MEMO

From: Bud McCrory, Director, Mobile Area Water and Sewer System
To: Mobile County Commissioner Connie Hudson
Re: Studies on Invasive Species Located in and Threatening Big Creek Lake

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The following memo is designed to provide background and context to the two studies commissioned by MAWSS following the first discovery of an invasive species – Giant Salvinia – in Big Creek Lake. Both studies, a summary document from Barry Vittor and Associates, and a recent report from the US Department of Homeland Security are also included. The document from the Department of Homeland Security has been lightly redacted to remove information related to operational security of the reservoir and pumping stations.

2021 Giant Salvinia Discovery

In 2021, Giant Salvinia, an invasive plant that doubles in size every three to five days, was detected in the reservoir. Following this discovery, MAWSS closed the lake and brought in outside experts to test water quality, treat the invasion, and reopen the lake to recreational use.

This discovery also prompted MAWSS to commission two separate studies on the threats facing the lake, MAWSS's options to prevent and/or remediate these threats, and potential costs to ratepayers.

MAWSS commissioned these two studies in 2022. One study had an environmental focus (conducted by Barry Vittor and Associates, now part of Thompson Engineering), and one had an engineering focus (conducted by HDR, a national engineering firm), in order to study the issue from two separate angles.

These studies were conducted independently but concurrently so that MAWSS could review their findings and make a determination on the best path forward for the utility and its 350,000 customers. In addition, MAWSS also underwent a security assessment from the U.S. Department of Homeland Security in April 2025 that further details the threats facing the reservoir.

Study Findings

The studies found that five invasive species are already present in the reservoir, and six additional invasive species are pressing threats. The most serious of these threats is the zebra mussel.

According to Barry Vittor (see attached summary document), the mussel "has not yet been found in the Lake or in the Mobile area generally, but was discovered in the Tombigbee River as far south as Demopolis several years ago and is expected to have extended its range farther downstream since then. This small bivalve is known to form extremely dense populations in water pipes, pumps, and valves of water supply facilities, power plants, and industrial facilities, damaging these systems and creating blockages that disrupt operations and are very costly to

correct. This species is known to be carried from place to place by commercial and private boats and cannot be eliminated once established in a water body such as Big Creek Lake."

The HDR report *(p.33)* echoes this finding, pointing out that the "U.S. State Department has noted that the infestation of zebra mussels as an invasive species could result in over $3 billion in mitigation and control across the country over the next 10 years, making the potential introduction of zebra mussels into Big Creek Lake a threat that MAWSS must consider."

Treatment, Prevention, and Remediation Options

With the discovery of these invasive species, MAWSS also asked these outside experts to analyze potential next steps to either prevent or remediate invasive species in the reservoir.

For context, MAWSS water from Big Creek Lake is currently some of the cleanest and least-expensive water for similar utilities around the region. In fact, on April 7, 2025, MAWSS was awarded "Best Tasting Drinking Water" by the Alabama/Mississippi Section of the American Water Works Association. MAWSS also claimed the award in 2023.

Because of that track record and commitment to ratepayers, MAWSS is particularly focused on two important aspects of treatment and prevention: first, ensuring that treatment chemicals are safe, effective, and have a minimal effect on the water quality, and second, keeping costs low for ratepayers.

As the old saying goes, "an ounce of prevention is worth a pound of cure." That's especially true for water utilities – preventing an invasive species from entering a reservoir is both more effective and less expensive for ratepayers than ongoing remediation. There is a direct connection between the level of invasive species in the reservoir and the amount of chemicals needed to remediate them: simply put, more invasive species means more treatment chemicals.

The DHS report notes that "prior to allowing recreational use on the lake, the spraying of pesticides into the drinking water was not necessary." *(DHS, p.3)* It is also important to note that while glyphosate, or Roundup, is a treatment option for certain invasive species, MAWSS has not sprayed this chemical in the reservoir and has no plans to do so in the future. Mentions of glyphosate treatment options listed within the provided reports have been rejected by the MAWSS staff and are not being considered.

While MAWSS continually treats the existing invasive species in the reservoir through safe and approved methods, utility leadership determined that preventing the spread of new invasive species was more effective and financially prudent long-term than waiting for them to enter the water and then saddling ratepayers with treatment costs. Per DHS, "eradication of invasive species, once introduced, is not likely." *(DHS, p.2)*

Though invasive species can spread through natural processes like wildlife or floods, "it is well established throughout the world that watercraft provide a primary vector for the movement of aquatic invasive species across waterbodies and ecosystems." (*HDR, p.25*)

The DHS report notes the role of boats as transmitters of invasive species: "it is highly likely these invasive species were introduced as a result of the period of recreational usage that was permitted since there has not been invasive species in [Big Creek Lake] prior to opening it up." *(DHS, p.2)*

Unlike wildlife, boats are controllable and their access can be limited – meaning that the likeliest source of new invasive species into the waterway is also the one that can be addressed.

As stated in Barry Vittor's summary document, "in its commitment to ensuring a safe and affordable public water supply, MAWSS has taken a very proactive approach to preventing introduction of Zebra Mussels into the Lake, in addition to controlling the invasive plant species already there. Consideration was given to operating a steam/hot water treatment station at the boat launch, to remove any mussel larvae that might be present on boats or boat trailers; however, this option was dismissed due to its high cost and due to an inability to treat every part of boats or trailers where larvae could be present."

Vittor also noted, "the consensus among the scientists and specialists was that no reasonable level of treatment could guarantee that mussel larvae would not be brought into the Lake." The HDR study also notes that "the highest level of protection against new invasive species would be to close watercraft access to Big Creek Lake." *(HDR, p. 34)*

This finding was also echoed by the US Department of Homeland Security, recommending that MAWSS "consider keeping the lake closed to recreational use to minimize the introduction of invasive species and reduce the potential that increased activity in the lake poses to the critical components of the system. Doing so will save millions of dollars in the efforts to delay the spread of invasive species and respond to the impacts to infrastructure, water quality, and economic costs to customers of the treated water." *(DHS, p.2)*

MAWSS Decision and Path Forward

MAWSS's sole purpose is providing clean drinking water to 350,000 residents in Mobile and Baldwin Counties, in addition to the region's industrial base, hospitals, schools, and fire departments. These studies laid out a clear threat to the sole water source for these communities.

MAWSS choice was simple: the utility could either take effective action to prevent these threats, or it could knowingly choose to wait until the invasive species entered the reservoir and then take action to remediate them, risking water quality, water supply, and ratepayer costs.

Only one option was a responsible choice for the 350,000 Mobile and Baldwin County residents who rely on MAWSS for clean drinking water.

Per Vittor, "after careful consideration of likely levels of prevention versus risk to the water supply, MAWSS has wisely opted to close the Lake to any recreational use that has the potential for bringing Zebra Mussels or any other aquatic invasive species into the Lake."

Recognizing that some area residents do enjoy recreational activities on the reservoir, on April 7, the MAWSS Board of Directors voted to move forward with a plan that would increase recreational options on Big Creek Lake while not allowing outside boats on the reservoir.

This path forward was also considered in the HDR report, noting "MAWSS could consider the use of a third-party boat launch and rental facility. This would require the use of watercraft dedicated to Big Creek Lake be rented at the site for lake access, meaning that those watercrafts would not leave Big Creek Lake and thus not introduce new invasive species to the lake" *(p. 32)*.

With this plan, MAWSS is beginning the process of securing a private entity that will operate a recreational facility on the lake. This will include boat rental options including fishing boats and kayaks, shore fishing, and areas for picnics and leisure.

MAWSS also intends to open an up to an additional 1100 acres of the reservoir for fishing. This would bring the total area available for fishing up to 1800 acres, more than double the 700 acres currently available. MAWSS also plans to increase the number of days that the lake is open for recreational use from 3 days per week to 5 days per week. The other two days will be used for treatment of the water and the existing invasive species.

All in all, this new approach allows for increased recreational activity while protecting the water supply for 350,000 residents of Mobile and Baldwin County, our economic development, our fire departments, schools, and hospitals.

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CYBERSECURITY & INFRASTRUCTURE SECURITY AGENCY

SECURITY ASSESSMENT AT FIRST ENTRY

Big Lake Creek

9 April 2025

On behalf of the U.S. Department of Homeland Security (DHS) Cybersecurity and Infrastructure Security Agency (CISA), thank you for your participation in the Security Assessment At First Entry (SAFE). We appreciate the opportunity to work with you through this process to assist your organization in improving its physical and operational security.

SAFE is designed to assess the current security posture and identify options for facility owners and operators to mitigate against relevant threats. It is not intended to be an in-depth security assessment.

SAFE may be the first step toward an effective security program. In the future, it may be appropriate to conduct a more detailed assessment, particularly after additional security measures have been implemented onsite.

CISA conducted a visit on 9 April 2025, at Big Lake Creek. This report lists commendable actions (what the facility is doing well), vulnerabilities (what the facility could improve), and options for consideration (potential security enhancements) based on the Protective Security Advisor's (PSA's) observations and discussions with key site personnel during that visit.

Findings

Vulnerabilities and Options for Consideration

The PSA identified potential vulnerabilities and suggested options the facility may consider to reduce them. The table below lists these vulnerabilities and options for consideration.

The SAFE process and options for consideration provide an opportunity for the facility to mitigate vulnerabilities and implement protective measures. The options for consideration are not prescriptive endorsements of specific protective measures to be installed and/or used at the facility. The owner or operator determines for the facility whether the options for consideration provide the desired enhancements in light of the facility's current security posture, anticipated growth or organizational changes, budgetary outlook, etc.

The options for consideration provide actions that may help improve physical and operational security. References for the options for consideration provided below are listed at the end of the report.

Vulnerabilities and Options for Consideration

Category	Vulnerability	Option for Consideration
Security Force	[redacted]	[redacted]
Perimeter Security	The J. B. Converse Reservoir, commonly called Big Creek Lake, is the source for fresh drinking water serving the city of Mobile, Alabama and its surrounding suburbs. Hundreds of thousands of Alabamians depend on this reservoir and the Mobile Area Water and Sewer System (MAWSS) to ensure the safety and security of this fresh water source. The lake has been open to recreational usage which was closed again upon the discovery of invasive species. It is highly likely these invasive species were introduced as a result of the period of recreational usage that was permitted since there has not been invasive species in the water prior to opening it up.	• Consider keeping the lake closed to recreational use to minimize the introduction of invasive species and reduce the potential that increased activity in the lake poses to the physical security of critical components of this system. Doing so will save millions of dollars in the efforts to delay the spread of invasive species and respond to the impacts to infrastructure, water quality, and economic costs to customers of the treated water. Eradication of invasive species, once introduced, is not likely.

Category	Vulnerability	Option for Consideration
Electronic Security Systems	[redacted]	[redacted]
Other	Pesticides are being used in the reservoir to combat the invasive species introduced when recreational use was authorized. Although the North American Invasive Species Management Association (NAISMA) advises pesticides to control invasive species, "pesticides are one of several management tools that stop the spread of invasive species when no other solution is available or economically feasible" (MAISMA). Prior to allowing recreational use on the lake, the spraying pesticides into the drinking water was not necessary.	• Reducing or eliminating the introduction of pesticides into drinking water would ensure not only safer water but also less expensive water for the citizens of Mobile and surrounding communities.

Conclusion

This report provides a summary of key findings of the SAFE at your facility and may be used as a guide for the consideration and implementation of future security measures. Please contact your PSA, [redacted] with any inquiries about the information contained in this report:

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Summary Statement by Barry A. Vittor, PhD

Big Creek Lake is managed by Mobile Area Water & Sewer Service (MAWSS) as the principal source of potable water for most of Mobile County and part of Baldwin County. Recreational boat use of the Lake has been permitted for many years, but public access to areas in proximity to the water intake structure has been prohibited to preclude introduction of materials that might cause fouling of intake pumps or degradation of water quality. Recently, it was discovered that a noxious floating plant species (Giant Salvinia) had spread across a large area of the Lake and represented a potential threat to MAWSS' pump station and to the cost of water treatment.

This plant is believed to have been introduced inadvertently by boaters who had operated their boats in other waters (especially parts of the Mobile River Delta) that contained Giant Salvinia, then were launched in Big Creek Lake.

MAWSS' response to this invasive species has involved implementation of research-supported control measures as well as periodic surveys of the Lake for other undesirable species. This also involved extensive research by scientists and specialists in exotic/invasive species control, concerning other invasive species that could occur in the general area and had the potential to create significant disruptions in the public water supply.

The most serious of these species was determined to be the Zebra Mussel, which has not yet been found in the Lake or in the Mobile area generally, but was discovered in the Tombigbee River as far south as Demopolis several years ago and is expected to have extended its range farther downstream since then. This small bivalve is known to form extremely dense populations in water pipes, pumps, and valves of water supply facilities, power plants, and industrial facilities, damaging these systems and creating blockages that disrupt operations and are very costly to correct.

This species is known to be carried from place to place by commercial and private boats and cannot be eliminated once established in a water body such as Big Creek Lake. In its commitment to ensuring a safe and affordable public water supply, MAWSS has taken a very proactive approach to preventing introduction of Zebra Mussels into the Lake, in addition to controlling the invasive plant species already there. Consideration was given to operating a steam/hot water treatment station at the boat launch, to remove any mussel larvae that might be present on boats or boat trailers; however, this option was dismissed due to its high cost and due to an inability to treat every part of boats or trailers where larvae could be present.

The consensus among the scientists and specialists was that no reasonable level of treatment could guarantee that mussel larvae would not be brought into the Lake.

Consequently, after careful consideration of likely levels of prevention versus risk to the water supply, MAWSS has wisely opted to close the Lake to any recreational use that has the potential for bringing Zebra Mussels or any other aquatic invasive species into the Lake.

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EVALUATION OF INVASIVE SPECIES MANAGEMENT MEASURES IN BIG CREEK LAKE

Prepared for

BOARD OF WATER AND SEWER COMMISSIONERS
OF THE CITY OF MOBILE
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MOBILE, ALABAMA 36618

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8060 COTTAGE HILL ROAD
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October 2023

Issue 1: What chemicals are presently used to control aquatic species in Big Creek Lake, what are their impacts on water quality and aquatic life, and what costs are incurred in conducting chemical treatment of aquatic species?

- Chemicals used to control nuisance aquatic plant species include Galleon SC herbicide, Schooner SC herbicide and RSi surfactant. MSD sheets for these chemicals are provided in Appendix A of this report.

- Herbicide treatments are focused primarily on Giant Salvinia but other nuisance species, such as Parrot Feather, are also treated because of their occurrence within Giant Salvinia aggregations.


Parrot Feather in Giant Salvinia Patch

- Galleon SC herbicide is typically applied as a mixture of 6 oz per 100 gallons of water, while Schooner SC is a mixture of 3 oz per 100 gallons of water. The amounts of these herbicides used per acre are typically 3 to 4 ounces of Galleon SC and 2 to 3 ounces of Schooner SC. Applications per treatment period have averaged 6 acres but on-going treatments could vary, depending on the extent of re-growth or spreading of Giant Salvinia. The current treatment program indicates some success in reducing the abundance of Giant Salvinia in areas that can be reached by the treatment vessel. However, as reported in May 2023, its percent cover increased from 14.6% in May 2022 to 18.8% in May 2023 (a 30% increase) despite herbicide treatments. More concerning was the wider distribution of this plant in May 2023, including the presence of a large amount of Giant Salvinia in the southern part of the Lake, approximately 1.2 miles from the pumping station. Treatment impacts on other notable species (Parrot's Feather and Cuban Bulrush) were inconclusive, with continued appearances in many areas of the Lake.


Dying Giant Salvinia May 10, 2022

- Short-term water quality impacts of herbicide treatments appear to be negligible and consistent with the published impacts provided in the MSD sheets. Although the treatments can damage or kill native (desirable) plant species as well as the targeted nuisance species, these impacts appear to be limited due to efforts to limit treatments to rafts of Giant Salvinia, with other nuisance species intermixed. Galleon SC (penoxsulam) has been shown not to be acutely toxic to aquatic species including fish, crustaceans, and snails, nor is it toxic to waterfowl such as ducks. It has been reported to cause minor skin irritation in humans and could be harmful if inhaled during application, but this herbicide has been approved by USEPA for use in waters designated for drinking, swimming, or fishing. Schooner SC (flumioxazin) degrades rapidly in water, with a half-life of 1 day at pH7. It has been approved for use in waters used for drinking water, swimming, or fishing, but cannot be applied more than 6 times per year in one location. It is moderately toxic to fish and aquatic invertebrates but has negligible toxicity to birds. Schooner SC can cause skin irritation and can be harmful if inhaled or absorbed through the skin.

- Long-term effects of herbicide applications on water quality are generally minor for Galleon SC; however, this herbicide biodegrades very slowly in the environment. At the same time, it has a low bioaccumulation potential so is unlikely to cause long-term adverse impacts to fish or birds such as ducks. Galleon SC has been shown to affect the kidneys or liver in mammals, with repeated exposure, but is has been shown not to be carcinogenic. Schooner SC also may have chronic effects on the liver or kidneys or mammals but is non-carcinogenic. Although it has a short half-life, it does represent a moderate risk for persistence in sediments and waters. Long-term effects on fish and other aquatic species have not been reported.

- Because of Galleon SC's low levels of toxicity to aquatic fauna, and the very high concentrations necessary to cause liver and kidney damage in mammals, there are no suggested limits to the amounts of this herbicide that should be applied. Schooner SC does carry a suggested limit of 400 ppb during any one application (that translates to application of 100 gallons of the standard solution (3 ounces per 100 gallons of water) to

1/16th of an acre of Lake, which is much more than the estimated application rate of 100 gallons per acre.

- As aquatic vegetation killed by the herbicides decomposes, it will consume dissolved oxygen in the water column with possible adverse impacts on water quality and aquatic biota. Such impacts have not been apparent but dissolved oxygen levels have not been monitored before or after treatments. The greatest potential impact or consequence of on-going herbicide application is likely to be public concern over use of chemicals in the drinking water supply. All too often, chemicals declared safe for human exposure have later been identified as having possible impacts on human health; this is illustrated by recent lawsuits involving possible carcinogenic effects of the herbicides Paraquat and Round-up. Even if no actual damage to human health is shown to occur, the perception of negative effects on the public water supply could be enough to create a public relations problem or, even worse, costly legal entanglements.

- While past practices of herbicide application in Big Creek Lake appear to be reasonable; maximum application rates advised by the manufacturers of Galleon SC and Schooner SC are higher than the rates that have been used to date. It is possible that raising the chemical concentrations would provide better results in controlling Giant Salvina.

- Application costs associated with present treatments for Giant Salvinia have averaged approximately $473/acre; the cost for the herbicides alone average approximately $85/acre. If the concentrations of each chemical were increased by 50%, the cost of treatments would increase to approximately $515/acre. Future costs are likely to increase due to inflation-related increases in labor and materials costs. Estimates of such increases would be speculative but could represent 5% per year under present economic conditions.

ITEM 2: Identify all the potential invasive species threats that have been or could be introduced into the Lake and provide recommended methods for control of these species.

Seven exotic/invasive plant species have been identified as occurring within Big Creek Lake, while two exotic/invasive macroinvertebrate species have the potential for being introduced in the Lake. While each of these species could become widespread and could displace some native species, only four of these species (three plants and one macroinvertebrate) represent potential threats to the use of the Lake as an essential public water supply. These significant species are Giant Salvinia (*Salvinia molesta*), Parrot's Feather (*Myriophyllum aquaticum*), Cuban Bulrush (*Cyperus blepharoleptos*), and Zebra Mussel (*Dreissena polymorpha*). Each of these species is addressed in detail below. The five exotic/invasive species that are of less concern include the following:

- Alligator Weed (*Alternanthera philoxeroides*) is abundant and widespread throughout the Lake and associated wetlands; it is rooted and well-established and is unlikely to be easily eradicated but is also unlikely to create a threat to the integrity of the water supply function of the Lake.


Alligator Weed - May 10, 2022

- Wild Taro (*Colocasia esculenta*) is a rooted plant that is uncommon along the margins of Big Creek Lake and is unlikely to present any issues that threaten water quality.


Wild Taro

- Torpedo Grass (*Panicum repens*) occurs along the margins of the Lake and forms very dense mats that are rooted but still have the potential to break loose and be moved to other areas of the Lake. This nuisance species


May 12, 2022

is too well-established and too widely distributed to eradicate or control but represents minimal risk to water quality or supply.

