Adaptive Management and Corrective Actions

Vegetation Management During Construction

During active construction, it will be necessary to monitor and actively manage vegetation on site to ensure the long-term success of the constructed habitats on the CHEERS project site. The primary management goals during this phase will be to stabilize the site against erosion and prevent the establishment of non-native, invasive vegetation. Monitoring and removing trash and debris from the site during the construction period is also necessary; trash and other debris may accumulate throughout the construction area as dredge material is being placed.

Dredge material inherently contains a variety of native and non-native seeds and vegetative fragments and can introduce invasive vegetation. Additionally, the disturbed nature of the site facilitates the establishment of invasive vegetation from adjacent populations and from material transported to the site by vehicles, equipment, wildlife, and other external sources. As each phase is constructed, the site should be monitored for invasive vegetation, and treatment methods should be implemented consistently using the recommended treatment method(s) for the species found. Vegetation monitoring should include the breakwater structure, upland and riparian areas, and aquatic habitats such as open water, submergent marsh, and shallow emergent marsh, where invasive aquatic vegetation can rapidly establish.

During construction, the site should be stabilized with a grass-only mix and/or an annual cover crop, such as *Avena sativa* (annual oats) or *Secale cereale* (annual rye). Cover crops can be applied annually on areas that will have ongoing dredge placement or grading. Once an area has been graded or left to settle for more than a year, a more permanent seed mix should be installed; Table 1 provides recommended seed mixes. Use of grass-only mixes will allow the use of broadleaf-selective herbicides to control most invasive species; however, some non-selective herbicides will be necessary to control invasive species in the graminoid classification. Many grasses and sedges also have extensive root systems that support soil stabilization, filtration, and improved soil health.

Table 1. Grass-Only Seed Mix Recommendation for Site Stabilization During Construction Only

Mix Name	Scientific Name	Common Name	Percent of Mix
UPL Native Grass Mix	*Elymus virginicus*	Virginia wildrye	35%
	Panicum virgatum	Switchgrass	25%
	Sorghastrum nutans	indiangrass	20%
	Andropogon gerardii	big bluestem	20%
FACW Wetland Native Mix	*Carex vulpinoidea*	fox sedge	27%
	Carex lurida	lurid sedge	26%
	Elymus virginicus	Virginia wildrye	24%
	Carex scoparia	blunt broom sedge	18%
	Juncus effusus	soft rush	5%

Monitoring activities should occur two to three times per year, during and post-construction, to capture the various species as they emerge and before they become readily established. Treatments should follow a similar schedule each year. Annual monitoring and treatment activities should generally occur as outlined in Table 2.

Table 2. Suggested Monitoring and Treatment Schedule for Invasive Species

Timeframe	Action Item	Target Species
April/May	Initial monitoring event	Reed canary grass, thistle, etc.
May/June	Initial herbicide treatment	
June/July	2nd monitoring event	Purple loosestrife, common reed, cattail, etc.
July/August	2nd herbicide treatment	
August	3rd monitoring event	Common reed, tree-of-heaven, multiflora rose, etc.
September	3rd herbicide treatment	

Following invasive vegetation treatments, areas with exposed soil should be reseeded with either a temporary cover or a permanent seed mix, depending on the construction phase, to provide stabilization. Seed mixes are typically installed in the spring or fall; however, cover crops can be applied at any time during the growing season to provide temporary stabilization.

Herbaceous plants and shrubs may become established on the breakwater structure, as desired by the owner; however, all invasive and non-native plants should be managed on the breakwater structure to prevent further spread and establishment. All large shrubs and trees should be cut and treated to prevent root growth, as the larger root structures of shrubs and trees could negatively impact the structural integrity of the breakwater structure.

Given the nature of this type of project, it may take several years for the dredge materials to reach final capacity and grade, making it likely that novel invasive species will occur over the course of the project. Table 3 lists some prevalent invasive species that may be encountered during monitoring and treatment; however, this list is not all-inclusive and should be updated over time to include additional species identified within the project area, their appropriate treatment windows, and effective treatment methods.

Additionally, aquatic invasive plants, floating or submergent, if observed during the construction phase, should be manually removed or treated with an aquatic-safe herbicide, following all state and federal regulations. Always consult the herbicide label on the container to determine what restrictions apply. Floating aquatic vegetation can be managed by mechanical removal, either by using a harvester or by hand, allowing the material to dry and be disposed of properly.

