LAKE ROAMING ROCK
Short-Term Management Plan

Prepared for:

Roaming Rock Association
1875 U.S. Route 6
Roaming Shores, OH 44085

Project No.: 14299
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Prepared by:

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Authorization for Release

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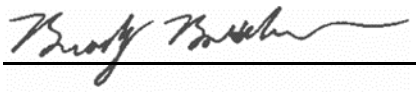
To the best of their knowledge, the undersigned attest that this document and the information contained herein are accurate and conform to EnviroScience's internal Quality Assurance standards.



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1.0 INTRODUCTION

Lake Roaming Rock is a 464-acre impoundment located in Ashtabula County, Ohio. The lake is the centerpiece of a private community of approximately 1,500 residents. Lake Roaming Rock is an outstanding recreational resource and serves as the centerpiece for the community. Recreational activities are important to the community, including boating, fishing, and swimming, and the lake currently provides excellent opportunities for these activities. The lake's watershed drains 66.4 mi^2 (approximately 42,500 acres), with the predominant surrounding land use consisting of agriculture and forest.

Despite its positive features, several related water quality problems exist within the lake. The lake has historically received a steady influx of nutrients, such as nitrogen and phosphorus, from the watershed, owing to the community's agricultural setting. Large amounts of these nutrients—particularly phosphorus—accumulate in the Lake Roaming Rock's sediments, where they are seasonally re-entrained into the water column due to anoxic conditions resulting from the stratification of the lake.

A variety of water quality studies and evaluations have been conducted regarding the lake in recent years, and most of these are summarized and available on the Roaming Rock Association's (RRA) website: www.roamingshores.org. Studies dating back to the late 1970s repeatedly highlight several ongoing issues, including eutrophication and uncontrolled sediment and nutrient inputs from the surrounding watershed. The influx of nutrients and sediment is largely responsible for undesirable conditions which require ongoing management.

After reviewing materials from RRA and the Lake Management Committee, water quality studies, and surveys completed by homeowners, it was determined that the primary concerns listed **in order of importance** include:

1. Excessive Algal Blooms
2. Water Quality – Toxins and Bacteria
3. Excessive Weeds
4. Overall Lake Appearance

After conferring with RRA and other entities' representatives, these concerns were confirmed and highlighted for management purposes. The list above is not comprehensive, but our interpretations represent the major focus in formulating our short-term management recommendations. Likely, there will be overlap with long-term management strategies, but the focus of this document will be on short-term recommendations suitable for implementation during summer 2021. Details for each recommendation will be outlined accordingly in the following sections. Briefly, management options included for consideration as part of the short-term management plan are as follows:

- **Harmful Algal Bloom (HAB) and Nuisance Algae Prevention/Eradication**
  - Whole Lake Chemical Treatments
    - Copper-based algaecides
    - Peroxide-based algaecides
  - Phosphorus Inactivation
    - Targeted phosphorus "removal" – hypolimnetic areas (the deepest, oxygen-depleted parts of a stratified lake)
  - Point Source Nutrient Mitigation
    - Dredging

        - Turbidity curtain
- **Aquatic Weed Control**
    - Targeted nuisance aquatic plant control by herbicide treatment
    - Nuisance aquatic plant control by mechanical harvesting
- **Geese Control to Decrease E.coli Bacterial Inputs in High-Risk Areas (Beaches)**
    - Nest disruption, egg disturbance
    - Harassment – Border Collies
    - Shoreline landscape management

In addition to the management options listed above, we are recommend expanded water quality monitoring and sediment sampling to evaluate the efficacy of the short-term management techniques being implemented and collect information from the lake and tributaries needed for the long-term management plan.

2.0 SHORT-TERM MANAGEMENT OPTIONS

The results gathered to date indicate that Lake Roaming Rock is in a eutrophic state, and this trend has continued over the past two decades. Steady inputs of nitrogen and phosphorus from agricultural sources in the watershed, coupled with the internal loading of phosphorus from the sediment under anoxic conditions, contribute to the increasing eutrophication of the lake. This eutrophication has resulted in more frequent blooms of nuisance and noxious blue-green algae (cyanobacteria). These blooms are not only aesthetically unpleasing but may also pose several other problems if not addressed. These include:

- A reduction of sunlight in the water column making it more difficult for aquatic macrophytes to become established and grow.
- A general depression in dissolved oxygen levels caused by the decomposition of algae as they decay.
- The blue-green algae tend to disrupt the overall food chain and are a much less desirable food source for many zooplanktivorous fish.
- A direct threat to human health from algal toxins sometimes produced by these blue-green algae.