- Pantropical Beaksedge (*Rhynchospora* sp. cf. *corymbosa*) has been observed in a small area of wetlands at the Big Creek Lake shoreline, on the north side of Hwy. 98. Populations of this exotic/invasive plant were first detected in Mobile County in 2011 by Howard Horne, in the Halls Mill Creek Watershed. The species is rapidly spreading locally, including movement into pristine undisturbed wetland areas. Although posing a potential threat to native wetland ecosystems, this species does not represent a potential threat to water quality or supply in Big Creek Lake.

- Giant Apple Snail (*Pomacea maculate*) has not been observed in Big Creek Lake but has been found in other parts of Mobile County, including Municipal Park Lake, Three Mile Creek; it is likely to have spread into the lower Mobile-Tensaw River Delta area as well. This macroinvertebrate species has very high fecundity and can produce large masses of eggs, attached to rooted vegetation. These egg masses are bright pink and one means of control of this species is manual removal and destruction of egg masses whenever they are found. The Apple Snail has the potential to disrupt native aquatic ecosystems but does not represent a threat to water quality or supply in Big Creek Lake.

The species that do have the potential to affect water quality and supply in the Lake are described as follows:

- Cuban Bulrush (*Cyperus blepharoleptos*) was observed in Big Creek Lake in September 2021 as a small floating mat on the inside edge of the Giant Salvinia containment boom across Crooked Creek but the species has not been detected during monitoring efforts since the initial observation. Although it does not represent an imminent threat to the waters of the Lake, Cuban bulrush is highly invasive and can significantly alter aquatic ecosystems and water quality through shading, dissolved oxygen depletion, and reduction of open water. This plant can colonize floating vegetation such as Giant Salvinia where it can gradually create its own habitat through accumulation of silt and organic matter, to the extent that it becomes a floating island which can quickly expand to obstruct waterways and flow, intake structures, or boat ramps. When detected, it should be treated immediately with the same herbicide applications used to control Giant Salvinia. Both Galleon SC and Schooner SC have been shown to cause an 80% reduction in biomass when applied prior to flowering but neither herbicide is effective at reducing submersed biomass. As with the use of those two herbicides for Giant Salvinia control, there are no apparent limitations in the frequency or concentrations of treatments, nor would there be short- or long-term adverse impacts of treatments on water quality or human health.

- Parrot's Feather (*Myriophyllum aquaticum*) is widespread in the shallow water shoreline areas of Big Creek Lake, usually in still backwater areas. It was recorded in 13 of 51 monitoring plots in May 2022 (25%) and in 15 of 54 monitoring plots in May 2023 (28%). In some areas, this plant has

formed dense mats amongst Giant Salvinia and other nuisance plant species (especially, Torpedo Grass) and has the potential to be a concern in several areas, by interfering with water flow. It can be fragmented easily, allowing it to be transported to other parts of the Lake. This species is difficult to control with herbicides because of its waxy cuticle and because of its tendency to become established in areas that are not readily accessible for herbicide treatments. It is unlikely to have adverse impacts on water quality but could affect water supply facilities through accumulations of plant material carried by currents to intake structures.

- Giant Salvinia (*Salvinia molesta*), also known as kariba-weed, is an aquatic fern native to South America. It was first introduced to the United States as an ornamental aquarium plant and is now rapidly spreading throughout the southeastern region, mainly through unintentional transport on boats and fishing gear, and also the dumping of aquaria into native waterbodies. This plant has become widespread in the lower Mobile-Tensaw River Delta and was first recognized as a serious concern in Big Creek Lake in 2021. Present measures implemented by MAWSS to control Giant Salvinia have been summarized previously in this report. Initial efforts to remove floating plants by mechanical means were largely unsuccessful because of the presence of numerous tree stumps in the shallow waters of the Lake where it has become most abundant. Herbicide treatment has been the control method of choice since August 2021, with mixed results. Despite repeated herbicide applications, Giant Salvinia has become more widely distributed around the Lake, generally through wind-driven transport of individual plants or small patches of plants. As stated earlier, it may be possible to increase the concentrations of the herbicides now in use, to increase their effectiveness in killing the floating plants; however, recommended application rates should not be exceeded, to preclude damage to water quality and other biota in the Lake. Costs for on-going herbicide treatment appear to be moderate and increasing the concentrations applied would have only a minor impact on those costs.

An alternative to herbicide control could be use of a biological agent, the weevil *Crytobagous salvineae*, which has been used in many areas of the world to manage Giant Salvinia infestations. This insect occurs in the United States (especially, Florida) but its presence in Mobile County hasn't been determined. Authorization to release the weevil as a control agent must be obtained from the U.S Department of Agriculture Animal and Plant Health Service (APHIS), Plant Protection and Quarantine (PPQ). Studies of temperature effects on over-wintering and reproduction of the weevil have shown that most strains are unlikely to be able to maintain population densities needed to provide effective control of Giant Salvinia due to winter temperatures that preclude egg production. However, researchers at Louisiana State University have been able to establish a viable weevil farming operation that provides adults, larvae, pupae, and eggs for dispersion into Giant Salvinia infestations. Inoculation of such areas has been very effective in removing these plants from waterways and ponds and is of potential benefit in Big Creek Lake.

LSU Giant Salvinia Weevil
https: www.lsuagcenter.com/topics environment/invasive%20species/giant%20salvinia/biocontrol%20program

- Zebra Mussel (*Dreissena polymorpha*) is a small mollusk species that has spread into many parts of the United States and is viewed as one of the most destructive invasive species because of its ability to create extremely dense populations in freshwater pipelines, water supply intakes, and industrial water systems. Densities as high as 700,000 individuals per square meter have been reported and the diameters of pipes have been reduced by two-thirds at water treatment facilities. This species has not been reported in Mobile County but it has been found in the Black Warrior River at Moundville and is likely to occur

downstream of that location. Control of Zebra Mussels typically involves chemical treatment with a variety of oxidizing or non-oxidizing compounds. Oxidizing compounds are already used to disinfect drinking water but are corrosive to metals. Non-oxidizing compounds have been used to control algae in water treatment facilities and may provide better results for Zebra Mussel control than oxidizing compounds but are generally more costly.

Item 3: Boat wash facility effectiveness and potential improvements

- The present Big Creek Lake boat wash facility was designed well to provide an efficient and user-friendly means of ensuring that undesirable biota are not introduced into the Lake by boaters who use the Fox Landing boat launch. When applied carefully, boaters are able to use non-heated pressurized water to remove plant material from their boats and trailers prior to launching. Observations of this process at Fox Landing does suggest that some parts of boat trailers that cradle the boat hull cannot be reached by pressure washing and may prevent some foreign plant material from being removed. For boats that are left out of the water for a prolonged period, this should not present a risk of introducing species such as Giant Salvinia or Parrot's Feather because those plants cannot survive out of the water. Also, the frequency of such introductions is expected to be very low with negligible contributions to the populations that already exist in the Lake.

- Boat owners appear to have been conscientious in using the boat wash facilities. Signage placed at the boat wash area provides good information about the importance of boat cleaning to protecting the Lake from damage that could be caused by undesirable invasive plants and animals. Our experience in conducting environmental studies of the Lake suggests that the people who

use the Lake for recreation are generally local repeat visitors who are more likely to be protective of the Lake's resources and aesthetics. We do not feel that hiring personnel to operate the boat washing equipment is necessary or would increase the effectiveness of the operation.

- Heated water is unlikely to increase the effectiveness of boat washing provided by the present pressurized system and use of heated water carries a risk of burn injury to operators of the washing equipment. Heated water could kill propagules and adult plants that are washed from boats and trailers but the present system includes a large detention basin that receives wash water and allows desiccation and decomposition of whatever plant (or animal) material might be removed from boats and trailers.

- We feel that the boat washing facility is very effective in preventing introduction of invasive biota into Big Creek Lake. The presence in the Lake of several such plant species suggests that boat and trailer washing can be beneficial in preventing on-going introductions but would have minimal effects on existing populations of these plants. We have no recommendations for changing or adding to the existing facility.

APPENDIX A:

MATERIAL SAFETY DATA SHEETS FOR HERBICIDES AND SURFACTANT

SAFETY DATA SHEET

Galleon® SC
Aquatic Herbicide

Section 1. Identification

GHS product identifier : Galleon® SC Aquatic Herbicide
Other means of identification : Not available.
EPA Registration No. : 67690-47

Supplier's details : SePRO Corporation
11550 North Meridian Street
Suite 600
Carmel, IN 46032 U.S.A.
Tel: 317-580-8282
Toll free: 1-800-419-7779
Fax: 317-580-8290
Monday - Friday, 8am to 5pm E.S.T.
www.sepro.com

Emergency telephone number (with hours of operation) : **INFOTRAC - 24-hour service 1-800-535-5053**

The following recommendations for exposure controls and personal protection are intended for the manufacture, formulation and packaging of this product. For applications and/or use, consult the product label. The label directions supersede the text of this Safety Data Sheet for application and/or use.

Section 2. Hazards identification

Hazard classification This material is not hazardous under the criteria of the Federal OSHA Hazard Communication Standard 29CFR 1910.1200.

Other hazards No data available

Section 3. Composition/information on ingredients

Chemical Nature: Mixture
This product is a mixture.

Component	CASRN	Concentration
Penoxsulam	219714-96-2	21.7%
Propylene glycol	57-55-6	4.5%
Balance	Not available	73.8%

Section 4. First aid measures

Description of first aid measures

General advice: If potential for exposure exists refer to Section 8 for specific personal protective equipment.

Inhalation: Move person to fresh air. If person is not breathing, call an emergency responder or ambulance, then give artificial respiration; if by mouth to mouth use rescuer protection (pocket mask etc). Call a poison control center or doctor for treatment advice.

Skin contact: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

Eye contact: Hold eyes open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eyes. Call a poison control center or doctor for treatment advice.

Ingestion: No emergency medical treatment necessary.

Most important symptoms and effects, both acute and delayed: Aside from the information found under Description of first aid measures (above) and Indication of immediate medical attention and special treatment needed (below), any additional important symptoms and effects are described in Section 11: Toxicology Information.

Indication of any immediate medical attention and special treatment needed

Notes to physician: No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient. Have the Safety Data Sheet, and if available, the product container or label with you when calling a poison control center or doctor, or going for treatment.

Section 5. Fire-fighting measures

Suitable extinguishing media: To extinguish combustible residues of this product use water fog, carbon dioxide, dry chemical or foam.

Unsuitable extinguishing media: No data available

Special hazards arising from the substance or mixture

Hazardous combustion products: Under fire conditions some components of this product may decompose. The smoke may contain unidentified toxic and/or irritating compounds. Combustion products may include and are not limited to: Sulfur oxides. Nitrogen oxides. Hydrogen fluoride. Fluorinated hydrocarbons. Carbon monoxide. Carbon dioxide.

Unusual Fire and Explosion Hazards: This material will not burn until the water has evaporated. Residue can burn.

Advice for firefighters

Fire Fighting Procedures: Keep people away. Isolate fire and deny unnecessary entry. Use water spray to cool fire exposed containers and fire affected zone until fire is out and danger of re-ignition has passed. To extinguish combustible residues of this product use water fog, carbon dioxide, dry chemical or foam. Contain fire water run-off if possible. Fire water run-off, if not contained, may cause environmental damage. Review the "Accidental Release Measures" and the "Ecological Information" sections of this (M)SDS.

Special protective equipment for firefighters: Wear positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, trousers, boots, and gloves). If protective equipment is not available or not used, fight fire from a protected location or safe distance.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures: Use appropriate safety equipment. For additional information, refer to Section 8, Exposure Controls and Personal Protection.

Environmental precautions: Prevent from entering into soil, ditches, sewers, waterways and/or groundwater. See Section 12, Ecological Information. Spills or discharge to natural waterways is likely to kill aquatic organisms.

Methods and materials for containment and cleaning up: Contain spilled material if possible. Small spills: Absorb with materials such as: Clay. Dirt. Sand. Sweep up. Collect in suitable and properly labeled containers. Large spills: Contact SePRO Corporation for clean-up assistance. See Section 13, Disposal Considerations, for additional information.

Section 7. Handling and storage

Precautions for safe handling: Keep out of reach of children. Do not swallow. Avoid contact with eyes, skin, and clothing. Avoid breathing vapor or mist. Wash thoroughly after handling. Use with adequate ventilation. See Section 8, EXPOSURE CONTROLS AND PERSONAL PROTECTION.

Conditions for safe storage: Store in a dry place. Store in original container. Keep container tightly closed when not in use. Do not store near food, foodstuffs, drugs or potable water supplies.

Section 8. Exposure controls/personal protection

Control parameters

Exposure limits are listed below, if they exist.

Component	Regulation	Type of listing	Value/Notation
Propylene glycol	US WEEL	TWA	10 mg/m3

RECOMMENDATIONS IN THIS SECTION ARE FOR MANUFACTURING, COMMERCIAL BLENDING AND PACKAGING WORKERS. APPLICATORS AND HANDLERS SHOULD SEE THE PRODUCT LABEL FOR PROPER PERSONAL PROTECTIVE EQUIPMENT AND CLOTHING.

Exposure controls

Engineering controls: Use local exhaust ventilation, or other engineering controls to maintain airborne levels below exposure limit requirements or guidelines. If there are no applicable exposure limit requirements or guidelines, general ventilation should be sufficient for most operations. Local exhaust ventilation may be necessary for some operations.

Individual protection measures

Eye/face protection: Use safety glasses (with side shields).

Skin protection

Hand protection: Chemical protective gloves should not be needed when handling this material. Consistent with general hygienic practice for any material, skin contact should be minimized.

Other protection: No precautions other than clean body-covering clothing should be needed.

Respiratory protection: Respiratory protection should be worn when there is a potential to exceed the exposure limit requirements or guidelines. If there are no applicable exposure limit requirements or guidelines, wear respiratory protection when adverse effects, such as respiratory irritation or discomfort have been experienced, or where indicated by your risk assessment process. For most conditions no respiratory protection should be needed; however, if discomfort is experienced, use an approved air-purifying respirator. The following should be effective types of air-purifying respirators: Organic vapor cartridge with a particulate pre-filter.

Section 9. Physical and chemical properties

Appearance	
Physical State	Liquid
Color	Tan
Odor	Musty
Odor Threshold	No test data available
pH	4.7 1% *pH Electrode* (1% aqueous solution)
Melting point/range	Not applicable
Freezing point	No test data available
Boiling point (760 mmHg)	No test data available
Flash point	**closed cup** > 100 °C (> 212 °F) *Setaflash Closed Cup ASTM D3828*
Evaporation Rate (Butyl Acetate = 1)	No test data available
Flammability (solid, gas)	No
Lower explosion limit	No test data available
Upper explosion limit	No test data available
Vapor Pressure	Not applicable
Relative Vapor Density (air = 1)	No test data available
Relative Density (water = 1)	1.110 at 20 °C (68 °F) *Digital Density Meter (Oscillating Coil)*
Water solubility	Not applicable
Partition coefficient: n-octanol/water	No data available
Auto-ignition temperature	No test data available
Decomposition temperature	No test data available
Dynamic Viscosity	No test data available
Kinematic Viscosity	No test data available
Explosive properties	No *Thermal*
Oxidizing properties	No
Liquid Density	1.110 g/cm3 at 20 °C (68 °F) *Digital density meter*
Molecular weight	No data available
Surface tension	60.0 mN/m at 20 °C (68 °F) *EC Method A5*

NOTE: The physical data presented above are typical values and should not be construed as a specification.

Section 10. Stability and reactivity

Reactivity: No data available

Chemical stability: Thermally stable at typical use temperatures.

Possibility of hazardous reactions: Polymerization will not occur.

Conditions to avoid: Some components of this product can decompose at elevated temperatures. Generation of gas during decomposition can cause pressure in closed systems.

Incompatible materials: Avoid contact with: Strong oxidizers.

Hazardous decomposition products: Decomposition products depend upon temperature, air supply and the presence of other materials.

Section 11. Toxicological information

Toxicological information appears in this section when such data is available.

Acute toxicity

Acute oral toxicity Very low toxicity if swallowed. Harmful effects not anticipated from swallowing small amounts.
As product: LD50, Rat, > 5,000 mg/kg No deaths occurred at this concentration.

Acute dermal toxicity Prolonged skin contact is unlikely to result in absorption of harmful amounts.
As product: LD50, Rat, > 5,000 mg/kg No deaths occurred at this concentration.

Acute inhalation toxicity No adverse effects are anticipated from single exposure to mist. Excessive exposure may cause irritation to upper respiratory tract (nose and throat).
As product: LC50, Rat, 4 Hour, Aerosol, > 0.74 mg/l
Maximum attainable concentration.

Skin corrosion/irritation Essentially nonirritating to skin.

Serious eye damage/ eye irritation Essentially nonirritating to eyes.

Sensitization As product: Did not cause allergic skin reactions when tested in guinea pigs.
For respiratory sensitization: No relevant data found.

Specific Target Organ Systemic Toxicity (Single Exposure) Evaluation of available data suggests that this material is not an STOT-SE toxicant.

Specific Target Organ Systemic Toxicity (Repeated Exposure) For the active ingredient(s):
In animals, effects have been reported on the following organs: Kidney; Liver.

For the minor component(s):
In animals, effects have been reported on the following organs after exposure to aerosols: Lung.

Carcinogenicity Active ingredient did not cause cancer in laboratory animals.

Teratogenicity For the active ingredient(s): Did not cause birth defects or any other fetal effects in laboratory animals.

Reproductive toxicity In animal studies, active ingredient did not interfere with reproduction.

Mutagenicity For the active ingredient(s): In vitro genetic toxicity studies were negative. Animal genetic toxicity studies were negative.

Aspiration Hazard Based on physical properties, not likely to be an aspiration hazard.

Section 12. Ecological information

Ecotoxicological information appears in this section when such data is available.

Toxicity

Acute toxicity to fish For the active ingredient: Material is very highly toxic to aquatic organisms on an acute basis (LC50/EC50 <0.1 mg/L in the most sensitive species).

As product: LC50, Oncorhynchus mykiss (rainbow trout), static test, 96 Hour, > 762 mg/l, OECD Test Guideline 203 or Equivalent

Acute toxicity to aquatic invertebrates EC50, Daphnia magna (Water flea), static test, 48 Hour, > 457 mg/l, OECD Test Guideline 202 or Equivalent

Acute toxicity to algae/aquatic plants ErC50, Pseudokirchneriella subcapitata (green algae), 72 Hour, Growth rate inhibition, 1.07 mg/l, OECD Test Guideline 201 or Equivalent

For the active ingredient: EbC50, Lemna gibba, 14 d, 0.00329 mg/l

Toxicity to Above Ground Organisms

Material is practically non-toxic to birds on an acute basis (LD50 > 2000 mg/kg).

Oral LD50, Colinus virginianus (Bobwhite quail), > 10000mg/kg bodyweight.

Oral LD50, Apis mellifera (bees), 48 Hour, > 99micrograms/bee

Contact LD50, Apis mellifera (bees), 48 Hour, > 100micrograms/bee

Toxicity to soil-dwelling organisms

LC50, Eisenia fetida (earthworms), 14 d, > 10,000 mg/kg

Persistence and degradability

Penoxsulam

Biodegradability: Material is expected to biodegrade very slowly (in the environment). Fails to pass OECD/EEC tests for ready biodegradability.

10-day Window: Fail
Biodegradation: 14.7 %
Exposure time: 28 d
Method: OECD Test Guideline 301B or Equivalent

Photodegradation
Sensitizer: OH radicals
Atmospheric half-life: 2.1 Hour
Method: Estimated.

Propylene glycol

Biodegradability: Material is readily biodegradable. Passes OECD test(s) for ready biodegradability. Biodegradation may occur under anaerobic conditions (in the absence of oxygen).
10-day Window: Pass
Biodegradation: 81 %
Exposure time: 28 d
Method: OECD Test Guideline 301F or Equivalent
10-day Window: Not applicable
Biodegradation: 96 %
Exposure time: 64 d
Method: OECD Test Guideline 306 or Equivalent

Theoretical Oxygen Demand: 1.68 mg/mg

Chemical Oxygen Demand: 1.53 mg/mg

Biological oxygen demand (BOD)

Incubation Time	BOD
5 d	69.000%
10 d	70.000%
20 d	86.000%

Photodegradation
Atmospheric half-life: 10 Hour
Method: Estimated.

Balance **Biodegradability:** No relevant data found.