Table 3.- Invasive Species Recommendations

Scientific Name	Common Name	Habitat Types[1]	Herbicide[2]	Time of Year	Treatment Method(s)	Recommended # Treatments per Year
Ailanthus altissima	tree of heaven	SS, U	G, T	late summer - late fall	foliar, basal bark, or hack and squirt	1
Berberis spp.	Japanese and common barberry	SS, U	G, T	fall/winter (cut-stump), summer/fall (foliar)	foliar, basal bark and/or cut-stump	2
Butomus umbellatus	flowering-rush	SM, EW	G	summer/fall	foliar	2
Celastrus orbiculatus	Oriental bittersweet	SS, U	G, T	fall/winter (cut-stump), summer/fall (foliar)	foliar, basal bark and/or cut-stump	2
Cirsium arvense	Canada thistle	SS, U	A, C	spring, fall	foliar	1
Conium maculatum	poison hemlock	SS, U	G, I	spring, summer	foliar, mechanical (mow)	1-2
Coronilla varia	crown vetch	SS, U	A, C	spring, summer, fall	foliar	1-2
Dipsacus spp.	teasel	SS, U	A, C	spring, summer, fall	foliar	1-3

Elaeagnus umbellata	autumn olive	SS, U	G, T	late summer/ early fall (all methods), fall/winter (cut-stump/basal)	mechanical (forestry mower), foliar, basal bark and/or cut-stump	2
Hydrocharis morsus-ranae	European frog-bit	SM, EW	Other	spring - summer	mechanical, chemical	2
Ligustrum vulgare	European privet	SS, U	G, T	late summer/ early fall (all methods), fall/winter (cut-stump/basal)	mechanical (forestry mower), foliar, basal bark and/or cut-stump	2
Lonicera japonica	Japanese honeysuckle	SS, U	G, T	late summer/ early fall (all methods), fall/winter (cut-stump/basal)	mechanical (forestry mower), foliar, basal bark and/or cut-stump	2
Lonicera spp.	bush honeysuckle	SS, U	G, T, I	late summer/ early fall (all methods), fall/winter (cut-stump/basal)	foliar, basal bark and/or cut-stump	1-2
Lythrum salicaria	purple loosestrife	EW, SS	G, T	mid-summer	foliar, limited hand-pulling	1
Microstegium vimineum	Japanese stiltgrass	SS, U	G	late summer prior to seed	foliar, mechanical removal	2
Phalaris arundinacea	reed canary grass	SS, U	G	early spring – fall	foliar	2
Phragmites australis	common reed	EW, SS, U	G, T, I	late summer – early fall	foliar	2-3
Polygonum cuspidatum	Japanese knotweed	SS, U	G, T	late summer - early fall	foliar, mechanical (bag cut material, do not mow or mulch)	2-3
Potamogeton crispus	curlyleaf pondweed	SM, EW	Other	spring (herbicide), summer to fall (mechanical)	herbicide, mechanical	1-2
Pyrus calleryana	callery pear	SS, U	G, T	late summer/ early fall (all methods), fall/winter (cut-stump/basal)	foliar, basal bark and/or cut-stump	1-2
Rhamnus spp.	common and glossy buckthorn	SS, U	G, T	late summer/ early fall (all methods), fall/winter (cut-stump/basal)	foliar, basal bark and/or cut-stump	1-2
Ranunculus ficaria	lesser celandine	SS, U	G	March-May	foliar	1
Rosa multiflora	multiflora rose	SS, U	G, T	late summer/ early fall (all methods), fall/winter (cut-stump/basal)	foliar, basal bark and/or cut-stump	1-2
Typha angustifolia, T. x *glauca*	narrowleaf and hybrid cattail	SM, EW, SS	G, I	late summer – early fall	foliar	1-2

[1] Submergent Marsh (SM), Emergent Wetland (EW), Shoreline Slope (SS), Upland (U)
[2] Glyphosate (G), Triclopyr (T), Imazapyr (I), Aminopyralid (A), Clopyralid (C)

Vegetation Management Post-Construction

As each phase of the project is complete and the final grade is achieved, transition to permanent native cover for the designed habitat type should be made. Each of these habitat types will require vegetation management techniques and corrective actions to maintain the desired habitat type, including management of native and non-native vegetation and wildlife. All areas will follow a monitoring and maintenance schedule similar to that during the construction phase, but with a more targeted approach. This adaptive management plan should be reviewed and updated at regular intervals, as determined by the project partners, to ensure that any new invasive species are recorded and that impacts from changes in lake levels, climate, or other factors are addressed.

