CAPITAL CASCADES TRAIL SEGMENT 4

Innovative Stormwater Technologies

A White Paper on Stormwater Management System Design Practice in Florida

BLUEPRINT

INTERGOVERNMENTAL AGENCY

JonesEdmunds

GEORGE & ASSOCIATES
CONSULTING ENGINEERS

INNOVATIVE STORMWATER TECHNOLOGIES

A WHITE PAPER ON

STORMWATER MANAGEMENT SYSTEM DESIGN PRACTICE IN FLORIDA

Prepared for:

Blueprint Intergovernmental Agency

315 S. Calhoun Street, Suite 450

Tallahassee, Florida 32301

Prepared by:

Jones Edmunds & Associates, Inc.

324 S Hyde Park Ave, Suite 250

Tampa, Florida 33606

George & Associates
Consulting Engineers, Inc.

1967 Commonwealth Ln Suite 200,

Tallahassee, FL 32303

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PREFACE

Blueprint Intergovernmental Agency is committed to creating holistic infrastructure solutions to improve the local community. Since the IA Board's approval of the Capital Cascades Master Plan in 2005, Blueprint has completed a substantial number of stormwater improvements along the Cascades Trail corridor improving both water quality and reducing area flooding. In all, these stormwater improvements represent a total investment of more than $57,000,000 and stretch approximately 2.5 miles. The improvements along Cascades Trail have won numerous awards and received accolades from many professional organizations. Cascades Park has won two national awards, one in 2015 from the American Public Works Association, and the second in 2016 from the American Planning Association. Franklin Boulevard, Cascades Park, the Cascades Connector pedestrian bridge, and Segment 3 have won many awards over the last 10 years from local and state sections from organizations such as the Urban Land Institute, Florida Landmarks Council and the National Association for the Preservation of African-American History and Culture, American Public Works Association, American Planning Association, and the American Institute of Architects. Continuing on this success, Capital Cascades Trail Segment 4 will complete the Master Plan by finishing the 4.25-mile trail system that stretches from Leon High to Lake Henrietta, providing amenities, water quality enhancements, and flood mitigation. With the completion of Segment 4, the Capital Cascades Trail will represent a final investment of over $71,000,000 extending recreational amenities and stormwater enhancement from downtown to south Tallahassee.

As part of the George and Associates project team for Capital Cascades Trail Segment 4, Jones Edmunds developed this White Paper on behalf of Blueprint to provide a common level of understanding of potential stormwater management system designs for the project by overviewing the practice of stormwater design in Florida. The overview of stormwater design practice in Florida is followed by a summary of known stormwater characteristics for the Capital Cascades Trail Segment 4 project watershed and a discussion of potential stormwater improvements that are most relevant to the project based on the established characteristics.

The paper also contains a summary of the water quality sampling data in the Central Drainage Ditch near the convergence to Munson Slough. The data shows a decreasing trend in nutrient concentrations suggesting that although relatively limited on-site stormwater treatment is provided within the project watershed, the stormwater retrofit projects implemented upstream by the City and Blueprint are effective at reducing the ambient nutrient load within the CDD. Moreover, the most immediate downstream waterbody, Munson Slough, is no longer considered impaired for nutrients based on the Florida Department of Environmental Protection (FDEP) 2020-2022 Biennial Assessment of Impaired Waters. Munson Slough includes the area between the Segment 4 project and Lake Munson.

Readers may not be aware of all the traditional stormwater designs discussed in this White Paper, meaning definitions of innovative will likely vary by individual experience. As presented here, we define traditional stormwater designs as those that have most commonly been implemented throughout Florida and are considered standard stormwater design practice.

The practice of stormwater design is evolving such that low-impact design (LID), green stormwater infrastructure (GSI), and other innovative stormwater technologies are becoming more commonplace. But we recognize that while LID, GSI, and some innovative technologies continue to gain in popularity, they are often still collectively considered to be innovative by most readers.

The breadth of potential material to be covered in this White Paper is immense. For simplicity, this White Paper presents a comprehensive, but not exhaustive, overview of the current state of stormwater design in Florida including engineering stormwater design criteria, traditional designs, LID, GSI, and innovative stormwater technologies. Any one of these overviews could be expanded to include more detail than presented here.

Specific to the Capital Cascades Trail Segment 4 project, further study of the project's stormwater characteristics is planned, including the development of a new stormwater model to aid in preliminary engineering of the project. This White Paper is not intended as a substitute for Capital Cascades Trail Segment 4 preliminary engineering, which needs to be completed before more definitive stormwater management system design recommendations are appropriate than presented here.

GLOSSARY

Stormwater Management System	The appurtenances, facilities, and designed features that collect, convey, channel, hold, treat, detain, or divert stormwater runoff. These systems may include traditional stormwater design components, LID techniques, GSI, and/or innovative stormwater technologies.
Land Development	A site improvement such as construction, reconstruction, demolition conversion, structural alteration, relocation, or enlargement of any structure, whether residential, commercial, industrial, office, professional, institutional, or recreational. This term is also generally used to include any use or extension of the use of land beyond its current state, including redevelopment. Stormwater management systems for land development are typically designed based on presumptive criteria.
Presumptive Criteria	Stormwater design criteria, which are presumed to meet regulatory goals and objectives based on prior studies and industry-accepted assumptions. A presumptive approach provides reasonable assurance that systems operate as expected without requiring monitoring or burdensome amounts of site-specific information.
Stormwater Retrofit	Stormwater management systems, or portions of a system that append an existing system and that do not serve land development but are focused on community improvement. These systems may include traditional stormwater design components, LID techniques, GSI, and/or innovative stormwater technologies. Stormwater retrofits may be focused on flood control, pollutant removal, or both.

	Stormwater retrofits are typically designed based on demonstrative criteria.
Demonstrative Criteria	Stormwater design criteria that are directly demonstrated to meet regulatory goals and objectives via detailed engineering calculations, monitoring, and/or performance testing.
Stormwater Attenuation	Stormwater attenuation is the capture and release of floodwaters, typically controlled via an engineered control structure, to protect downstream waters. Attenuation volume based on existing-condition discharge is required for stormwater designs to meet presumptive criteria.
Stormwater Treatment	Stormwater treatment is the removal of pollutants from stormwater runoff by physical, chemical, or biological means. Stormwater treatment is synonymous with water-quality improvement and is typically focused on nutrient and sediment removal. Treatment volume based on the proposed-condition rainfall-runoff-response is required for stormwater designs to meet presumptive criteria.
Control Structure	Control structures regulate discharge of stormwater runoff and are used to establish stormwater attenuation and treatment volumes.
Existing Condition	The drainage condition of the project site before activities related to land development have been constructed.
Proposed Condition	The drainage condition of the project site after activities and construction related to proposed land development have been completed.
Low-impact Design (LID)	A land development practice that stives to maintain green space, existing condition hydrology, and natural habitats to the greatest extent practical. LID stormwater management systems commonly include GSI in a treatment train but may also include traditional stormwater design components or innovative stormwater technologies.
Green Stormwater Infrastructure (GSI)	Stormwater design components intended to mimic nature by providing stormwater attenuation and treatment near the runoff source. GSI is commonly considered as an alternative to traditional stormwater design but is often coupled with traditional stormwater design and/or innovative stormwater technologies to meet design criteria.
Treatment Train	A series of complementary stormwater designs when combined meet or exceed stormwater treatment goals. A treatment train may include multiple traditional stormwater designs, GSIs, and/or innovative technologies.

BLUEPRINT
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1 BACKGROUND

Blueprint Intergovernmental Agency is a joint City of Tallahassee-Leon County agency within the Department of Planning, Land Management and Community Enhancement. Blueprint is committed to holistic infrastructure planning and community redevelopment. These efforts are highlighted by the Capital Cascades Trail (CCT) projects, which include multi-use stormwater and recreation facilities and a connected trail network. The CCT projects are divided into four segments and the final segment, Segment 4, is currently being developed. Goals for the Segment 4 project include flood protection, water-quality improvement, habitat restoration, and creation of park-like areas for public recreation.

Blueprint contracted George & Associates, Consulting Engineers, Inc. (GAC) to complete Task 1 of CCT Segment 4, which includes stormwater analysis and the development of preliminary design concepts. Jones Edmunds is part of the GAC project team for Task 1 and will be primarily responsible for stormwater analysis and the stormwater design portion of concept development.

Before developing stormwater design concepts for CCT Segment 4, Blueprint has requested this White Paper to overview to current state of stormwater design practice in Florida and discuss stormwater design components and innovative technologies that are applicable to the CCT Segment 4 project.

2 PURPOSE

This White Paper will provide readers with a common level of understanding of the current state of stormwater design practice in Florida, followed by a summary of stormwater characteristics for the Capital Cascades Trail Segment 4 project, and lastly a discussion of the most relevant potential stormwater improvements based on these characteristics.

The breadth of potential material to be covered in this White Paper is immense. For simplicity, this White Paper presents a comprehensive, but not exhaustive, overview of the current state of stormwater design in Florida including engineering stormwater design criteria, traditional designs, low-impact design (LID) and green stormwater infrastructure (GSI), and innovative stormwater technologies. Any one of these overviews could be expanded to include more detail than presented here. Instead, focus throughout is given to topics most applicable for

the CCT Segment 4 project, and was based on our judgment and understanding of the project goals at the time of this White Paper.

This White Paper is organized as follows:

- Section 3 provides the basics of stormwater design criteria in Florida.
- Section 4 overviews traditional stormwater design components and approaches.
- Section 5 overviews LID techniques and GSI.
- Section 6 overviews innovative stormwater technologies.
- Section 7 summarizes the CCT Segment 4 watershed characteristics to establish potential limitations of the project design.
- Section 8 discusses potential stormwater designs, technologies, and techniques that are most relevant to the CCT Segment 4 project.
- Section 9 concludes with the CCT Segment 4 key findings.

3 STORMWATER DESIGN CRITERIA

In general, a stormwater management system design should consider service life, cost, public safety, and ease of maintenance. Stormwater management systems must comply with local, state, and federal stormwater design (permit) criteria. For land development, including redevelopment, these permit criteria are often presumptive and due to their prescriptive nature, highly dependent on traditional stormwater designs for compliance. Importantly, improving the watershed is not a goal of presumptive criteria. Instead, presumptive criteria in Florida were established with two goals:

1. Minimizing flooding and subsequent damage to life and property by providing adequate flood control.
2. Reducing 85 percent or more of pollutant loading from land development.

Demonstrating compliance with presumptive criteria requires stormwater analysis of existing and proposed conditions but does not require direct calculation of project impacts at the community level, such as flood-risk reduction or pollutant-load reduction.

By comparison, stormwater management systems that do not serve land development and are designed to improve the community, also known as *stormwater retrofits*, are typically held to design criteria that demonstrate net improvement to the community, either through flood-risk reduction or pollutant-load reduction. This so-named demonstrative approach requires more complex analyses to demonstrate project impacts at the community level.

The CCT Segment 4 project's stormwater management system is expected to serve proposed project improvements and as a stormwater retrofit for the project watershed. The project's ability to provide a net improvement to the community will be dictated by watershed characteristics and site constraints, which include the land available for improvements and hydraulic conditions at the site. Simplistically, the watershed characteristics dictate what type of stormwater improvements are warranted while the site constraints dictate what level of stormwater improvement is practical. The combination of watershed characteristics and site

constraints places a practical limit on the net improvement to the community the CCT Segment 4 project can be reasonably expected to achieve.

The CCT Segment 4 project's stormwater management system will be regulated at the state level by the Northwest Florida Water Management District (NWFWMD) through the Environmental Resource Permitting Rules in the Florida Administrative Code, Chapter 62-330, and at the local level by City Growth Management through the City's Land Development Code. The project's stormwater management system will be regulated at the federal level by the United States Army Corps of Engineers (USACE) and Federal Emergency Management Agency (FEMA) per the Federal Register.

4 TRADITIONAL STORMWATER DESIGNS

Traditional stormwater designs that use wet detention or infiltration for stormwater treatment have well-established presumptive criteria in Florida. Although wet detention is almost always associated with a wet-detention pond, several varieties of infiltration-based designs exist. The appropriateness of these two practices to a site are usually dictated by soils and depth to the groundwater table. Presumptive design criteria typically include:

1. Limiting discharge of attenuation volumes to the existing condition peak discharge or less from infrequent, large storms.
2. Providing treatment volumes based on the proposed condition rainfall-runoff-response from more frequent, smaller storms.
3. Requiring discharge of these volumes within prescribed recovery times.

A few traditional stormwater designs exist that are not as commonly used to support land development but that do have established presumptive design criteria. Two notable examples are constructed wetlands and stormwater harvesting. These stormwater designs can be designed to serve only stormwater treatment goals, not stormwater attenuation, and operate as variations on wet-detention or infiltration-based designs.

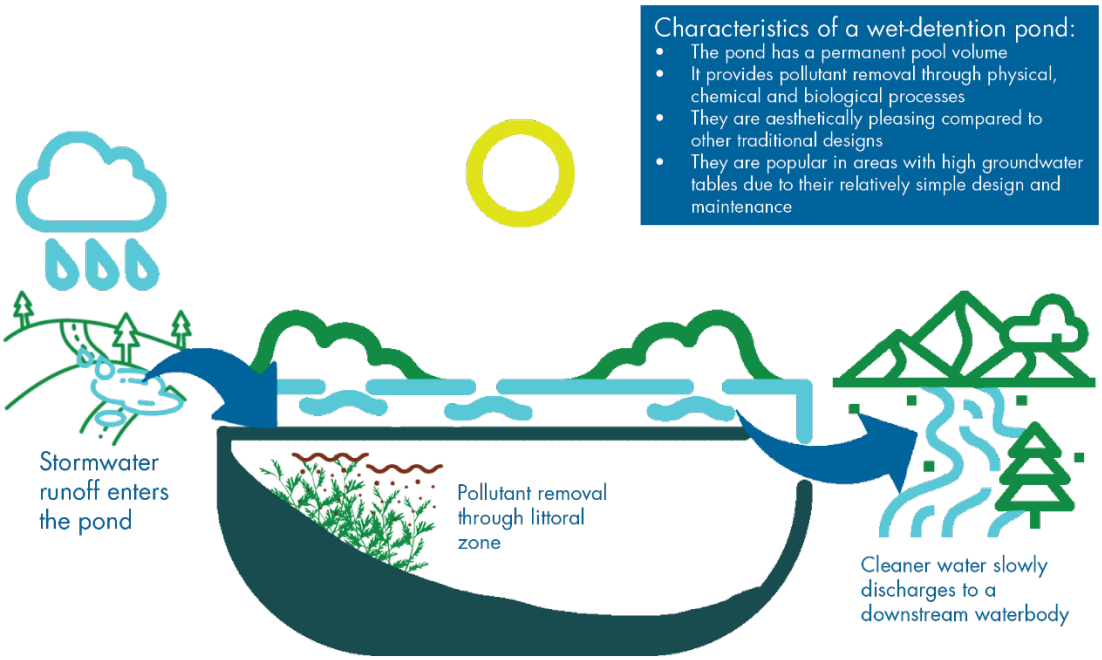
Several more traditional stormwater designs exist that are not typically used to support land development because they do not have associated presumptive criteria and do not provide stormwater attenuation. These designs include but are not limited to sediment traps, trash traps, chemical treatment, and erosion control. These stormwater designs are used to only provide stormwater treatment.

While the most common application of traditional stormwater design components is a single component serving a single site, other stormwater design approaches worthy of mention are over design, off-site design, and combination designs. These stormwater design approaches rely on one or more of the previously mentioned traditional stormwater designs to meet project goals. Overviews of the most relevant traditional stormwater designs are provided in this Section.

4.1 Wet Detention

Wet-detention designs are typically a man-made pond that receives stormwater runoff from a storm-drain or swaled system and slowly discharges the captured runoff through a control structure to a downstream waterbody as shown in Figure 1. The pond volumes and control structure discharge rates are engineered to meet presumptive design criteria. The *wet* portion of the pond is also known as the permanent pool volume.

Figure 1 Wet Detention Pond Example



Wet-detention ponds often incorporate a littoral zone to further facilitate pollutant removal. The littoral zone is a portion of the pond that is designed to be shallow and contain rooted aquatic plants. The aquatic plants promote nutrient removal primarily by providing a habitat for microorganism activity and provide limited direct nutrient uptake. However, several studies have shown most pollutant removal from wet-detention ponds occurs within the permanent pool volume and that pollutant-removal potential is well correlated to the hydraulic residence time of this volume. Simply stated, the bigger the wet-detention pond the higher potential pollutant removal.

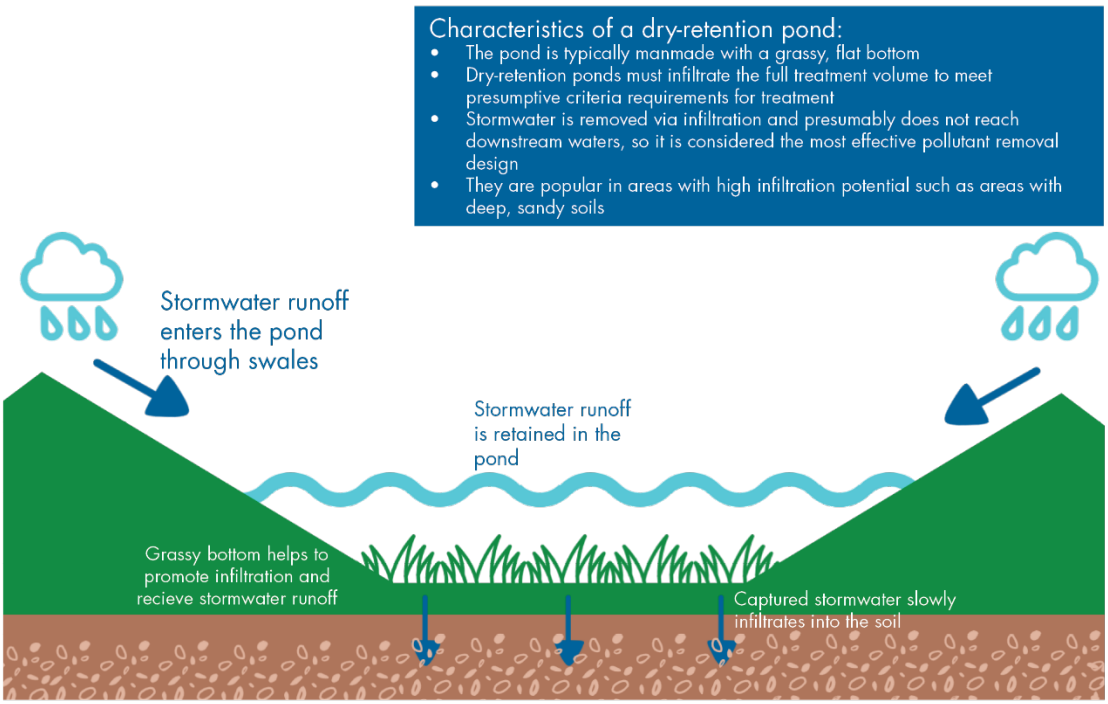
4.2 Retention

The most common infiltration-based design is a dry-retention pond. These ponds are typically manmade with a grassy flat bottom to promote infiltration as shown in Figure 2 and receive stormwater runoff from a storm drain or swaled system. Dry-retention ponds typically

infiltrate the full volume of runoff received from smaller storm events and slowly release the attenuation volume through an engineered control structure to meet presumptive criteria requirements for attenuation for larger storm events.

Since volumes discharged via infiltration and their associated pollutant load presumably do not reach downstream waters, retention is traditionally considered the most effective pollutant-removal design. These designs are popular in areas with high infiltration potential such as areas with deep, sandy soils. However, these designs must consider potential localized impervious layers or high groundwater tables that would limit the infiltration potential.

Figure 2 Dry Retention Pond Example



4.3 EXFILTRATION

An exfiltration system is another infiltration-based design and performs similarly to a dry-retention pond, except that the system is entirely subsurface. Exfiltration systems include perforated drainage pipes that are surrounded underground by porous aggregate or media to promote infiltration. The main advantage of exfiltration systems is that they are completely subsurface, which makes these systems popular in areas that are very space limited. Exfiltration systems may be designed to infiltrate the full storm volume or discharge the attenuation volume to downstream waters. However, periodic replacement of the aggregate is required due to sediment accumulation within the system to maintain infiltration rates and can often be expensive compared to maintenance of other traditional stormwater designs.

4.4 Swales and Vegetated Strips

Swales and vegetated strips are two more infiltration-based designs. These designs slowly convey stormwater runoff through a small channel (swale) or via sheet flow (vegetated strip) over grassy areas with high-infiltration potential. For these designs, the attenuation volume is typically discharged overland or through a storm pipe at the system's outfall to downstream waters. The treatment volume is discharged via infiltration. These designs are popular when only a small amount of runoff needs to be managed or as pre-treatment components within a stormwater treatment train.

4.5 Detention with Filtration

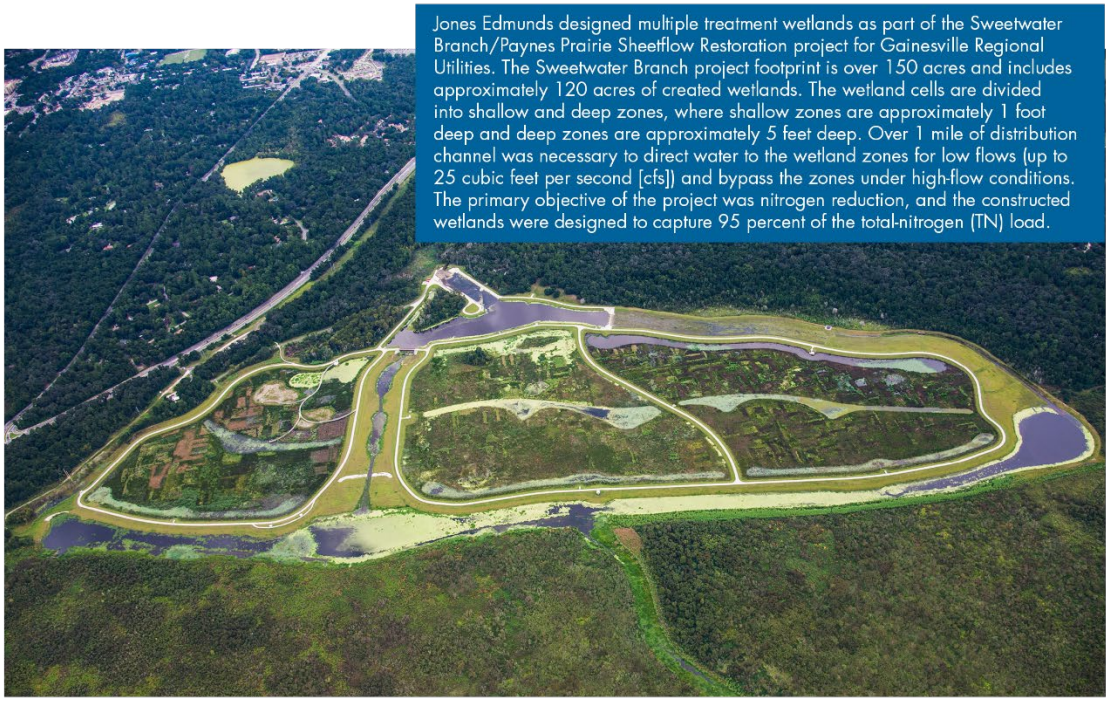
Some dry-pond designs include under-drains or side-drains to facilitate infiltration. These drains are perforated drainage pipes that are installed in a bed of porous media, most commonly sand. The drains collect and convey stormwater flows from underneath or the side of the pond. Stormwater collected by the drain system is not infiltrated to a groundwater system but is filtered before discharge to downstream waters. For this reason, these systems are considered detention systems since the full treatment volume is not discharged via infiltration. Discharge of filtered flows and the attenuation volume typically occurs through an engineered control structure and then to downstream waters.

In practice, these systems often operate as hybrid systems where some of the treatment volume is infiltrated and some filtrated and discharged downstream. Although some pollutant removal is provided during filtration between the pond and the drains, studies show pollutant removal from the filtration process to be limited and unreliable, particularly for dissolved pollutants like nitrogen. Accordingly, these designs are not as effective at pollutant removal as retention systems unless coupled with engineered media. These stormwater designs also typically require more maintenance.

4.6 Constructed Wetlands

Constructed wetlands use wetland vegetation, soils, and associated microbial activity to improve water quality. These systems are sometimes referred to as treatment wetlands or created wetlands and are as varied as the available vegetation, including surface flow, subsurface flow, and combination systems. When properly designed, constructed wetland are very effective at stormwater treatment. An example of a large-scale constructed wetland is the Sweetwater Branch treatment wetland, which was designed by Jones Edmunds and is pictured in Figure 3. The Sweetwater Branch treatment wetland serves an urban watershed of approximately 3 square miles and was designed to primarily treat inflows less than 10 cfs and can capture storm flows up to 25 cfs. Sweetwater Branch also has the relative benefit of treating WWTP effluent that is mixed in with storm flows, meaning incoming nutrient concentrations higher than typical storm flow, which allows the wetland components to remove nutrient loads very efficiently.

Figure 3 Constructed Wetland Example – Sweetwater Branch



However, inflow and velocity through a constructed wetland are typically limited to avoid damaging vegetation, to avoid resuspending captured pollutants, and to allow time for the rate-dependent biological treatment processes to occur. In short, properly designed constructed wetlands are excellent for stormwater treatment of the accepted flows when sufficient nutrient concentrations are present, but often bypass a significant portion of flow from larger storm events. In comparison to other types of stormwater treatment types, constructed wetlands require a much larger area to achieve a similar pollutant load reduction.

4.7 Stormwater Harvesting

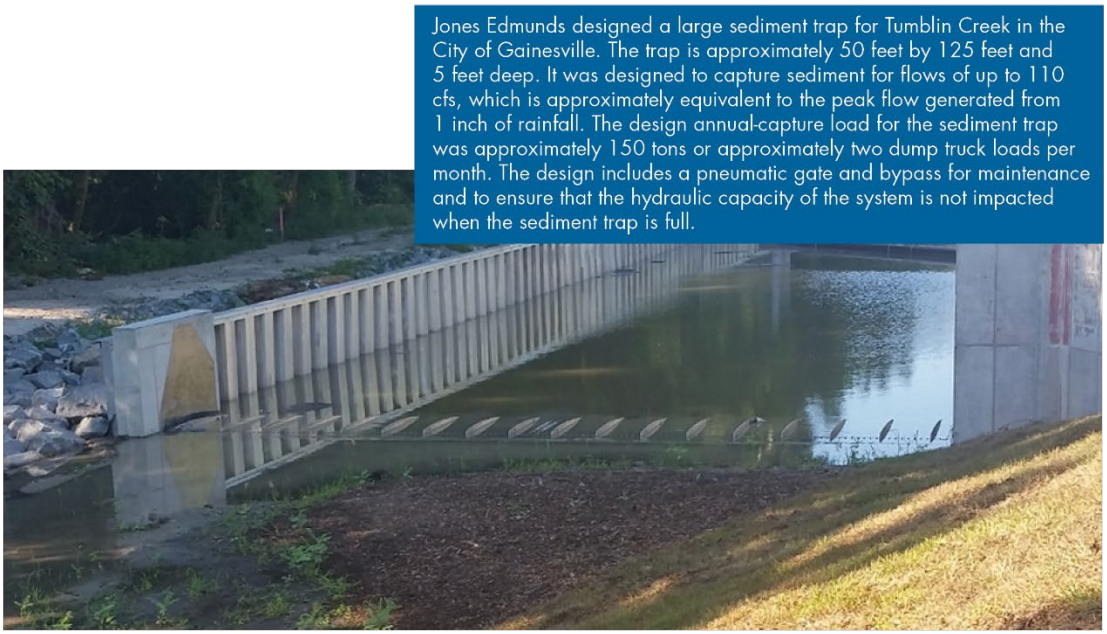
From a stormwater design perspective, stormwater harvesting (or stormwater reuse) is an improvement to wet detention for stormwater treatment, but typically does not directly provide stormwater attenuation since stormwater is harvested between storm events. Unlike a traditional wet-detention pond where the treatment volume is slowly released downstream, stormwater harvesting removes some or all of the treatment volume for another non-potable use, most commonly irrigation. In this way, the concept is very similar to residential rainwater harvesting.

Stormwater harvesting is slowly gaining popularity to increase pollutant removal and to offset potable supply demands from non-potable uses, such as on-site irrigation needs. However, the timing of storm flows needs to be considered when stormwater harvesting is used as an alternative irrigation source. Seasonal rainfall patterns often necessitate a backup irrigation source or a very large storage volume.

4.8 Sediment Traps

Sediment traps promote sediment deposition by sufficiently reducing flow velocity to allow time for most of the sediment to settle before stormwater flows and their sediment load are released downstream. An example of a large sediment trap is shown in Figure 4.

Figure 4 Sediment Trap Example



Sediment deposition also occurs in other stormwater designs, but with sediment traps the focus is on sediment removal. Accordingly, sediment traps typically do not provide stormwater attenuation. Sediment traps differ from sediment sumps, which are manmade pits to temporarily store runoff commonly associated with construction activities and designed to last only as long as the construction activities. By comparison, sediment traps are designed as permanent improvements and typically hardened so that maintenance activities can easily remove accumulated sediment over time without damaging the trap.