Bioaccumulative potential

Penoxsulam **Bioaccumulation:** Bioconcentration potential is low (BCF < 100 or Log Pow < 3).
Partition coefficient: n-octanol/water(log Pow): -0.602 Measured

Propylene glycol **Bioaccumulation:** Bioconcentration potential is low (BCF < 100 or Log Pow < 3).
Partition coefficient: n-octanol/water(log Pow): -1.07 Measured
Bioconcentration factor (BCF): 0.09 Estimated.

Balance

Bioaccumulation: No relevant data found.

Mobility in soil

Penoxsulam Potential for mobility in soil is high (Koc between 50 and 150).
Partition coefficient(Koc): 73 Measured

Propylene glycol

Given its very low Henry's constant, volatilization from natural bodies of water or moist soil is not expected to be an important fate process.
Potential for mobility in soil is very high (Koc between 0 and 50).
Partition coefficient(Koc): < 1 Estimated.

Balance No relevant data found.

Section 13. Disposal considerations

Disposal methods: If wastes and/or containers cannot be disposed of according to the product label directions, disposal of this material must be in accordance with your local or area regulatory authorities. This information presented below only applies to the material as supplied. The identification based on characteristic(s) or listing may not apply if the material has been used or otherwise contaminated. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste identification and disposal methods in compliance with applicable regulations. If the material as supplied becomes a waste, follow all applicable regional, national and local laws.

Section 14. Transport information

DOT Not regulated for transport

Classification for SEA transport (IMO-IMDG):

Proper shipping name ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (Penoxsulam)

UN number UN 3082

Class 9

Packing group III

Marine pollutant Penoxsulam

Transport in bulk according to Annex I or II of MARPOL 73/78 and the IBC or IGC Code Consult IMO regulations before transporting ocean bulk.

Classification for AIR transport (IATA/ICAO):

Proper shipping name Environmentally hazardous substance, liquid, n.o.s.(Penoxsulam)
UN number UN 3082
Class 9
Packing group III

This information is not intended to convey all specific regulatory or operational requirements/information relating to this product. Transportation classifications may vary by container volume and may be influenced by regional or country variations in regulations. Additional transportation system information can be obtained through an authorized sales or customer service representative. It is the responsibility of the transporting organization to follow all applicable laws, regulations and rules relating to the transportation of the material.

Section 15. Regulatory information

OSHA Hazard Communication Standard

This product is not a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency Planning and Community Right-to-Know Act of 1986) Sections 311 and 312

Chronic Health Hazard

Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency Planning and Community Right-to-Know Act of 1986) Section 313

This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

California Proposition 65 (Safe Drinking Water and Toxic Enforcement Act of 1986)

This product contains no listed substances known to the State of California to cause cancer, birth defects or other reproductive harm, at levels which would require a warning under the statute.

Pennsylvania (Worker and Community Right-To-Know Act): Pennsylvania Hazardous Substances List and/or Pennsylvania Environmental Hazardous Substance List:

The following product components are cited in the Pennsylvania Hazardous Substance List and/or the Pennsylvania Environmental Substance List, and are present at levels which require reporting.

Components	CASRN
Propylene glycol	57-55-6

Pennsylvania (Worker and Community Right-To-Know Act): Pennsylvania Special Hazardous Substances List:

To the best of our knowledge, this product does not contain chemicals at levels which require reporting under this statute.

United States TSCA Inventory (TSCA)

This product contains chemical substance(s) exempt from U.S. EPA TSCA Inventory requirements. It is regulated as a pesticide subject to Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) requirements.

Federal Insecticide, Fungicide and Rodenticide Act

EPA Registration Number: 67690-47
This chemical is a pesticide product registered by the Environmental Protection Agency and is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets, and for

workplace labels of non-pesticide chemicals. Following is the hazard information as required on the pesticide label:

CAUTION
Harmful if inhaled

Section 16. Other information

Hazard Rating System
NFPA

Health: 0 Fire: 1 Reactivity: 0

Legend

TWA	8-hr TWA
US WEEL	USA. Workplace Environmental Exposure Levels (WEEL)

Information Source and References
This SDS is prepared by Product Regulatory Services and Hazard Communications Groups from information supplied by internal references within our company.

History

Date of issue: 12/21/15

Notice to reader
To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

SCHOONER™ SC

SAFETY DATA SHEET

EMERGENCY CALL: 1-800-424-9300 (CHEMTREC)

1. IDENTIFICATION

PRODUCT NAME: **Schooner SC**

DESCRIPTION: **Liquid Herbicide**

EPA REG. NO.: **91234-204**

COMPANY IDENTIFICATION: **Atticus, LLC**
5000 CentreGreen Way, Suite 100
Cary, NC 27513

2. HAZARD IDENTIFICATION

WARNING

Suspected of damaging fertility or the unborn child (H361)
May cause damage to bone marrow through prolonged or repeated exposure (H373)
Very toxic to aquatic life with long lasting effects (H400+H410)

HAZARD CLASSIFICATION

Health Hazards	Category	Environmental Hazards	Category
Reproductive toxicity	2	Hazardous to the aquatic environment, short-term	1
Specific target organ toxicity (repeated exposure)	2	Hazardous to the aquatic environment, long-term	1
Physical Hazards	**Category**		
None	-		

HAZARDS NOT REQUIRING CLASSIFICATION

Do not mix or allow coming in contact with oxidizing agents. Hazardous chemical reaction may occur.

PRECAUTIONARY STATEMENTS

Do not handle until all safety precautions have been read and understood. Wear protective clothing as described in Section 8 of this document. (P202+ P280)

IF exposed or concerned: Get medical advice / attention. Get medical advice/attention if you feel unwell. (P308+P313+P314)

Do not breathe fume/mists/vapors/spray. (P260)

Avoid release to the environment not in accordance with the product label. (P273)

Collect spillage. (P391)

Store locked up. (P405)

Dispose of contents / container in accordance with local regulations. Refer to the product label for specific disposal instructions. (P501)

3. COMPOSITION / INFORMATION ON INGREDIENTS

Common Name	Chemical Name	CAS #	Composition
Flumioxazin	1H-Isoindole-1,3(2H)-dione, 4,5,6,7-tetrahydro-2-(7-fluoro-3,4-dihydro-3-oxo-4-(2-propynyl)-2H-1,4-benzoxazin-6-yl)-	103361-09-7	41.4%
Propylene glycol	1,2-Propanediol	57-55-6	5-8%

NOTE: Ingredients not precisely identified are proprietary or non-hazardous. Values are not product specifications.

4. FIRST AID MEASURES

Have the product container or label with you when calling a poison control center or doctor or going for treatment. For emergency medical assistance, call SafetyCall: 1-844-685-9173. For chemical emergency: spill, leak, fire, exposure or accident, call CHEMTREC: 1-800-424-9300.

5. FIREFIGHTING MEASURES

Flash Point: >110°C (>230°F)

Fire and Explosion Hazards: None known.

Extinguishing Medium: Water fog, carbon dioxide, foam, and dry chemical.

Fire Fighting Equipment: Firefighters should wear full protective clothing and self-contained breathing apparatus.

Fire Fighting Instructions: As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH approved (or equivalent) and full protective gear. Evacuate area and fight fire upwind from a safe distance to avoid hazardous vapors and decomposition products. Dike and collect water used to fight fire to prevent environmental damage due to run off.

Hazardous Combustion Products: Thermal decomposition or combustion may produce harmful/irritant gas or fumes such as nitrogen oxides, carbon oxides, hydrogen fluoride or organic compounds.

NFPA Ratings: Health – 1 / Flammability – 1 / Reactivity - 0

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions: Isolate area and keep unnecessary and unprotected personnel from entering. Wear suitable personal protective clothing and equipment as described in Section 8 of this document.

Environmental Precautions: Prevent material from entering public sewer systems or any waterways. Do not flush to drain. Large spills to soil or similar surfaces may necessitate removal of topsoil. The affected area should be removed and placed in an appropriate container for disposal.

Spill Cleanup: This material will disperse or dissolve in water. Stop the source of the release. Contain and isolate to prevent further release on to soil or into surface water. Dike spill using absorbent or impervious materials such as earth, sand or clay. Collect and contain contaminated absorbent and dike material for disposal. Pump free liquid into an appropriate container. Absorb residual with inert absorbent material. Wash entire spill area with detergent slurry, absorb and sweep into container for disposal. Decontaminate tools and equipment following cleanup.

7. HANDLING AND STORAGE

Handling: Avoid breathing spray mist. Avoid contact with skin, eyes or clothing. Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.

Storage: Store in a tightly closed container in a cool, dry place. Store in original container and out of reach of children, preferably in a locked storage area.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls: Where engineering controls are indicated by specific use conditions or a potential for excessive exposure, use local exhaust ventilation at the point of generation.

Protective Clothing: When working with any chemical, avoid contact with eyes. Eye contact can be avoided by wearing safety glasses. Applicators and other handlers must wear long-sleeved shirt and long pants, shoes plus socks and chemical-resistant gloves made of any waterproof material.

General: Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and was PPE separately from other laundry. Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

Exposure Limits:

Chemical Name	ACGIH Exposure Limits	OSHA Exposure Limits	Manufacturer's Exposure Limits
Flumioxazin	None	None	None
Propylene glycol	None	10 (WEEL)	None
Others	None	None	None

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	off white liquid
Odor:	moderately bittersweet
Melting/freezing point:	not available
Boiling point/Boiling range:	not available
Flammability:	not available
Flammability limits (upper/lower):	not available
Flash point:	>110°C (>230°F)
Auto-ignition temperature:	not available
Decomposition temperature:	not available
pH:	5.5 – 7.5 (1% disp.)
Viscosity:	Non-Newtonian fluid
Solubility:	not available
Partition coefficient:	not available
Vapor pressure:	not available
Specific Gravity:	not available
Bulk Density:	9-10 lbs./gal.
Relative vapor density:	not available
Particle characteristics:	not available

10. STABILITY AND REACTIVITY

CONDITIONS TO AVOID: Extremes of temperature and direct sunlight.

CHEMICAL STABILITY: Stable under recommended storage conditions.

INCOMPATIBILITY WITH OTHER MATERIALS: None known based on information supplied.

HAZARDOUS DECOMPOSITION PRODUCTS: None known based on information supplied.

HAZARDOUS POLYMERIZATION: Will not occur.

11. TOXICOLOGICAL INFORMATION

The following data is from a similar substance:

ORAL TOXICITY (rat LD_{50}): 5,000 mg/kg

DERMAL TOXICITY (rat LD_{50}): > 5,000 mg/kg

INHALATION TOXICITY (rat LC_{50}): > 2.10 mg/L (4-hr) (no mortalities)

EYE IRRITATION: Non-irritating (Rabbit)

SKIN IRRITATION: Slightly irritating (Rabbit)

SKIN SENSITIZATION: Guinea pig – Non-sensitizer

CARCINOGENICITY:

EPA: Not likely to be carcinogenic to humans (flumioxazin)
ACGIH: Not Listed **NTP:** Not Listed
IARC: Not Listed **OSHA:** Not Listed

MUTAGENIC TOXICITY: Flumioxazin Technical was not mutagenic in most in vitro assays: gene mutation and a chromosome aberration assay in the absence of metabolic activation. In three in vivo assays, chromosome aberration, unscheduled DNA synthesis and micronucleus assay, Flumioxazin Technical was not mutagenic. The only positive response was observed in the in vitro chromosome aberration assay in the presence of metabolic activation. Overall, Flumioxazin Technical does not present a genetic hazard.

REPRODUCTIVE TOXICITY: Reproductive effects were observed in rats exposed to high levels of flumioxazin technical. Flumioxazin technical produced birth defects in the offspring of female rats.

SUBCHRONIC TOXICITY: Compound related effects of Flumioxazin Technical noted in rats following subchronic exposures at high dose levels were hematotoxicity including anemia, and increases in liver, spleen, heart, kidney, and thyroid weights. In dogs, the effects produced at high dose levels included a slight prolongation in activated partial thromboplastin time, increased cholesterol and phospholipid, elevated alkaline phosphatase, increased liver weights and histological

11. TOXICOLOGICAL INFORMATION (CONT.)

changes in the liver. The lowest no-observable-effect-level (NOEL) in subchronic studies was 30 ppm in the three-month toxicity study in rats.

CHRONIC/CARCINOGENICITY: In a one year dog feeding study, Flumioxazin Technical produced treatment-related changes in blood chemistry and increased liver weights at 100 and 1000 mg/kg/day. Minimal treatment-related histological changes were noted in the livers of animals in the 1000 mg/kg/day group. Based on these data the NOEL is 10 mg/kg/day. Dietary administration of Flumioxazin Technical for 18 months produced liver changes in mice of the 3000 and 7000 ppm groups. There was no evidence of any treatment-related oncogenic effect. The NOEL for this study is 300 ppm. Dietary administration of Flumioxazin Technical for 24 months produced anemia and chronic nephropathy in rats of the 500 and 1000 ppm groups. The anemia lasted throughout the treatment period, however, it was not progressive nor aplastic in nature. No evidence of an oncogenic effect was observed. The NOEL for this study is 50 ppm.

DEVELOPMENTAL TOXICITY: Flumioxazin Technical produces developmental toxicity in rats in the absence of maternal toxicity at doses of 30 mg/kg/day by the oral route and 300 mg/kg/day by the dermal route. The developmental effects noted consisted primarily of decreased number of live fetuses and fetal weights, cardiovascular abnormalities, wavy ribs and decreased number of ossified sacrococcygeal vertebral bodies. The developmental NOEL in the rat oral and dermal developmental toxicity studies were 10 and 100 mg/kg/day, respectively. The response in rabbits was very different from that in rats. No developmental toxicity was noted in rabbits at doses up to 3000 mg/kg/day, a dose well above the maternal NOEL of 1000 mg/kg/day.

Mechanistic studies indicate that the effects seen in the rat are highly unlikely to occur in the human and that flumioxazin would not be a developmental toxicant in the human.

REPRODUCTION: Reproductive toxicity was observed in F1 males, P1 females and F1 females at 300 ppm Flumioxazin Technical, the highest dose tested and a dose that also produced signs of systemic toxicity. Toxicity was also observed in the F1 and F2 offspring at doses of 200 ppm and grester.

STOT- REPEATED EXPOSURE: Cat 2 – Rat 90-day repeated dose toxicity study: Bone Marrow

12. ECOLOGICAL INFORMATION

This pesticide is practically non-toxic to bees and avian species. It is slightly to moderately toxic to freshwater fish and moderately to highly toxic to aquatic invertebrates.

The following information is for the active ingredient, Flumioxazin:

AQUATIC TOXICITY

Fish (Rainbow Trout) (96-hour LC_{50}): 2.3 mg/kg; (NOEC): >7.7µg/L, <16µg/L
Fish (Bluegill Sunfish) (96-hour LC_{50}): >21 mg/L
Fish (Sheepshead Minnow) (96-hour LC_{50}): >4.7 mg/L
Daphnia magna (Water Flea) (48-hour EC_{50}): >5.5 mg/L; NOEC >52 µg/L, <99µg/L
Invertebrate (Mysid Shrimp) (96-hour LC_{50}): >0.23 mg/L; (NOEC): >15µg/L, <27µg/L
Shell Deposition (Eastern Oyster) (96-hour EC_{50}): 2.8 mg/L

AVIAN TOXICITY

Bobwhite Quail (Oral LD_{50}): > 2,250 ppm
Bobwhite Quail (Dietary LC_{50}): > 5,620 ppm
Mallard Duck (Dietary LC50): >5,620 ppm

OTHER NON-TARGET ORGANISM TOXICITY:

Flumioxazin Technical is practically non-toxic to bees. The acute contact LC50 in bees was greater than 105 µg/bee.

13. DISPOSAL CONSIDERATIONS

PESTICIDE DISPOSAL: Pesticide spray mixture or rinsate that cannot be used should be disposed of in a landfill approved for pesticides. Improper disposal of excess pesticide spray mixture or rinsate is a violation of Federal law. If these wastes cannot be disposed of by the use according to label instructions, contact your State Pesticide or Environmental Control Agency or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL: Nonrefillable container. Do not reuse or refill this container. Refer to the product label for specific container disposal instructions.

14. TRANSPORT INFORMATION

US-DOT: Not regulated[2]

IMDG:

Containers ≤ 1.3 gal. (5 L) in strong outer packaging:
Not regulated

Containers > 1.3 gal. (5 L) or containers not in strong outer packaging:

Shipped internationally by vessel: UN3082, Environmentally hazardous substance, liquid, N.O.S. (contains flumioxazin), 9, PG III, Marine Pollutant

IATA:

Shipments by air: UN3082, Environmentally hazardous substance, liquid, N.O.S. (contains flumioxazin), 9, PG III

This information is not intended to convey all specific regulatory or operational requirements/information relating to this product. Transportation classifications may vary by container volume and may be influenced by regional or country variations in regulations. Additional transportation system information can be obtained through an authorized sales or customer service representative. It is the responsibility of the transporting organization to follow all applicable laws, regulations and rules relating to the transportation of the material.

[2] 49 CFR §172.101 Appendix B(4)

15. REGULATORY INFORMATION

FIFRA –

This chemical is a pesticide product registered by the Environmental Protection Agency and is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets, and for workplace labels of non-pesticide chemicals. The following is the hazard information as required on the pesticide label:

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS

Harmful if inhaled or absorbed through the skin. Causes moderate eye irritation. Avoid breathing spray mist. Avoid contact with skin, eyes, or clothing. Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.

See inside label booklet for additional precautionary statements.

15. REGULATORY INFORMATION (CONT)

ENVIRONMENTAL HAZARDS

This pesticide is toxic to plants. Use strictly in accordance with the drift and run-off precautions on this label in order to minimize off-site exposures.

PHYSICAL OR CHEMICAL HAZARDS

DO NOT mix or allow coming in contact with oxidizing agent. Hazardous chemical reaction may occur.

All pesticides are governed under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The regulatory information presented below is pertinent only when this product is handled outside of the normal use and application as a pesticide. This product is excluded from listing requirements under EPA/TSCA.

SARA Title III – Section 302 Extremely Hazardous Substances
Not listed

SARA Title III – Section 311/312 Hazard Categories
Immediate (acute), Delayed (chronic)

SARA Title III – Section 312 Threshold Planning Quantity
The threshold planning quantity (TPQ) for this product treated as a mixture is 10,000 lbs. This product contains no ingredients with a TPQ of less than 10,000 lbs.

SARA Title III – Section 313 Reportable Ingredients
None

CERCLA Reportable Quantity (RQ) –
None

CALIFORNIA PROP 65 STATUS –
This product does not contain any chemical known to the State of California to cause cancer or other reproductive harm.

CANADA –
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the SDS contains all of the information required by CPR.

16. OTHER INFORMATION

This Safety Data Sheet (SDS) serves different purposes than and DOES NOT REPLACE OR MODIFY THE EPA APPROVED PRODUCT LABELING (attached to and accompanying the product container). This SDS provides important health, safety, and environmental information for employers, employees, emergency responders and others handling large quantities of the product in activities generally other than product use, while the labeling provides that information specifically for product use in the ordinary course.

To the extent consistent with applicable law, neither Atticus, LLC nor Seller be liable for any incidental, consequential or special damages resulting from the use or handling of this product. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE EXCLUSIVE LIABILITY OF ATTICUS, LLC AND SELLER FOR ANY AND ALL CLAIMS, LOSSES, INJURIES OR DAMAGES (INCLUDING CLAIMS BASED ON BREACH OF WARRANTY, CONTRACT, NEGLIGENCE, TORT, STRICT LIABILITY OR OTHERWISE) RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT, SHALL BE THE RETURN OF THE PURCHASE PRICE OF THE PRODUCT OR, AT THE ELECTION OF ATTICUS, LLC OR SELLER, THE REPLACEMENT OF THE PRODUCT.

SDS Version: 1.0 Effective Date: 10/06/2020

MATERIAL SAFETY DATA SHEET

RED RIVER 90

MSDS DATE: 7/16/10
SUPERSEDES: 04/06/06

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: RED RIVER 90

DISTRIBUTOR: Red River Specialities, Inc
ADDRESS: PO Box 7241, Shreveport, LA 71137

INFORMATION PHONE: 318-425-5944

CHEMICAL NAME: Nonionic Surfactant Blend
CHEMICAL FAMILY: Nonionic Surfactant
CHEMICAL FORMULA: Mixture

PRODUCT USE: Adjuvant

SECTION 1 NOTES: None

SECTION 2: HAZARDOUS INGREDIENTS

			SARA 313	OSHA			ACGIH		
INGREDIENT	CAS NO.	% WT/% VOL	REPORTABLE	TWA	STEL	Ceiling	TWA	STEL	Ceiling
Ethanol, 2, 2-oxybis	111-46-6	<20	No	Not established			Not established		
Ethylene oxide	75-21-8	<1 ppm	No	1 ppm	5ppm/15min		1 ppm		

SECTION 2 NOTES: None

SECTION 3: HAZARDS IDENTIFICATION

ROUTES OF ENTRY: Eyes, skin, ingestion, inhalation

POTENTIAL HEALTH EFFECTS

EYES: Slightly irritating. May cause redness, ittitation.