If not addressed, the severity and frequency of blue-green algal blooms in Lake Roaming Rock are likely to worsen in the coming years. The following discussion outlines restoration and management techniques that were evaluated to potentially address the eutrophication-related problems currently occurring in Lake Roaming Rock in the short term (next 12 months). Recommended actions for the short-term time horizon are summarized in Section 3.0. The recommended actions selected are based on weighing feasibility, reliability, and associated cost.

Where possible, the management options presented below include rough estimates for implementation.

2.1 HAB AND NUISANCE ALGAE CONTROL

In discussions with the RRA board, the most common complaint regarding the lake was the frequent blooms of algae. Many management options exist for the control of algae in lakes. These can be broadly categorized as 1) chemical controls, 2) nutrient control techniques, 3) physical controls, and 4) biological controls. Several control techniques may overlap with one or more of these categories. Similarly, some of the techniques may be useful in addressing other problems in addition to nuisance algae. In fact, this was a primary criterion relied upon when selecting potential management options and technologies for

further consideration below. Finally, the management options listed below are not an exhaustive list of possible management options. Rather, they represent only those options believed to be:

- Most applicable to Lake Roaming Rock based on our knowledge of the lake's physical, chemical, and biological characteristics, as well as recreational usage by the community.
- Most feasible given budgetary constraints.
- Most likely to produce rapid and noticeable water quality improvement during summer 2021.

2.1.1 Algaecides

A whole-lake algaecide treatment will be the primary control technique to achieve meaningful, immediate results. Algaecides kill algae in the lake during a targeted activation period based on environmental conditions. The most common and widely used algaecide is copper, a cellular toxicant that comes in a variety of forms. Copper sulfate ($CuSO_4$) and chelated forms of this compound are the most common algaecides in use today and can be used in potable water, though restrictions apply in most states. In alkaline water, hard water, or water having high organic content, copper can be quickly lost from the solution. In these cases, the liquid chelated form is used to allow the copper to remain in the solution long enough to kill the algae. Most algae will be killed by doses of 1 to 2 mg $CuSO_4$/L; however, many blue-green algae species may require larger doses for copper sulfate to be effective.

Although our main recommendation is to utilize algaecides as a tool for 2021 (and likely 2022) as the primary lake treatment, repeated use of copper over time may aggravate algal problems. Cyanobacteria have been documented as developing increasing resistance to $CuSO_4$ over time, and repeated treatments may reduce other more desirable algal species (North American Lake Management Society, 2001). Copper application may also release taste and odor agents into the water column. In killing certain species of the blue-green algae, algaecides may release cellular toxins that can cause human illness, but these typically become inactive or denatured within a couple of days post-treatment. Fish and zooplankton can be particularly sensitive to copper with improper use, and the reduction or loss of these biological groups is detrimental to overall lake health. Finally, long-term use of copper can result in significant accumulations of this toxic heavy metal in the lake sediments. In many lakes that have used copper over a period of decades, the sediment concentration of copper has reached levels where dredged material is deemed a hazardous waste under EPA regulations.

The potential risks listed above can be mitigated with proper application rates and effective implementation based on environmental conditions. Through working discussions with our recommended applicator, Aqua Doc, we have evaluated several chemical treatment options deemed to have the greatest potential.

OPTION 1 – SeClear

SeClear is an EPA-registered copper sulfate pentahydrate algaecide (16.2% CuSO4; 83.8% other ingredients) with a proprietary formula that simultaneously binds and removes some amount of phosphorus from the water column.

- **Whole Lake Treatment (Monthly Applications – June, July, and August) – $89,500.00**

OPTION 2 – Captain XTR

Captain XTR is a widely used, EPA-registered chelated copper-based algaecide (copper ethanolamine complex 28.2%; 71.8% other ingredients) with a proprietary formula that increases copper infusion into algae cells, improving control of certain tough to treat species (mat-forming, colonial, and mucilaginous species).

- **Whole Lake Treatment (Monthly Applications – June, July, and August) – $117,250.00**

OPTION 3 – Phycomycin

Phycomycin is an EPA-registered peroxide-based (85.0% sodium carbonate peroxyhydrate; 15% other ingredients) algaecide. Granular in nature, this formulation is more selective than copper-based herbicides, helps target benthic algae populations, and has none of the negative long-term effects associated with the use of copper-based algaecides.

- **Whole Lake Treatment (Two Treatments) – $252,000.00**

OPTION 4 – VodaGuard C

VodaGuard C is a relatively new EPA-registered copper sulfate pentahydrate (96% CuSO4; 4.0% other ingredients) algaecide packaged in a lipid coating. The lipid coating allows for buoyancy in the water-column, specifically targeting and tracking movements of HAB species with changes in currents, wave action, etc. Materials naturally degrade for a total contact time of approximately 18-48 hours.