Baffle boxes are a type of self-contained sediment trap. They are so-named since the prefabricated boxes include a series of sediment settling chambers separated by baffles. Baffle boxes are typically positioned at outfalls and though simple, can be difficult to maintain due to access issues.

4.9 Trash Traps

The most effective method of anthropogenic (human-caused) trash reduction is source reduction or collection nearest the source as practical. However, larger trash collection designs can be engineered to serve large stormwater conveyance systems. The design components

are commonly referred to as trash traps. An example of a large trash trap is shown in Figure 5 and as seen in the figure, trash traps are commonly supplemented with a floating boom that directs trash on the surface to the trap. Baskets and bags typically float and capture trash directly. By comparison, a trash screen typically does not float and captures trash within most or all of the water column.

Figure 5 Trash Trap Example

Simply stated, trash traps are capture points for trash that allow relatively easy removal and maintenance compared to removing trash from a larger stormwater system, such as an open channel or pond. Trash traps do not provide stormwater attenuation. Two primary complicating factors exist with all trash traps:

1. Trash traps, particularly screens, are inherent hydraulic constrictions and commonly require bypass designs to allow high storm flows without adverse impacts. This hydraulic need will increase the footprint of the design or limit its function.

2. Trash traps will capture more than just anthropogenic trash. Trash traps will capture any large debris carried by storm flows. Accordingly, trash traps are more appropriately named *gross pollutant* removal designs since the anthropogenic trash is likely to be mixed with organic debris and, depending on the characteristics of the system, may only be a small portion of the captured load, even in urban watersheds where tree cover can potentially generate high loads of leaf litter.

4.10 Erosion Control

One of the most common improvement goals for an urban stream is erosion control. Permanent erosion control measures come in several varieties including but not limited to concrete, sheet pile, geotextile, and gabion designs. These types of stormwater designs eliminate or greatly reduce the erosive potential of an urban stream segment, but do not by themselves remove sediment loads that are conveyed through the segment to downstream waters, improve water quality downstream relative to upstream, or provide attenuation. These designs do provide stormwater treatment by preventing degradation of water quality within the improved segment. An example of erosion control for an urbanized system is just upstream of CCT Segment 4 in the City's *Lower Central Drainage Ditch Improvements*, which is a gabion design.

4.11 Over Design, Off-Site Design, and Combination Designs

In some situations, physical limitations such as property availability or access points make construction of a single traditional stormwater design component impractical. In other situations, one design component is not sufficient to meet permit criteria. To address these limitations, a few approaches have become more commonplace to stormwater design, but are all dependent on one or more of the traditional stormwater designs.

One approach is to provide stormwater attenuation or stormwater treatment to a greater extent than required by rule, commonly known as over design. This approach uses the over design of one element to offset the under design of another. For example, some communities have capitalized on the over design provided by stormwater retrofits to support a single site development, such as coupling a stormwater retrofit project with a community park, or supporting multiple future developments, such as stormwater design that provides enhanced attenuation and/or treatment of the watershed's existing condition but also provides credits for future land development so that future on-site stormwater designs are minimized or potentially not required. In these cases, the stormwater management system is over designed relative to permit criteria.

A similar approach is to design a stormwater management system off site, commonly known as off-site compensation. In our experience, off-site compensation for land development is typically not allowed by regulatory agencies unless coupled with over design so that a net community improvement is demonstrated. Accordingly, although over design does not require off-site compensation, off-site compensation typically does require over design. A stormwater retrofit project that also serves future land development would be considered over design and off-site compensation for future development.

The last approach is a combination system, which is a very popular option for stormwater retrofit projects and is gaining popularity to support land development. A combination system approach uses multiple design components in a treatment train to meet permit criteria. A LID stormwater management system is an example of a combination system.

5 LOW-IMPACT DESIGNS

The concept of LID was popularized almost 30 years ago and for most of that time was commonly known as *low-impact development*. Recently, *low-impact design* has replaced *low-impact development* as the more accepted term for LID within the industry. LID as a planning or engineering approach is often used synonymously with other terms such as smart development, sustainable development, and new-urbanism. As related to stormwater management system design, we have defined LID as a design practice that strives to maintain existing-condition hydrology and natural habitats to the greatest extent practical and is therefore distinct from traditional stormwater design practice. GSI design components are commonly included in LID stormwater management systems.

5.1 WHAT IS LID?

A LID stormwater design typically uses GSI design components integrated as a treatment train to replicate stormwater treatment and attenuation provided by the natural landscape. Although traditional stormwater designs collect, control, and treat stormwater runoff to meet presumptive criteria using an *end-of-pipe* solution, such as a stormwater pond, a LID stormwater management system includes nature-based retention, detention, treatment, and harvesting design components, i.e., GSI, distributed across the site to promote stormwater attenuation and treatment at or near the source of stormwater runoff. LID goals include:

- Preserve or conserve existing site features as much as possible to mimic existing conditions.
- Distribute stormwater attenuation and treatment design components, typically GSI, across the project site and as near to large sources of runoff (typically an impervious area) as possible.
- Reuse captured rainwater or stormwater on site.
- Minimize potential soil compaction from site development and promote stormwater infiltration.

LID and GSI are also well known for benefits beyond stormwater attenuation and treatment. Preserving natural areas creates aesthetically pleasing environments, provides wildlife habitat, and can limit landscape maintenance needs. GSI design components also make use of natural features, which helps maintain connectivity of green spaces on site and within the community. The source control provided by GSI can also reduce capital costs compared to traditional stormwater design.

However, including GSI within a stormwater management system typically does not completely offset the need for a traditional stormwater design to meet project goals or regulatory objectives. Also, a significant difference between GSI and traditional stormwater design components is that from a regulatory perspective, well-established design criteria may not be available for GSI design components. Although improved in recent years, these limitations of GSI have slowed the adoption of LID stormwater management systems as standard practice. To promote LID and GSI, some local communities have provided guidance for LID and developed design criteria for GSI, commonly within community manuals. Some examples of these include the *Pinellas County Stormwater Manual*, *Duval County LID Design*

Manual, *Alachua County LID Manual*, and the *Sarasota County LID Guidance Document*. Readers interested in learning more about LID and GSI are encouraged to review those manuals.

5.2 What is GSI?

GSI design components are intended to mimic nature by providing stormwater attenuation and treatment near the runoff source. GSI is commonly considered as an alternative to traditional stormwater design but in practice GSI is often coupled with traditional stormwater design and/or innovative stormwater technologies to meet permit criteria. Some of the most well-known GSI design components are the various forms of bioretention and permeable pavement. Other design components considered to be GSI when associated with LID stormwater management systems were previously discussed in this document, including swales, baffle boxes, and exfiltration systems.

The potential confusion between GSI and traditional stormwater design regarding LID is an artifact of LID being an approach-based practice that is not limited by design components. Any number of stormwater design components may be included in a LID stormwater management system if they help meet the fundamental goals of LID. To help the reader, we offer the following simplified distinction. The difference between a traditional stormwater design and LID is often a matter of the design component(s) size, location, and vegetation. Smaller, nature-based design components are often considered GSI and when GSI design components are included in the treatment train, the stormwater management system is often considered to be LID.

Table 1 provides a list of stormwater design components that are commonly considered to be GSI when associated with LID stormwater management systems, along with the Section of this White Paper where the design component is more fully discussed. Overviews of potential GSI design components not previously discussed are provided in this section. Furthermore, many innovative stormwater technologies, which are discussed in Section 6, are also often considered GSI.

Table 1 Previously Mentioned GSI Design Components

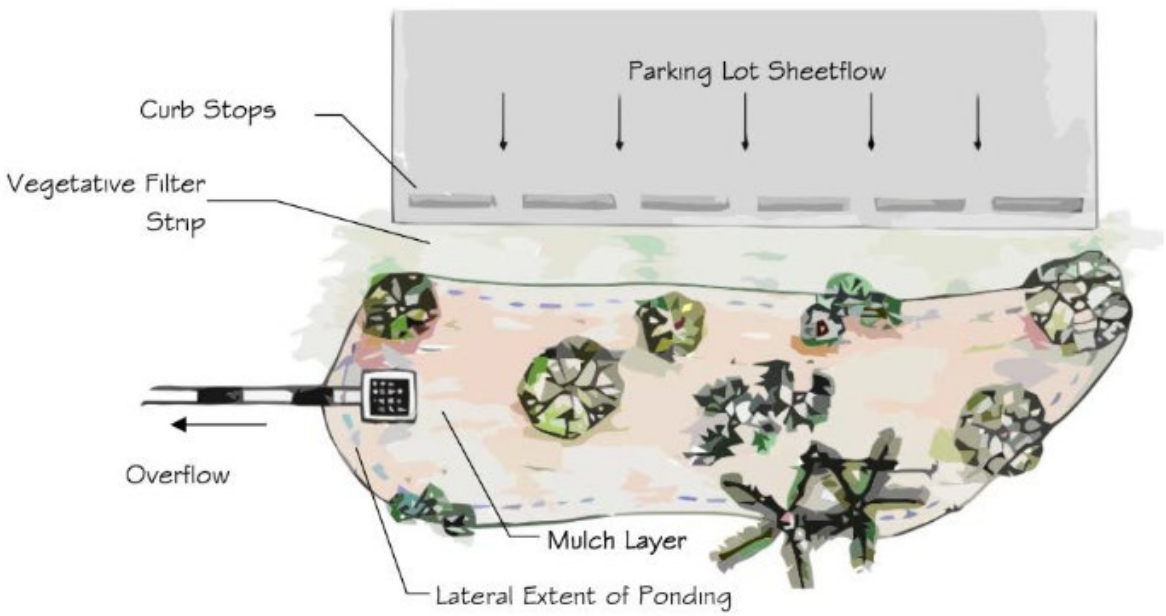
Design Component	Document Reference
Exfiltration	Section 4.3
Swales	Section 4.4
Vegetated Strips	Section 4.4
Constructed Wetlands	Section 4.6
Stormwater Harvesting	Section 4.7
Baffle Boxes	Section 4.8

5.2.1 Bioretention

Bioretention is an infiltration-based design component that provides the same engineering function as a retention design, but instead of only grass within the retention area, bioretention

includes engineered media, soils, mulch, and/or native plants to facilitate infiltration and enhance pollutant removal. An example of a bioretention system is shown in Figure 6.

Figure 6 Bioretention Example



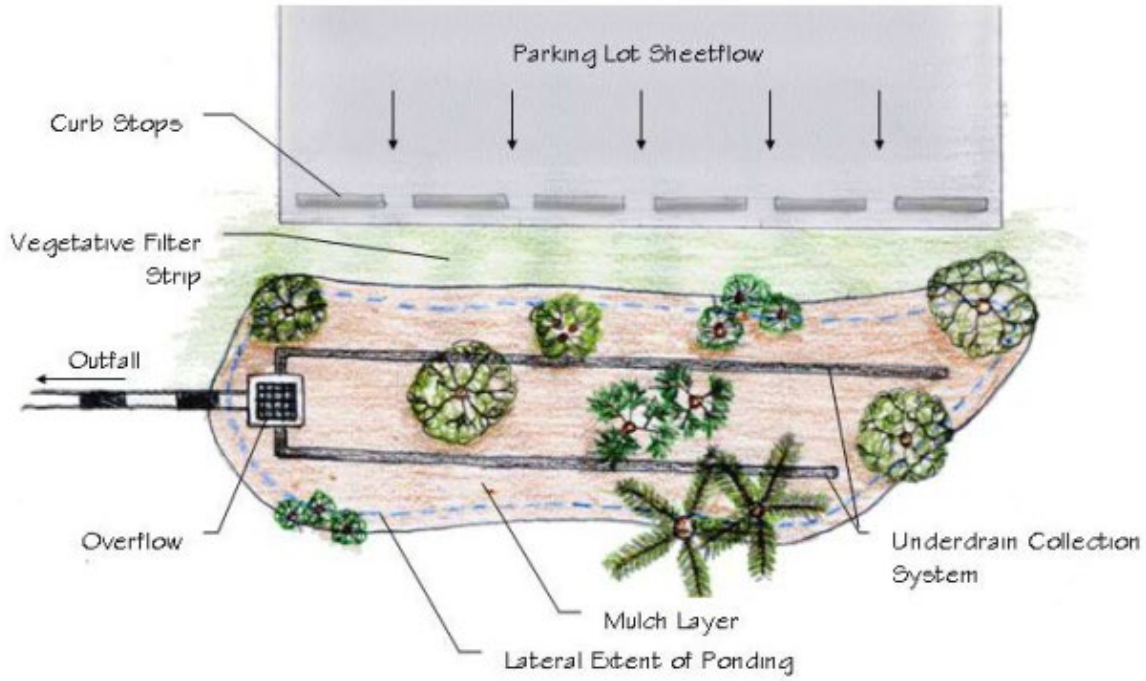
When stormwater attenuation is solely provided through infiltration, these systems are sometimes referred to as shallow bioretention. When properly designed, bioretention systems are more effective than conventional retention systems due to the increased interaction of stormwater runoff with soil, microbes, and vegetation enhancing biogeochemical processes that remove pollutant loads.

Bioretention is often used synonymously with a bioswale, rain garden, or planter box. The distinction typically is in the size and service area. In practice, bioretention areas usually refer to systems of relative size serving a large parking lot or building. Bioswales are bioretention systems that also serve as a swale conveyance, typically associated with a road or pedestrian path. Rain gardens are bioretention systems that serve a smaller parking lot or building, such as a single-family home. Planter boxes are bioretention areas that serve a very small area. A specific example of a planter box is a tree box, which uses a tree for uptake.

5.2.2 Detention with Biofiltration

Like detention with filtration (Section 4.5), biofiltration systems can be designed to function in areas with high ground water tables by using underdrains to facilitate infiltration via filtration from the surface to the drain. An example of a biofiltration system is shown in Figure 7.

Figure 7 Detention with Biofiltration Example



The difference between detention with filtration and with bioretention is in the filtration process and design filtration rates. Like bioretention, biofiltration systems increase interaction of stormwater runoff with soil, microbes, and vegetation, which enhances biogeochemical processes that remove pollutant loads. Detention with biofiltration systems have much lower infiltration (filtration) rates compared to bioretention and therefore typically include vegetation that thrive in wet conditions for prolonged periods. In biofiltration systems, stormwater is intentionally slowly filtered through the system to maximize pollutant-load reductions from the biogeochemical process.

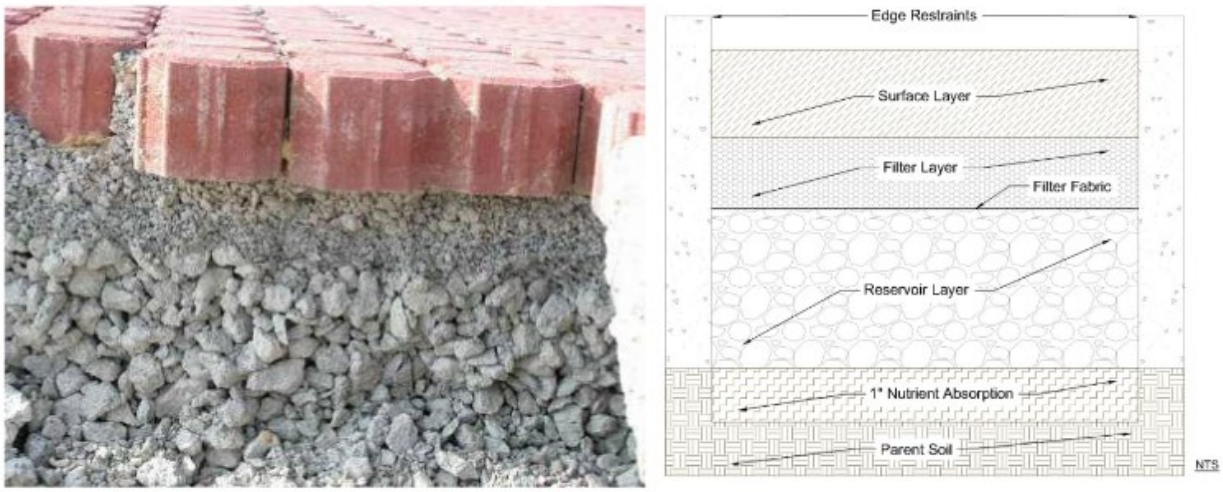
Due to the slow rate of filtration, detention with biofiltration systems typically provide relatively high levels of stormwater treatment but can capture only small volumes and provide only limited stormwater attenuation. As with bioretention systems, detention with biofiltration is often used synonymously with a bioswale, rain garden, or planter box and the distinction typically is in the size and service area.

5.2.3 Permeable Pavement

Permeable pavement is an infiltration-based design component that uses gray infrastructure. The pavement, concrete, pavers, turf, or other manufactured surface type is porous and allows runoff to infiltrate through the surface to a below-grade system where stormwater attenuation and treatment are provided. Accordingly, permeable pavement systems are more than just the manufactured surface and typically include multiple layers that make a modular system, such as permeable pavement, filter layer(s), reservoir, and subgrade/parent soil as

shown in Figure 8. Permeable pavement is most applicable in areas with infrequent traffic and light loads.

Figure 8 Permeable Pavement Example



Permeable pavement systems may also include underdrains, where the system will perform like detention with filtration. Stormwater that passes through the permeable pavement system but is ultimately discharged to downstream waters via underdrains typically receives only minimal treatment unless the modular system includes engineered media.

5.2.4 Rainwater Harvesting

Rainwater harvesting serves the same engineering function as stormwater harvesting except that the harvesting occurs close to the source collection. Harvested rainwater typically comes from a building rooftop and is stored in a cistern near landscaping that will be the benefactor of the harvested rainwater via irrigation. These systems are typically small but are also popular primarily to offset potable supply demands for irrigation. However, seasonal rainfall patterns may necessitate a backup irrigation source depending on the landscaping.

5.2.5 Green Roofs

A green roof functions as a specialized detention system with biofiltration that is on the roof of a building and is typically coupled with a cistern or other storage design component. Green roofs are quickly gaining popularity in heavily urbanized areas where other green spaces are limited due to their aesthetic appeal and long design life, which is commonly twice that of traditional roofing material. However, green roof design can be quite complex due to structural considerations especially when public access is allowed.

6 INNOVATIVE STORMWATER TECHNOLOGIES

For this White Paper, innovative technologies are improvements on traditional stormwater and GSI design components. These technologies are commonly associated with stormwater retrofit projects but have also been used to support land development.

6.1 Engineered Media

Engineered media, sometimes called green media, is incorporated into stormwater designs to enhance pollutant removal through a filtration-like process that also includes biological treatment. The most well-known engineered media for stormwater design is biosorption-activated media (BAM). BAM is generally designed to remove nitrogen and phosphorus and is commonly customized to site-specific conditions for incoming nutrient loads and design flows. Like filtration processes, the design flux rate through BAM is limited; therefore, treatment of even moderately high flows requires a very large BAM surface area.

BAM is perhaps best known for application within a modified baffle box where BAM is used within an upflow filter, the baffles collect sediment, and a trash trap collects floatable debris. This type of combined system design is very popular since it is prefabricated, but it is also limited to relatively low treatment flows through the upflow filter for a single unit. These systems are also often considered to be GSI even though they are not nature-based. A similar BAM system is planned as part of the CCT Segment 3D-B project.

BAM is also commonly incorporated into infiltration-based designs such as dry-retention ponds, exfiltration trenches, permeable pavement, or bioretention. The stated design life of a BAM system varies from a few years to over 20 years depending on the site-specific application; however, since the technology is still relatively new, the upper end of design life has not been fully tested for many applications.

6.2 Chemical Treatment

Chemical treatment of stormwater typically refers to an alum system designed to remove nutrients, although there are other chemical treatment methods besides alum. These systems are typically an improvement on wet-detention ponds where the chemical treatment is applied to pond inflow to promote nutrient removal within the pond.

Chemical treatment systems that use alum are very effective at phosphorus removal but are relatively expensive and require significant maintenance. They are most applicable immediately upstream of a protected waterbody and are often considered as a last resort when all other treatment options have been exhausted. The City operates multiple alum treatment facilities, including one of the largest facilities in Florida, in the Upper Lake Lafayette watershed, known as the Upper Lake Lafayette Nutrient Reduction Facility (ULLNRF) and pictured in Figure 9.

Figure 9 Chemical Treatment Example – ULLNRF Contact Chambers

6.3 Floating Orifices

Floating orifices, sometimes called self-skimmers, have traditionally been associated with temporary sediment sumps, since the design can significantly decrease sediment discharge to downstream waters. From an engineering perspective, a floating orifice provides a few advantages over a more traditional static orifice, most notable being maintenance of a single discharge rate over a wide range of operating conditions and reduced potential for sediment discharge. Although this type of stormwater design is not commonly used to support land development, these designs are increasing in popularity in Florida as a stormwater retrofit to an existing wet-detention pond, since the retrofit from a static orifice to a floating orifice can provide significant gains in pollutant-load reduction for a relatively low cost. These benefits are most demonstrable for existing wet-detention ponds with relatively short residence times and/or relatively high sediment loads.

6.4 Floating Wetlands

Floating wetlands, sometimes called managed aquatic plant systems (MAPS), improve on traditional designs of wet-detention ponds. Floating wetlands are named appropriately, since these systems are floating mats strategically planted with wetland plants. From an engineering perspective, the floating wetland will increase pollutant-load removal from the pond through nutrient uptake from the plants and nutrient removal from increased biological activity within the root zone. Although this type of stormwater design is not commonly used to support land development, these designs are increasing in popularity in Florida as a stormwater retrofit to an existing wet-detention pond. However, these systems may carry a high maintenance burden depending on site constraints impacting the wetland function.

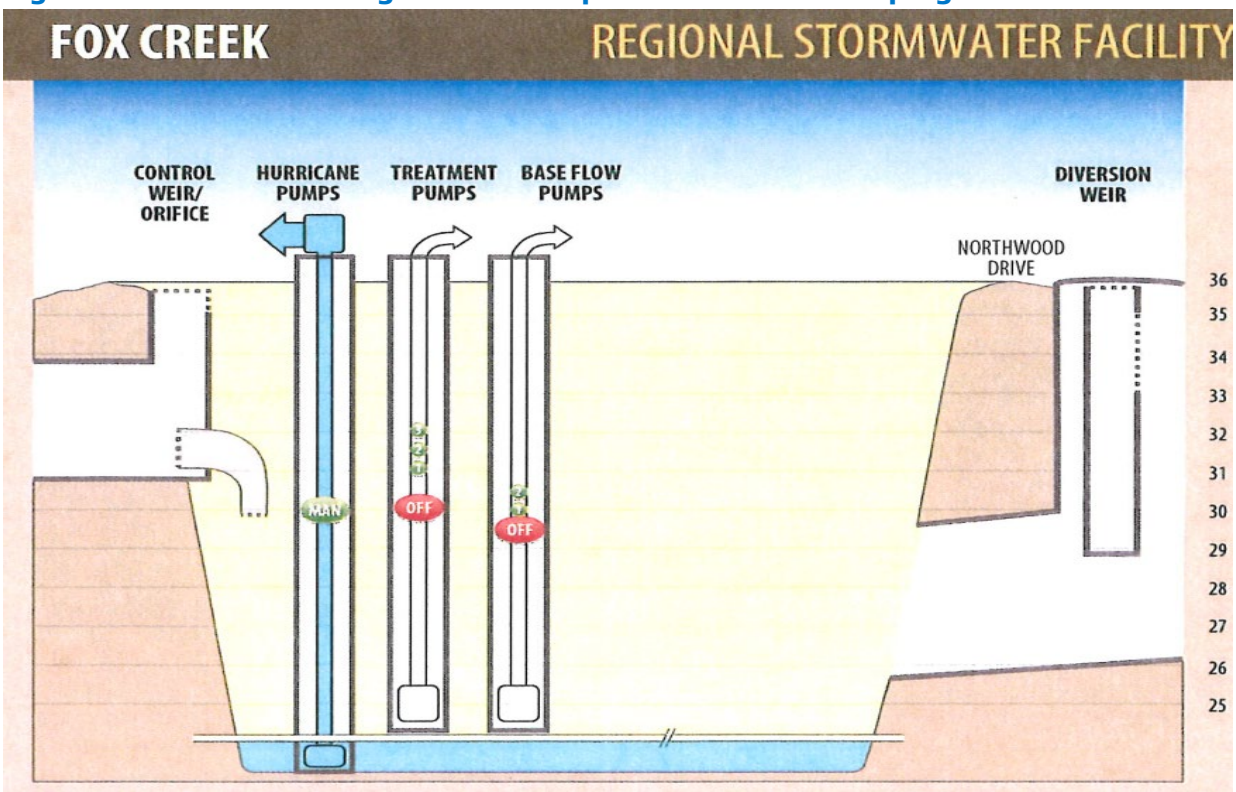
6.5 Active Management

Most stormwater designs use passive infrastructure components, such as ponds, pipes, and channels. The passive infrastructure is intended to only require maintenance between storm events so that the system is prepared to function as designed when a storm begins, will function similarly throughout the storm, and continue to function when the next storm begins, regardless of when the storm events occur. By comparison, active stormwater infrastructure components change how the system performs during a storm, from storm-to-storm, between storms, or during maintenance activities. The most common active components are pumps, which are typically designed to actively control water levels within the system or convey storm flows against gravity.

Active control of water levels can enhance treatment volume recovery, provide additional attenuation volume before large rainfall events, and/or allow more effective maintenance. For example, Jones Edmunds helped St. Johns County optimize the design of the *Fox Creek Regional Stormwater Treatment Facility*, which is an over 30-acre wet-detention pond that uses pump stations to control base flow, control the release of treatment volume, and to draw down water levels over 15 feet within 72 hours before large storms – also known as *hurricane pumps*. Figure 10 provides a schematic sketch of how the pumps actively manage water levels for the Fox Creek facility.

Pumps can also be used to increase wet-detention pond inflow and treatment. For example, Jones Edmunds designed a new pump system to increase inflow to the St. Johns River Water Management District's Deep Creek West facility (a wet-detention pond) from an adjacent below-grade agricultural ditch, which in turn increased the annual pollutant-load reduction through capture and treatment of previously untreated runoff.

Figure 10 Active Management Example – Fox Creek Pumping Schematic



A more unique implementation of stormwater pumps is recirculation of captured flow to provide inter-event or low-flow treatment. For example, Jones Edmunds recently designed a retrofit treatment project for Volusia County, known as the Ariel Canal Treatment Facility, that uses inter-event treatment. This facility diverts stream flows that occur following up to a 1-inch storm event to a wet detention pond. The permanent pool volume within the pond is continuously pumped through a BAM treatment system, which establishes a much lower nutrient concentration within the pond when compared to a typical wet detention pond. The low-concentration (permanent pool) volume is discharged at the start of the next storm event and replaced with new stream flow. The inter-event treatment significantly and cost-effectively increases the pollutant load reduction of the system.

Jones Edmunds, in conjunction with Pegasus Engineering, also designed the Gabordy Canal Treatment Facility for Volusia County, which continuously pumps low flows from the canal into a BAM treatment system before discharging the flows into a flood compensation pond for additional reaeration prior to discharge back to the Canal. This facility eliminates nearly 6,000 pounds of phosphorous per year using only a 1-acre facility footprint, which is very efficient compared to more traditional stormwater designs of similar size and associated pollutant load inflow.

Another example of an active management system is a mechanical rake designed to self-clean a trash trap. The City operates a mechanical rake for a trash trap near the Florida State University/City of Tallahassee (FSU-COT) Regional Stormwater Facility (RSF) and Blueprint has included a mechanical rake with the trash trap currently being constructed as part of CCT

Segment 3D-B. These mechanical rakes help remove trash collected on a screen to a more convenient location for disposal (such as a dumpster). They also help maintain storm flows through the trash trap by cleaning the collection screen automatically during and after storm events.

6.6 Real-Time Adaptive Controls

Stormwater technology has advanced during the past decade commensurate with advancements and cost reductions of novel sensors, wireless communications, rainfall forecasting, and data management platforms. The merging of active management designs with real-time, adaptive control technology has resulted in *smart* stormwater designs. Smart systems can be included in a new stormwater design or retrofitted into an existing system. Smart systems are most often associated with wet-detention and chemical treatment systems in Florida but have many applications. Some of the potential benefits include, but are not limited to:

- Increasing available attenuation volume before storm events.
- Increasing pollutant-load reduction between storm events by extending residence times.
- Improving stormwater-harvesting potential by retaining more water after storms.
- Recreating a more natural hydroperiod and flow characteristics to support natural systems.

Smart systems are commonly controlled through a supervisory control and data acquisition (SCADA) system. The City operates a SCADA system that controls existing active management stormwater systems, such as the ULLNRF, FSU-COT RSF mechanical rake, and planned CCT Segment 3D-B mechanical rake. Although the capital cost for these types of technologies has become more affordable, they carry unique maintenance and operation needs compared to traditional stormwater design components. Therefore, the operation and maintenance of smart systems needs to be strongly considered before implementation and is one reason why the industry has been slow to adopt these technologies.

Though more complex, the advantages of stormwater management systems that can adapt in real-time are too numerous to ignore when considered against the increasing scarcity of water resources. Smart systems are widely acknowledged to be the future of community-wide stormwater management.

