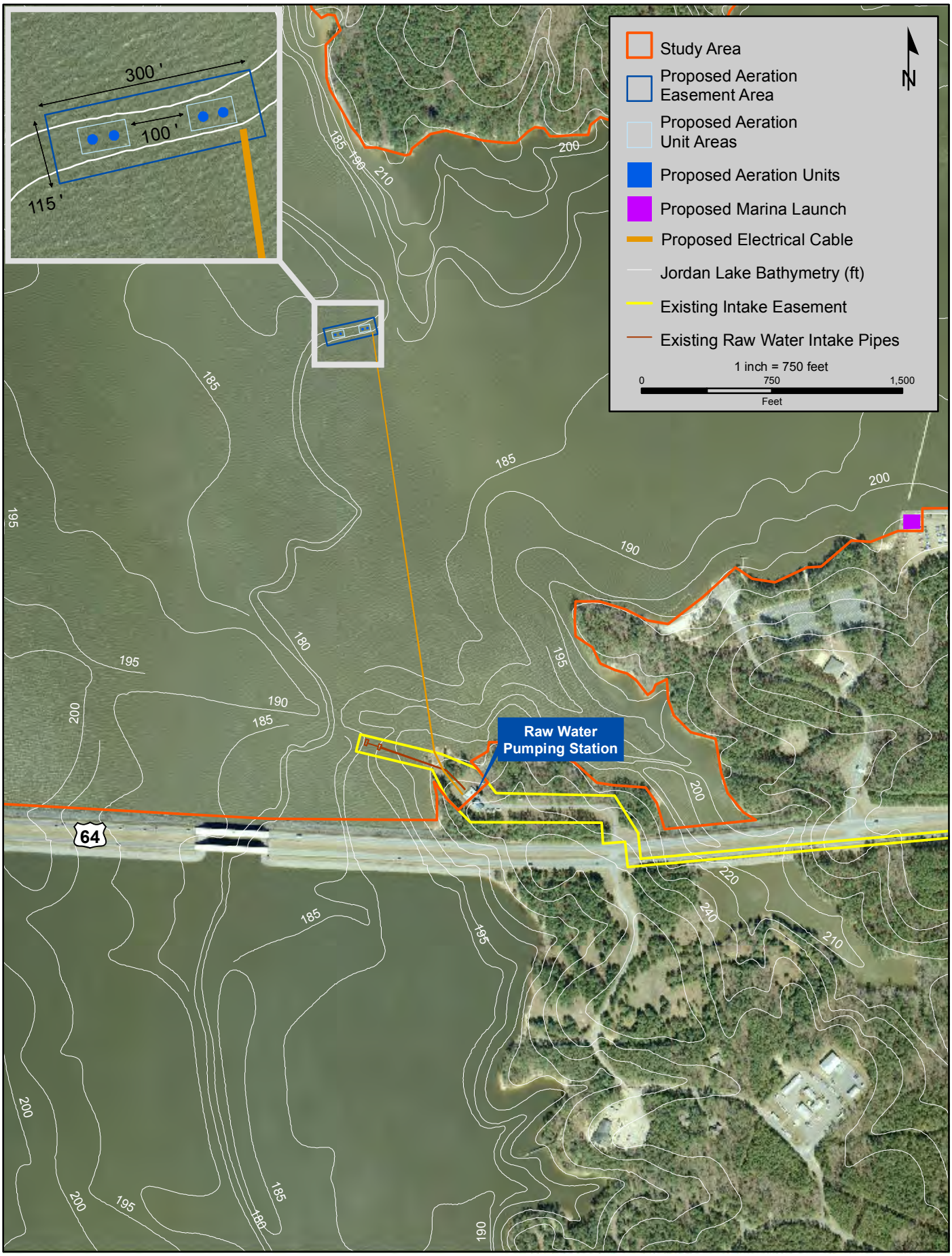
Source: National Geographic



Proposed Lake Aeration System

Exhibit 2

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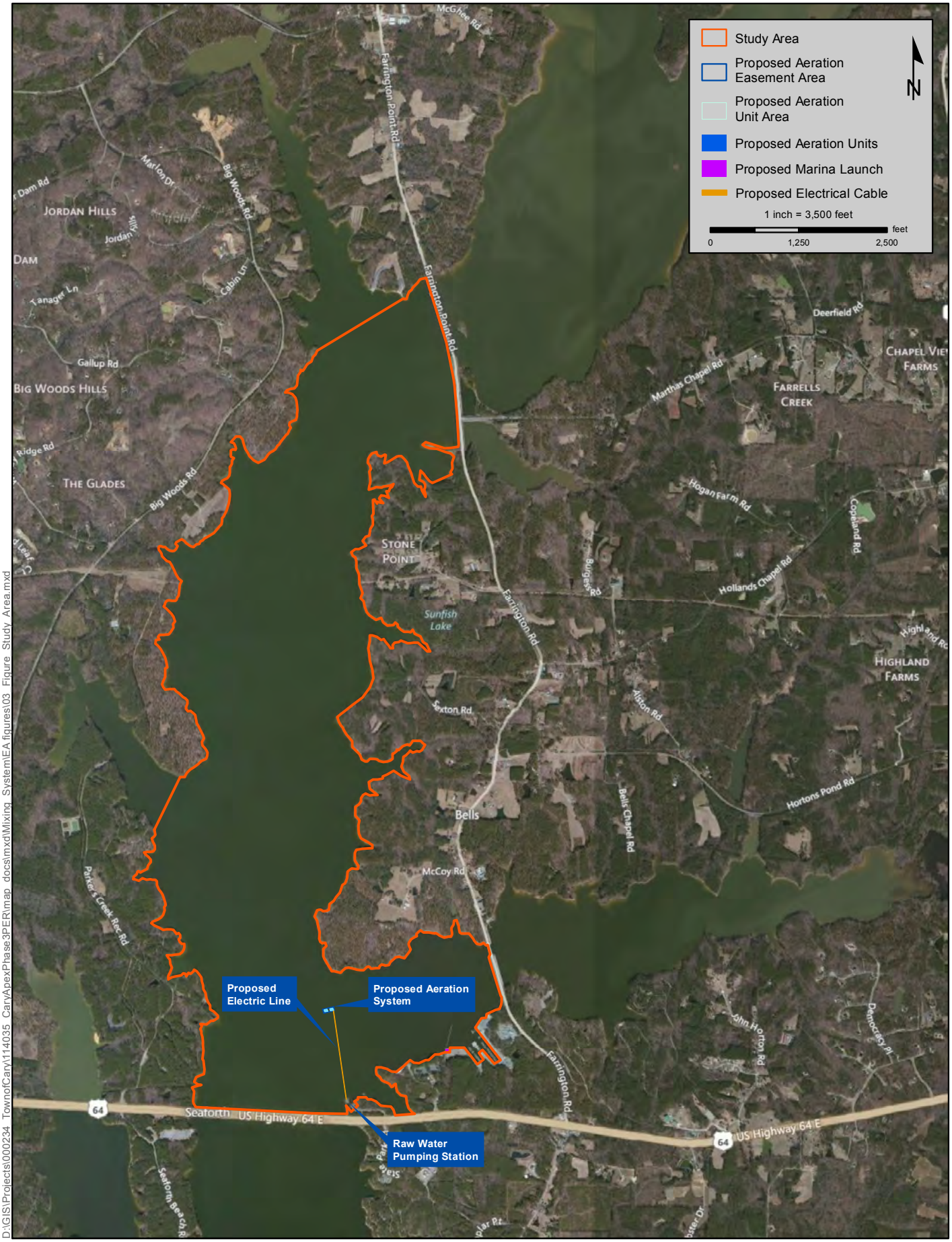
Source: 2007 Chatham County Aerial



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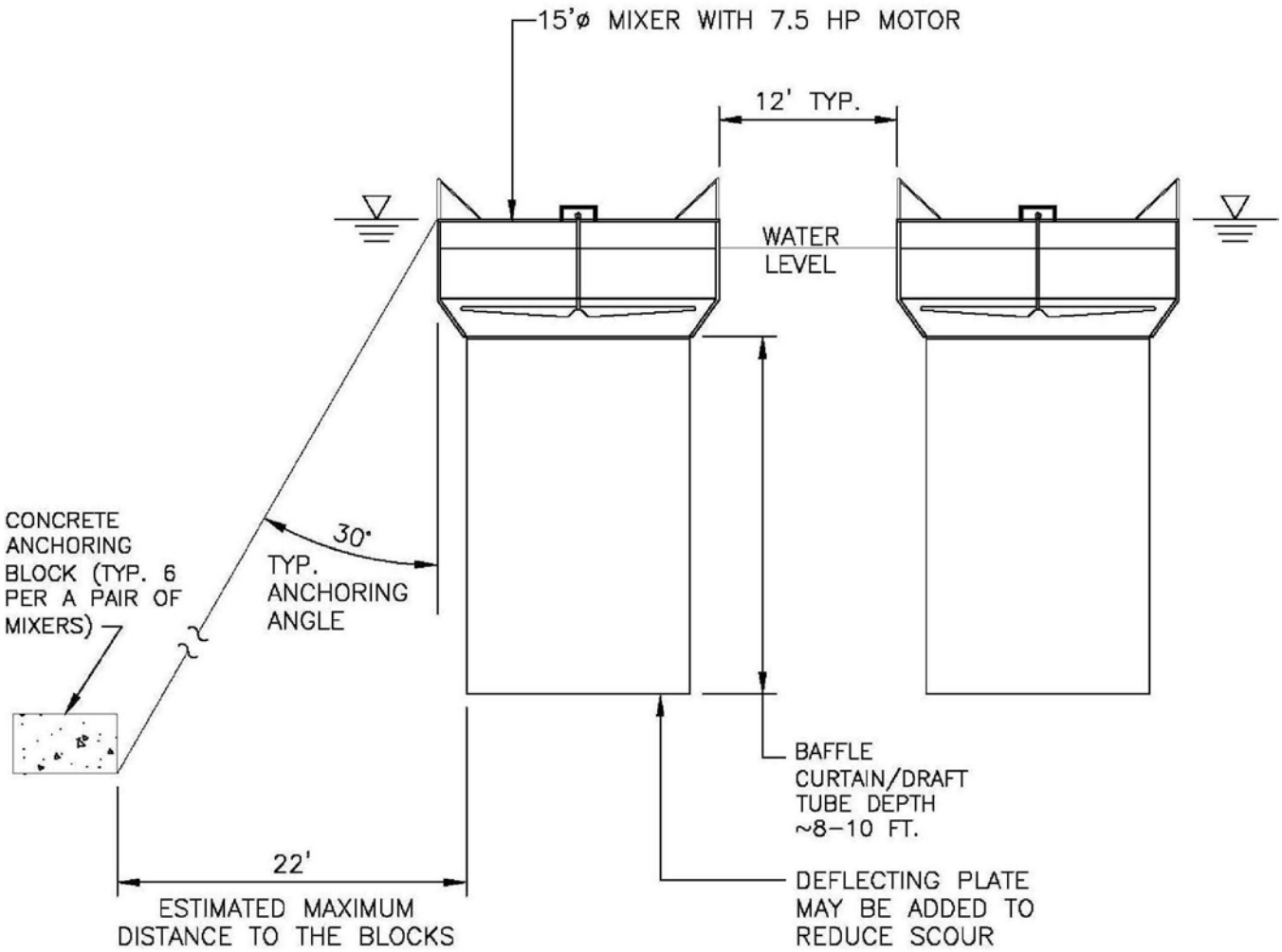
Study Area

Exhibit 3

Town of Cary | Proposed Jordan Lake Aeration System for the CAWTF | Environmental Assessment

Source: Bing Aerial



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Aeration Unit Schematic

Exhibit 4

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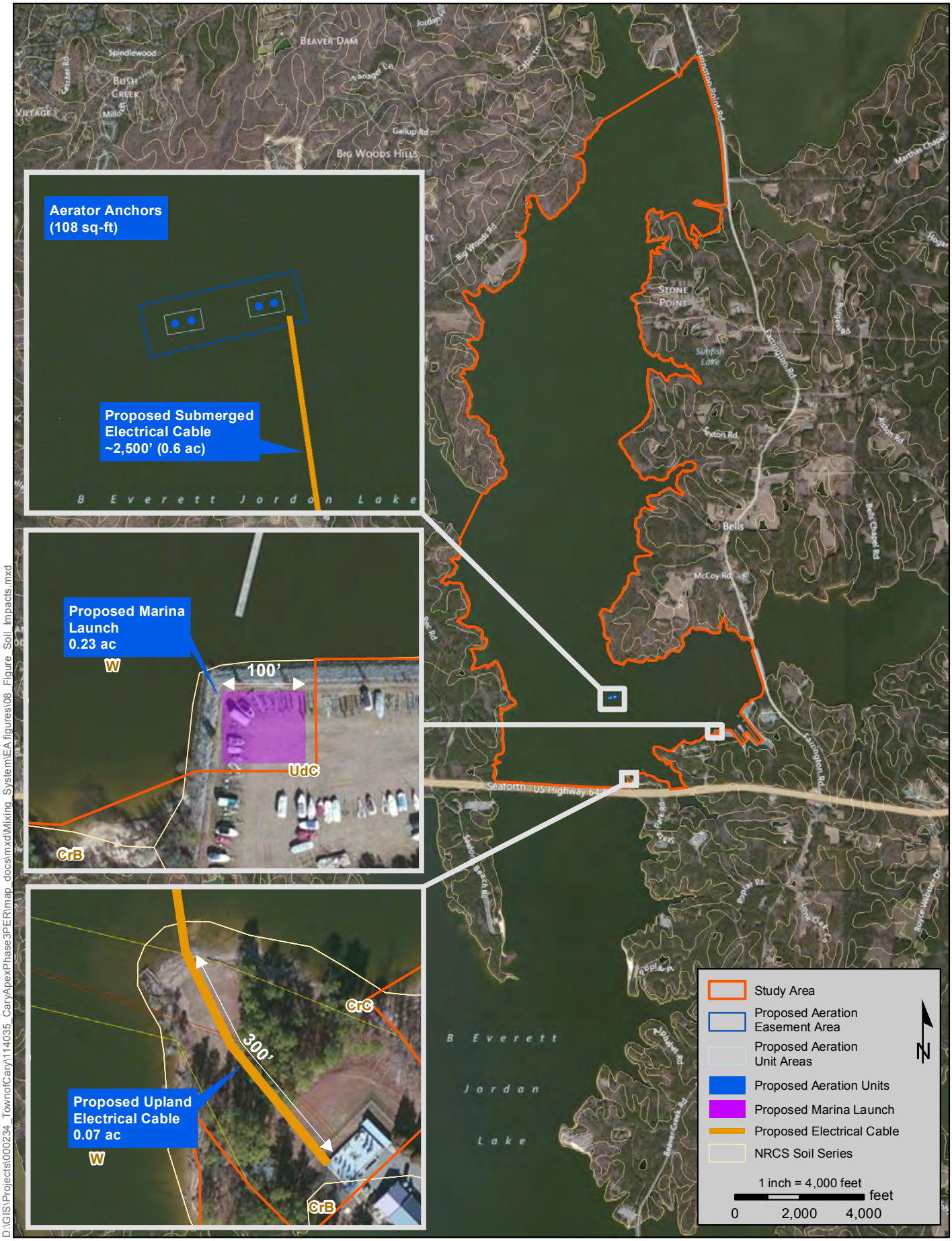
Source: HDR