SKIN: Brief contact is not irritating. Prolonged contact may cause redness.

INGESTION: May cause abdominal discomfort, nausea, vomiting and diarrhea.

INHALATION: Inhalation not likely. Mist may cause irritation of the respitory tract.

ACUTE HEALTH HAZARDS:

CHRONIC HEALTH HAZARDS:

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE:

CARCINOGENICITY
OSHA: No **ACGIH:** No **NTP:** No **IARC:** No **OTHER:** No

SECTION 3 NOTES: None

SECTION 4: FIRST AID MEASURES

If in Eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses if present, after the first 5 minutes, then continue rinsing eye. Have the product container with you when calling a poison control center or doctor, or going for treatment.

If on Skin or Clothing: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes.

If Swallowed: Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person.

If Inhaled: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth to mouth if possible.

NOTES TO PHYSICIANS OR FIRST AID PROVIDERS:

SECTION 4 NOTES: None

SECTION 5: FIRE-FIGHTING MEASURES

FLAMMABLE LIMITS IN AIR, UPPER: NA
(% BY VOLUME) LOWER: NA

FLASH POINT:
F: >200
C: >93
METHOD USED: PMCC

AUTOIGNITION TEMPERATURE:
F: NA
C: NA

NFPA HAZARD CLASSIFICATION
HEALTH: 1 **FLAMMABILITY:** 1 **REACTIVITY:** 0 **OTHER:** -

HMIS HAZARD CLASSIFICATION
HEALTH: NA **FLAMMABILITY:** NA **REACTIVITY:** NA **PROTECTION:** NA

EXTINGUISHING MEDIA: Foam, Water fog, Dry chemical, ABC fire extinguisher.

SPECIAL FIRE FIGHTING PROCEDURES: Self-contained positive breathing apparatus and protective clothing should be worn.

UNUSUAL FIRE AND EXPLOSION HAZARDS: None known

HAZARDOUS DECOMPOSITION PRODUCTS: NA

SECTION 5 NOTES: None

SECTION 6: ACCIDENTAL RELEASE MEASURES

ACCIDENTAL RELEASE MEASURES: If material is released or spilled wear eye and skin protection. Floor may be slippery; use care to avoid falling. Contain spill immediately with inert materials (e.g. sand, earth). Avoid discharge to natural waters. Transfer liquids and solid diking material to suitable containers for recovery or disposal.

SECTION 6 NOTES: None

SECTION 7: HANDLING AND STORAGE

HANDLING AND STORAGE: Use with adequate ventilation. Wash thoroughly after handling. Keep away from heat, sparks and flames.

SECTION 7 NOTES: Keep in original container tightly closed. Do not reuse empty container. Avoid contact with eyes, skins, and clothing. Do not store with food, feed, or other material to be used or consumed by humans or animals.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

VENTILATION :	Local exhaust ventilation recommended if generating vapor, dust, or mist. If exhaust ventilation is not available or inadequate, use MSHA or NIOSH approved respirator as appropriate.
RESPIRATORY PROTECTION:	None necessary unless local exhaust is inadequate. Then use NIOSH-appoved PPE
EYE PROTECTION:	Chemical safety goggles
SKIN PROTECTION:	Impervious gloves and clothing
OTHER PROTECTIVE CLOTHING OR EQUIPMENT:	Long-sleeves and pants. Safety showers and eye wash stations
WORK HYGIENIC PRACTICES:	Wash thoroughly with soap and water after handling product and before eating, drinking, or using tobacco products. Clean affected clothing, shoes, and protective equipment before reuse.
EXPOSURE GUIDELINES:	None estabfished for this product
SECTION 8 NOTES:	None

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE:	Clear, light golden
ODOR:	Alcohol
PHYSICAL STATE:	Liquid
pH AS SUPPLIED:	NA
pH (Other):	
BOILING POINT:	NA
F:	Unknown
C:	Unknown
MELTING POINT:	
F:	Unknown
C:	Unknown
FREEZING POINT:	
F:	Unknown
C:	Unknown
VAPOR PRESSURE (mmHg):	Unknown
@	
F:	NA
C:	NA
VAPOR DENSITY (AIR = 1):	Unknown
@	
F:	NA
C:	NA
SPECIFIC GRAVITY (H2O = 1):	
@	
F: 68	~1.03
C: 20	
EVAPORATION RATE:	Unknown
BASIS (butyl acetate=1):	
SOLUBILITY IN WATER:	Soluble
VISCOSITY:	Unknown
@	
F:	NA
C:	
SECTION 9 NOTES:	None

SECTION 10: STABILITY AND REACTIVITY

STABILITY: Stable ◉ Unstable ○

CONDITIONS TO AVOID (STABILITY): Open flame or extreme heat.

INCOMPATIBILITY (MATERIAL TO AVOID): Avoid strong oxidizing and reducing agents.

HAZARDOUS DECOMPOSITION OR BY-PRODUCTS: Burning can products carbon monoxide and/or carbon dioxide.

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID (POLYMERIZATION): None

SECTION 10 NOTES: None

SECTION 11: TOXICOLOGICAL INFORMATION

TOXICOLOGICAL INFORMATION: Not available

SECTION 11 NOTES: None

SECTION 12: ECOLOGICAL INFORMATION

ECOLOGICAL INFORMATION: Not available

SECTION 12 NOTES: None

SECTION 13: DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHOD: Do not contaminate water, food or feed by storage or disposal. Dispose of in an approved waste disposal facility in accordance with all Federal, State and Local Regulations. Offer container for recycling or dispose of in a sanitary landfill or by other procedures approved by local regulations.

RCRA HAZARD CLASS: Not regulated

SECTION 13 NOTES: None

SECTION 14: TRANSPORT INFORMATION

U.S. DEPARTMENT OF TRANSPORTATION

PROPER SHIPPING NAME:	Not regulated
HAZARD CLASS:	Not regulated
ID NUMBER:	Not regulated
PACKING GROUP:	Not regulated
LABEL STATEMENT:	Not regulated

OTHER AGENCIES: None

SECTION 14 NOTES: None

SECTION 15: REGULATORY INFORMATION

U.S. FEDERAL REGULATIONS

TSCA (TOXIC SUBSTANCE CONTROL ACT): All components of this product are listed or excluded from listing on the US Toxic Substance Control Act (TSCA) Chemical Substance Inventory.

CERCLA (COMPREHENSIVE RESPONSE COMPENSATION, AND LIABILITY ACT):

Chemical Name	CAS Number	Range in %	RQ
Glycol ethers (fraction of product matching EPA definition)	Mixture	1.00-2.99	1
Residual ethylene oxide (typical)	75-21-8	<0.001	10

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT):

Section 302/304 Extremely Hazardous Substances

Chemical Name	CAS Number	Range in %	TPQ	RQ
Residual ethylene oxide (typical)	75-21-8	<0.001	Below reportable concentrations	

311/312 HAZARD CATEGORIES:
This product has been reviewed according to the EPA "Hazard Categories" promulgated under Section 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

313 REPORTABLE INGREDIENTS:

CAS Number	Chemical Name	Concentration
Mixture	Glycol ethers (fraction of product matching EPA definition)	0.20-0.69

STATE REGULATIONS:

WARNING! This product contains a detectable amount of ethylene oxide, which is known to the State of California to cause cancer and/or reproductive toxicity.

Ethoxylated products may contain residual amounts of ethylene oxide (EO) which can accumulate in the container headspace and be released into the ambient environment. This process is enhanced when the product is agitated, as during tank car loading and unloading, and blending operations. Ethylene oxide causes tumors in laboratory animals. The Occupational Safety and Health Administration (OSHA) Permissible Exposure Level (PEL) for EO is 1 ppm for an eight-hour time weighted average exposure. The standard regulates occupational exposure to EO from all sources, including products containing residual EO. It is the responsibility of the employer to comply with OSHA ethylene oxide standard (29) CFR 1910.1047).

INTERNATIONAL REGULATIONS: None

SECTION 15 NOTES: None

SECTION 16: OTHER INFORMATION

OTHER INFORMATION: None

PREPARATION INFORMATION: Prepared on 7/16/10

DISCLAIMER:

The recommendation for safe handling and protection procedures is believed to be generally suitable for the standard uses of this compound. However, each user should identify his intended uses of this material and determine whether they are appropriate. All data included in this document is released as typical values and should not be utilized to determine the suitability of this material for a particular use or purpose. No warranty, either expressed or implied, is hereby made, nor do we give permission, inducement, or recommendations to practice any patented invention without a license. All data is offered for consideration, investigation and verification purposes only.

Red River Specialties, Inc.
PO Box 7241
Shreveport, LA 71137

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Big Creek Lake Invasive Species Study and Operational Alternatives Analysis

MAWSS
MOBILE AREA WATER & SEWER SYSTEM

October 9, 2024

Contents

Tables

Appendices

1 Introduction

Big Creek Lake is a municipal reservoir located in the Escatawpa watershed and the main drinking water supply for Mobile, Alabama and the surrounding communities. Three tributaries flow into Big Creek Lake, including Big Creek, Crooked Creek, and Hamilton Creek. On June 27, 2021, giant salvinia (*Salvinia molesta*) was detected in Big Creek Lake in Mobile, Alabama. Giant salvinia is an exotic, invasive, floating aquatic plant that forms large, dense floating mats. If not controlled, the giant salvinia can be a limiting factor for native plant growth, reduce bioavailable oxygen, and cause degradation of water quality for aquatic species. In addition, giant salvinia mats impede boating, fishing, and swimming.

At the request of the Mobile Area Water and Sewer System (MAWSS), HDR has prepared recommendations for MAWSS to consider adopting into their invasive species management program for Big Creek Lake.

2 Review of Potential Invasive Species and Management Practices at Big Creek Lake

An invasive species is defined in the United States as a non-native organism whose introduction causes or is likely to cause economic or environmental harm, or harm to human, animal, or plant health. It is estimated that currently invasive species cost the United States approximately $21 billion per year with a majority of costs related to damages and losses as opposed to invasive species management (Fantle-Lepczyk et al., 2022).

The species of primary concern in Big Creek Lake is giant salvinia. Additional invasive aquatic species identified by Barry A. Vittor & Associates and most recently by HDR during site visits were also considered in this review along with potential invasive species that have the chance to be introduced to Big Creek Lake, were also considered. A cost analysis for species removal or treatment is provided. Past and current treatment programs as carried out by the contractor Aqua Services Inc. are discussed and include water quality implications from the use of aquatic herbicides within Big Creek Lake.

2.1 Potential Aquatic Invasive Species

It is recommended that MAWSS continually monitor the U.S. Department of Agriculture (USDA) National Invasive Species Center website list of Aquatic Invasives and the Invasive.org Center for Invasive Species and Ecosystem Health list of Invasive and Exotic Aquatic Plants. Based on this inventory, a preliminary list of aquatic invasive species, including plants and mollusks, were created to note those invasive species that have the potential to impact the water quality of Big Creek Lake and the water treatment facility infrastructure and operations. MAWSS should be knowledgeable of these species, understand their potential impacts, and implement sound measures to prevent their introduction into Big Creek Lake. In order to be prepared for a potential introduction

into Big Creek Lake by these species, it is critical that MAWSS has a proactive understanding of species-specific control and management methods.

To initiate the review of the potential invasive species and management practices at Big Creek Lake, Table 1 was developed to provide a preliminary list of invasive species that MAWSS should be aware of that have the potential to clog water intake systems and disrupt water quality. This list includes aquatic invasive plants and mollusks. It should be noted that mechanical removal or hand removal of invasive species compared to pesticide application is typically the better management approach when considering water quality and removing plant seed sources. However, herbicide application is needed for follow-up maintenance and is a critical management tool.

Table 1 – Potential Invasive Species

Potential Invasive Species Threats to the MAWSS Big Creek Lake Water Treatment Facility			
Invasive Aquatic Plants			
(with a focus on floating and submerged aquatic plants with potential to clog water intake systems and/or disrupt water quality)			
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Currently confirmed present in Big Creek Lake		Eurasian watermilfoil	*Myriophyllum spicatum*
Alligatorweed	*Alternanthera philoxeroides*	Feathered mosquito-fern	*Azolla pinnata*
Cuban bulrush	*Cyperus blepharoleptos*	Giant reed*	*Arundo donax*
Giant salvinia	*Salvinia molesta*	Hydrilla	*Hydrilla verticillate*
Parrotfeather	*Myriophyllum aquaticum*	Purple loosestrife*	*Lythrum salicaria*
Primrose willow*	*Ludwigia* spp.	Water chestnut	*Trapa* natans
Torpedograss*	*Panicum repens*	Water hyacinth	*Eichhornia* crassipes
Species that are not currently confirmed present		Water lettuce	*Pistia stratiotes*
Brazilian waterweed	*Egeria densa*	Water-clover	*Marsilea spp.*
Brittleleaf naiad	*Najas minor*		
Common reed*	*Phragmites australis*		
*Species that are mostly considered non-floating aquatics but can create floating mats and islands when combined with other floating aquatic species. Some of these can have dense root systems allowing them to become floating islands.			
Invasive Aquatic Mollusks			
(with a focus on freshwater lake species with potential to clog water intake systems)			
Common Name		**Scientific Name**	
Asian clam		*Corbicula fluminea*	
Quagga Mussel		*Dreissena rostriformis bugensis*	
Zebra mussels		*Dreissena polymorpha*	

2.2 Invasive Species Management Practices

2.2.1 Recommended Herbicides for Managing Existing and Potential Invasive Species

Aquatic herbicides are chemicals used to control aquatic plants by either killing the target species, or by severely interrupting growth. Aquatic herbicides vary in modes of action and in spectrum of weeds controlled by a given active ingredient. Herbicides can be generally grouped as either contact herbicides or systemic herbicides. Contact herbicides act quickly and are less selective than systemic herbicides as they are lethal to all plant cells that they come into contact with. Contact herbicides do not move throughout plant tissues and are more effective on annual herbaceous species. Systemic herbicides are typically slower acting as they are absorbed by plants and translocated throughout the plants tissues where they disrupt chemical processes vital to plant survival. Because of this ability to translocate throughout the entire plant, systemic herbicides can kill roots and woody tissues from the inside resulting in better control of perennial and woody species (Avery 2013).

Both systemic and contact herbicides have a Mode of Action (MOA) that describes the targeted biological process that is disrupted by the active ingredient of the herbicide. These biological processes control plant growth and development and, once an herbicide is applied, are disrupted resulting in plant death and injury (UF/IFAS 2020b). Closely related to the MOA designation, is the Weed Science Society of America's (WSSA) resistance management grouping. MOA and WSSA resistance classifications can provide insight on the possibility of an invasive plant population developing resistance to an herbicide MOA within a particular grouping. Overreliance on a single MOA for weed control in a given system will increase the probability of selecting for an herbicide-resistant population.

To prevent and mitigate herbicide resistance, it is advised that applicators rotate or combine herbicides with differing MOAs to reduce the selective pressure applied by any one active ingredient. Applying different products that use the same active ingredient, or different active ingredients that are within the same MOA, does not constitute resistance management (UF/IFAS 2020b).

All aquatic herbicide products for use in United States waters must be registered and labeled for use by the U.S. Environmental Protection Agency and subsequently approved on an individual basis by the state agency charged with pesticide registration (Masser et al. 2003). Trademarked aquatic herbicides are approved on an individual basis, regardless of whether an active ingredient is already approved for aquatic use in other registered products.

Table 2 provides a list of approved aquatic herbicides that are effective for treating the previously identified aquatic plant threats in Big Creek Lake, while noting the two currently used herbicides – flumioxazin and penoxsulam. Based on current and potential invasive plant species threats, 12 active ingredients were identified as viable options to control these threats in Big Creek Lake as noted in Table 2. These active ingredients and recommended trademarked products have all been approved for aquatic use in Alabama

by the Alabama Department of Agriculture and Industry and are discussed briefly in this section. For each of these 12 active ingredients, it is important to note the following:

- When applying pesticides, the label is the law and must be adhered to. All applications of aquatic herbicides are the sole responsibility of the licensed applicator contracted to carry out such work.
- Individual herbicide product labels detail conditions and methods that are utilized under specific situations which will have to be evaluated on a case-by-case basis by the licensed applicator.
- Aquatic herbicides are not toxic to fish when applied according to label directions. Not following label directions can result in fish kills (Masser et al. 2003).
- In a growing number of cases ,aquatic plants are developing herbicide resistance. For this reason, it is prudent to rotate herbicides used on a specific weed in specific areas and not use the same or cheapest herbicide over and over (Masser et al. 2003).
- Certain active ingredients have annual application limits that must be adhered to, these limits were developed with consideration to ecological and human health, as well as herbicide resistance in target species. As such, it is encouraged that MAWSS considers the entire array of approved, aquatic herbicides presented for use on invasive plant threats.

Table 2 – Approved Aquatic Herbicides

Aquatic group & vegetation	bispyribac	carfentrazone	chelated copper	diquat	endothall	flumioxazin[2]	glyphosate	imazamox	imazapyr	Penoxsulam[2]	triclopyr	2,4-D
	Floating plants											
feathered mosquitofern		G		G						E		
giant salvinia[1]		G		G		G	G	E		E		
water chestnut						E		G			G	G
water hyacinth	E	G	G	E			G	E	E	E	E	E
water lettuce	E	E	G	E		E	G		E	E	G	
water clover				E			G				G	
	Submersed plants											
eurasian watermilfoil	G	E	G	E	E	G		G		E	E	E
hydrilla	E		G	G	G	G		G		E		
brazilian waterweed			G	E		E				G		
brittleleaf naiad			G	E	E	E				G		
Parrotfeather[1]				E	E	G		G	G	G	G	E
	Emergent plants											
Alligatorweed[1]	E					G	G	G	E		E	
common reed							E	G	E			
giant reed							E	G	E			
cuban bulrush[1]							G		E	G		
primrose-willow[1]							E	E	E		E	E
purple loosestrife							E		E			
torpedo grass[1]							E		E			

1 - Species that are confirmed present in Big Creek Lake, 2 - Herbicides currently being used to treat vegetation in Big Creek Lake,
E = excellent control, G = good control
Source: Southern Regional Aquaculture Center, Aquatic Weed Management: Herbicides. February 2013.

Additional information regarding each of these recommended aquatic herbicides is summarized below.

Bispyribac

Bispyribac-sodium is a selective, systemic herbicide. It is effective on many floating and submerged aquatic plants. Its mode of action is to inhibit acetolactate synthase (ALS), which is a key plant enzyme in the synthesis of certain amino acids. It is slow acting and requires 30 to 60 days contact time for submerged plant control. For submerged species, treat closed-off coves for best results. It can be applied either subsurface or foliar, depending on the target plant.

Registered aquatic herbicide product(s): Tradewind

Target species: water hyacinth, water lettuce, eurasian watermilfoil, hydrilla, alligatorweed

Herbicide group, MOA: 2, ALS Inhibitor

Application notes: An approved nonionic surfactant should be added when it is used as a foliar application. Allow 30 days between applications and apply no more than 8 oz of product per acre per year. Do not exceed 4 applications per year.

Carfentrazone

Carfentrazone is a liquid contact herbicide that is light-dependent in its activity. Its mode of action promotes the formation of peroxides, which serve to disrupt cell membranes. It can control many floating species and some submersed and emergent species. It degrades rapidly in high pH water (pH > 9), which may result in reduced efficacy, as will murky water conditions.

Registered aquatic herbicide name(s): Stingray

Target species: feathered mosquitofern, giant salvinia, water hyacinth, water lettuce, eurasian watermilfoil

Herbicide group, MOA: 14, PPO Inhibitor

Application notes: An approved nonionic surfactant should be added when it is used as a foliar application. Wait a minimum of 14 days between retreatment of the same body of water. Do not exceed 13.5 fluid ounces per acre in any single application. Do not use tank additives that alter the spray solution below pH 5 or above pH 8. Buffer solution to alter the pH range as appropriate.

Chelated copper complexes

Copper is used as a contact herbicide, when it is held in an organic complex it is known as chelated copper. Chelated copper formulations do not readily precipitate in high alkalinity waters, but stay in solution and remain active longer than copper sulfate. Because it is more soluble, chelated copper is generally used at slightly lower rates than copper sulfate. Chelated copper formulations are slightly less toxic to fish than copper sulfate. Chelated copper compounds such as Komeen and Nautique are particularly effective on submersed plant species.