7 SEGMENT 4 WATERSHED EVALUATION

The CCT Segment 4 project footprint is near the downstream end of the Central Drainage Ditch (CDD). The watershed (area of contributing stormwater flows) for the project includes the CDD watershed and the historical Saint Augustine Branch (SAB) watershed.

The SAB drains to the CDD and has been enclosed within large box culverts as part of prior CCT projects. The project watershed covers approximately 8 square miles and is sandwiched between the aptly named West Ditch and East Ditch. These three urban ditch systems converge near Lake Henrietta to form the headwaters of Lake Munson (also known as Munson Slough); however, the CCT Segment 4 watershed is only a small portion (approximately 10 percent) of the headwaters by area.

The project watershed is generally depicted in Figure 11, which includes a color ramp of ground surface elevations, roadway map, an outline of the project watershed, and some notable locations.

The physical landscape of the project watershed is best described as heavily urbanized and includes much of downtown Tallahassee, FSU, Florida A&M University (FAMU), and surrounding residential and commercial areas. Much of the urbanized area was developed before modern stormwater regulations; therefore, relatively little on-site stormwater attenuation or treatment is provided at the watershed scale. The stormwater runoff and pollutant-load potential for this type of watershed is relatively high. The community has invested in several stormwater retrofit projects in the area that provide stormwater attenuation and treatment.

Significant stormwater retrofit facilities include the FSU-COT RSF, Coal Chute Pond, Smokey Hollow Pond and Boca Chuba Pond in Cascades Park, and Lake Anita to name a few. Blueprint is also currently constructing a new stormwater retrofit facility as part of the CCT Segment 3D-B project, which includes a wet-detention pond, trash trap, and BAM treatment system. A summary listing of municipal projects that included stormwater improvements within the project watershed is provided in Table 2. Figure 12 presents the projects on a map. The total capital cost of the projects listed is approximately $144 Million, though many of the projects were multipurpose including roadway improvements, parks, etc, and presented costs are not adjusted to 2022 dollars.

Table 2 Summary of Municipal Projects within the Project Watershed

Project	Responsible Agency	Year Completed	Approximate Capital Cost
Capital Cascades Trail Segment 1 (Franklin Blvd)	Blueprint	2015	$13.3 Million
Capital Cascades Trail Segment 2 (Cascade Park)	Blueprint	2015	$33.8 Million
Capital Cascades Trail Segment 3 (Lake Anita and Coal Chute Pond)	Blueprint	2022	$4.8 Million
Capital Cascades Trail Segment 3 (3D RSF)	Blueprint	2022	$5.7 Million

Project	Responsible Agency	Year Completed	Approximate Capital Cost
Tallahassee Junction Stormwater Management Facility	City	2018	$3.0 Million
Bond Community Stormwater Management Facility	City	2006	$2.0 Million
Lower Central Drainage Ditch Erosion Control Project	City	2020	$11.5 Million
Lake Munson Restoration (Lake Henrietta)	County	2001	$13.6 Million
FSU-COT Regional Stormwater Facility	City	1998	$10.5 Million
Whitehall and Chapel Drive Stormwater Improvements	City	2008	$0.3 Million
Campus Circle Drainage Improvements	City	2005	$3.5 Million
Frenchtown Watershed Stormwater Improvements	City	2023	$15.4 Million
Madison-Gaines Street Supplemental Stormwater Outfall	City	2018	$5.2 Million
Downtown Stormwater Outfall	City	1998	$2.3 Million
Call-Cadiz Street Drainage Improvements	City	2006	$1.8 Million
Lafayette Park Stormwater Improvements	City	2012	$1.3 Million
Pensacola Street Outfall	City	2020	$2.0 Million
Capital Cascade Trail Segment 4	Blueprint	2025	$14.0 Million
Total			**$144 Million**

7.1 Flood Risk

As common to heavily urbanized watersheds, stormwater runoff generated within the project watershed is rapidly conveyed to the primary drainage features, which include the SAB, CDD, and large storm drain systems. This type of watershed is commonly referred to as *flashy* since peak storm flows and stages occur within only a few hours after peak rainfall and recede just as quickly. Based on previous modeling efforts, peak flows through the CDD near the CCT Segment 4 location will exceed 3,000 cfs during large storm events or approximately one semi-trailer full of stormwater every second.

The ability of a stormwater management system to manage flood risk is defined through peak stage and commonly referred to as the system's level-of-service. The level-of-service provided is the designed frequency of flood risk occurrence. For example, most urban drainage systems constructed before modern stormwater standards, like many within the project watershed, provide an approximate 10-year level-of-service. This means these systems are expected to fail (result in flooding) once every 10 years. Statewide presumptive stormwater attenuation criteria are based on a 25-year level-of-service. Meanwhile, FEMA flood maps are developed to reflect the flood risk that occurs once every 100 years.

Figure 11 Project Watershed

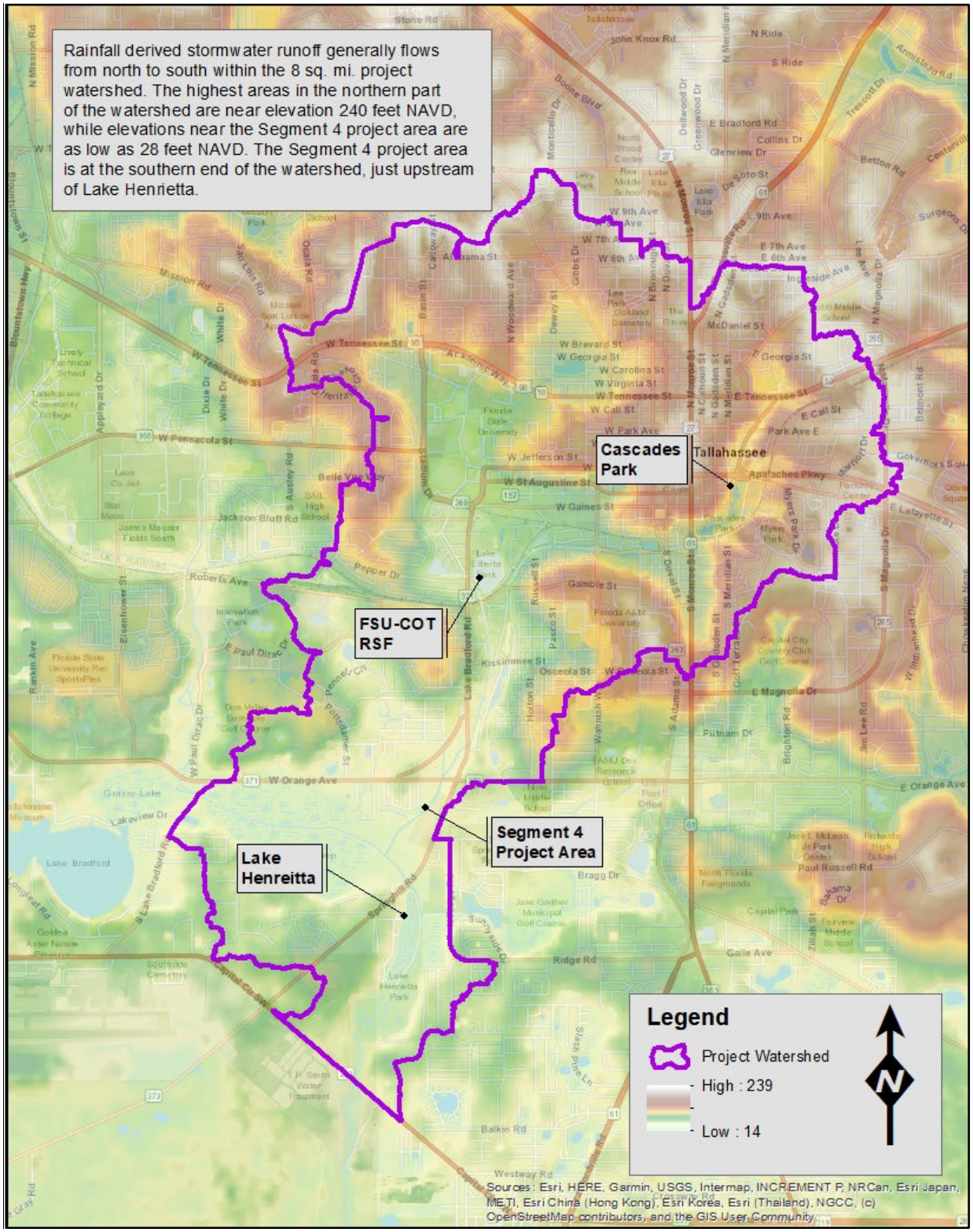
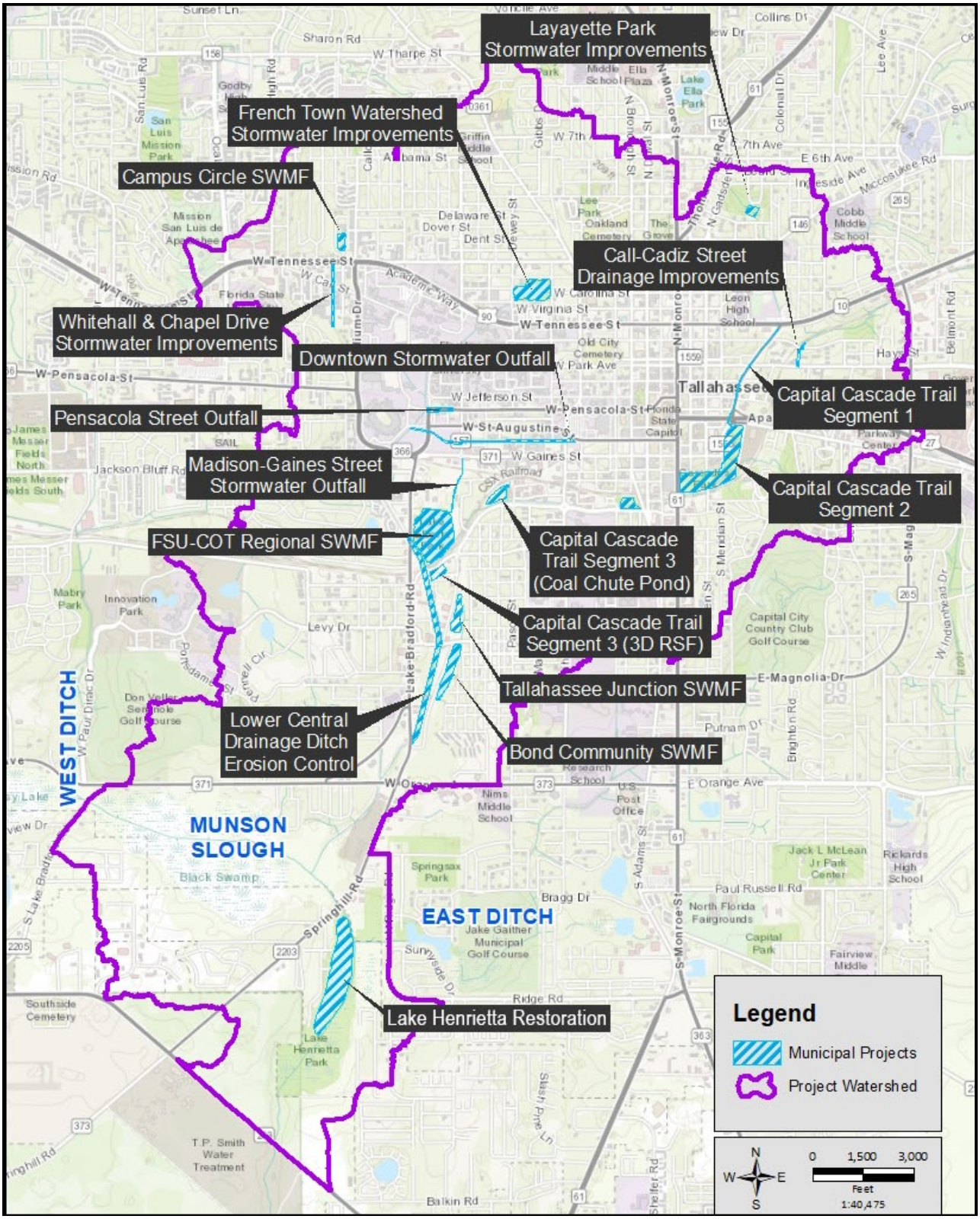


Figure 12 Municipal Projects in Central Drainage Ditch Watershed



When discussing flood risk within the project watershed, it is important to define what level of risk is being considered. Areas at risk of flooding following frequently occurring storm events, such as only a few inches of rain, can be located anywhere within the watershed when local drainage systems are under-designed or in need of maintenance. This type of flooding is common in residential areas developed before modern stormwater regulations, but not common for the watershed's major stormwater conveyance systems. Areas at risk of flooding from infrequent storms events, such as once in a 25-year or 100-year occurrence, are commonly more widespread and may include major conveyance systems.

Residential areas near the downstream portion of the CDD, near the CCT Segment 4 project, are known to be susceptible to flooding. Flood conditions in this area are exemplified by the homes along McPhearson Drive, which are elevated on stilts as shown in Figure 13. Residents in Liberty Park have also experienced flood conditions in the past.

Figure 13 Flood Protection Example – Elevated Homes Along McPhearson Drive

The NWFWMD has recorded 15-minute stage data since 1989 for the CDD at Orange Avenue, which is within the CCT Segment 4 project footprint. The highest recorded stage during the period of record is 40.7 feet North American Vertical Datum of 1988 (NAVD88), and only two dates recorded stages above 40 feet – June 12, 2001, and March 3, 2002. CDD stages near 40 feet are approximately 3 feet below the CDD top-of-bank and 4 feet below Orange Avenue. The available stage data suggest that the CDD has not exceeded its banks near Orange Avenue during the last 30 years. However, prior stormwater analyses have suggested the CDD will exceed its banks during a 100-year storm event upstream of Orange Avenue.

Additionally, we can reasonably assume that downstream conditions within Munson Slough associated within the recorded stages within the CDD near 40 feet are likely indicative of flood conditions in Liberty Park, where some home finished-floor elevations appear below 39 feet, and along McPhearson Drive where the roadway elevation is below 35 feet in stretches. This assumption is based on the limited predicted headloss (peak stage reduction) from Orange Avenue to Munson Slough from past stormwater analyses.

It is also known that during large storms the timing of stormwater flows from the three urban ditch systems that converge at Munson Slough can cause flows to reverse direction, from south to north. This *backwater effect* has been observed in real-time by City and County staff but has not been well studied during prior stormwater analyses.

Based on available stage gauge data, past modeling efforts, and observations relayed by City and County staff, the known flood conditions in Liberty Park and along McPhearson Drive are more likely driven by hydraulic conditions within Munson Slough rather than hydraulic conditions within the CDD. A more robust stormwater analysis will be performed as part of the CCT Segment 4 project to better understand the potential backwater effect from Munson Slough on the project and adjacent residential areas.

Based on available information it appears that while the CDD is characterized by very high flows following storm events, the existing flood conditions present near the project are mostly controlled by peak water-surface elevations in Munson Slough. Ultimately, the project watershed is a relatively small contributor (10 percent by area) to Munson Slough and improvements associated with the project are unlikely to demonstrably impact future peak stages within Munson Slough.

7.2 Water Quality

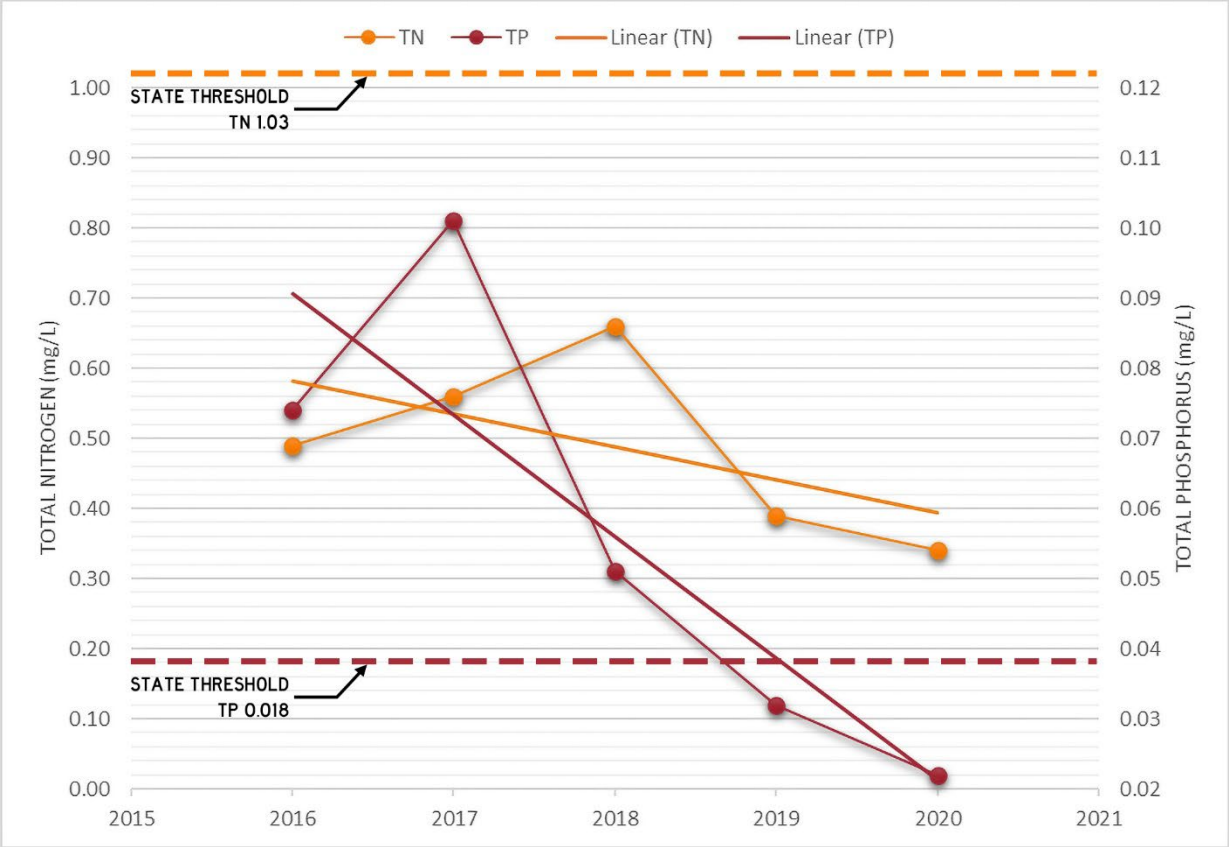
Stormwater runoff naturally collects and conveys pollutants downstream. Given that the watershed is mostly urbanized with development predominately occurring prior to modern stormwater treatment requirements, potentially high dissolved nutrient loads from over fertilization and high anthropogenic trash loads may be generated across the watershed. Since the project watershed is known to be a flashy system, a high potential for erosive conditions within natural conveyances also exists, which generates high sediment loads and particle-bound nutrient loads like phosphorus.

To better understand the potential pollutant load carried by the CDD through the CCT Segment 4 project area, we reviewed water-quality sampling data collected by the City to support their municipal separate storm sewer system (MS4) program. The most relevant available data are ambient water samples collected near the terminus of the CDD, which is in the downstream portion of the CCT Segment 4 project area. Ambient conditions are generally defined as the normal operating condition for the system and are more reflective of base flow than of storm flow.

Annual geometric means (AGMs) of ambient conditions over the last five reporting periods at this location are shown in Figure 14 and suggest that the nutrient load within the CDD is limited. The current ambient conditions of the CDD include total nitrogen (TN) concentrations near 0.5 milligram per liter (mg/L) and total phosphorus (TP) concentrations near 0.05 mg/L. The TN and TP AGMs for the CDD within the CCT Segment 4 project area are near the lower limit, least potential nutrients, of what is achievable from traditional stormwater designs, LID and GSI, and even most innovative stormwater technologies. We also observed a decreasing trend for TN and TP AGMs over time. Nutrient concentrations at this level and the decreasing trends over time suggest that although relatively limited on-site stormwater treatment is provided within the project watershed, the stormwater retrofit projects implemented

upstream by the City and Blueprint are effective at reducing the ambient nutrient load within the CDD.

Figure 14 Nutrient Concentrations Trend in CDD near Munson Slough Convergence



We also observed ambient total suspended solids (TSS) concentrations to be similarly low, generally near 5 mg/L, and exhibit the same decreasing trend. Although the cause-and-effect relationship of TSS with stormwater retrofits of the watershed is complex and often takes multiple years after project completion to manifest completely, we can logically infer from the reported TSS concentrations that the 2+ miles of ditch enclosure completed by Blueprint and 1 mile of gabion improvements completed by the City have significantly reduced the in-stream erosion potential of the watershed.

The anthropogenic trash load of any watershed is difficult to estimate, limited data are available, and available data may not be transferable from one location to another. We assume that some amount of anthropogenic trash load will be present at the project due to the urban characteristics of the watershed. However, we are also aware of multiple trash traps within the watershed, including a boom and screen within the CDD near Eppes Drive, a mechanical trash trap recently constructed at the FSU-COT RSF, and a mechanical trash trap currently being constructed as part of the CCT Segment 3D-B project.

Given the collective recency of these improvements, we can reasonably expect the downstream trash load from the watershed will follow a similar decreasing trend in the coming years as observed in the water quality monitoring data.

Based on available information, nutrient concentrations and suspended sediments will be very limited under ambient and low flow conditions, which are typically the focus of retrofit treatment systems. Moreover, the most immediate downstream waterbody, Munson Slough, is no longer considered impaired for nutrients based on the Florida Department of Environmental Protection (FDEP) 2020–2022 Biennial Assessment of Impaired Waters. Munson Slough includes the area between the Segment 4 project and Lake Munson.

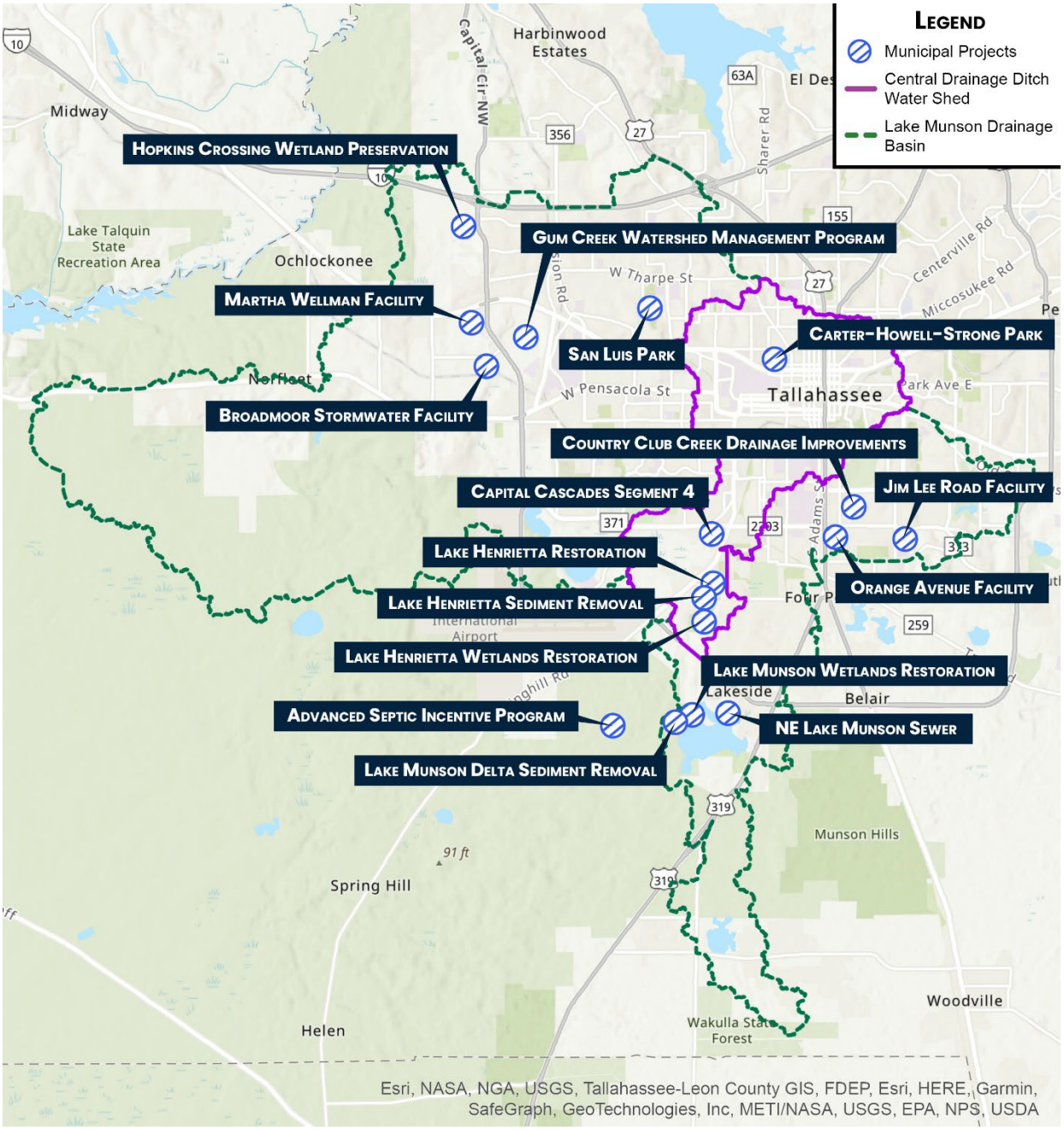
Unfortunately, Lake Munson itself continues to exhibit poor water quality and experience recurring algal blooms that limit the lake's function for extended periods of time. The earliest well known compressive effort to analyze Lake Munson was the NWFWMD *Water Quality Evaluation of Lake Munson* (1988). As described in the evaluation, Lake Munson was cypress swamp land that became recognizable as a lake after impoundment in 1950 and likely became impaired from anthropogenic sources shortly thereafter with algal blooms and fish kills reported in the mid-1950s. In the early 1980s, Lake Munson was considered one of the most degraded lakes in the state; however, between 1984 when wastewater effluent discharge to the lake was eliminated and the evaluation in the late 1980s, NWFWMD observed that Lake Munson *significantly improved*. At the time of the evaluation, two primary sources of nutrient loading to the lake remained: stormwater runoff inflow from Munson Slough and in-lake sediments.

Following NWFWMD's work, the City of Tallahassee and Leon County jointly created the *Lake Munson Stormwater Management Plan* (1991). The County subsequently completed the *Lake Munson Action Plan* (1994) and included structural (capital improvements) and non-structural improvements designed to provide flood control and water quality enhancements in the Lake Munson basin and along major drainage branches. The non-structural recommendations were primarily preservation and restoration initiative through regulatory and land management programs. The structural improvements included the creation of seven regional wet detention stormwater management facilities along the major tributaries to the Lake to address flooding as well as capture a significant portion of nutrients, suspended solids, and other contaminants. The plan again identified inflow from Munson Slough and in-lake sediments as the main sources of nutrient loading to the lake and proposed a combination of solutions that would address both sources.

Setting aside the $ 71,000,000 Capital Cascades Trail investment, over the past 20 years Leon County, City of Tallahassee, and Blueprint implemented thirteen Lake Munson Action Plan projects representing stormwater management facilities to improve water quality reaching Munson Slough and multiple efforts have occurred at Lake Munson, including drawdowns and sediment removal. These capital improvements represent $73,000,000 in infrastructure improvements. Two future Lake Munson Bain projects, Lake Henrietta Sediment Removal and NE Lake Munson Sewer and the on-going Advanced Septic Tank Incentive Program add an additional $15,000,0000 investment for a combined capital expenditures of $159,000,000.

During this same period, multiple studies have shown that improvements to Munson Slough may significantly improve the inflow from Munson Slough going into Lake Munson.

Figure 15 Municipal Projects in Lake Munson Drainage Basin



During workshops facilitated by the Leon County Science Advisory Committee in 2016, FDEP discussed results of a biogeochemical study conducted during the 2011 lake drawdown as part of the *Lake Munson: Spatial and Temporal Changes in Nutrient Characteristics of Sediments During a Drawdown Event* presentation. Nutrient concentration data collected as part of the study showed in-lake TN and TP was 10 to 15 times higher than inflow or outflow concentrations and that inflow concentrations were below outflow concentrations, which is a pattern indicative of significant nutrient recycling (from lake sediments to lake water) occurring at Lake Munson. The study also suggested that while sediment TN could potentially be reduced through future optimized lake drawdowns, the 2011 drawdown did not significantly reduce sediment TP.

Also presented during the 2016 workshops was results of the Evaluation of the Feasibility of Sediment Nutrient Inactivation in Lake Munson by Environmental Research and Design (ERD) on behalf of the City of Tallahassee.

The ERD study evaluated data collected since the 1988 NWFWMD Evaluation, including data related to water depth, water quality, fish and wildlife, and lake sediments. The study concluded that the observed algal blooms at Lake Munson were most likely due to elevated levels of TP (not TN) from high sediment presumably from the accumulation of nutrient-rich inflow from urban areas and wastewater treatment facilities prior to the 1980s.