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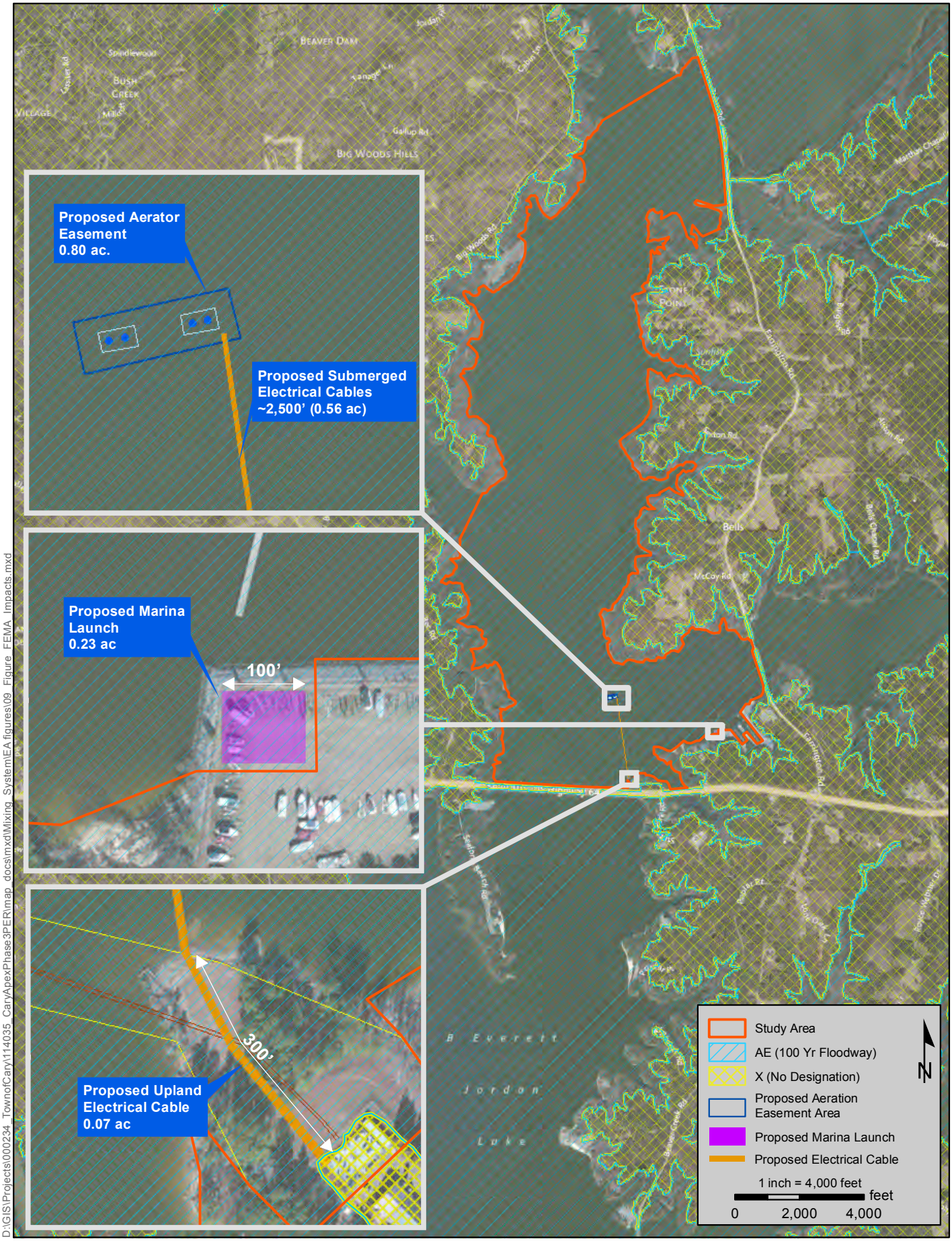
Soil Impacts

Exhibit 5

Town of Cary | Proposed Jordan Lake Aeration System for the CAWTF | Environmental Assessment

Source: Bing Aerial



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FEMA Impacts

Exhibit 6

Town of Cary | Proposed Jordan Lake Aeration System for the CAWTF | Environmental Assessment

Source: Bing Aerial

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Aeration Units Visualization from Parker's Creek Campground

Exhibit 7

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Aeration Units Visualization from US 64

Exhibit 8

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Aeration Units Visualization from Marina

Exhibit 9

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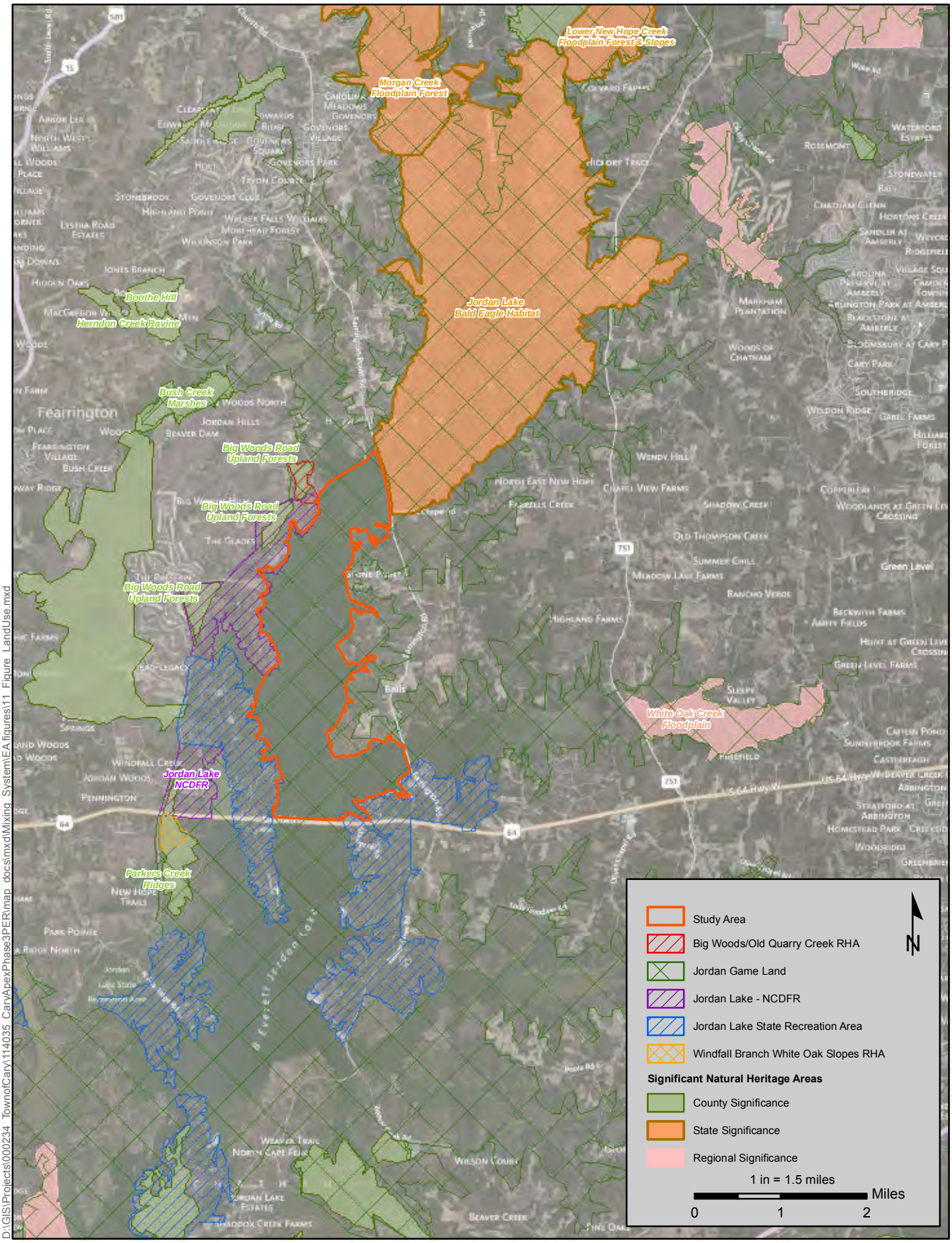
Vegetation Impacts

Exhibit 10

Town of Cary | Proposed Jordan Lake Aeration System for the CAWTF | Environmental Assessment

Source: 2007 Chatham County Aerial



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Managed Natural Areas and Public Lands

Exhibit 11

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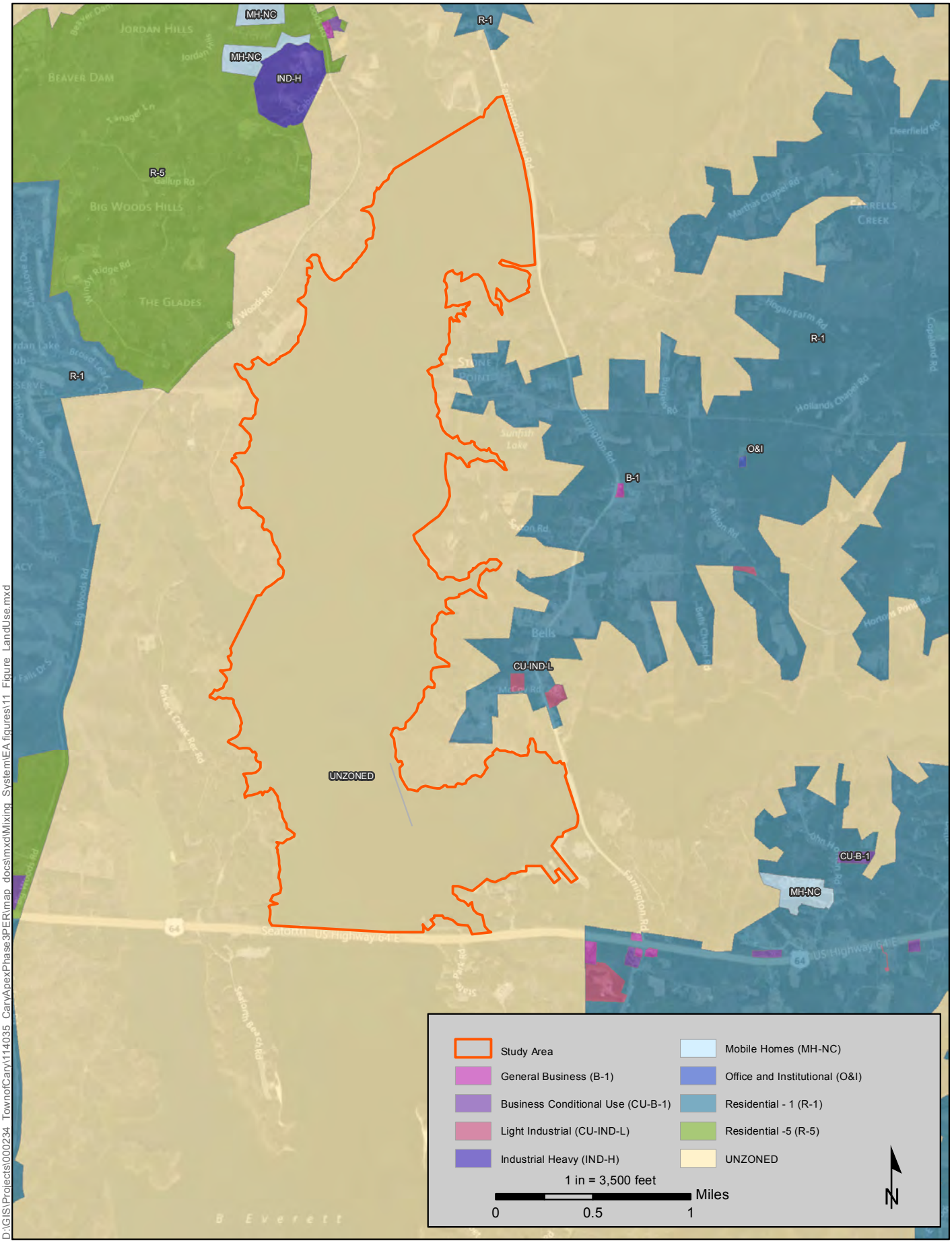
Town of Cary | Proposed Jordan Lake Aeration System for the CAWTF | Environmental Assessment

Source: Bing Aerial



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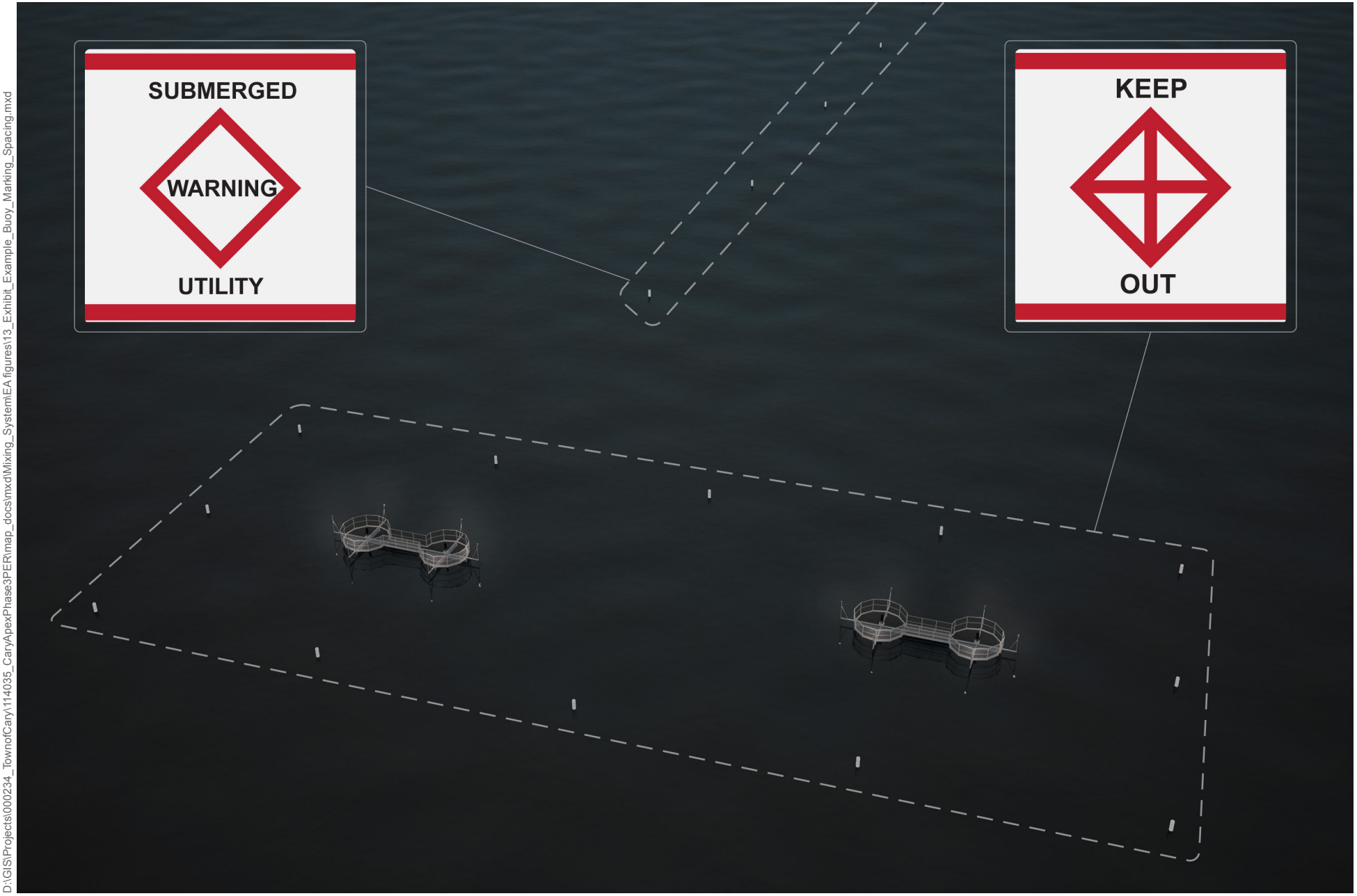
Land Use

Exhibit 12

Town of Cary | Proposed Jordan Lake Aeration System for the CAWTF | Environmental Assessment

Source: Bing Aerial



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Example Buoy and Marking Spacing

Exhibit 13

Appendix A

Water Quality Data from other WEARS Installations

Water Quality Data for WEARS Installations

Timor Reservoir, Australia

The WEARs destratification system was installed in 1999. Figure 8 illustrates cyanobacteria counts recorded in the reservoir. The reservoir experienced yearly algal blooms prior to installation of the destratification system in 1999. Since installation of the mixing system, the reservoir has not experienced cyanobacteria blooms and has experienced significant reduction in cell counts of other algal species in the last 2.5 years.