Registered aquatic herbicide name(s): Nautique, Komeen

Target species: water hyacinth, water lettuce, eurasian watermilfoil, hydrilla, Brazilian waterweed, brittleleaf naiad

Herbicide group, MOA: Undefined

Application notes: A nonionic surfactant can be added to improve distribution of the herbicide when treating floating vegetation. Do not treat more than half of a water body at one time and wait at least 14 days between treatments. Do not apply more than 1.0 ppm as metallic copper in any waters during any single treatment.

Diquat

Diquat is a contact herbicide that can be sprayed or injected into water to control submersed weeds and filamentous algae. Its mode of action is the destruction of cell membranes. It can also be used as a foliar application to control floating vegetation. Diquat binds tightly to clay particles and is not effective in muddy water. Diquat quickly kills plants and should be used as a partial pond treatment for dense vegetation. Mixing diquat with liquid chelated copper has proven to provide better control of many submersed weeds than either chemical alone.

Registered aquatic herbicide name(s): Tribune, Reward, Diquat

Target species: feathered mosuitofern, giant salvinia, water hyacinth, water lettuce, water clover, eurasian watermilfoil, hydrilla, Brazilian waterweed, brittleleaf naiad, parrotfeather

Herbicide group, MOA: 22, Photosystem I Electron Diverter

Application notes: An approved nonionic surfactant must be added when diquat is used as a foliar application. Do not treat more than half of the water body at one time and wait at least 14 days between treatments.

Endothall

Endothall is a selective contact herbicide that is absorbed rapidly and damages the cells of susceptible plants, but does not affect areas untouched by the herbicide, like roots or tubers. The dipotassium salt of endothall successfully controls many submersed weeds as either spot or partial lake treatments. Plant damage is typically apparent within one week.

Recommended aquatic herbicide name(s): Aquathol K

Target species: eurasian watermilfoil, hydrilla, brittleleaf naiad, parrotfeather

Herbicide group, MOA: Undefined, PPO Inhibitor

Application notes: Use lower labeled rates for large contiguous treatment blocks or in protected areas such as coves where reduced water movement will not result in rapid dilution of the active ingredient from the target treatment area.

Flumioxazin

Flumioxazin is a broad-spectrum contact herbicide. It is fast acting and may be applied either subsurface or as a foliar spray. It controls certain floating weeds, submersed plant species, and macrophytic filamentous algae. Its mode of action is by inhibiting synthesis of an enzyme required in chlorophyll production. It should be applied to actively growing plants. Flumioxazin degrades more rapidly in high pH water (pH > 8.5), which may greatly reduce efficacy**.** When making applications to submersed weeds, the label recommends using weighted hoses to distribute the herbicide within the plant bed.

Registered aquatic herbicide name(s): Schooner-SC, Clipper-SC, Semera-SC

Target species: giant salvinia, water chestnut, water lettuce, eurasian milfoil, hydrilla, Brazilian waterweed, brittleleaf naiad, parrotfeather, alligatorweed

Herbicide group, MOA: 14, PPO Inhibitor

Application notes: An aquatically approved nonionic surfactant should be added when it is used as a foliar application. Do not retreat the same section of water within 28 days of application, except in areas with dense weed cover - in these areas, treat the remaining weeds within 10-14 days. Do not exceed 400 ppb of this product during any one application. Do not retreat the same section of water with this product more than 6 times per year. Mix with water having pH of 5 to 7. If pH is higher than 7, use an appropriate buffering agent if necessary.

Glyphosate

Glyphosate is a foliar-applied, systemic herbicide used to control most shoreline vegetation and several emersed weeds. Glyphosate translocates from the treated foliage to underground storage organs (e.g., rhizomes). Its mode of action is to inhibit the synthesis of certain amino acids and other

secondary metabolites. It is most effective when applied during a perennial weed's flowering or fruiting stage. On annual species it is most effective when applied during active plant growth.

Registered aquatic herbicide name(s): AquaNeat, Round Up Custom

Target species: water hyacinth, water lettuce, water clover, alligatorweed, common reed, giant reed, Cuban bulrush, primrose willow, purple loosestrife, torpedo grass

Herbicide group, MOA: 9, EPSP Synthase Inhibitor

Application notes: A nonionic surfactant should be added with when using glyphosate products that do not come pre-mixed with surfactant. Do not exceed 8 quarts per acre per year or during any single treatment. Avoid wash-off of sprayed foliage by spray boat or recreational boat backwash or by rainfall within 6 hours of application. Do not retreat within 24 hours following the initial treatment.

Imazamox

Imazamox is a selective, systemic herbicide that is effective in controlling many floating, submersed, and emergent plants. Its mode of action is to inhibit the enzyme acetohydroxyacid synthase (AHAS), which is involved in the synthesis of certain amino acids. It may be particularly effective on plants such as water hyacinth and water lettuce. It is a slow-acting herbicide that takes 60 to 120 days or longer to completely kill the target plants.

Registered aquatic herbicide name(s): Clearcast, Castaway

Target species: giant salvinia, water chestnut, water hyacinth, eurasian milfoil, hydrilla, parrotfeather, alligatorweed, common reed, giant reed, primrose willow

Herbicide group, MOA: 2, ALS Inhibitor

Application notes: A nonionic surfactant should be added when used as a foliar application. Wait 10 days between retreatment and do not apply more than 36 treatments per year. Do not apply to achieve a total active ingredient concentration in the water greater than 500 ppb.

Imazapyr

Imazapyr is a foliar-applied, translocated, systemic herbicide used to control many floating and emergent weed species. It appears to be particularly effective on emergent plants such as alligatorweed and giant reed. Imazapyr is rapidly absorbed by plants and works in the meristematic tissue by inhibiting the synthesis of certain amino acids in protein production. The growing plant tips usually yellow and die within 1 to 4 weeks after treatment.

Registered aquatic herbicide name(s): Polaris, Ecomazapyr

Target species: water hyacinth, water lettuce, parrotfeather, alligatorweed, common reed, giant reed, Cuban bulrush, primrose-willow, purple loosestrife, torpedo grass

Herbicide group, MOA: 2, ALS Inhibitor

Application notes: A nonionic surfactant should be used with imazapyr. Wait at least 10 – 14 days between treatments and do not apply more than 5 pints per acre per year. Imazapyr is unaffected by rain 1 hour after application.

Penoxsulam

Penoxsulam is a selective, systemic herbicide that is available in a liquid formulation. It can be absorbed through emerged leaves and submerged shoots or roots. Penoxsulam is currently the only aquatic herbicide that can be applied to exposed sediment after drawdown to inhibit the regrowth of susceptible weeds. Its mode of action is by inhibiting acetolactate synthase (ALS), which is a key plant enzyme in the synthesis of certain amino acids. It is effective in controlling many floating and submerged aquatic plants. Rapid dilution of in-water application will reduce its effectiveness. It is a slow-acting herbicide that takes 60 to 120 days or longer to completely kill the target plants, so any condition resulting in rapid dilution of treated water will reduce its effectiveness.

Registered aquatic herbicide name(s): Galleon-SC

Target species: feathered mosquitofern, giant salvinia, water hyacinth, water lettuce, eurasian milfoil, hydrilla, Brazilian waterweed, brittleleaf naiad, parrotfeather, Cuban bulrush

Herbicide group, MOA: 2, ALS Inhibitor

Application notes: A nonionic surfactant should be added when treating floating and emergent vegetation. The concentration of any single application or sum of all applications must not exceed 150 ppb per annual growth cycle for in-water applications.

Triclopyr

Triclopyr is a systemic herbicide used to control many floating, submersed and emergent plants. Its mode of action is to stimulate uncontrolled cell division and growth in the meristematic tissue, which ultimately causes plant death. It may be particularly effective on plants such as alligatorweed, willows, water hyacinth and milfoils. It can be applied to the leaves or to cut surfaces. Triclopyr works by translocating to the roots and disrupting growth metabolism. Therefore, it should be applied while plants are actively growing and leaves are fully developed.

Registered aquatic herbicide name(s): Garlon 3A, Renovate 3

Target species: water chestnut, water hyacinth, water lettuce, water clover, eurasian milfoil, parrotfeather, alligatorweed, primrose willow

Herbicide group, MOA: 4, T1R1 Auxin Receptors

Application notes: A non-ionic surfactant should be added when treating floating and emergent vegetation. When applying by sub-surface injection to control submersed species, use a weighted trailing hose. Apply no more than 2 gallons per acre per year.

2,4-D

2,4-D is a systemic herbicide. Its mode of action is to stimulate uncontrolled cell division and growth in the meristematic tissue, which ultimately causes plant death. 2,4-D is particularly effective in control of floating weeds and several emergent weeds. 2,4-D is available as an ester or amine formulation. Amine formulations are slightly better for aquatic applications because they are less toxic to fish.

Registered aquatic herbicide name(s): Weedar 64, Clean Amine

Target species: water chestnut, water hyacinth, eurasian milfoil, parrotfeather, primrose willow

Herbicide group, MOA: 4, T1R1 Auxin Receptors

Application notes: A non-ionic surfactant should be added when treating floating and emergent vegetation. Wait 21 days between retreatment and do not apply more than 2 treatments per season. Do not exceed 8.42 pints per surface acre per season.

Table 3 provides a summary of information presented in this section and provides each aquatic herbicides' active chemical ingredient, approved application rates, costs, and their associated water quality implications. For more detailed information on recommended application rates for use on identified and potential invasive plant species in Big Creek Lake, refer to Appendix A. Details on recommended aquatic herbicides, Mode of Action, herbicide resistance grouping, and potential target species are presented below. Product labels and Safety Datasheets (SDS) for all recommended aquatic herbicides will be provided to MAWSS outside of this report.

Table 3 – Herbicide Evaluation

							Water Quality Impacts (short term & long term, aquatic life and humans)			
Aquatic Herbicide Products (and generics)	**Active Ingredient**	**Target Species**	**Foliar Application Rate (min-max rate)**	**Submersed Application Rate (min-max rate)**	**Cost range per acre (foliar rate)**	**Cost range per acre (submersed rate*2.5')**	**Potable Water Use Restrictions**	**Recreational Restrictions (fishing and swimming)**	**Aquatic Life Water Quality Criteria***	**Human Health Water Quality Criteria***
Herbicides Currently Used at Big Creek Lake										
Schooner-SC, Clipper-SC, Semera-SC	flumioxazin	salvinia, water chestnut, water lettuce, eurasian milfoil, hydrilla, Brazilian waterweed, naiad, parrotfeather, alligatorweed	6-12 fl oz / acre	1.1-2.1 pt / acre-foot	$15.00 - $34.22	$110.00 - $239.53	No restriction	No restriction	N/A	N/A
Galleon-SC	penoxsulam	mosuitofern, salvinia, water hyacinth, water lettuce, eurasian milfoil, hydrilla, Brazilian waterweed, naiad, parrotfeather, cuban bulrush	2-5.6 fl oz/ acre	4.4-26.1 fl oz / acre-foot	$42.15 - $118.02	$231.82 - $1375.12	No restriction	No restriction	N/A	N/A
Herbicides Effective Against Potential Invasive Species										

							Water Quality Impacts (short term & long term, aquatic life and humans)			
Aquatic Herbicide Products (and generics)	**Active Ingredient**	**Target Species**	**Foliar Application Rate (min-max rate)**	**Submersed Application Rate (min-max rate)**	**Cost range per acre (foliar rate)**	**Cost range per acre (submersed rate*2.5')**	**Potable Water Use Restrictions**	**Recreational Restrictions (fishing and swimming)**	**Aquatic Life Water Quality Criteria***	**Human Health Water Quality Criteria***
Tradewind	bispyribac	water hyacinth, water lettuce, eurasian milfoil, hydrilla, alligatorweed	1-8 oz / acre	1.3-2.4 oz / acre-foot	$48.46 - $387.65	$157.48 - $290.74	No restriction	No restriction	N/A	N/A
Stingray	carfentrazone	mosquitofern, salvinia, water hyacinth, water lettuce, eurasian milfoil	3.4-13.5 fl oz / acre	0.29 gal / acre-foot	$17.27 - $68.58	$471.28	1 day restriction on use if >20% of water body surface is treated. Cannot be applied directly to water within 0.25 mi of an active intake. (Maximum contaminant goal level of 0.2 ppm)	No restriction	N/A	N/A
Nautique	chelated copper	water hyacinth, water lettuce, eurasian milfoil, hydrilla, brazilian waterweed, naiad	4-12 gal / acre	1.8-3 gal / acre-foot	$167.48 - $502.44	$188.42 - $314.03	No restriction	No restriction	Yes; determined by calculation (Eq. 5 and 6 in document).	Yes; MCL 1300 ug/L
Komeen	chelated copper	water hyacinth, water lettuce, eurasian milfoil, hydrilla, brazilian waterweed, naiad	3.3 gal / acre	1.7-3.3 gal / acre-foot	$113.45	$146.12 - $283.64	No restriction	No restriction	Yes; determined by calculation (Eq. 5 and 6 in document).	Yes; MCL 1300 ug/L
Tribune, Reward	diquat	mosquitofern, salvinia, water hyacinth, water lettuce, water clover, eurasian milfoil, hydrilla, Brazilian	0.5-2 gal / acre	0.5-2.0 gal / acre-foot	$34.40 - $192.00	$86.00 - $480.00	1-3 day restriction on use (Maximum contaminant goal level of 0.02 ppm)	No restriction	N/A	N/A

							Water Quality Impacts (short term & long term, aquatic life and humans)			
Aquatic Herbicide Products (and generics)	**Active Ingredient**	**Target Species**	**Foliar Application Rate (min-max rate)**	**Submersed Application Rate (min-max rate)**	**Cost range per acre (foliar rate)**	**Cost range per acre (submersed rate*2.5')**	**Potable Water Use Restrictions**	**Recreational Restrictions (fishing and swimming)**	**Aquatic Life Water Quality Criteria***	**Human Health Water Quality Criteria***
		waterweed, naiad, parrotfeather								
Aquathol K	endothall	eurasian milfoil, hydrilla, naiad, parrotfeather	1.9-3.2 gal / acre	1.3-3.2 gal / acre-foot	$158.27 - $266.56	$270.73 - $666.40	7-25 day restriction on use. Cannot be applied directly to water within 0.5 mi of an active intake. (Maximum contaminant goal level of 0.1 ppm)	1 day	N/A	N/A
AquaNeat, Round Up Custom	glyphosate	salvinia, water hyacinth, water lettuce, water clover, alligatorweed, common/giant reed, cuban bulrush, primrose-willow, purple loosestrife, torpedo grass	5-7.5 pt / acre	N/A	$20.00 - $30.47	N/A	Cannot be applied directly to water within 0.5 mi of an active intake. (Maximum contaminant goal level of 0.7 ppm)	No restriction	N/A	N/A

							Water Quality Impacts (short term & long term, aquatic life and humans)			
Aquatic Herbicide Products (and generics)	**Active Ingredient**	**Target Species**	**Foliar Application Rate (min-max rate)**	**Submersed Application Rate (min-max rate)**	**Cost range per acre (foliar rate)**	**Cost range per acre (submersed rate*2.5')**	**Potable Water Use Restrictions**	**Recreational Restrictions (fishing and swimming)**	**Aquatic Life Water Quality Criteria***	**Human Health Water Quality Criteria***
Clearcast, Castaway	imazamox	salvinia, water chestnut, water hyacinth, eurasian milfoil, hydrilla, parrotfeather, alligatorweed, common/giant reed, primrose-willow	16-128 fl oz / acre	35-69 fl oz / acre-foot	$30.00- $296.43	$164.06 - $399.49	Cannot be applied directly to water within 0.25 mi of an active intake. (Maximum contaminant goal level of 50 ppb (0.05 ppm)	No restriction	N/A	N/A
Polaris, Ecomazapyr	imazapyr	water hyacinth, water lettuce, parrotfeather, alligatorweed, common/giant reed, cuban bulrush, primrose-willow, purple loosestrife, torpedo grass	1-6 pt / acre	N/A	$9.50 - $61.88	N/A	Cannot be applied directly to water within 0.5 mi of an active intake. (No maximum contaminant level goal stated)	No restriction	N/A	N/A
Renovate 3, Garlon 3A	Triclopyr	water chestnut, water hyacinth, water lettuce, water clover, eurasian milfoil, parrotfeather, alligatorweed, primrose-willow	2-8 qt / acre	0.7-2.3 gal / acre-foot	$37.50 - $241.68	$131.25 - $694.83	Cannot be applied directly to water within 200-1300 ft of an active intake. (Maximum contaminant goal level of 0.4 ppm)	No restriction	N/A	N/A
Weedar 64, Clean Amine	2,4-D	water chestnut, water hyacinth, eurasian milfoil, parrotfeather, primrose-willow	2-4 qt / acre	1.42-2.84 gal/ acre-foot	$13.40 - $28.00	$95.14 - $198.80	Cannot be applied directly to water within 600-2400 ft of an active intake. (Maximum contaminant goal	No restriction	N/A	N/A

							Water Quality Impacts (short term & long term, aquatic life and humans)			
Aquatic Herbicide Products (and generics)	Active Ingredient	Target Species	Foliar Application Rate (min-max rate)	Submersed Application Rate (min-max rate)	Cost range per acre (foliar rate)	Cost range per acre (submersed rate*2.5')	Potable Water Use Restrictions	Recreational Restrictions (fishing and swimming)	Aquatic Life Water Quality Criteria*	Human Health Water Quality Criteria*
							level of 70 ppb (0.07 ppm)			

Notes: Recommended rates were developed based on guidelines provided in label of trade-marked herbicides. All aquatic pesticides were evaluated and approved for use by the US EPA and subsequently approved by the state of Alabama through the Alabama Department of Agriculture and Industry. When applying pesticides, the product labels of herbicides are the law and must be adhered to. Deviation from conditions provided within labels is a violation of federal law.

When considering water quality effects for humans, the following categories are considered: Carcinogenicity, teratogenicity, reproductive toxicity, and mutagenicity. When considering effects on aquatic life, chemical Safety Data Sheets provide acute toxicity thresholds for fish and invertebrates. These parameters will be further documented in the final report along with a detailed cost analysis.

*As outlined in Alabama Department of Environmental Management - Water Division - Water Quality Program Chapter 335-6-10 - Water Quality Criteria (https://www.epa.gov/sites/default/files/2014-12/documents/alwqs_chapter335610.pdf). N/A = Chemicals are currently not listed in the Water Quality Criteria, therefore there are no applicable regulations for these chemicals yet.

2.2.2 Additional Recommended Management Practices

Recent research and development regarding invasive species has resulted in a concept approach of Early Detection and Rapid Response (EDRR). According to the assessment conducted by Reaser et al. (2019), EDRR is the process of detecting populations of non-native species that pose the greatest risks to resources and swiftly responding to eradicate them. EDRR is an important failsafe when a new non-native species evades prevention methods and requires the process of surveying for, reporting, and verifying the presence of a non-native species before the initial population becomes established or spreads so widely that eradication is no longer feasible. Rapid response is the step that is employed to eradicate the initial population of a non-native species from a specific location. Rapid response actions include exclusion methods that prevent further establishment of recent invaders, as well as the adoption of chemical, mechanical, and biological control methods that serve to eliminate or arrest the growth of invasive populations. There is a short window of opportunity to respond and eradicate or contain the species and delays in responding may result in costly long-term and wide-spread control efforts (Reaser et al., 2019).

The most effective way to avoid or curtail new invasions by nuisance plant species is through exclusion, the prevention of new invasive plants from entering un-infested or currently infested systems (Gettys 2014). Accidental transfer of aquatic weeds to new water bodies can be avoided if all boats, trailers, and other equipment are thoroughly cleaned and inspected before entering a waterbody (Refer to Section 4 of this report for a detailed discussion on boat washing). Floating booms should be regularly inspected to ensure they remain in place and fixed as soon as possible if gaps are observed.

According to the Alabama Aquatic Nuisance Species Management Plan, education on invasive species and invasion pathways that targets the general public, government agencies, non-governmental agencies, and user groups (specifically boaters and anglers that may enter Big Creek Lake) is a critical aspect of managing these species. Educational signage and pamphlets should be developed and distributed within publicly accessible areas of Big Creek Lake, as well as to partners of MAWSS and the general public through community and public events. Any efforts to prevent fertilizer runoff from entering the water body to reduce the nutrients that encourage the excessive growth of aquatic plants are recommended as well (Everest & Bayne, 2022).