Although not a habitat type, vegetation management of the breakwater structures is essential to ensure structural integrity. As mentioned in the construction phase, as desired by the owner, herbaceous plants and shrubs may become established on the breakwater structure. Invasive and non-native plants should be managed throughout the breakwater structure to prevent further spread and establishment within the project area. All large shrubs and trees, native or non-native, should be cut and treated to prevent root growth, as the larger root structures of shrubs and trees have the potential to negatively impact the structural integrity of the breakwater structure.

Submergent Marsh

This habitat is essential for freshwater fauna. These habitats should be regularly monitored for aquatic invasive species, and corrective actions should be taken, including chemical or mechanical methods. Best management practices include regular treatment and/or removal of any observed invasive vegetation. Caution should be used when using mechanical methods, as many aquatic invasive species propagate through vegetative fragments. Additionally, caution should be used when using chemical treatments. Treatments should be well thought out with an ecologist to prevent overapplication, resulting in negative consequences of fish kills.

Table 4. Submergent Marsh Corrective Actions

Triggering Condition	Corrective Action
Any invasive vegetation detected	Conduct targeted herbicide applications and/or mechanical removal.
Trash accumulation	Conduct trash removal and disposal activities as needed.

Shallow Emergent Marsh

This habitat area is prone to aquatic invasive vegetation and should be closely monitored to prevent potential spread into the marsh habitat. Encouraging the establishment of native submergent, emergent, and floating vegetation in these areas will help reduce the potential for invasive vegetation establishment. Other potential management needs include monitoring and removing trash and debris from these areas, as they may accumulate along shorelines.

Depending on water levels, aquatic and upland invasive species can become problematic. Due to accessibility, wetlands can become inundated with stands of phragmites, cattail, purple loosestrife, reed canary grass, flowering rush, etc. Many of these species are susceptible to disturbance dispersal, such as the breaking of nodules in the soil or the breaking of rhizomes, which promotes new plant colonies elsewhere. Given the number of sensitive wetland species, protective measures should be implemented when treating areas with herbicides. Such methods include, but are not limited to, herbicide shielding, hand wicking, and injection.

If any aquatic invasive vegetation is detected during monitoring, control efforts should be made using the recommended treatment method(s) for the species found, including herbicide application and mechanical removal. Some of the potential triggers and corrective actions for this habitat type are listed in Table 5.

Table 5. Shallow Emergent Marsh Corrective Actions

Triggering Condition	Corrective Action
Any invasive aquatic vegetation exceeds 10%	Conduct mechanical or targeted herbicide treatments using the information in Table 3 above for the species of concern.

Trash accumulation	Conduct trash removal and disposal activities as needed.

Shoreline emergent

Plant communities contiguous to and affected by the surface and subsurface hydrology of Lake Erie. During establishment, communities of phragmites, cattail, purple loosestrife, etc., are capable of outcompeting native species. Encroachment of invasive species may be more prevalent once the soil structure has more time to develop.

Prior to the installation of any vegetation, these habitats should be heavily treated for invasive vegetation to reduce competition. Install riparian species to achieve high native plant density. Installing a wetland ground cover that will not interfere with shrub establishment will help stabilize the site and prevent excessive invasive vegetation from establishing during this phase. Establishment can be further enhanced by planting multi-aged trees and shrubs. Utilizing a combination of plant ages and sizes mimics natural succession in riparian habitats.

During early successional phases, when tree and shrub cover is sparse and immature, invasive vegetation control will be critical for establishing a healthy riparian habitat. Control can be achieved using targeted herbicide applications based on Table 6.

Table 6. Shoreline Emergent Corrective Actions

Triggering Condition	**Corrective Action**
Invasive vegetation cover exceeds 10%	Conduct targeted herbicide applications using the information in Table 3 above for the species of concern.
Trash accumulation	Conduct trash removal and disposal activities as needed.