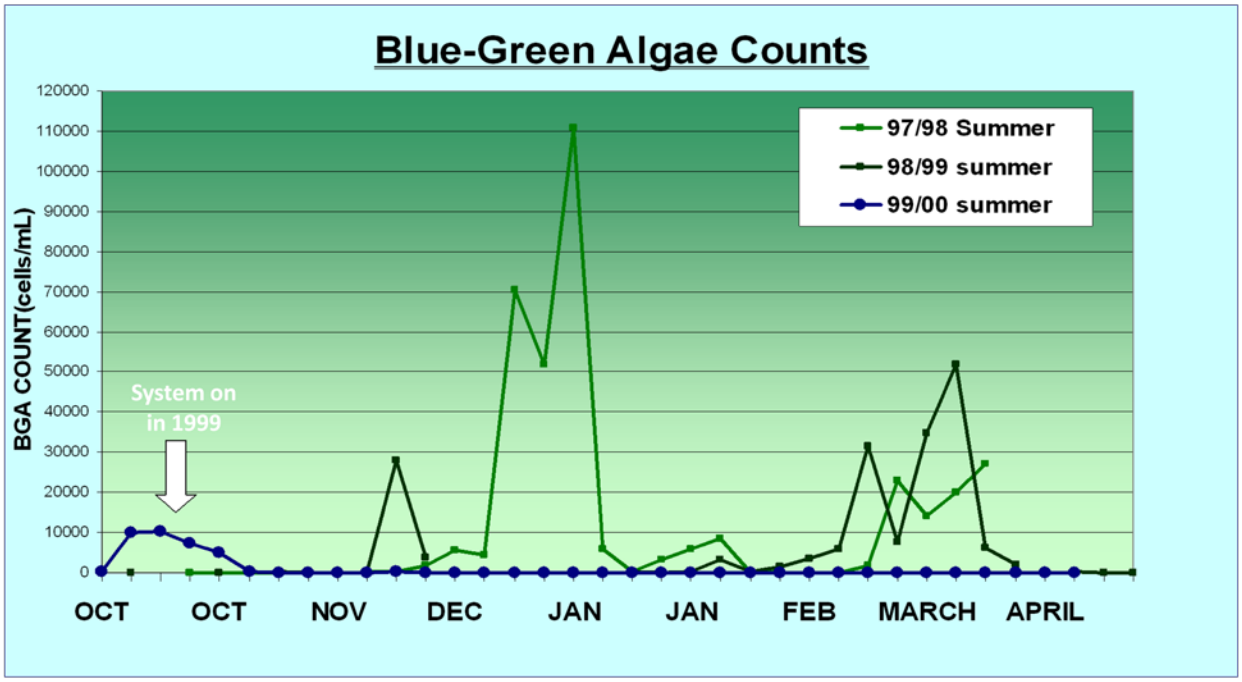


Figure 8. Timor Reservoir Blue-Green Algae Data

Cooby Reservoir, Australia

Figures 9 and 10 summarizes temperature gradient and D.O. gradient data collected before and after the mixing system was installed. The data indicates that reduced temperature gradients and improved D.O. profiles have been achieved since installation of the mixing system.

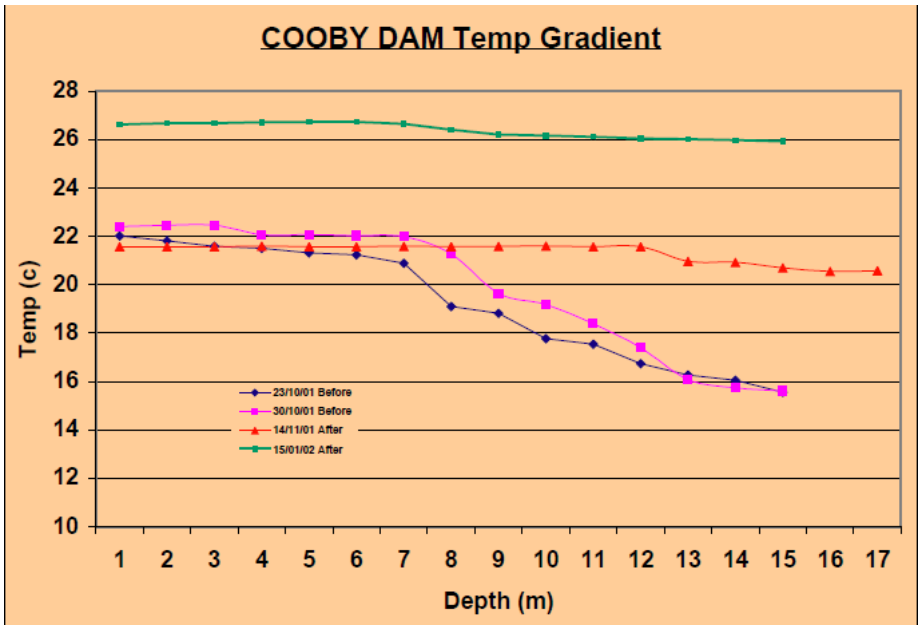


Figure 9. Cooby Dam Temperature Data Before and After Installation of Mixing System.

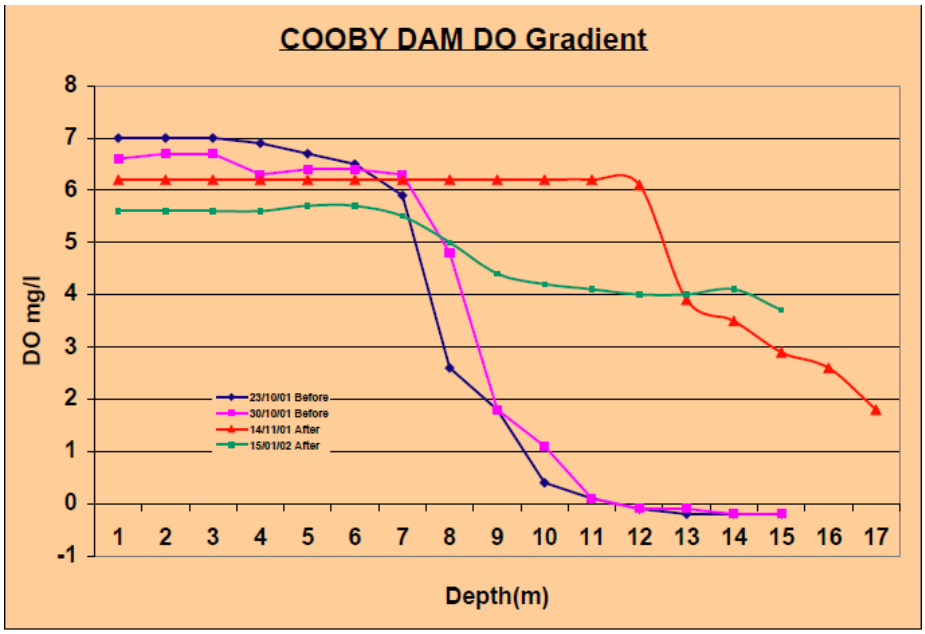


Figure 10. Cooby Dam D.O. Gradient Data Before and After Installation of Mixing System.

Perseverance Dam, Australia

Figures 11 and 12 summarizes temperature gradient and D.O. gradient data collected before and after the mixing system was installed. The data indicate that reduced temperature gradients and improved D.O. profiles have been achieved since installation of the mixing system.

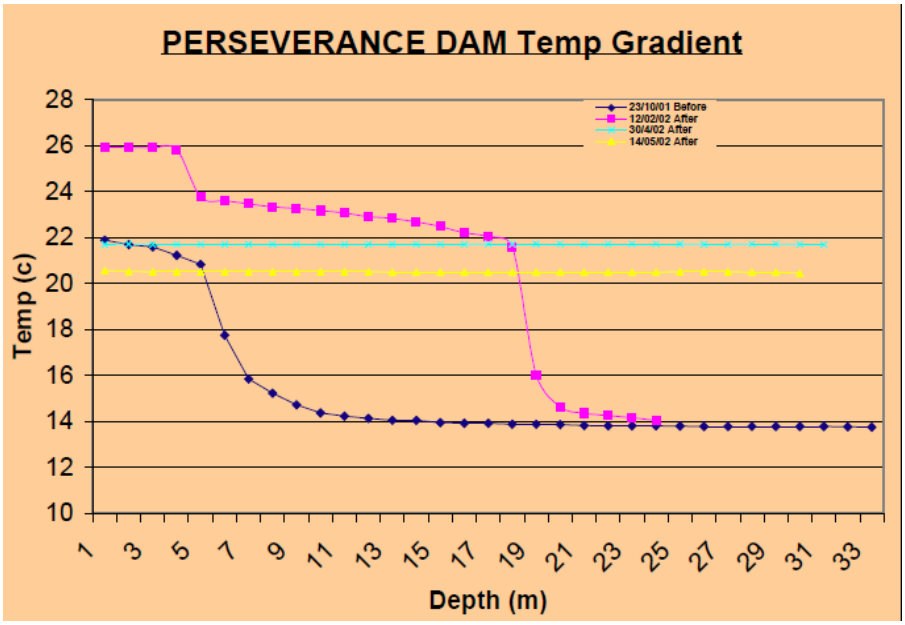


Figure 11. Perseverance Dam Temperature Data Before and After Installation of Mixing System.

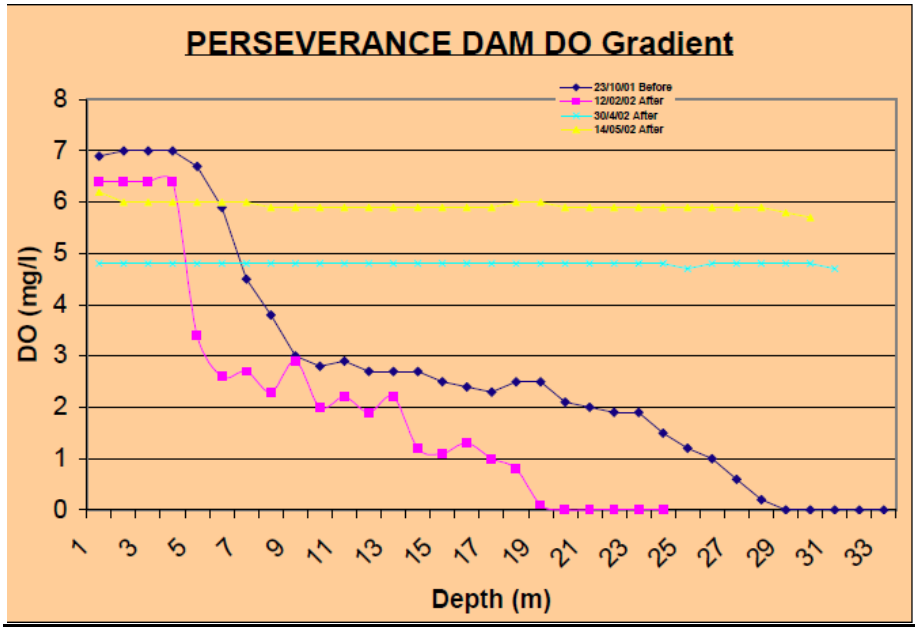


Figure 12. Perseverance Dam D.O. Data Before and After Installation of Mixing System

Cotter Reservoir, Australia

Figures 13 through 15 summarize water quality data for the Cotter Reservoir before and after the mixing system was installed. The data indicate that reduced temperature gradients and improved D.O. profiles have been achieved since installation of the mixing system.

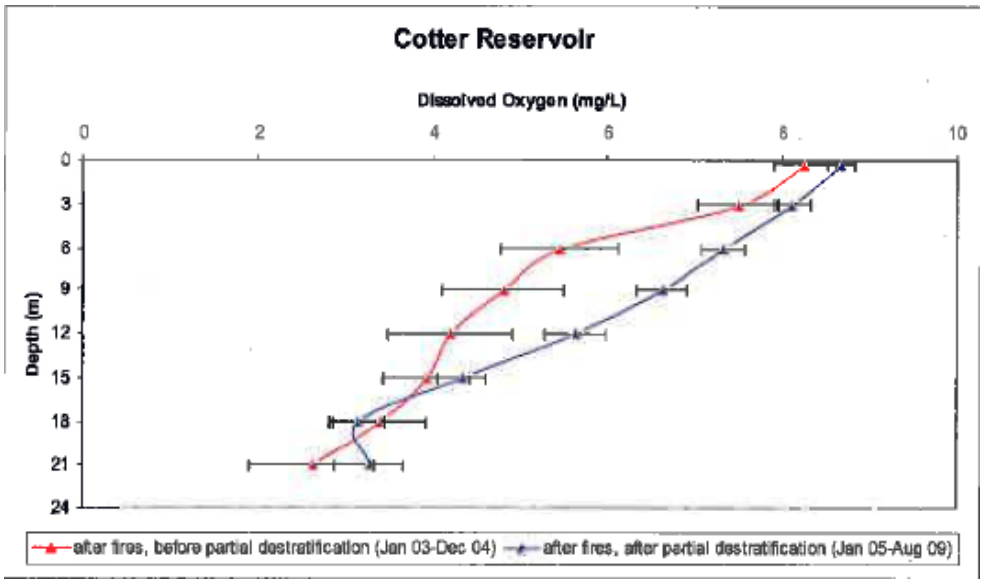


Figure 13. Cotter Reservoir D.O. Data Before and After Installation of Mixing System

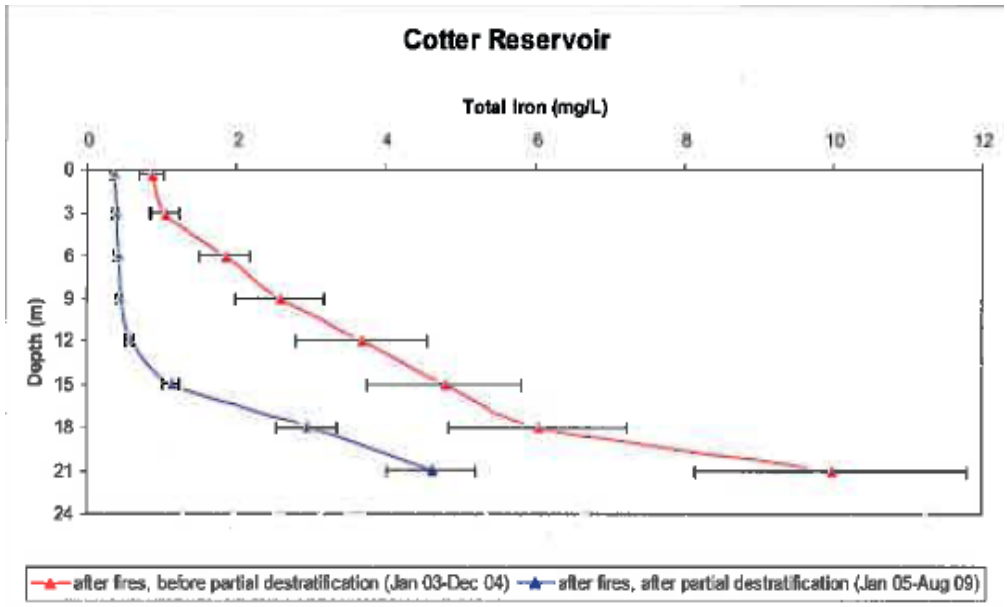


Figure 14. Cotter Reservoir Iron Data Before and After Installation of Mixing System