Mechanical removal can be an effective option, especially if invasions of new species are small and localized. The success of this method is dependent on whether it is possible to remove entire plants as many aquatic invasive plants will regrow from root crowns, tubers, rhizomes, or even plant fragments. Mechanical harvesting will typically produce numerous fragments from which invasive species can easily root. This can result in spreading the weed further if these fragments are not collected. Certain species like submerged hydrilla will produce roots and new plants from miniscule fragments, as such, mechanical removal may be better suited for targeting floating species like giant salvinia currently found in Big Creek Lake.

It is important to also consider where harvested plant material can be disposed of. Ideally, it would be placed in uplands adjacent to the lake where it can be left to

desiccate before composting. If there is no feasible area for placement of harvested material near the lake, transport and disposal to a landfill could be very cost-prohibitive as up to 95% of the weight in material is water (Gettys 2014).

Biological control is the use of living organisms to reduce weed populations. This technique is based on the concept that most species become invasive after introduction to a new region because the predators that keep them in check in their native range aren't present in their new habitat. Biological control agents must be host-specific and cause damage only to the target weed species while leaving other plants unharmed; in addition, they must be able to survive, grow, and reproduce in the new range of the weed (Gettys 2014).

There are several biocontrol organisms that can be useful for aquatic weed control. For example, the salvinia weevil *(Cyrtobagous salviniae)* causes significant damage to the floating fern giant salvinia. Numerous insects have been investigated as biological control agents for giant salvinia, but the salvinia weevil is recognized throughout the world as the insect of choice for management of giant and common salvinia. This insect feeds and reproduces only on plants in the Salviniaceae family. The salvinia weevil is a small, black weevil that, is native to South America which is also where giant salvinia originates. Adults feed on floating fronds and rhizomes but prefer newly formed buds. Salvinia weevil larvae are white and feed within rhizomes and buds in addition to the floating and submersed fronds. Because of this, feeding by the larvae is often more destructive than that of adults. The combined feeding action of adults and larvae can be significant and can impact populations of giant and common salvinia in several months as opposed to the longer periods of time required by other insect biocontrol agents. Attacked plants turn brown in small patches that eventually merge together until the colony loses structural integrity, becomes waterlogged, and sinks. (Gettys et al., 2014)

The alligatorweed flea beetle *(Agasicles hygrophila)*, a small black and yellow beetle native to South America, can reduce populations of noxious alligatorweed to the point that other weed control strategies can be reduced or, rarely, eliminated, though this is dependent on whether winter temperatures are mild enough to allow the beetles to survive until spring (Center et al., 2009). Another species, the alligatorweed thrips *(Amynothrips andersoni)* has difficulty competing with the alligatorweed flea beetle, however, will thrive on rooted alligatorweed which is usually not targeted by the flea beetle. The thrips damage to alligatorweed is primarily restricted to new growth and is the most cold tolerant of the insects utilized for alligatorweed biological control, however the effectiveness of this organism has not been fully evaluated for control of alligatorweed in the United States (Center et al., 2010). The alligatorweed stem borer *(Arcola malloi)*, a tiny light tan moth, produces larvae that feed within the stems of the weed causing reduced nutrient flow through thereby causing stems to collapse, turn yellow and die (Wells & Minteer, 2020).

There are numerous other insects that serve as biological control agents for invasive aquatic vegetation. Further examples include: water hyacinth weevils *(Neochetina spp.)* that are used to slow the growth of water hyacinth; hydrilla weevils (*Bagous spp.)* that attack tubers of submersed hydrilla; the water lettuce weevil *(Neohydronomous affinis)* which feed on leaves and crowns of water lettuce; and purple loosestrife leaf beetles *(Galerucella spp.)* that have successfully reduced infestations of purple loosestrife in other US states (Cuda 2014). These example organisms are not an exhaustive list of all

the possible biological control agents and, while useful for aquatic weed control, will not eradicate invasive weeds completely. Successful establishment and even minimal control of targeted invasive species is also not guaranteed. When more complete and targeted control of aquatic weeds is desired, resource managers will typically rely on chemical control, or the use of herbicides (Gettys 2014).

The success of invasive vegetation control methods will be heavily dependent on accurate, current knowledge of invasive populations at Big Creek Lake. HDR recommends that MAWSS prioritizes early detection of new invaders and continues to employ or contract staff that can regularly assess the conditions and effectiveness of treatments of invasive aquatic vegetation in Big Creek Lake.

2.2.3 Assessment of Current Invasive Species Mitigation Practices in Big Creek Lake

According to the Giant Salvinia Baseline Study carried out by Barry A. Vittor & Associates, the current herbicide treatments have been successful in reducing salvinia coverage in targeted areas, specifically in Crooked Creek. However, the overall distribution of giant salvinia has increased across Big Creek Lake as it is being spread to new, previously un-infested areas. This is most likely due to recreational boating dislodging and transporting the plant. A more detailed discussion on recommendations for addressing recreational boating in Big Creek Lake is provided in Section 4 of this report.

There are two aquatic herbicides currently being used at Big Creek Lake to control giant salvinia - Galleon-SC and Schooner-SC. Galleon-SC and Schooner-SC are respectively rated as having “Excellent” and “Good” ratings of effectiveness for controlling this species (see Table 2) and utilize separate MOAs that act on different biological processes which is ideal to combat herbicide resistance.

Schooner-SC (flumioxazin) is a PPO inhibitor and belongs to the WSSA resistance group 14 while Galleon-SC (penoxsulam) is an ALS inhibitor and belongs to the WSSA resistance group 2. These herbicides also control numerous other invasive species that have the potential to invade Big Creek Lake and are appropriate choices for the current treatment program. However, well-established best management practices dictate that herbicide rotation is a key driver to successful chemical control programs.

Most aquatic herbicides also carry an annual or seasonal application limit in the label which must not be exceeded. Summarized below is key information regarding limitations to the two herbicides currently utilized by MAWSS in Big Creek Lake:

- **Schooner-SC:** DO NOT retreat the same section of water with this product more than 6 times per year. This product is a Group 14 herbicide. Any weed population may contain or develop plants naturally resistant to this product and other Group 14 herbicides. The resistant biotypes may dominate the weed population if these herbicides are used repeatedly in the same field. Appropriate resistance-management strategies should be followed. If a weed pest population continues to progress after initial treatment with this product, discontinue use of this product, and switch to another management strategy or herbicide with a different mode of action, if available.

- **Galleon-SC**: The concentration of any single application or sum of all applications must not exceed 150 ppb per annual growth cycle. The mode of action of Galleon SC is the inhibition of the acetolactate synthase (ALS) enzyme. Weed populations may develop biotypes that are resistant to different herbicides with the same mode of action. If herbicides with the same mode of action are used repeatedly at the same site, resistant biotypes may eventually dominate the weed populations and may not be controlled by these products.

These annual application limits for the herbicides currently used in Big Creek Lake should be considered at the beginning of a season and will help to form a robust management plan that will remain effective and legal throughout the year. At a minimum, additional herbicides belonging to resistance groups other than 2 and 14 should be rotated into the management plan before annual application limits of Galleon-SC or Schooner-SC herbicide are met. Based on the list of recommended herbicides and their active ingredients provided in Tables 2 and 3, products that utilize the active ingredients diquat (WSSA resistance group 22) and glyphosate (WSSA resistance group 9) would be effective choices to rotate alongside Galleon-SC and Schooner-SC for the control of giant salvinia.

An alternative to Galleon-SC that is within the same resistance group 2, and similarly inhibits the ALS pathway, is Clearcast (imazamox). However Clearcast is rated as “Good” for control of giant salvinia versus Galleon-SC’s “Excellent” rating. An alternative to Schooner-SC that is within the same resistance group 14, and similarly inhibits the PPO pathway, is Stingray (carfentrazone) which carries an “Excellent” rating for control of giant salvinia versus Schooner-SC’s “Good” rating.

Ideally, invasive weeds should be targeted in the spring months (March, April, May) when weeds are actively growing and will readily uptake herbicides, before the majority of a species’ total annual growth occurs through spring and summer (Masser et al. 2003). In addition, regular maintenance treatments that occur every 2 to 4 weeks are ideal to manage invasive threats throughout the year, with previously treated areas being revisited within those 2 to 4 weeks. Given the large size of Big Creek Lake, this may be difficult but would be aided by regular monitoring events by MAWSS staff or contracted biologists who can help identify problem areas where target weed species persist or have been recently established.

2.2.4 Herbicide Application Costs Analysis

To perform a cost analysis of herbicide application, HDR utilized 2023 invoices from Aqua Services Inc based upon application rates of currently used herbicides at Big Creek Lake for Galleon-SC and Schooner-SC (see Table 4 below) or at the minimum recommended rate for effective treatment of giant salvinia. Each 100-gallon spray tank mix was comprised of 6 fl oz of Galleon-SC, 3 fl oz of Schooner-SC, and 32 fl oz of RSI 90 surfactant.

Based on acreages of treated areas and total volume of herbicide mix sprayed, Galleon-SC was applied at a rate of 1.99 fl oz per acre, on average, which is in line with the label rate of 2 fl oz per acre. However, Schooner-SC was applied at a rate of 0.99 fl oz per acre, on average, which is well below the minimum effective label rate of 6 fl oz per acre.

Table 4 – Aqua Services Application Rates

Aqua Services Herbicide Mix		
Product Per 100 Gallon Tank		Application rate Per Acre*
RSI 90 Surfactant	32 oz	10.66 oz Per Acre
Galleon SC	6 oz	1.99 oz Per Acre
oz Schooner	3 oz	0.99 oz Per Acre

*Application rate derived from May 2023 Treatment Map
600 gallons herbicide mix/18 acres= 33.33 gallons per acre
Product volume per 100 gal tank/.33 = Product volume per Acre

Costs for recommended herbicides as provided by distributors Nutrien Ag Solutions and Helena Agri-Enterprises in this section are likewise based on the minimum effective treatment rate for giant salvinia that can be found in the respective herbicide labels. A complete cost table for all alternative, recommended herbicides as well as costs for Galleon-SC and Schooner-SC are provided in Appendix A. These costs are separated by distributor and are based on minimum and maximum label rates that encapsulate the range of suggested application rates for all potential invasive species and are further divided by foliar and submersed application rates.

To compare the costs of the current herbicide application regime to the previously identified alternative herbicides, the May 2023 invoices and May 2023 treatment map were utilized. The May 2023 map indicates that for 18 acres of treatment, 600 gallons of herbicide mix was applied. This information along with Aqua Services reported herbicide quantities utilized for 100-gallon tank mix was used to extrapolate the cost for the application of recommended herbicides to be rotated into the treatment program.

As previously mentioned, rotation of herbicide types outside of the currently used resistance groups could be recommended, if required to avoid the development of herbicide resistance. For each herbicide, the label specified minimum application rate per acre was utilized to calculate cost for an 18-acre treatment event. The treatment event assumed a standard cost mark up of 2.0 for herbicides and surfactant. The cost for surfactant was standardized at the current application rate of 32 ounces per 100 gallons for all cost comparisons.

Due to the significantly larger minimum application rate and unit cost for Clearcast (Imazamox), it becomes the most expensive treatment option within the Resistance Group 2 at approximately 42 percent more expensive per treatment than Galleon ($2,727.57 vs $1,577.08, respectively). The cost difference between the Resistance Group 14 alternatives (Schooner and Stingray) is approximately 12% ($599.70 vs. $681.30 respectively).

Following label recommendations and rotating outside of herbicide resistance treatment groups, a treatment event utilizing Tribune (Diquat, group 22) and AquaNeat (Glyphosate, group 9) would be within 1 percent of costs associated with the current herbicide regimen ($2,176.78 vs $2,146.65, respectively) with the current herbicide program being highlighted below in Table 5.

Table 5 – Herbicide Treatment Cost Comparison

Herbicide Treatment Costs								
Product	Group	Active Ingredients	Application rate*	Treatment Effectiveness	Surfactant Cost	Unit cost of Herbicide	Cost per acre	Treatment event**
Galleon	2	Penosulam	2 oz per ac	Excellent	$ 59.70	$674.39 per 1 qt	$84.30	$1,577.08
Schooner*	14	Flumioxazin	6 oz per ac	Good	$ 59.70	$320.00 per 1 gal	$30.00	$599.70
Clearcast	2	Imazamox	32 oz per ac	Excellent	$ 59.70	$296.43 per 1 gal	$148.22	$2,727.57
Stingray	14	Carfentrazone	3.4 oz per ac	Good	$ 59.70	$162.51 per 1 qt	$34.53	$681.30
Tribune	22	Diquat	64 oz per ac	Good	$59.70	$72.00 per 1 gal	$72.00	$1,355.70
AquaNeat	9	Glyphosate	80 oz per ac	Good	$59.70	$32.50 per 1 gal	$40.63	$790.95

* Current Application rate at less than label minimum
**Assumed treatment scenario per treatment map for May 2023

2.3 Water Quality Impacts from Herbicide Treatment

2.3.1 Big Creek Lake Water Quality Background

Big Creek Lake is a municipal reservoir located in the Escatawpa watershed and the main drinking water supply for Mobile, Alabama and the surrounding communities. Three tributaries flow into Big Creek Lake, including Big Creek, Crooked Creek, and Hamilton Creek.Big Creek Lake is designated as 'waters of the State' and assigned the Water Use Classifications: Potable Water Supply (PWS) and Fish and Wildlife (F&W) by the Alabama Department of Environmental Management (ADEM) and the Environmental Protection Agency (EPA). In 2008, Big Creek Reservoir was listed on Alabama's 303(d) list of impaired waters for not meeting its Public Water Supply/Fish & Wildlife (PWS/F&W) water use classifications due to impairments caused by atmospheric deposition of metals (mercury) (Integrated Water Quality Assessment Report, ADEM 2022). Big Creek Lake does not currently have a Total Maximum Daily Load (TMDL) for mercury; therefore, monitoring and reporting is not required.

The PWS and F&W Water Use Classifications include water quality criteria for temperature, Dissolved Oxygen (DO), bacteria, and turbidity. The water quality criteria assigned to Big Creek Lake is for chlorophyll a. The MAWSS currently conducts water quality monitoring quarterly to measure for pH, conductivity, salinity, temperature, turbidity, DO, Oxidation Reduction Potential (ORP). Samples are collected 0.5 meters above the lake bottom and analyzed for Total Suspended Solids (TSS), NO_3/NO_2, Total Nitrogen (TN), Total Phosphorus (TP), Total Kjeldahl Nitrogen (TKN), Dissolved Organic Carbon (DOC), Total Organic Carbon (TOC), *E. coli* and chlorophyll-a.

2.3.2 Potential Water Quality Impacts from Currently Applied Herbicides

The herbicide treatments currently being used at Big Creek Lake to control giant salvinia are Galleon-SC (active ingredient penoxsulam) and Schooner-SC (active ingredient flumioxazin).

The active ingredient in Galleon-SC is penoxsulam. There are no potable water or recreation (swimming or fishing) restrictions for the application of penoxsulam. As listed from the EPA Fact Sheet, there are no human health risks of concern from the use of penoxsulam. Penoxsulam is expected to be very mobile, but not persistent, in either aqueous or terrestrial environments. The results of the screening-level risk assessment suggest that penoxsulam will not pose a threat to aquatic or terrestrial animals and has a low potential to bioaccumulate in fish. The EPA regulatory position for penoxsulam use is to adhere to the herbicide label directions as the law.

The active ingredient in Schooner-SC is flumioxazin. There are no potable water or recreation restrictions on the application of flumioxazin. As listed from the EPA Fact Sheet, flumioxazin is classified as Toxicity Category III. The data indicate that flumioxazin is highly phytotoxic; however, it is unlikely that flumioxazin will pose a risk of acute or chronic toxicity to non-target animals. Flumioxazin is relatively unstable and its potential to leach to groundwater is low. Potential for the degradation products to leach to groundwater is high. Flumioxazin is slightly toxic to the bluegill sunfish (96-hour LC50 > 21.0 ppm) and moderately toxic to the rainbow trout (96-hour LC50 = 2.3 ppm). It is also moderately toxic to Daphnia pulex (48- hour EC50 = 5.5 ppm). However, these species are not found in Big Creek Lake. The EPA regulatory position for flumioxazin use is to adhere to the herbicide label directions as the law, do not apply directly to water, and to avoid spray drift at the application site.

2.3.3 Potential Water Quality Impacts from Other Recommended Herbicides

Based on current and potential invasive plant species threats, 12 active ingredients were identified as viable options to control these threats in Big Creek Lake and include the following: bispyribac, carfentrazone, chelated copper, diquat, endothall, flumioxazin, glyphosate, imazamox, imazapyr, penoxsulam, triclopyr, 2,4-D. Summarized below are the potential water quality impacts and designed water quality criteria assigned to the 10 recommended herbicide active ingredients, in addition to penoxsulam and flumioxazin that were discussed in the previous section.

- Bispyribac: The EPA identified no drinking water, swimming, fishing, or fish consumption restrictions for aquatic uses of bispyribac-sodium. Therefore, treatment using bispyribac-sodium should not have any impacts on public water supply or water use.
- Carfentrazone: The EPA identified no swimming, fishing, or fish consumption restrictions for aquatic uses of carfentrazone-ethyl. The EPA concluded, based on the toxicity data available, there is no reasonable risk to human health from carfentrazone-ethyl. Carfentrazone-ethyl is moderately toxic to freshwater and estuarine fish, ranging from 1-2 ppm. The EPA reported that toxicity testing of four carfentrazone-ethyl degradation products with rainbow trout, water flea, and mysid

shrimp indicate that these degradation products are slightly toxic to practically nontoxic to aquatic organisms. The potable water restrictions for applying carfentrazone include: one day restriction on use if >20% of water body surface is treated. Carfentrazone cannot be applied directly to water within 0.25 mi of an active intake, and the Maximum Contaminant Limit (MCL) is 0.2 ppm.

- Chelated copper: The EPA identified no recreational or potable water restrictions for the use of copper. The EPA listed copper as a toxic pollutant to aquatic life and therefore, assigned aquatic life water quality criteria. For copper, the criteria are provided by the equations listed in the ADEM Use Classifications for Surface Water (Eq. 5 & 6). The EPA listed copper as potentially toxic to human health and assigned a human health criterion of 1,300 µg/L MCL for consumption of water and fish.
- Diquat: The EPA identified diquat as potentially harmful to human health. For all products there is a drinking water standard of 0.02 ppm. There are no recreational restrictions for the application of diquat.
- Endothall: The EPA identified endothall as potentially harmful to human health and has a PWS Water Use classification; for all products there is a drinking water standard of 0.1 ppm and cannot be applied within 600 feet of a potable water intake. In addition, endothall applications have a recreational (fishing and swimming) restriction of one day.
- Glyphosate: The EPA identified glyphosate as potentially harmful to human health. For all products there is drinking water standard of 0.7 ppm and cannot be applied within 600 feet of a potable water intake. There are no recreational restrictions for the application of glyphosate.
- Imazamox: There are no recreation restrictions on the application of imazamox. According to the EPA, imazamox does not bioconcentrate in fish and concentrations in fish following aquatic applications were below the limit of quantification. Applicators may apply imazamox to potable water sources at concentrations up to 500 ppb so long as the application area is not within one-quarter mile from an active potable water intake. Within a one-quarter mile radius of an active potable water intake, imazamox water concentrations may not exceed 50 ppb.
- Imazapyr: The EPA determined there is no reasonable human health risk for imazapyr applications to waterways. There are no recreational restrictions applied to imazapyr applications. The EPA regulatory position for imazapyr use is to adhere to the herbicide label directions as the law, do not apply directly to water within 600 feet of an active intake, and to avoid spray drift at the application site.
- Triclopyr: The EPA identified triclopyr as potentially harmful to human health. For all products there is a drinking water standard of 0.4 ppm and cannot be applied within 200 feet of a potable water intake. There are no recreational restrictions for the application of triclopyr.
- 2,4-D: The EPA determined there is no reasonable human health risk for 2,4 D applications to waterways. For all products there is a drinking water standard of 0.07 ppm and cannot be applied within 600 feet of a potable water intake. There are no recreational restrictions applied to 2,4 D applications.

2.3.4 Water Quality Related Recommendations

Based on current and potential invasive plant species threats, 12 active ingredients were identified as viable options to control these threats in Big Creek Lake. The herbicide treatments currently being used at Big Creek Lake to control giant salvinia are Galleon-SC and Schooner-SC. As outlined in ADEM - Water Division - Water Quality Program, chemicals currently not listed with Water Quality Criteria or Use Classifications do not have regulations for these chemicals yet and no monitoring or reporting is required. If MAWSS continues with the current invasive species control program, no additional actions are required to be protective of water quality.