Although Capital Cascades Trail Segment 4, as defined in the 2005 Master Plan, focuses on improvements along the St. Augustine Branch and the lower Central Drainage Ditch to provide water quality benefits upstream of Lake Munson, it is located more than two miles away from Lake Munson and represents a small portion of the entire Lake Munson watershed. Capital Cascades Trail Segment 4 is one more component within the overall system. Information on past projects within the Lake Munson watershed is included to show the scope of investment by the community not only within the St. Augustine Branch and Central Drainage Ditch but across the entire Lake Munson watershed. A comprehensive summary of past studies and projects in the Lake Munson watershed were provided to the Leon County Board of Commissioners on October 11, 2022, as part of agenda item number 26. A copy of that item is provided as Appendix A for reference. At that meeting, the Board unanimously approved the action plan as presented in the item.

8 DISCUSSION

Based on the goals for CCT Segment 4, the project's stormwater management system will serve proposed project improvements and create a net stormwater improvement for the community. The stormwater management system design should also consider service life, cost, public safety, and ease of maintenance.

8.1 CURRENT PROJECT UNDERSTANDING AND CONSIDERATIONS

The permit criteria for the CCT Segment 4 project will be established in coordination with City Growth Management and NWFWMD during future project stages but we expect the project will need to demonstrate a net stormwater improvement for the community. At this time, we

can judge the potential to provide a net stormwater improvement for the community based on the watershed characteristics, site constraints, and our experience developing stormwater management solutions throughout Florida.

Based on the available CDD stage records near Orange Avenue, previous stormwater analyses, and City/County staff accounts, it is unlikely that the CCT Segment 4 project's stormwater management system can be feasibly designed to significantly mitigate flood conditions at the project or within adjacent neighborhoods. To better assess flood conditions near the project, Jones Edmunds is developing a stormwater model, which will build upon stormwater analyses completed by others as part of past Blueprint projects and will be developed with particular attention to the known backwater effects from Munson Slough that can impact flood conditions near the project.

Based on available information, it appears that existing flood conditions present near the project are mostly controlled by peak water-surface elevations in Munson Slough. Given the relatively small project footprint compared to Munson Slough and the relatively small contribution from the project watershed (10 percent by area) to Munson Slough, it is likely that future analysis using the stormwater model being developed for this project will also demonstrate that potential stormwater management system designs for this project are not capable of mitigating peak water-surface elevations in Munson Slough sufficiently to mitigate existing flood conditions. For comparison, the FSU-COT RSF is over 25 acres, Lake Henrietta is over 40 acres, and Black Swamp within Munson Slough is over 300 acres. Meanwhile, within the CCT Segment 4 project area less than 5 acres are available for potential stormwater improvements north of Orange Ave and less than 10 acres south of Orange Avenue.

Based on the available water-quality data for the CDD near the project location, which is representative of ambient conditions, insufficient nutrient concentrations appear to be available for the project's stormwater management system design to reasonably achieve relatively large nutrient load reductions from CDD flows under ambient and low-flow conditions. Moreover, the most immediate downstream waterbody, Munson Slough, is no longer considered impaired for nutrients based on the FDEP 2020–2022 Biennial Assessment of Impaired Waters. The ambient sample results and change in impairment status for Munson Slough are representative of a healthy project watershed and are a credit to past stormwater improvement efforts.

The relatively healthy project watershed and change in impairment for Munson Slough are also representative of the limited impact CCT Segment 4 is likely to have on Lake Munson. While Lake Munson continues to exhibit high TN and TP levels, recent studies suggest that the continued algal blooms at the lake are related to high sediment TP levels in-lake, not TN and/or TP loading from stormwater inflow through Munson Slough. Weather patterns such as extended heat or dry conditions can contribute to algal blooms. The combined water quality characteristics of the project watershed, Munson Slough, and Lake Munson indicate that the most effective solutions to improve water quality at Lake Munson will be focused on treatment and/or removal of in-lake sediments.

There are also significant site constraints for large scale design components within the CCT Segment 4 project area beyond low inflow concentrations. These additional constraints include

very large peak flows within the CDD, current flood conditions upstream, potential hydraulic depth within the CDD (i.e., the vertical distance from the CDD hydraulic grade line to adjacent land), and available land for engineering improvements. Given the site constraints and improved downstream condition for nutrients, we can reasonably assume large scale design components focused on nutrient-load reduction will carry a prohibitively high cost per pound of removal.

Design components that are commonly used to maximize nutrient load reductions include stormwater ponds, constructed wetlands, engineered media (such as BAM), and chemical treatment. All these design components would require very large footprints to achieve large nutrient load reductions for CCT Segment 4. A constructed wetland would likely require the largest footprint of these components to achieve a similar pollutant load reduction since flows and velocities through a constructed wetland are intentionally limited to avoid damaging vegetation, to avoid resuspending captured pollutants, and to allow time for the rate-dependent biological treatment processes to occur. All these design components would need to bypass a significant portion of flow from larger storm events, meaning most storm flows carrying sufficiently high nutrient concentrations for removal will bypass the treatment system by hydraulic necessity.

To help overcome hydraulic constraints, stormwater management systems that provide treatment can be designed as offline systems. Offline systems divert low flows from the primary conveyance system but allow moderate and high flows to bypass the treatment system. The treatment volume for offline systems typically needs to be below the existing hydraulic grade line, such that flow diversion can occur by gravity and not adversely impact upstream flood conditions, and typically requires a large available footprint to achieve significant load reductions.

For CCT Segment 4, a gravity-based diversion system would require extensive land excavation and the pollutant load removal effectiveness of the offline treatment system will still likely be limited by low inflow nutrient concentrations.

A relevant out-of-watershed treatment system comparison that illustrates these constraints is the Sweetwater Branch treatment wetland, which was designed by Jones Edmunds. The Sweetwater Branch treatment wetland serves an urban watershed of approximately 3 square miles and was designed to primarily treat inflows less than 10 cfs. The service area is less than 50% of the CCT Segment 4 project watershed and yet the required treatment wetland footprint was over 150 acres or 10 times larger than the CCT Segment 4 area available for stormwater improvements. Sweetwater Branch also has the relative benefit of treating WWTP effluent that is mixed in with the storm flows, meaning incoming nutrient concentrations are much higher than those expected for the CDD.

However, smaller scale nutrient-focused design components deserve consideration for inclusion in the project's treatment train. Small scale examples include the traditional stormwater design components mentioned above but also many GSI design components. In all cases, the achievable nutrient load reduction is limited according to the scale and site constraints. To reduce land excavation cost for a smaller scale system that treats CDD flows,

low flows could be diverted from the CDD via a small stormwater pump instead of gravity. However, stormwater pump systems will carry a higher recurring maintenance cost.

Similar to nutrient concentrations, the potential for project inflow to include high sediment concentration appears limited. Furthermore, past projects within the project watershed that either enclosed or hardened open-cut ditches make it very likely that historically occurring in-stream erosion has also been greatly reduced. On the other hand, unlike the demonstrated improving condition for nutrients downstream, the County continues to experience sedimentation issues at Lake Henrietta. In our opinion, design components focused on sediment-load reduction deserve consideration for inclusion in the project's treatment train, but achievable sediment load reduction will be limited by site constraints.

Due to the lack of representative data, the potential to reduce anthropogenic trash load is the least certain of the water-quality constituents reviewed. Multiple trash collection improvements have been constructed upstream, which should significantly reduce the downstream trash load, but it is likely that a trash load will continue to be present at the project. Design components focused on trash-load reduction deserve consideration for inclusion in the project's treatment train, but the achievable trash load reduction is uncertain and will be limited by site constraints.

8.2 Design Component Applicability

In our opinion, the most effective stormwater management system designs include multiple design components in a treatment train. For this reason, our recommendation is that the CCT Segment 4 project stormwater management system be based on a LID-like approach, including traditional design components, GSI, and innovative stormwater technologies to achieve a net stormwater improvement for the community.

Based on our current understanding of the project watershed, existing site constraints will prohibit capture of moderate and high storm flows and therefore significantly limit the net stormwater improvement achievable by the project. Moreover, it is very unlikely that mitigation of existing flood conditions or large nutrient load reductions are achievable through this project given the site constraints. Instead, our recommendation is that the project's stormwater management system should focus on potential trash, sediment, and nutrient load reductions that can be reasonably achieved under low flow conditions.

Several traditional stormwater designs, GSIs, and innovative technologies were mentioned in this White Paper that could be incorporated into the project's treatment train. All the design components mentioned in this White Paper are categorized in Table 3 based on their applicability to the watershed characteristics and site constraints.

Table 3 Project Applicable Design Components

Design Component	Most Likely Applicable	Least Likely Applicable
Wet Detention		X
Retention		X
Exfiltration		X
Swales	X	
Vegetated Strips	X	
Detention w/Filtration		X
Constructed Wetlands		X
Stormwater Harvesting		X
Sediment Traps	X	
Trash Traps	X	
Erosion Control	X	
Bioretention	X	
Detention w/Biofiltration	X	
Permeable Pavement	X	
Rainwater Harvesting		X
Green Roofs		X
Engineered Media		X
Chemical Treatment		X
Floating Orifices		X
Floating Wetlands		X
Active Management	X	
Real-time Adaptive Controls		X

Preliminary engineering needs to be completed before more definitive stormwater management system design recommendations are appropriate.

9 CONCLUSION

To sum up, below is a list of key findings as it relates to the current water quality and flood mitigation of the watershed and potential innovative stormwater design applicable at the project area.

- The community has invested $130M in stormwater retrofit facilities to provide attenuation and treatment. The most immediate downstream waterbody, Munson Slough, is no longer considered impaired for nutrients based on FDEP 2020-2022 Biennial Assessment of Impaired Waters.
- Recent studies suggest that the continued algal blooms at the lake are related to high sediment TP levels in-lake, not TN and/or TP loading from stormwater inflow through Munson Slough.
- Based on the relatively low nutrient concentrations observed in the available water-quality data under ambient condition for the CDD near the project location, stormwater retrofit treatment of the flows would not result in large nutrient load reductions and would be costly in terms of dollars per pound of nutrient removed.

- Given the relatively small project footprint, the potential stormwater management system designs for this project will be insufficient to mitigate existing flood conditions or significantly reduce nutrient load reductions.
- Likely design components include traditional design components, GSI, and innovative stormwater technologies at the project program sites and along the trail. Erosion control, sediment traps, and trash traps should also be considered.

APPENDIX A

Leon County Board of County Commissioners
Agenda Item # 26
October 11, 2022
Status Report on Best Management Practices for Lake Munson

Agenda Item #26 for the Meeting of Tuesday, October 11, 2022

GENERAL BUSINESS:

26. Status Report on Best Management Practices for Lake Munson
(County Administrator/ County Administration/ Public Works)

This document distributed October 5, 2022.

Leon County
Board of County Commissioners

Notes for Agenda Item #26

Leon County Board of County Commissioners

Agenda Item #26

October 11, 2022

To: Honorable Chairman and Members of the Board

From: Vincent S. Long, County Administrator

Title: Status Report on Best Management Practices for Lake Munson

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Review and Approval:	Vincent S. Long, County Administrator
Department/ Division Review:	Alan Rosenzweig, Deputy County Administrator Ken Morris, Assistant County Administrator Brent Pell, Director, Public Works Charles Wu, Director, Engineering Services
Lead Staff/ Project Team:	Anna Padilla, Stormwater Management Coordinator

Statement of Issue:

This item provides a status update on the natural conditions and past contamination of Lake Munson, the progress made in water quality as a result of cooperative actions, strategic investments and prioritization in capital improvements, present day challenges, and best management practices for the ongoing and planned enhancements to Lake Munson. For the mitigation of recent algal blooms and rapid growth of an invasive aquatic plant (hydrilla), the item seeks Board approval to implement an Action Plan for Lake Munson which includes an immediate and temporary drawdown of the water level to coincide with enhanced water quality monitoring, and an aerial topographic survey of the lake bottom. The Action Plan includes long-term strategies to supplement the State's in-lake restoration activities and provides a higher level of service to County residents including the use of hydrogen peroxide to treat algal blooms, implementing an invasive vegetation management program, ongoing engagement over the next two years to evaluate the Lake's response to the drawdown, and regular status updates to the Board every six months.

As requested at the Board's September 13, 2022 meeting, this item also includes an analysis of the requests brought forward by the Lake Munson citizen group.

Fiscal Impact:

This item has a fiscal impact. The drawdown plan and treatments for Lake Munson are estimated to cost $130,000 in FY 2023. Funding is included in a separate agenda item as a carry-forward for these purposes.

Staff Recommendation:

Option #1: Accept the Status Report on Best Management Practices for Lake Munson.

Option #2: Approve the Lake Munson Action Plan, presented herein, including the immediate drawdown plan.

Report and Discussion

Background:

This item provides a status update on the natural conditions and past contamination of Lake Munson, the progress made in water quality as a result of cooperative actions, strategic investments and prioritization in capital improvements, present day challenges, and best management practices for the ongoing and planned enhancements to Lake Munson. For the mitigation of recent algal blooms and rapid growth of an invasive aquatic plant (hydrilla), the item seeks Board approval to implement an Action Plan for Lake Munson which includes an immediate and temporary drawdown of the water level to coincide with enhanced water quality monitoring and an aerial topographic survey of the lake bottom. The Action Plan also presents long-term initiatives based on best management practices for Lake restoration.

On September 13, 2022, the County Administrator advised the Board that staff was preparing an agenda item for the October 11th meeting that would seek Board approval to proceed with a temporary drawdown of Lake Munson and provide recommendations for any additional short- and long-term best management practices that may be advisable for the Lake. At that time, the Board directed staff to meet with a Lake Munson citizens group (Workgroup) to address their concerns about the Lake, and to bring back an analysis of the Workgroup's ten requests submitted to the County in writing as part of this agenda item.

The Workgroup is made up of residents who live near Lake Munson and other stakeholders. Based on the Board's direction, staff immediately contacted the Workgroup to schedule meetings and coordinate with the appropriate subject matter experts across County departments, Blueprint, State agencies, and the County's Science Advisory Committee (SAC). While the proposed Lake Munson Action Plan addresses some of the issues raised by the Workgroup as described throughout this agenda item, specific responses for each of the ten requests begin on page 23 of the Analysis section.

This status report advances the following FY2022-FY2026 Strategic Initiative:

- *Ensure County's water quality and stormwater regulations, programs and projects are evaluated and implemented holistically to advance the County's adopted strategic priority: to protect the quality and supply of our water. (2022-16)*

This particular Strategic Initiative aligns with the Board's Environment Strategic Priorities:

- *(EN1) Protect the quality and supply of our water.*
- *(EN2) Conserve and protect environmentally sensitive lands and our natural ecosystems.*

This item provides a background on Lake Munson including the millions of dollars the County has made and continues to make in investments in watershed planning, major project implementation, and follow-up studies throughout the basin since the 1990s. Despite the better water quality, in-lake mitigation, and the magnitude of investments in upstream infrastructure, Lake Munson continues to experience occurrences of fish kills, algal blooms, invasive vegetation and snails, low game fish productivity, and depressed oxygen levels. This item presents ongoing and additional best practices to these challenges with the County has been performing or will be implementing,

including a planned drawdown with more frequent water quality testing, an aerial topographic survey of Lake Munson to the measure elevations of compacted sediment to evaluate for future in-Lake mitigation strategies, a new vegetation management program for treating invasive plants, and implementing periodic drawdowns in consultation with FWC to reduce the need to mechanically remove organic-rich sediment. And finally, this item provides information on the County's cooperative efforts with a group of local residents to address their concerns surrounding present day lake challenges.

Lake Munson is an approximately 288-acre, cypress-rimmed lake located south of the City of Tallahassee. It is a state-managed waterbody with a history of chronic water quality and ecological problems including fish kills, algal blooms, exotic vegetation and snails, high nutrient levels, low game fish productivity, sediment contamination, and depressed oxygen levels. The Lake is believed to have originally been a cypress swamp but has since been impounded and now functions as a shallow man-made lake. This description of the Lake is not a value statement, rather the origin and mode of formation of the Lake is important to understand how it functions ecologically. Today, Lake Munson is designated by the Florida Department of Environmental Protection (FDEP) as a Class III waterbody suitable for fish consumption and recreational activities. However, the shallow and stagnant nature of the waterbody makes it susceptible to the growth of algal in the Lake resulting in a bloom.

Lake Munson has historically been subjected to drainage with high nutrient loads and wastewater discharges to the tributary system, which has resulted in the embedding of legacy nutrients in the lake-bottom soil. The Lake receives surface water flow from a 32,000-acre basin, much of which is located in the City of Tallahassee (Attachment #1). All flow enters Lake Munson through Munson Slough, from Lake Henrietta which receives upstream flow from the east and from the north (Attachment #2). In the early 1980s the effluent from the City of Tallahassee T.P. Smith Water Reclamation Facility was redirected from Munson Slough to the Tram Road Sprayfields and since then, effluent from T.P. Smith does not discharge into Lake Munson (neither directly nor indirectly). Decades of development in the Tallahassee red-clay hills, wastewater treatment facilities discharging to the tributary system, and drainage activities focused on flood reduction contributed high nutrient loads entering Lake Munson resulting in poor water quality. Efforts to improve the water quality and reduce the nutrient loading in Lake Munson have been ongoing since the 1990s, including hundreds of millions of dollars of capital investment by the County, City, and Blueprint, and requires the continuous coordination among governmental partners with respect to each's responsibilities to protect natural resources.

1991 Stormwater Management Plan

In 1991, the Northwest Florida Water Management District (NWFWMD), under a joint contract through the County and City of Tallahassee (City), completed a Stormwater Management Plan (SMP) for Lake Munson. The SMP included structural (capital improvements) and non-structural (preservation, land use, and regulatory) recommendations. The 1991 Lake Munson SMP identified stormwater management improvements designed to provide flood control and water quality enhancements in the Lake Munson basin and along major drainage branches. The non-structural recommendations were primarily preservation and restoration initiatives through regulatory and land management programs.

The structural improvements recommended in the 1991 SMP included the creation of seven regional wet detention stormwater management facilities along the major tributaries to the Lake to address flooding as well as capture a significant portion of nutrients, suspended solids, and other contaminants. Importantly, over the next three decades, the regional stormwater management facilities were constructed throughout the basin including the Carter Howell Strong Park in Frenchtown at the headwaters of the FSU Branch, the FSU stormwater facility (known as Lake Elberta) along the Central Drainage Ditch, the Jim Lee Road and East Branch facilities along the East Drainage Ditch. Also constructed were the Vega Drive and Eisenhower Avenue facilities on the West Drainage Ditch and the Orange Avenue facility on the East Drainage Ditch (Attachment #3).

All non-structural recommendations in the 1991 Lake Munson SMP were prioritized and completed over this time. Major restoration efforts included the Gum Swamp wetland restoration, the North Ridge Road wetland and Silver Lake restoration, and the Lake Munson Restoration project including the construction of the Lake Henrietta stormwater facility, Munson Slough restoration, sediment removal from the Lake Munson delta, Lake Henrietta wetlands restoration, and Lake Munson wetlands restoration. The Gum Creek Watershed Management Program and the Hopkins Crossing wetland preservation have also been completed. Additionally, regulatory measures have been implemented to preserve wetlands and floodplains.

The 1991 SMP examined the entirety of the Lake Munson Basin for deficiencies and developed basin-wide recommendations. Based on a desire to improve the Water Quality of Lake Munson, an action team was assembled to develop a management plan specific to Lake Munson with recommendations that would directly benefit the Lake.

1994 Lake Munson Action Plan

The 1994 Lake Munson Action Plan was written by the Lake Munson Action Team, a twelve-member group created by the County Commission in the early 1990s. The Action Team included a technical staff representative from County departments, state agencies, and private citizens with an interest and concern for Lake Munson.

Over the course of 18 months, the Action Team reviewed the problems of the Lake and possible solutions before developing an overall strategy for restoration. The 1994 Lake Munson Action Plan incorporated three major strategies to restore Lake Munson: watershed management, in-lake restoration, and community action. The Action Team recommended commencing the watershed management and community action strategies immediately. The in-lake restoration was recommended to follow the watershed management so that resources would be directed toward upstream improvements to ensure that clean water was entering the Lake. Much like a leaky pipe, it is important to first stop what is coming out of the pipe before cleaning up what spilled. The plan also recommended specific projects in each of these categories.

Watershed Management

The watershed management component of the 1994 Action Plan consisted of upstream improvements to reduce the nutrients and sediment entering the Lake. Facilities farthest upstream were prioritized since the design and performance of downstream alternatives would be adversely affected by a lack of upstream control. The Action Team determined that implementation of the

1991 SMP was the top priority and was crucial for the Lake's restoration. In addition to the 1991 SMP stormwater and restoration projects, the Action Team recommended trash racks be installed upstream of Lake Munson and the creation of a water quality monitoring program. Since the 1994 Action Plan, the County, City, and Blueprint Intergovernmental Agency (Blueprint) prioritized and completed these upstream improvements and infrastructure projects.

In-Lake Restoration

The 1994 Action Plan recommended in-lake restoration including sediment removal, drawdowns, dam refurbishment, and invasive exotic plant control with herbicide treatment. The Plan identified dredging as a cost-effective method but cited turbidity problems (e.g., disturbing sediment and resuspending it in the water) and the proximity of disposal sites as prohibitive challenges, so exploring additional alternatives was recommended. The Plan also recommended fall and winter drawdowns as part of a well-coordinated restoration plan. To control the invasive exotic vegetation, which at the time was hyacinth and hydrilla, the Action Team recommended the continued, judicious use of herbicides to suppress water hyacinth, and for control alternatives to be implemented for hydrilla. Since the Plan was adopted, the County conducted a drawdown in 2000 and again in 2010, reconstructed the Lake Munson dam, and continues to coordinate with the Florida Fish and Wildlife Conservation Commissioner (FWC) for herbicide treatment of the exotic vegetation.

Community Action

The final component of the 1994 Action Plan involved community and political action on a broad range of issues. The Plan recommended a strategy that built on the attributes of the area and promoted a positive image, one based on environmental education and natural area-based recreation. It called for the creation of lakefront parks with boat ramps, picnic areas, and adequate parking and further recommended the parks be part of a greenway system of public land along watercourses. The Action Team also emphasized the importance of educating the public about the proper design and maintenance of septic systems, best management practices for construction and lawncare, and the need for individuals to take personal responsibility for reducing soil erosion, nutrients, and other types of pollution. This strategy resulted in the opening of Gil Waters Park Preserve at Lake Munson which was constructed in 2000 and includes a boat ramp and landing, picnic areas, a scenic overlook, trails, and paved parking. Additional parks created in the basin include Anita Davis Preserve at Lake Henrietta Park, Broadmoor Pond Park, Martha Wellman Park, Orange Avenue – Meridian Street Park, and Blueprint's Debbie Lightsey Nature Park. Still in design, Blueprint's Capital Circle SW Greenway will connect neighborhoods in south and southwest Tallahassee, will connect users to several parks and greenways and the Apalachicola National Forest. Fulfilling the call for better septic systems and personal responsibility for reducing nutrient pollution, later sections of this item highlight the County's focus on eliminating conventional septic tanks and regulatory actions to protect our natural resources including restrictions on the use fertilizer.

The 1994 Lake Munson Action Plan provided a comprehensive approach to lake and watershed restoration and preservation. It prioritized the implementation of the 1991 SMP structural (capital improvement) projects and non-structural recommendations (land use and regulatory actions) within the basin, which represent the early efforts to restore Lake Munson, and identified additional upstream improvements. Structural projects included repairing the Lake Munson Dam,

implementation of the 1991 SMP, installing trash racks, land acquisition projects to preserve wetlands and waterbodies, aquatic plan control, and a water quality monitoring program. The non-structural recommendations included regulations changes for land use and density limits, surface water quality protection, trash and sediment reduction requirements for new development, and special protection zone regulations. The recommendations also included community outreach initiatives and education programs, lake clean up events, information on septic tank maintenance, and periodic drawdowns of the Lake.

From the Lake Munson SMP crafted in 1991 to the 1994 Lake Munson Action Plan, the implementation of both plans demonstrates the County's and City's ongoing support of projects that enhance water quality in Lake Munson. These plans guided the community strategy, efforts, and investments to enhance water quality by recognizing and prioritizing the need for upstream improvements to ensure that clean water was going into the Lake before undertaking an in-Lake dredging project that would disturb the existing sediment.

Continuous Investment in the Lake Munson Basin

Since the 1990s, the County, City, and Blueprint have dedicated hundreds of millions of dollars and completed numerous projects upstream of Lake Munson to provide water quality treatment, reduce sediment transport, and collect trash. Trash racks have been installed east of Jake Gaither Golf Course on the East Drainage Ditch, west of Lake Bradford Road on the Central Drainage Ditch, and upstream of Lake Henrietta. The City's Erosion Control and South City/Country Club Creek Drainage projects, both with the Lake Munson basin, reduce the amount of sediment flowing to Lake Munson by protecting the channel banks. Notable water quality improvement projects include Gum Swamp Restoration and Cascades Park as well as the San Luis Park, Broadmoor, Martha Wellman, Bond, Carter-Howell-Strong, Bond, Tallahassee Junction, and Coal Chute stormwater management facilities (SWMFs). Many of these projects were water quality enhancements to larger projects such as the addition of Broadmoor SWMF with the widening of Capital Circle NW/SW and the creation of Coal Chute Pond and Tallahassee Junction SWMF expansion with the FAMU Way project. Blueprint has completed a substantial number of stormwater improvements along the Capital Cascades Trail corridor improving both water quality and reducing area flooding. In all, these stormwater improvements represent a total investment of more than $130 million and stretch approximately 2.5 miles. Another major upstream restoration project designed to enhance water was the Lake Munson Restoration Project which constructed the Lake Henrietta stormwater facility, made improvements to Munson Slough, removed trash and the sediment delta from Lake Munson, and restored wetlands around Lake Henrietta and Lake Munson.

The strategies from the 1994 Lake Munson Action Plan have facilitated the continuous investment in the Lake Munson basin and have been broadened over the years to include new technologies and methods in lake management and restoration best practices which are explored further in the Analysis section. For the mitigation of current conditions on the Lake including recent algal blooms and rapid growth of hydrilla, this item seeks Board approval to implement an Action Plan for Lake Munson which includes an immediate and temporary drawdown of the water level to coincide with enhanced water quality monitoring and an aerial topographic survey of the lake bottom. The Action Plan also presents long-term actions to enhance the Lake based on best management practices.

Analysis:

Leon County Government, the City of Tallahassee, and the Blueprint Intergovernmental Agency have dedicated hundreds of millions of dollars for projects in the Lake Munson basin and prioritized upstream improvements which reduce the transport of sediment and benefit the Lake water quality. While the Lake continues to improve, undoing decades of damage will take continuous commitment. The 1994 Lake Munson Action Plan has been used as the basis to guide watershed and stormwater improvements, regular testing and monitoring of water quality, and regulatory actions to limit pollutants and protect natural resources. Since 2019, two studies have been completed on sediment contamination in Lake Munson which will guide the evaluation and analyses of future restoration projects. As a result of these studies, in-lake sediment removal is no longer a viable mitigation option to reduce nutrient levels in Lake Munson at this time; however, as new technologies and information become available, dredging may become a viable option in the future.

In preparing this item, staff sought input from the Leon County Science Advisory Committee on the current water conditions, quality and ecology of Lake Munson. The SAC has a great deal of institutional knowledge on Lake Munson and has provided input to the Board over the years on lake management best practices. On September 2, 2022, SAC reviewed the County's water quality data and concurred with staff that over the past several decades, the water quality in the Lake has been improving; Munson Slough and Lake Munson are exceeding their State-mandated nutrient levels for nitrogen while phosphorus levels have declined significantly over the last ten years and are now approaching the target levels. The SAC finds that the upstream improvements since the 1990s have resulted in lower concentrations of nitrogen and phosphorus flowing into the Lake meaning that the quality of incoming water is better than the water in Lake Munson.

Despite the better water quality, in-lake mitigation, and investments in upstream infrastructure, Lake Munson continues to experience occurrences of fish kills, algal blooms, invasive vegetation and snails, low game fish productivity, and depressed oxygen levels. Several of these conditions were experienced by Lake Munson residents this summer, providing an opportunity to hear directly from residents and other stakeholders. This item articulates not only all that Leon County has done to enhance water quality in the Lake Munson basin, but also describes the three decades of strategies which informed and prioritized the infrastructure investments by cooperative local governments. And finally, the item details the County's next steps to address these recent conditions including those that were planned and, in some cases, those which came out of the meetings with the Workgroup. These next steps are hereafter referred to as the Lake Munson Action Plan (Action Plan) throughout the agenda materials.

For the continued improvement of Lake Munson and consideration of future in-Lake restoration projects, the County will continue to utilize the SAC and engage State agency partners for their resources and expertise. State agencies, water management districts, and local governments each have a unique role in watershed, stormwater, and lake management. The continuous coordination between local governments and State agencies is necessary to address water quality in Lake Munson as described throughout this item. However, it is important to clearly understand the roles and responsibilities of each jurisdiction with regard to planning improvements to a State waterbody.