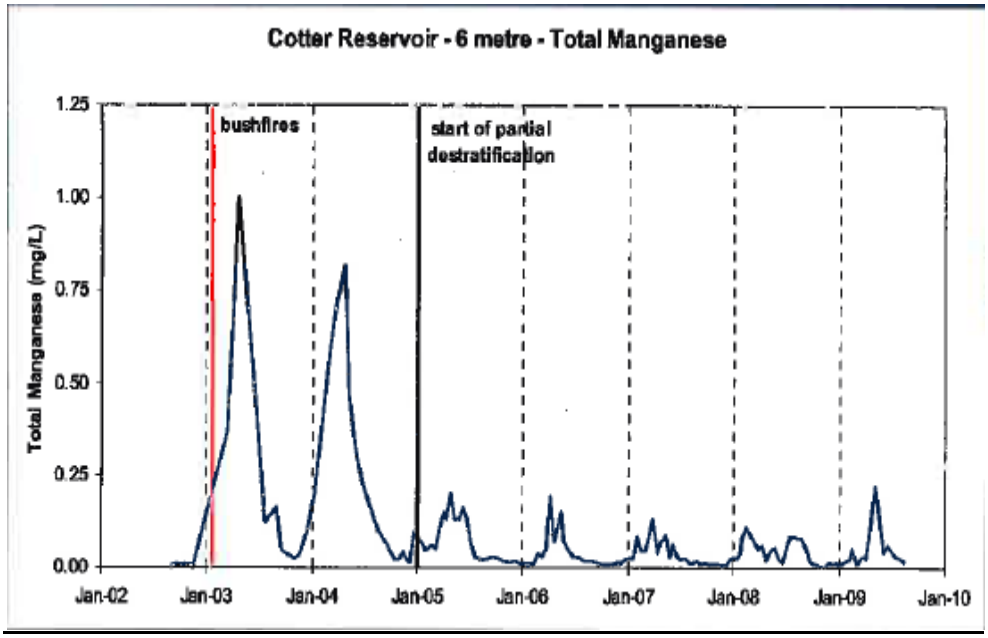


Figure 15. Cotter Reservoir D.O. Data Before and After Installation of Mixing System

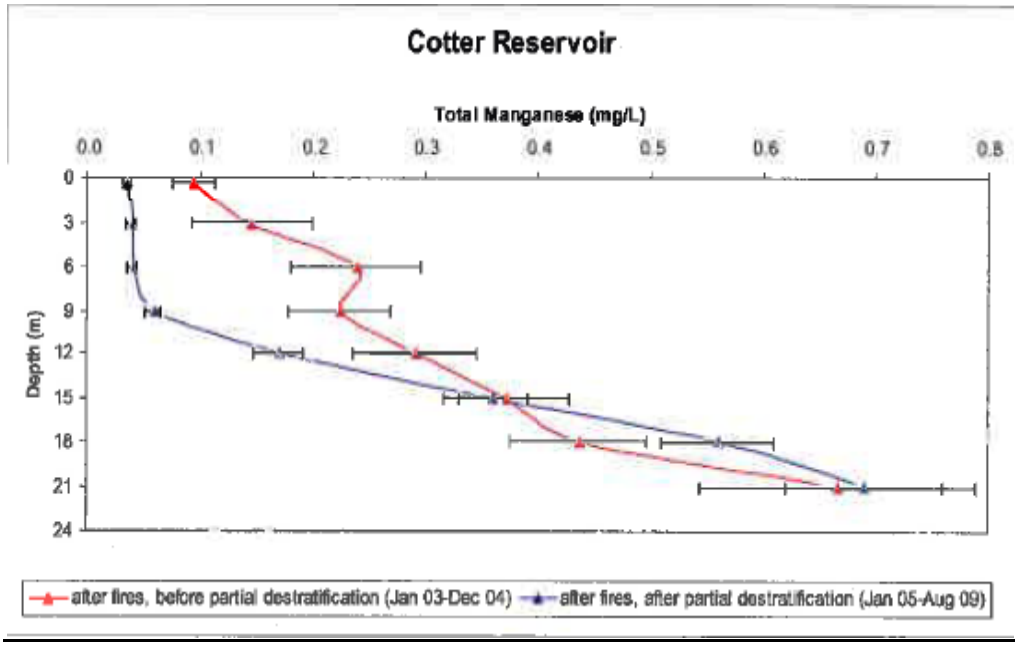


Figure 16. Cotter Reservoir Total Manganese Data Before and After Installation of Mixing System

Appendix B

Scoping Comments

From:	Bailey, Erika L.
To:	Hosey, Michael L II SAW
Cc:	Owens, Jennifer L SAW; D"Adamo, Peter; Miller, Vickie M; Sydney Miller
Subject:	FW: Aqua Sierra Inc. and the Aeration of Jordan Lake
Date:	Thursday, October 06, 2011 11:20:45 AM

Michael,

This is the last e-mail pertaining to the three comments the Town of Cary received from vendors of lake aeration technologies regarding the proposed lake aeration system.

Below is the last of the three sets of comments received.

Thanks and please let me know if you have any questions.

Erika L. Bailey
PE

HDR Engineering, Inc. of the Carolinas
Senior Project Manager | Professional Associate

3733 National Drive Suite 207 | Raleigh, NC 27612-4845
919.785.1118 | c: 919.740.1876
erika.bailey@hdrinc.com | hdrinc.com <http://www.hdrinc.com/>

Follow Us – Facebook <http://www.facebook.com/pages/HDR-Inc/142672125757519?ref=ts> | Twitter <http://www.twitter.com/HDR_Inc> | YouTube <http://www.youtube.com/HDRinc>

From: PeterStitcher [mailto:PeterStitcher@aqua-sierra.com]
Sent: Friday, September 09, 2011 4:52 PM
To: 'stevebrown@townofcary.org'
Subject: Aqua Sierra Inc. and the Aeration of Jordan Lake

Steve

Thank you for your time and for allowing me to introduce Aqua Sierra Inc. (ASI) and our reservoir aeration services to you this afternoon. Established in 1989, our team of biologists and engineers bring a combined 125 years of experience to the table managing and enhancing water and fisheries. Whether it is aerating a degraded reservoir in the Rockies, protecting industrial infrastructure from Zebra Mussels on the Great Lakes, or building hatcheries overseas, our thousands of customers both in the States and abroad can attest to the effectiveness of our systems, the thoroughness of our science, and the quality of our service. I have attached a case study of Bear Creek Reservoir (Lakewood, CO) in which we replaced a hypolimnetic system with our ADS bottom laid modules, and the subsequent improvements to the reservoir. In addition to completely removing the thermocline, our system is

facilitating a complete turnover of the 652 million gallon reservoir once every three days. Using the housing structure of the previous unit and one of its compressors, we were able to install this comprehensive treatment system for approximately 1/30th of the cost of your projected budget. I have also included a brochure highlighting a study that proves the effectiveness and efficiency of our systems.

When installed in the deepest reaches of the lake, our system will break the thermocline enabling the entire water column to remain in a perpetual state of mixing, and optimizing the oxidation and precipitation of iron, manganese, and phosphorus across the entire basin as opposed to hypolimnetic systems that symptomatic treatment of an isolated point. For greater treatment, enhanced oxidation, and the digestion of off-tasting organic material, ozone can be injected through our system to treat the formerly anoxic benthos.

Other benefits of our system include:

- A 5-year manufacturers guarantee on workmanship
- 3% oxygen transfer per vertical foot
- Easy installation and minimal maintenance
- System wide treatment
- Extremely energy efficient
- No recreational hazards to boaters or swimmer
- Enhances the fishery enabling organisms to inhabit the entire water column
- Protection against oxygen induced winterkill

The team at Aqua Sierra Inc. and myself would like to provide you with a free system design and proposal should you desire to explore this option at greater depth. To do so we would need a bathymetric survey or the lake, the location of existing shelters with a description of their power supply, any water quality data you have for the resource, and any information you can provide on prominent wind patterns (ex. East to West) at Jordan Lake. This would enable us to craft the best system based on the specific needs of the resource. If this data has not been collected I would be able to provide a proposal for ASI to conduct the necessary studies. I would also be glad to provide you with a client reference who can speak to both his experience with hypolimnetic systems and our fine-bubble, bottom laid aeration system.

Steve, I am confident that we can provide you with a vastly superior, comprehensive, and cost effective treatment solution. Should you have any questions regarding the attachments and services, or would like to explore this option more fully, you can reach me via my e-mail or cell any time.

I look forward to continuing the conversation.

Sincerely:

Peter Stitcher

Aquatic Biologist/Restoration Ecologist

Aqua Sierra, Inc.

8350 S. Mariposa Dr.

Morrison, CO. 80465

C: (303)929-8202

PH: (303) 697-5486 ext. 102

FAX: (303) 697-5069

www.aqua-sierra.com <http://www.aqua-sierra.com/>

PeterStitcher@aqua-sierra.com <mailto:kholmes25@aqua-sierra.com>

October 25th, 2011

Mr. Michael Hosey
Corps of Engineers – Jordan Lake Visitor Center
P.O. Box 144
Moncure, NC 27559

RE: Jordan Lake Aeration Project

Dear Michael,

I am writing to submit the *Aqua Sierra Inc.'s Reservoir Aeration System* as an alternative to the Weirs Australia hypolimnetic towers currently specified for Jordan Lake. Enclosed is a system proposal, module placement map based on the bathymetry of the lakebed, treatment and price comparisons, reservoir treatment case study, system performance review based on EPA standards, and statement of company qualifications. With more than 125 years combined experience in the fisheries and water quality management, Aqua Sierra Inc. has implemented these systems in the treatment of hundreds of lakes and reservoirs across the country.

Aqua Sierra Inc.'s proposed system will create a *120 acre field of treatment*, turn over *more than one billion gallons* ever other day, and do so at just *28% of the cost* of the proposed hypolimnetic system. Thank you for your consideration and for the opportunity to present our system. Please feel free to call if there are any questions regarding the proposal or if you would like additional information regarding the benefits of the system.

Sincerely,

Peter Stitcher
Aquatic Biologist / Restoration ecologist

RECEIVED
OCT 26 2011
BY: MMR

Aqua Sierra Inc.

Excellence in Fisheries and
Water Quality Management

Aqua Sierra Inc.'s
Reservoir Aeration System Proposal
For Jordan Lake – Cary, NC

Prepared for: Town of Cary –
Public Works and Utilities Department

Prepared by:
Peter Stitcher
Aqua Sierra Inc.
Aquatic Biologist / Restoration Ecologist

9094 US Highway 285, Morrison, CO 80465-8950
(303) 697-5486
(Toll Free) (800) 524-FISH (3474)
FAX (303) 697-5069
http://www.aqua-sierra.com

Introduction

Aqua Sierra, Inc. (ASI) has provided a cost estimate and proposal to design and install a bottom diffused aeration system in Jordan Lake based on the stated desires of the Town of Cary Public Works and Utilities Department in the Scoping Letter (September 30th 2011) and the associated bathymetric data. Many of the issues currently being experienced in the lake are due to a large anoxic zone below the thermocline in which metal and phosphorus rich water are being drawn into the water treatment plant. This condition has necessitated the costly chemical treatment of raw waters in order to flocculate high levels of manganese and iron. Aqua Sierra Inc.'s design has been customized to turn-over move than 1 billion gallons of the water once every two days across a 120 acre zone of treatment. The oxygenation and removal of the thermocline in this zone will greatly increase the dissolved oxygen concentration in the hypolimnion and facilitate the oxidation of metals and phosphorus throughout the entire water column. The addition of ozone diffusion through the aeration modules will act to maintain the system and increase its oxidation potential.

Aeration

The natural process of lake aging is increased by the addition of nutrients and sediments into the system. Nutrients and metals enter into the resource from tributaries and runoff as well as through the accumulation of organic matter. As this organic material sinks to the bottom and begins to decompose, a sludge layer forms and increases over time. At depths below the thermocline these organic layers are exposed to anoxic conditions that can create toxic gasses such as hydrogen sulfide, ammonia, and methane. These gasses dissolve and can produce noxious odors and well as off-tasting water. Low oxygen levels increase the dissolution rate of iron and manganese into the water as well as phosphorus that are released from sediments leading to vegetation and algae blooms. This issue is generically magnified during summer stratification. If left untreated, the contents of this layer will continue to create an environment that can compound fisheries and water quality problems throughout the system.

Bottom diffused aeration and ozone act to treat the problem at its source. The mixing created by the aeration module array initiates the turnover of the entire volume of water within the zone of treatment thus maximizing dissolved oxygen concentrations from top to bottom. Increasing oxygen levels then facilitates the oxidation and flocculation of phosphorous, iron, and manganese removing them from the water.

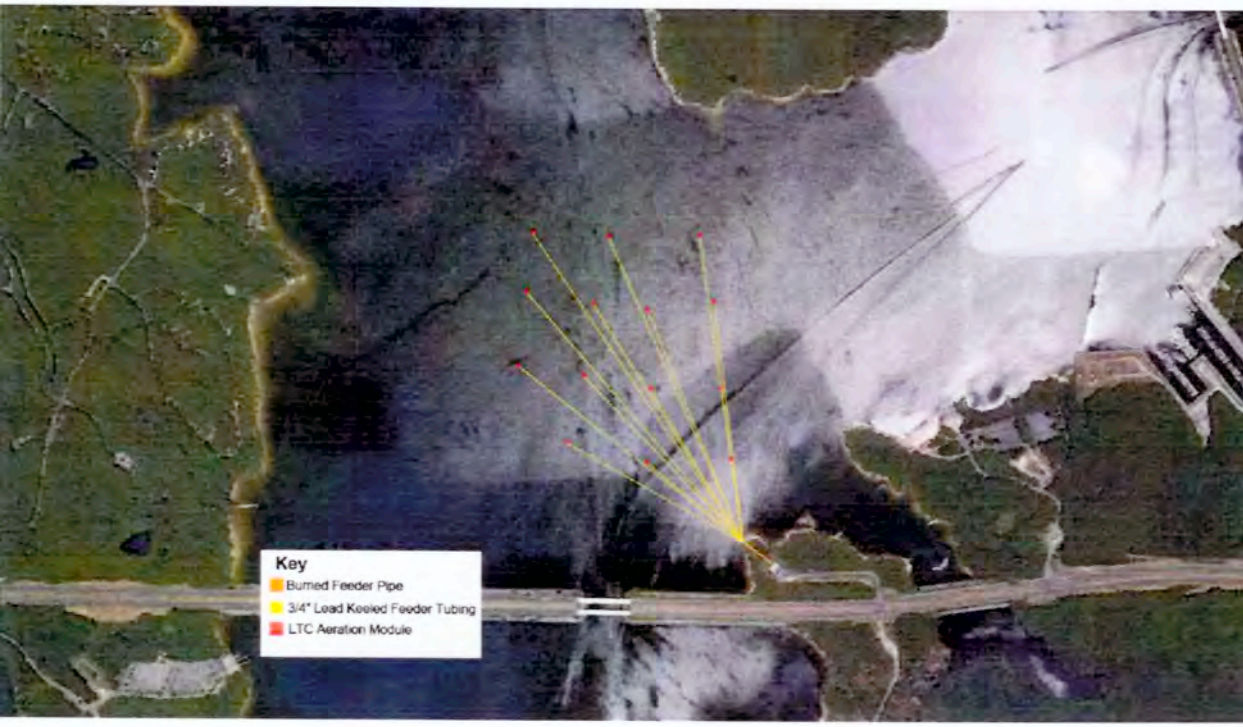
Aqua Sierra Inc.'s proprietary aeration modules releases over 1 billion "champagne like" bubbles per day, lifting cold, dense water from the lakebed in a plume towards the surface. Upon reaching the surface this plume mixes with and carries oxygenated surface waters back down through the water column effectively breaking the thermocline. In addition to exposing the entire volume of the treatment area to the oxygenated surface layers once every two days, our aeration tubing has been independently tested using the *American Society of Civil Engineers* (*ASCE*) standards and procedure, and has a proven industry best **oxygen transfer rate of 3% per vertical foot** of water depth. Increased oxygen levels in the previously anoxic hypolimnion will initiate the oxidation and flocculation of phosphorus, iron, and manganese, improve water quality, and decrease treatment costs.

A marked increase in overall fishery health is an added benefit of aeration as organisms are able to inhabit the entire water column during the summer stratification period. Furthermore recreational access is not impeded as the system does not require an easement restricting boater traffic.