- **Whole Lake Treatment (Applications – June and July*) – $43,600.00**
    - $21,800.00/application
    - **Additional August application may be warranted based on efficacy*

OPTION 5 – VodaGuard O

VodaGuard O is also a relatively new EPA-registered peroxide-based (82.45% sodium carbonate peroxyhydrate; 17.55% other ingredients) algaecide, which is also packaged in a lipid coating. The lipid coating allows for buoyancy in the water-column, specifically targeting and tracking movements of HAB species with changes in currents, wave action, etc. Materials naturally degrade for a total contact time of approximately 18-48 hours. As with other peroxide-based algaecides, VodaGuard O has none of the drawbacks usually associated with copper-based algaecides.

- **Whole Lake Treatment (Two Treatments) – $103,600.00**

2.1.2 Phosphorus Inactivation

Although we believe a detailed analysis of phosphorus inactivation is best included as part of EnviroScience's Long-term Management Plan, we are including some information below as it may be possible to implement a phosphorus inactivation program this year should the RRA board be interested in doing so.

Phosphorus inactivation controls algae by limiting phosphorus availability in the water column. It is also important to recall that there are two major sources of biologically available phosphorus. The first is phosphorus flushed into the lake from the watershed, and the second is the internal release from the sediments under anoxic conditions. Phosphorus inactivation can help reduce the amount of phosphorus in the water column and its release from the sediment, but it may do little to control the continued influx from the watershed.

Reduction of phosphorous in the water column is accomplished by using chemicals to precipitate phosphorus from the water column and by adding a binder to prevent the release of phosphorus from the sediments, in effect forming a cap on the sediment surface. The most commonly used chemical for this purpose is aluminum sulfate (or alum). Often applied in a buffered form at the water surface at a rate between 100 and 500 pounds per acre, alum forms a nontoxic precipitate that scavenges phosphorus as it settles through the water column. When used in an appropriate dose, a thin layer of aluminum hydroxide will cover the sediments and continue to tie up phosphorus as it is released from lake sediments.

Nutrient inactivation has received increasing attention over the last decade as long-lasting results have been demonstrated in many projects (North American Lake Management Society, 2001). The longevity of

phosphorus inactivation treatments has generally been excellent where external inputs of phosphorus have been controlled. Suitable candidate lakes for phosphorus inactivation have low external nutrient loads and high internal phosphorus release from the sediment. Where significant nutrient inputs from the watershed exist, algal blooms may still result. If the external nutrient inputs from the watershed can be controlled, or further studies demonstrate that the external nutrient loading is relatively small compared to internal loading, phosphorus inactivation may prove a viable treatment option.

OPTION 1 – Alum

Aluminum sulfate removes phosphate through precipitation (floc). The thin layer of floc helps cap and further bind phosphorus released from the sediment.

- **Whole Lake Treatment – $1M+***

OPTION 2 – Phoslock

Phoslock is a modified bentonite clay product containing lanthanum, a naturally occurring earth element. The patented materials bind with phosphorus, "locking" it in the sediment permanently.

- **Optimum Treatment:**
  - **Whole Lake Treatment Based on Vertex Model – $5.6M+***
- **Cumulative Treatment:**
  - **Two – 100# Phoslock Treatments – $140,000+***

***estimates based on current information; to be reassessed accurately upon LRR approval*

2.1.3 Point Source Nutrient Mitigation – Dredging Activity

In 2021, operations expect to continue dredging the near-shore "south end" of the lake and "Spanish Cove" of Lake Roaming Rock. Dredging operations at Lake Roaming Rock are crucial for lake navigation and access for homeowners but disturb the natural sedimentation and capping of nutrients (phosphorus) that have settled over time. Legacy phosphorus is resuspended with every load of sediment taken from the bottom. Data collected by the Lake Management Committee clarifies that this operation is negatively impacting lake water quality. Although the dredging operation is important to many homeowners on the lake, this point source of nutrients must be controlled if a meaningful reduction in algal blooms is to be accomplished in 2021. We believe this crucial operation can continue by implementing the best management practice of using a turbidity curtain.

A turbidity curtain, also commonly referred to as a turbidity barrier, silt barrier, or silt curtain, is used to contain turbidity (sediment and silt) stirred up by construction activities taking place in or near bodies of water, dredging operations, and rainwater runoff. Floating turbidity curtains have a series of continuous flotation elements along their top and a fabric skirt hanging below the floats. The skirt is typically long enough to be within one foot of the bottom. It can be used to contain various turbidity, including the release of organics, into the water column.