Roles and Responsibilities

The management of waterbodies is governed by the Federal Clean Water Act which establishes the basic structure for regulating discharges of pollutants into the waters of the United States, establishes quality standards for surface waters, and delegates much of the regulatory enforcement to the states. At the state level, the FDEP is responsible for the administration of water resources along with the enforcement of federal and state laws and programs. This includes monitoring and responding to red tide on the coast, algal blooms in freshwater, and fish kill investigations conducted by FWC. According to FDEP's website:

> *It is a policy of the Legislature that the State's water resources be managed at a state and regional level.*

The FDEP is responsible for the administration of the water resources at the state level and exercises general supervisory authority over the state's five water management districts which are responsible for the administration of the water resources at the regional level. The state's five water management districts include the Northwest Florida Water Management District, the Suwannee River Water Management District, the St. Johns River Water Management District, the Southwest Florida Water Management District, and the South Florida Water Management District. The core mission of Florida's five water management districts is water supply, water quality, flood protection and floodplain management, and natural systems management. For waterbodies within their regions, the water management districts construct or help fund the construction of water quality projects to benefit our state's waterbodies. In addition, the districts administer regulatory programs designed to achieve the protection of the state's water quality.

The FWC is the lead State agency for managing fish and wildlife, and their habitats on Florida's aquatic resources. The agency develops comprehensive Lake Management Plans detailing its management activities which can include, but are not limited to, habitat protection, restoration and enhancement, fish management, and invasive plant management such as herbicide treatments, biological controls, and mechanical removal. The FWC supports Lake Munson through its Aquatic Plan Management Program which chemically treats invasive exotic aquatic vegetation. FWC's program is currently the only aquatic plant management strategy for lakes in Leon County and is subject to available State funding.

FWC also has a history of lake restoration projects on state-managed waterbodies in Leon County. This includes sediment removal projects on Lakes Iamonia and Miccosukee and, in 2001, State funds were programmed for an in-Lake and upstream restoration project to benefit Lake Munson. Following delays to begin the project, in 2003 the Board adopted a Resolution urging FWC to begin the in-Lake removal of sediment. The project never commenced and FWC notified the County in 2007 that it was no longer a priority project.

The County is responsible for regularly collecting and reporting water quality data, administering the stormwater management program, and developing policies or regulatory measures to protect water resources in the unincorporated areas of our community. County staff monitors the quality of our water resources through field sampling to analyze the chemical makeup and assess the biological health of our waterbodies to ensure that waterbodies are within acceptable nutrient levels. Should a waterbody exceed the water quality thresholds established by the State, FDEP and the County would prepare a restoration plan to identify programs and improvements designed

to reduce nutrient levels to meet the state standards. The following section describes this exact scenario from 2013 related to Lake Munson.

FDEP Environmental Assessment and Restoration

Lake Munson has a long history of poor water quality and not meeting the State minimum water quality standards. In 2010, a Total Maximum Daily Load (TMDL) was in development for Wakulla Springs and because Lake Munson contributes to Wakulla Springs, it was necessary to reduce nutrient levels at Lake Munson. Through the FDEP environmental assessment program, individual parameters within a waterbody are analyzed to determine if the waterbody is meeting its designated uses. Lake Munson was impaired for nitrogen and phosphorus. FDEP adopted a TMDL for Lake Munson and Munson Slough in 2013. The TMDL set limits for nutrients that must be achieved by the County and City for Lake Munson.

As part of the Water Quality Monitoring Program, Leon County samples Lake Munson quarterly. This data is summarized in the Annual Water Quality Report that presents the previous calendar year's data. Leon County has water quality data dating back to 2001 when the program began. County staff reviews and analyzes the data for trends in the system. The water quality in Lake Munson has been below the TMDL limit for nitrogen since 2017 and has been steadily declining in phosphorus (24% reduction since 2013) that it is now approaching the TMDL limit. Graphs of Lake Munson's nitrogen and phosphorus concentrations are included in Attachment #4.

The lack of stability in the nitrogen and phosphorus levels through time reflects the changing nature of Lake Munson. For example, the explosion of apple snails in 2004-2005 and the resultant elimination of aquatic plants caused an extensive algal bloom and the Lake to change. The crash of the apple snail population further perturbed the system.

The ups and downs in the nutrient values also represent the Lake trying to reach some sort of stability. A lake dominated by algae takes a very long time to stabilize, if ever. The algae will take up the nutrients and prevent other higher-level plants from establishing or reestablishing. The quarterly samples in recent years show much greater stability of nutrient levels which means the Lake appears to have stabilized.

After the drawdown in 2010, the nutrient level dramatically fluctuated. This was in part caused by the plants in the lake bottom dying off, and in part due to FWC's aggressive chemical treatment for the water hyacinth that emerged at that time. Some variability in the nutrient values after the Lake is refilled and tries to restabilize can be expected. The proposed Action Plan described later in this analysis includes more frequent chemical treatment of the invasive exotic species in an effort to reduce this instability.

The changes to nitrogen and phosphorus levels over the last seven years are most certainly a result of the ongoing upstream improvements. The submersed aquatic plants in the Lake decrease the nitrogen and phosphorus levels in the water column; however, aquatic vegetation alone would not result in such a drastic drop in concentrations.

2019 FGS Sediment Study

While the upstream improvements significantly reduced the nutrient levels in the lake, in-lake restoration was part of the recommended improvement strategies from the 1994 Action Plan. In order to dredge the lake, information on how much material needed to be removed and determine if there were any contaminants in the material. In order to determine this, a sediment study was needed. This study would remove material from the lake, test the material for contaminants, and determine how dangerous the levels of any detected contaminants are. The report prepared though this study would be used to guide future decisions on in-lake restoration strategies. As a State-managed waterbody, staff consulted with FDEP for guidance and the agency offered to conduct a sediment study.

The Florida Geological Survey (FGS), a division of FDEP, together with the Bureau of Laboratories under the Florida Department of Health, had the staff, expertise, knowledge, and equipment to investigate the Lake Munson sediments. The purpose of the Sediment Study was to determine the depth to and thickness of organic muck, native sand, and clay beneath the waterbodies; determine if hazardous wastes occur and their location and depth within the sediment muck layer; determine the nutrient concentrations in the sediment muck layer; and investigate two known karst features and attempt to identify unknown karst features within Lake Munson.

Between September and November 2018, FGS collected vibracore sediment samples from 37 sample sites, 32 in Lake Munson, 2 in Lake Henrietta, and 3 in Munson Slough. The sediment samples were analyzed for a suite of heavy metals and other containments. The final report was completed in February 2019 (2019 FGS Sediment Study). In short, the study found polychlorinated biphenyls (PCBs) and heavy metals in the sediment samples.

The samples with the highest concentrations of contaminants were further analyzed. This analysis indicated that the contaminants are tightly bound to the sediment and do not leach under simulated rainfall, so they are not soluble in overlying water. These types of contaminants are attracted to sediment particles and when they find a particle they latch on; the chemicals are then moved around through sediment transport or movement. The FGS testing indicates that when the exposed particles are rained on, they remain stuck to the sediment and does not run-off. This suggests that contaminants were transported at some point to Lake Henrietta and Lake Munson attached to the sediment particles, from somewhere upstream and not flowing downstream in the water from a leak or other source. The FGS testing also suggests that once the sediment particles settle to the bottom within the Lake, the contaminants are not releasing off the sediment into the water; therefore, the sediment on the bottom is stable and not releasing toxins. The SAC accepted the findings but shortly thereafter, the City of Tallahassee hired a consultant to review the results of the 2019 FGS Sediment Study.

The City of Tallahassee hired Terracon, a national engineering consulting firm specializing in environmental, geotechnical and materials services, to provide recommendations in response to the FGS Sediment Study. Completed in 2021, the Terracon Report found that the use of PCBs has been banned since 1979 and the use of heavy metals are regulated such that they are only allowed in small concentrations. The Terracon Report determined that the contaminated sediment accumulated from activities prior to the mid-1990s and are still detectable due to how slowly they

break down. The report also determined that upstream source sampling for historical sources is unnecessary because they are unlikely to be contributing new contamination to Lake Munson.

The PCBs found in the sediment are likely relic contaminants prior to current regulations or may have been transported downstream or downwind during development activity decades ago. Significant development and construction activity have occurred upstream of Lake Munson which provided ample opportunities for potentially contaminated soil to be exposed, rained upon, and carried downstream. Based on these recent reports and findings from experts in the public and private sectors, it is unlikely the sediment contributes to water column contamination to which people, pets, and fish would be exposed. After consultation with the FDEP on the results of the analysis and the known conditions of the basin, no upstream source sampling for PCBs and/or heavy metals had been pursued.

The purpose of the 2019 FGS Sediment Study was to obtain new information that could be used to guide future lake management strategies. The Sediment Study provided new information on the extent of contaminated sediments in the Lake. Analysis by staff, the SAC, and leading environmental firms the County has on contract of these studies have concluded that dredging is not a preferred mitigation method at this time. The PCBs are not causing harm to the water, fish, or Wakulla Springs because they are bound to the sediment so dredging the Lake at this time would disturb the sediment resulting in greater harm to the Lake and downstream.

Present Day Challenges

In May 2022, Lake Munson experienced an algal bloom which are a common and natural occurrence in Florida's fresh waters, including Lake Munson, and are attributed to environmental factors such as sunny days, warm water temperatures, low rainfall amounts, still water conditions, and a plentiful supply of nutrients in the water which cause blue-green algae (cyanobacteria) to rapidly accumulate and result in an algal bloom. At that time, staff was working closely with State agency partners FDEP, FWC, and the FDOH to ensure the health of our water bodies and residents. For context as to the prevalence of these blooms, FDEP is currently monitoring nearly 200 active algal blooms across the state. While algal blooms can occur with or without toxins, FDOH determined that Lake Munson's algal bloom earlier this summer produced a microcystin toxin and issued a health alert for residents to avoid contact with the water.

On May 23rd, FDOH issued a health alert specifically advising residents to not drink, swim, wade, use a personal watercraft, or boat in Lake Munson and warned residents to keep pets away from the area. At the urging of FDOH, the County closed the boat ramps due to the anticipated Memorial Day Weekend traffic and shared FDOH's alerts across the County's digital platforms. At that time, the Board received an email with a comprehensive summary of the issue and a status report was placed on the Board's July 12th meeting agenda detailing the progression of the algal bloom and toxicity. The next week, on July 21st, FDOH lifted the health alert for blue-green algal toxins at Lake Munson based on water samples collected by FDEP. FDOH advised the public may resume water-related activities and to continue to exercise caution on the lake as algae blooms can move around, subside, and reappear when conditions are favorable. At that time, the County reopened the Lake Munson boat ramps for recreational use.

In late August 2022, residents living near Lake Munson brought forward additional concerns related to a fish kill, people experiencing adverse health conditions, and a call-to-action for the County to address these issues. In addition, staff had observed the rapid growth of aquatic vegetation (hydrilla) which requires mitigation. As these issues arose, staff consulted with the appropriate State agencies and sought input from the County's SAC to assess mitigation options, where appropriate, for Lake Munson.

There is a consensus among staff, State agency partners, and the SAC that immediate mitigation is needed, and a drawdown of Lake Munson will help address the algal, nutrient, and aquatic vegetation challenges in the Lake. In consultation with State agency partners and the SAC, staff began developing the drawdown plan as well as short- and long-term best management practices. On September 13, 2022, the County Administrator advised the Board that an agenda item would be brought back at the October 11th meeting seeking Board approval to proceed with the drawdown.

Lake Munson Action Plan

The proposed Lake Munson Action Plan provides an opportunity to better articulate ongoing and long-term infrastructure projects to benefit the basin, the planned drawdown with more frequent water quality testing, an aerial topographic survey of Lake Munson to the measure elevations of compacted sediment to evaluate for future in-lake mitigation strategies, a new vegetation management program for treating invasive plants, and implementing periodic drawdowns in consultation with FWC to reduce the need to mechanically remove organic-rich sediment. The Action Plan captures recommendations sought by the Workgroup including the deployment of hydrogen peroxide to treat algal blooms, point-source testing for PCBs, ongoing engagement over the next two years to evaluate the Lake's response to the drawdown, and regular status updates to the Board every six months. This holistic approach will allow the immediate strategies to quickly mitigate the rapid growth of hydrilla and eliminate the algal bloom while the long-term actions will supplement the State's in-lake activities and provide a higher level of service to County residents. Consistent with the management strategies adopted by the 1994 Lake Munson Action Team, this Action Plan was developed with input from State agency partners, citizen stakeholders on the SAC and with the Workgroup, and industry best practices for lake management to include the following components:

- Lake Munson Drawdown & Enhanced Monitoring
    - Water Quality Study
    - Aerial Topographic Survey
    - Point-Source Testing for PCBs
- Ongoing and Planned Infrastructure Projects
- Long-Term Lake Management Actions
    - Invasive Exotic Vegetation Management Program
    - Hydrogen Peroxide to Treat Algal Blooms
    - Reoccurring Drawdown Schedule
    - Innovative Technology Exploration

Drawdown and Enhanced Monitoring

This summer Lake Munson experienced algal blooms, a fish kill, and most recently an abundance of aquatic vegetation. While the nutrient levels in the Lake have been steadily declining, these issues pose a need for immediate mitigation. A drawdown will help address the algal, nutrient, and aquatic vegetation challenges in the Lake. The drawdown will kill off the hydrilla and algae and will form a "cap" on the sediment to reduce the nutrients leaving the sediment. In addition to the immediate benefit, drawdowns provide long-term benefits to the nutrient-rich sediment. A drawdown is most efficient during the "dry" season, which in Leon County is starting now. An optimal start of the drawdown in October, coupled with a minimum length of time the Lake is down during the dry season create an urgency to start the drawdown right away. If a drawdown were to be deferred to next fall/winter, it is possible many of the current issues in the Lake will continue through the fall or will return next summer.

Drawdowns are a proven technique in lake management and are beneficial to the Lake by allowing the sediments to de-water, oxidize, and form a hardened crust over the lake bottom. A drawdown would serve to "cap" the underlying sediment which would provide habitat for fish spawning and reduce nutrient recycling once the Lake is reflooded. A complete drawdown is planned to provide the maximum benefit.

The Lake drawdown is anticipated to start at the beginning of November, or sooner if possible, and would last for 3-5 months, depending on the weather through the winter. A warm and wet winter would require a longer drawdown to allow the lake bottom to dry out; whereas, a cool and dry winter could allow for a shorter drawdown period.

The drawdown starts by opening the gate on the Lake Munson dam to allow more water out than is flowing into the Lake, slowly lowering the water level of the Lake until most of the lake bottom is exposed and the amount of water flowing into the Lake is the same as the amount of water flowing out. The amount of water released through the gate is a balance. Enough water should be let out to lower the lake level in a reasonable amount of time, but not so much water that the increased flow causes erosion or flooding problems downstream. Like the drawdown in 2010, the increased discharge of the Lake downstream is not anticipated to cause adverse impacts.

A majority of the bottom of the Lake will be exposed when the drawdown is complete, but several areas such as the north lobe (bunny ear) and the southwest portion (back foot) are anticipated to still have water in them, although at a lower depth. This is due to the differences in the elevation of the lake bottom, as it relates to the elevation of the dam gate. These two areas have a lower lake bottom elevation creating pools of water that cannot drain. Also, these areas are located off the main flow through channel line, making it more difficult for the water to flow out of them to the dam. Once the water has drained from the Lake, the gate at the dam will remain open so that any water that comes into the Lake passes directly through. If the Lake Munson drainage basin were to receive a large rain event, the Lake could fill up for a short period of time.

A complete drawdown exposes the most sediments and would force fish and other biota into the sinkhole in the southwest corner of the Lake. Many fish and other organisms would not survive a complete drawdown; however, the Lake biota would recover quickly upon refill. The fish populations could be re-established from those that survived in the sinkhole, from upstream, and

from re-stocking by FWC. Staff will coordinate with FWC to minimize the death of fish and other creatures during the complete drawdown. It is important to remember that the primary goal of the drawdown is to improve sediment quality, and thereby water quality, improving the long-term health of the entire lake ecosystem. Creatures that live naturally in Lake Munson have recovered from past drawdowns. The current condition of the Lake, including an abundance of hydrilla and warm temperatures, threaten the entire fish population and can cause fish kills like the one experienced in August 2022.

With the water drained from the Lake, the bottom can begin to dry out. The submerged aquatic vegetation in the Lake will slowly die. The sun will begin to dry out the sediments and muck on the bottom of the Lake will begin compressing. The aquatic vegetation will be replaced with terrestrial plants, which are plants that live on land, and the sediments will continue to dry out. During the drawdown there can be some unpleasant smells as the vegetations die off and the wet lake bottom begins to dry.

The length of time needed to dry out the sediments is dependent on nature and the weather. Staff will work closely with FWC and FDEP to determine the optimal time to begin refilling the Lake. When it is time to complete the drawdown, Leon County will slowly begin closing the gates to allow water to remain in the Lake. Much like lowering the Lake level, refilling the Lake is a balancing act. The goal is to hold enough water back in the Lake, without adversely impacting downstream wetlands and waterbodies by not sending enough water downstream. The time it takes to refill the Lake is also weather dependent. If it is a wet spring the Lake will refill quickly, but a drier spring would mean a longer refill period. The sediments in the bottom of the Lake serve as a seed bank. When the Lake refills, the terrestrial plants will be drowned, providing fish habitat, and will be replaced with the aquatic vegetation that grows from the seed bank.

The drawdown of the Lake will necessitate a large public information component, including coordination with various divisions within FWC, FDEP, and NWFWMD as well as the SAC and the Water Resources Committee. Staff will also communicate with the Wakulla Springs Alliance, the Friends of Wakulla Springs State Park, and other concerned citizen and/or citizen groups in advance of, and during the drawdown.

The drawdown also provides an excellent opportunity for citizen engagement through lake clean-up events. These events have multiple benefits including actively engaging citizens with our natural resources, providing educational opportunities alongside nature, and improving the water quality and ecology of the Lake by removing garbage and debris from the lakebed. The County has held numerous successful lake clean-up events including for past drawdowns of Lake Munson. Staff from Public Works is coordinating with Community & Media Relations to explore dates for early next year to host a clean-up event on Lake Munson during the dry season.

The planned drawdown also does not include any vegetation removal from the lake bottom. Immediately after drawdown, the lake bottom will be too wet to support the equipment necessary to remove the vegetation that remains. After the sediments begin to harden, the vegetation will be left in place so as not to disturb the sediment, potentially allowing the sediment to resuspend and mix into the water column when the Lake refills. Cutting or mowing down the vegetation is a management strategy but the vegetation could not be harvested without sediment disturbance so

the cut vegetation would be left to flow downstream. In some cases, vegetation can be burned during a drawdown; however, this method was previously discussed by the County during a natural drawdown on Upper Lake Lafayette and it was determined the associated liability far outweighed the benefit.

In recent meetings with the Lake Munson Workgroup on the proposed Action Plan, the Workgroup was supportive of the planned drawdown but felt very strongly about the need to pair it with sediment removal efforts while the Lake was dry. Lake drawdowns often present an opportunity to dredge a waterbody or, at times, remove the top layer of sediment from the lakebed. However, the planned drawdown for Lake Munson does not include any dredging or removal of muck and sediments due to the known contaminants identified in the 2019 Florida Geological Survey (FGS) Sediment Study. While dredging and the removal of sediments have been advised in the historically accepted mitigation strategies for the Lake and advised in the 1994 Lake Munson Action Plan, these methods are not recommended at this time as recent studies and data analyses indicate that removing the sediments may cause more harm to the Lake. If the Lake were to be dredged these contaminants could be released into the water column and be transported downstream to Wakulla Springs. However, future technologies could make dredging a viable option.

Lake Munson is also believed to contain sinkholes. Data collected as part of the 2019 FGS Sediment Study indicates several areas of high karst potential. A major concern with dredging the Lake is the potential for inadvertently opening a sinkhole. Heavy equipment, digging too deep or removing too much material could create a sinkhole. If a sinkhole were to open on the Lake, it could completely change the hydrology and ecosystem. Much like Lake Jackson, the Lake could drain and stay down until the sinkhole naturally filled.

During conversations with the Workgroup, the removal of sediment in Lake Munson was improperly compared to other dredging projects in the community and around the State. For example, Lake Munson is a natural lake system upstream of a first-magnitude spring so dredging of the lakebed poses the risk of the releasing relict contaminants. Directly upstream, Lake Henrietta is a constructed stormwater facility designed to collect sediment for periodic removal, to redirect or bypass the water flow during construction to minimize impacts downstream, and is fully accessible to construction equipment. For these reasons, Lake Henrietta has an upcoming sediment removal project that will benefit Lake Munson.

Over the summer months, a member of the Workgroup shared information on water quality and sediment removal projects in other parts of the State including Lake Apopka, bordering Orange and Lake Counties, and a project just north of Lake Okeechobee which straddles several counties along the Kissimmee River. In addition to all the aforementioned risks of dredging Lake Munson directly upstream of Wakulla Springs following the findings of the 2019 FGS Sediment Study, there are additional factors which distinguish these projects.

One of the primary differences between Lake Munson and Lakes Apopka and Okeechobee is the sheer size of these waterbodies. Lake Munson is 288 acres (0.45 square miles) with an average depth of 5 feet; whereas Lake Apopka is 48 square miles with an average depth of approximately 15 feet and Lake Okeechobee is 730 square miles with an average depth of approximately 9 feet.

Removal of aquatic vegetation in the larger lakes has less of an impact because it is less of a shock to the system as within a smaller lake such as Lake Munson. On Lake Munson, all of the vegetation in the lake could be removed in a matter of days, which would be a drastic change in a short period of time. Conversely, on a lake like Okeechobee, the amount of vegetation that could be removed in the same period of time is very small compared to the total size of the lake, making the change much less noticeable. Lakes Apopka and Okeechobee do not have the widespread sediment contamination as Lake Munson which would require disposal far away from the basin or at a managed site like a landfill so it does not return to the ground or water. The muck that is dredged from Lakes Apopka and Okeechobee can be land applied nearby the project based on the known types of contaminants in those waterbodies.

A common thread between the Lakes Apopka and Okeechobee projects which happen to impact multiple jurisdictions is that these complex water quality projects in State-managed waterbodies are, in fact, led by the State. Being responsible for the management of these waterbodies, the State determined, often through the regional water management districts, to initiate the improvements to these waterbodies.

Water Quality Study

Water quality sampling pre- and post-drawdown is an excellent opportunity to monitor and quantify the effects of the drawdown on water and quality in Lake Munson. As part of the drawdown, a water quality study will be conducted using samples collected both upstream and downstream of the Lake, at up to four locations, and will be analyzed for the County's standard water quality parameters. An initial sample event will be collected prior to drawdown to provide pre- and post-drawdown comparison. After the Lake has started to refill, samples will be collected monthly for a period of two years. Between the County and City, samples are collected upstream and downstream of the Lake on a quarterly basis; however, this sampling frequency does not provide the level of detail needed to follow the evolution of the Lake as it re-stabilizes after refill. The sampling plan was developed incorporating suggestions from the SAC.

The Action Plan calls for the SAC to receive an update on the drawdown and monthly water quality data on a quarterly basis, to include the Workgroup for participate in the quarterly SAC updates to discuss the available samping data and drawdown progress, and for staff to prepare six-month status reports to the Board on the progress at Lake Munson throughout the drawdown phase.

Aerial Topographic Survey

Additional data collection includes an aerial topographic survey of the lake bottom. The survey will be conducted immediately after the lake bottom has been fully exposed and again immediately prior to refilling the Lake. This information will provide data on how much the sediment compacted, as well as information on the elevations of the current lake bottom. Data quantifying the amount of compaction is useful in evaluating the effectiveness of the drawdown. It also provides information on the responsiveness of the Lake during a drawdown which is beneficial in determining future drawdown timing. A current lake bottom survey is useful for evaluating future in-lake mitigation strategies. Topographic survey of the lake bottom was not collected during the drawdown in 2010 but staff noted this would have been valuable information to have acquired at that time.

Point-Source Testing for PCBs

At its September meeting, the SAC discussed sampling the water flowing into Lake Munson for dissolved concentrations of contaminants. Point-source testing would validate the 2019 FGS Sediment Study and the Terracon Report to show that the sediment contaminants are not resulting in water column contamination. Based on the SAC discussion, County staff have developed an event sampling plan for point-source testing. Samples will be collected from four sites, including upstream of the Lake, in Lake Munson, and downstream of the Lake. The samples will be collected during a high flow event and tested for the suite of contaminants in 2019 FGS Sediment Study. In the unlikely event that elevated dissolved concentrations are found, additional sampling or an investigation into the upstream sources may be warranted.

The Lake Munson Workgroup welcomed the point-source testing for PCBs but sought for the County to conduct ongoing tests. The reason the County seeks to conduct the point-source testing for PCBs is to validate the findings from the recent studies by FGS and Terracon. The 2019 FGS Sediment Study, which the Workgroup relies upon as the basis to perform testing, states that, "Upstream sampling <u>may help</u> to identify the source(s) of those contaminations" (emphasis added). Should the testing at the four locations confirm that the sediment contaminants are not resulting in water column contamination, ongoing testing would be unnecessary. Future tests may be warranted and performed by the County based on new information or the conditions of the Lake.

<u>Ongoing and Planned Infrastructure Improvements</u>

Earlier sections of this item documented the hundreds of millions of dollars invested by the County, City, and Blueprint to enhance the water quality in Lake Munson dating back to the 1990s. At present, there are several ongoing and planned infrastructure projects within the Lake Munson Basin which are described in this section (Attachment #5).

The County's Lake Henrietta Sediment Removal project is anticipated to commence in 2023 and will reduce the amount of sediments transported into Lake Munson, thereby improving water quality. Managed by Blueprint, the first two segments of the Capital Cascades Trail and network of stormwater facility projects have already been completed and Segment 3, which includes a regional stormwater facility (3D-B Stormwater Facility) along the FAMU Way Corridor, is currently under construction. Capital Cascades Trail Segment 4 will remove sediment and trash and improve downstream water quality in the Lake Munson basin. The Segment 4 improvements will begin at the convergence of two stormwater conveyance systems (Central Drainage Ditch and St. Augustine Branch) near FAMU Way and extend south to Lake Henrietta at Springhill Road. Blueprint staff anticipates bringing an agenda item back to the Intergovernmental Agency Board in March 2023 seeking acceptance of the design concepts so that the project can proceed to the final design and permitting phase. Capital Cascades Trail Segment 4 will complete the 4.25-mile stormwater treatment and recreational improvements, stretching from Leon High School south to the Lake Henrietta stormwater facility, as provided in the Capital Cascades Master Plan approved by the Blueprint Intergovernmental Agency Board (IA Board) on January 31, 2005.

As our community has continued to make so many investments on these upstream improvements to ensure that clean water is flowing downstream, the priority has shifted to include millions of dollars in resources allocated to address water quality in the basin through the reduction of household septic systems. Consistent with the third strategy in the 1994 Lake Munson Action Plan

calling for community actions such as emphasizing the importance of educating the public on the proper design and maintenance of septic systems so that individuals can take personal responsibility in reducing pollution, the County and the State have prioritized the proliferation of advanced septic systems and septic to sewer projects in recent years.

Based on the shared desire to enhance water quality in our region through nitrogen reduction projects, Leon County and FDEP jointly adopted the Leon County Water Quality and Springs Protection Infrastructure Improvement Plan (Springs Improvement Plan) in FY 2018. This first of its kind multi-year agreement between the State and a county was the result of Leon County's strong commitment to reducing nitrogen levels in the primary springs protection zone and FDEP's willingness to provide a dollar-for-dollar match toward projects in Leon County. Lake Munson, and portions of the Munson basin, are within the primary springs protection zone which allows residents to be eligible for the voluntary wastewater projects. Both parties committed over $32 million through FY 2024 for water quality and springs protection infrastructure projects, subject to annual appropriation by the Board and Florida Legislature.

The Springs Improvement Plan includes funding for the County's Northeast Lake Munson Septic to Sewer project and two programs that financially support homeowners who wish to voluntarily upgrade their septic systems to advanced nitrogen-reducing systems. As the County has done upstream of the Lake, the County is also actively addressing over $12 million dollars in bringing sewer to the neighborhoods immediately adjacent to the Lake and removing up to 220 septic tanks. Downstream of the Lake Munson basin, millions of dollars have been committed to bring sewer to Woodville which will be vital to Wakulla Springs. The plan also includes future commitments to broadening the Comprehensive Wastewater Treatment Facilities Plan by funding future studies on the best methods of wastewater treatment for reducing nitrogen County-wide.

Based the City of Tallahassee's shared commitment to improving the water quality in Lake Munson, the City and County entered a Water and Sewer agreement in 1993 and revised in 2005, whereby the City commits to maintain or improve its sewer system so it can provide capacity to jointly identified target areas. This agreement helped make the NE Lake Munson Septic to Sewer Project possible.

Long-Term Lake Management Actions

The Action Plan calls for an expanded role for the County in managing Lake Munson as it continues to coordinate with State agencies on long-term restoration opportunities. As upstream contributors to the Lake, the County and City have focused on stormwater improvements to reduce the nutrient loading and sediment entering the system and monitoring the water quality for system trends. At the State's request, the County provided assistance in managing previous drawdowns on Lake Munson. As a State-managed waterbody, the County relies on the State for in-lake management such as the treatment of aquatic vegetation and sediment removal projects. The Action Plan proposes supplementing the State's lake-management efforts and responsibilities related to Lake Munson by implementing an enhanced vegetation management program, periodic drawdowns in consultation with FWC to reduce the need to mechanically remove organic-rich sediment, algal bloom treatments, and exploring new and innovative methods for in-lake management including potential opportunities through FDEP's Innovative Technologies Grant. The cost for these supplemental lake-management services is estimated to be $60,000 in FY 2023.