Ozone Injection

Ozone (O_3) injection offers multiple benefits to the system and resource. Ozone is an oxidizing agent that is about twice as powerful as chlorine, yet has a half-life of about 18 minutes in pure water. Ozone injection acts to clean the lines and aeration modules as it readily oxidizes and breaks down organic material and benthic sludge. In phosphorus and metal rich hypolimnetic waters, ozone multiplies the systems oxidation potential and free O_2 molecules act to increasing the dissolved oxygen levels throughout the water column.

Proposed ASI Aeration System



Zone of Treatment

***Area*:** 120 surface acres

Maximum Depth: 30 feet

Average Depth: 27 feet

Volume: 141,135,000 feet^3, 1,055,685,312 gallons

Rate of Turnover Per Volume: 2 day

System Components

2 - 40 hp Screw Compressors (running alternately to insure continual treatment and system integrity), Air-Cooled After coolers, and Membrane Dryer
14 - ADS ® LTC Aeration Modules and weighted feeder tubing
Custom built control panel, Aeration manifold, Flow meters
Ozone generator and injection unit
Assorted fittings and accessories

Aqua Sierra Inc. is a full service design build firm using only the highest quality, tested, and proven equipment and materials when design aeration systems. The proposed system for Jordan Lake will inject a volume of air through 14 ADS ® LTC Aeration Modules at a rate sufficient for completely mixing the 1,055,000,000 gallons of water in the treatment zone once every other day. Ozone injection is also recommended to help maintain equipment and increase the oxidation and flocculation of iron, manganese, and phosphorus. This system will likely fit inside of the existing utilities shelter and is easy to maintain with all moving parts being located on land. The weighted feeder tubing is quickly incorporated into the substrate protecting the lines from recreational boating and fishing, and will not require easements or enclosures that would limit recreation and access on the lake.

The estimated price for this system is approximately ***$500,000***. This budgetary number would include engineering, system installation and startup, and four maintenance visits in the first year to assure that the system is running properly. Not included in this price is a shelter, trenching from the shelter to the edge of the lake, and electrical hookups. Should you be interested in exploring this option more fully, Aqua Sierra Inc. is available to answer questions and this custom engineered system to provide the Town of Cary with the most thorough and cost efficient treatment.

I thank you for your time and consideration as you explore treatment options, and hope that we can assist you and the Town of Cary in providing the most complete, efficient, and cost effective treatment of Jordan Lake. Please contact me at your convenience to discuss any questions you may have.

Sincerely:

Peter Stitcher
Aquatic Biologist / Restoration Ecologist

Miller, Vickie M

From: Sydney Miller [Sydney.Miller@townofcary.org]
Sent: Friday, November 18, 2011 8:23 AM
To: Bailey, Erika L.
Subject: FW: Jordan Lake Aeration System

Here is confirmation of Michael Hosey's meeting summary, as well as two additional comments from Phil Vasko.

--
Sydney Paul Miller
Water Resources Engineer

Department of Public Works and Utilities
Town of Cary
PO Box 8005, Cary, NC 27512-8005
Voice: 919-462-2066, Fax: 919-388-1116
sydney.miller@townofcary.org

In keeping with the NC Public Records Act, emails and all attachments may be released to others upon request for inspection and copying without prior notification.

From: Philip Vasko [mailto:pvasko@nc.rr.com]
Sent: Thursday, November 17, 2011 3:06 PM
To: Hosey, Michael L II SAW
Cc: Sydney Miller; Owens, Jennifer L SAW
Subject: Re: Jordan Lake Aeration System

Sydney and Mike:

My sincere thanks to you both for attending our Auxiliary flotilla meeting on November 10. Your presentation was very informative and naturally generated many comments among our members who are not inhibited in commenting on public boating safety issues.

You have done an excellent job in capturing virtually all of the concerns and comments generated at our Auxiliary flotilla meeting. We have just two other comments by our membership:

1. The positioning of the aeration system in a very busy boating traffic lane. During our safety patrols we have observed considerable sailboat and powerboat traffic through that area due to the location of the Crosswinds Marina. We realize, of course, that the components need to be positioned near the intake tubes.

2. The other issue is one of debris (log, boating debris) should float to the System and get "jammed" what is the "alarm" system to notify all that (1) it is jammed) and (2) to not "overheat/blow" the motor ??

My sense is that you have already considered the above issues but wanted to get our "oar in the water" as an interested entity.

We wish you great success in this endeavor and if there is anything that the Cary Flotilla of the USCG Auxiliary can assist you with, please don't hesitate to let us know how we may help.

Best regards,

Phil Vasko

On Nov 14, 2011, at 10:30 AM, Hosey, Michael L II SAW wrote:

Commander Vasko,

Thanks for the opportunity to attend the CG Auxiliary meeting last Thursday and the thoughtful discussions during the Town's presentation of their proposed aeration (mixing) system. Understand that members of the CG Auxiliary may be submitting written comments individually. Comments are welcome but would appreciate receiving them as soon as possible since the official scoping period has ended.

These are items I noted from participants in the discussions during the presentation. Understand that these are comments of individuals and not official comments on behalf of the Coast Guard.

- avoid navigation hazard through use of buoys and lighting
- potential for anchors to snag submerged electric line
- structures ability to withstand lake fluctuations
- location relative to prevailing winds
- impact of wind and waves on structure
- entrainment of fish
- potential to for concentration bait fish and in turn game fish and fisherman creating congestion in the area
- security - potential for vandalism & trespass

As discussed, the next step in the process is preparation of the Environmental Assessment (EA). Comments received during the scoping process will be addressed in the EA. When it is complete the EA will be sent out for a 30 day comment period. Comments received on the EA will be addressed in the Finding of No Significant Impact (FONSI) if one is prepared. If a FONSI is signed the Town would be able to proceed with the project as described in the EA/FONSI. If significant impacts are identified during by the EA process a FONSI would not be prepared; an Environmental Impact Statement (EIS) would be required.

Thanks again for your interest and the continued service to the public. Let me know if you all have questions.

Michael

Michael Hosey
Operations Division - Lakes Branch
USACE Wilmington District

office 919-542-4501 x26
cellular 919-630-4117

Miller, Vickie M

From: Sydney Miller [Sydney.Miller@townofcary.org]
Sent: Friday, November 18, 2011 8:21 AM
To: Bailey, Erika L.
Subject: FW: Jordan Lake Aeration System

Below is a summary of our meeting with the USCG Auxiliary, from Michael Hosey. I will also forward Phil Vasko's response.

--
Sydney Paul Miller
Water Resources Engineer

Department of Public Works and Utilities Town of Cary PO Box 8005, Cary, NC 27512-8005
Voice: 919-462-2066, Fax: 919-388-1116
sydney.miller@townofcary.org

In keeping with the NC Public Records Act, emails and all attachments may be released to others upon request for inspection and copying without prior notification.

-----Original Message-----
From: Hosey, Michael L II SAW [mailto:Michael.L.Hosey.II@usace.army.mil]
Sent: Monday, November 14, 2011 10:30 AM
To: pvasko@nc.rr.com
Cc: Sydney Miller; Owens, Jennifer L SAW
Subject: Jordan Lake Aeration System

Commander Vasko,

Thanks for the opportunity to attend the CG Auxiliary meeting last Thursday and the thoughtful discussions during the Town's presentation of their proposed aeration (mixing) system. Understand that members of the CG Auxiliary may be submitting written comments individually. Comments are welcome but would appreciate receiving them as soon as possible since the official scoping period has ended.

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Thanks again for your interest and the continued service to the public. Let me know if you all have questions.

Michael

Michael Hosey
Operations Division - Lakes Branch
USACE Wilmington District
office 919-542-4501 x26
cellular 919-630-4117

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City Of Raleigh
North Carolina

To: Craig Shoe, Operations Project Manager
69 Darlington Avenue
Wilmington, NC 28403-1343

Date: November 16, 2011

Re: Lake Jordan Intake Aeration System

In response to your request for comments regarding the proposed Jordan Lake Aeration System submitted by the Towns of Cary and Apex, the City of Raleigh would like to express our full support for this project moving forward.

As you know, the City of Raleigh has a contractual agreement with the Army Corps of Engineers to withdraw water from Falls Lake for drinking water purposes, and we also maintain and operate drinking water resources in the Swift Creek watershed. As with many reservoirs in the Piedmont region, stratification during the summer months can present significant treatability issues and we have recently considered mixing solutions similar to the proposed project. We believe this type of aeration system may effectively prevent stratification during the summer and improve water quality in the area directly around the intake structure. It should also be noted that the Town of Cary has established a strong environmental stewardship record as demonstrated in their Secondary and Cumulative Impact Management Plan and successful water conservation programs. For these reasons, it is our belief that the Applicants will ensure such a system will have minimal impact on environmental conditions within the reservoir.

In this context, we feel that the potential improvements to raw water quality and anticipated minimal environmental impacts warrants this project moving to implementation. If you should have any questions regarding this matter, please do not hesitate to contact me at (919) 996-3471.

Sincerely,

John R. Carman, P.E.
Public Utilities Director

From: Bailey, Erika L.
To: Hosey, Michael L II SAW
Cc: Owens, Jennifer L SAW; Sydney Miller; D"Adamo, Peter; Miller, Vickie M
Subject: Proposed Jordan Lake Aeration System Comments
Date: Wednesday, October 05, 2011 5:00:31 PM

Michael,

I mentioned to Jenny last week that the Town has received three comments from vendors of lake aeration technologies regarding the proposed lake aeration system. I will be forwarding the three sets of comments in separate e-mails. Below is the first comment. We will address alternatives to the proposed system in the draft EA.

Thanks and please let me know if you have any questions.

Erika L. Bailey
PE

HDR Engineering, Inc. of the Carolinas
Senior Project Manager | Professional Associate

3733 National Drive Suite 207 | Raleigh, NC 27612-4845
919.785.1118 | c: 919.740.1876
erika.bailey@hdrinc.com | hdrinc.com <http://www.hdrinc.com/>

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From: Bob Kortmann [bob@ecosystemconsulting.com]
Sent: Wednesday, September 21, 2011 1:36 PM
To: Kelvin Creech; Charles Bonnell
Cc: Jarrod Buchanan; David Spencer; Betsy Drake; Penny Rosser
Subject: Jordan Lake Artificial Circulation

Kelvin,

I am a professional applied limnologist; and have worked in the water supply reservoir management area since 1980. I read about your plan to attempt destratification at Jordan Lake. I believe there is a

very real potential that such a project will be unsuccessful on such a large run-of-river reservoir (almost 14,000 surface acres). I also believe there is a very significant risk of serious water quality and habitat impacts associated with the plan. Jordan Lake is a strongly stratified, productive system which experiences high levels of both autochthonous and allochthonous organics. I do believe there are very cost-effective approaches which can improve water quality and overall ecosystem integrity; especially improvement of raw water supply quality. From my knowledge of the nature of the Jordan Lake Ecosystem and experience with improving other similar reservoir systems, I think some combination of reservoir partitioning of the anoxic hypolimnion and aeration/circulation can be very effective and comparably low cost (certainly a much lower cost than currently contemplated). I have attached some information to illustrate some of the concepts I'd take a serious look at before proceeding with the current plan. Additional information is available at our website:

www.EcosystemConsulting.com , (especially on our literature page).

We wish you success with your reservoir management efforts, and would welcome an opportunity to work with you to ensure that a cost-effective approach fits the ecosystem structure and function of Jordan Lake and your raw water quality requirements.

Bob Kortmann

Robert (Bob) Kortmann, Ph.D.

Ecosystem Consulting Service, Inc.

Haw River Assembly
Defending the river since 1982.
P.O. Box 187 Bynum NC 27228 (919) 542-5790 info@hawriver.org

RECEIVED
OCT 28 2011
BY: umR

October 26, 2011

Craig Shoe
US Army Corps of Engineers
Jordan Lake Visitor Assistance Center
PO Box 144
Moncure, NC 27559

Dear Mr. Shoe:

I have reviewed the scoping letter for the environmental assessment that will be undertaken by the US Army Corps for the reservoir aeration system project proposed by Cary and Apex. My initial question is how much prevention of pollution through stormwater BMP's and retrofits in the jurisdictions of these two towns could be funded by the equivalent cost of the WEARS ResMix system? I hope some consideration is given to that idea as this project is evaluated.

I understand that the goal is to provide better water quality near the drinking water supply intake in Jordan Lake, and that some of the pollution problems, such as heavy metals in sediment, would not be improved by reducing incoming pollution in White Oak and Beaver creeks.

Having looked online at other WEARS ResMix reservoir aeration projects in Australia and other parts of the world, I did not read about any major problems. However, as with all human attempts to solve problems in natural systems with technology, there can be unintended consequences. I hope the following concerns will be addressed by the US Army Corp of Engineers in the EA for this project:

1. I believe this would be the first system of this type and scale to be installed in the southeast US? If so, are there any significant climate, soil, or aquatic biology differences that would affect the way this aeration system would work, and its impact on Jordan Lake?

2. There are potential benefits to fish in the part of Jordan Lake that would have better water quality and oxygen mixing at lower levels when the system is in place. Have there been any reports of negative impacts or hazards to fish, birds, or other wildlife in reservoirs where these WEARS ResMIX systems are installed?

3. What are the potential conflicts with recreational users? What kind of signage will be used to alert boaters of the equipment in the water? How will this signage be maintained and protected from storm damage so that it is consistently viewable?

4. What measures will be required to protect the lake habitat and water quality during the installation and construction of the aeration system, including the on shore maintenance areas?

Thank you for considering my concerns as you move forward with the Environmental Assessment for this project.

Elaine Chiosso
Haw Riverkeeper

5

NCDENR

North Carolina Department of Environment and Natural Resources
Division of Coastal Management

Beverly Eaves Perdue
Governor

Dee Freeman
Secretary

October 4, 2011

RECEIVED
OCT 05 2011

Craig Shoe, Operations Project Manager
B. Everett Jordan Lake
Jordan Lake Visitor Assistance Center
US Army Corps of Engineers
PO Box 144
Moncure, NC 27559

SUBJECT: Proposed Jordan Lake Aerations System at the B. Everett Jordan Lake, Chatham County, North Carolina (DCM#20110161)

Dear Mr. Shoe:

We received a copy of the Public Notice requesting scoping comments for an environmental assessment (EA) that will be prepared concerning a proposed Jordan Lake Aeration System. Jordan Lake is in Chatham County, which is not a coastal county. Nevertheless, the proposed project could have a reasonable foreseeable coastal effect within North Carolina's coastal area since the waters flowing out of Jordan Lake enter the State's coastal zone through the Cape Fear River.

We encourage the EA to evaluate the issue of whether the proposed project would or would not have a reasonable foreseeable effect on North Carolina's coastal area. Should the EA conclude that the proposed project would have a reasonable foreseeable coastal effect; the Corps would be required to make a consistency determination and submit it to the North Carolina Division of Coastal Management for consistency review. Should the EA conclude that there would be no reasonable foreseeable coastal effect; no consistency review by DCM would be required. Should you have any questions, please contact me at 252-808-2808. Thank you for your consideration of the North Carolina Coastal Management Program.

Sincerely,

Stephen Rynas, AICP
Federal Consistency Coordinator

Cc: Doug Huggett, Division of Coastal Management
Jeff Richter, US Army Corps of Engineers
Michael Hosey, US Army Corps of Engineers

400 Commerce Ave., Morehead City, NC 28557-3421
Phone: 252-808-2808 \ FAX: 252-247-3330 Internet: www.nccoastalmanagement.net

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OCT 27 2011
BY: [illegible]

North Carolina Department of Cultural Resources

State Historic Preservation Office

Ramona M. Bartos, Administrator

Beverly Eaves Perdue, Governor
Linda A. Carlisle, Secretary
Jeffrey J. Crow, Deputy Secretary

Office of Archives and History
Division of Historical Resources
David Brook, Director

October 25, 2011

Craig Shoe
Jordan Lake Visitor Assistance Center
PO Box 144
Moncure, NC 27559

Re: Jordan Lake Aeration System, Cary/Apex Water Treat Facility, Chatham County, ER 11-1954

Dear Mr. Shoe:

We have received notification from the US Army Corps of Engineers concerning the above project.