Meadow

These habitat areas should be managed to promote native, herbaceous vegetation and prevent the establishment of woody and invasive vegetation. Weed control is critical during the first three years after planting. Maintenance will be reduced once the vegetation is established and native plants dominate the site. Appropriately timed mowing and herbicide applications can provide weed control during the establishment period. Understanding plant life cycles will help determine the timing of management activities.

Monitor between May and June to identify problems such as emerging noxious weeds or woody vegetation. During the first two growing seasons, it is essential to prevent weeds from setting seed by mowing at a height of at least 8 inches from May to July. Mow before weeds reach 16 inches and do not allow them to exceed 18 inches or form seed heads. Large amounts of cut vegetation can smother newly planted natives; therefore, it is essential to mow before the biomass forms a thick thatch layer when mowed. Repeat mowing until the native vegetation reaches 6 to 8 inches in height. Once this occurs, continue weed monitoring and maintenance using targeted herbicide applications.

In the third year of establishment, complete monitoring as above and mow as short as possible just before the start of the growing season in February/March to remove the thatch layer. Conduct targeted herbicide applications in June/July and August/September to control invasive and woody vegetation.

Long-term management should include ongoing monitoring and targeted herbicide treatments as needed to control invasive and woody vegetation. Once a site is established, mowing frequency should be reduced

to once every 2 to 3 years to maximize benefits to vegetation and wildlife diversity. Mowing height should always be set to 8 inches or higher, and a flushing bar can be used to avoid direct impacts on pollinators and other wildlife. Mowing should be avoided during the primary wildlife reproductive period of March 1 through July 15. If possible, prescribed burning can be used in lieu of mowing.

Prescribed burning is the ideal method to suppress woody plant encroachment and manage thatch accumulation over time. It also offers additional benefits, including stimulating the growth of many native plants above and below ground, promoting substantial root development, solarizing the soil to promote seed germination, giving native warm-season plants an earlier start, and recycling nutrients back into the soil. Prescribed burning is typically conducted in the spring or fall, between February and March or September and November, and should be repeated every 2 to 3 years.

Corrective actions should be taken if the invasive and/or woody vegetation cover exceeds the established monitoring thresholds for these habitats. There are various triggers for implementing corrective action; the most prevalent are listed in Table 7 below.

Table7. Meadow Corrective Action

Triggering Condition	**Corrective Action**
Woody vegetation cover exceeds 10%	Conduct targeted herbicide applications using basal bark or cut-stump methods to minimize impacts on native vegetation.
Invasive vegetation cover exceeds 10%	Conduct targeted herbicide applications using the information in Table 3 above for the species of concern.
Bare ground exceeds 5%	Overseed/frost seed bare areas with the original seed mix or a variation based on survey information (*i.e.*, if forb cover is low, overseed with a forb-only mix).
Native forb coverage drops below 40%	Mow and/or spray areas with grass-dominant cover and overseed with a forb-only seed mix.

Wildlife Management During Construction

As with any aspect of CHEERS, wildlife should be thoughtfully managed throughout the project. Actions should be grounded in research-based scientific knowledge, taking into account population ecology, habitat selection, and/or behavior. Potential issues may arise during and post-construction, including wildlife abundance, damage, mortality, disease, and other human-wildlife conflicts. Swift adoption of site-specific management practices is essential to mitigate conflicts while maintaining a balance with habitats, wildlife, and stakeholders. The holistic approach to wildlife management for mitigating damage should aim to increase the value of wildlife as a community resource while protecting its future benefits.

Wildlife populations will rise and fall with changes in their habitat, including food and water availability, access to shelter/cover, and predator abundance. As these demographics change, environmental stressors can increase or decrease, potentially altering the site's dynamics. Such changes to the landscape on a microscale, such as the CHEERS project, will become noticeable. These can manifest as wildlife damage to native vegetation and/or infrastructure, creating conflict among all stakeholders.