Invasive Exotic Vegetation Management Program

The Action Plan calls for the County to implement an Invasive Exotic Vegetation Management Program to supplement the State's treatment efforts on Lake Munson. Invasive exotic plants adversely impact native plant communities and, if left untreated, will rapidly colonize and take over a waterbody. Native species create a healthier ecosystem; they allow a variety of plants to grow and serve as food and nesting habitat for fish and wildlife. As a State-managed waterbody, the County relies on FWC's Aquatic Plant Management Program for treatment of exotic vegetation for area lakes.

FWC's service area covers the entire Florida panhandle, from Escambia to Jefferson County, so County Water Resources staff often identifies areas of exotic vegetation growth and notifies the State. FWC spot treats the areas of concern with a chemical herbicide subject to the availability of personnel and funding.

Leon County has a small vegetation management program that is limited to treating stormwater facilities. This item proposes enhancing the Invasive Exotic Vegetation Management Program to better manage the aquatic vegetation in area waterbodies by supplementing the State's plant management services to prevent the rapid growth of invasive exotic species and facilitate the growth of native aquatic vegetation. When an area is identified for treatment, staff will coordinate with FWC to determine its availability to respond before reaching out to the private contractor. This supplemental program is anticipated to provide a quicker response time and more frequent mitigation of the aquatic vegetation. More frequent treatment in smaller areas is better for lake ecology because less product is generally needed.

The Invasive Exotic Vegetation Management Program will be an in-lake mitigation tool the County can utilize as a long-term strategy to manage area lakes. This program will be implemented for Lake Munson later this year following the drawdown and anticipates county-wide expansion in FY 2024.

Algal Blooms Management Program

One of the requests by the Workgroup was a peroxide treatment of the algal blooms. Peroxide treatment methods on algal blooms are very new to Florida. As more information becomes available, staff will continue to review the results peroxide treatment on algal blooms state-wide and will evaluate the use on future blooms on Lake Munson, as well as continuing to explore the best treatment method for Lake Munson. The proposed long-term initiatives include an algal bloom management program.

A peroxide treatment immediately in advance of the drawdown would not provide significant benefits to the lake. The algae need water to grow, so when the lake is drawn down, the algae are removed with the water leaving the lake. Therefore, peroxide treatment this fall has not been included in the proposed action plan.

The peroxide treatment recommended by the Workgroup was Lake Guard, which was developed by BlueGreen Water Technologies (BlueGreen), that can be used to treat algal blooms. This method of treatment has been used in other areas of the world but is very new to the United States and Florida; prior to 2020, peroxide treatments had never been applied to Florida waterbodies.

The Lake Guard is a granular chemical product that floats on the surface of the water and can be transported by current or wind to the location of the algal blooms. The Lake Guard can be applied by hand or by boat or airplane. When the Lake Guard mixes with water it changes into a hydrogen peroxide chemical. The hydrogen peroxide mixture stresses the blue-green algae, breaking down their cells, and causing them to die. The product is intended to be applied (and is most effective) in the early stages of a bloom. According to BlueGreen, there needs to be an active bloom for the product to be effective.

Lake Guard is designed to treat the cyanobacteria in the waterbody; the cyanobacteria in Lake Munson have been limited and the predominant algae type is the filamentous algae (the stringy stuff on top of the water). There is little information on the effectiveness of the product on the filamentous algae and the BlueGreen has not utilized it in this manner. There is also little information available on any adverse impacts to the waterbody after treatment with Lake Guard. Staff asked BlueGreen for this information but have not received the requested information.

Lake Guard can provide real relief from the side effects of toxic algae because the cyanobacterial toxins produced by the active bloom in the treatment area will die off and sink. Because Lake Munson is not the normal conditions Lake Guard is designed for (open water with cyanobacteria actively blooming) it is unknown what level of relief may be achieved on Lake Munson.

Normally, Lake Guard is used in open water where the chemical can be added to the water, and the current moves the product to the location of the algal bloom. This would not work in Lake Munson due to the large amounts of hydrilla. In the case of Lake Munson, because of the large amounts of hydrilla and the lack of flowing water, the product would need to be applied evenly throughout the application zone. During the meeting with the Workgroup on Monday, BlueGreen stated they would need to develop an alternative application plan, which staff have not received. BlueGreen did state the application may require the use of a helicopter.

BlueGreen stated they can deploy to treat an area within approximately 72 hours of receiving a contract and a purchase order. Under normal conditions (open water), an application can be completed relatively quick. Because the alternative application plan has not been developed it is unclear how long application on Lake Munson would take. After application, under normal conditions the algae die off within 24 to 48 hours; a second application is suggested after 48 to 72 hours. Since the Lake is topped out with aquatic vegetation, it is not clear if the product will treat the algae in the same length of time. BlueGreen also recommended the County stockpile a supply of Lake Guard to spot treat the algae in the future.

BlueGreen was contracted by the St. John's River Water Management District (SJRWMD) for a pilot project on Lake Minneola and by the South Florida Water Management District (SFWMD) to conduct a test project on the C-43 Canal/ Caloosahatchee River, both using Lake Guard. Because they are state-managed waterbodies, the FDEP and Water Management Districts paid for and oversaw the projects. The Lake Minneola has been plagued with cyanobacteria, so this pilot project was developed to test Lake Guard's ability to prevent agal blooms. Water samples were tested to determine algal bloom prone areas, which were then treated with Lake Guard. The Pilot Project lasted a year and a half. From this project, the SJRWMD is developing a rapid response plan to take on algal blooms before they overwhelm lakes and rivers. The C-43 Canal/

Caloosahatchee River is a mixture of natural and manmade canal networks that have a history of heavy cyanobacteria issues. The project was intended to mitigate the effects of the blooms through treatment and text the products ability to in treating heavy blooms and maintaining the system in a bloom-free condition. Both scenarios are different than Lake Munson. In both cases, the Lake Guard was applied in an open water situation, and where the product could flow to and with the cyanobacteria. Also, both waterbodies have long histories of significant cyanobacteria issues, whereas, Lake Munson has primarily had issues with filamentous algae this summer. It's also important to note that like Lake Munson, both waterbodies are state-managed and hence the Water Management Districts sponsored the projects.

Lake Guard is a very new method of treatment in Florida. Little information is available on how the peroxide mixes and disperses in the water. During the meeting with the Workgroup, a question was raised on if Lake Guard left enough vegetation in the system to allow the fish and other wildlife to survive. More research is needed to determine optimal levels needed to suppress blooms, while not affecting fish or other wildlife.

The use of Lake Guard is a management and mitigation strategy. The product can treat active blooms and may be able to prevent future blooms. In both cases, the use of Lake Guard would be an on-going treatment method and would require continual use to achieve the algal management.

Reoccurring Drawdown Schedule

Periodic and reoccurring drawdowns are not a new concept and have previously been used on lakes in Leon County. Drawdowns are beneficial to the health of the Lake, especially on lakes that do not experience natural drawdowns. Episodic drawdowns reduce the need to remove nutrient and organic-rich sediment. Drawdowns should be reasonably frequent with timing that mimics the natural draining and refill cycle that keeps lakes in a healthy state. Based on recommendations from the SAC and FWC, Leon County Public Works will implement a planned drawdown cycle of every 5-10 years which allows flexibility of more frequent drawdowns if needed. The exact period of time between drawdowns will be determined by the conditions and health of the Lake, and in consultation with FWC and the SAC. On average, the driest months in Tallahassee are October through January. Drawdowns beginning in October and lasting through the winter are ideal. Complete lake drawdowns will be utilized to provide the maximum benefit to the Lake, unless the health of the Lake dictates otherwise, as determined by FWC and the SAC. Staff will prepare an agenda item seeking Board approval of future drawdowns and will provide ample notice to the public through Community and Media Relations.

Innovative Technology Exploration

And finally, staff will continue to explore new and innovative methods for lake management and any potential strategies and technologies will be presented to the SAC and State agency partners for discussion and analysis. On August 15th, the County applied for an FDEP Innovative Technologies Grant for a pilot project on Lake Munson utilizing Biochar, a charcoal-like substance capable of removing the dissolved nutrients that facilitate algal blooms. This grant will explore the effectiveness of the Biochar and determine scalability if implemented in a larger setting. The successful outcome from this and other Innovative Technologies Grants could be used on Lake Munson in the future. As more FDEP Innovated Technology grants are awarded, the best practices

in lake management and restoration will continue to evolve as these projects are completed and new strategies are proven to be effective.

Lake Munson Workgroup

This summer, residents living near Lake Munson joined with local environmental advocates and brought forward concerns related to algal blooms, people experiencing adverse health conditions, a fish kill, aquatic vegetation, and a proposal for an FDEP grant. Through phone calls, emails, news advisories, as well as large public and small neighborhood meetings, the County was responsive to the concerns brought forward about the Lake which often required coordination with State agency partners at FDEP, FWC, and FDOH.

County employees strive to always be receptive to new ideas and innovative solutions to complex problems such as the continuous efforts to enhance water quality in Lake Munson, an examination of the County's role versus the State in lake management, or the County's response to algal blooms in state-managed waterbodies. As these issues arose, staff consulted with the appropriate state agencies and sought input from the County's Science Advisory Committee, where appropriate, for additional guidance and expertise. Unsatisfied with the information provided by the County, the Lake Munson Workgroup provided ten specific requests in writing for the Board's consideration. On September 13, 2022, the Board directed staff to meet with the Workgroup to address their concerns about the Lake and to bring back an analysis of the Workgroup's ten requests as part of this agenda item.

Based on the Board's direction, staff immediately contacted the Workgroup to schedule meetings and coordinate with the appropriate subject matter experts across County departments, Blueprint, state agencies, and the County's Science Advisory Committee. Over the course of a week, the Workgroup convened twice for a total of approximately five hours to discuss the ten requests, listen to residents' experiences and concerns, and engage subject matter experts on issues related to water quality conditions, marine life, prudent health precautions related to algal blooms, and the projects and programs designed to enhance Lake Munson. The proposed Action Plan for Lake Munson presented in this agenda item addresses the issues raised by the Workgroup, and identifies where there is agreement on certain mitigation techniques and best practices for Lake Munson.

As submitted by the Workgroup, several of the requests touch on multiple subject areas which require extensive responses. Other requests refer back to previous sections of this agenda item for a greater level of detail on an issue. It is important to note that a few of the requests and issues raised in the Workgroup meetings will be familiar to the Board as these County-wide policy matters have been considered in recent agenda items but continue to be pursued by the environmental advocate members of the Workgroup whom do not live near Lake Munson. Specifically, the Lake Munson Workgroup requested the following:

1. *We want a 2 year plan to clean the lake and remove sediments. This includes short, intermediate, and long term objectives, as well as identifying funding sources, disposal sites, etc. That means starting work in 2 years.*

   Response: Leon County has made continuous efforts to enhance the water quality in the Lake since the 1990s through upstream capital improvements and, in recent years, nitrogen reduction wastewater projects including a sewer project in NE Lake Munson and providing

residents of the basin financial incentives to upgrade their conventional septic systems. In addition to the ongoing and long-term infrastructure projects that benefit the basin, the Action Plan describes the planned drawdown with more frequent water quality testing, an aerial topographic survey of Lake Munson to the measure elevations of compacted sediment to evaluate for future in-Lake mitigation strategies, a new vegetation management program for treating invasive plants, and implementing periodic drawdowns in consultation with FWC to reduce the need to mechanically remove organic-rich sediment. This holistic approach will allow the immediate strategies to quickly mitigate the rapid growth of hydrilla and eliminate the algal bloom while the long-term actions will supplement the State's in-lake activities and provide a higher level of service to County residents.

As described on page 13 of this analysis, in-lake sediment removal is not included in the plan.

The purpose of the 2019 FGS Sediment Study was to obtain new information that could be used to guide future lake management strategies. The Sediment Study provided new information on the extent of contaminated sediments in the Lake. Analysis by staff, the SAC, and leading environmental firms the County has on contract of these studies have concluded that dredging is not a preferred mitigation method at this time. The PCBs are not causing harm to the water, fish, or Wakulla Springs because they are bound to the sediment so dredging the Lake would disturb the sediment resulting in greater harm to the Lake and downstream. In the future as more information is known and technologies change and become safer or more cost-effective, dredging may become a viable option.

The Lake continues to improve; however, Lake Munson's water quality issues date back decades and undoing this damage will take continuous commitment. The County will continue to explore new and innovative methods for lake management and any potential strategies and technologies. As more FDEP Innovated Technology grants are awarded, the best practices in lake management and restoration will continue to evolve as these projects are completed and new strategies are proven to be effective.

2. *We want our group involved in this plan and decisions that affect our health and property, along with scientists from our group on any committee formed by the county to consult on remedies, similar to how the 1994 Munson Management Plan was devised.*

   Response: The Action Plan captures recommendations sought by the Workgroup including the deployment of hydrogen peroxide to treat algal blooms, point-source testing for PCBs, ongoing engagement over the next two years to evaluate the Lake's response to the drawdown, and regular status updates to the Board every six months.

   During the first Workgroup meeting, Mr. Terry Ryan proposed convening the Workgroup and County staff on a quarterly basis through the end of the drawdown. Staff concurred with the frequency of meetings but insisted that the SAC host the future meetings to evaluate the progress of the drawdown and enhanced water quality sampling. The Action Plan calls for the SAC to receive an update on the drawdown and monthly water quality

data on a quarterly basis, to include the Workgroup for participate in the quarterly SAC updates to discuss the available samping data and drawdown progress, and for staff to prepare six-month status reports to the Board on the progress at Lake Munson throughout the drawdown phase.

3. *Short Term: We want a drawdown ASAP and if taking too long -- peroxide treatments to kill the cyanobacteria. Staff is indicating the drawdown will occur this fall after hurricane season.*

   Response: A drawdown is proposed for November 1st, or sooner if possible, following adequate public notice. A drawdown will mitigate the current algae and hydrilla challenges as well as form a "cap" over the sediments to prevent nutrients from leaving the sediment in the future. Refer to Page 9 for additional details.

   A peroxide treatment immediately in advance of the drawdown would not provide a drastic benefit to the lake. The algae need water to grow, so when the lake is drawdown, the algae go away. During the September 26th meeting with the Workgroup, FWC staff stated that peroxide algae treatment prior to the drawdown was not likely worth the investment. Staff consulted with BlueGreen Water Technologies (BlueGreen), the developer of the peroxide treatment the Workgroup referenced, and requested a scope to spray in an area around the homes but have not received a response.

   As more information becomes available, peroxide treatments may become a worthwhile management strategy to mitigate and manage algal blooms. Staff will continue to review the results of the Pilot Studies and will seek funding opportunities to use Lake Guard in the future. Peroxide treatment for algal blooms has also been incorporated into the long-term initiatives for the lake.

4. *Short Term: We want an emergency declaration regarding the condition of the lake and acknowledgment of the potential human health impacts to city and county residents.*

   Response: As has been said, Lake Munson presents significant challenges with past contamination but will continue to receive attention and resources as evidenced by all of the previous, planned, and ongoing water quality infrastructure projects within the basin and all the ongoing and planned best management practices addressed herein, including, the planned drawdown of the Lake in a few weeks. The current conditions at Lake Munson do not meet the definition of an emergency as defined in the County's Emergency Management Ordinance nor do the proposed courses of action to remediate the current conditions support the issuance of a local state of emergency. Local states of emergency enable the County to take emergency measures pursuant to the disaster recovery plans of the County. They can be a mechanism for the County to qualify for funding that would not otherwise available absent an emergency. Local states of emergency may also be issued to enable the County to take emergency measures on an expedited basis in circumstances where the County would otherwise be limited or without authority to act, such as establishing curfews, directing persons to shelter-in-place during incidents involving the release of hazardous waste, suspending otherwise applicable state and local

procurement and contracting requirements, and in some instances directing and compelling the evacuation of all or some portion of the County population.

It is undisputed that the Lake has a history of chronic water quality and ecological problems. However, according to surface water quality testing conducted by the County and the City of Tallahassee, the water quality of the Lake currently meets the Total Maximum Daily Load levels set by the FDEP for nutrients. Moreover, algal blooms are a common and natural occurrence in Florida's fresh waters, including the Lake, and are attributed to environmental factors such as sunny days, warm water temperatures, low rainfall amounts, still water conditions, and nutrients in the water which cause blue-green algae to accumulate. Additionally, FDOH has a process and procedures in place for assessing public health conditions related to algal blooms, with a dedicated web page providing information on the natural occurrence of algal blooms in Florida and precautions residents should take for themselves and their pets. While exposure to such blooms may result in temporary respiratory issues and irritations of the eyes, nose, and skin, the FDOH has taken the position that such occurrences are a nuisance, and do not pose a serious health risk to most people.

For the Board to issue a local state of emergency, the purpose and requirements of the Emergency Management Ordinance, codified in Chapter 2, Article VIII of the Code of Laws of Leon County, Florida (Leon County Code), must be met. An "emergency" is defined in Sec. 2-305. of the Leon County Code to mean:

> "*any occurrence, or threat thereof . . . which results or may result in substantial injury or harm to the population or substantial damage to or loss of property*."

As a threshold matter, an occurrence or event that cannot objectively and scientifically meet this definition fails to constitute an emergency. Accordingly, a local state of emergency is not necessary or appropriate at this time for a state-managed waterbody, based upon current objective and scientific data gathered by state and local governments.

5. *We oppose the county's tea bag grant proposal. This is a giant, missed funding opportunity.*

<u>Response</u>: On July 12, 2022 the Board provided direction for staff to evaluate opportunities to enhance Lake Munson through the FDEP Innovative Technologies Grant. Mr. Max Epstein presented staff with a proposal that included dredging the lake bottom by relocating and harvesting the organic matter. As detailed in the response to Request #1 by the Workgroup, professional engineers at Public Works explained the risks associated with sediment removal but continued to work with Mr. Epstein to evaluate his proposal, troubleshoot operational challenges, and gather information from state and federal agencies as well as the private sector to evaluate new innovative technologies that could benefit Lake Munson.

In addition to the sediment and aquatic vegetation removal, there were several other prohibitive obstacles with Mr. Epstein's proposal for the County to endorse the application to FDEP for grant funding including:

- Securing a location destination to land apply the organic materials.
- Determining the costs associated with transporting said materials, often the most expensive component of sediment removal projects, without knowing the final destination to calculate roundtrip distances and needing to anticipate those costs during a period of high inflation with rising gasoline prices.
- Reliability of the cost estimates to ensure the County secures funding for the full project costs.
- Supposition that FDEP would award a $2.5 million grant, despite concerns about the reliability of the cost estimates, given the allocation of grant awards last cycle. In FY 2022, most of the 16 grants awarded were between $200k - $300k. The two highest grants were slightly less than $1 million. While there is a larger pool of funding available to consider grant awards this year, FDEP is seeking to provide a greater volume of awards to water management districts and local governments across the state.

After working with Mr. Epstein for several weeks on his proposal, staff presented a new innovative technology for the County to seek funding. Since that time, the County has been accused of "failing to apply for a $2.5 million grant," being unwilling to invest in Lake Munson, and "pulling a "bait and switch" on its grant application. This undermines the many hours of collective work put forth by both Mr. Epstein and County staff throughout this process, which requires the County to endorse the grant application and take on the responsibility of managing/implementing the project.

The County submitted an Innovative Technologies Grant application to FDEP on August 15th. Awards are anticipated to be announced by spring 2023. The grant application was developed after consultation with AECOM, a leading engineering consulting firm with an extensive portfolio in lake management and algae technologies, for a pilot project using Biochar, a charcoal like substance, evaluating its effectiveness at taking up dissolved nutrients to prevent harmful algal blooms. The Biochar will be suspended in mesh-bags and placed at specific areas around the Lake at different heights within the water column, within the first 12 inches below the surface and approximately 12 inches above the bottom. If successful, the pilot project results will provide valuable information on how to scale-up the technology for future use. This approach will not disturb the sediment in Lake Munson, is non-invasive, and does not affect the submerged aquatic vegetation. Biochar is an established product; however, it has not been used in a small lake setting and there are no robust studies demonstrating its ability to remove nutrients in a lake such as Lake Munson. The use of Biochar in Lake Munson is a prime candidate for the grant since it is applying a known technology in a new way.

6. *Short/Intermediate Term: We want an agenda item back for increased water testing, including point-source testing as recommended by the county's own 2019 report for contaminants suspected to be actively entering the lake.*

Response: The Action Plan calls for point-source testing to validate the 2019 FGS Sediment Study and the Terracon Report and show that the sediment contaminants are not resulting in water column contamination. An event sampling plan for point-source testing was provided during the meetings with the Workgroup. Samples will be collected from four sites, including upstream of the Lake, in Lake Munson, and downstream of the Lake. The samples will be collected during a high flow event and tested for the suite of contaminants in 2019 FGS Sediment Study. In the unlikely event that elevated dissolved concentrations are found, additional sampling or an investigation into the upstream sources may be warranted.

This request pre-dates the summer algal bloom on Lake Munson as Mr. Terry Ryan, a member of the Workgroup, has been advocating for point-source contaminate testing based on the 2019 FGS Sediment Study. Since the algal bloom this summer, some members of the Workgroup have conflated the contaminated sediment in the lakebed with the toxicity of the algae and the algal blooms. However, the 2019 Sediment Study contradicts this assertion. Algae grows when there is an abundance of nitrogen in the system and blooms occur when the algae grow rapidly. Environmental factors such as sunny days, warm water temperatures, low rainfall amounts, still water conditions can also cause algae to rapidly grow and accumulate, resulting in an algal bloom. While the sediments may release nutrients into the water column, this is not the case for the contaminants in the sediment. The contaminants are tightly bound to sediment and are not releasing into the water column.

The Lake Munson Workgroup welcomed the point-source testing for PCBs but sought for the County to conduct ongoing tests. The 2019 FGS Sediment Study, which the Workgroup relies upon as the basis to perform testing, states that, "Upstream sampling may help to identify the source(s) of those contaminations" (emphasis added). Should the testing at the four locations confirm that the sediment contaminants are not resulting in water column contamination, it would confirm the recent studies and ongoing testing would be unnecessary. Future tests may be warranted and performed by the County based on new information or changes to the conditions of the Lake.

Upstream sampling generally refers to the stormwater conveyance systems owned and maintained primarily by the City of Tallahassee. The East Drainage Ditch and Munson Slough enter City limits just east and just north of Lake Henrietta. The point-source testing requested by the Workgroup include water column or sediment testing starting at Lake Henrietta and continuing upstream in every direction until the contaminants are no longer detected, indicating the location the contaminants entered the system.

The Workgroup continues to reference one paragraph in the summary of the Sediment Study which states, "Lake Henrietta was constructed in 2000 and is periodically dredged, thus its sediments were recently deposited. The contaminants detected in Lake Henrietta's sediments are therefore from continuing sources. Upstream sampling may help to identify the source(s) of those contaminants."

There are issues with not interpreting the Sediment Study and the Terracon Report holistically. This paragraph contains an error that was inadvertently not corrected prior to final publication. Lake Henrietta has not been dredged since construction in 2000; therefore, deposited sediments are unlikely to be recent. The Workgroup is neglecting to look at the prior two paragraphs of the Sediment Study which provides data that suggests the contaminants are tightly attached to the sediment and will not leach off into the water column. While upstream sampling *may* help to identify the source, the necessity for upstream sampling was challenged in the Terracon Report. The Terracon report states, "This information indicates that upstream sampling is unwarranted as the data suggests the system is working as intended and serving as a filter for Lake Munson."

The use of PCBs has been banned since 1979 and the use of heavy metals are regulated such that they are only allowed in small concentrations. The Terracon Report determined that the contaminated sediment accumulated from activities prior to the mid-1990s and are still detectable due to how slowly they break down. The PCBs found in the sediment are likely relic contaminants prior to current regulations or may have been transported from upstream and upwind during development activity in the last few decades. Significant development and construction activity have occurred upstream of Lake Munson, which provided ample opportunities for potentially contaminated soil to be exposed, rained upon, and carried downstream. The 2019 FGS report was provided to, and discussed with FDEP, and no recommendations for further sampling were made.

During the September SAC meeting, the environmental advocates' request for upstream point-source sampling was discussed. The SAC suggested sampling the water flowing into Lake Munson for dissolved concentrations of contaminants. This testing would validate the 2019 FGS Sediment Study and the Terracon Report to prove the contaminants are not contributing to water column contamination. County staff have developed a single event sampling plan. Samples will be collected from four sites, including upstream of the Lake, in Lake Munson, and downstream of the Lake. The samples will be collected during a high flow event and tested for the suite of contaminants in 2019 FGS Sediment Study. In the unlikely event that elevated dissolved concentrations are found, additional sampling or an investigation into the upstream sources may be warranted. This sampling plan is not in conjunction with the drawdown or any lake management plans, because the contaminants are a different issue than the current lake concerns.

The County plan includes water column testing instead of sediment testing. The sediment in Lake Munson and Lake Henrietta has been sampled and is known to contain PCBs and other contaminants. Additional sampling in these areas provides no worthwhile information. While sediment samples could be tested upstream of Lake Henrietta, only one sample could be taken before entering the city limits. One sample would also not provide useful information and does not accomplish the upstream point-source tracing desired by the environmental advocates.

Based on conversations with the Workgroup and the environmental advocates, it appears the root of the issue in the requests for the upstream sampling is the concern that the contaminants are producing the toxic algae. By testing the water column, worthwhile

information can be provided demonstrating contaminants are staying bound to the sediment and do not pose a threat to people, pets, or wildlife.

This contaminant sampling plan was discussed with the Workgroup during the meetings. The Workgroup does not approve of the County's plan. They would like year-round testing, similar to the County's water quality monitoring program. The Workgroup is also adamant about the upstream point-source tracing of the contaminants, despite being provided information suggesting it is not necessary.

Although at this time only a single sampling event is planned, the County is receptive to one or more follow-up sampling events after the lake refills, and under different lake and flow conditions.

7. *Intermediate Term: We would like a workshop on cyanobacteria, its health effects, and how to combat this problem going forward, and create policies for blooms county-wide.*

Response: As described throughout the agenda materials, FDOH is the lead agency to address the health effects of cyanobacteria algal blooms throughout the state. FDOH has procedures in place for assessing public health conditions related to algal blooms and a dedicated web page providing information their natural occurrence in Florida, precautions residents should take for themselves and their pets, and FAQs. FDOH-Leon was able to participate in one of the meetings with the Lake Munson Workgroup and respond to specific questions about the health effects of algal blooms and the agency's procedures. At that time, FDOH-Leon had only been made aware of two residents experiencing exposure-related symptoms and agreed to mail out educational materials to residents living near the Lake. Since the algal bloom is no longer toxic, FDOH-Leon did not find the requests for door-to-door outreach or a town hall meeting to be warranted at this time.

Lake Munson Workgroup members specifically requested both FDOH-Leon and Leon County Government provide financial assistance to residents having incurred medical expenses and/or experiencing physical ailments associated with the algal blooms. Both FDOH-Leon and Leon County Government denied consideration of the request for financial compensation and reiterated that algal blooms are naturally occurring events which tend to formulate in warm and stagnant waters. Further, the County maintains that Lake Munson, as a waterbody of the State, is the legal responsibility of the State of Florida under the administrative and regulatory auspices of the FDEP. The County is responsible for its conveyance systems to the Lake and, at times, has coordinated the State's in-Lake mitigation efforts (drawdowns, etc.).

While FDOH's position at this time is that exposure to algal blooms may result in nuisance health effects including temporary respiratory issues and irritations of the eyes, nose, and skin, it is important to note that additional research is underway at the federal and state levels to better understand this issue. The U.S. Centers for Disease Control is conducting surveillance studies on human and animal illnesses that are associated with exposures to cyanobacteria algal blooms and the State of Florida is utilizing four universities to improve the understanding of potential human health impacts of algal blooms and red tide. Through

FDOH, the State provided $650,000 to four universities in 2019 for ongoing studies on the prevention of toxic algal blooms, treatment for exposed individuals, health disparities related to the exposure of toxins, and better screening to quickly detect toxic blooms.

Based on FDOH's role as the lead agency to address the health effects of cyanobacteria algal blooms throughout the state and the ongoing academic research in environmental and human health, this analysis finds that a Board workshop would not be a productive venue to address the health effects of cyanobacteria.

The Workgroup also requested the County explore the creation of policies and response protocols for algal blooms including the closure of Gil Waters Preserve at Lake Munson. The County closed the boat ramps at Gil Waters Preserve to prevent access to Lake Munson, however, the park remained open to the public with signage advising patrons about the algal bloom. Since the algal bloom toxins can be aerosolized and blow onshore, the Workgroup is seeking the closure of County parks which may be adjacent to future toxic blooms.

Red tide is a saltwater algal bloom that can also be aerosolized and blown onshore resulting in the same temporary symptoms freshwater algal blooms. Both are generally considered seasonal and people with preexisting respiratory conditions are advised to avoid proximity with both types of algal blooms. However, the beaches remain fully open during a red tide and there is no prohibition for swimming.

The best course of action related to County parks is to rely on the subject matter experts at FDEP and FDOH to determine the necessary precautions associated with an algal bloom and respond as needed on a case-by-case basis. The State agencies responsible for testing and interpreting the lab data are charged with identifying the level of toxicity and issuing caution advisories or alerts based on their findings. As with any potential danger in a County facility, including parks, the County facilities would be closed to the public.