We have conducted a review of the project and are aware of no historic resources which would be affected by the project. Therefore, we have no comment on the project as proposed.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, please contact Renee Gledhill-Earley, environmental review coordinator, at 919-807-6579. In all future communication concerning this project, please cite the above-referenced tracking number.

Sincerely,

Renee Gledhill-Earley

for Ramona M. Bartos

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
4407 Bland Road, Suite 117
Raleigh, North Carolina 27609

Michael J. Hinton, ASTC-Easements & WR
Fax: (919) 873-2103
Fax: (919) 873-2156
Email: mike.hinton@nc.usda.gov

October 12, 2011

RECEIVED
OCT 14 2011
BY:

Mr. Michael Hosey
Jordan Lake Visitor Assistance Center
P.O. Box 144
Moncure, NC 27559

Dear Mr. Hosey:

Thank you for the opportunity to provide comments on the Environmental Assessment (EA) for a proposed Jordan Lake Aeration System. The system would be in the vicinity of the existing Cary/Apex Water Treatment Facility (CAWTF) in the Town of Cary in Wake County, North Carolina, and proposes to address raw water quality concerns, particularly poorer water quality present at the lower lake elevations.

The Natural Resources Conservation Service does not have any comments at this time.

If you need additional information, please feel free to contact me at (919) 873-2103.

Sincerely,

Michael J. Hinton
Assistant State Conservationist for Easements & Water Resources

North Carolina
Department of Administration

Beverly Eaves Perdue, Governor

Moses Carey, Jr., Secretary

November 7, 2011

Mr. Michael Hosey
Department of the Army
Jordan Lake Visitor Assistance Center
P.O. Box 144
Moncure, NC 27559

Dear Mr. Hosey:

Re: SCH File # 12-E-0000-0087; SCOPING; Proposal to implement the Jordan Lake Aeration System located in the vicinity of existing Cary/Apex Water Treatment Facility to address raw water quality concerns

The above referenced environmental impact information has been submitted to the State Clearinghouse under the provisions of the National Environmental Policy Act. According to G.S. 113A-10, when a state agency is required to prepare an environmental document under the provisions of federal law, the environmental document meets the provisions of the State Environmental Policy Act. Attached to this letter for your consideration are the comments made by agencies in the course of this review.

If any further environmental review documents are prepared for this project, they should be forwarded to this office for intergovernmental review.

Should you have any questions, please do not hesitate to call.

Sincerely,

William E. H. Creech

Attachments

cc: Region J

Mailing Address:
1301 Mail Service Center
Raleigh, NC 27699-1301

Telephone: (919)807-2425
Fax (919)733-9571
State Courier #51-01-00
e-mail state.clearinghouse@doa.nc.gov

Location Address:
116 West Jones Street
Raleigh, North Carolina

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North Carolina Department of Environment and Natural Resources

Beverly Eaves Perdue
Governor

Dee Freeman
Secretary

MEMORANDUM

TO: Zeke Creech
State Clearinghouse

FROM: Melba McGee
Environmental Review Coordinator

RE: 12-0087 - Scoping - Proposed Jordan Lake Aeration System in Wake County

DATE: October 31, 2011

The Department of Environment and Natural Resources has reviewed the proposed project. The attached comments are for the applicant's consideration. More specific comments will be provided during the environmental review process.

Thank you for the opportunity to respond.

Attachment

1601 Mail Service Center, Raleigh, North Carolina 27699-1601
Phone: 919-707-8600 \ Internet: http://portal.ncdenr.org
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NCDENR
North Carolina Department of Environment and Natural Resources
Division of Water Quality
Coleen H. Sullins
Director

Beverly Eaves Perdue
Governor

Dee Freeman
Secretary

October 26, 2011

MEMORANDUM

TO: Melba McGee
Department of Environment and Natural Resources

THRU: Jeff Manning, Supervisor JM
Basinwide Planning Unit

FROM: Hannah Headrick, DWQ's SEPA Coordinator HH

SUBJECT: Wake County – Proposed Jordan Lake Aeration System
DWQ#14399; DENR#12-0087

The Division of Water Quality (DWQ) has reviewed the subject scoping document and has the following concerns that should be addressed in the *Environmental Assessment* prepared for this project:

1. The proposed destratifiers are quite different to air injection systems that have been installed in other reservoirs across the state for the purpose of improving raw drinking water quality. Therefore, DWQ requests detailed schematics, pictures, and a discussion on how these units will destratify the lake near the raw water intake.
2. While the destratifiers may improve water quality near the intake and decrease the likelihood of a localized algae bloom, please address the potential of the destratifiers pulling in blooms moving downstream from the upper end of the reservoir and displacing them down toward the intake.
3. What areas of the lake will the operation of these destratifiers impact?
4. To what depth will the destratifiers displace the lake water?
5. Please discuss what impacts the cool, low oxygen water displaced toward the surface during the summer may have on aquatic life in the lake. We are concerned whether the cooler water near the surface of the lake could potentially attract fish seeking a temperature refuge during the summer?
6. DWQ requests detail on how the destratifiers will be operated, including details such as:
   - Will they be run continuously?
   - Can they be controlled remotely or must an operator be on site to turn the units off or on?
   - What emergency plans will be in place in the event of unit failure or malfunction?
   - How often will the destratifiers be serviced and the debris from the lake cleared from the units?
7. In the event of a significant and sudden rise in the reservoir water level (as in Hurricane Fran), will these units be anchored is such a way as to allow them to rise with the water level?
8. Odor problems have been encountered with air injection systems used for lake destratification. Odor is related to bottom water containing high levels of sulfides brought to the surface of the lake. Will the proposed destratification units for Jordan Lake also have this potential, and if so how will they be addressed?

1617 Mail Service Center, Raleigh, North Carolina 27699-1617
Location: 512 N. Salisbury St. Raleigh, North Carolina 27604
Phone: 919-807-6300 \ FAX: 919-807-6492 \ Customer Service: 1-877-623-6748
Internet: www.ncwaterquality.org
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OCT 24 20 DWSS

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF WATER RESOURCES
PUBLIC WATER SUPPLY SECTION

Inter-Agency Project Review Response

Project Number
12-0087

County
Wake

Project Name US Army Corps of Engineers/Wilmington District

Type of Project EA - Proposed Jordan Lake Aeration System located in vicinity of existing Cary/Apex Water Treatment Facility (CAWTF) raw water intakes

Comments provided by:

- ☐ Regional Program Person
- ☒ Regional Supervisor for Public Water Supply Section
- ☐ Central Office program person

Name Michael Douglas-Raleigh RO Date: 10/11/2011

Telephone number: 919-791-4200

Program within Division of Water Resources:

- ☒ Public Water Supply
- ☐ Other, Name of Program: _____

Response (check all applicable):

- ☐ No objection to project as proposed
- ☐ No comment
- ☐ Insufficient information to complete review
- ☐ Comments attached
- ☒ See comments below

No comment at this time. I reserve the right to comment as the project is in further development.

Return to:
Public Water Supply Section
Environmental Review Coordinator for the
Division of Water Resources

NORTH CAROLINA STATE CLEARINGHOUSE
DEPARTMENT OF ADMINISTRATION
INTERGOVERNMENTAL REVIEW

COUNTY: WAKE

H01: WATER SUPPLY SYSTEMS

STATE NUMBER: 12-E-0000-0087
DATE RECEIVED: 10/05/2011
AGENCY RESPONSE: 11/02/2011
REVIEW CLOSED: 11/07/2011

MS CAROLYN PENNY
CLEARINGHOUSE COORDINATOR
CC&PS - DIV OF EMERGENCY MANAGEMENT
FLOODPLAIN MANAGEMENT PROGRAM
MSC # 4719
RALEIGH NC

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DENR LEGISLATIVE AFFAIRS
DEPT OF CULTURAL RESOURCES
DEPT OF TRANSPORTATION
TRIANGLE J COG

PROJECT INFORMATION

APPLICANT: Department of the Army
TYPE: National Environmental Policy Act
Scoping

DESC: Proposal to implement the Jordan Lake Aeration System located in the vicinity of existing Cary/Apex Water Treatment Facility to address raw water quality concerns

The attached project has been submitted to the N. C. State Clearinghouse for intergovernmental review. Please review and submit your response by the above indicated date to 1301 Mail Service Center, Raleigh NC 27699-1301.

If additional review time is needed, please contact this office at (919)807-2425.

AS A RESULT OF THIS REVIEW THE FOLLOWING IS SUBMITTED: ☐ NO COMMENT ☒ COMMENTS ATTACHED

SIGNED BY: Jennifer W. Ott

DATE: 10/27/2011

North Carolina Department of Crime Control and Public Safety
Division of Emergency Management
Office of Geospatial and Technology Management

Beverly Eaves Perdue, Governor
Reuben F. Young, Secretary

H. Douglas Hoell, Jr., Director

OCT 2011
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Secretary's Office
DOA

October 27, 2011

State Clearinghouse
N.C. Department of Administration
1301 Mail Service Center
Raleigh, North Carolina 27699-1301

Subject: Intergovernmental Review State Number: 12-E-0000-0087
Jordan Lake Aeration System

As requested by the North Carolina State Clearinghouse, the North Carolina Department of Crime Control and Public Safety Division of Emergency Management Office of Geospatial and Technology Management (GTM) reviewed the proposed project listed above and offer the following comments:

1) The proposed project is located in an unincorporated area of Chatham County. Chatham County participates in the National Flood Insurance Program and enforces a Flood Damage Prevention Ordinance that requires a Floodplain Development Permit be issued for all development located in the Special Flood Hazard Area (SFHA) within their jurisdiction. Please ensure the County Floodplain Administrator reviews and issues permits for each part of the proposed Jordan Lake Aeration System that impacts a SFHA.

2) The proposed Aeration System appears to impact the SFHA of Jordan Lake. Any grading, fill or placement of equipment or materials in the SFHA will need a floodplain development permit issued by Chatham County.

3) All structures and utilities should be protected to the regulatory floodplain elevation as described in the Chatham County ordinance and 44 CFR 60.3.

Mail:
4719 Mail Service Center
Raleigh, NC 27699-4719
Telephone: 919-715-5711

www.NCCrimeControl.org

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Location:
1812 Tillery Place, Suite 105
Raleigh, NC 27604
Fax: 919-715-0408

A Nationally Accredited Agency

Thank you for your cooperation and consideration. If you have any questions concerning the above comments, please contact Dan Brubaker, P.E., CFM, the NC NFIP Engineer at (919) 715-5711 x110, by email at dbrubaker@ncem.org or at the address shown on the footer of this documents.

Sincerely,

Kenneth W. Ashe, P.E., CFM
Assistant Director

c: John Gerber, NFIP State Coordinator
Dan Brubaker, NFIP Engineer

NORTH CAROLINA STATE CLEARINGHOUSE
DEPARTMENT OF ADMINISTRATION
INTERGOVERNMENTAL REVIEW

COUNTY: WAKE
Chatham

H01: WATER SUPPLY SYSTEMS

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OCT 06 2011
HISTORIC PRESERVATION OFFICE

STATE NUMBER: 12-E-0000-0087
DATE RECEIVED: 10/05/2011
AGENCY RESPONSE: 11/02/2011
REVIEW CLOSED: 11/07/2011

MS RENEE GLEDHILL-EARLEY
CLEARINGHOUSE COORDINATOR
DEPT OF CULTURAL RESOURCES
STATE HISTORIC PRESERVATION OFFICE
MSC 4617 - ARCHIVES BUILDING
RALEIGH NC

ER 11-1954

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DENR LEGISLATIVE AFFAIRS
DEPT OF CULTURAL RESOURCES
DEPT OF TRANSPORTATION
TRIANGLE J COG

Due 10/24/11 S - (VC) JOK 10/17/11

PROJECT INFORMATION

APPLICANT: Department of the Army
TYPE: National Environmental Policy Act
Scoping

DESC: Proposal to implement the Jordan Lake Aeration System located in the vicinity of existing Cary/Apex Water Treatment Facility to address raw water quality concerns

The attached project has been submitted to the N. C. State Clearinghouse for intergovernmental review. Please review and submit your response by the above indicated date to 1301 Mail Service Center, Raleigh NC 27699-1301.

If additional review time is needed, please contact this office at (919)807-2425.

AS A RESULT OF THIS REVIEW THE FOLLOWING IS SUBMITTED: ☒ NO COMMENT ☐ COMMENTS ATTACHED

SIGNED BY: Renee Gledhill-Earley DATE: 10.20.11

OCT 2011
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Secretary's Office
DCA

OCT 07 2011

From: Bailey, Erika L.
To: Hosey, Michael L II SAW
Cc: Owens, Jennifer L SAW; Sydney Miller; D"Adamo, Peter; Miller, Vickie M
Subject: Proposed Jordan Lake Aeration System Comments
Date: Wednesday, October 05, 2011 5:08:12 PM

Michael,

Per my previous e-mail, the Town of Cary has received three comments from vendors of lake aeration technologies regarding the proposed lake aeration system. I will be forwarding the three sets of comments in separate e-mails. We will address alternatives to the proposed system in the draft EA.

Below is the second of the three comments.

Thanks and please let me know if you have any questions.

Erika L. Bailey
PE

HDR Engineering, Inc. of the Carolinas
Senior Project Manager | Professional Associate

3733 National Drive Suite 207 | Raleigh, NC 27612-4845
919.785.1118 | c: 919.740.1876
erika.bailey@hdrinc.com <mailto:erika.bailey@hdrinc.com> | hdrinc.com <http://www.hdrinc.com/>

Follow Us – Facebook <http://www.facebook.com/pages/HDR-Inc/142672125757519?ref=ts> | Twitter <http://www.twitter.com/HDR_Inc> | YouTube <http://www.youtube.com/HDRinc>

From: Ken Hudnell [mailto:kenhud@solarbee.com]
Sent: Thursday, September 22, 2011 5:02 PM
To: D'Adamo, Peter
Cc: Sydney Miller; Glen Harrell; Joel Bleth; Bruce Richards
Subject: Re: UNC workshop and Peter D'Adamo

Hi Peter

Thank you for the email. Could you address there specific issues?

1. We noticed that your report to Cary shows a complete cost breakdown for all alternatives but the SolarBee. Why was this the case? Did you do one? If so, please send a copy.

2. Your report shows a capital cost of $1,740,000 for the SolarBees, but the SolarBee quote is $1,288,457 for the units running in the water. Why was this the case?

3. This change caused the O&M cost to be much higher than otherwise. Even using the excessive 5% annual O&M figure, and 4% the inflation figure, the O&M would be closed to $1,404,420 instead of $1,903,000. Total PW (Present Worth) would be closer to $2,692,875 as compared to the $3,643,000 in the report. That amount would make us the lowest cost alternative. Are you willing to correct these apparent mistakes in your report?

4. The boating interference issue is a red herring. That has not proven to be the case in the approximately 300 waterbodies where SolarBees operate. As shown in our attached peer-reviewed scientific journal article (not mentioned in the report), the units are spaced at 35 ac per unit, resulting in a distance between units of approximately 200 m. The article shows an aerial photo of Lake Palmdale. That lake is used extensively for boat recreation, and airplanes land and take off between the SolarBee units. These no more interfere with boating than channel markers. Did anyone working on the report or the Army Corp person you mention actually visit a water body containing SolarBees to objectively assess this issue?

Thank you for your response to these issues.

Ken

_____

H Kenneth Hudnell, PhD

Director of Science

SolarBee, Inc.

Adjunct Associate Professor

UNC-CH Dept. Env. Sci. & Eng.