- **ABASCO Type 2 Heavy Duty Turbidity Curtain – $9,708.00***
  - 300 ft length (6-50 ft sections)
  - 20 ft adjustable skirt depth with furling lines
  - Floats
  - 22 oz coated PVC fabric

*quote based on parameters listed; length of curtain may need adjustment based on operator input

Although the use of a turbidity curtain will impede the dredging operation and may result in the need for an additional dedicated person and increase costs, we believe that diligent use of a silt curtain is of critical importance to overall lake water quality and the success of the other recommendations contained in this report.

2.2 AQUATIC WEED CONTROL

A balanced and healthy native plant community is critical to the ongoing health of Lake Roaming Rock. The benefits associated with promoting a healthy plant community are numerous and include:

- Stabilizing bottom sediments
- Oxygenating water
- Providing refuge for zooplankton, aquatic insects, and small fish
- Providing food and habitat for waterfowl and other wildlife

Additionally, because aquatic plants compete for and tie up substantial amounts of nutrients in the lake, a healthy plant community can help control nuisance algae problems.

OPTION 1 – Targeted Herbicide Application

AquaDoc has been working with individual homeowners for the treatment of aquatic macrophytes along their shorelines and docks. Homeowners have been receptive to the treatments, and we recommend continuing the program as was discussed with the RRA board.

- **AquaDoc Targeted Aquatic Plant Management – Priced by individual lot and paid by homeowners**

OPTION 2 – Mechanical Harvesting

The RRA owns and operates a mechanical harvester. Unlike herbicides, harvesting is generally non-selective and can negatively impact fish and amphibian populations. Although the mode and frequency of operation are unknown at present, harvesting may be compatible with targeted herbicide application and be conducted in an environmentally sound manner provided the following guidelines are adhered to:

- Use is restricted to the limited control of lily pads impeding boat traffic.
- Areas dominated by Eurasian watermilfoil are avoided, as fragmentation caused by the harvester can increase the rate of spread of this invasive species.
- Harvesting is not conducted in shallow water areas to avoid disturbance of sediment.
- As many cuttings as possible are removed from the lake.

2.3 GEESE CONTROL

A single goose can produce up to 1-3 lbs of droppings per day, which deters recreational activities, can contribute to *E. coli* levels, and is a source of excess nutrient loading to the lake. In relation to Lake Roaming Rock, annual reports to the RRA board from recent years have indicated periodic elevated levels of E. coli, with goose excrement as a possible source of this pollution. Geese control is recommended to remedy this variable for the major recreation season June-August. Canada geese are federally protected under the Migratory Bird Treaty Act of 1918. Birds and their eggs or nests cannot be harmed or destroyed (as well as a host of other actions) without federal and state permits. Working within these limitations, some strategies can be implemented effectively in areas of primary recreation (beaches, public docks, etc.).

OPTION 1 – Harassment

Geese harassment does not harm the birds but disturbs them so they leave to graze, roost, and nest elsewhere. As no harmful techniques are used, neither federal nor state permits are required. Repetitive canine patrols can provide a means of keeping recreational areas clean and clear of goose droppings, potentially decreasing direct influent sources of E. coli.

- **Trapper Bob's Nuisance Trapping & Goose Control LLC – $60.00/day**
  - Estimated Minimum – $1,800.00 (4 Weeks Intermittent)
  - Estimated Maximum – $5,400.00 (Daily – June, July, August)

OPTION 2 – Shoreline Landscape Management

The preferred habitat for geese around a lake is maintained turfgrass free from access obstructions. Strategic placement of riparian buffers with natural prairie or ornamental grasses can provide functions for nutrient runoff control and geese deterrent. EnviroScience's restoration group can work with individual homeowners or provide workshops in implementing successful riparian buffers for the lake community.

- **EnviroScience Restoration Services – Cost TBD based on community interest**
  - EnviroScience Community Workshop (1/2 day) – ~$2,000.00-3,000.00 depending on options such as on-site demonstrations, take-way materials, etc.

2.4 ADDITIONAL WATER QUALITY / SEDIMENT MONITORING

Collecting information about the lake and its immediate watershed is essential to developing any management plan for the lake. Biological and chemical parameters outlined in the Lake Roaming Rock proposal will be implemented in addition to sediment sampling at six sites to inform management decisions involving the use of phosphorus binding agents. Both water chemistry and biological parameters will be monitored at two historically sampled lake sites (mid-lake and dam) as well as the four influent streams: Rock Creek (UST Rt. 6 Bridge), Plum Creek, Sugar Creek, and the unnamed tributary that flows into Fisherman's Cove.