Wildlife damage can reduce native vegetation, opening the way for infestations of non-native or other pest species through selective foraging or infrastructure damage. Therefore, during site construction and vegetation establishment, efforts should be made to prevent wildlife damage. Actions include wildlife deterrence through habitat manipulation, vegetation selection, and the implementation of

exclusionary methods, such as caging or fencing, for carp, geese, and deer. By reducing nuisance wildlife populations, property managers can mitigate future conflicts. Examples of wildlife that can be nuisances include carp, geese, ducks, deer, beavers, muskrats, voles, and moles.

Overall, during construction and vegetation establishment, wildlife management must be considered. Wildlife management and techniques should be planned prior to allowing adaptation to changing conditions. This can be done by monitoring wildlife damage to vegetation communities and extrapolating information from vegetation monitoring data.

Preliminary Contingency Plans

The project intends to improve shoreline resilience, establish habitat, and provide a park space adjacent to Lake Erie. If the project areas are not performing as proposed by the end of the fifth year of post-construction monitoring, the monitoring period may be extended, and/or it may be necessary to develop and implement a corrective action plan.

Annual monitoring may still be performed following year five at the option of the project Partners or if the project has not met project goals as described in the Performance Metrics section. If significant corrective actions are proposed by the project Partners following year five, the monitoring and annual reporting will continue until performance metrics are met for two consecutive years.

Performance Metrics

Based on the proposed site grades, a variety of habitat types, ranging from open water to wetlands and upland woodlands, are anticipated to be established on the site. Changes in Lake Erie water levels and energy regimes may alter the distribution of habitat zones within the open water, shallow near shore, scrub/shrub, and emergent wetlands in response to naturally occurring conditions.

The following performance metrics are proposed to assess the need for additional adaptive management of the CHEERS site. The metrics address the stability of the perimeter breakwater, invasive vegetation management, and establishment of native vegetation. Within five years after the completion of construction of Phase I, the site should achieve the following metrics:

1. Healthy native plants are present and in good condition. Bare ground areas should be limited to 5% or less. Desired species will be determined from the construction plans and will vary by habitat type.

2. Planted trees and shrubs are healthy and free of disease and/or pests.

3. There will be less than 20% relative cover of invasive plant species within the restoration areas. These species will be managed through active invasive plant control methods, as necessary. In some cases, the cover of invasive vegetation common in restored areas may exceed this threshold early in site development until woody vegetation is established and a canopy develops.

4. The perimeter breakwater will be stable. Deterioration of the perimeter breakwater would allow increased wave energy to reach the project interior, increasing the risk of damage to the interior structures, grading, and vegetation. The condition of the perimeter breakwater will be inspected annually by a professional engineer registered in the State of Ohio, with experience in the design and inspection of similar structures. If, in the professional engineer's opinion, a portion of the

breakwater structures has deteriorated in a manner that would significantly increase the risk to the project's success, corrective measures will be recommended.

Monitoring Criteria

Annual monitoring is proposed for 5 years following construction completion. The data outlined in Table 8 shall be collected each year. If the site is meeting performance metrics for two consecutive years prior to Year 5, successive monitoring years will not be required.

Table 8. Annual Monitoring Tasks

TASK	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
As-built Report	X									
Vegetation Monitoring	X	X	X	X	X	X	X	X	X	X
Topographic/Hydrographic Survey	X	X			X					X
Structural Assessment	X	X	X	X	X					

Monitoring Methodology

Vegetation

Monitoring is designed to evaluate plant composition, cover, and wildlife habitat values. To monitor vegetation, monitoring points will be established within different projected habitat types and permanently marked for future monitoring by staking the center of each plot with ultraviolet light-resistant polyvinyl chloride stakes.

Information regarding plant species composition and percent cover at each monitoring point will be collected during the site visits. Areal cover of invasive plant species will be determined through a combination of cover at the monitoring points, GPS mapping, and visual observation.

Topographic and Hydrographic Surveys

Performing topographic and hydrographic surveys will provide a comparison of site conditions to the as-built survey performed after construction. The surveys will also allow periodic comparisons of site conditions to document the site's stability. Survey drawings will be submitted with the data represented by 1-foot contours.

Structural Assessments

The perimeter breakwater will be inspected for signs of deterioration, including displaced armor stone, exposed core or filter stone, fractured stone, or uneven settling of the structure. The assessment will include only a visual inspection. Multi-beam sonar or diving inspections are not anticipated to be required.