8. *Intermediate Term: We want the county to bring back another fertilizer ordinance agenda item to consider wet-season bans as instituted by other counties on the forefront of water quality issues.*

<u>Response</u>: On May 11, 2021, the Board adopted an amendment to the County's Fertilizer Ordinance modeled after the State Model Fertilizer Ordinance. The County's Fertilizer Ordinance includes a provision that goes beyond the Model Ordinance and imposes a "fertilizer time-out" in advance of storms forecasted to produce a certain amount of rain. The Workgroup's request seeks the Board's reconsideration of the County's Fertilizer Ordinance which was adopted less than 18 months ago at a Public Hearing.

By prohibiting the use of fertilizer in advance of a storm, the Ordinance prevents fertilizer from washing off lawns and into waterbodies when it rains. The Workgroup is seeking a months-long wet-season ban to use fertilizer. This alternative was included in the agenda materials and discussed by the Board prior to the adoption of the existing Ordinance. The Board preferred the targeted approach of the "fertilizer time-out" before a rainfall event

instead of the full wet-season ban during the summer months. Of the 67 counties in Florida, only 17 counties have a fertilizer ordinance that includes the requested wet season ban. The Workgroup did not provide any new information to support the need to revisit the Ordinance. Revision of the fertilizer ordinance is not recommended.

9. *Intermediate Term: We want public education about cyanobacteria, including involving the health department, mailers, and/or door to door outreach, and to catalogue human health effects. Tackling this problem is multifaceted and will include strengthening testing and changing development regulations.*

   Response: Staff has been working in close coordination with FDOH-Leon since the presence of algal blooms (without toxins) was discovered in Lake Munson in early May. While algal blooms can occur with or without toxins, a laboratory analysis from a subsequent water sample found "low level toxins present" in Lake Munson. The state determined that the algal bloom produced a microcystin toxin and FDOH-Leon issued a health alert for residents to avoid contact with the water. The health alert specifically advised residents to not drink, swim, wade, use a personal watercraft, or boat in Lake Munson. It also warned residents to keep pets away from the area and offered FAQs including, "Is blue-green algae harmful?" The FAQs provided links to state agency websites for additional information. For broader dissemination of this important alert, Leon County Community and Media Relations disseminated the FDOH-Leon alert across the County's digital platforms.

   Algae blooms including red tide and blue green algae are generally considered health nuisances. The smell can cause temporary respiratory issues and irritations of the eyes, nose, and skin. The World Health Organization considers the presence of low-level toxins (under 10 micrograms/liter) to represent a low-level risk for adverse health outcomes from short-term recreational exposure; however, certain sensitive populations (e.g., children, the elderly and immunocompromised populations) may still be at risk even at low concentrations and should avoid any exposure. During the algal blooms this summer that with microcystin toxins detected, most of the samples collected had levels less than 0.5 micrograms/liter. One sample in mid-May detected toxin at 1.1 micrograms/liter. The State has processes and procedures for assessing public health conditions related to algal blooms. Physicians and medical laboratories in Florida are required to report conditions of public health importance to FDOH. Should physicians observe and report dangerous medical conditions, epidemiologists at FDOH will determine the appropriate public health response (public educational outreach, further medical assessment, isolation, etc.).

   During the summer months while the toxins were still present, members of the Lake Munson Workgroup requested FDOH-Leon to mail educational materials to residents about cyanobacteria, conduct door-to-door outreach, and gather information from residents on their symptoms related to the algal blooms. FDOH-Leon was not responsive to the Workgroup's initial requests until the newly appointed FDOH-Leon Health Officer, Ms. Brandi Knight, was contacted by the Workgroup in mid-July. Upon looking into the matter further, Ms. Knight found that FDOH-Leon had only been made aware of two residents reporting exposure-related symptoms which, by definition, are not generally considered

harmful to a person's health. Further, FDOH-Leon lifted the health alert for blue-green algal toxins a few days later which negated any consideration of door-to-door efforts since Lake Munson no longer had an active toxic bloom.

Ms. Knight participated in a Workgroup meeting hosted by the County and agreed to mail out educational materials this month to residents living near Lake Munson. Ms. Knight also informed the Workshop that FDOH-Leon would consider door-to-door outreach in the future if there were enough reports of adverse health impacts and the toxic bloom was still ongoing. The purpose of the outreach would be to educate residents, perform epidemiologic investigations, and provide general medical guidance to avoid the water, wear long sleeves for sensitive skin, and remain indoors if necessary.

FDOH and FDEP have dedicated web pages and educational materials providing information on the natural occurrence of algal blooms in Florida and the precautions residents should take for themselves and their pets. Attachment #6 provides a sample of the online educational materials available through multiple state agencies. At the time of this writing, the toxins have not been present in Lake Munson for 2.5 months. On July 21st, FDOH-Leon lifted the health alert for blue-green algal toxins at Lake Munson based on water samples collected by FDEP. FDOH-Leon advised the public may resume water-related activities and to continue to exercise caution on the lake as algae blooms can move around, subside, and reappear when conditions are favorable.

With regard to the Workgroup's request to change development regulations, no specific suggestions were immediately offered to enhance water quality, so a brief overview of the County's Land Development Code (LDC) was provided at the subsequent meeting. The County can enact regulatory measures which help reduce the amount of nutrients entering waterbodies. The County's Environmental Services Director provided an overview of the County's LDC which provides for the regulations, procedures, and standards for the review and approval of all development and use of land in the unincorporated portions of the County.

Staff addressed concerns from the Workgroup regarding perceptions that the LDC and Environmental Management Act (EMA) are not as stringent as other Florida counties with regard to stormwater protection standards. Specifically, the question arose about whether the EMA should be amended to require preservation of 40% of the vegetation on-site for proposed developments within the County. The County's Environmental Services Director informed the Workgroup that the LDC already contains open space/landscape area standards with some requiring as much as 60% set-aside open space for certain development in Lake Protection, and 50% of set-aside in perpetual conservation easement for conservation subdivisions. Staff provided additional information on the County's EMA requirements related to landscape and natural minimum areas which can be mitigated if projects are designed in a manner that account for the natural features on-site.

Members of the Workgroup were pleasantly surprised upon learning of the existing land development regulations in place and moved on to discuss other issues.

10. *Intermediate/Long Term: We want to involve Blueprint's Capital Cascades 4 as a solution to fixing the lake going forward. There needs to be an active, ongoing discussion about these environmental issues and how to address Munson at the BPIA. This includes the board requesting an agenda item for discussion.*

    Response: The Capital Cascades Trail is a multi-faceted network of stormwater and recreation facility projects separated into physically distinct segments stretching from Leon High School south to the Lake Henrietta stormwater facility. Managed by Blueprint, the first two segments have already been completed and Segment 3, which includes Coal Chute Pond along the FAMU Way Corridor, is currently under construction. Capital Cascades Trail Segment 4 will remove sediment and trash and improve downstream water quality in the Lake Munson water basin. The improvements will begin at the convergence of two stormwater conveyance systems (Central Drainage Ditch and St. Augustine Branch) near FAMU Way and extend south to Lake Henrietta at Springhill Road. Blueprint staff anticipates bringing an agenda item back to the Intergovernmental Agency Board in March 2023 seeking acceptance of the design concepts so that the project can proceed to the final design and permitting phase. Capital Cascades Trail Segment 4 is funded at approximately $19 million and will complete the 4.25-mile stormwater treatment and amenity improvements as contemplated in the Capital Cascades Master Plan approved by the Blueprint Intergovernmental Agency Board (IA Board) on January 31, 2005.

    As noted previously in this item, staff met with Mr. Epstein over the summer to evaluate opportunities for an FDEP Innovative Technologies Grant to support water quality projects for Lake Munson. In addition to dredging the Lake bottom, Mr. Epstein has advocated for the acquisition of 125 acres of U.S. Forest Service property for the construction of a wetland on the western bank of the Lake to filter stormwater, similar to the Sweetwater Branch Sheetflow Restoration Project in Alachua County. As presented, neither of these two concepts are viable water quality projects for Lake Munson. For reasons explained throughout this item related to the FGS Sediment Study, in-lake sediment removal is no longer considered a mitigation option to reduce nutrient levels in Lake Munson. Disturbance of the existing sediment poses a contamination risk to the water and aquatic life. The concept to construct a 125-acre wetland was based on a project in Alachua County serving a smaller stormwater basin. The Lake Munson basin is about twenty times larger so a constructed wetland similar to the Sweetwater Branch system would have to be several times the size of the proposed 125-acre facility.

    During the Lake Munson Workgroup meetings in recent weeks, Mr. Epstein suggested expanding the scope of the upcoming Capital Cascades Trail Segment 4 project to include additional downstream improvements to benefit Lake Munson. Mr. Epstein was advised that the Segment 4 project area was established along the Central Drainage Ditch nearly 20 years ago, the improvements extend as far south as Lake Henrietta, and that his proposed improvements along the western bank of Lake Munson are more than two miles from the project terminus. The Capital Cascades Trail stormwater improvements were intended to address water quality and flood concerns in the heavily urbanized drainage system comprised of the St Augustine Branch and the southern end of the Central Drainage Ditch,

both of which are in the Lake Munson basin. All the modeling, analysis, designed and built projects to date have focused on these two stormwater conveyance systems.

On September 29, 2022, Mr. Epstein provided written and verbal comments to the IA Board seeking to extend the study area for Capital Cascades Trail Segment 4 to include a wetland treatment area along Lake Munson. The IA Board directed Blueprint staff to bring back an agenda item to develop a scope and estimated fee for a study that would consider a treatment facility on the west side of Lake Munson. The IA Board made it clear that it does not intend to slow down the conceptual design process for the Segment 4 project. The Lake Munson analysis agenda item will be brought back to the IA Board at its next meeting on December 8, 2022.

Conclusion

Lake Munson is a state-managed waterbody with a history of chronic water quality and ecological problems including fish kills, algal blooms, exotic vegetation and snails, high nutrient levels, low game fish productivity, sediment contamination, and depressed oxygen levels. The shallow and stagnant nature of the waterbody makes it susceptible to the growth of algal in the Lake resulting in this summer's bloom. The Lake receives surface water flow from a 32,000-acre basin, much of which is located in the City of Tallahassee, and has historically been subjected to drainage with high nutrient loads and wastewater discharges to the tributary system which has resulted in the embedding of legacy nutrients in the lake-bottom soil.

Significant efforts to improve the water quality and reduce the nutrient loading in Lake Munson have been ongoing since the 1990s and requires the continuous coordination among governmental partners with respect to our respective responsibilities to protect natural resources. The 1994 Lake Munson Action Plan has been used as the basis to guide watershed and stormwater improvements, regular testing and monitoring of water quality, and regulatory actions to limit pollutants and protect natural resources. Leon County Government, the City of Tallahassee, and the Blueprint Intergovernmental Agency have dedicated hundreds of millions of dollars for projects in the Lake Munson basin and prioritized upstream improvements which reduce the transport of sediment and benefit the Lake water quality. The County's SAC finds that the upstream improvements have resulted in lower concentrations of nitrogen and phosphorus flowing into the Lake meaning that the quality of incoming water is better than the water in Lake Munson. Munson Slough and Lake Munson are exceeding their State-mandated nutrient levels for nitrogen while phosphorus levels have declined significantly over the last ten years and are now approaching the target levels.

In recent years, the County, City and FDEP have invested millions of dollars and allocated future resources to address water quality through the reduction of household septic systems. In 2018, Leon County and FDEP jointly adopted a Springs Improvement Plan with both parties committing $32 million through FY 2024 for water quality and springs protection infrastructure projects. Lake Munson, and portions of the Munson basin, are within the primary springs protection zone which allows residents to be eligible for these voluntary wastewater projects which remove or upgrade conventional septic systems.

Despite the better water quality, in-lake mitigation, and investments in upstream infrastructure, Lake Munson continues to experience occurrences of fish kills, algal blooms, invasive vegetation

and snails, low game fish productivity, and depressed oxygen levels. Several of these conditions were experienced by Lake Munson residents this summer, resulting in concerns expressed by from residents and other stakeholders. On September 13, 2022, the Board directed staff to meet with a Workgroup made up of residents who live next to Lake Munson and other stakeholders to address their concerns about the Lake and to bring back an analysis of the Workgroup's ten requests posed to the County in writing. This information on the County's next steps to address the recent Lake conditions including those that were planned and, in some cases, those which came out of the meetings with the Workgroup are presented as the Lake Munson Action Plan.

This item and the proposed Action Plan provides an opportunity to better articulate the magnitude and duration of the past, ongoing, and long-term infrastructure projects to benefit the basin, the planned drawdown with more frequent water quality testing, an aerial topographic survey of Lake Munson to the measure elevations of compacted sediment to evaluate for future in-Lake mitigation strategies, a new vegetation management program for treating invasive plants, and implementing periodic drawdowns in consultation with FWC to reduce the need to mechanically remove organic-rich sediment. The Action Plan captures recommendations sought by the Workgroup including the deployment of hydrogen peroxide to treat algal blooms, point-source testing for PCBs, ongoing engagement over the next two years to evaluate the Lake's response to the drawdown, and regular status updates to the Board every six months. This holistic approach will allow the County to quickly mitigate the rapid growth of hydrilla and eliminate the algal bloom while the long-term lake management actions will supplement the State's chemical treatment services and provide a higher level of service to County residents.

The drawdown plan and treatments for Lake Munson are estimated to cost $130,000 in FY 2023. Funding is included in a separate agenda item as a carry-forward for these purposes. The annual recurring costs for FY 2024 will be included in the Public Works Operating Budget.

While the Lake continues to improve, undoing decades of damage will take continuous commitment. Over the next two years, the Action Plan calls for the SAC to receive an update on the drawdown and review the available enhanced sampling data on a quarterly basis, invite the Workgroup to participate in the quarterly SAC meetings to discuss the available samping data and drawdown progress, and for staff to prepare six-month status reports to the Board on the progress at Lake Munson throughout the drawdown phase. The drawdown is proposed for November 1st, or sooner if possible, following adequate notice to the public.

Options:

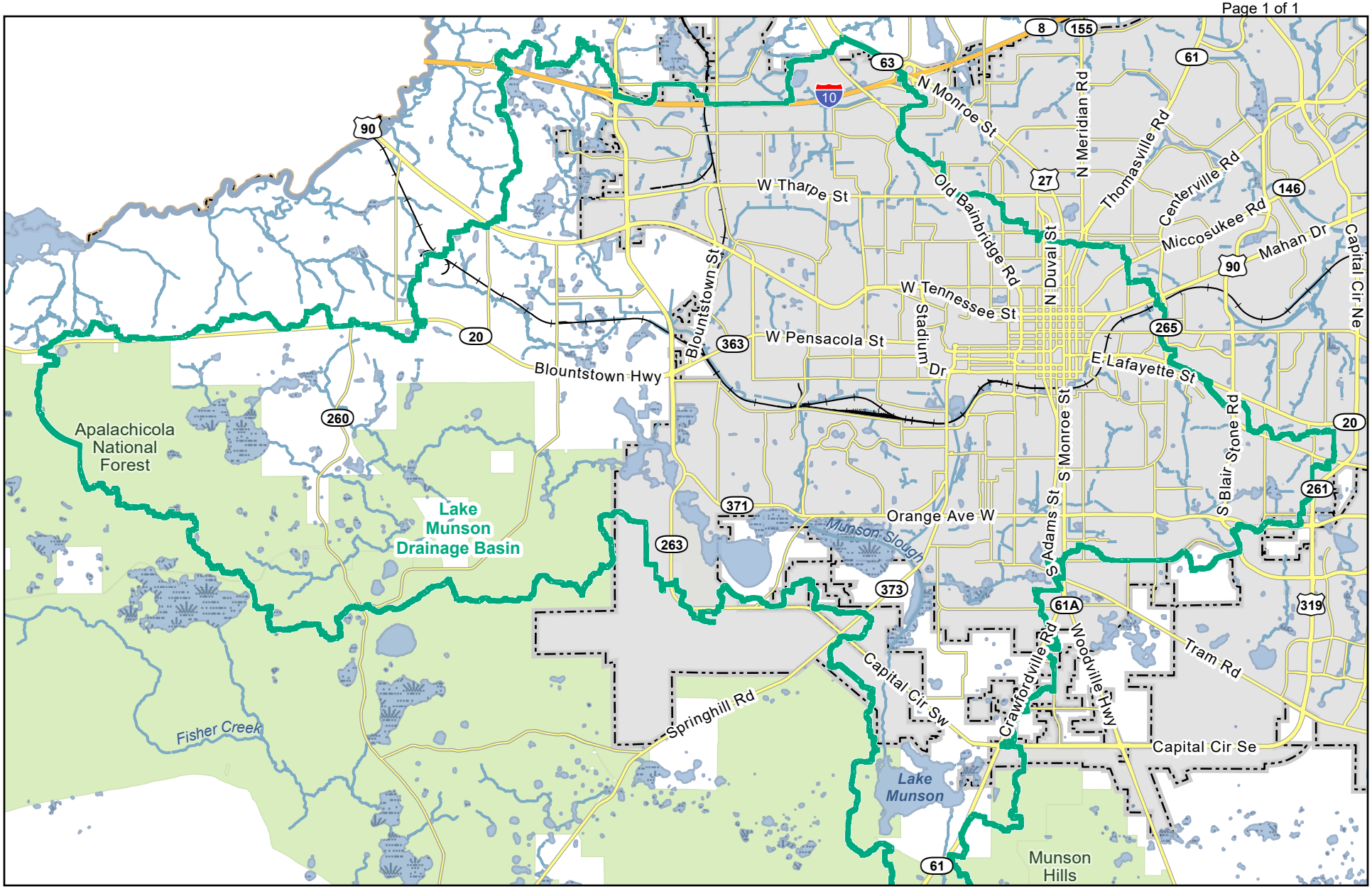
1. Accept the Status Report on Best Management Practices for Lake Munson.
2. Approve the Lake Munson Action Plan, presented herein, including the immediate drawdown plan.
3. Board direction.

Recommendation:

Options #1 and #2

Attachments:

1. Lake Munson Drainage Basin Map
2. Lake Munson Map
3. Projects List and map
4. Graphs of Nitrogen and Phosphorous concentrations
5. Ongoing and planned infrastructure projects within the Lake Munson Basin
6. FDOH and FDEP educational material



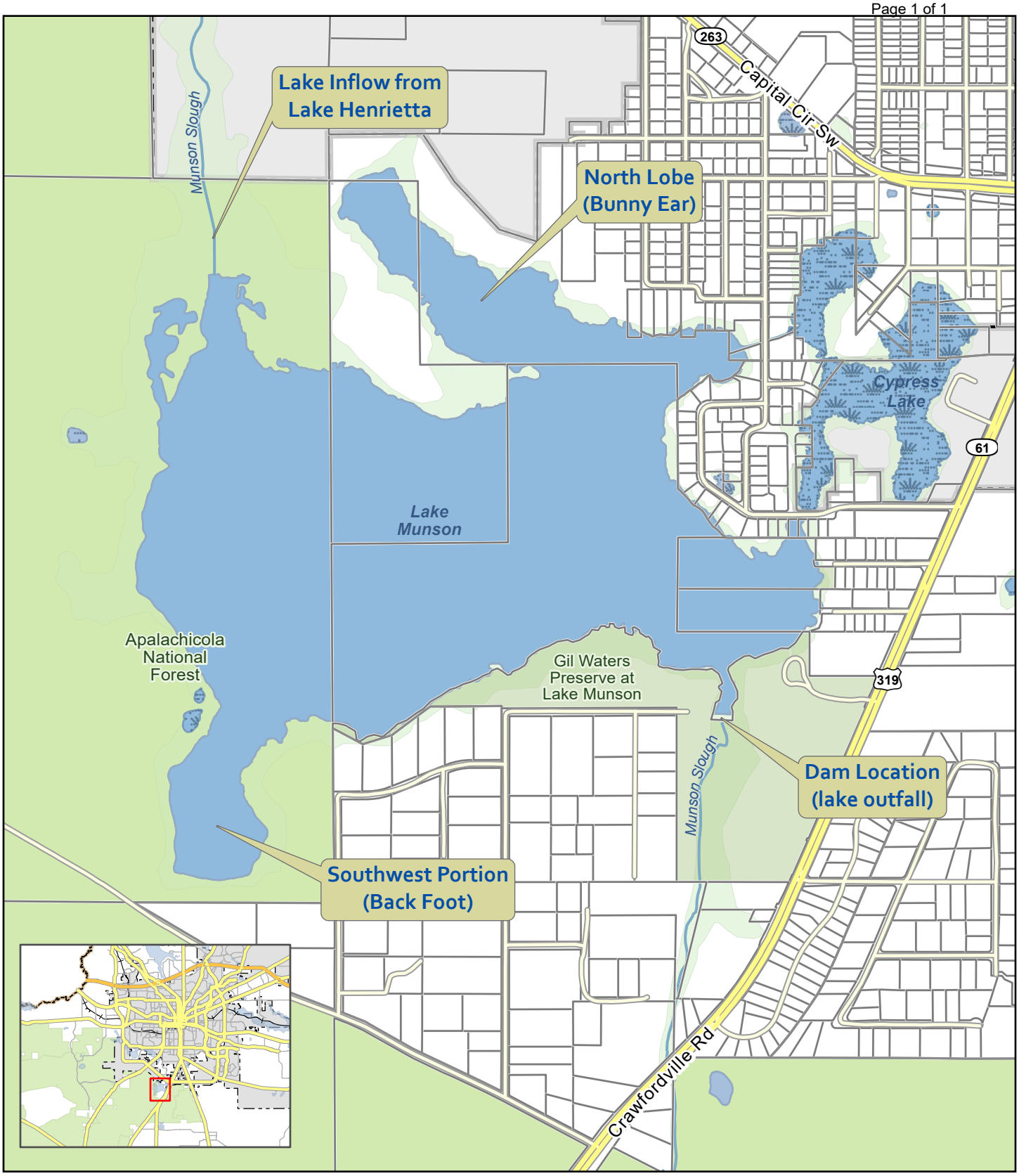
This product has been compiled from the most accurate source data from Leon County, the City of Tallahassee, and the Leon County Property Appraiser's Office. However, this product is for reference purposes only and is not to be construed as a legal document or survey instrument. Any reliance on the information contained herein is at the user's own risk. Leon County, the City of Tallahassee, and the Leon County Property Appraiser's Office assume no responsibility for any use of the information contained herein or any loss resulting therefrom.

- Lake Munson Basin
- Wetland
- Lake
- Tallahassee City Limit

N

Lake Munson Drainage Basin

Date Drawn: 9/20/2022



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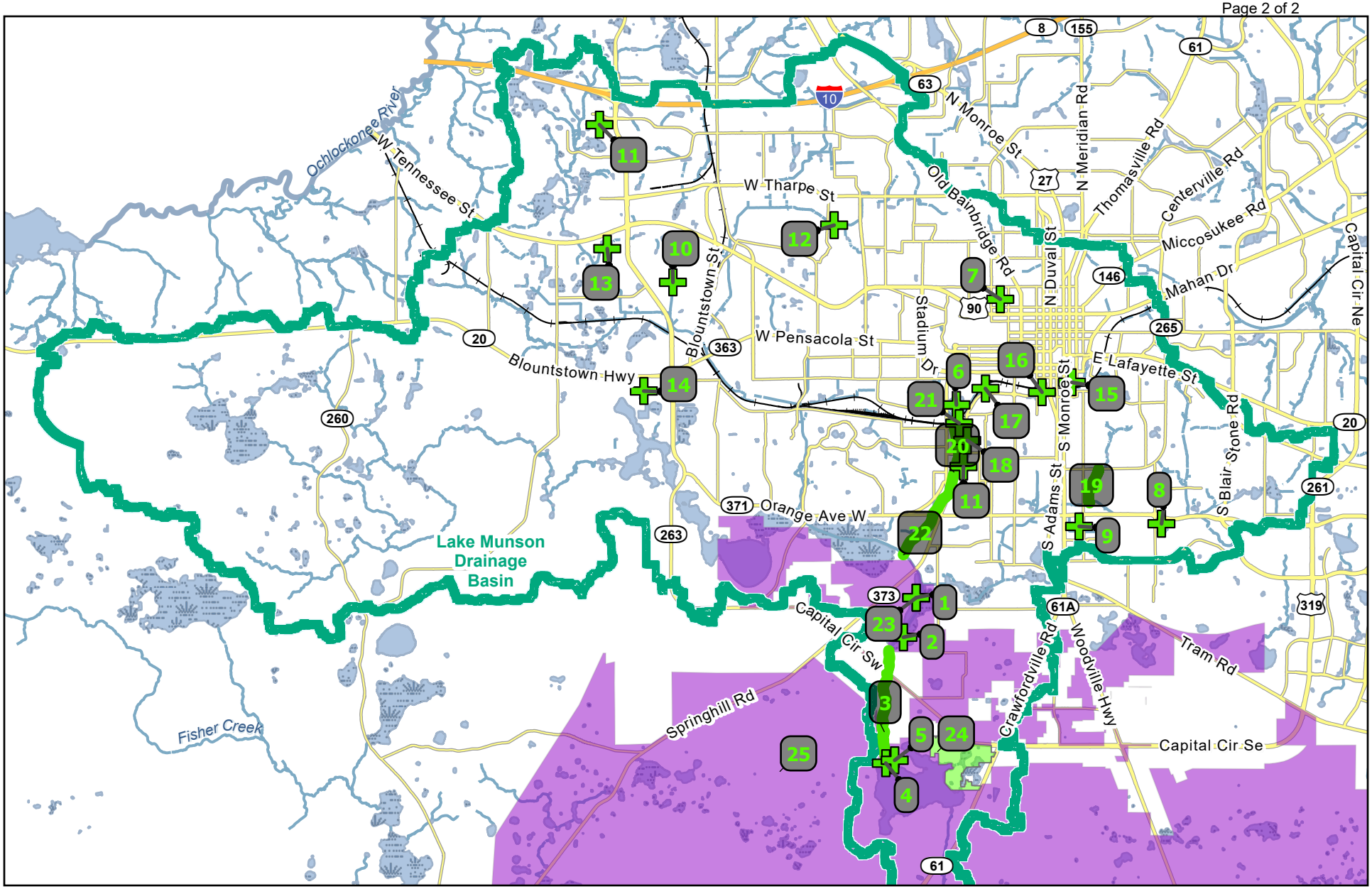
Lake Munson

N

Date Drawn: 9/19/2022

Past Projects in Lake Munson Drainage Basin		
Map Number	**Project Name**	**Agency**
1	Lake Henrietta Restoration	Leon County
2	Lake Henrietta Wetlands Restoration	Leon County
3	Munson Slough Restoration	Leon County
4	Lake Munson Delta Sediment Removal	Leon County
5	Lake Munson Wetlands Restoation	Leon County
6	Lake Elberta	Tallahassee
7	Carter-Howell-Strong Park	Tallahassee
8	Jim Lee Road Facility	Tallahassee
9	Orange Avenue Facility	Leon County
10	Gum Creek Watershed Management Program	Leon County
11	Hopkins Crossing Wetland Preservation	Leon County
11	Bond Stormwater Facility	Blueprint
12	San Luis Park	Tallahassee
13	Martha Wellman Facility	Leon County
14	Broadmoor Stormwater Facility	Blueprint
15	Cascades Park	Blueprint
16	Lake Anita	Blueprint
17	Coal Chute Stormwater Facility	Blueprint
18	Tallahassee Junction Facility	Blueprint
19	Country Club Creek Drainage Improvements	Tallahassee
20	Lower CDD Erosion Control	Tallahassee
Ongoing and Future Projects in Lake Munson Drainage Basin		
Map Number	**Project Name**	**Agency**
21	3D-B Regional Stormwater Facility	Blueprint
22	Capital Cascades Segment 4	Blueprint
23	Lake Henrietta Sediment Removal	Leon County
24	NE Lake Munson Sewer	Leon County
25	Advanced Septic Incentive Program	Leon County



NE Lake Munson Sewer Project (24)

Septic Upgrade Projects (25)