- **Additional Sediment Sampling (6 Sites) – ~$4,500.00, including sample collection costs**
  - Seasonal Hypolimnetic Sediment P Species Analysis
  - One-time sediment analysis from depths greater than 10 ft
    - Two – Level 1 Analysis - $265.00/sample
    - One – Level 2 Analysis - $500.00/sample
  - One-time sediment analysis from upper reaches of reservoir depths less than 10 ft
    - Two – Level 1 Analysis - $265.00/sample
    - One – Level 2 Analysis - $500.00/sample

3.0 CONCLUSIONS AND RECOMMENDATIONS

Recommendations for short-term management and treatment options for 2021 are described below. These options have been selected to mitigate current issues at Lake Roaming Rock that impair beneficial uses, considering cost and their potential for success. Our rationale for recommending each option is provided.

1. **Implement a whole-lake VodaGuard C algaecide treatment program –** Although we have no direct experience with this product, this is the recommended treatment option of Aqua Doc, and they do have at least limited experience applying it in Northeast Ohio. Aqua Doc is familiar with the application requirements, and both they and the manufacturer believe that two applications will likely be enough for season-long control. We note that this is the least expensive option, and although we would have preferred the use of a peroxide-based algaecide for environmental

reasons, we believe that a copper-based based formulation can be safely used for a limited number of years.

SeClear was also viewed as an attractive option due to its proven track record in the industry and its ability to bind and remove soluble phosphorus from the water column. It may also still be an option if the results of the first VodaGuard C application prove unsatisfactory. Uncertainty regarding how much phosphorus would be removed and the significantly higher cost per application make SeClear our second-best choice for implementation in 2021.

2. **Delay consideration of a large-scale phosphorous inactivation program using alum or Phoslock until it can be more thoroughly evaluated as part of the Long Term Management Plan –** Although a large-scale phosphorus inactivation program could possibly be implemented in 2021 and has great potential to provide long-term control of HABs, a great deal of uncertainty exists regarding how much phosphorus is in the sediments and how much will continue to enter from uncontrolled watershed sources. Additionally, very high implementation costs make it unlikely that a project is affordable in 2021, based on our discussions with the Lake Management Committee.

   Despite these constraints, we believe a limited amount of additional funds should be budgeted to collect additional water quality, sediment, and flow information necessary to design and price a phosphorus inactivation program for future implementation. We will provide detailed rational and estimated costs for this additional sampling in a separate document.

3. **Control sediment dispersion from dredging operations using a turbidity curtain –** Data collected by the Lake Management Committee in 2020 demonstrates that dredging in the coves elevates phosphorus levels in the main lake. We expect this impact to be even greater while dredging along the southern shores north of the Route 6 bridge. In addition to the up-front cost of the curtain, increased labor costs will likely be incurred based on our discussions with Randy Ruebel, who directs this operation. Nevertheless, we believe the use of a sediment curtain that completely surrounds the dredging operation and extends from the water surface to the sediment surface is critical. Failure to do so could jeopardize the success of the algae control efforts recommended for implementation this coming summer.

4. **Proceed with a targeted herbicide-based weed control program developed by Aqua Doc and limit mechanical harvesting to lily pad control in areas where they interfere with boat traffic –** We believe that a targeted control program involving a limited number of shoreline properties and docks can be conducted in an environmentally responsible manner using products recommended by Aqua Doc including ProcellaCOR, a fast-acting systemic herbicide which should effectively provide long-term control for nuisance aquatic weeds. Further, we believe that a moderate increase in the percentage of shoreline being treated compared to 2020 levels can be permitted without serious negative impacts on the overall system. We are also of the opinion that mechanical harvesting can be safely used in conjunction with Aqua Doc's effort to control lily pads that interfere with boat traffic, provided the guidelines included above are followed.

5. **Implement a geese management option such as egg disturbance (shaking) or harassment while simultaneously developing an educational program for the community –** We believe that geese control options such as egg shaking (requires permits from the Ohio Department of Natural Resources) or harassment by trained dogs can be a cost-effective, short-term control option. However, we also believe that additional effort should be directed toward community education on homeowner-based control techniques, including shoreline plantings and vegetative buffers, to discourage grazing and nesting. We would suggest a half-day workshop supplemented

by recorded and printed material. This workshop could also incorporate erosion control and shoreline erosion prevention measures. EnviroScience will provide details regarding such a program along with estimated costs upon request.

4.0 LITERATURE CITED

North American Lake Management Society and Terrene Institute. (2001). Managing Lakes and Reservoirs. 3rd ed. *North American Lake Management Society*.