105 Serrano Way

Chapel Hill, NC 27517-8545

Ph: 919-932-7229;

Cell: 919-619-3524

Fax: 919-967-9487

kenhud@SolarBee.com

---

http://www.SolarBee.com

http://www.sph.unc.edu/

_____

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Raleigh Field Office
Post Office Box 33726
Raleigh, North Carolina 27636-3726

October 20, 2011

RECEIVED
OCT 24 2011
BY: UMR

Mr. Michael Hosey
Jordan Lake Visitor Assistance Center
PO Box 144
Moncure, NC 27559

Re: Proposed Jordan Lake Aeration System- Wake County, NC

Dear Mr. Hosey:

This letter is to inform you that a list of all federally-protected endangered and threatened species with known occurrences in North Carolina is now available on the U.S. Fish and Wildlife Service's (Service) web page at http://www.fws.gov/raleigh. Therefore, if you have projects that occur within the Raleigh Field Office's area of responsibility (see attached county list), you no longer need to contact the Raleigh Field Office for a list of federally-protected species.

Our web page contains a complete and frequently updated list of all endangered and threatened species protected by the provisions of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.)(Act), and a list of federal species of concern[1] that are known to occur in each county in North Carolina.

Section 7 of the Act requires that all federal agencies (or their designated non-federal representative), in consultation with the Service, insure that any action federally authorized, funded, or carried out by such agencies is not likely to jeopardize the continued existence of any federally-listed endangered or threatened species. A biological assessment or evaluation may be prepared to fulfill that requirement and in determining whether additional consultation with the Service is necessary. In addition to the federally-protected species list, information on the species' life histories and habitats and information on completing a biological assessment or evaluation and can be found on our web page at http://www.fws.gov/raleigh. Please check the web site often for updated information or changes.

---

[1] The term "federal species of concern" refers to those species which the Service believes might be in need of concentrated conservation actions. Federal species of concern receive no legal protection and their designation does not necessarily imply that the species will eventually be proposed for listing as a federally endangered or threatened species. However, we recommend that all practicable measures be taken to avoid or minimize adverse impacts to federal species of concern.

If your project contains suitable habitat for any of the federally-listed species known to be present within the county where your project occurs, the proposed action has the potential to adversely affect those species. As such, we recommend that surveys be conducted to determine the species' presence or absence within the project area. The use of North Carolina Natural Heritage program data should not be substituted for actual field surveys.

If you determine that the proposed action may affect (i.e., likely to adversely affect or not likely to adversely affect) a federally-protected species, you should notify this office with your determination, the results of your surveys, survey methodologies, and an analysis of the effects of the action on listed species, including consideration of direct, indirect, and cumulative effects, before conducting any activities that might affect the species. If you determine that the proposed action will have no effect (i.e., no beneficial or adverse, direct or indirect effect) on federally listed species, then you are not required to contact our office for concurrence (unless an Environmental Impact Statement is prepared). However, you should maintain a complete record of the assessment, including steps leading to your determination of effect, the qualified personnel conducting the assessment, habitat conditions, site photographs, and any other related articles.

With regard to the above-referenced project, we offer the following remarks. Our comments are submitted pursuant to, and in accordance with, provisions of the Endangered Species Act.

Based on the information provided and other information available, it appears that the proposed action is not likely to adversely affect any federally-listed endangered or threatened species, their formally designated critical habitat, or species currently proposed for listing under the Act at these sites. We believe that the requirements of section 7(a)(2) of the Act have been satisfied for your project. Please remember that obligations under section 7 consultation must be reconsidered if: (1) new information reveals impacts of this identified action that may affect listed species or critical habitat in a manner not previously considered; (2) this action is subsequently modified in a manner that was not considered in this review; or, (3) a new species is listed or critical habitat determined that may be affected by the identified action.

However, the Service is concerned about the potential impacts the proposed action might have on aquatic species. Aquatic resources are highly susceptible to sedimentation. Therefore, we recommend that all practicable measures be taken to avoid adverse impacts to aquatic species, including implementing directional boring methods and stringent sediment and erosion control measures. An erosion and sedimentation control plan should be submitted to and approved by the North Carolina Division of Land Resources, Land Quality Section prior to construction. Erosion and sedimentation controls should be installed and maintained between the construction site and any nearby down-gradient surface waters. In addition, we recommend maintaining natural, vegetated buffers on all streams and creeks adjacent to the project site.

The North Carolina Wildlife Resources Commission has developed a Guidance Memorandum (a copy can be found on our website at (http://www.fws.gov/raleigh) to address and mitigate secondary and cumulative impacts to aquatic and terrestrial wildlife resources and water quality. We recommend that you consider this document in the development of your projects and in completing an initiation package for consultation (if necessary).

We hope you find our web page useful and informative and that following the process described above will reduce the time required, and eliminate the need, for general correspondence for species' lists. If you have any questions or comments, please contact John Ellis of this office at (919) 856-4520 ext. 26.

Sincerely,

Pete Benjamin
Field Supervisor

List of Counties in the Service's Raleigh Field Office Area of Responsibility

Alamance
Beaufort
Bertie
Bladen
Brunswick
Camden
Carteret
Caswell
Chatham
Chowan
Columbus
Craven
Cumberland
Currituck
Dare
Duplin
Durham
Edgecombe
Franklin
Gates
Granville
Greene
Guilford
Halifax
Harnett
Hertford
Hoke
Hyde
Johnston
Jones
Lee
Lenoir
Martin
Montgomery
Moore
Nash
New Hanover
Northampton
Onslow
Orange
Pamlico
Pasquotank
Pender
Perquimans
Person
Pitt
Randolph
Richmond
Robeson
Rockingham
Sampson
Scotland
Tyrrell
Vance
Wake
Warren
Washington
Wayne
Wilson

North Carolina Wildlife Resources Commission

Gordon Myers, Executive Director

MEMORANDUM

TO: Melba McGee, Environmental Coordinator
Office of Legislative and Intergovernmental Affairs

FROM: Shari L. Bryant, Piedmont Region Coordinator
Habitat Conservation Program

DATE: 31 October 2011

SUBJECT: Scoping for Jordan Lake Aeration System, Town of Cary, Wake County, DENR Project No. 12-0087.

Biologists with the North Carolina Wildlife Resources Commission (NCWRC) have reviewed the subject document and we are familiar with the habitat values of the area. Our comments are provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and North Carolina General Statutes (G.S. 113-131 et seq.).

The Town of Cary proposes to install an aeration system in Jordan Lake. The system would consist of four units, each with a 7.5 hp electric motor. The units would be installed as two separate systems located approximately 100-feet apart. Power would be supplied to the units from the existing raw water pump station. The total estimated easement for the units is 1.4 acres. It is anticipated the aeration system would reduce the algae blooms near the intake, reduce dissolved manganese and iron concentrations, and improve the overall water quality in the area where the intakes are located. The purpose of the aeration system is to help improve raw water quality for the Town's water treatment plant.

B.E. Jordan Reservoir supports a diverse fishery including sunfish (*Lepomis* spp.), crappie (*Pomoxis* spp.), catfish (*Ictalurus* spp.), largemouth bass (*Micropterus salmoides*), and striped bass (*Morone saxatilis*). Listed terrestrial species include the state threatened bald eagle (*Haliaeetus leucocephalus*).

We are concerned about direct impacts of the aeration system on aquatic resources and boating. The proposed aeration system would be located at the confluence of New Hope Creek and White Oak Creek. This area is overwintering habitat and a critical staging area for striped bass and crappie populations in the reservoir. Also, boating traffic in this area is high due to two public boat launch areas on White Oak Creek, and it is a travel corridor between the upper and lower sections of the reservoir. We request the EA include an alternatives analysis that evaluates other alternatives (e.g., bottom diffuser) to the proposed aeration system, and includes a discussion of environmental impacts from construction, operation, and maintenance of both the proposed aeration system and other alternatives. More specifically, we request the following information regarding the aeration system is included in the EA:

Mailing Address: Division of Inland Fisheries • 1721 Mail Service Center • Raleigh, NC 27699-1721
Telephone: (919) 707-0220 • **Fax:** (919) 707-0028

Aquatic Habitat and Fisheries

- How the aeration system would be operated. We are particularly interested in the months of the year it is anticipated the aeration system would be operated and whether it would be operated daily or periodically during this time period.
- How temperature and dissolved oxygen would be affected in the area immediately surrounding the aeration system when it is first started. We are particularly interested in its effect on temperature and dissolved oxygen if the aeration system is started after a thermocline has formed.
- As described, the aeration system will push surface water to the bottom and slowly mix the water. Please describe whether it is anticipated that there will be areas with low dissolved oxygen when the system is first started. Also, please describe the average amount of time it would take for the thermocline to disappear in the area affected by the aeration system.
- The area (e.g., acreage) that will be affected by the aeration system.
- How temperature and dissolved oxygen will transition between mixed and unmixed areas. We are particularly interested in whether it will be an abrupt change or a transitional change.
- Detailed information regarding any screening to prevent fish from entering the aeration system, and the mechanical parts inside of the aeration system that fish would have to pass through if they became entrained in the aeration system. Also, please include detailed information regarding the flow rate (e.g., feet/sec.) for the aeration system. For intake structures, NCWRC recommends passive screens with openings not to exceed one centimeter and with a maximum intake velocity of 0.5 feet/sec to minimize impingement and/or entrainment of fish.
- Detailed information regarding the submersible electrical cable and how it will be installed between the aeration system and the raw water pump station.

Boating Traffic and Safety

- An evaluation of other locations within the reservoir for the aeration system. We are concerned the proposed location would be a significant navigational hazard that could create boating safety issues.
- Detailed information on how the aeration system will be marked to alert daytime and nighttime boaters of its location. We recommend it is marked with strobe lighting on each of the four corners, and at a minimum, strobe lighting is added in one place near the center along the shorter side (115-feet) and two places at approximately 100-feet from each end along the longer side (300-feet). This should make the aeration system more visible during the nighttime hours. In addition, buoys such as "Boats Keep Out" should be placed around the aeration system to alert anglers or boaters of its presence and minimize the chances of them entering the area. These buoys should be placed approximately 20 yards from the structure.

At this time, the information provided is not sufficient for our staff to make definitive recommendations or conclusions concerning this project. Thank you for the opportunity to provide input in the early planning stages for this project. If we can be of further assistance, please contact our office at (336) 449-7625 or shari.bryant@ncwildlife.org.

cc: Michael Hosey, USACE
Corey Oakley, NCWRC
Reggie Barker, NCWRC

Appendix C

Federally Listed Species by County

U.S. Fish & Wildlife Service

Endangered Species, Threatened Species,Federal Species of Concern, and Candidate Species,

Chatham County, North Carolina

Updated: 09-22-2010

Critical Habitat Designations:

Cape Fear shiner - *Notropis mekistocholas* - Approximately 4.1miles of the Rocky River from North Carolina State Highway 902 Bridge downstream to Chatham County Road 1010 Bridge; and approximately 0.5river mile of Bear Creek, from Chatham County Road 2156 Bridge downstream to the Rocky River, then downstream in the Rocky River (approximately 4.2river miles) to the Deep River, then downstream in the Deep River (approximately 2.6river miles) to a point 0.3river mile below the Moncure, North Carolina, U.S.Geological Survey Gaging Station. Constituent elements include clean streams with gravel, cobble, and boulder substrates with pools, riffles, shallow runs and slackwater areas with large rock outcrops and side channels and pools with water of good quality with relatively low silt loads.
Federal Register Reference: September 25, 1987, Federal Register, 2: 36034-36039.

Common Name	Scientific name	Federal Status	Record Status
Vertebrate:			
American eel	*Anguilla rostrata*	FSC	Current
Bachman's sparrow	*Aimophila aestivalis*	FSC	Current
Bald eagle	*Haliaeetus leucocephalus*	BGPA	Current
Cape Fear shiner	*Notropis mekistocholas*	E	Current
Carolina darter	*Etheostoma collis lepidinion*	FSC	Current
Carolina redhorse	*Moxostoma* sp. *2*	FSC	Current
Red-cockaded woodpecker	*Picoides borealis*	E	Historic
Invertebrate:			
Atlantic pigtoe	*Fusconaia masoni*	FSC	Current
Brook floater	*Alasmidonta varicosa*	FSC	Current

Carolina creekshell	*Villosa vaughaniana*	FSC	Current
Septima's clubtail	*Gomphus septima*	FSC	Current
Yellow lampmussel	*Lampsilis cariosa*	FSC	Current
Vascular Plant:			
Buttercup phacelia	*Phacelia covillei*	FSC	Current
Harperella	*Ptilimnium nodosum*	E	Current
Sweet pinesap	*Monotropsis odorata*	FSC	Current
Virginia quillwort	*Isoetes virginica*	FSC	Historic
Nonvascular Plant:			
Lichen:			

Definitions of Federal Status Codes:
E = endangered. A taxon "in danger of extinction throughout all or a significant portion of its range."
T = threatened. A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."
C = candidate. A taxon under consideration for official listing for which there is sufficient information to support listing. (Formerly "C1" candidate species.)
BGPA =Bald and Golden Eagle Protection Act. See below.
FSC = federal species of concern. A species under consideration for listing, for which there is insufficient information to support listing at this time. These species may or may not be listed in the future, and many of these species were formerly recognized as "C2" candidate species.
T(S/A) = threatened due to similarity of appearance. A taxon that is threatened due to similarity of appearance with another listed species and is listed for its protection. Taxa listed as T(S/A) are not biologically endangered or threatened and are not subject to Section 7 consultation. See below.
EXP = experimental population. A taxon listed as experimental (either essential or nonessential). Experimental, nonessential populations of endangered species (e.g., red wolf) are treated as threatened species on public land, for consultation purposes, and as species proposed for listing on private land.
P = proposed. Taxa proposed for official listing as endangered or threatened will be noted as "PE" or "PT", respectively.

Bald and Golden Eagle Protection Act (BGPA):

In the July 9, 2007 Federal Register(72:37346-37372), the bald eagle was declared recovered, and removed (de-listed) from the Federal List of Threatened and Endangered wildlife. This delisting took effect August 8,2007. After delisting, the Bald and Golden Eagle Protection Act (Eagle Act) (16 U.S.C. 668-668d) becomes the primary law protecting bald eagles. The Eagle Act prohibits take of bald and golden eagles and provides a statutory definition of "take" that includes "disturb". The USFWS has developed National Bald Eagle Management Guidelines to provide guidance to land managers, landowners, and others as to how to avoid disturbing bald eagles. For mor information, visit http://www.fws.gov/migratorybirds/baldeagle.htm

Threatened due to similarity of appearance(T(S/A)):

In the November 4, 1997 Federal Register (55822-55825), the northern population of the bog turtle (from New York south to Maryland) was listed as T (threatened), and the southern population (from Virginia south to Georgia) was listed as T(S/A) (threatened due to similarity of appearance). The T(S/A) designation bans the collection and interstate and international commercial trade of bog turtles from the southern population. The T(S/A) designation has no effect on land management activities by private landowners in North Carolina, part of the southern population of the species. In addition to its official status as T(S/A), the U.S. Fish and Wildlife Service considers the southern population of the bog turtle as a Federal species of concern due to habitat loss.

Definitions of Record Status:
Current - the species has been observed in the county within the last 50 years.

Historic - the species was last observed in the county more than 50 years ago.
Obscure - the date and/or location of observation is uncertain.
Incidental/migrant - the species was observed outside of its normal range or habitat.
Probable/potential - the species is considered likely to occur in this county based on the proximity of known records (in adjacent counties), the presence of potentially suitable habitat, or both.