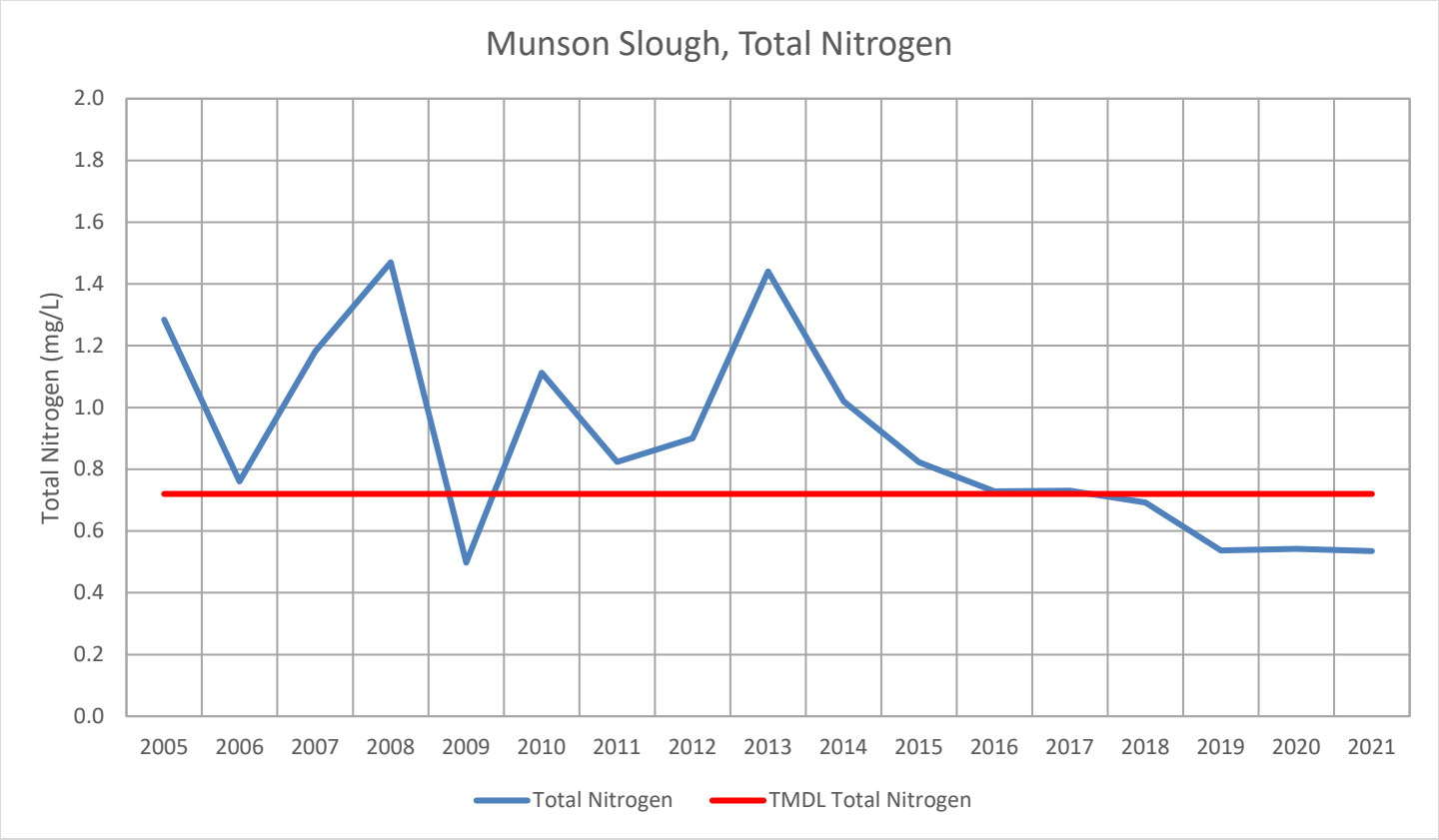
Munson Projects (Line)

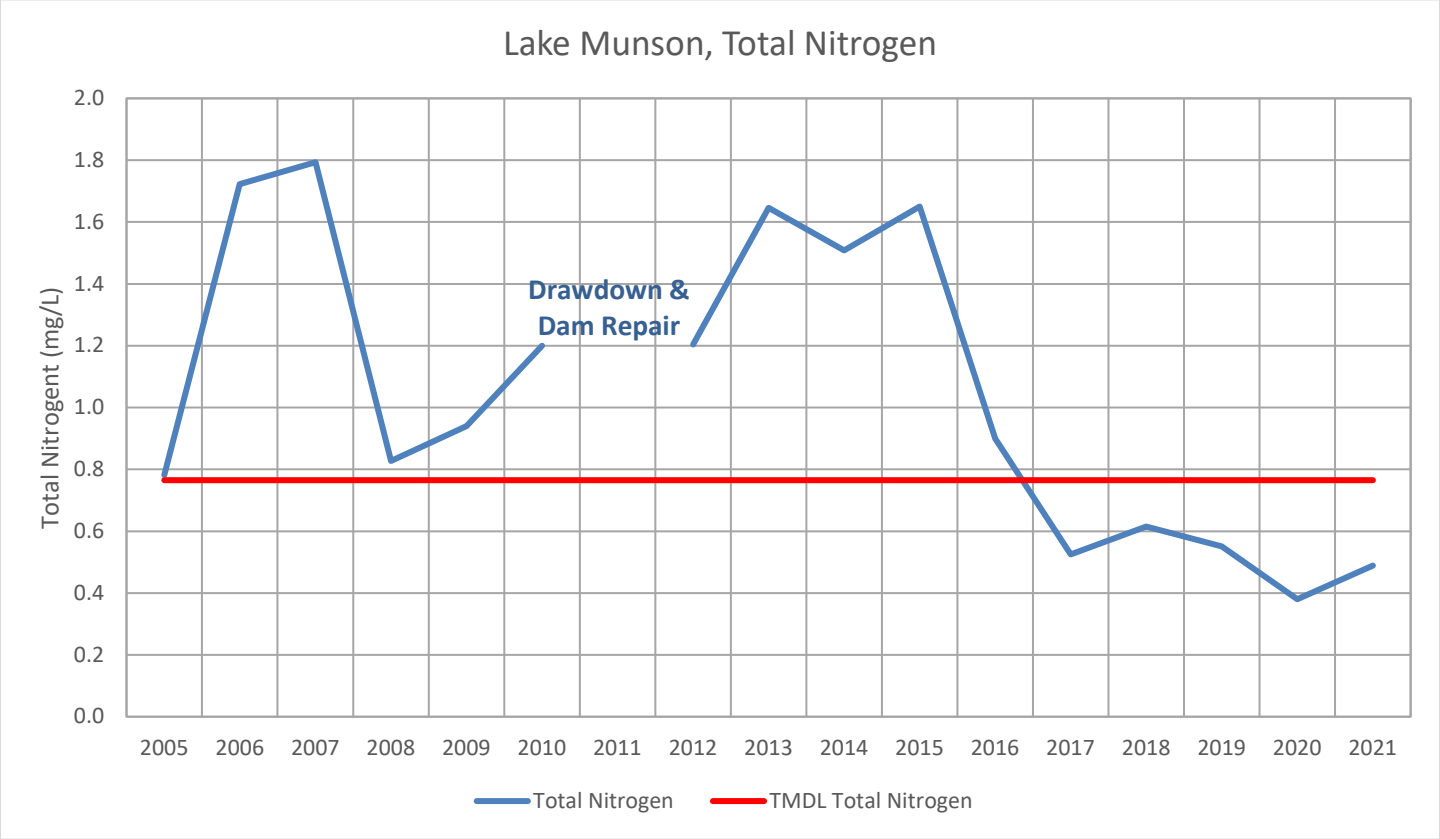
N

Lake Munson Drainage Basin Past, Ongoing, and Future Projects

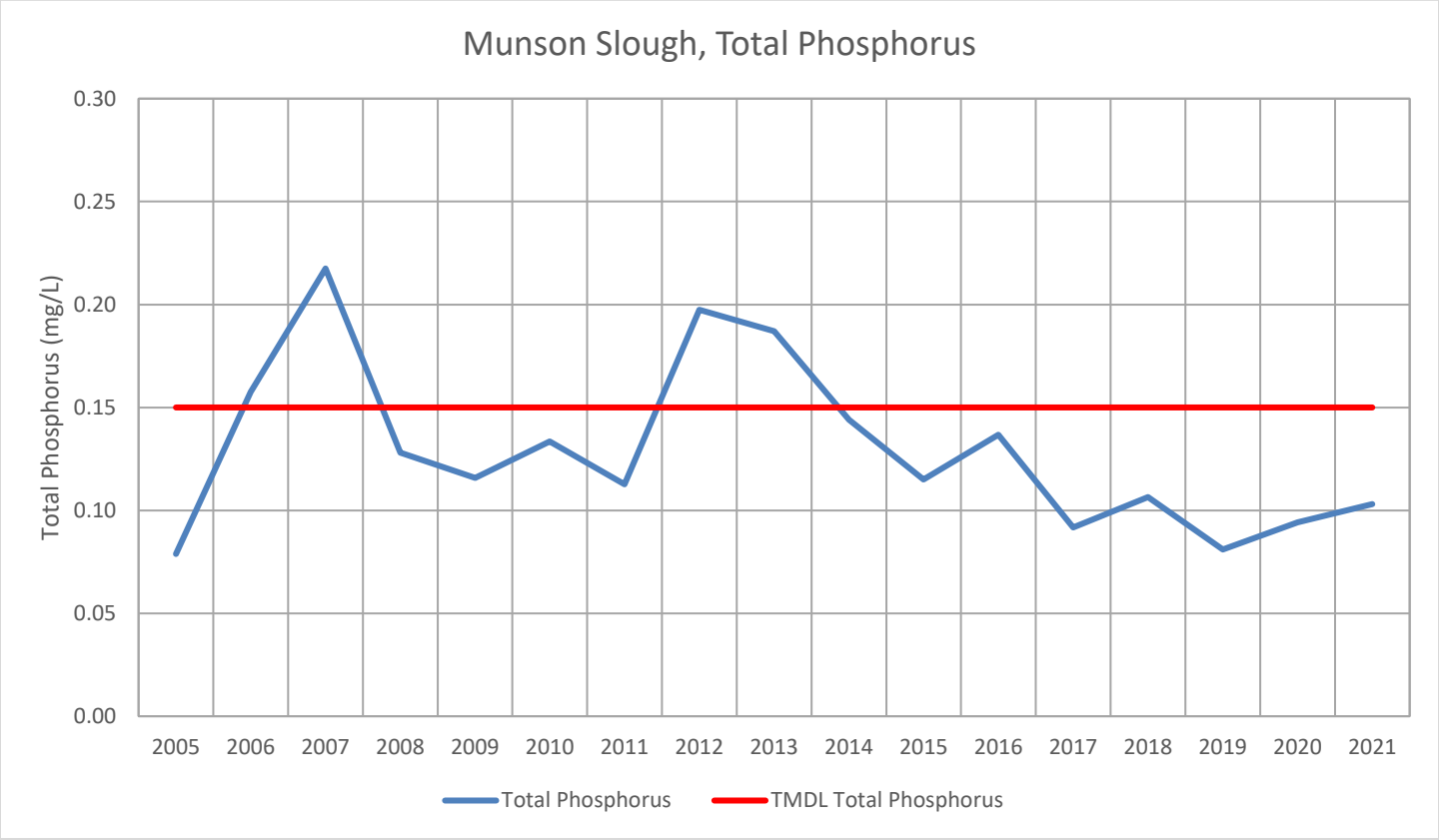
Date Drawn: 10/5/2022

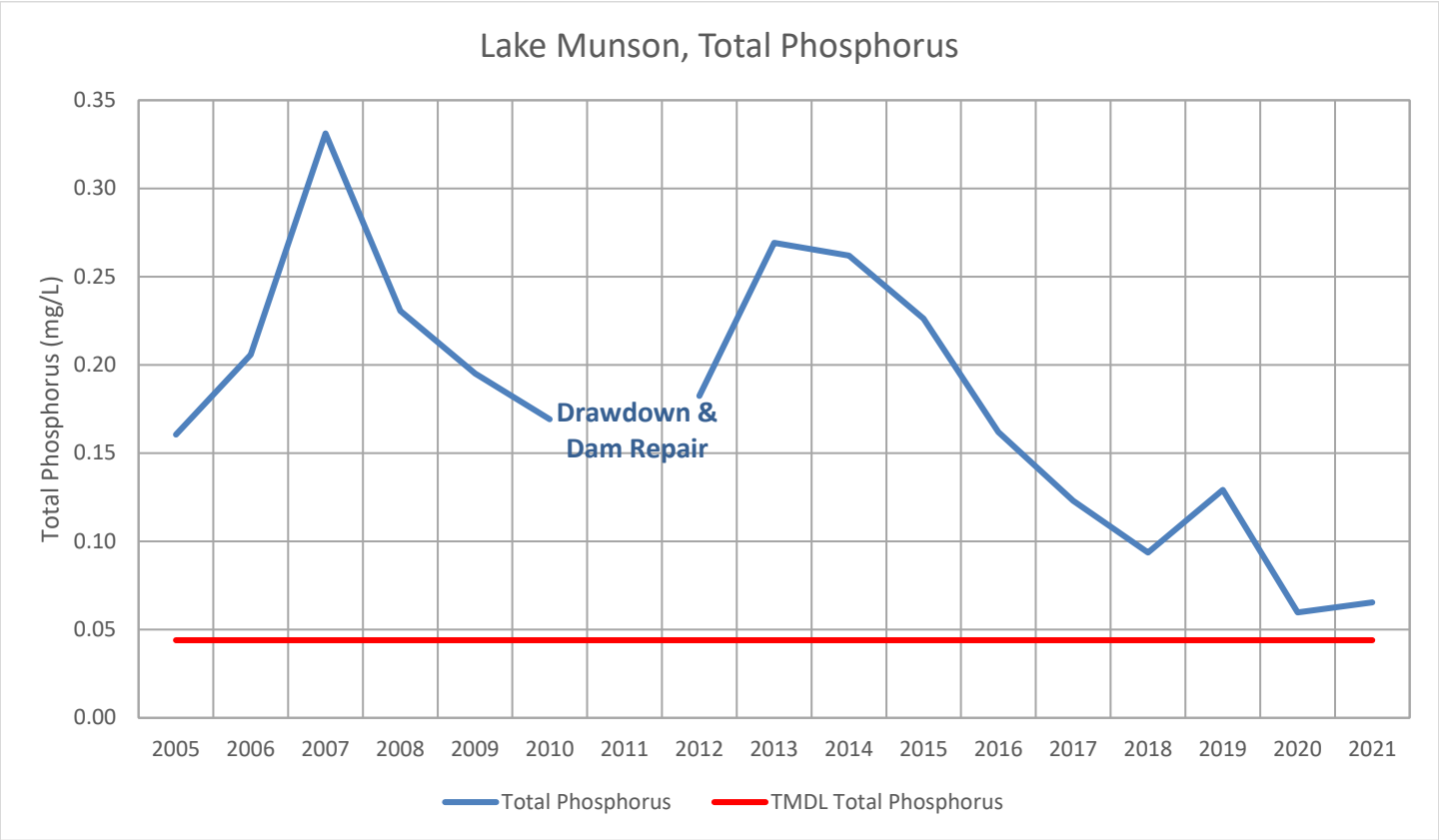
Annual Average Nitrogen Concentrations





Annual Average Phosphorus Concentrations





ONGOING AND PLANNED LEON COUNTY INFRASTRUCTURE PROJECTS

ADVANCED SEPTIC PILOT PROJECT

- $1.5 million FDEP grant
- Design and construction
- Wakulla Springs PFA
- Upgrade existing septic systems to INRB systems
- 49 sites complete – Anticipate 35 more

COMPREHENSIVE WASTEWATER TREATMENT FACILITIES PLAN

- $500,000 FDEP grant
- Study on best type of advanced nitrogen-reducing treatment
- County-wide
- Identifies target areas for future projects
- Provides treatment recommendations on a parcel by parcel basis

NE LAKE MUNSON SEPTIC TO SEWER

- $12.1 million ($4.6 FDEP grant / $7.5 local match)
- Design and construction
- Central sewer in neighborhoods adjacent to Lake Munson
- 220 properties
- Construction to start this Fall

SEPTIC UPGRADE INCENTIVE PROGRAM

- $1.11 million FDEP grant
- Design and construction
- Wakulla Spring PFA
- Upgrade existing septic systems to advanced nitrogen removing technology
- Nearly 150 sites

FDEP INNOVATIVE TECHNOLOGIES GRANT *(If Awarded)*

- $186,000 FDEP grant
- Design, implementation, after-action report
- Pilot project to test capability of BioChar at removing dissolved nitrogen
- Anticipate grant agreement spring 2023
- Implementation anticipated summer 2023

KEY

LEON COUNTY

CITY OF TALLAHASSEE

BLUEPRINT

LOWER CENTRAL DRAINAGE DITCH EROSION CONTROL

- Over $9.1 million
- Springhill Road upstream to the FAMU Way extension
- Armors channel banks and protects adjacent properties from erosion
- Eliminates ditch erosion
- Reduces phosphorus in Lake Munson
- Completed Spring 2020

SOUTH CITY/COUNTRY CLUB DRAINAGE IMPROVEMENTS

- Country Club Creek upstream of the East Drainage Ditch
- Improve conveyance and reduce sediment
- Decreased flooding
- Completed in Spring 2020
- Over $2.5 million

LAKE HENRIETTA SEDIMENT REMOVAL

- $2 million ($1.6 million Federal grant / $400,000 local match)
- Design and construction
- Remove approximately 20,000 cubic yards of sediment
- Restore to original design
- Design to start this fall
- Construction anticipated in 2023

BLUEPRINT CAPITAL CASCADES SEGMENT 4

- Includes water quality and stormwater improvements
- Currently in design
- Construction anticipated in Spring 20224
- Estimated $20 million total project cost

BLUEPRINT 3D-B REGIONAL STORMWATER MANAGEMENT FACILITY

- Regional stormwater management facility
- Water quality treatment
- Trash capture
- Estimated completion end of 2022

LAKE MUNSON BASIN PROJECTS 2018-2024

2018

Advanced Septic Pilot Project
49 Septic Systems upgraded to-date
BEGAN SEPTEMBER 2018

Comprehensive Wastewater Treatment Facilities Plan
BEGAN JUNE 2019

2019

Florida Geological Survey (FGS) Sediment Study
COMPLETED JUNE 2019

2020

South City/ Country Club Creek Drainage
COMPLETED APRIL 2020

Lower Central Drainage Ditch Erosion Control
COMPLETED MAY 2020

Blueprint 3D-B Regional Stormwater Facility Construction
BEGAN JANUARY 2021

2021

Blueprint Capital Cascades Segment 4 Design
BEGAN SEPTEMBER 2021

2040 Master Sewer Plan Approved
OCTOBER 2021

NE Lake Munson Septic to Sewer Design & Permitting
COMPLETED OCTOBER 2022

2022

Lake Munson Drawdown
BEGINS NOVEMBER 2022

Septic Upgrade Incentive Program
Nearly 150 Septic Systems to be upgraded
BEGINS NOVEMBER 2022

Lake Munson Management Plan
BEGINS OCTOBER 2022

NE Lake Munson Septic to Sewer Construction
Serves 220 parcels
BEGINS DECEMBER 2022

2023

Lake Henrietta Sediment Removal
BEGINS JANUARY 2023

FDEP Innovative Technologies Grant
(If Awarded)
BEGINS MAY 2023

2024

Blueprint Capital Cascades Segment 4 Construction
BEGINS MARCH 2024

Leon County Basin Management Plan Updates
ANTICIPATED TO BEGIN 2023

KEY
LEON COUNTY
CITY OF TALLAHASSEE
BLUEPRINT

Keep Your Pet Safe From Harmful Algal Blooms in Florida

What are algal blooms?

Algal blooms occur when algae, which are usually found in water, multiply very quickly. In Florida, algal blooms can be found in our fresh water, salt water and brackish water bodies. Algal blooms are temporary and can occur at any time but tend to occur most commonly in Florida in late summer and early fall.

An algal bloom may have the following features:

- Discoloration of the water such as green, blue, brown or red
- Look like foam, scum, mats or paint on the surface of the water
- Smell bad
- Have dead fish in or around the water

What are harmful algal blooms?

Harmful algal blooms occur when there is rapid growth of certain types of algae which can cause harm to people, animals or the local environment. The harmful algal blooms of most concern to human and animal health are those that produce toxins. It is not possible to tell if there are toxins associated with the bloom just by looking at it.

In fresh water such as lakes and rivers, the most common harmful algal blooms are caused by cyanobacteria, sometimes called blue-green algae. In salt water, an example of a harmful algal bloom is red tide that may be found in the Gulf of Mexico.

Why are harmful algal blooms important to my pet's health?

Toxins can be produced by harmful algal blooms which can cause serious illness and death in animals. Illness and death in Florida dogs have been linked to exposure to harmful algal blooms.

How can my pet get sick from harmful algal blooms?

Dogs can be exposed by swimming in or drinking water that contains harmful algal bloom toxins. Some dogs may also be attracted to the smell and taste of algae. They may eat scum, foam or dead fish in or around the water that contains toxins. In addition, dogs may also lick algae off their fur after swimming.

What symptoms might my pet have?

Symptoms in dogs normally occur within a few minutes to days of exposure to toxins from harmful algal blooms. Symptoms in dogs can include:

- Lack of energy
- Not eating
- Vomiting
- Diarrhea
- Yellow eyes or gums
- Bruising
- Dark urine
- Weakness, stumbling
- Tremors, seizures
- Difficulty breathing
- Excessive drooling

What should I do if I suspect my pet has been exposed to harmful algal blooms?

If your dog swam in an algal bloom, wash your dog off with clean water immediately. If your dog drank any water with an algal bloom or has eaten any material near the algal bloom, please call a veterinarian immediately, especially if they are showing any signs of illness. You may also call the ASPCA Animal Poison Control Center at 1-888-426-4435 or the Pet Poison Helpline at 1-855-764-7661 if you have questions about your pet (there is a fee for these calls).

How should I prevent my pet from getting sick from harmful algal blooms?

If you see signs of an algal bloom as described above:

- Keep your dog on a leash and away from the water.
- Do not let your dog wade or swim in the water.
- Do not let your dog drink the water or eat any material (e.g. dead fish, scum) nearby.
- Do not let your dog lick their fur until they have been bathed if they have been in contact with an algal bloom.

If there is health signage present, follow the signs to keep your dog safe.

Remember, you cannot tell if a bloom is toxic just by looking at it. If in doubt, keep out!

Learn more about harmful algal blooms at FloridaHealth.gov/environmental-health/aquatic-toxins

UNDERSTANDING BLUE-GREEN ALGAE

WHAT ARE BLUE-GREEN ALGAE?

Blue-green algae are a type of bacteria that occur frequently in Florida's freshwater environments.

Blue-green algae, like plants, use light energy from the sun and nutrients acquired from the environment to help them grow.

A bloom occurs when rapid growth of algae leads to an accumulation of individual cells that discolor water and often produce floating mats that emit unpleasant odors. Blooms may negatively impact fish and other aquatic animals.

Some environmental factors that contribute to blue-green algae blooms are sunny days, warm water temperatures, still water conditions and a plentiful supply of nutrients.

Reducing the supply of nutrients, particularly nitrogen and phosphorus, can help decrease the intensity and duration of blue-green algal blooms.

ARE BLUE-GREEN ALGAE HARMFUL?

Many types of blue-green algae can produce toxins. Algal blooms can result in high toxin concentrations. Unfortunately, there are no visual signs that might indicate definitively when blue-green algae are producing toxins.

Ingestion of water with high concentrations of algal toxins can result in serious health effects.

Direct contact or breathing airborne droplets containing high levels of algal toxins can cause irritation of the skin, eyes, nose and throat.

In addition to health effects on people, blue-green algae blooms can cause health impacts in animals.

People and pets should not drink or swim in water where blue-green algae blooms are present. Children, the elderly, and those who are immunocompromised may be at risk even at low concentrations and should avoid any exposure.

DEP tests water samples regularly to determine the type of blue-green algae present. If the algae identified are known to produce toxins, additional testing is carried out to determine if toxins are present and how concentrated they are.

The presence and level of toxins produced by a bloom can vary. Therefore, recurring and persistent blooms are routinely monitored and retested.

WHERE CAN I REPORT A BLUE-GREEN ALGAL BLOOM?

Report algal blooms through:

ReportAlgalBloom.com
or 1-855-305-3903

PROTECTING TOGETHER

ProtectingFloridaTogether.gov

FRESHWATER ALGAL BLOOMS FREQUENTLY ASKED QUESTIONS

What is blue-green algae?

Blue-green algae, or cyanobacteria, is a type of algae found naturally in freshwater environments. This algae is a microorganism that functions like a plant in that it feeds through photosynthesis and derives its energy from the sun.

Blue-green algae can be found all over the world, and occur in Florida's freshwater and brackish habitats, such as lakes, rivers and estuaries.

What causes an algal bloom?

Although blue-green algae are found naturally, increases in nutrients can exacerbate the extent, duration and intensity of blooms. Other factors that contribute to blooms include warm temperatures, reduced water flow, and lack of animals that eat algae. Although they can occur at any time, blue-green algae are most common in Florida during the summer and early fall, with high temperatures and abundant sunlight. The summer also brings storms that have the potential to deliver nutrients into waterways through stormwater runoff.

Are all types of blue-green algae harmful?

Some – not all – blue-green algae can produce toxins that can contribute to environmental problems and affect public health. Little is known about exactly what environmental conditions trigger toxin production. Over time, these toxins are diluted and eventually break down and disappear.

Non-toxic blooms can also harm the environment by depleting oxygen levels in the water column and reducing the amount of light that reaches submerged plants.

Are algal blooms predictable?

The nature of most freshwater algal bloom events makes it difficult to predict where and when a bloom will occur or how long it will last. However, lessening the negative effects of algal blooms is possible through restoration work to improve water quality by reducing nutrients. Reducing nitrogen and phosphorous levels can help decrease the intensity and duration of algal blooms.

Can you identify algal type or if it is producing toxins by looking at it?

No, this is why the Florida Department of Environmental Protection (DEP) coordinates with the water management districts and the Florida Fish and Wildlife Conservation Commission to routinely sample observed and reported algal blooms and test for algal identification and toxicity.

What are the health risks associated with algal blooms?

The Florida Department of Health (DOH) takes the lead in determining if a harmful algal bloom presents a risk to human health. DOH issues health advisories for recreational waters where there is a risk of the public coming into contact with an existing algal bloom as it deems appropriate.

The World Health Organization considers toxin levels under 10 micrograms/liter to represent a low-level risk for adverse health outcomes from short-term recreational exposure; however, certain sensitive populations (e.g., children, the elderly and immunocompromised populations) may still be at risk even at low concentrations and should avoid any exposure.

continued

What should I do if I see an algal bloom in a freshwater system?

The state's bloom response team encourages everyone to be on the lookout for blooms and report them.

Residents statewide can now easily report algal blooms to the department 24 hours a day, 7 days a week. Information can be reported online through at www.reportalgalbloom.com, as well as through a new toll-free number at 1-855-305-3903.

To report fish that are either dead or in poor physical condition, residents should contact the Fish Kill Hotline 1-800-636-0511.

People experiencing symptoms or illnesses should contact the Florida Poison Control Center at 1-800-222-1222.

What happens when an algal bloom is reported?

The department collects detailed information such as location, description and size of the bloom. The reports are then evaluated and prioritized for inclusion in near-term sampling plans based on severity of the bloom and potential for human exposure.

How can I stay updated on algal blooms in my area?

To ensure the health and safety of our state's residents and visitors, DEP is committed to keeping Floridians updated on current algal blooms and how the state is responding to protect human health, water quality and the environment.

DEP is placing sampling results, monitoring and testing information and latest actions by DEP, the water management districts and other local, state and federal response team partners on our website.

Where are algal bloom samples tested?

Most algal bloom samples are processed in DEP's nationally recognized lab in Tallahassee.

What does DEP's lab test for?

Algal samples are tested to identify the type of algae present. If the algae is a type that is capable of producing toxins, it is then tested to determine if it is producing toxin and if so, at what level. The toxins typically tested for include microcystin, cylindrospermospin and anatoxin-a.

How long does it take to test samples?

All samples will still be shipped to DEP's laboratory in Tallahassee for formal algal identification and toxin analysis, which can take approximately three to five days.

Who collects samples?

DEP and Florida's water management districts collect samples when algal blooms are observed during their routine water quality monitoring as well as when blooms are reported. FWC samples nearshore marine waters.

How often are samples collected?

DEP and Florida's water management districts frequently monitor Florida's water quality, and routinely collect algal bloom samples as soon as they are observed as part of this effort. In addition, staff can be deployed to take additional samples in response to reported blooms – whether from a citizen, other response team agencies or other sources.

continued

If a specific site or bloom is tested, is there a need for retesting?

Yes, because whether a bloom is producing toxins and the levels of toxins produced can vary, recurring and persistent blooms are routinely monitored and retested.

Who should I contact about beach closures?

For the most up-to-date information regarding public beach closures, residents and visitors are encouraged to contact the counties directly as they have information on the latest actions.

- Martin County: 772-320-3112
- St. Lucie County: 772-229-2850
- Palm Beach County
  - North Palm Beach County (Juno Beach and north): 561-624-0065
  - South Palm Beach County (Riviera Beach and south): 561-629-8775
- Visit www.floridastateparks.org for state park beach closure alerts

PROTECTING TOGETHER

JOIN US IN PROTECTING AND RESTORING FLORIDA'S WATERS

BE MINDFUL OF BLUE-GREEN ALGAE

Blue-green algae can produce toxins, which can be harmful to humans and pets.

- **Blooms are often green in color.**
- **Blooms may appear on the surface of the water as scum or a floating mat.**
- **Blooms may produce unpleasant odors.**

CHECK RECENT BLOOM ACTIVITY

ProtectingFloridaTogether.gov/StayInformed

- **Sign up for alerts.**
- **Find volunteer opportunities.**
- **Learn what the state is doing to protect and restore our waters.**

IF YOU SEE A BLUE-GREEN ALGAL BLOOM

People and pets should stay out of the water.

- **Do not swim, wade or walk in the water.**
- **Do not let pets swim or go near the water.**
- **Rinse fish with tap water. Throw out guts.**
- **Do not use water from this site for drinking or cooking.**
- **Do not eat shellfish.**

Report blooms at ReportAlgalBloom.com or 1-855-305-3903

Florida Department of Environmental Protection

Florida Fish and Wildlife Conservation Commission

Florida HEALTH