This report recommends an additional 10 active ingredients as viable options for invasive species control. For chemicals with EPA listed national drinking water standards, concentrations in Big Creek Lake are not to exceed the drinking water MCL. The EPA requires that the herbicide labels are to be followed as law and best management practices are to be implemented to mitigate potential water quality impacts. Should MAWSS decide to incorporate additional herbicides into its treatment regime, water quality sampling should be performed for any herbicide with a drinking water MCL, such as endothall, diquat, and glyphosate.

3 Assessment of Boat Washing Practices

It is well established throughout the world that watercraft provide a primary vector for the movement of aquatic invasive species across waterbodies and ecosystems. This occurs at a global scale due to international shipping that has increased over the past several decades as waterway obstacles such as Niagara Falls in the Great Lakes have been bypassed and global economies have expanded considerably, as well as at local scales whereby recreational boaters can unwittingly carry invasive species from one water body to another. This has prompted numerous aquatic management agencies and regional collaborations in North America to establish protocols based on science-based work to be deployed in order to decontaminate watercraft as they move between and even within waterbodies. This section will focus on how MAWSS can increase its effectiveness to reduce the risk of invasive species both entering and leaving Big Creek Lake through its boat washing practices.

In assessing the current boat washing practices at Big Creek Lake, it is assumed that the majority of boaters are anglers and that hours of lake access are limited during the day with boaters asked to use the provided facility to clean their own watercraft. From discussions with MAWSS, while security is present, there does not appear to be inspections by trained professionals to assess how effective boat owners are in fully decontaminating their watercraft.

The following discussion is intended to be a comprehensive set of recommendations regarding watercraft inspection and cleaning for Big Lake Creek. While the aquatic macrophyte giant salvinia is the primary species of current focus, we also offer recommendations that would apply to dreissenid mussels, based on their prevalence in North America and how injurious they can be to municipal infrastructure as well as damaging to aquatic food webs. Also, elevated decontamination protocols for dreissenid

mussels will likely also be sufficient to guard against most other invasive species present in North America at this time.

3.1 Current Boat Washing Practices at Big Creek Lake

MAWSS currently operates a well-designed boat washing station for Big Creek Lake. Boaters must pass through and presumably use the station when both entering and exiting the lake. An advanced, pressurized water system is provided for surface cleaning the watercraft. This water is not heated (presumablely due to liability from potential scalding from the use of hot water), but the system does have the capacity to heat water based upon the review of the record drawings for the boat washing facility.

Most anglers are not aware of the variety of ways that invasive species can be present on their watercraft, such as in onboard compartments including livewells. Based on the evaluation conducted, MAWSS does support the Stop Aquatic Hitchhikers “Clean – Drain – Dry” program but perhaps outreach efforts could be expanded in order to increase the efficacy of the decontamination program.

From the evaluation of the current boat washing practices, it does not appear that MAWSS collects any information necessary to determine how effective their current boat decontamination program is.

3.2 Use of Heated Water vs Non-Heated for Boat Washing

Heated water is considered to be a key attribute of decontamination, particularly as required to kill the veligers (larval form) of dreissenid mussels that can often be present inside of boat compartments, including the bilge as well as livewells and baitwells. Heated water needs to be used at 140 degrees F and at low pressure (i.e. equivalent to the flow of a garden hose) on internal boat compartments. High pressure water can potentially damage internal fittings and pumps. The required exposure time at 140 degrees F is only 10 seconds. The outside surfaces of the watercraft can be sprayed at high pressure (3000 psi) and at a temperature of 120 degrees F for an exposure time of two minutes. Often, one of the requirements for the use of heated water for boat washing is the presence of trained staff to perform the cleaning for anglers due to the danger of scaling from the elevated water temperatures.

Even when using heated water, it is very important to clean all surfaces as well as the various components of the trailer including rollers and bunks. All boat compartments must be cleaned, including livewells, bilge, baitwells, or ballast tanks. Ballast tanks as used in some watercraft such as wake boats are difficult to fully decontaminate and complete draining and flushing with 140F water is important.

3.3 Recommended Boat Washing Practices and Cost Analysis

Given that heated water is necessary for sufficiently dealing with invasive species, permanent staff will be necessary at Big Creek Lake to ensure a sufficient degree of compliance for effective decontamination upon entering and exiting the lake. Staff should be employed on all weekends due to higher levels of lake use by anglers (Friday

through Sunday) and on two randomly chosen weekdays. Initially, 1.5 full time equivalents (FTEs) can be employed if hours of access to the lake are restricted and until the nature of the invasive species risk is fully assessed. Policies limiting hours of access to the lake will obviously reduce staff time required.

The approximate cost of one FTE that is properly trained to conduct decontamination would approximately $55,000 annually including benefits based on feedback from other states requiring permanently staffed boat washes. Additional, part time interns can also be hired to assist the trained FTE. This cost may be approximately $18,000 annually for a half time intern to account for the 1.5 FTEs. Given that MAWSS typically sees approximately $1,000 to $2,500 per month during prime boating session, MAWSS would likely need to roughly double to triple the existing charges for using Big Creek Lake to 'break even' with the cost of providing full-time staff at the boat washing facility.

Training levels and recommendations for the full time staff at the boat washing facility are provided in *Uniform Minimum Protocols and Standards for Watercraft Inspection and Decontamination Programs for Dreissenid Mussels in the Western United States*, 2016 edition. Training resources are also available online at https://www.westernais.org/trainer-resources.

To support the incorporation of heated water into the boat washing practices at Big Creek Lake, the existing system for delivering water should be modified as needed to regulate both temperature (assume that this capacity already exists) and also pressure. Low pressure should be used for internal boat compartments. Cost of this modification is likely to be minimal unless the existing system will not accommodate this change and needs to be replaced completely. It is also assumed that the current boat washing facility has the ability to effectively capture the effluent from boat washing activities to reduce any escape of any invasive species.

However, should MAWSS elect to not staff the boating washing station and the boat wash station continues to be operated voluntarily by the watercraft owner, simple surveys should be used to estimate degree of compliance and how thorough anglers are when conducting their own decontamination. The survey can also include a brief interview with the boat owner. The following simple survey modified from use by other entities will allow MAWSS to determine the nature and degree of risk of aquatic invasive species being moved to and from Big Lake Creek:

- What was the last water body that you fished and on what date?
- What water body will you go to next and on what approximate date?
- What is your residential zip code (optional to respect privacy)?
- Have you been interviewed before at this facility? (Note that this question will allow for the estimation of the number of anglers that are fishing at Big Creek Lake using standard multiple mark-recapture estimation methods.)

This recommendation assumes that the nature of the invasive species risk at Big Creek Lake has high uncertainty. Sources of uncertainty may include not knowing what fraction of boat owners are carrying invasive species either upon arrival or even after cleaning their boats when they depart. This uncertainty can also be reduced through consultation with local agencies that are already fully invested in deterring invasive species.

Another source of uncertainty is the number of boaters that are using Big Creek Lake, and how often they engage in effective practices such as leaving their boat to dry for five or more days (see below). Giant salvinia is well adapted to attach to boats and trailers. High pressure water needs to cover all trailer components including bunks and rollers, and thus thorough cleaning may be difficult for some watercraft owners. Note that recommendations (high pressure water) for giant salvinia are sufficient to apply to the other aquatic invasive plants in this system.

The national Stop Aquatic Hitchhikers provides affective tools for outreach to lake users. MAWSS should fully subscribe and utilize this program. The nation-wide Clean – Drain -- Dry program (Home- Stop Aquatic Hitchhikers) is considered to be effective and successful at reducing accidental transfer from one infested water body to another. Alabama Wildlife and Freshwater Fisheries is a member and thus could be consulted on appropriate outreach materials and methods.

Drying of watercraft is recommended for five days, which is considered largely effective given that most boaters are weekend users. Note that the simple survey listed above will allow MAWSS staff to determine what proportion of anglers fishing in Big Creek Lake do effectively leave their boat dry for 5 days or longer.

While introductions of zebra mussels via veligers released from fishing boats is relatively low probability to result in a new introduction, a key mechanism for transfer is the movement of semi-permanent structures such as docks and boat lifts. Adult zebra mussels can be viable and attached to the internal metal compartments, and without an extended period to desiccate and die (can be up to 30 days, temperature and humidity dependent), will proceed to reproduce and thus create a new infestation. Big Lake Creek does not appear to have such structures along the shoreline, and thus will obviously not be an issue. If such structures do exist, then very close inspection should be conducted of existing structures and also before any new structures are allowed into the lake.

4 Recommendations for Treatment and Mitigation of Invasive Species

Based on results of the assessment performed by HDR, the following actions are recommended for MAWSS to support the treatment and mitigation of invasive species in Big Creek Lake:

- MAWSS should continually monitor the U.S. Department of Agriculture (USDA) National Invasive Species Center website list of Aquatic Invasives and the Invasive.org Center for Invasive Species and Ecosystem Health list of Invasive and Exotic Aquatic Plants.
- MAWSS should prioritize early detection of new invaders and continues to employ or contract staff that can regularly assess the conditions and effectiveness of treatments of invasive aquatic vegetation in Big Creek Lake.
- Inspections and herbicide treatment of Big Creek Lake should follow the Big Creek Lake Invasive Species Monitoring and Treatment Standard Operating

Procedure (SOP) developed by HDR in partnership with Thompson/BVA (August 2024) and provided in Appendix B noting the following:

  - The recommended herbicide treatment schedule included in the Standard Operating Procedure is specific to giant salvinia and prioritizes treatment of previously established plots rather than the entirety of Big Creek Lake.
  - Should emergent vegetation other than giant salvinia be encountered, a secondary tank of a glyphosphate, imazapyr, and nonionic surfactant mixture should be utilized for spot treatment of these emergent species.

- Big Creek Lake is a large area to manage, and it is not practical to treat every foot of shoreline from both a cost and time perspective. By using established points that are both treated and monitored on a regular basis as outlined in the SOP, MAWSS will be able to gain an understanding of how different treatment practices (i.e., active ingredients, application rates, and frequency) can inform management decisions moving into the future.

It is important to note that these recommendations are focused on the mitigation and treatment of invasive species in Big Creek Lake regardless of any changes to operation of Big Creek Lake as a both a water supply reservoir and recreational lake. Further considerations and analysis for operational alternatives for Big Creek Lake are discussed in the next section of this report.

5 Big Creek Lake Operational Alternatives Analysis

As part of the overall evaluation into the control and mitigation of invasive species, MAWSS requested that HDR perform a further analysis into operational alternatives for the continued operation and access to this important drinking water supply reservoir. The key considerations for this operational alternative analysis were focused on estimating operational costs and implementation logistics should Big Creek Lake remain open to boaters while also evaluating the associated impacts of modifying access to Big Creek Lake for non-MAWSS related purposes.

5.1 Status of MAWSS Current Operation of Big Creek Lake

As previously discussed in Section 3.1 of this report, MAWSS currently allows boaters access to specific areas within Big Creek Lake for recreational activities and provides those boaters access to a well-designed boat washing facility. However, the boat washing facility does not supply boaters with the required heated water to mitigate the potential presence of dreissenid mussels that can have a significant impact on water supply reservoirs.

Based on a review of revenues generated through boater access to Big Creek Lake shared with HDR from 2022 and 2023, MAWSS averages between 40 and 50 visitors

to Big Creek Lake per month, which generates revenue with boaters paying $10 per visit for access while bank fishers pay $1 per visit. For the period of July 2022 to June 2023, the total revenue generated by MAWSS by allowing access to Big Creek Lake was $17,680.

Given the presence of the previously discussed invasive species in Big Creek Lake, MAWSS currently performs routine monitoring and treatment of this drinking water supply reservoir in an attempt to control and mitigate the concerns associated with the invasive species, such as Giant Salvinia. It is important to note that the monitoring and treatment of invasive species in Big Creek Lake is required regardless of whether or not non-MAWSS personnel are allowed access to the lake. As discussed in Section 2.2.4 of this report, each treatment event results in a cost of approximately $2,175 per treatment event. Based on the Big Creek Lake Invasive Species Monitoring and Treatment SOP provided in Appendix B, it is recommended that MAWSS may conduct up to 11 treatment events over the course of a calendar year. This would result in an approximate invasive species treatment cost of $23,925 per year.

In addition to the cost of the application of chemicals for invasive species treatment, MAWSS has additional costs for the operation of Big Creek that are summarized and estimated below based on information provided between July 2022 and July 2023:

- Alabama Power – approximately $4,700 per year
- Security – approximately $23,000 per year
- Landscaping – approximately $11,500 per year
- Other miscellaneous cost – approximately $2,500 per year

Thus, the current operational cost of the Big Creek Lake by MAWSS, including performing invasive species treatment, is approximately $65,625 per year while generating less than $18,000 of annual revenue from boaters and bank fishers.

5.2 Alternatives for Modified Access to Big Creek Lake

To further mitigate the threat of invasive species in Big Creek Lake, MAWSS may consider alternatives that would modify access to the lake. These alternatives include the following:

- Closing Access to Big Creek Lake for Non-MAWSS Personnel
- Implementation of New Requirements for Big Creek Lake Access

It should be noted that should MAWSS consider implementing either of these alternatives for modifying access to Big Creek Lake that the application of chemicals for treatment of invasive species will continue as currently performed.

The considerations for each of these alternatives will now be discussed in further detail.

5.2.1 Close Access to Big Creek Lake for Non-MAWSS Personnel

The most significant action that MAWSS can implement to protect Big Creek Lake water quality against the further occurrence of invasive species is closing of watercraft access to the lake for all non-MAWSS personnel. While this alternative would eliminate watercraft access to Big Creek Lake for recreational boaters, MAWSS could continue to

allow visitors to the lake for bank fishing. As previously noted, MAWSS would still be required to perform treatment of Big Creek Lake in accordance with the Big Creek Lake Invasive Species Monitoring and Treatment SOP, which would result in treatment costs of approximately $23,925 per year. MAWSS personnel would continue to use the existing boat washing facility without heated water to clean MAWSS and their contractor's watercrafts upon entering and leaving the lake for monitoring and treatment activities.

Additionally, it is anticipated MAWSS would need to continue to incur the previously discussed costs for power, landscaping, and other miscellaneous costs for the overall operation of Big Creek Lake as a water supply reservoir, but security costs would no longer be incurred. The annual cost of these other operating costs for Big Creek Lake were estimated to be $18,700 as noted in Section 5.1 of this report.

Through closing watercraft access to Big Creek Lake for non-MAWSS personnel, MAWSS will no longer generate the estimated $18,000 annual revenue from boaters and bank fishers, but will eliminate the potential for transferring invasive species from visiting watercraft to Big Creek Lake.

5.2.2 Implementation of New Requirements for Big Creek Lake Access

Should MAWSS continue to allow visitors to access Big Creek Lake for recreational purposes, there are additional requirements that can be implemented to continue allowing access to the lake while supporting the effort to control the further occurrence of invasive species. Those requirements are described in the following discussion.

Use of a Boat Washing Facility with Heated Water

Should MAWSS continue to allow visitors to access Big Creek Lake, one of the primary options for the implementation of new requirements for accessing the lake is improving the existing boat washing facility to incorporate heated water for watercraft decontamination. MAWSS currently has a well-designed, well-maintained boat washing facility that would only require minor modifications to reconnect the existing water heater at the facility to neutralize zebra mussels.

As discussed in Section 3.3 of this report, the operation of boat washing facility using heated water at MAWSS would require specialized, trained, permanent staff to ensure compliance with effective watercraft decontamination upon arrival and departure from Big Creek Lake. Based on a survey of similar heated water boat washing facilities, it is anticipated that approximately 1.5 full-time equivalents (FTEs) can be employed if MAWSS maintains its current lake access hours. The approximate cost of 1.5 FTEs on annual basis would be $82,500 based on a one FTE that is properly trained to conduct decontamination costing approximately $55,000 per year (including benefits). Alternatively, MAWSS could solicit bids from third-party vendors for heated boat wash operations. Based on other utility contract operations fee structures, MAWSS could expect to pay a 2.0 to 3.0 multiplier from a third-party applied to the labor costs noted above for the estimated costs for MAWSS to provide these boat washing services.

Using a heated boat washing facility, it is also anticipated that MAWSS would see an increase of power usage for the heating of the water. Currently, historical cost information has shown that annual power costs for boat washing at Big Creek Lake are

typically less than $5,000. This annual cost is anticipated to increase by five-fold should the boating washing facility be upgraded to include heated water, which would result in an estimated annual power cost at the boating washing facility of $25,000.

Based on the anticipated costs of providing specialized, permanent staff to operate the boat washing facility and the additional power costs for heating the water to the required temperature, MAWSS should anticipate annual operating costs on the order of $107,500 for allowing access to Big Creek Lake but requiring the use of an improved boat washing facility utilized heated water.

As previously noted, MAWSS generates approximately $18,000 annually from visitors to Big Creek Lake based on $10 per visit for boaters and $1 per visit for bank fishers with there being between 40 and 50 visitors per month. At most, MAWSS could anticipate approximately 600 visitors per year (assuming 50 visitors per month over a 12-month period), and to create a neutral financial position for allowing public access to Big Creek Lake, MAWSS would likely have to charge boaters $180 per visit to recover operational costs. Realizing that many of the boaters are repeat visitors, MAWSS could also consider the sale of annual passes for Big Creek Lake so that more frequent visitors can receive a reduced per visit cost.

Use of Third-Party Boat Launch and Rentals at Big Creek Lake

As another alternative to allow the boaters to access Big Creek Lake, MAWSS could consider the use of a third-party boat launch and rental facility. This would require the use of watercraft dedicated to Big Creek Lake be rented at the site for lake access, meaning that those watercrafts would not leave Big Creek Lake and thus not introduce new invasive species to the lake. Boaters would not be able to bring their own personal watercraft into Big Creek Lake, yet bank fishers would still be allowed to access the lake. It should be noted that for this consideration MAWSS would not need to improve the existing boat washing facility to a heated water system with permanent staff as the watercraft having access to water bodies outside of Big Creek Lake would not be permitted.

Based on a review of other privately owned and Alabama state park owned lakes, there were no confirmed third-party boat launch and rental facilities where the vendor was contracted directly with the owner of the lake, such as the case for MAWSS and Big Creek Lake. In fact, for the Alabama State Park owned lakes, the rental of boats is owned and operated directly by the state rather than a third party.

Should MAWSS consider this option, it is recommended that MAWSS prepare a Request for Proposals to receive proposals from potential vendors interested in providing a boat launch and rental service at Big Creek Lake. Alternatively, MAWSS could also investigate owning and renting boats that do not leave Big Creek Lake and achieve the same invasive species risk mitigation objectives.

5.3 Additional Considerations Regarding Big Creek Lake Public Access

In addition to the operational alternatives previously discussed, MAWSS could also consider requiring annual passes for boat access that require waivers attesting to the following:

- Boaters are Mobile County residents
- Boats are not used in other water bodies before being introduced to Big Creek Lake.
- Boaters agree to follow all boat washing requirements and only access areas of Big Creek Lake open for recreational fishing.

The use of annual waiver system for boating access to Big Creek Lake would potentially eliminate the need for the implementation of a heated boat washing system.

If MAWSS elects to maintain complete, open public access to Big Creek Lake, MAWSS should implement the use of surveys to estimate degree of compliance with boat washing and how thorough anglers are when conducting their own decontamination, particularly if the use of heated water boat washing is not utilized at the existing boat washing facility.

As previously noted for any of the operational alternatives considered, MAWSS should have no concerns with continuing to allow bank fishing. Particularly if MAWSS elects to limit public access to boaters on Big Creek Lake, opportunities to encourage and support bank fishing could be considered to create more walking trails and fishing areas along Big Creek Lake. MAWSS should explore partnering and funding opportunities with other public and non-profit organizations that could be leveraged to establish walking trails, educational signage and other amenities to encourage bank access at Big Creek Lake. This initiative may require additional security and lighting (power) costs to MAWSS.

5.4 Operational Alternatives Analysis Summary

Regardless of whether MAWSS modifies the existing operation of Big Creek Lake as both a water supply reservoir and a recreational lake, the mitigation and treatment of invasive species will continue. Based on the SOP developed in conjunction with this study and currently implemented by MAWSS, the mitigation and treatment of invasive species using herbicides results in an annual cost of approximately $23,925. This cost will continue as the lake serves as the primary drinking water supply for MAWSS, and as such, this cost should be accounted for in the annual operations and maintenance budget for Big Creek Lake.