County Record Search Results

Search Criteria: [County Name is like Chatham] [Any Scientific Name] [Any Common Name] [Any State Rank] [Any Global Rank] [Any Name Category] [Any Protection Status][Introduced populations included]

Records Returned: [Animal Assemblage: 1] [Invertebrate Animal: 19] [Natural Community: 21] [Vascular Plant: 17] [Vertebrate Animal: 10] [Total: 68]

Name Category	Scientific Name (click for map)	Common Name	State Status	Federal Status	State Rank	Global Rank	County	County Status
Animal Assemblage	Colonial Wading Bird Colony				S3	G5	Chatham	Current
Invertebrate Animal	Alasmidonta undulata	Triangle Floater	T		S2	G4	Chatham	Current
Invertebrate Animal	Alasmidonta varicosa	Brook Floater	E	FSC	S1	G3	Chatham	Current
Invertebrate Animal	Cambarus davidi	Carolina Ladle Crayfish	SR		S2S3	G3	Chatham	Current
Invertebrate Animal	Choroterpes basalis	a mayfly	SR		S2	G5	Chatham	Current
Invertebrate Animal	Elliptio roanokensis	Roanoke Slabshell	T		S1	G3	Chatham	Current
Invertebrate Animal	Fusconaia masoni	Atlantic Pigtoe	E	FSC	S1	G2	Chatham	Current
Invertebrate Animal	Gomphus abbreviatus	Spine-crowned Clubtail	SR		S3?	G3G4	Chatham	Obscure
Invertebrate Animal	Gomphus quadricolor	Rapids Clubtail	SR		S1?	G3G4	Chatham	Obscure
Invertebrate Animal	Gomphus septima	Septima's Clubtail	SR	FSC	S1S2	G2	Chatham	Current
Invertebrate Animal	Lampsilis cariosa	Yellow Lampmussel	E	FSC	S1	G3G4	Chatham	Current
Invertebrate Animal	Lampsilis radiata	Eastern Lampmussel	T		S1S2	G5	Chatham	Current
Invertebrate Animal	Neurocordulia virginiensis	Cinnamon Shadowdragon	SR		S2?	G4	Chatham	Current
Invertebrate Animal	Pontia protodice	Checkered White	SR		S1S2	G4	Chatham	Current
Invertebrate Animal	Somatogyrus virginicus	Panhandle Pebblesnail	SR	FSC	S1?	G2G3	Chatham	Current
Invertebrate Animal	Strophitus undulatus	Creeper	T		S2	G5	Chatham	Current
Invertebrate Animal	Toxolasma pullus	Savannah Lilliput	E	FSC	S1	G2	Chatham	Current
Invertebrate Animal	Villosa constricta	Notched Rainbow	SC		S3	G3	Chatham	Current
Invertebrate Animal	Villosa delumbis	Eastern Creekshell	SR		S3	G4	Chatham	Current
Invertebrate Animal	Villosa vaughaniana	Carolina Creekshell	E	FSC	S2	G2	Chatham	Current
Natural Community	Basic mesic forest (piedmont subtype)				S2	G5T3	Chatham	Current
Natural Community	Basic oak--hickory forest				S3	G4	Chatham	Current

Natural Community	Dry-mesic oak--hickory forest				S5	G5	Chatham	Current
Natural Community	Dry oak--hickory forest				S4	G5	Chatham	Current
Natural Community	Floodplain pool				S2S3	G3?	Chatham	Current
Natural Community	Hillside seepage bog				S2	G2	Chatham	Current
Natural Community	Mesic mixed hardwood forest (piedmont subtype)				S4	G5T5	Chatham	Current
Natural Community	Piedmont Boggy Streamhead				S2?	GNR	Chatham	Current
Natural Community	Piedmont longleaf pine forest				S1	G1?	Chatham	Current
Natural Community	Piedmont mafic cliff				S1	G1G2	Chatham	Current
Natural Community	Piedmont monadnock forest				S4	G5	Chatham	Current
Natural Community	Piedmont/coastal plain heath bluff				S3	G4?	Chatham	Current
Natural Community	Piedmont/low mountain alluvial forest				S5	G5	Chatham	Current
Natural Community	Piedmont/mountain bottomland forest				S3?	G5	Chatham	Current
Natural Community	Piedmont/mountain levee forest				S3?	G5	Chatham	Current
Natural Community	Piedmont/mountain semipermanent impoundment				S4	G5	Chatham	Current
Natural Community	Piedmont/mountain swamp forest				S1S2	G2	Chatham	Current
Natural Community	Rocky bar and shore				S5	G5	Chatham	Current
Natural Community	Upland depression swamp forest				S3	G3	Chatham	Current
Natural Community	Upland pool				S1	G1	Chatham	Current
Natural Community	Xeric hardpan forest				S3	G3G4	Chatham	Current
Vascular Plant	Carex vestita	Velvet Sedge	SC-H		SH	G5	Chatham	Historical
Vascular Plant	Collinsonia tuberosa	Piedmont Horsebalm	SC-V		S1	G3G4	Chatham	Current
Vascular Plant	Dichanthelium annulum	Ringed Witch Grass	SR-P		S1	GNR	Chatham	Historical
Vascular Plant	Enemion biternatum	Eastern Isopyrum	SC-V		S2	G5	Chatham	Historical
Vascular Plant	Eurybia spectabilis	Showy Aster	SR-O		S2?	G5	Chatham	Current
Vascular Plant	Fothergilla major	Large Witch-alder	SR-T		S3	G3	Chatham	Current
Vascular Plant	Gillenia stipulata	Indian Physic	T		S2	G5	Chatham	Historical
Vascular Plant	Isoetes virginica	Virginia Quillwort	SR-L	FSC	S1	G1	Chatham	Historical
Vascular Plant	Lindera subcoriacea	Bog Spicebush	SR-T	FSC	S2S3	G2G3	Chatham	Current
Vascular Plant	Monotropsis odorata	Sweet Pinesap	SC-V	FSC	S3	G3	Chatham	Current
Vascular Plant	Paspalum fluitans	Horsetail Crown Grass	SR-P		S1	G5	Chatham	Historical

Vascular Plant	Phacelia covillei	Buttercup Phacelia	SR-T	FSC	S3	G3	Chatham	Current
Vascular Plant	Ptilimnium nodosum	Harperella	E	E	S1	G2	Chatham	Current
Vascular Plant	Scutellaria australis	Southern Skullcap	E		S1	G4?Q	Chatham	Historical
Vascular Plant	Scutellaria nervosa	Veined Skullcap	E		S1	G5	Chatham	Historical
Vascular Plant	Thermopsis mollis	Appalachian Golden-banner	SC-V		S2	G3G4	Chatham	Historical
Vascular Plant	Trifolium reflexum	Buffalo Clover	T		S1S2	G3G4	Chatham	Historical
Vertebrate Animal	Ambloplites cavifrons	Roanoke Bass	SR	FSC	S2	G3	Chatham	Current
Vertebrate Animal	Etheostoma collis	Carolina Darter	SC	FSC	S3	G3	Chatham	Current
Vertebrate Animal	Haliaeetus leucocephalus	Bald Eagle	T		S3B,S3N	G5	Chatham	Current
Vertebrate Animal	Hemidactylium scutatum	Four-toed Salamander	SC		S3	G5	Chatham	Current
Vertebrate Animal	Lanius ludovicianus	Loggerhead Shrike	SC		S3B,S3N	G4	Chatham	Current
Vertebrate Animal	Moxostoma sp. 3	Carolina Redhorse	T	FSC	S1	G1G2Q	Chatham	Current
Vertebrate Animal	Notropis mekistocholas	Cape Fear Shiner	E	E	S1	G1	Chatham	Current
Vertebrate Animal	Peucaea aestivalis	Bachman's Sparrow	SC	FSC	S3B,S2N	G3	Chatham	Current
Vertebrate Animal	Phalacrocorax auritus	Double-crested Cormorant	SR		S1B,S5N	G5	Chatham	Current
Vertebrate Animal	Picoides borealis	Red-cockaded Woodpecker	E	E	S2	G3	Chatham	Historical

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Explanation of codes NC County Map Index

Results current as of Tuesday, 24 January 2012 @ 14:55:40 EST

North Carolina Natural Heritage Program
Division of Natural Resources Planning and Conservation
Department of Environment and Natural Resources
1601 MSC
Raleigh NC 27699-1601

Appendix D

Fish Swim Speeds

Species	Life Stage	Total Length (in)	Swim Speed (ft/s) Prolonged / Critical	Swim Speed (ft/s) Burst / Startle	References
Largemouth Bass	Fry	0.79-0.87	0.78-1.02	1.56-2.04	Larimore and Deuver (1968) cited in Beamish (1978)
	Juvenile	2.05-5.04	0.92-1.64	1.84-3.28	Hocutt (1973); Farlinger and Beamish (1977) cited in Beamish (1978); Larimore and Deuver (1968) cited in Beamish (1978); Dahlberg et al. (1968) cited in Carlander (1977); Kolok (1991); Otto and Rice (1974) cited in Beamish (1978);
	Juvenile	5.91-10.63	1.51-2.17	3.02-4.34	Beamish (1970) cited in Carlander (1977)
Bluegill	Juvenile	2.01-2.13	0.92	1.84	Schuler (1968); King (1969); Beamish (1978);
	Adult	3.94-5.91	1.22	2.44	Gardner et al. (2006)
	Adult	6.02	-	4.30	Webb (1978); Deng et al. (2004); Drucker and Lauder (1999)
White Crappie	Juvenile	3.03	0.18-0.52	0.36-1.04	Schuler (1968); King (1969); Smiley and Parsons (1997)
Blue Catfish	Juvenile	7.58	3.28	3.61	Beecham et al. (2009)
Hybrid Catfish (Female Channel Catfish x Male Blue Catfish)	Juvenile	6.30-9.06	3.94	7.88	Beecham et al. (2009)
Striped Bass*	Adult	47.20	7.87	32.8	Brett 1964 cited in The University of Iowa 2010; Brainbridge 1961 cited in The University of Iowa 2010
Blue Sucker	Adult	26.20	4.36	19.51	Brett 1964 cited in The University of Iowa 2010; Brainbridge 1961 cited in The University of Iowa 2011
Pallid Sturgeon	Juvenile	5.26	1.54	2.36	Hoover et al. (2005)
	Juvenile	3.59	1.51	2.42	Hoover et al. (2005)
Pallid Sturgeon	Adult	32.10	5.36	23.39	Brett (1964) cited in The University of Iowa (2010); Brainbridge (1961) cited in The University of Iowa (2010)
Shovelnose Sturgeon	Adult	28.30	4.72	20.92	Brett (1964) cited in The University of Iowa (2010); Brainbridge (1961) cited in The University of Iowa (2010)
Paddlefish	Juvenile	3.53	1.38	2.17	Hoover et al. (2005)
Paddlefish	Adult	47.20	7.87	32.8	Brett (1964) cited in The University of Iowa (2010); Brainbridge (1961) cited in The University of Iowa (2010)

* Used as surrogate for white bass

NOTE: Burst/Startle speed calculated at 50% greater than Prolonged/Critical speed based on Bell (1991) unless burst speed provided in the literature (e.g. adult bluegill, juvenile blue catfish, pallid sturgeon [Hoover et al. 2005]) and paddlefish (Hoover et al. 2005).

Appendix E

List of Recipients

List of Recipients		
Organization	**Name**	**Title**
Advisory Council on Historic Preservation	Attn: Exec. Director	
Aqua Sierra, Inc.	Peter Stitcher	Aquatic Biologist/Restoration Ecologist
Board of Chatham County Commissioners		Chairman
Board of Wake County Commissioners	Chairman Joe Bryan	
Cape Fear River Assembly, Inc.	Roger Sheats, Jr.	Executive Director
Carolina Outdoors LLC	Jeffrey Thomas	
Chatham County	County Manager	
Chatham County	David Hughes	Public Works Director
Chatham County	Mike Sturdivant	District Conservationist
City of Durham	Vicki Westbrook	Assistant Director of Water Management
City of Fayetteville, Public Works Commission	Mick Noland, PE	Water Resources Chief Operations Officer
City of Raleigh		Chief Engineer
City of Raleigh		Dir. Public Utilities
City of Raleigh		Conservation Engineer
City of Raleigh	Kenny Waldroup	Assistant Public Utilities Director
City of Sanford	Victor Czar	Public Works Director
Conservation Trust for North Carolina		
Crosswinds Boating Center	John Norton and Howard Mendlovitz	Owners
Department of the Interior, Off. Of Environmental Policy and Compliance	Gregory L. Hogue	REO
Department of the Interior, Off. Of Environmental Policy and Compliance	Joyce A. Stanley	
Durham County	Joseph Pearce	Utility Division Manager
Environmental Defense Fund of NC	Michelle Duval	
Federal Highway Administration		
Freedom Boat Club	Larry Kroeger	Club General Manager
Harnett County	Steve Ward	Director of Public Utilities
Haw River Assembly	Elaine Chiosso	Executive Director
Hawg Hunter Guide Service	Kennon Brown	
Heyward Incorporated	Tim R. Bishop	
Jordan Lake Partnership	Warren Miller	President, Fountainworks
National Center for Environmental Health	Sarah K. Heaton	MPH
National Wildlife Federation		
NC 7th Congressional District Office	Mary Ellen Simmons	
NC Commission of Indian Affairs	Gregory Richardson	Executive Director
NC Council of Governments - Region J		Exec. Director
NC Department of Cultural Resources	Renee Gledhill-Earley	
NC Dept. of Admin/State Clearinghouse	Crystal Best	Environmental Policy Act. Coordinator
NC House of Representatives	Hon. Darren Jackson	
NC House of Representatives	Hon. Rosa U. Gill	
NC House of Representatives	Honorable Joe Hackney	Minority Leader 2011-2012 Session

List of Recipients		
Organization	**Name**	**Title**
NC House of Representatives	Honorable Marilyn Avila	
NC House of Representatives	Honorable Tom Murry	
NC House of Representatives	Rep. Deborah K. Ross	
NC House of Representatives	Rep. Grier Martin	
NC House of Representatives	Rep. Jennifer Weiss	
NC House of Representatives	Rep. Nelson Dollar	
NC House of Representatives	Rep. Paul Stam	
NCDENR	John Dorney	
North Carolina Senate	Hon. Eleanor Kinnaird	
North Carolina Senate	Hon. Tamara Barringer	
North Carolina Senate	Honorable Bob Atwater	
North Carolina Senate	Honorable Dan Blue	
North Carolina Senate	Honorable Neal Hunt	
Office of Environmental Policy & Compliance	Attn: Director	
Orange County	Tom Davis	Water Resources Coordinator
Orange Water and Sewer Authority	Ed Holland	Planning Director
Outdoor Expeditions USA LLC		
Phil Cable Fishing Guide Service	Phil Cable	
Robert J. Goldstein & Associates, Inc.	Gerald Pottern	
SolarBee, Inc.	H Kenneth Hudnell, PhD	Director of Science
South Carolina Indian Affairs Comm.	Chief Gene Norris	Chair
Striper Sniper Adventures	Troy Roberson	
Tar River Land Conservancy		Exec. Director
The Nature Conservancy, NC Chapter		
The Wilderness Society		
Town of Apex	Tim Donnelly	Public Works and Utilities Director
Town of Cary, Department of Public Works & Utilities,	Sydney Paul Miller	Water Resources Engineer
Town of Hillsborough	Kenny Keel	Town Engineer
Town of Holly Springs	Staphanie Sudano	Director of Engineering
Town of Morrisville	Amanda Boone	Engineer
Town of Pittsboro	William Terry	Town Manager
Triangle J Council of Governments	Mike Schlegel	Water Resources Program Manager
U. S. Representative	Hon. Walter Jones, Jr.	
U. S. Senate	Honorable Kay R. Hagen	
U.S. Fish & Wildlife Service	Pete Benjamin	Field Supervisor
U.S. Senate	Honorable Richard Burr	
US Coast Guard Auxiliary, Flotilla 9-11	Phil Vasko	Flotilla Commander
US Department of Housing & Urban Development	Len Smith	
US Dept. of Energy, Off. Of Environ. Compliance		
US Environmental Protection Agency	Paul Gagliano	
US Environmental Protection Agency, Region 4	Ted Bisterfeld	
US Environmental Protection Agency, Region 4	Wesley Crum	Chief
USDA, Natural Resources Conservation Service		State Conservationist

List of Recipients		
Organization	**Name**	**Title**
USDA, Natural Resources Conservation Service		
USDA, Natural Resources Conservation Service		State Conservationist
USDA, State & Private Forestry		Reg'l. Director
Virginia Council on Indians	Karenne Wood	Chairperson
Wake County		County Manager
Wake County	John Roberson	Project Manager
Wake County CDS Engineering		County Engineer