Should MAWSS continue to allow boater access to Big Creek Lake, it is recommended that MAWSS implement the use of a heated water boat washing facility which would require full-time, trained staff. As previously discussed, it is anticipated that the annual cost for the operation of a heated water boat washing facility would be approximately $107,500, including both the cost for labor and increased power cost for the heating of the water. Given that approximately 40 to 50 visitors access Big Creek Lake monthly, the current access boater access fee of $10 per visit would need to be increased by more

than 15-fold for MAWSS to recoup the anticipated annual cost for the operation of a heated water boat washing facility.

If MAWSS does not want to incur the cost of the operation of a heated water boat washing facility and is unable to recoup the costs through lake access charges, MAWSS could also consider the use of a third-party vendor for the launch and rental of boats that are dedicated to Big Creek Lake. The viability of this option is market dependent and would require MAWSS to develop a procurement to identify a vendor as there currently no known vendors performing this service for other lakes in the general area.

The most significant way that MAWSS could protect water quality in Big Creek Lake from invasive species is the closing of lake access to non-MAWSS personnel. MAWSS could continue to allow and even identify opportunities to promote bank fishing under this option, but would remove the threat of introducing new invasive species such as zebra mussels into Big Creek Lake. The U.S. State Department has noted that the infestation of zebra mussels as an invasive species could result in over $3 billion in mitigation and control across the country over the next 10 years, making the potential introduction of zebra mussels into Big Creek Lake a threat that MAWSS must consider. Several state agencies have estimated a range of zebra mussel treatment costs based on direct impacts that have been observed in various water bodies in those states. One of the more conservative estimates from the State of Montana Department of Natural Resources projects zebra mussel mitigation and treatment costs are approximately $5.75 per acre-foot per year. As Big Creek Lake is approximately a 17 billion gallon reservoir, the use of this conservative estimate would in approximately $300,000 of annual operations and maintenance costs for MAWSS to address a zebra mussel infestation.

The highest level of protection against new invasive species would be to close watercraft access to Big Creek Lake, but even this option would not completely eliminate the threat of new invasive species developing in the lake.

A summary of estimated annual operational and maintenance costs for MAWSS continued operation of Big Creek Lake and associated revenues generated through permitting access to the lake is included in Table 6 on the following page.

Table 6 – Big Creek Lake Economic Analysis for Annual Costs and Revenues

Big Creek Lake Operational Alternative	Estimated Annual Operational and Maintenance Costs						Total Annual Costs	Estimated Annual Revenue	Net
	Invasive Species Treatment	MAWSS Boat Wash Operator	Power	Security	Landscaping	Misc.			
Status Quo – Current Operations	$25,000	$0	$4,700	$23,000	$11,500	$2,500	$66,700	$17,680	-$49,020
a. MAWSS Operated Boat Launch	$25,000	$82,500	$25,000	$23,000	$11,500	$2,500	$169,500	$17,680	-$151,820
b. Third Party Operated Boat Rentals	$25,000	$0	$4,700	$23,000	$11,500	$2,500	$66,700	$0	-$66,700
c. Close Access to Watercraft - Bank Fishing Only	$25,000	$0	$4,700	$0	$11,500	$2,500	$43,700	$0	-$43,700
d. Close Access	$25,000	$0	$4,700	$0	$11,500	$2,500	$43,700	$0	-$43,700

6 Resources

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A

Appendix A – Herbicide Application Rates for use on Identified and Potential Invasive Plant Species

Helena Agri-Enterprises - Foliar Application Cost Range

Active Ingredient	Alligare	e	Atticus	$/acre	Bayer	$/acre	Corteva	$/acre	Loveland	$/acre	Nufarm	$/acre	Sepro	$/acre	a	$/acre	UPI	$/acre
flumioxazin			Semera-SC	$17.11 - $34.22														
penoxsulam													Galleon-SC*	$42.15 - $118.02				
bispyribac																		
carfentrazone													Stingray*	$17.27 - $68.56				
chelated copper																		
chelated copper																		
diquat															Tribune	$36.88 - $147.50		
endothall																	Aquathol K	$158.27 - $266.56
glyphosate					Round up Custom	$20.00 - $30.00												
imazamox			Castaway	$30.00 - $240.00														
imazapyr											Polaris	$9.82 -						
triclopyr																		
2,4-D																		

*no generics, per UF IFAS

Product	Mfgr	Unit	Price
Castaway	Atticus	gal	$240.00
Semera SC	Atticus	gal	$365.00
Roundup Custom	Bayer	gal	$32.00
Polaris	Nufarm	gal	$78.55
Galleon SC	Sepro	qt	$674.39
Stingray	Sepro	qt	$162.51
Tribune	Syngenta	gal	$73.75
Aquathol K	UPI	gal	$83.30

Active Ingredient	Application Rate (max rec. foliar rate) per acre		Gallon conversion	Quart conversion
flumioxazin	6	fl oz	0.04688	
penoxsulam	2	fl oz	0.01563	0.0625
bispyribac	1	oz		
carfentrazone	3.4	fl oz	0.02656	0.10625
chelated copper (Nautique)	4	gal	4	
chelated copper (Komeen)	3.3	gal	3.3	
diquat	0.5	gal	0.5	
endothall	1.9	gal	1.9	
glyphosate	5	pt	0.625	
imazamox	16	fl oz	0.125	
imazapyr	1	pt	0.125	
Triclopyr	2	qt	0.5	
2,4-D	2	qt	0.5	

Active Ingredient	Application Rate (max rec. foliar rate) per acre		Gallon conversion	Quart conversion
flumioxazin	12	fl oz	0.09375	
penoxsula	5.6	fl oz	0.04375	0.175
bispyribac	8	oz		
carfentrazo	13.5	fl oz	0.10546875	0.42188
chelated copper (Nautique)	12	gal	12	
chelated copper (Komeen)	3.3	gal	3.3	
diquat	2	gal	2	
endothall	3.2	gal	3.2	
glyphosate	7.5	pt	0.9375	
imazamox	128	fl oz	1	
imazapyr	6	pt	0.75	
Triclopyr	8	qt	2	
2,4-D	4	qt	1	

Helena Agri-Enterprises - Submersed Application Cost Range

Active Ingredient	Alligare	$/acre*	Atticus	$/acre**	Bayer	$/acre*	Corteva	$/acre*	Lovelan	$/acre**	Nufarm	$/acre*	Sepro	$/acre**	Syngent	$/acre**	UPI	$/acre**
flumioxazin			Semera-SC	$125.47 - $239.53														
penoxsulam													Galleon-SC*	$231.82 - $1375.12				
bispyribac																		
carfentrazone													Stingray*	$471.28				
chelated copper																		
chelated copper																		
diquat															Tribune	$92.19 - $368.75		
endothall																	Aquathol K	$270.73 - $666.40
~~glyphosate~~					~~Round up Custom~~													
imazamox			Castaway	$164.06 - $323.44														
~~imazapyr~~											~~Polaris~~							
triclopyr																		
2,4-D																		

** Assumes average treatement depth of 2.5 feet

*no generics, per UF IFAS

Product	Mfgr	Unit	Price
Castaway	Atticus	gal	$240.00
Semera SC	Atticus	gal	$365.00
Roundup Custom	Bayer	gal	$32.00
Polaris	Nufarm	gal	$78.55
Galleon SC	Sepro	qt	$674.39
Stingray	Sepro	qt	$162.51
Tribune	Syngenta	gal	$73.75
Aquathol K	UPI	gal	$83.30

Active Ingredient	Application Rate (min rec. submersed rate) per acre-foot		Gallon conversion	Quart conversion
flumioxazin	1.1	pt	0.1375	
penoxsulam	4.4	fl oz	0.0344	0.1375
bispyribac	1.3	oz		
carfentrazone	0.29	gal		1.16
chelated copper (Nautique)	1.8	gal	1.8	
chelated copper (Komeen)	1.7	gal	1.7	
diquat	0.5	gal	0.5	
endothall	1.3	gal	1.3	
glyphosate	NA	NA		
imazamox	35	fl oz	0.2734	
imazapyr	NA	NA		
Triclopyr	0.7	gal	0.7	
2,4-D	1.42	gal	1.42	

Active Ingredient	Application Rate (max rec. submersed rate) per acre-foot		Gallon conversion	Quart conversion
flumioxazin	2.1	pt	0.2625	
penoxsula	26.1	fl oz	0.20390625	0.81563
bispyribac	2.4	oz		
carfentrazo	0.29	gal		1.16
chelated copper (Nautique)	3	gal	3	
chelated copper (Komeen)	3.3	gal	3.3	
diquat	2	gal	2	
endothall	3.2	gal	3.2	
glyphosate	NA	NA		
imazamox	69	fl oz	0.5390625	
imazapyr	NA	NA		
Triclopyr	2.3	gal	2.3	
2,4-D	2.84	gal	2.84	

B

Appendix B – Standard Operating Procedure for Big Creek Lake Invasive Species Monitoring and Treatment

I. PURPOSE

- The purpose of this Standard Operating Procedure (SOP) is to outline the monitoring and treatment of invasive plant species at Big Creek Lake (BCL), primary water supply of the Mobile Area Water and Sewer System (MAWSS).
- For more information, refer to Big Creek Lake Invasive Species Study (prepared in May 2024 by HDR for MAWSS), Section 2.2 – Invasive Species Management Practices.

II. SCOPE

- To specify the frequency and extent of monitoring activities
- To specify the type, dosage and frequency of herbicide applications.

III. RESPONSIBILITY

- BCL Pump Station Operators and contracted licensed operators are responsible for performing this procedure for monitoring and treatment activities.
- BCL Pump Station Operators must notify their Supervisor of any deviation.
- The MAWSS Engineering Department is responsible for the maintenance of this procedure.
- Operators must wear personal protection equipment according to the task to be performed and as specified on the label for the herbicides being applied for treatment, but never less than the minimum requirements established by the MAWSS Safety Department.
- NOTE: It is imperative that watercraft being used to monitor and treatment for invasive species **DO NOT** drive through patches of the invasive species present in Big Creek Lake.

IV. STANDARD PROCEDURES

A. Monitoring

A.1. Monitor Permanent Monitoring Plots (P1 to P62 as identified in the attached site map) once per month

A.2. Complete Work Order Form for each plot inspected.

A.2.1. Record the following information for each plot inspected:

A.2.1.1. Job code, plot ID number , date, time, weather conditions, water temperature

A.2.1.2. Percent cover of giant salvinia within quadrant (absent, minimal, moderate, or significant) within a 1-square meter quadrant

A.2.1.3. Expand species observations within these quadrants to include estimates of percent cover of other invasive species (identified species include parrotfeather, alligator weed, Cuban bulrush, primrose-willow, torpedo grass)

A.2.1.4. Include pictures of inspected areas.

A.2.1.5. Include any additional general comments.

A.3. Complete additional quarterly monitoring events that cover all of Big Creek Lake shoreline areas between plots to identify new problem areas where additional plots may be helpful.

A.3.1. Record the following information for each shoreline area inspected between the permanent monitoring plots:

A.3.1.1. Job code, shoreline area between permanent monitoring plot, date, time, weather conditions, water temperature

A.3.1.2. Percent cover of giant salvinia within the shoreline area (absent, minimal, moderate, or significant)

A.3.1.3. Expand species observations within these shoreline areas to include estimates of percent cover of other invasives (identified species include parrotfeather, alligator weed, Cuban bulrush, primrose-willow, torpedo grass)

A.3.1.4. Record observations of any apparent non-effectiveness of herbicide treatment

A.3.1.5. Include pictures of inspected areas.

A.3.1.6. Include any additional general comments

A.3.1.7. Evaluate conditions of floating booms and consider additional areas where these may prove effective to slow the spread of invasive species (especially where tributaries and creeks flow into Big Creek Lake)

B. Treatment Activities

B.1. Treat plots for giant salvinia once or twice per month depending on time of year and shoreline between plots at least four times per year.

B.1.1. When applying pesticides, the label is the law and must be adhered to.

B.1.2. All applications of aquatic herbicides are the sole responsibility of the licensed applicator contracted to carry out such work.

B.1.3. In addition to plot and shoreline area treatment, perform opportunistic removal of floating giant salvinia plants

B.2. Complete work order forms for each herbicide application activity to record the following:

B.2.1. Job code, plot ID or other location, date, time, weather conditions, water temperature

B.2.2. Checkboxes for additional invasive species known to be present (identified species to date include: parrotfeather, alligatorweed, Cuban bulrush, primrose-willow, torpedo grass)

B.2.3. Identify any other newly found invasive species

B.2.4. Record types and volumes (gallons) of herbicide sprayed for giant salvinia

B.2.5. Include any additional general comments.

C. Treatment Schedule

SPRING	*All Permanent Monitoring Plots of BCL should be visited and treated twice per month of this season. Treatment should occur between plots as well, along the entire shoreline of BCL before summer.* *Biomass has the highest potential to multiply through this season, do not allow any area to go untreated or unmonitored as neglected areas may harbor small infestations that multiply within a shorter timeframe. This material also has the potential to spread to other areas.*

March	All Plots should be treated twice in this month with follow-up treatments after fourteen days, if possible.
	• 1st treatment
	  ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant
	• 2nd treatment
	  ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant

April	Shoreline areas between plots should be monitored, assessed, and invasive vegetation treated. All Plots should also be treated once this month.
	• Shoreline area treatment between plots
	  ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant
	• Plot treatment
	  ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant

May	All Plots should be treated twice in this month with follow-up treatment after fourteen days, if possible.
	• 1st treatment
	  ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant
	• 2nd treatment
	  ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant

SUMMER	*First attend to problem plots or areas identified by monitoring event in spring. Problematic areas would be those where biomass persists despite treatment. If possible, do not allow the remaining, less-problematic plots to go untreated each month.*
June	Prioritize treatment of problematic plots. Base priority of problematic areas off of monitoring reports where plots had highest densities of giant salvinia. With remaining time, treat the remaining less-problematic Plots. • Treatment ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant

July	Prioritize treatment of any problematic areas where monitoring may have identified a significant infestation between established plots. Shoreline areas between plots should be monitored, assessed, and invasive vegetation treated. Once shoreline area between plots have been treated, focus on problematic plots first and (if possible) treat every remaining plot in this month.
	• Shoreline area treatment between plots
	  ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant
	• Plot treatment
	  ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant

August	All plots should be treated once in this month. • Treatment ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant

FALL	*Continue to prioritize problem areas (based on Spring/Summer monitoring reports) through this season where biomass has been shown to persist, either due to recreational activities enabling spread/recruitment or environmental conditions promoting growth.*
September	All Plots should be treated once in this month. • Treatment ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant

October	Shoreline area between plots should be monitored, assessed, and invasive vegetation treated. All plots should also be treated once this month.
	• Shoreline Treatment
	  ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant
	• Plot Treatment
	  ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant

November	This month will likely the last opportunity to deal with larger infestations before average temperature drops and plants move to dormancy over winter. Prioritize areas with the highest concentration of biomass. • Treatment ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant

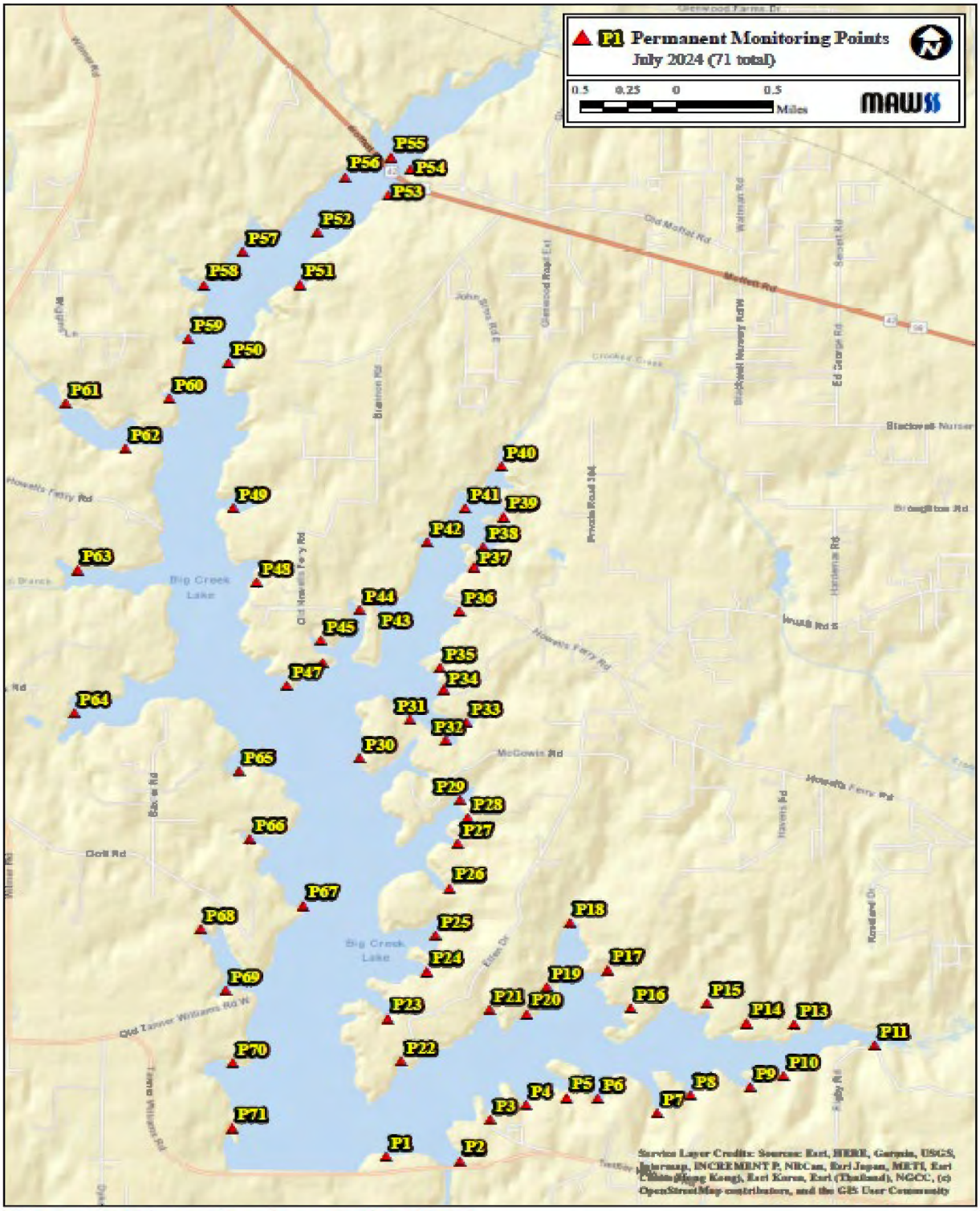
WINTER	*Depending on observations and data collected from plot monitoring, it may not be necessary for each plot (or shoreline areas between plots) to receive treatment each month through winter.* *Herbicide uptake/efficacy will be reduced but so will opportunity for plant growth. Recommend mix of penoxsulam (at max rate as water temperatures below 60°F may limit uptake of herbicide) + carfentrazone + surfactant through winter. To avoid waste of high-cost herbicide containing carfentrazone, only apply herbicides with this active ingredient if water temperature is above 50°F.* *This will be the last opportunity to eliminate living material in neglected or less problematic areas before spring, ensuring these areas will not harbor viable plant material that may be transported to areas with more favorable growing conditions, either by recreational activities or weather patterns that move biomass around.* *Avoid targeting necrotic/senescing plant matter and focus on living material, particularly larger individuals which may persist through freezes.*
December	Monitor entire shoreline and treat invasive vegetation within plots and areas between plots with equal priority. • Treatment ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant
January	Monitor entire shoreline and treat invasive vegetation within plots and areas between plots with equal priority. • Treatment ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant
February	Monitor entire shoreline and treat invasive vegetation within plots and areas between plots with equal priority. • Treatment ○ Penoxsulam (2-5.6 fl oz/acre) + flumioxazin (6-12 fl oz /acre) + nonionic surfactant

V. ATTACHMENTS

Date	Description
7.2024	Giant Salvinia Monitoring Points
7.2024	Current Boom Placement Map

VI. SOP REVISION HISTORY

Date	Version	Action	Revised/Reviewed By
8.2024	01	First Issuance	MAWSS, HDR, Thompson/BVA



Salvina Monitoring Locations (July 18, 2024)

BIG CREEK LAKE BOOM PROJECT VICINITY MAP